Dell PowerConnect W-Series ArubaOS 6.1

User Guide

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Contents

Figures

Tables

This User Guide describes the features supported by ArubaOS and provides instructions and examples for configuring controllers and Access Points (APs). This chapter covers:

Audience

This guide is intended for system administrators responsible for configuring and maintaining wireless networks and assumes you are knowledgeable in Layer 2 and Layer 3 networking technologies.

Fundamentals

Throughout this document reference are made to controllers; controllers categories are based on architecture:

- MIPS Controllers—W-6000, W-3000 Series, W-600 Series

Configuring your controller and AP is accomplished using either the Web User Interface (WebUI) or the command line interface (CLI).

WebUI

Each controller supports up to 22 simultaneous WebUI connections. The WebUI is accessible through a standard Web browser from a remote management console or workstation. The WebUI includes configuration wizards that step you through easy-to-follow configuration tasks. The wizards are:

- AP Wizard—basic AP configuration
- Controller Wizard—basic controller configuration
- LAN Wizard—creating and configuring new WLAN(s) associated with the "default" ap-group
- License Wizard—installation and activation of software licenses

In addition to the wizards, the WebUI includes a Dashboard monitoring feature that provides enhanced visibility into your wireless network's performance and usage. This allows you to easily locate and diagnose WLAN issues. For details on the WebUI Dashboard, see Chapter 13, "Dashboard Monitoring" on page 339.

CLI

The CLI is a text-based interface accessible from a local console connected to the serial port on the controller or through a Telnet or Secure Shell (SSH) session.

NOTE: By default, you access the CLI from the serial port or from an SSH session. You must explicitly enable Telnet on your controller in order to access the CLI via a Telnet session.

When entering commands remember that:

- commands are not case sensitive
- the space bar will complete your partial keyword
- the backspace key will erase your entry one letter at a time
- the question mark (?) will list available commands and options

Related Documents

The following items are part of the complete documentation for the Dell user-centric network:

- *Dell PowerConnect W-Series Controller Installation Guides*
- *Dell PowerConnect W-Series Access Point Installation Guides*
- *Dell PowerConnect W-Series ArubaOS Quick Start Guide*
- *Dell PowerConnect W-Series User Guide*
- *Dell PowerConnect W-Series Command Line Reference Guide*
- *Dell PowerConnect W-Series MIB Reference Guide*
- *Release Notes*

Conventions

The following conventions are used throughout this manual to emphasize important concepts:

Table 1 *Typographical Conventions*

Type Style	Description
Italics	This style is used to emphasize important terms and to mark the titles of books.
`System items`	This fixed-width font depicts the following: • Sample screen output • System prompts • Filenames, software devices, and specific commands when mentioned in the text
`Commands`	In the command examples, this bold font depicts text that you must type exactly as shown.
<*Arguments*>	In the command examples, italicized text within angle brackets represents items that you should replace with information appropriate to your specific situation. For example: # **send** <*text message*> In this example, you would type "send" at the system prompt exactly as shown, followed by the text of the message you wish to send. Do not type the angle brackets.
`[Optional]`	In the command examples, items enclosed in brackets are optional. Do not type the brackets.
`{Item A | Item B}`	In the command examples, items within curled braces and separated by a vertical bar represent the available choices. Enter only one choice. Do not type the braces or bars.

The following informational icons are used throughout this guide:

NOTE: Indicates helpful suggestions, pertinent information, and important things to remember.

CAUTION: Indicates a risk of damage to your hardware or loss of data.

⚠ WARNING: Indicates a risk of personal injury or death.

Contacting Support

Table 2 *Contacting Dell Support*

Web Site	
Main Website	dell.com
Support Website	support.dell.com
Documentation Website	support.dell.com/manuals

Chapter 1

The Basic User-Centric Networks

This chapter describes how to connect an Dell controller and Dell APs to your wired network. After completing the tasks described in this chapter, see "Access Points" on page 107 for information on configuring APs.

This chapter describes the following topics:

Configuring the User-Centric Network

Configuring your controller and AP is done through either the Web User Interface (WebUI) or the command line interface (CLI).

- WebUI is accessible through a standard Web browser from a remote management console or workstation. The WebUI includes configuration wizards that step you through easy-to-follow configuration tasks. Each wizard has embedded online help. The wizards are:
  - AP Wizard—basic AP configuration s including LAN, Remote, LAN Mesh and Remote Mesh deployment scenarios
  - Controller Wizard—basic controller configuration including system settings, Control Plane security, cluster settings and licenses
  - WLAN/LAN Wizard—creating and configuring new WLANs and LANs associated with the "default" ap-group. Includes campus only and remote networking.
  - License Wizard—installation and activation of software licenses (see Chapter 34 on page 651)

NOTE: Clicking Cancel from the Wizards return you to where you launched the wizard. Any configuration changes you entered are not saved.

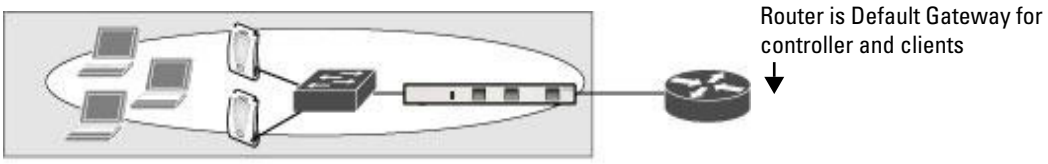
- The command line interface (CLI) allows you to configure and manage controllers. The CLI is accessible from a local console connected to the serial port on the controller or through a Telnet or Secure Shell (SSH) session from a remote management console or workstation.

NOTE: By default, you can only access the CLI from the serial port or from an SSH session. To use the CLI in a Telnet session, you must explicitly enable Telnet on the controller.

Deployment and Configuration Tasks

This section describes typical deployment scenarios and the tasks you must perform in connecting an Dell controller and Dell APs to your wired network. For details on performing the tasks mentioned in these scenarios, see the remaining sections within this chapter.

Deployment Scenario #1



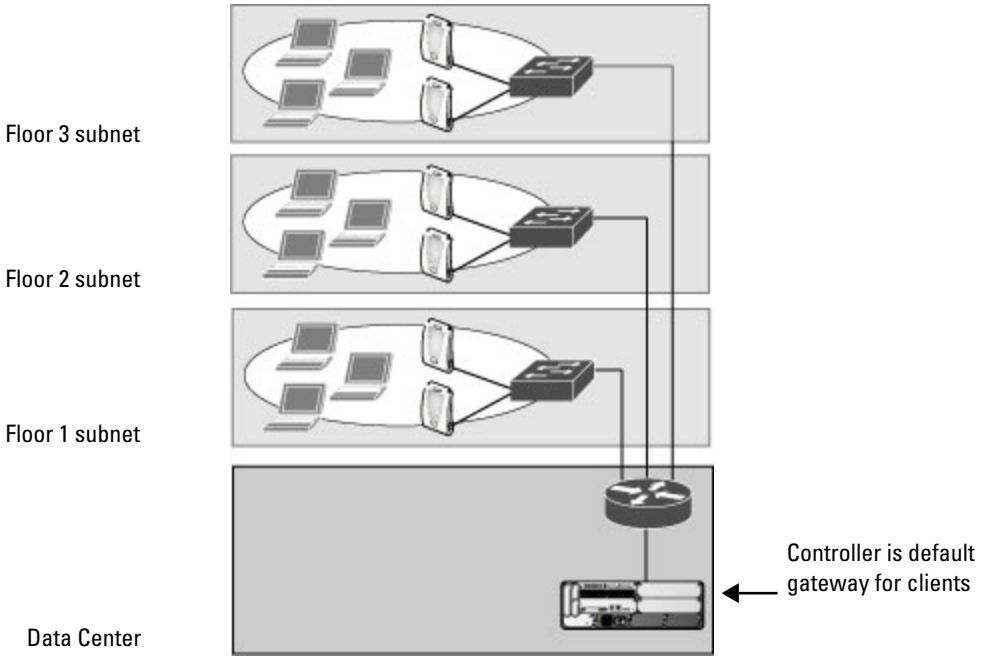
In this deployment scenario, the APs and controller are on the same subnetwork and will use IP addresses assigned to the subnetwork. There are no routers between the APs and the controller. APs can be physically connected directly to the controller. The uplink port on the controller is connected to a layer-2 switch or router.

For this scenario, you must perform the following tasks:

1. Run the initial setup wizard.
   - Set the IP address of VLAN 1.
   - Set the default gateway to the IP address of the interface of the upstream router to which you will connect the controller.
2. Connect the uplink port on the controller to the switch or router interface. By default, all ports on the controller are access ports and will carry traffic for a single VLAN.
3. Deploy APs. The APs will use the Aruba Discovery Protocol (ADP) to locate the controller.

Configure the SSID(s) with VLAN 1 as the assigned VLAN for all users.

Deployment Scenario #2



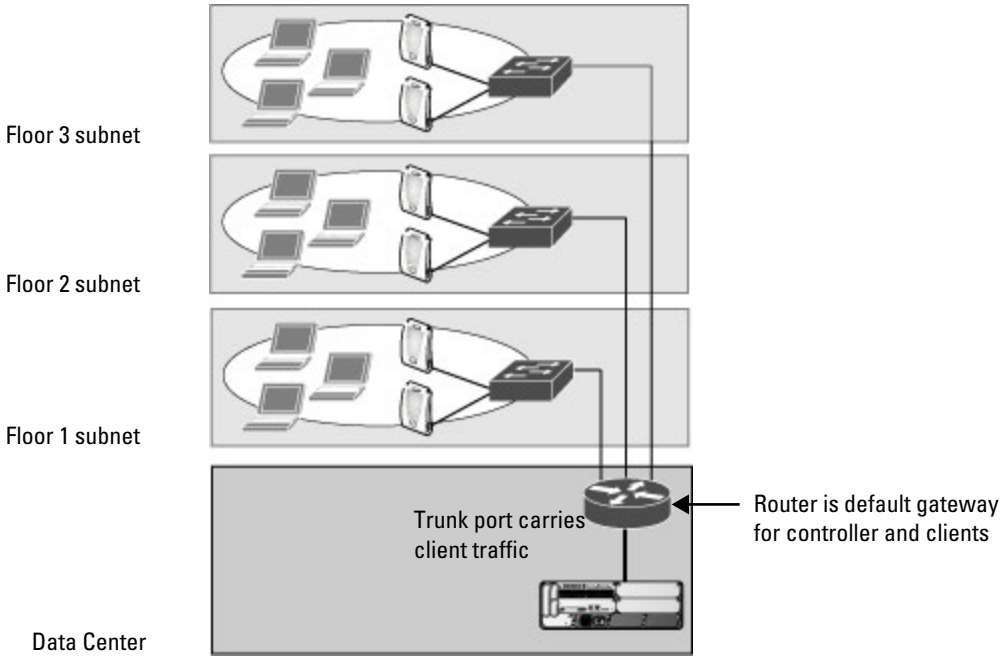
In this deployment scenario, the APs and the controller are on different subnetworks and the APs are on multiple subnetworks. The controller acts as a router for the wireless subnetworks (the controller is the default gateway for the wireless clients). The uplink port on the controller is connected to a layer-2 switch or router; this port is an access port in VLAN 1.

For this scenario, you must perform the following tasks:

1. Run the initial setup wizard.
   - Set the IP address for VLAN 1.
   - Set the default gateway to the IP address of the interface of the upstream router to which you will connect the controller.
2. Connect the uplink port on the controller to the switch or router interface.
3. Deploy APs. The APs will use DNS or DHCP to locate the controller.
4. Configure VLANs for the wireless subnetworks on the controller.
5. Configure SSIDs with the VLANs assigned for each wireless subnetwork.

NOTE: Each wireless client VLAN must be configured on the controller with an IP address. On the uplink switch or router, you must configure static routes for each client VLAN, with the controller's VLAN 1 IP address as the next hop.

Deployment Scenario #3



In this deployment scenario, the APs and the controller are on different subnetworks and the APs are on multiple subnetworks. There are routers between the APs and the controller. The controller is connected to a layer-2 switch or router through a trunk port that carries traffic for all wireless client VLANs. An upstream router functions as the default gateway for the wireless users.

NOTE: This deployment scenario does *not* use VLAN 1 to connect to the layer-2 switch or router through the trunk port. The initial setup prompts you for the IP address and default gateway for VLAN 1; use the default values. In later steps, you configure the appropriate VLAN to connect to the switch or router as well as the default gateway.

For this scenario, you must perform the following tasks:

1. Run the initial setup.
   - Use the *default* IP address for VLAN 1. Since VLAN 1 is *not* used to connect to the layer-2 switch or router through the trunk port, you must configure the appropriate VLAN in a later step.
   - Do *not* specify a default gateway (use the default "none"). In a later step, you configure the default gateway.
2. Create a VLAN that has the same VLAN ID as the VLAN on the switch or router to which you will connect the controller. Add the uplink port on the controller to this VLAN and configure the port as a trunk port.
3. Add client VLANs to the trunk port.
4. Configure the default gateway on the controller. This gateway is the IP address of the router to which you will connect the controller.
5. Configure the loopback interface for the controller.
6. Connect the uplink port on the controller to the switch or router interface.
7. Deploy APs. The APs will use DNS or DHCP to locate the controller.
8. Now configure VLANs on the controller for the wireless client subnetworks and configure SSIDs with the VLANs assigned for each wireless subnetwork.

Configuring the Controller

The tasks in deploying a basic user-centric network fall into two main areas:

- Configuring and connecting the controller to the wired network (described in this section)
- Deploying APs (described later in this section)

To connect the controller to the wired network:

1. Run the initial setup to configure administrative information for the controller.

   Initial setup can be done using the browser-based Setup Wizard or by accessing the initial setup dialog via a serial port connection. Both methods are described in the *Dell PowerConnect W-Series Quick Start Guide* and are referred to throughout this chapter as "initial setup."
2. (Deployment #3) Configure a VLAN to connect the controller to your network. You do *not* need to perform this step if you are using VLAN 1 to connect the controller to the wired network.
3. (Optional) Configure a loopback address for the controller. You do *not* need to perform this step if you are using the VLAN 1 IP address as the controller's IP address. Disable spanning tree on the controller if necessary.
4. Configure the system clock.
5. (Optional) Install licenses; see Chapter 34, "Software Licenses" on page 651.
6. Connect the ports on the controller to your network.

This section describes the steps in detail.

Running the Initial Setup

When you connect to the controller for the first time using either a serial console or a Web browser, the initial setup requires you to set the role (master or local) for the controller and passwords for administrator and configuration access.

NOTE: Do not connect the controller to your network when running the initial setup. The factory-default controller boots up with a default IP address and both DHCP server and spanning tree functions are not enabled. Once you have completed the initial setup, you can use either the CLI or WebUI for further configuration before connecting the controller to your network.

The initial setup might require that you specify the country code for the country in which the controller will operate; this sets the regulatory domain for the radio frequencies that the APs use.

NOTE: You cannot change the country code for controllers designated for certain countries, such as the U.S. Improper country code assignment can disrupt wireless transmissions. Many countries impose penalties and sanctions for operators of wireless networks with devices set to improper country codes.

If none of the channels supported by the AP you are provisioning have received regulatory approval by the country whose country code you selected, the AP will revert to Air Monitor mode.

The initial setup requires that you configure an IP address for the VLAN 1 interface, which you can use to access and configure the controller remotely via an SSH or WebUI session. Configuring an IP address for the VLAN 1 interface ensures that there is an IP address and default gateway assigned to the controller upon completion of the initial setup.

Connecting to the Controller after Initial Setup

After you complete the initial setup, the controller reboots using the new configuration. (See the *Dell PowerConnect W-Series Quick Start Guide* for information about using the initial setup.) You can then connect to and configure the controller in several ways using the administrator password you entered during the initial setup:

- You can continue to use the connection to the serial port on the controller to enter the command line interface (CLI). (See Chapter 32, "Management Access" for information on how to access the CLI and enter configuration commands.)
- You can connect an Ethernet cable from a PC to an Ethernet port on the controller. You can then use one of the following access methods:
  - Use the VLAN 1 IP address to start an SSH session where you can enter CLI commands.
  - Enter the VLAN 1 IP address in a browser window to start the WebUI.
  - WebUi Wizards.

NOTE: This chapter and the user guide in general focus on CLI and standard WebUI configuration examples. However, basic controller configuration and WLAN/LAN creation can be completed using the alternative wizards from within the WebUI. If you wish to use a configuration wizard, navigate to Configuration > Wizards, click on the desired wizard, and follow the imbedded help instructions within the wizard.

Configuring a VLAN for Network Connection

You must follow the instructions in this section only if you need to configure a trunk port between the controller and another layer-2 switch (shown in "Deployment Scenario #3" on page 51).

This section shows how to use both the WebUI and CLI for the following configurations (subsequent steps show how to use the WebUI only):

- Create a VLAN on the controller and assign it an IP address.
- Optionally, create a VLAN pool. A VLAN pool consists of two more VLAN IDs which are grouped together to efficiently manage multi-controller networks from a single location. For example, policies and virtual application configurations map users to different VLANs which may exist at different controllers. This creates

redundancy where one controller has to back up many other controllers. With the VLAN pool feature you can control your configuration globally.

CAUTION: VLAN pooling should *not* be used with static IP addresses.

- Assign to the VLAN the ports) that you will use to connect the controller to the network. (For example, the uplink ports connected to a router are usually Gigabit ports.) In the example configurations shown in this section, a controller is connected to the network through its Gigabit Ethernet port 1/25.
- Configure the port as a trunk port.
- Configure a default gateway for the controller.

Creating and Updating a VLAN

You can create and update a single VLAN or bulk VLANS using the WebUI or the CLI. See "Creating and Updating VLANs" on page 59.

NOTE: In the WebUI configuration windows, clicking the Save Configuration button saves configuration changes so they are retained after the controller is rebooted. Clicking the Apply button saves changes to the running configuration but the changes are not retained when the controller is rebooted. A good practice is to use the Apply button to save changes to the running configuration and, after ensuring that the system operates as desired, click Save Configuration.

Viewing Existing VLAN IDs

Use the CLI to view VLAN IDs.

```
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z
(host) (config) #show vlan

VLAN CONFIGURATION
------------------
VLAN   Description  Ports
----   -----------  -----
1      Default      FE1/0-3 FE1/6 GE1/8
2      VLAN0002
4      VLAN0004
12     VLAN0012
210    VLAN0210
212    VLAN0212     FE1/5
213    VLAN0213     FE1/4
1170   VLAN1170     FE1/7
```

Creating, Updating, and Deleting VLAN Pools

CAUTION: VLAN pooling should *not* be used with static IP addresses.

You can create, update, delete a VLAN pool using the WebUI or the CLI. See "Creating, Updating and Deleting VLAN Pools" on page 60.

Adding existing VLAN IDs to a VLAN Pool in the CLI

Use the CLI to add existing VLAN IDS to a pool.

```
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z
(host) (config) #vlan-name mygroup pool
(host) (config) #vlan mygroup 2,4,12
(host) (config) #
```

To confirm the VLAN pool status and mappings assignments, use the show vlan mapping command:

```
(host) (config) #show vlan mapping
VLAN Name                          Pool Status  VLAN IDs
---------                          -----------  --------
mygroup                           Enabled      2,4,12
group123 Disabled
```

Assigning and Configuring the Trunk Port

The following procedures configures a Gigabit Ethernet port as trunk port.

In the WebUI

1. Navigate to the Configuration > Network > Ports window on the WebUI.
2. In the Port Selection section, click the port that will connect the controller to the network. In this example, click port 25.
3. For Port Mode, select Trunk.
4. For Native VLAN, select VLAN 5 from the scrolling list, then click the left (<--) arrow.
5. Click Apply.

In the CLI

```
interface gigabitethernet 1/25
   switchport mode trunk
   switchport trunk native vlan 5
```

To confirm the port assignments, use the show vlan command:

```
(host) (config) #show vlan

VLAN CONFIGURATION
------------------
VLAN   Name       Ports
----   ----       -----
1      Default    Fa1/0-23 Gig1/24
5      VLAN0005   Gig1/25
```

Configuring the Default Gateway

The following configurations assign a default gateway for the controller.

In the WebUI

1. Navigate to the Configuration > Network > IP > IP Routes window.
2. To add a new static gateway, click the Add button below the static IP address list.
   a. In the IP Address field, enter an IP address in dotted-decimal format.
   b. In the Cost field, enter a value for the path cost.
   c. Click Add.
3. You can define a dynamic gateway using DHCP, PPPOE or a cell uplink interface. In the Dynamic section, click the DHCP, PPPoE or Cellular checkboxes to select one or more dynamic gateway options. If you select more than one dynamic gateway type, you must also define a cost for the route to each gateway. The controller will first attempt to obtain a gateway IP address using the option with the lowest cost. If the

controller is unable to obtain a gateway IP address, it will then attempt to obtain a gateway IP address using the option with the next-lowest path cost.

4. Click Apply.

In the CLI

```
ip default-gateway <ipaddr>|{import cell|dhcp|pppoe}|{ipsec <name>} <cost>
```

Configuring the Loopback for the Controller

You must configure a loopback address if you are not using a VLAN ID address to connect the controller to the network (see "Deployment Scenario #3" on page 51).

NOTE: After you configure or modify a loopback address, you must reboot the controller.

If configured, the loopback address is used as the controller's IP address. If you do not configure a loopback address for the controller, the IP address assigned to the first configured VLAN interface IP address. Generally, VLAN 1 is configured first and is used as the controller's IP address.

ArubaOS allows the loopback address to be part of the IP address space assigned to a VLAN interface. In the example topology, the VLAN 5 interface on the controller was previously configured with the IP address 10.3.22.20/24. The loopback IP address in this example is 10.3.22.220.

NOTE: You configure the loopback address as a host address with a 32-bit netmask. The loopback address should be routable from all external networks.

Spanning tree protocol (STP) is enabled by default on the controller. STP ensures a single active path between any two network nodes, thus avoiding bridge loops. Disable STP on the controller if you are not employing STP in your network.

In the WebUI

1. Navigate to the Configuration > Network > Controller > System Settings window.
2. Enter the IP address under Loopback Interface.
3. On this window, you can also turn off spanning tree. Click No for Spanning Tree Enabled.
4. Click Apply at the bottom of the window (you might need to scroll down the window).
5. At the top of the window, click Save Configuration. Note that you must reboot the controller for the new IP address to take effect.
6. Navigate to the Maintenance > Controller > Reboot Controller window.
7. Click Continue.

In the CLI

```
interface loopback ip address 10.3.22.220
no spanning-tree
write memory
reload
```

The controller returns the following messages:

```
Do you really want to reset the system(y/n):
```

Enter y to reboot the controller or n to cancel.

```
System will now restart!
...
Restarting system.
```

To verify that the controller is accessible on the network, ping the loopback address from a workstation on the network.

Configuring the System Clock

You can manually set the clock on the controller, or configure the controller to use a Network Time Protocol (NTP) server to synchronize its system clock with a central time source. For more information about setting the controller's clock, see "Setting the System Clock" on page 604.

Installing Licenses

ArubaOS consists of a base operating system with optional software modules that you can activate by installing license keys. If you use the Setup Wizard during the initial setup phase, you will have the opportunity to install software licenses at that time. See Chapter 34, "Software Licenses" on page 651 for detailed information on Licenses.

Connecting the Controller to the Network

Connect the ports on the controller to the appropriately-configured ports on an L2 switch or router. Make sure that you have the correct cables and that the port LEDs indicate proper connections. See the *Installation Guide* for the controller for port LED and cable descriptions.

NOTE: In many deployment scenarios, an external firewall is situated between various Dell devices. Appendix B, "External Firewall Configuration" describes the network ports that must be configured on the external firewall to allow proper operation of the network.

To verify that the controller is accessible on the network:

- If you are using VLAN 1 to connect the controller to the network ("Deployment Scenario #2" on page 50 and "Deployment Scenario #3" on page 51), ping the VLAN 1 IP address from a workstation on the network.
- If you created and configured a new VLAN ("Deployment Scenario #3" on page 51), ping the IP address of the new VLAN from a workstation on the network.

Additional Configuration

Wireless users can connect to the SSID but because you have not yet configured authentication, policies, or user roles, they will not have access to the network. Other chapters in the *ArubaOS User Guide* describe how to build upon this basic deployment to configure user roles, firewall policies, authentication, authentication servers, and other wireless features.

Chapter 2

Network Parameters

This chapter describes some basic network configuration on the controller. This chapter describes the following topics:

Configuring VLANs

The controller operates as a layer-2 switch that uses a VLAN as a broadcast domain. As a layer-2 switch, the controller requires an external router to route traffic between VLANs. The controller can also operate as a layer-3 switch that can route traffic between VLANs defined on the controller.

You can configure one or more physical ports on the controller to be members of a VLAN. Additionally, each wireless client association constitutes a connection to a *virtual port on the controller*, with membership in a specified VLAN. You can place all authenticated wireless users into a single VLAN or into different VLANs, depending upon your network. VLANs can exist only inside the controller or they can extend outside the controller through 802.1q VLAN tagging.

You can optionally configure an IP address and netmask for a VLAN on the controller. The IP address is *up* when at least one physical port in the VLAN is up. The VLAN IP address can be used as a gateway by external devices; packets directed to a VLAN IP address that are not destined for the controller are forwarded according to the controller's IP routing table.

Creating and Updating VLANs

You can create and update a single VLAN or bulk VLANs.

Using the WebUI

1. Navigate to the Configuration > Network > VLANs page.
2. Click Add a VLAN to create a new VLAN. (To edit an existing VLAN click Edit for the VLAN entry.) See "Create a Bulk VLANs Using the WebUI" on page 60 to create a range of VLANs.
3. In the VLAN ID field, enter a valid VLAN ID. (Valid values are from 1 to 4094, inclusive).
4. To add physical ports to the VLAN, select Port. To associate the VLAN with specific port-channels, select Port-Channel.
5. (Optional) Click the Wired AAA Profile drop-down list to assign an AAA profile to a VLAN. This wired AAA profile enables role-based access for wired clients connected to an untrusted VLAN or port on the controller.

   Note that this profile will only take effect if the VLAN or port on the controller is untrusted. If you do not assign an wired AAA profile to the VLAN, the global wired AAA profile applies to traffic from untrusted wired ports.

6. If you selected Port in step 4, select the ports you want to associate with the VLAN from the Port Selection window.

   -or-

   If you selected Port-Channel in step 4, click the Port-Channel ID drop-down list, select the specific channel number you want to associate with the VLAN, then select the ports from the Port Selection window.
7. Click Apply.

Using CLI

```
(host) (config) #vlan <id>
(host) (config) #interface fastethernet|gigabitethernet <slot>/<port>
(host) (config-if) #switchport access vlan <id>
```

Create a Bulk VLANs Using the WebUI

1. To add multiple VLANs at one time, click Add Bulk VLANs.
2. In the VLAN Range pop-up window, enter a range of VLANs you want to create at once. For example, to add VLAN IDs numbered 200-300 and 302-350, enter 200-300, 302-350.
3. Click OK.
4. To add physical ports to a VLAN, click Edit next to the VLAN you want to configure and click the port in the Port Selection section.
5. Click Apply.

Using CLI

```
(host) (config) #vlan
(host) (config) #vlan range 200-300,302-350
```

Creating, Updating and Deleting VLAN Pools

You can create, update and delete a VLAN pool.

Creating a VLAN pool Using the WebUI

The following configurations create a VLAN Pool named mygroup. VLAN IDs 2, 4 and 12 are then assigned to the VLAN pool mygroup.

1. Navigate to Configuration > Network > VLAN.
2. Select the VLAN Pool tab to open the VLAN Pool window.
3. Click Add.
4. In the VLAN Name field, enter a name that identifies this VLAN pool. Names must be between 1 and 32 characters; spaces are not allowed. The VLAN name can not be modified; choose the name carefully.
5. In the List of VLAN IDs field, enter the VLAN IDs you want to add to this pool. If you know the ID, enter each ID separated by a comma. Or, click the drop-down list to view the IDs then click the <-- arrow to add the ID to the pool..

CAUTION: VLAN pooling should *not* be used with static IP addresses.

6. You must add two or more VLAN IDs to create a pool.
7. When you finish adding all the IDs, click Add.

The VLAN pool along with its assigned IDs appears on the VLAN Pool window. If the pool is valid (it has two or more IDs assigned to it), its status is enabled. If you create a VLAN pool and add only one or no VLAN IDs, its status appears as disabled.

8. Click Apply.
9. At the top of the window, click Save Configuration.

Updating a VLAN Pool

1. On the VLAN Pool window, click Modify next to the VLAN name you want to edit.
2. Modify the list of VLAN IDs. Note that you can not modify the VLAN name.
3. Click Update.
4. Click Apply.
5. At the top of the window, click Save Configuration.

Deleting a VLAN Pool

1. On the VLAN Pool window, click Delete next to the VLAN name you want to delete. A prompt appears.
2. Click OK.
3. Click Apply.
4. At the top of the window, click Save Configuration.

Create a VLAN Pool Using CLI

The pool option allows you to create a VLAN pool consisting of two more VLAN IDs.

```
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z
(host) (config) #vlan-name mygroup pool
(host) (config) #
```

Viewing Existing VLAN IDs Using CLI

```
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z
(host) (config) #show vlan

VLAN CONFIGURATION
------------------
VLAN   Description  Ports
----   -----------  -----
1      Default      FE1/0-3 FE1/6 GE1/8
2      VLAN0002
4      VLAN0004
12     VLAN0012
212    VLAN0212     FE1/5
213    VLAN0213     FE1/4
1170   VLAN1170     FE1/7
1170   VLAN1170     FE1/7
```

Adding Existing VLAN IDs Using CLI

The following example illustrates adding existing VLAN IDs to a VLAN pool:

```
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z
(host) (config) #vlan-name mygroup pool
(host) (config) #vlan mygroup 2,4,12
(host) (config) #
```

To confirm the VLAN pool status and mappings assignments, use the show vlan mapping command:

```
(host) (config) #show vlan mapping
VLAN Name                          Pool Status  VLAN IDs
---------                          -----------  --------
mygroup                            Enabled      2,4,12
group123                           Disabled
```

Add a Bandwidth Contract to the VLAN

Bandwidth contracts on a VLAN can limit broadcast and multicast traffic. ArubaOS includes an internal exception list to allow broadcast and multicast traffic using the VRRP, LACP, OSPF, PVST and STP protocols. To remove per-VLAN bandwidth contract limits on an additional broadcast or multicast protocol, add the MAC address for that broadcast/multicast protocol to the VLAN Bandwidth Contracts MAC Exception List.

The command in the example below adds the MAC address for CDP (Cisco Discovery Protocol) and VTP (Virtual Trunking Protocol to the list of protocols that are not limited by VLAN bandwidth contracts.

```
(host) (config) #vlan-bwcontract-explist mac 01:00:0C:CC:CC:CC
```

To show entries in the VLAN bandwidth contracts MAC exception list, use the show vlan-bwcontract-explist [internal] command:

```
(host) (config) #show vlan-bwcontract-explist internal

VLAN BW Contracts Internal MAC Exception List
---------------------------------------------
MAC address
-----------
01:80:C2:00:00:00
01:00:0C:CC:CC:CD
01:80:C2:00:00:02
01:00:5E:00:82:11
```

Optimize VLAN Broadcast and Multicast Traffic

Broadcast and Multicast (BCMC) traffic from APs, remote APs, or distributions terminating on the same VLAN floods all VLAN member ports. This causes critical bandwidth wastage especially when the APs are connected to L3 cloud where the available bandwidth is limited or expensive. Suppressing the VLAN BCMC traffic to prevent flooding can result in loss of client connectivity.

To effectively prevent flooding of BCMC traffic on all VLAN member ports, use the **`bcmc-optimization`** parameter under the `interface vlan` command. This parameter ensures controlled flooding of BCMC traffic without compromising the client connectivity. By default this option is disabled. You must enable this parameter for the controlled flooding of BCMC traffic.

The **`bcmc-optimization`** parameter has the following exemptions:

- All DHCP traffic will continue to flood VLAN member ports even if the **`bcmc-optimization`** parameter is enabled.
- The controller will do proxy ARP if the target IP entry exists on the controller. If the target IP does not exist on the controller, ARP requests will be flooded on all VLAN member ports.

You can configure BCMC optimization in CLI and in the WebUI.

In the CLI

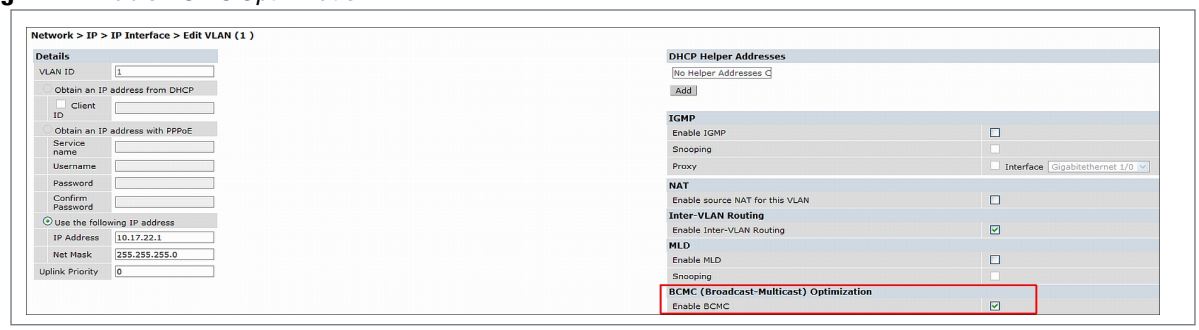
```
(host) (config) #interface vlan 1
(host) (config-subif)#bcmc-optimization
(host) (config-subif)#show interface vlan 1

VLAN1 is up line protocol is up
```

```
Hardware is CPU Interface, Interface address is 00:0B:86:61:5B:98 (bia
00:0B:86:61:5B:98)
Description: 802.1Q VLAN
Internet address is 10.17.22.1  255.255.255.0
Routing interface is enable, Forwarding mode is enable
Directed broadcast is disabled, BCMC Optimization enable
Encapsulation 802, loopback not set
MTU 1500 bytes
Last clearing of "show interface" counters 12 day 1 hr 4 min 12 sec
link status last changed 12 day 1 hr 2 min 21 sec
Proxy Arp is disabled for the Interface
```

In the WebUI

1. Navigate to Configuration > Network > IP.
2. In the IP Interfaces tab, click the Edit button of the VLAN for configuring BCMC optimization.
3. Select Enable BCMC check box to enable BCMC Optimization for the selected VLAN.

Figure 1 *Enable BCMC Optimization*



Configuring Ports

Both Fast Ethernet and Gigabit Ethernet ports can be set to access or trunk mode. By default, a port is in access mode and carries traffic only for the VLAN to which it is assigned. In trunk mode, a port can carry traffic for multiple VLANs.

For a trunk port, specify whether the port will carry traffic for all VLANs configured on the controller or for specific VLANs. You can also specify the native VLAN for the port. A trunk port uses 802.1q tags to mark frames for specific VLANs, However, frames on a native VLAN are not tagged.

Classifying Traffic as Trusted or Untrusted

You can classify wired traffic based not only on the incoming physical port and channel configuration but also on the VLAN associated with the port and channel.

About Trusted and Untrusted Physical Ports

By default, physical ports on the controller are trusted and are typically connected to internal networks while untrusted ports connect to third-party APs, public areas, or other networks to which access controls can be applied. When you define a physical port as untrusted, traffic passing through that port needs to go through a predefined access control list policy.

About Trusted and Untrusted VLANs

You can also classify traffic as trusted or untrusted based on the VLAN interface and port/channel. This means that wired traffic on the incoming port is trusted only when the port's associated VLAN is also trusted, otherwise the traffic is untrusted. When a port and its associated VLANs are untrusted, any incoming and outgoing traffic

must pass through a predefined ACL. For example, this setup is useful if your company provides wired user guest access and you want guest user traffic to pass through an ACL to connect to a captive portal.

You can set a range of VLANs as trusted or untrusted in trunk mode. The following table lists the port, VLAN and the trust/untrusted combination to determine if traffic is trusted or untrusted. both the port and the VLAN have to be configured as trusted for traffic to be considered as trusted. If the traffic is classified as untrusted then traffic must pass through the selected session access control list and firewall policies.

Table 3 *Classifying Trusted and Untrusted Traffic*

Port	VLAN	Traffic Status
Trusted	Trusted	Trusted
Untrusted	Untrusted	Untrusted
Untrusted	Trusted	Untrusted
Trusted	Untrusted	Untrusted

Configuring Trusted/Untrusted Ports and VLANs

You can configure an Ethernet port as an untrusted access port, assign VLANs and make them untrusted, and designate a policy through which VLAN traffic on this port must pass.

Using WebUI

1. Navigate to the Configuration > Network > Ports window.
2. In the Port Selection section, click the port you want to configure.
3. In the Make Port Trusted section, clear the Trusted check box to make the port untrusted. The default is trusted (checked).
4. In the Port Mode section, select Access.
5. From the VLAN ID drop-down list select the VLAN ID whose traffic will be carried by this port.
6. In the Enter VLAN(s) section, clear the Trusted check box to make the VLAN untrusted. The default is trusted (checked).
7. In the VLAN Firewall Policy drop-down list, select the policy through which VLAN traffic must pass. You can select a policy for both trusted and untrusted VLANs.
8. From the Firewall Policy section, select the policy from the in drop-down list through which inbound traffic on this port must pass.
9. Select the policy from the out drop-down list through which outbound traffic on this port must pass.
10. To apply a policy to this session's traffic on this port and VLAN, select the policy from the session drop-down list.
11. Click Apply.

Using CLI

```
(host) (config) #interface range fastethernet 1/2
(host) (config-if)#switchport mode access
(host) (config-if)#no trusted
(host) (config-if)#switchport access vlan 2
(host) (config-if)#no trusted vlan 2
(host) (config-if)#ip access-group ap-acl session vlan 2
(host) (config-if)#ip access-group validuserethacl in
(host) (config-if)#ip access-group validuserethacl out
(host) (config-if)#ip access-group validuser session
```

Configure Trusted/Untrusted Ports and VLANs in Trunk Mode

The following procedures configure a range of Ethernet ports as untrusted native trunks ports, assign VLANs and make them untrusted and designate a policy through which VLAN traffic on the ports must pass.

Using the WebUI

1. Navigate to the Configuration > Network > Ports window.
2. In the Port Selection section, click the port you want to configure.
3. For Port Mode select Trunk.
4. To specify the native VLAN, select a VLAN from the Native VLAN drop-down list and click the <-- arrow.
5. Choose one of the following options to control the type of traffic the port carries:
   - Allow All VLANS Except– The port carries traffic for all VLANs except the ones from this drop-down list.
   - Allow VLANs – The port carries traffic for all VLANs selected from this drop-down list.
   - Remove VLANs – The port does not carry traffic for any VLANs selected from this drop-down list.
6. To designate *untrusted* VLANs on this port, click Trusted except. In the corresponding VLAN field enter a range of VLANs that you want to make *untrusted*. (In this format, for example: 200-300, 401-500 and so on). Only VLANs listed in this range are untrusted. Or, to make only one VLAN untrusted, select a VLAN from the drop-down menu.
7. To designate *trusted* VLANs on this port, click Untrusted except. In the corresponding VLAN field enter a range of VLANs that you want to make *trusted*. (In this format, for example: 200-300, 401-500 and so on). Only VLANs listed in this range are trusted. Or, to make only one VLAN trusted, select a VLAN from the drop-down menu.
8. To remove a VLAN, click the Remove VLANs option and select the VLAN you want to remove from the drop-down list and click the left arrow to add it to the list.
9. To designate the policy through which VLAN traffic must pass, click New under the Session Firewall Policy field.
10. Enter the VLAN ID or select it from the associated drop-down list. Then select the policy, through which the VLAN traffic must pass, from the Policy drop-down list and click Add. Both the selected VLAN and the policy appear in the Session Firewall Policy field.
11. When you are finished listing VLAN and policies, click Cancel.
12. Click Apply.

Using CLI

```
(host) (config) #interface fastethernet 2/0
(host) (config-if)#description FE2/
(host) (config-if)#trusted vlan 1-99,101, 104, 106-199, 201-299
(host) (config-range)# switchport mode trunk
(host) (config-if)#switchport trunk native vlan 100
(host) (config-range)# ip access-group
(host) (config-range)# ip access-group test session vlan 2
```

About VLAN Assignments

A client is assigned to a VLAN by one of several methods. There is an order of precedence by which VLANs are assigned. The assignment of VLANs are (from lowest to highest precedence):

1. The default VLAN is the VLAN configured for the WLAN (see "Virtual AP Profiles" on page 139).
2. Before client authentication, the VLAN can be derived from rules based on client attributes (SSID, BSSID, client MAC, location, and encryption type). A rule that derives a specific VLAN takes precedence over a rule that derives a user role that may have a VLAN configured for it.

3. After client authentication, the VLAN can be the VLAN configured for a default role for an authentication method, such as 802.1x or VPN.
4. After client authentication, the VLAN can be derived from attributes returned by the authentication server (*server-derived rule*). A rule that derives a specific VLAN takes precedence over a rule that derives a user role that may have a VLAN configured for it.
5. After client authentication, the VLAN can be derived from Microsoft Tunnel attributes (Tunnel-Type, Tunnel Medium Type, and Tunnel Private Group ID). All three attributes must be present. This does not require any server-derived rule.
6. After client authentication, the VLAN can be derived from Vendor Specific Attributes (VSA) for RADIUS server authentication. This does not require any server-derived rule. If a VSA is present, it overrides any previous VLAN assignment.

How a VLAN Obtains its IP Address

A VLAN on the controller obtains its IP address in one of the following ways:

- Manually configured by the network administrator. This is the default method and is described in "Assigning a Static Address to a VLAN" on page 66. At least one VLAN on the controller must be assigned a static IP address.
- Dynamically assigned from a Dynamic Host Configuration Protocol (DHCP) or Point-to-Point Protocol over Ethernet (PPPoE) server.

Assigning a Static Address to a VLAN

You can manually assign a static IP address to a VLAN on the controller. At least one VLAN on the controller must be assigned a static IP address.

Using the WebUI

1. Navigate to the Configuration > Network > IP > IP Interfaces page on the WebUI. Click Edit for the VLAN you just added.
2. Select the Use the following IP address option. Enter the IP address and network mask of the VLAN interface. If required, you can also configure the address of the DHCP server for the VLAN by clicking Add.
3. Click Apply.

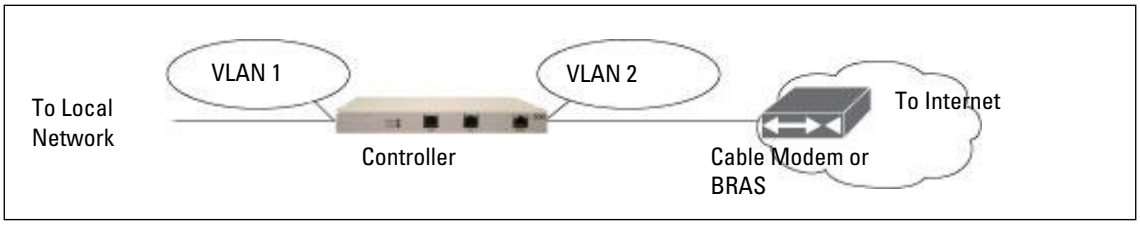
Using CLI

```
interface vlan <id>
   ip address <address> <netmask>
```

Configuring a VLAN to Receive a Dynamic Address

In a branch office, you can connect a controller to an uplink switch or server that dynamically assigns IP addresses to connected devices. For example, the controller can be connected to a DSL or cable modem, or a broadband remote access server (BRAS). shows a branch office where a controller connects to a cable modem. VLAN 1 has a static IP address, while VLAN 2 has a dynamic IP address assigned via DHCP or PPPoE from the uplink device.

Figure 2 *IP Address Assignment to VLAN via DHCP or PPPoE*



Configuring Multiple Wired Uplink Interfaces (Active-Standby)

You can assign up to four VLAN interfaces to operate in active-standby topology. An active-standby topology provides redundancy so that when an active interface fails, the user traffic can failover to the standby interface.

To allow the controller to obtain a dynamic IP address for a VLAN, enable the DHCP or PPPoE client on the controller for the VLAN.

The following restrictions apply when enabling the DHCP or PPPoE client on the controller:

- You can enable the DHCP/PPPoE client multiple uplink VLAN interfaces (up to four) on the controller; these VLANs cannot be VLAN 1.
- Only one port in the VLAN can be connected to the modem or uplink switch.
- At least one interface in the VLAN must be in the up state before the DHCP/PPPoE client requests an IP address from the server.

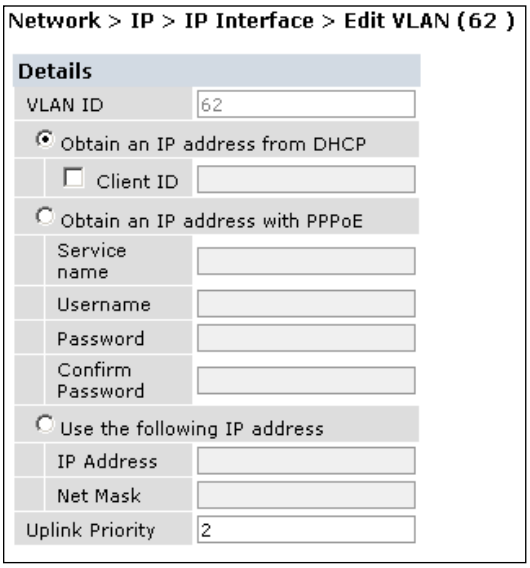
Enabling the DHCP Client

The DHCP server assigns an IP address for a specified amount of time called a lease. The controller automatically renews the lease before it expires. When you shut down the VLAN, the DHCP lease is released.

Using the WebUI

1. Navigate to the Configuration > Network > IP > IP Interfaces page.
2. Click Edit for a previously-created VLAN.
3. Select Obtain an IP address from DHCP.
4. Enter a priority value for the VLAN ID in the Uplink Priority field. By default, all wired uplink interfaces have the same priority. If you want to use an active-standby topology then prioritize each uplink interfaces by entering a different priority value (1– 4) for each uplink interface.

Figure 3 *Assigning VLAN uplink priority—Active-Standby configuration*



5. Click Apply.

Using the CLI

In this example, the DHCP client has the client ID name *myclient* and the interface VLAN 62 has an uplink priority of 2.

```
interface vlan 62
uplink wired vlan 62 priority 3
```

```
interface vlan 62 ip address dhcp-client client-id myclient
```

Enabling the PPPoE Client

To authenticate to the BRAS and request a dynamic IP address, the controller must have the following configured:

- PPPoE user name and password to connect to the DSL network
- PPPoE service name — either an ISP name or a class of service configured on the PPPoE server

When you shut down the VLAN, the PPPoE session terminates.

Using the WebUI

1. Navigate to the Configuration > Network > IP > IP Interfaces page.
2. Click Edit for a previously-created VLAN.
3. Select Obtain an IP address with PPPoE.
4. Enter the service name, username, and password for the PPPoE session.
5. Enter a priority value for the VLAN ID in the Uplink Priority field. By default, all wired uplink interfaces have the same priority. If you want to use an active-standby topology then prioritize each uplink interfaces by entering a different priority value (1– 4) for each uplink interface.
6. Click Apply.

Using CLI

In this example, a PPoE service name, username and password are assigned. The interface VLAN 14 has an uplink priority of 3.

```
interface vlan 14
ip address pppoe
interface vlan 14 ip pppoe-service-name <service_name>
interface vlan 14 ip pppoe-username <username>
interface vlan 14 ip pppoe-password *****
uplink wired vlan 14 priority 3
```

Default Gateway from DHCP/PPPoE

You can specify that the router IP address obtained from the DHCP or PPPoE server be used as the default gateway for the controller.

Using the WebUI

1. Navigate to the Configuration > Network > IP > IP Routes page.
2. For Default Gateway, select (Obtain an IP address automatically).
3. Select Apply.

Using CLI

```
ip default-gateway import
```

Configuring DNS/WINS Server from DHPC/PPPoE

The DHCP or PPPoE server can also provide the IP address of a DNS server or NetBIOS name server, which can be passed to wireless clients through the controller's internal DHCP server.

For example, the following configures the DHCP server on the controller to assign addresses to authenticated employees; the IP address of the DNS server obtained by the controller via DHCP/PPPoE is provided to clients along with their IP address.

Using the WebUI

1. Navigate to the Configuration > Network > IP > DHCP Server page.
2. Select Enable DCHP Server.
3. Under Pool Configuration, select Add.
4. For Pool Name, enter employee-pool.
5. For Default Router, enter 10.1.1.254.
6. For DNS Servers, select Import from DHCP/PPPoE.
7. For WINS Servers, select Import from DHCP/PPPoE.
8. For Network, enter 10.1.1.0 for IP Address and 255.255.255.0 for Netmask.
9. Click Done.

Using CLI

```
ip dhcp pool employee-pool
   default-router 10.1.1.254
   dns-server import
   netbios-name-server import
   network 10.1.1.0 255.255.255.0
```

Configuring Source NAT to Dynamic VLAN Address

When a VLAN interface obtains an IP address through DHCP or PPPoE, a NAT pool (dynamic-srcnat) and a session ACL (dynamic-session-acl) are automatically created which reference the dynamically-assigned IP addresses. This allows you to configure policies that map private local addresses to the public address(es) provided to the DHCP or PPPoE client. Whenever the IP address on the VLAN changes, the dynamic NAT pool address also changes to match the new address.

For example, the following rules for a guest policy deny traffic to internal network addresses. Traffic to other (external) destinations are source NATed to the IP address of the DHCP/PPPoE client on the controller.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page. Click Add to add the policy guest.
2. To add a rule, click Add.
   a. For Source, select any.
   b. For Destination, select network and enter 10.1.0.0 for Host IP and 255.255.0.0 for Mask.
   c. For Service, select any.
   d. For Action, select reject.
   e. Click Add.
3. To add another rule, click Add.
   a. Leave Source, Destination, and Service as any.
   b. For Action, select src-nat.
   c. For NAT Pool, select dynamic-srcnat.
   d. Click Add.
4. Click Apply.

Using CLI

```
ip access-list session guest
   any network 10.1.0.0 255.255.0.0 any deny
   any any any src-nat pool dynamic-srcnat
```

Configuring Source NAT for VLAN Interfaces

The example configuration in the previous section illustrates how to configure source NAT using a policy that is applied to a user role. You can also enable source NAT for a VLAN interface to cause NAT to be performed on the source address for *all* traffic that exits the VLAN.

Packets that exit the VLAN are given a source IP address of the "outside" interface, which is determined by the following:

- If you configure "private" IP addresses for the VLAN, the controller is assumed to be the default gateway for the subnetwork. Packets that exit the VLAN are given the IP address of the controller for their source IP address.
- If the controller is forwarding the packets at Layer-3, packets that exit the VLAN are given the IP address of the next-hop VLAN for their source IP address.

Example Configuration

In the following example, the controller operates within an enterprise network. VLAN 1 is the outside VLAN. Traffic from VLAN 6 is source NATed using the IP address of the controller. In this example, the IP address assigned to VLAN 1 is used as the controller's IP address; thus traffic from VLAN 6 would be source NATed to 66.1.131.5.

Figure 4 *Example: Source NAT using Controller IP Address*

Using the WebUI

1. Navigate to the Configuration > Network > VLANs page. Click Add to configure VLAN 6 (VLAN 1 is configured through the Initial Setup).
   a. Enter 6 for the VLAN ID.
   b. Click Apply.
2. Navigate to the Configuration > Network > IP > IP Interfaces page.
3. Click Edit for VLAN 6:
   a. Select Use the following IP address.
   b. Enter 192.168.2.1 for the IP Address and 255.255.255.0 for the Net Mask.
   c. Select the Enable source NAT for this VLAN checkbox.
4. Click Apply.

Using CLI

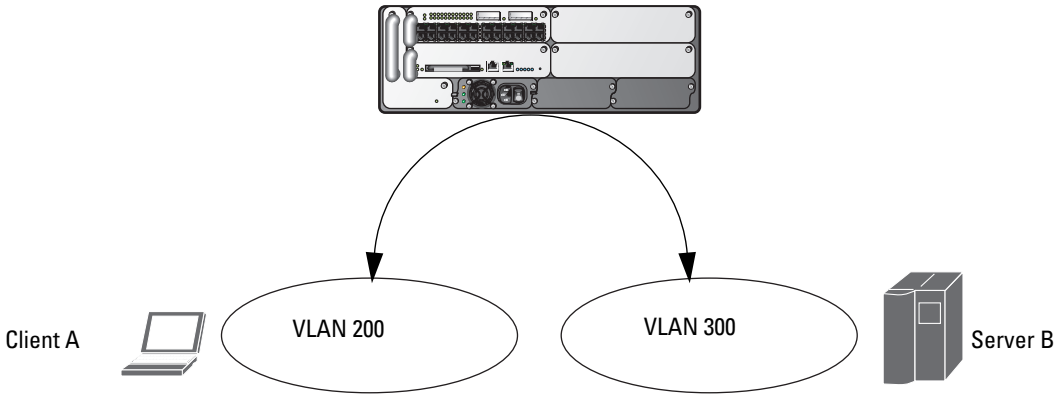
```
interface vlan 1
ip address 66.1.131.5 255.255.255.0
interface vlan 6
ip address 192.168.2.1 255.255.255.0
   ip nat inside
ip default-gateway 66.1.131.1
```

Inter-VLAN Routing

On the controller, you can map a VLAN to a layer-3 subnetwork by assigning a static IP address and netmask or by configuring a DHCP or PPPoE server to provide a dynamic IP address and netmask to the VLAN interface. The controller, acting as a layer-3 switch, routes traffic between VLANs that are mapped to IP subnetworks; this forwarding is enabled by default.

In Figure 5, VLAN 200 and VLAN 300 are assigned the IP addresses 2.1.1.1/24 and 3.1.1.1/24, respectively. Client A in VLAN 200 is able to access server B in VLAN 300 and vice versa, provided that there is no firewall rule configured on the controller to prevent the flow of traffic between the VLANs.

Figure 5 *Default Inter-VLAN Routing*



You can optionally disable layer-3 traffic forwarding to or from a specified VLAN. When you disable layer-3 forwarding on a VLAN, the following restrictions apply:

- Clients on the restricted VLAN can ping each other, but cannot ping the VLAN interface on the controller. Forwarding of inter-VLAN traffic is blocked.
- IP mobility does not work when a mobile client roams to the restricted VLAN. You must ensure that a mobile client on a restricted VLAN is not allowed to roam to a non-restricted VLAN. For example, a mobile client on a guest VLAN should not be able to roam to a corporate VLAN.

To disable layer-3 forwarding for a VLAN configured on the controller:

Using the WebUI to restrict VLAN routing

1. Navigate to the Configuration > Network > IP > IP Interface page.
2. Click Edit for the VLAN for which routing is to be restricted.
3. Configure the VLAN to either obtain an IP address dynamically (via DHCP or PPPoE) or to use a static IP address and netmask.
4. Deselect (uncheck) the Enable Inter-VLAN Routing checkbox.
5. Click Apply.

Using CLI

```
interface vlan <id>
   ip address {<ipaddr> <netmask>|dhcp-client|pppoe}
   no ip routing
```

Configuring Static Routes

To configure a static route (such as a default route) on the controller, do the following:

Using the WebUI

1. Navigate to the Configuration > Network > IP > IP Routes page.
2. Click Add to add a static route to a destination network or host. Enter the destination IP address and network mask (255.255.255.255 for a host route) and the next hop IP address.
3. Click Done to add the entry. Note that the route has not yet been added to the routing table.
4. Click Apply to add this route to the routing table. The message Configuration Updated Successfully confirms that the route has been added.

Using CLI

```
ip route <address> <netmask> <next_hop>
```

Configuring the Loopback IP Address

The loopback IP address is a logical IP interface that is used by the controller to communicate with APs. The loopback address is used as the controller's IP address for terminating VPN and GRE tunnels, originating requests to RADIUS servers and accepting administrative communications. You configure the loopback address as a host address with a 32-bit netmask. The loopback address is not bound to any specific interface and is operational at all times. To use this interface, ensure that the IP address is reachable through one of the VLAN interfaces. It should be routable from all external networks.

You must configure a loopback address if you are not using VLAN1 to connect the controller to the network. If the loopback interface address is not configured then the first configured VLAN interface address is selected. Generally, VLAN 1 is the factory default setting and thus becomes the controller IP address

Using the WebUI

1. Navigate to the Configuration > Network > Controller > System Settings page and locate the Loopback Interface section.
2. Modify the IP Address as required.
3. Click Apply.

CAUTION: If you are using the loopback IP address to access the WebUI, changing the loopback IP address will result in loss of connectivity. Dell recommends that you use one of the VLAN interface IP addresses to access the WebUI.

4. Navigate to the Maintenance > Controller > Reboot Controller page to reboot the controller to apply the change of loopback IP address.
5. Click Continue to save the configuration.

6. When prompted that the changes were written successfully to flash, click OK.

7. The controller boots up with the changed loopback IP address.

Using CLI

```
interface loopback ip address <address>
write memory
```

Using the CLI to reboot the controller

Enter the following command in Enable mode:

```
reload
```

Configuring the Controller IP Address

The Controller IP address is used by the controller to communicate with external devices such as APs.

You can set the Controller IP address to the loopback interface address or to an existing VLAN ID address. This allows you to force the controller IP address to be a specific VLAN interface or loopback address across multiple machine reboots. Once you configure an interface to be the controller IP address, that interface address cannot be deleted until you remove it from the controller IP configuration.

If the controller IP address is not configured then the controller IP defaults to the current loopback interface address. If the loopback interface address is not configured then the first configured VLAN interface address is selected. Generally, VLAN 1 is the factory default setting and thus becomes the controller IP address.

Using the WebUI

1. Navigate to the Configuration > Network > Controller > System Settings page.
2. Locate the Controller IP Details section.
3. Select the address you want to set the Controller IP to from the VLAN ID drop-down menu. This list only contains VLAN IDs that have statically assigned IP addresses. If a loopback interface IP address has been previously configured then it will also appear in this list. Dynamically assigned IP addresses, for example DHCP/PPPOE do not display.
4. Click Apply.

NOTE: Any change in the controller's IP address requires a reboot.

5. Navigate to the Maintenance > Controller > Reboot Controller page to reboot the controller to apply the change of controller IP address.
6. Click Continue to save the configuration.

7. When prompted that the changes were written successfully to flash, click OK.

8. The controller boots up with the changed controller IP address. of the selected VLAN ID.

Using CLI

```
(host) (config) #controller-ip [loopback|vlan <VLAN ID>]
```

Configuring GRE Tunnels

A controller supports generic routing encapsulation (GRE) tunnels between the controller and APs. An AP opens a GRE tunnel to the controller for each radio interface. On the AP, the other end of the GRE tunnel is specified by the IP address configured variable values (in descending order of priority) <*master*>, <*servername*>, and <*serverip*>. If these variable are left to default values, the AP uses DNS to look up aruba-master to discover the IP address of the controller.

The controller also supports GRE tunnels between the controller and other GRE-capable devices. This section describes how to configure a GRE tunnel to such a device and how to direct traffic into the tunnel.

NOTE: The controller uses GRE tunnels for communications between master and local controllers; these GRE tunnels are automatically created and are not subject to the configuration described in this section.

Creating a Tunnel Interface

To create a GRE tunnel on the controller, you need to specify the following:

- Tunnel ID: this can be a number between 1 and 2147483647.
- IP address and netmask for the tunnel.
- Tunnel source: the local endpoint for the tunnel on the controller. This can be one of the following:
  - Loopback address of the controller
  - A specified IP address
  - A specified VLAN
- Tunnel destination: the IP address of the remote endpoint of the tunnel on the other GRE device.

Using the WebUI

1. Navigate to the Configuration > Network > IP > GRE Tunnels page.
2. Click Add.
3. Enter the tunnel ID.
4. Enter the IP address and netmask for the tunnel.
5. Select (check) Enabled to enable the tunnel interface.
6. Select the tunnel source, if it is not the loopback address of the controller. If you select IP Address, enter the IP address for the tunnel source. If you select VLAN, select the ID of the VLAN.
7. Enter the IP address of the tunnel destination.
8. Click Apply.

Using CLI

```
interface tunnel <id>
   tunnel mode gre <num> <ip>
   ip address <ipaddr> <netmask>
   no shutdown
   tunnel source {<ipaddr>| loopback | vlan <vlan>}
   tunnel destination <ipaddr>
```

Directing Traffic into the Tunnel

You can direct traffic into the tunnel by configuring one of the following:

- Static route, which redirects traffic to the IP address of the tunnel
- Firewall policy (session-based ACL), which redirects traffic to the specified tunnel ID

Static Routes

You can configure a static route that specifies the IP address of a tunnel as the next-hop for traffic for a specific destination. See "Configuring Static Routes" on page 72 for descriptions of how to configure a static route.

Firewall Policy

You can configure a firewall policy rule to redirect selected traffic into a tunnel.

Traffic redirected by a firewall policy rule is *not* forwarded to a tunnel that is "down" (see "Tunnel Keepalives" on page 75 for more information on how GRE tunnel status is determined). If you have more than one GRE tunnel configured, you can create multiple firewall policy rules with each rule redirecting the same traffic to different tunnels. If the tunnel in the first traffic redirect rule is down, then the tunnel in the subsequent traffic redirect rule is used instead.

WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to create a new firewall policy, or click Edit to edit a specific policy.
3. Click Add to create a new policy rule.
4. Configure the Source, Destination, and Service for the rule.
5. For Action, select redirect to tunnel. Enter the tunnel ID.
6. Configure any additional options, and click Add.
7. Click Apply.

CLI

```
ip access-list session <name>
   <source> <destination> <service> redirect tunnel <id>
```

Tunnel Keepalives

The controller can determine the status of a GRE tunnel by sending periodic keepalive frames on the tunnel. If you enable tunnel keepalives, the tunnel is considered to be "down" if there is repeated failure of the keepalives. If you configured a firewall policy rule to redirect traffic to the tunnel, traffic is not forwarded to the tunnel until it is "up". When the tunnel comes up or goes down, an SNMP trap and logging message is generated. The remote endpoint of the tunnel does not need to support the keepalive mechanism.

By default, the controller sends keepalive frames at 60-second intervals and retries keepalives up to three times before the tunnel is considered to be down. You can reconfigure the intervals from the default. For the interval, specify a value between 1-86400 seconds. For the retries, specify a value between 0-1024.

Using the WebUI

1. Navigate to the Configuration > Network > IP > GRE Tunnels page.
2. Click Edit for the tunnel for which you are enabling tunnel keepalives.
3. Select (check) Enable Heartbeats to enable tunnel keepalives and display the Heartbeat Interval and Heartbeat Retries fields.
4. Enter values for Heartbeat Interval and Heartbeat Retries.
5. Click Apply.

Using CLI

```
interface tunnel id
tunnel keepalive [<interval> <retries>]
```

Chapter 3

RF Plan

RF Plan is a wireless deployment modeling tool that helps you design an efficient Wireless Local Area Network (WLAN) that optimizes coverage and performance, without complicated WLAN network setup. RF Plan provides the following critical functionality:

- Defines WLAN coverage.
- Defines WLAN environment security coverage.
- Assesses equipment requirements.
- Optimizes radio resources.

RF Plan provides a view of each floor, allowing you to specify how you want to provide wireless coverage for each area. RF Plan also generates coverage maps with AP and AM placement.

Unlike other static site survey tools that require administrators to have intricate knowledge of building materials and other potential radio frequency (RF) hazards, RF Plan calibrates coverage in real-time through a sophisticated RF calibration algorithm. This real-time calibration lets you characterize the indoor propagation of RF signals to determine the best channel and transmission power settings for each AP. You can program the calibration to occur automatically or you can manually launch the calibration at any time to quickly adapt to changes in your wireless environment.

This chapter discusses the following topics:

Supported Planning

All the features included in the WebUI RF Plan tool will aide you in the planning 802.11n standard compliant deployments.

This WebUI RF Plan supports planning of the following types of deployments:

- 802.11n Deployments—The RF Plan now supports planning of network environments that use the Dell's AP-12x series of indoor access points, which are 802.11n compliant. RF Plan supports the planning of these APs in the following capacity: 802.11a/n, 802.11b/g/n, or 802.11a/b/g/n.
- 802.11n Hotspot Deployment within an Existing Environment—This type of environment requires that AP/AM locations be fixed at the building level, see "Fix All Suggested AP/AMs" on page 96. If you set and fix the location of APs prior to planning for the 802.11n APs, the APs will not move when you initialize/optimize the 802.11n AP locations.
- 802.11n Hotspot Deployment and New Environment—The RF Plan allows you to plan for a new deployment that uses an 802.11n hotspot and 802.11a and/or 802.11 b/g support outside of the hotspot.

  To plan for this type of deployment, start by planning your 802.11n hotspot. When you initialize and optimize the APs planned for the hotspot, the 802.11n APs are placed within the hotspot area. However, the same AP type will also be placed outside of the hotspot area with 802.11n support disabled.

RF Plan will deploy APs outside of the hotspot area based on the 802.11a and/or 802.11b/g rates defined by the system. For the system to define 802.11a and/or 802.11b/g rates, the system looks at the defined 802.11n rate and the distance covered by the defined rate; it then selects corresponding 802.11a and/or 802.11b/g rates based on the distance covered.

Before You Begin

Review the following steps to create a building model and plan the WLAN for your model.

Task Overview

1. Gather information about your building's dimensions and floor plan.
2. Determine the level of coverage you want for your APs and AMs.
3. Create a new building and add its dimensions.
4. Enter the parameters of your AP coverage.
5. Enter the parameters of your AM coverage.
6. Add floors to your building and import the floor plans.
7. Define special areas.
8. Generate suggested AP and AM tables by executing the AP/AM Plan features.

Planning Requirements

You should collect the following information before using RF Plan. Having this information readily available will expedite your planning efforts.

- Building dimensions
- Number of floors
- Distance between floors
- Number of users and number of users per AP
- Radio type(s)
- Overlap Factor
- Desired data rates for APs
- Desired monitoring rates for AMs
- Areas of your building(s) that you do not necessarily want coverage
- Areas of your building(s) where you do not want or cannot deploy an AP or AM
- Areas of your building(s) where you want to deploy an 802.11n Hotspot (Zone)
- Any area where you want to deploy a fixed AP or AM

Use the worksheets (Table 4, Table 5, and Table 6) to collect your information:

Table 4 *Planning Worksheet - Building Dimensions*

Building Dimensions
Height:
Width:
Number of Floors:
Number of Users:
Users per AP:

Table 4 *Planning Worksheet - Building Dimensions (Continued)*

Building Dimensions
Radio Types:
AP Type:
Overlap Factor:
802.11a Desired Rate:
802.11n (HT) Support:
Use 40 MHz Channel Spacing:
802.11n Desired Rate:

Table 5 *Planning Worksheet - AP Desired Rates (2.4 GHz Radio Properties)*

AP Desired Rates (2.4 GHz Radio Properties)
802.11b/g Desired Rate:
802.11n (HT) Support:
Use 40 MHz Channel Spacing:
802.11n Desired Rate:

Table 6 *Planning Worksheet - AM Desired Rates*

AM Desired Rates
802.11b|g:
802.11a:
Don't Care/Don't Deploy Areas
802.11n Hotspot (Zone) Areas

NOTE: If 802.11n (HT) support is enabled, the system will automatically define the 802.11a and/or 802.11b/g rate as applicable. For details, see "Radio Properties (Desired Rates and HT Support Options)" on page 86.

Launching the RF Plan

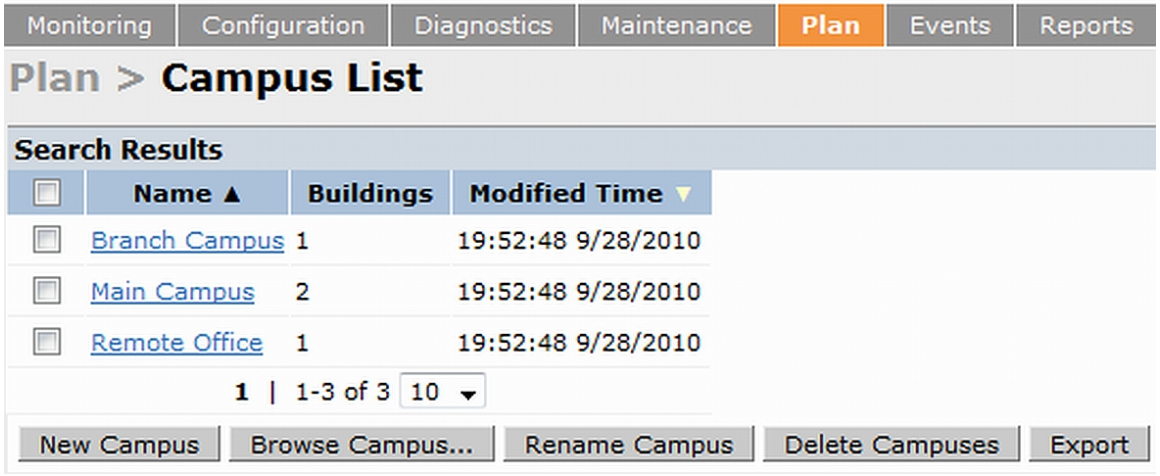
This section describes how to launch the RF Plan and enter information in RF Plan windows.

To launch RF Plan from the WebUI, click the Plan tab in the WebUI menu bar. When you launch the RF Plan, the browser window displays the Campus List page.

Campus List Page

The Campus List is the first page you see when you start RF Plan. This list contains a default campus and any campus you have defined using the RF Plan software.

Figure 6 *Plan>Campus List Window*



You may add, edit, and delete campuses using this page. You may also import and export campus information. Table 7 details the buttons on the Campus page.

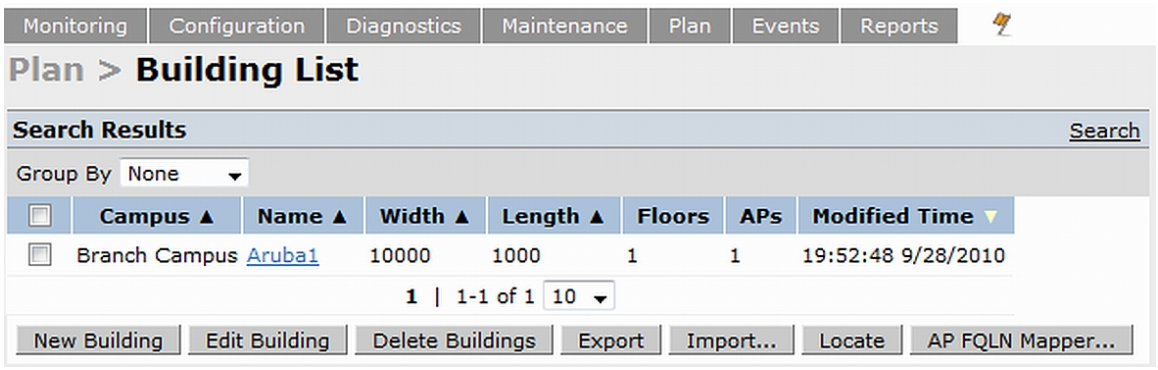
Table 7 *Definition of Campus List Buttons*

Buttons	Description
New Campus	Use this button to create a new campus.
Browse Campus	Use this button to edit existing campuses from the campus list. To edit a campus, select the checkbox next to the campus name, then click Browse Campus. When you edit a campus, you can access other RF Plan pages.
Rename Campus	Use this button to rename an existing campus in the list. To rename a campus, select the checkbox next to the campus name, then click Rename Campus. A dialog box appears into which you enter the new name of the campus. Click OK to accept the new name, or click Cancel to exit this action.
Delete Campuses	Use this button to delete existing campuses in the list. To delete a campus, select the checkbox next to the building ID, then click Delete Campuses. You can only delete empty campuses. If you attempt to delete a campus that contains one or more buildings, an error message appears.
Export	Use this button to export a database file with all the specifications and background images of one or more selected campuses in the list. See "Exporting and Importing Files" on page 97.
Import	Use this button to import database files that define campuses into the RF Plan list. See "Exporting and Importing Files" on page 97.
AP FQLN Mapper	The AP name is a fully-qualified location name (FQLN) in the format *APname.floor.building.campus* (the *APname* portion of the FQLN must be unique). The FQLN is not case sensitive and supports a maximum of 249 characters, including spaces. You can use any combination of characters except a new line, carriage return, and non-printable control characters. You can manually set the FQLN for the AP by clicking the AP FQLN Mapper button. Setting the FQLN will reboot the APs. See "FQLN Mapper" on page 98

Building List Pane

Edit a campus from the building list pane.

Figure 7 *Plan>Building List Pane*



You can add, edit, and delete buildings using this page. You may also import and export building information. The buttons on this page are defined in Table 8.

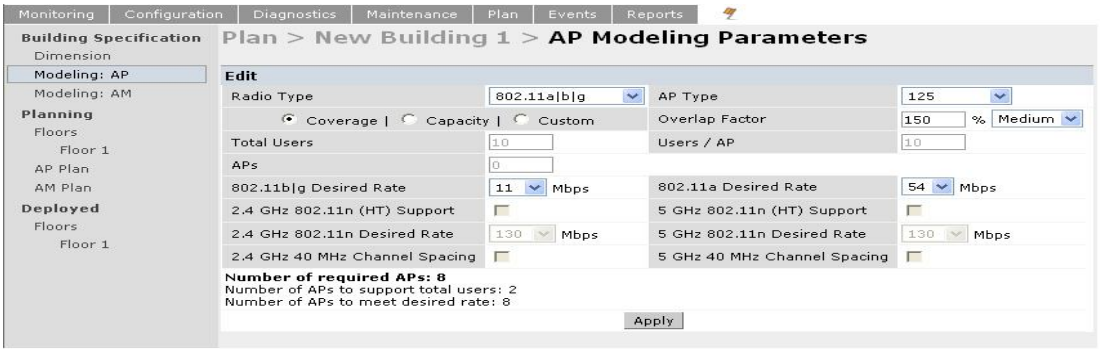
Table 8 *Building List Buttons*

Buttons	Description
New Building	Use this button to create a new building. When you add or edit a building, you can access other RF Plan pages.
Edit Building	Use this button to edit existing buildings in the building list. To edit a building, select the checkbox next to the building ID, then click Edit Building. When you add or edit a building, you can access other RF Plan pages.
Delete Buildings	Use this button to delete existing buildings in the building list. To delete a building, select the checkbox next to the building ID, then click Delete Building.
Export	Use this button to export a database file with all the specifications and background images of one or more selected buildings in the building list. See "Exporting and Importing Files" on page 97.
Import	Use this button to import database files that define buildings into the RF Plan building list. See "Exporting and Importing Files" on page 97.
Locate	Use this button to locate Wi-Fi devices in a building. See "Locate" on page 98.
AP FQLN Mapper	The AP name is a fully-qualified location name (FQLN) in the format *APname.floor.building.campus* (the *APname* portion of the FQLN must be unique). The FQLN is not case sensitive and supports a maximum of 249 characters, including spaces. You can use any combination of characters except a new line, carriage return, and non-printable control characters. You can manually set the FQLN for the AP by clicking the AP FQLN Mapper button. Setting the FQLN will reboot the APs. See "FQLN Mapper" on page 98.

Building Specifications Overview

The Building Specification Overview window displays the default values for a building that you are adding or the current values for a building that you are modifying.

Figure 8 *Plan>New Building>Overview Window*



The Overview page includes the following:

- Building Dimensions: Your building's name and dimensions
- Access Point Modeling Parameters
- Air Monitor Modeling Parameters
- Building Dimension button (in the upper right-hand portion of the page). Click on this button to edit the building dimensions settings.

When you create or edit information for a building, there are several ways you can navigate through RF Plan windows:

- The navigation pane on the left side of the browser window displays RF Plan pages in the order in which they should be accessed when you are creating a new building. If you are editing a building, simply click on the page you want to display or modify.
- A button for the next page appears in the upper right-hand portion of the page. You can click on this button to display the next page. For example, the Building Dimension button appears in the Building Specifications Overview page.
- Clicking Apply on editable pages sequences you to the next page. For example, when you click Apply in the Building Dimensions page, the AP Modeling Parameters page displays.

Building Dimension Page

The Building Dimension page allows you to specify the name and identification for the building and its dimensions. Table 9 defines the parameters to insert in this window.

Figure 9 *Plan>New Building>Specification Window*

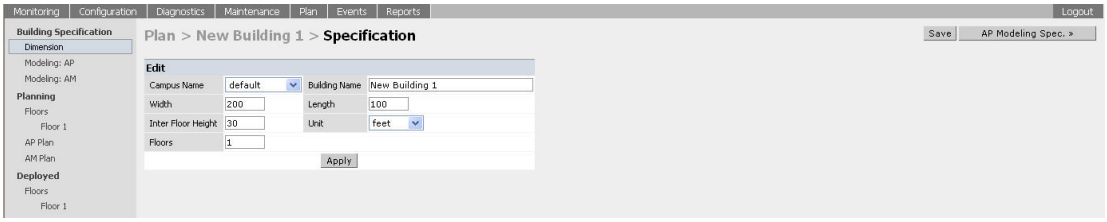
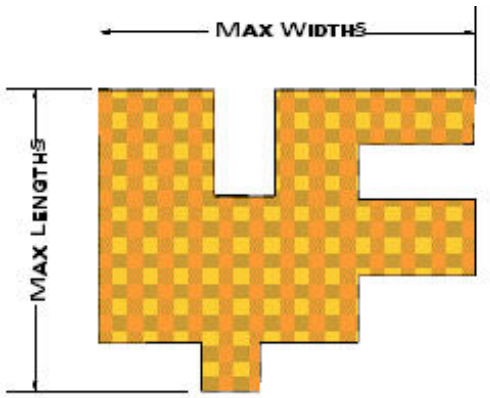


Table 9 contains the information for you to enter in the Specification window.

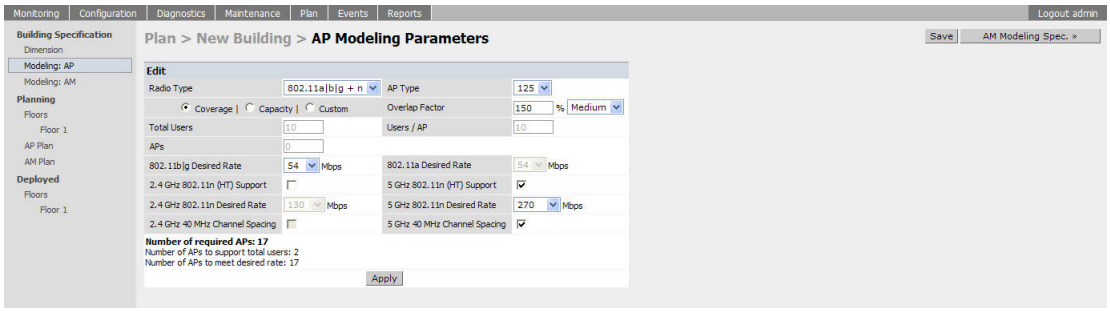
Table 9 *New Building Specifications Parameters*

Parameter	Description
Campus Name	Select a campus for this building from the drop-down menu.
Building Name	The Building Name is an alphanumeric string up to 64 characters in length.
Width and Length	Enter the rectangular exterior dimensions of the building. The valid range for this field is any integer from 1 to a value corresponding to 1x10,000.  If your building has an irregular shape, the width and length should represent the maximum width and length of the overall footprint of the building as seen from above. For example: When width and length are specified, RF Plan creates a rectangular area in the Planning feature pages that represent the overall area covered by the building. You need to import an appropriate background image (see "Floor Editor Dialog Box" on page 90.) to aid you in defining areas that do not require coverage or areas in which you do not wish to deploy APs and AMs (see "Area Editor Dialog Box" on page 91).
Inter-Floor Height	This is the distance between floor surfaces in the building. The valid range for this field is any integer from 1 to a value corresponding to 1x10,000. RF Plan uses the inter-floor height to allow APs on one floor to service users on adjacent floors. If you do not want RF Plan to factor adjacent floors, select a high inter-floor height value (for example, 300). NOTE: This is *not* the distance from floor to ceiling. Some buildings have a large space between the interior ceilings and the floor above.
Floors	Enter the number of floors in your building here. The valid range for this field is any integer from 1 to 255. A building can have a maximum of 255 floors. You can also configure negative floor IDs. Negative floor IDs let you allocate floors as sub floors, ground floors, basements or other underground floors, or floors where you do not need to deploy APs. You specify a negative integer when modifying an existing floor; you do not configure negative floor settings when adding a building or adding a floor. For more information, see "Level" on page 90.
Unit	Specify the unit of measurement for the dimensions you specified on the page. The choices are feet and meters.

AP Modeling Parameters Page

The AP Modeling Parameters page allows you to specify the information necessary for RF Plan to determine the appropriate placement of your APs. These settings are on a per-building basis. If you have a mix of APs, choose the most common one to define the building parameters.

Figure 10 *Plan>New Building>AP Modeling Parameters Window*



This window allows you to select or control the parameters as defined in Table 10.

Table 10 *AP Modeling Parameters*

Parameter	Description
Radio Type	Use this drop-down menu to specify the radio type. See "Radio Type" on page 85
AP Type	Dell AP device. Use the drop-down menu to select the device type. The supported APs listed in the drop-down menu are dependent on the selected radio type.
Design Model	Use the Coverage, Capacity, and Custom radio buttons to specify a design model to use in the placement of APs. See"Design Model" on page 85
Overlap Factor	Use this field and drop-down to specify an overlap factor. See"Overlap Factor" on page 85.
Users	Use this field to specify the number of users on your WLAN. See "Users/AP" on page 86.
Radio Properties (Desired Rates and HT Support Options)	Use this drop-down to define 802.11a, 802.11b/g, and 802.11n settings for the 5 GHz and 2.4 GHz frequency bands, including high-throughput, data rates, and 40 Mhz channel spacing See "Radio Properties (Desired Rates and HT Support Options)" on page 86.
APs	Use this field to enter the fixed number of APs to be used in this building's network (Custom model only).

Radio Type

Use the drop-down radio type menu to specify radio type of your AP. The available types are defined in Table 11.

Table 11 *Radio Type Definitions*

Parameter	Description
801.11a/b/g	Simultaneous use of 802.11b/g and 802.11a.
802.11b/g	2.4 GHz, Direct Spread Spectrum (DSSS) multiplexing with data rates up to 11 Mbps, combined with Orthogonal Frequency Division Multiplexing/Complementary Code Keying (OFDM/CCK) with data rates up to 54 Mbps.
802.11a	5 GHz Orthogonal Frequency Division Multiplexing (OFDM) with data rates up to 54 Mbps.
802.11a/b/g + n	Mixed-mode radio type which allows for simultaneous use of 802.11b/g and 802.11n traffic on the 2.4 GHz frequency band, and 802.11a and 802.11n traffic on the 5 GHZ frequency band.
802.11b/g + n	Mixed-mode radio type that allows for simultaneous use of 802.11b/g and 802.11n traffic on the 2.4 GHz frequency band.
802.11a + n	Mixed-mode radio type that allows for simultaneous use of 802.11a and 802.11n traffic on the 5 GHz frequency band.

Design Model

Three radio buttons, defined in Table 12, allow you to control the kind of model used to determine the number and type of APs.

Table 12 *Design Model Radio Buttons*

Radio Button	Description
Coverage	Use this option to let RF Plan automatically determine the number of APs based on desired data rates and the configuration of your building. The higher the data rate, the smaller the coverage area, and the more APs that are required. Coverage is the most common type of installation.
Capacity	Use this option to let RF Plan determine the number of APs based on the total number of users, ratio of users to APs, and desired data rates. Capacity-based coverage is useful for high capacity conference or training rooms, where the APs could have a high volume of users.
Custom	Use this option to specify a fixed number of APs. Custom coverage is useful for deployments with a known number of APs or if you have a fixed project budget.

Overlap Factor

The Overlap Factor is the amount of signal area overlap when the APs are operating. Overlap is important if an AP fails as it allows the network to self-heal with adjacent APs powering up to assume some of the load from the failed device. Although there may be no holes in coverage in this scenario, there is likely to be a loss of throughput. Increasing the overlap allows for higher throughputs when an AP has failed and allows for future capacity as the number of users increases.

You can select a pre-determined value from the drop-down overlap menu or specify a value in the text box to the left of the drop-down. The following table describes the available options.

Table 13 *Overlap Factor Values*

Overlap Factor	Description
100% Low	Use this option for buildings that contain open spaces such as warehouses.
150% Medium	Use this option for most typical office environments with cubicles and sheetrock walls that have higher WLAN user density than warehouses.
200% High	Use this option for dense deployments such as buildings with poor RF coverage characteristics including buildings with thick brick or concrete walls, lots of metal, or excess RF noise (for example, data centers).
Custom	Use this option to enter a custom rate. For most office spaces, 120% works well. When specifying the custom rate, the valid range is 1% to 1000%.

Users/AP

NOTE: The Users text boxes are active only when the Capacity model is selected.

Enter the number of users you expect to have on your WLAN in the Users text box. Enter the number of users per AP you expect in the Users/AP text box.

The numbers entered in these two text boxes must be non-zero integers between 1-255 inclusive.

Radio Properties (Desired Rates and HT Support Options)

Define 802.11a, 802.11b/g, and 802.11n settings for the 5 GHz and 2.4 GHz frequency bands, including high-throughput, data rates, and 40 Mhz channel spacing.

Table 14 *Radio Properties*

Radio Property	Description
802.11a Desired Rate	The desired 802.11a rate defines the estimated transmit rate within the WLAN coverage area. The higher the speed, the smaller the coverage area, and the more APs required. The valid values are: 54, 48, 36, 24, 18, 12, 9, 6. This option is only available when 802.11n (HT) support is disabled (unchecked or grayed out). When an 802.11n radio type, such as 802.11a + n or 802.11a/b/g + n, is selected and 802.11n (HT) support is enabled (checked) on the 5 GHz band, the system will automatically define the 802.11a rate. The system looks at the defined 802.11n rate and the distance covered by the defined rate; the system then selects a corresponding 802.11a rate based on the distance covered.
5 GHz 802.11 (HT) Support	High-throughput is available when utilizing the IEEE 802.11n standard and can be enabled on the 5 GHz frequency band when either the 802.11a + n or 802.11a/b/g + n mixed-mode radio type is selected. The 802.11n (high-throughput) draft standard supports MIMO (Multiple Input, Multiple Output) and the option of 40 MHz mode of operation. However, high-throughput can be utilized on a 20 MHz channel or on a 40 MHz channel (bonded channel pair).
5 GHz 802.11n Desired Rate	The desired 802.11n rate defines the estimated transmit rate within the WLAN coverage area. The higher the speed, the smaller the coverage area, and the more APs required. This option is only available when 802.11n (HT) support is enabled (checked). The valid values when using 20 MHz channel spacing: 6.5, 13.0, 19.5, 26.0, 39.0, 52.0, 58.5, 65.0, 78.0, 104.0, 117.0, 130.0. The valid values when using 40 MHz channel spacing: 13.5, 27.0, 40.5, 54.0, 81.0, 108.0, 121.15, 135.0, 162.0, 216.0, 243.0, 270.0.

Table 14 *Radio Properties (Continued)*

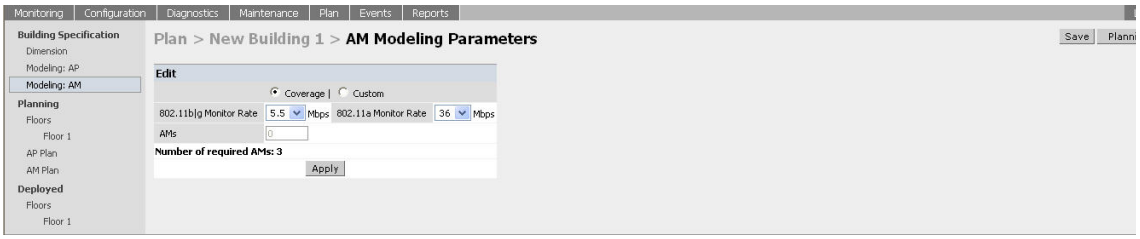
Radio Property	Description
5 GHz Use 40 MHz Channel Spacing	Use 40 MHz Channel Spacing—40 MHz operation, which supports higher data rates by utilizing two 20 MHz channels as a bonded pair, requires that high-throughput be enabled (checked). 40 MHz mode is most often utilized on the 5 GHz frequency band due to a greater number of available channels. This option is only available when 802.11n (HT) support is enabled (checked).
802.11b/g Desired Rate	The desired 802.11b/g rate defines the estimated transmit rate within the WLAN coverage area. The higher the speed, the smaller the coverage area, and the more APs required. The valid values are: 54, 48, 36, 24, 18, 12, 9, 6, 11, 5.5, 2, 1. This option is only available when 802.11n (HT) support is disabled (unchecked or grayed out). When an 802.11n radio type, such as 802.11g + n or 802.11a/b/g + n, is selected and 802.11n (HT) support is enabled (checked) on the 2.4 GHz band, the system will automatically define the 802.11b/g rate. The system looks at the defined 802.11n rate and the distance covered by the defined rate; the system then selects a corresponding 802.11b/g rate based on the distance covered.
2.4 GHz 802.11 (HT) Support	High-throughput is available when utilizing the IEEE 802.11n standard and can be enabled on the 2.4 GHz frequency band when either the 802.11g + n or 802.11a/b/g + n mixed-mode radio type is selected. The 802.11n (high-throughput) draft standard supports MIMO (Multiple Input, Multiple Output) and the option of 40 MHz mode of operation. However, high-throughput can be utilized on a 20 MHz channel or on a 40 MHz channel (bonded channel pair).
2.4 GHz 802.11n Desired Rate	The desired 802.11n rate defines the estimated transmit rate within the WLAN coverage area. The higher the speed, the smaller the coverage area, and the more APs required. This option is only available when 802.11n (HT) support is enabled (checked). The valid values when using 20 MHz channel spacing: 6.5, 13.0, 19.5, 26.0, 39.0, 52.0, 58.5, 65.0, 78.0, 104.0, 117.0, 130.0. The valid values when using 40 MHz channel spacing: 13.5, 27.0, 40.5, 54.0, 81.0, 108.0, 121.15, 135.0, 162.0, 216.0, 243.0, 270.0.
2.4 GHz Use 40 MHz Channel Spacing	40 MHz operation, which supports higher data rates by utilizing two 20 MHz channels as a bonded pair, requires that high-throughput be enabled (checked). Due to a limited number of channels on the 2.4 GHz frequency band, 40 MHz mode is most often utilized on the 5 GHz frequency band where a greater number of channels are available. This option is only available when 802.11n (HT) support is enabled (checked).

AM Modeling Page

The AM Modeling page allows you to specify the information necessary for RF Plan to determine the appropriate placement of your AMs.

NOTE: The AM coverage rate refers to the rate at which an AM captures packets. RF Plan uses that information to determine the placement of AMs.

Figure 11 *AM Modeling Page*



Controls on this page allow you to select the following functions, which are described in more detail in this section:

Table 15 *AM Modeling Radio Buttons*

Radio Button	Description
Design Model	Use these radio buttons to specify a design model to use in the placement of AMs. See "Design Models" on page 88.
Monitor Rates	Use this drop-down menu to specify the desired monitor rate for the AMs. See "Monitor Rates" on page 88.
AMs	Use this field to manually specify the number of AMs to deploy (Custom Model only).

Design Models

Two radio buttons on the page allow you to specify the model used to determine the number and type of APs.

Table 16 *Design Model Radio Buttons*

Radio Button	Description
Coverage	Use this option to let RF Plan automatically determine the number of AMs based on desired monitor rates and the configuration of the building. Desired rate is selectable from 1 to 54 Mbps in the Coverage model.
Custom	Use this option to specify a fixed number of AMs. When the AM Plan portion of RF Plan is executed, RF Plan distributes the AMs evenly.

NOTE: The monitor rates you select for the AMs should be less than the data rates you selected for the APs. If you set the rate for the AMs at a value equal to that specified for the corresponding PHY type AP, RF Plan allocates one AM per AP. If you specify a monitor rate greater than the data rate, RF Plan allocates more than one AM per AP.

Monitor Rates

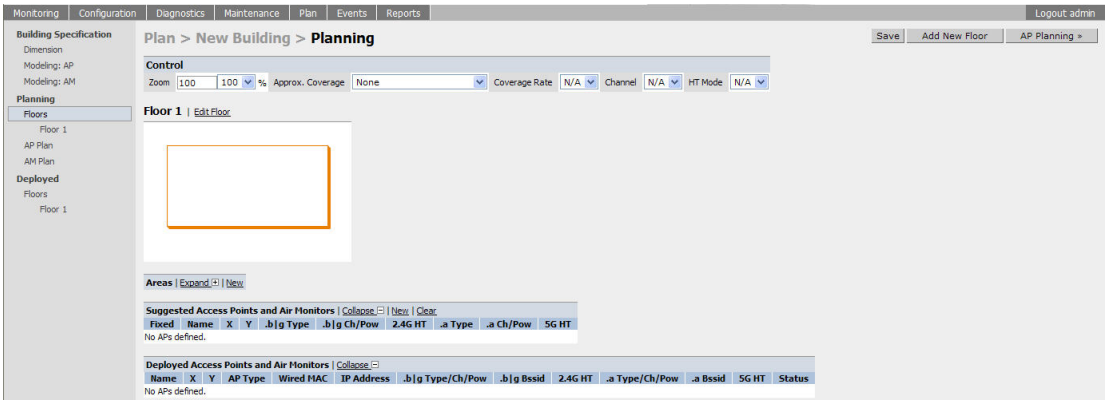
Use the drop down menus to select the desired monitor rates for the 2.4 Ghz (802.11b/g) and 5 GHz (802.11a) frequency bands. The available monitor rates that display in drop-down lists will vary: these rates are dependent on the radio type selected on AP modeling page and they will also be adjusted to accommodate for 20 MHz vs. 40 MHz channel spacing when 802.11n (HT) support is enabled.

NOTE: This option is available only when the coverage design model is selected.

Planning Floors Page

The Planning Floors page enables you to see the footprint of your floors.

Figure 12 *Planning Floors*



You can select or adjust the features as described in Table 17:

Table 17 *Floor Planning Features*

Feature	Description
Zoom	Use this drop-down menu or type a zoom factor in the text field to increase or decrease the size of the displayed floor area. See "Zoom" on page 89.
Approximate Coverage Map (select radio type)	Use this drop-down to select a particular radio type for which to show estimated coverage. See "Approximate Coverage Map" on page 90.
Edit Floor	Click on this link to launch the Floor Editor dialog box. See "Floor Editor Dialog Box" on page 90.
New in Areas section	Click on this link to launch the Area Editor dialog box. See "Area Editor Dialog Box" on page 91.
New in Suggested Access Points and Air Monitors section	Click on this link to launch the Suggested Access Point Editor dialog box. See "Access Point Editor Dialog Box" on page 92.
Status in Deployed Access Points and Air Monitors section	The Status column displays the status of each AP for the floor you are viewing within a live network. Up: AP is up (live). The corresponding AP icon on the floor map will display a live AP icon.  Down: AP is down. The corresponding AP icon on the floor map will display with a red "X" over the AP icon symbolizing that the AP is down. 

Zoom

The Zoom control sets the viewing size of the floor image. It is adjustable in finite views from 10% to 1000%. You may select a value from the drop-down zoom menu or specify a value in the text box to the left of the drop-down. When you specify a value, RF Plan adjusts the values in the drop-down to display a set of values both above and below the value you typed in the text box.

Approximate Coverage Map

Select a radio type from the Coverage drop-down menu to view the approximate coverage area for each of the APs that RF Plan has deployed in AP Plan or AM Plan. Adjusting the coverage values help you to understand how the AP coverage works in your building.

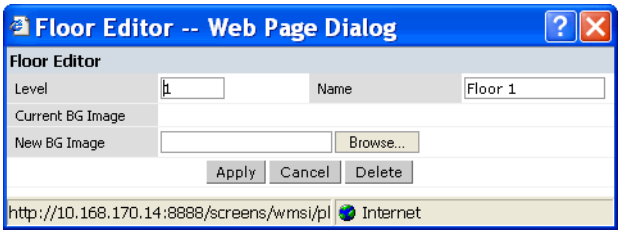
NOTE: You will not see coverage areas displayed here until you have executed either an AP Plan or an AM Plan.

Figure 13 *Coverage Map Example*

Floor Editor Dialog Box

The Floor Editor dialog box allows you to modify the floor level, specify the background image, and name the floor. The Floor Editor is accessible from the Floors Page by clicking on the **Edit Floor** link.

Figure 14 *Floor Editor Dialog Box*



Level

When modifying an existing floor, you can configure it with a negative integer to specify a basement or some other underground floor that you do not need or want to deploy APs.

To configure a negative floor, specify a negative integer in the Level field. The valid range is -100 to 255; however, a building can have a maximum of 255 floors.

Naming

You may name the floor anything you choose as long as the name is an alphanumeric string with a maximum length of 64 characters. The name you specify appears to the right of the Floor Number displayed above the background image in the Planning view.

Background Images

You can import a background image (floor plan image) into RF Plan for each floor. A background image is extremely helpful when specifying areas where coverage is not desired or areas where an AP/AM is not to be physically deployed.

Use the guidelines in this section when importing background images. By becoming familiar with these guidelines, you can ensure that your graphic file is edited properly for pre- and post-deployment planning.

- Edit the image—Use an appropriate graphics editor to edit the file as needed.
- Scale the image—If the image is not scaled, proportional triangulation and heat map displays can be incorrect when the plan is deployed.
- Calculate image dimensions—Calculate the image pixels per feet (or meters) against a known dimension. Use that value to calculate the width and length of the image.
- Leave a border around the image—When creating the image, leave a boarder around the image to help triangulate Wi-Fi devices outside of the building.
- Multiple floors—If your building has multiple floors, make sure there is a common anchor point for all floors; for example an elevator shaft, a staircase, and so on.
- Larger dimensions—Use larger dimensions only for scaling to more accurately calculate the full dimensions. For best results, final floor images 2048 X 2048 and smaller perform best.

Select a background image using the Browse button on the Floor Editor dialog box.

- File Type and Size

  Background images must be JPEG format and may not exceed 2048 X 2048 pixels in size. Attempting to import a file with a larger pixel footprint than that specified here results in the image not scaling to fit the image area in the floor display area.

  Because background images for your floors are embedded in the XML file that defines your building, you should strongly consider minimizing the file size of the JPEGs that you use for your backgrounds. You can minimize the file size by selecting the maximum compression (lowest quality) in most graphics programs.

NOTE: The ArubaOS WebUI displays floor plans using Adobe Flash Player, which does not support progressive JPEG images. If you have a progressive JPEG image you want to use as background image, open the image in an image editing program and re-save the image with standard/baseline compression.

- Image Scaling

  Images are scaled (stretched) to fit the display area. The display area aspect ratio is determined by the building dimensions specified on the Dimension page.

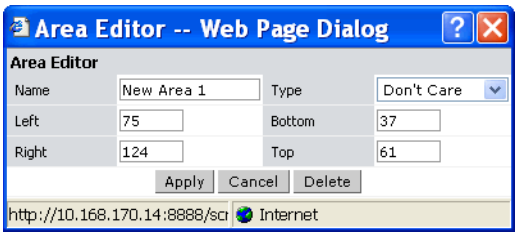
Area Editor Dialog Box

The Area Editor dialog box allows you to specify areas on your building floors where you either do not care about coverage, or where you do not want to place an AP or AM.

Open the Area Editor dialog box by clicking **New** in the Areas section.

You specify these areas by placing them on top of the background image using the Area Editor.

Figure 15 *Area Editor Dialog Box*



Naming

Logical name of area, as an alphanumeric string consisting of 1 to 64 characters. Dell recommends that you provide a meaningful name to the area to ensure that it is readily identifiable.

Location and Dimensions

Specify absolute coordinates for the lower left corner and upper right corner of the box that represents the area being defined.

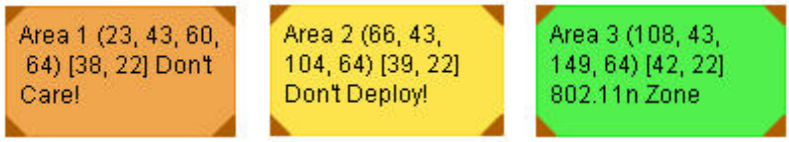
- Begin the measurement with the lower left corner of the rectangular display area that represents your building's footprint.
- The coordinates of the upper right-hand corner of the display area are the absolute values of the dimensions you provided for the building.

Location settings are zero-based. Values range from 0 to (height -1 and width -1). For example, coordinates of the upper right corner for a building that measures 200 ft. wide x 400 ft. in length, would be 199 and 399.

NOTE: The unit of measurement displayed as either feet or meters is based on your building settings. See "Building Dimension Page" on page 82 for details about configuring building parameters.

You may also use the drag and drop feature of the Area Editor to drag your area to where you want it and resize it by dragging one or more of the handles displayed in the corners of the area.

Area Types



Select one of the area types from the drop-down menu: Don't Care, Don't Deploy, or 802.11n Zone.

- Don't Care: Coverage is not required in the area specified in this dialog box. This specification typically applies to areas where coverage cannot be guaranteed.

  This setting results in the display of an orange rectangle at the associated area in the floor diagram.
- Don't Deploy: No APs are to be positioned in the area specified in this dialog box.

  This setting results in display of a yellow rectangle at the associated area in the floor diagram.
- 802.11n Zone: 802.11n compliant APs are required to be positioned in the area specified in this dialog box only.

  This setting results in display of a green rectangle at the associated area in the floor diagram.

You cannot right-click within an existing area to add another area inside of it. For instance, if a Don't Care or Don't Deploy Area needs to overlap with an 802.11n Zone, you must create each of the areas outside of one another and then move them to the correct position of overlap. You can click and drag the areas to the appropriate positions of overlap, or you can right-click on the area to modify its location.

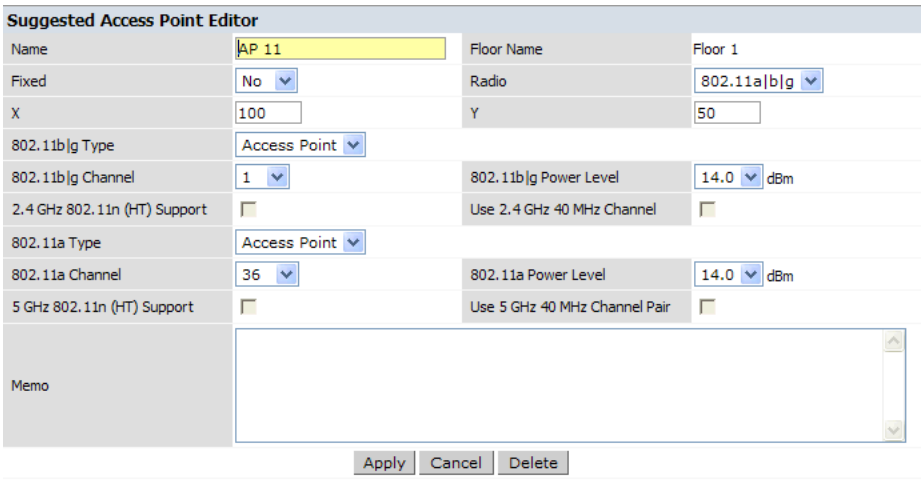
Access Point Editor Dialog Box

The Access Point Editor allows you to manually create or modify a suggested AP.

To create an AP, open the Access Point Editor dialog box by clicking **New** in the Suggested Access Points and Air Monitors section.

To modify an existing AP, place the cursor over the AP and click it to display the Suggested Access Point Editor dialog box.

Figure 16 *Access Point Editor*



Naming

RF Plan automatically names APs using the default convention `ap` *number*, where *number* starts at 1 and increments by one for each new AP. When you manually create an AP, the new AP is assigned the next number and is added to the bottom of the suggested AP list.

You may name an AP anything you wish. The name must consist of alphanumeric characters and be 64 characters or less in length.

Fixed

Fixed APs do not move when RF Plan executes the positioning algorithm.

NOTE: You might typically set a fixed AP when you have a specific room, such as a conference room, in which you want saturated coverage. You might also want to consider using a fixed AP when you have an area that has an unusually high user density.

Choose Yes or No from the drop-down menu. Choosing Yes locks the position of the AP as it is shown in the coordinate boxes of the Access Editor. Choosing No allows RF Plan to move the AP as necessary to achieve best performance.

Radio Types

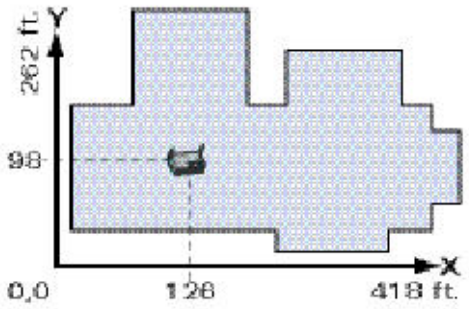
The Radio drop-down menu allows you to specify what frequency band the AP uses. You can choose from one of the following:

- 802.11a/b/g (2.4 GHz and 5 GHz frequency bands)
- 802.11a (5 GHz frequency band)
- 802.1 b/g (2.4 GHz frequency band)

NOTE: 802.11n (HT) support features are available on the 2.4 or 5 GHz frequency band. The availability of these options on these frequency bands is dependent on the radio (frequency band) chosen and whether or not these feature were enabled on the AP modeling page at the building level.

X and Y Coordinates

The physical location of the AP is specified by X-Y coordinates that begin at the lower left corner of the display area. The numbers you specify in the X and Y text boxes are whole units. The Y-coordinate increases as a point moves up the display and the X-coordinate increases as they move from left to right across the display.



802.11 Types

The 802.11 b/g and 802.11a Type drop-down menus allow you to choose the mode of operation for the AP. You may choose to set the mode of operation to Access Point or Air Monitor.

802.11 Channels

The 802.11a and 802.11b/g channel drop-down menus allow you to select from the available channels.

NOTE: The available channels vary depending on the regulatory domain (country) in which the device is being operated.

802.11 Power Levels

The power level drop-down menus allow you to specify the transmission power of the AP. Choices are OFF, 0, 1, 2, 3, and 4. A setting of 4 applies the maximum Effective Isotropic Radiated Power (EIRP) allowed in the regulatory domain (country) in which you are operating the AP.

802.11n Features

- 802.11n (HT) Support (2.4 or 5 GHz): Specify if 802.11n high-throughput support should be enabled on this AP.

  In order to enable high-throughput on a new AP being added to the plan at the floor level, 802.11n (HT) support must first be enabled at the building level within the AP modeling parameters. If not, this option will be grayed out. See "AP Modeling Parameters Page" on page 83 for details about AP modeling parameters.
- Use 40 MHz Channel (2.4 or 5 GHz): Specify if 802.11n high-throughput support should utilize a 40 MHz channel (bonded channel pair).

  In order to select a valid 40 MHz channel for a new AP being added at the floor level, use of 40 MHz channel spacing must first be enabled at the building level within the AP modeling parameters. If not, this option will be grayed out. See "AP Modeling Parameters Page" on page 83 for details about AP modeling parameters.

  If high-throughput is enabled and use of a 40 MHz channel pair is not enabled, a 20 Mhz channel will be utilized.

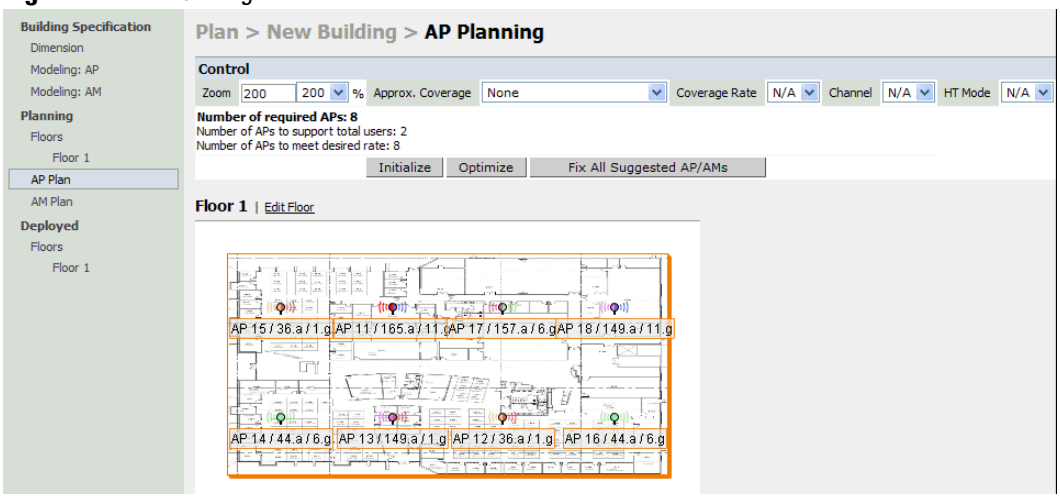
Memo

The Memo text field allows you to enter notes regarding the AP. You can enter a maximum of 256 alphanumeric characters in the Memo field.

AP Plan Page

The AP Plan page uses the information entered in the modeling pages to locate APs in the building(s) you described. All of the options on the Floors page can also be viewed and configured on the AP Plan page. The AP Plan page also includes some additional options, such as initializing, optimizing, and fixing AP/AM locations.

Figure 17 *AP Planning*



Initialize

Initialize the Algorithm by clicking the Initialize button. This makes an initial placement of the APs and prepares RF Plan for the task of determining the optimum location for each of the APs. As soon as you click Initialize you see the AP symbols appear on the floor plan.

Colored circles around the AP symbols on the floor plan indicate the approximate coverage of the individual AP and the color of the circle represents the channel on which the AP is operating. The circles appear when you select an *approximate coverage* value on one of the Floors pages. You may also click an AP icon and drag it to manually reposition it.

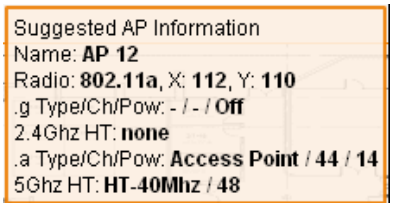
Optimize

Click Optimize to launch the optimizing algorithm. The AP symbols move on the page as RF Plan finds the optimum location for each.

The process may take several minutes. You may watch the progress on the status bar of your browser. The algorithm stops when the movement is less than a threshold value calculated based on the number of APs. The threshold value may be seen in the status bar at the bottom of the browser window.

Viewing the Results

The results of optimizing algorithm may be viewed two ways: graphically and in a table of suggested APs. You may obtain information about a specific AP by placing the cursor over its symbol. An information box appears that contains information regarding location, radio type, high-throughput support, channel(s), and power.



The Suggested Access Points and Air Monitors table lists the coordinates, power, location, power setting, high-throughput support, and channel(s) for each of the APs that are shown in the floor plan.

Suggested Access Points and Air Monitors | Collapse | New | Clear

Fixed	Name	X	Y	.b|g Type	.b|g Ch/Pow	2.4G HT	.a Type	.a Ch/Pow	5G HT
No	AP 11	151	76	-	- / -	-	Access Point	36 / 14	40Mhz/40
No	AP 12	77	125	-	- / -	-	Access Point	44 / 14	40Mhz/48
No	AP 13	225	26	-	- / -	-	Access Point	44 / 14	40Mhz/48
No	AP 14	75	25	-	- / -	-	Access Point	157 / 14	40Mhz/161
No	AP 15	227	126	-	- / -	-	Access Point	157 / 14	40Mhz/161
No	AP 16	51	75	-	- / -	-	Access Point	149 / 14	40Mhz/153
No	AP 17	251	77	-	- / -	-	Access Point	149 / 14	40Mhz/153

Fix All Suggested AP/AMs

Fix existing AP/AM locations at the building level. If AP/AM locations are fixed, AP/AMs will not move from their fixed locations during initialization or optimization. Clicking on this button will fix the locations of existing APs and AMs. You only need to click this button on either the AP or AM Plan page.

AM Plan Page

The AM Plan page uses the information entered in the modeling pages to locate AMs in the building(s) you described and calculate the optimum placement for the AMs. All of the options on the Floors page can also be viewed and configured on the AM Plan page. The AM Plan page also includes some additional options, such as initializing, optimizing, and fixing AP/AM locations.

Initialize

Initialize the Algorithm by clicking Initialize. This makes an initial placement of the AMs and prepares RF Plan for the task of determining the optimum location for each of the AMs. When you click Initialize, the AM symbols appear on the floor plan.

Optimize

Click Optimize to launch the optimizing algorithm. The AM symbols move on the page as RF Plan finds the optimum location for each.

The process may take several minutes. You may watch the progress on the status bar of your browser. The algorithm stops when the movement is less than a threshold value calculated based on the number of AMs. The threshold value may be seen in the status bar at the bottom of the browser window.

Viewing the Results

Viewing the results of the AM Plan feature is similar to that for the AP Plan feature.

The results of optimizing algorithm may be viewed two ways: graphically and in a table of suggested AMs. You may obtain information about a specific AM by placing the cursor over its symbol. An information box appears that contains information about the exact location, PHY type, high-throughout-support, channel, power, and so on.

The Suggested Access Points and Air Monitors table lists the coordinates, power, location, power setting, and channel for each of the AMs that are shown in the floor plan.

Fix All Suggested AP/AMs

Fix existing AP/AM locations at the building level. If AP/AM locations are fixed, AP/AMs will not move from their fixed locations during initialization or optimization. Clicking on this button will fix the locations of existing APs and AMs. You only need to click this button on either the AP or AM Plan page.

Exporting and Importing Files

Both the Campus List page and the Building List page have Export and Import buttons, which allow you to export and import files that define the parameters of your campus and buildings. You can export a file so that it may be imported into and used to automatically configure a controller. On a controller, you can import a file that has been exported from another controller or from the standalone version of RF Plan that runs as a Windows application.

NOTE: The WebUI version of RF Plan only supports JPEG file formats for background images.

The files that you export and import are XML files and, depending on how many buildings are in your campus, floors are in your buildings, and how many background images you have for your floors, the XML files may be quite large. (See "Background Images" on page 90.)

NOTE: In order for the WebUI RF Plan tool to import and read a standalone plan that incorporates 802.11n standard APs and was originally created in the Java-based standalone RF Plan tool, the plan must be exported out from the standalone tool using the Controller WebUI Format (version 3.0).

Export Campus

To export a file that defines the parameters of one or more campuses, including all of its associated buildings, select the campus(es) to be exported in the Campus List page and then click Export.

After you click the Export button, you are prompted to include the background images.

When exporting a campus file, Dell recommends that you click OK to export the background images. If you click Cancel, the exported file does not include the background images. The File Download window appears.

From the File Download window, click Save to save the file. The Save As dialog box appears. From here, navigate to the location where you want to save the file and enter the name for the exported file. When naming your exported file, be sure to give the file the.*XML* file extension, for example, *My_Campus.XML*.

Exported campus files include detailed information about the campus and the selected building(s).

Import Campus

You can import only XML files exported from another controller or from the standalone version of RF Plan that runs as a Windows application.

NOTE: Importing any other file, including XML files from other applications, may result in unpredictable results.

To import a file that defines the building parameters of one or more campuses, click the Import button in the Campus List page. The Import Buildings page appears, as described in "Import Buildings Page" on page 98.

Export Buildings Page

To export a file that defines the parameters of one or more buildings, select the building(s) to be exported in the Building List page and then click Export.

After you click the Export button, you are prompted to include the background images.

When exporting a building file, Dell recommends that you click OK to export the background images. If you click Cancel, the exported file does not include the background images. The File Download window appears.

From the File Download window, click Save to save the file. The Save As dialog box appears. From here, navigate to the location where want to save the file and enter the name for the exported file. When naming your exported file, be sure to give the file the.*XML* file extension, for example, *My_Building.XML*.

Exported building files include the name of the campus to which the building belongs; however, detailed campus parameters are not included.

Import Buildings Page

You can import only XML files exported from another controller or from the standalone version of RF Plan that runs as a Windows application.

NOTE: Importing any other file, including XML files from other applications, may result in unpredictable results.

To import a file that defines the parameters of one or more buildings, click the Import button in the Building List page.

In the Import Buildings page, click Browse to select the file to be imported, then click the Import button.

Locate

The Locate button on the Building List page allows you to search for APs, AMs, monitored clients, etc. on a building by building basis. To use this feature, select the building in which you want to search, and click **Locate**.

The Target Devices table displays information on each of these devices. To add a device, click **Add Device**. To delete a device, click **Remove Device**. To select a device, click **Choose Devices**.

FQLN Mapper

Both the Campus List page and the Building List page have the AP FQLN Mapper button, which allows you to create a fully-qualified location name (FQLN) for the specified AP/AM in the format *APname.Floor.Building.Campus*.

The FQLN is not case sensitive and supports a maximum of 249 characters, including spaces. You can use any combination of characters except a new line, carriage return, and non-printable control characters.

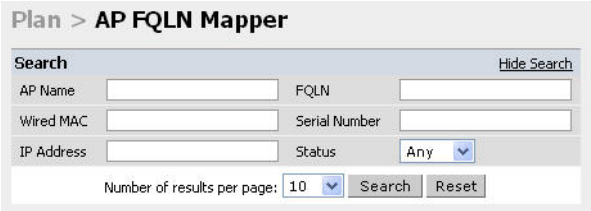
You can use the FQLN mapper for multiple purposes, including:

- Searching for deployed APs/AMs
- Configuring the AP name in the form APname.Floor.Building.Campus
- Modifying the location of APs

To use this feature, select one or more campuses from the Campus List page, or one or more buildings from the Building List page, and click AP FQLN Mapper.

The AP FQLN Mapper page appears. From here, you can search for deployed APs by entering one or more parameters in the Search fields, view the results in the Search Results table, configure the FQLN, and modify the location of an AP.

To search for deployed APs, enter information in the Search fields and click Search.



You can perform a search based on one or more of the following AP properties:

Table 18 *AP Property Search*

Property	Description
AP Name	Logical name of the AP or AM. You can enter a portion of the name to widen the search.
Wired MAC	MAC address of the AP or AM. You can enter a portion of the MAC address to widen the search.
IP Address	IP address of the AP or AM. You can enter a portion of the IP address to widen the search.
FQLN	Fully-qualified location name of the AP, in the form APname.floor.building.campus. You can enter a portion of the FQLN to widen the search.
Serial Number	Serial number of the AP. You can enter a portion of the serial number to widen the search.
Status	Current state of the AP, including Up/Down/Any.

Use the drop-down list to the right of the Number of results per page to specify the number of APs to display in the search results.

After entering the search criteria, you can either click Reset to clear the entries or click Search to search for APs. If you click Search, the results are displayed in the Search Result table:

You can view the information in ascending or descending order. By default, the display is in ascending order, based on the AP name (the white arrow indicates the row that is being used to sort the information). Left-click on a column head to view the information in ascending or descending order (you may need to click multiple times to get the desired display).

In addition to displaying AP names, wired MAC addresses, serial numbers, IP addresses, FQLNs, and AP status, the Search Result table displays the AP type and when it was last updating.

From here you can modify the attributes that create the FQLN for the selected AP, using the following drop-down lists:

- Campus—Displays the campus where the AP is deployed. To deploy the AP in a different campus, select a campus form the drop-down list. The Campus defines the buildings and floors displayed.

NOTE: This drop-down list only displays the existing campuses that you are managing. To add a new campus, see "Campus List Page" on page 80.

- Building—Displays the building where the AP is deployed. To deploy the AP in a different building, select a building from the drop-down list.

NOTE: This drop-down list only displays the available buildings in the selected campus. To add a new building, see "Building List Pane" on page 81.

- Floor—Displays the floor where the AP is deployed. To deploy the AP on a different floor, select a floor from the drop-down list.

NOTE: This drop-down lists only displays the available floors in the selected building. To add a new floor, see "Planning Floors Page" on page 88.

To submit your changes, click Set FQLN. Setting the FQLN reboots the APs.

Using the FQLN Mapper in the AP Provision Page

The AP Provision page (available from Configuration > Wireless > AP Installation) allows you to set an FQLN during the AP provisioning process.

Scroll to the FQLN Mapper near the bottom of the AP Provision page to modify the following attributes that create the FQLN:

- Campus
- Building
- Floor

The AP name appears in the AP List at the bottom of the page and will be used when provisioning the AP. To rename an AP, enter the new name in the AP Name field.

To retain the old FQLN value when reprovisioning an AP, *do not* select the Overwrite FQLN checkbox. However, if you configure new values for the campus, building, and floor settings, the FQLN value is changed, even if the Overwrite FQLN checkbox is selected. To remove a previously configured value, you can select N/A for a specific attribute.

If you provision more than one AP, the selected value for the campus, building, and floor is based on the first selected AP and applies to all APs. Only the AP name will be different as each AP must have a unique name.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Installation page. The list of discovered APs appears in the page.
2. Select the AP you want to set an FQLN, and click Provision.
3. Modify the FQLN attributes:
   - In the Provisioning page, scroll to the FQLN Mapper near the bottom of the page and modify the campus, building, and floor attributes.
   - Optionally, if you want rename an AP, scroll to the AP List at the bottom of the page and enter the new name in the AP Name field. For more information about AP names, see Chapter 4, "Access Points" on page 107.
4. Click Apply and Reboot.

Using CLI

Reprovisioning the AP causes it to automatically reboot. When configuring the FQLN, you may also provision other AP settings.

The following example assumes you are not renaming an AP For more information about AP names, see Chapter 4, “Access Points” on page 107.

```
provision-ap
      read-bootinfo ap-name <name>
      copy-provisioning-params ap-name <name>
      fqln <name>
      reprovision ap-name <name>
```

RF Plan Example

This section guides you through the process of creating a building and populating it with APs and AMs using RF Plan. Ensure you have sample.JPEG floor images handy for walking through this planning example.

Sample Building

Table 19 lists the information to be used in this coverage-based planning example.

Table 19 *Sample Building*

Building Dimensions
Height: 100
Width: 100
Number of Floors: 2
User Information
Number of Users: N/A
Users per AP: N/A
Radio Types: 802.11a/b/g/n
AP Type: AP-93
Overlap Factor: 150% (Medium)
AP Desired Rates (5 GHz Radio Properties)
802.11a Desired Rate: 48 Mbps
802.11n (HT) Support: N/A
Use 40 MHz Channel Spacing: N/A
802.11n Desired Rate: N/A
AP Desired Rates (2.4 GHz Radio Properties)
802.11b/g Desired Rate: 48 Mbps
802.11n (HT) Support: N/A
Use 40 MHz Channel Spacing: N/A
802.11n Desired Rate: N/A
AM Desired Rates
802.11b|g: 24 Mbps
802.11a: 24 Mbps

Table 19 *Sample Building (Continued)*

Building Dimensions
Don't Care/Don't Deploy Areas
Shipping & Receiving = Don't CareLobby = Don't Deploy
802.11n Hotspot (Zone) Areas
N/A

Create a Building

In this section you create a building using the information supplied in the planning table.

1. In the Campus List, select New Campus. Enter: My Campus and click OK.
2. In the Campus List, select the checkbox next to My Campus, and click Browse Campus.
3. Click New Building. The Overview page appears.
4. Click Save. A dialog box appears that indicates the new building was saved successfully. Click OK to close the dialog box.
5. Click Building Dimension. The Specification page appears.
6. Enter the following information in the text boxes.

Table 20 *Create a Building*

Text Box	Information
Campus Name	My Campus (The name is automatically populated based on what you entered in step 1)
Building Name	My Building
Width	100
Length	100
Inter Floor Height	20
Units	Feet
Floors	2

7. Click Save. A dialog box appears that asks if you want to save and reload this building now since the building name was changed. Click OK to accept.

   Another dialog box appears stating that the building was saved successfully. Click OK to close the dialog box.
8. Click Apply. RF Plan returns you to the Overview page.

Model the Access Points

You now determine how many APs are required to cover your building with a specified data transfer rate and overlap.

In this example, you use the Coverage Model. The following are assumed about the performance of the WLAN:

- Radio Types: 802.11a/b/g/n
- AP Type: AP-93
- Overlap factor: Medium (150%)
- 802.11a desired rate: 48 Mbps
- 802.11b desired rate: 48 Mbps

1. From the navigation tree, Click on Modeling:AP under Building Specification. The AP Modeling Parameters page appears.
2. Select 801.11 a|b|g|n from the Radio Type drop-down menu.
3. Select Medium from the Overlap Factor drop-down menu.
4. Notice that the percentage show at the left of the drop-down menu changes to 150%.
5. Select 48 from the 802.11 b|g Desired Rate drop-down menu.
6. Select 48 from the 801.11 a Desired Rate drop-down menu.
7. Click Save, then OK.
8. Click Apply. RF Plan moves to the AM Modeling Parameters page.

Model the Air Monitors

You now determine how many AMs are required to provide a specified monitoring rate. In this example you continue to use the Coverage Model and make the following assumptions:

- 802.11 b|g monitor rate: 24 Mbps
- 802.11 a monitor rate: 24 Mbps

1. Select 24 from the 802.11 b|g Monitor Rate drop-down menu.
2. Select 24 from the 802.11 a Monitor Rate drop-down menu.
3. Click Save, then OK.
4. Click Apply. RF Plan moves to the Planning page.

Add and Edit a Floor

You now add floor plans to your floors. In this section you:

- Add a background image floor plan for each floor
- Name the floors

NOTE: The information in this section assumes that you have a JPEG file that you can use as a sample background image when re-creating the steps.

Adding the background image and naming the first floor

1. In the Planning page, click the Edit Floor link at the right of the Floor 1 indicator. The Floor Editor dialog box appears.
2. Enter: Entrance Level in the Name box of the Floor Editor Dialog.
3. Use the Browse button to locate the background image for the 1st floor.
4. Click Apply.

Adding the background image and naming the second floor

1. Click the Edit Floor link at the right of the Floor 2 indicator.
2. Enter: Second Level in the Name box of the Floor Editor Dialog.
3. Use the Browse button to locate the background image for the 2nd floor.
4. Click Apply.
5. Click Save on the Planning page, then OK.

Defining Areas

Before you advance to the AP and AM Planning pages, define special areas, such as Don't Care, Don't Deploy, or 802.11n Zone. This example includes a Don't Care and a Don't Deploy Area.

This example assumes the following:

- We do not care if we have coverage in the Shipping and Receiving Area
- We do not want to deploy APs or AMs in the Lobby Area

Creating a Don't Care Area

NOTE: You can zoom in on the floor plan using the Zoom drop-down near the top of the AP Planning page, or type a zoom value in the text box at the left of the drop-down and press the enter key on your keyboard. For example, enter a zoom factor of 400.

1. In the Planning page, click the New link in the Areas section under Floor 1 (named Entrance Level).

   This opens the Area Editor.
2. Enter: Shipping and Receiving in the Name text box in the Area Editor.
3. Select Don't Care from the Type drop-down menu box.
4. Click Apply.

   Notice that an orange box appears near the center of the floor plan.
5. Use your mouse (or other pointing device) to place the cursor over the box.

   Notice that the information you typed in the editor appears in the box. You see the name and type of area, as well as the coordinates of the lower left corner and upper right corner of the box.

NOTE: The x = 0 and y = 0 coordinates correspond to the lower left corner of the layout space.

6. Using your mouse, left-click and drag the box to the area of your floor plan that will represent the shipping and receiving area.
7. To position the Don't Care box, drag one corner of the box to a corresponding corner and using one of the corner handles of the box, stretch it to fit.

   You can also position the box by entering values in the Left, Bottom, Right, and Top fields.
8. Click Save, then OK.

Creating a Don't Deploy Area

1. Click the New link in the Areas section under Floor 1 (named Entrance Level) to open the Area Editor.
2. Enter: Lobby in the Name text box in the Area Editor.
3. Select Don't Deploy from the Type drop-down menu box.
4. Click Apply.

   Notice that an yellow box appears near the center of the floor plan.
5. Use your mouse (or other pointing device) to place the cursor over the box.

   Notice that the information you typed in the editor appears in the box. You see the name and type of area, as well as the coordinates of the lower left corner and upper right corner of the box.

NOTE: The x = 0 and y = 0 coordinates correspond to the lower left corner of the layout space.

6. Using your mouse, left-click and drag the box to the area of your floor plan that you wish to designate are the Lobby Area.
7. To position the Don't Deploy box, drag one corner of the box to a corresponding corner and using one of the corner handles of the box, stretch it to fit.

   You can also position the box by entering values in the Left, Bottom, Right, and Top fields.
8. Click **Save**, then **OK**.

Running the AP Plan

In this section you run the algorithm that searches for the best place to put the APs.

1. From the navigation tree, click AP Plan under the Planning section. The AP Planning page appears.

   You might want to zoom in on the floor plan. Zoom in using the zoom drop-down near the top of the AP Planning page, or type a zoom factor in the text box at the left of the drop-down and press the enter key on your keyboard.

   Try entering a zoom factor of 400.

   Notice that the number of required APs displays towards the top of the page, which represents the same value that you saw when you modeled your APs on the AP Modeling Parameters page. Notice that the APs are not yet displayed on the floor plan.
2. Click Initialize.

   You should see the required total number of AP symbols appear on the two floor diagrams. Also notice that the Suggested Access Points tables below each floor diagram have been populated with information about the suggested APs for each corresponding floor.
3. Click Optimize.

   After you Initialize the APs you must optimize the algorithm. The APs move around on the floor plans as the algorithm is running.

   The algorithm stops when the movement is less than a threshold value calculated based on the number of APs. The threshold value may be seen in the status bar at the bottom of the browser window.

NOTE: To see the approximate coverage areas of each of the APs, select an AP type from the Approx. Coverage drop-down box and select a rate from the Coverage Rate drop-down box.

4. Click Save, then OK.

Running the AM Plan

Running the AM Plan algorithm is similar to running the AP Plan.

1. From the navigation tree, click AM Plan under the Planning section. The AM Planning page appears.
2. Click Initialize then Optimize.

   The algorithm stops when the movement is less than a threshold value calculated based on the number of AMs. The threshold value may be seen in the status bar at the bottom of the browser window.
3. Click Save, then OK.

Chapter 4

Access Points

In ArubaOS, related configuration parameters are grouped into *profiles* that you can apply as needed to an AP group or to individual APs. When an AP is first installed on the network and powered on, the AP locates its host controller and the AP's designated configuration is "pushed" from the controller to the AP. This chapter gives an overview of the basic function of each AP profile, and describes the process to install and configure the APs on your network.

The following topics are included in this chapter:

Basic Functions and Features

You configure APs using the WebUI and the CLI on the controller. Table 21 list the basic configuration functions and features.

Table 21 *AP Configuration Function Overview*

Features and Function	Description
Wireless LANs	A wireless LAN (WLAN) permits wireless clients to connect to the network. An AP broadcasts the SSID (which corresponds to a WLAN configured on the controller) to wireless clients. APs support multiple SSIDs. WLAN configuration includes the authentication method and the authentication servers by which wireless users are validated for access. The WebUI includes a WLAN Wizard that provides easy-to-follow steps to configure a new WLAN. NOTE: All new WLANs are associated with the ap-group named "default".
AP operation	An Dell AP can function as an AP that serves clients, as an air monitor (AM) performing network and radio frequency (RF) monitoring, or as a hybrid AP that both serves clients and performs spectrum analysis a single radio channel. You can also specify the regulatory domain (the country) which determines the 802.11 transmission spectrum in which the AP will operate. Within the regulated transmission spectrum, you can configure 802.11a, 802.11b/g, or 802.11n (high-throughput) radio settings. NOTE: The 802.11n features, such as high-throughput and 40 MHz configuration settings, are supported on APs that are 802.11n standard compliant.
Quality of Service (QoS)	Configure Voice over IP call admission control options and bandwidth allocation for 5 GHz (802.11a) or 2.4 GHz (802.11b/g) frequency bands of traffic.

Table 21 *AP Configuration Function Overview (Continued)*

Features and Function	Description
RF management	Configure settings for balancing wireless traffic across APs, detect holes in radio coverage, or other metrics that can indicate interference and potential problems on the wireless network. Adaptive Radio Management (ARM) is an RF spectrum management technology that allows each AP to determine the best 802.11 channel and transmit power settings. ARM provides several configurable settings.
Intrusion Detection System	Configure settings to detect and disable rogue APs, ad-hoc networks, and unauthorized devices, and prevent attacks on the network. You can also configure signatures to detect and prevent intrusions and attacks.
Mesh	Configure Dell APs as mesh nodes to bridge multiple Ethernet LANs or extend wireless coverage. A mesh node is either • a mesh portal—an AP that uses its wired interface to reach the controller • or a mesh point—an AP that establishes a path to the controller via the mesh portal Mesh environments use a wireless backhaul to carry traffic between mesh nodes. This allows one 802.11 radio to carry traditional WLAN services to clients and one 802.11radio to carry mesh traffic as well as WLAN services. Chapter 8, "Secure Enterprise Mesh" on page 217 contains more specific information on the Mesh feature.

AP Names and Groups

In the Dell user-centric network, each AP has a unique name and belongs to an AP group.

Each AP is identified with an automatically-derived name. The default name depends on if the AP has been previously configured.

- The AP has not been configured—the name is the AP's Ethernet MAC address in colon-separated hexadecimal digits.
- Configured with a previous ArubaOS release—the name is in the format *building.floor.location*

You can assign a new name (up to 63 characters) to an AP; the new name must be unique within your network. For example, you can rename an AP to reflect its physical location within your network, such as "building3-lobby".

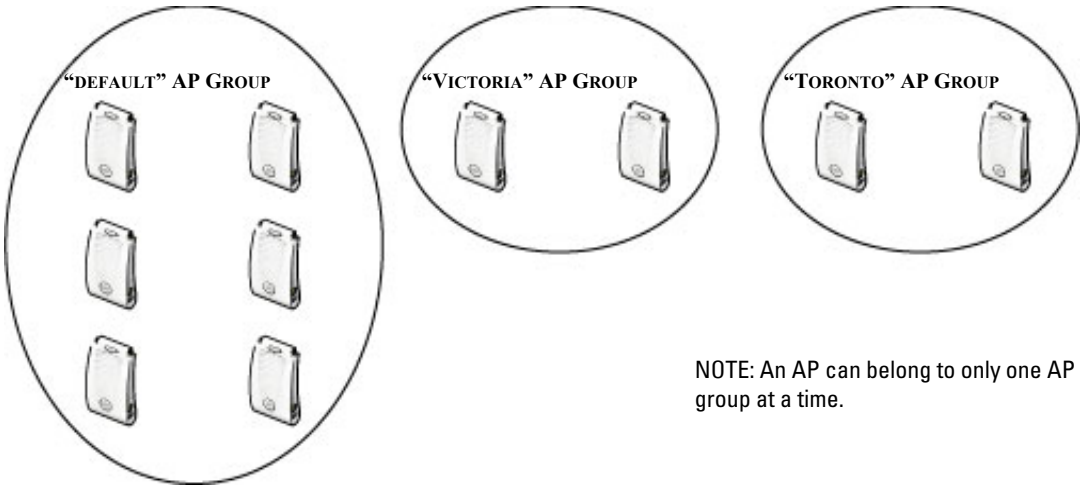
CAUTION: Renaming an AP requires a reboot of the AP before the new name takes effect. Therefore, if you need to do this, there should be little or no client traffic passing through the AP.

In RF Plan or RF Live, the AP name can be part of a fully-qualified location name (FQLN) in the format *APname.floor.building.campus*. The *APname* portion of the FQLN must be unique.

An *AP group* is a set of APs to which the same configuration is applied. There is an AP group called "default" to which all APs discovered by the controller are assigned. By using the "default" AP group, you can configure features that are applied globally to all APs.

You can create additional AP groups and assign APs to that new group. However, an AP can belong to only one AP group at a time. For example, you can create an AP group "Victoria" that consists of the APs that are installed in a company's location in British Columbia. You can create another AP group "Toronto" that consists of the APs in Ontario. You can configure the "Toronto" AP group with different information from the APs in the "Victoria" AP group (see Figure 18).

Figure 18 *AP Groups*



While you can use an AP group to apply a feature to a set of APs, you can also configure a feature or option for a specific AP by referencing the AP's name. Any options or values that you configure for a specific AP will override the same options or values configured for the AP group to which the AP belongs.

The following procedures describes how to create an AP group and, because all discovered APs initially belong to the AP group named "default", how to reassign an AP to your newly-created AP group.

NOTE: Reassigning an AP from an AP group requires a reboot of the AP for the new group assignment to take effect. Therefore, if you need to do this, there should be little or no client traffic passing through the AP.

Creating an AP group

You can use the WebUI or the CLI to create a new AP group.

in the WebUI

1. Navigate to the Configuration > Wireless> AP Configuration > AP Group page.
2. Click New. Enter the new AP group name and click Add. The new AP group appears in the Profile list.

Creating an AP group in the CLI

Use the following command to create an AP group:

```
ap-group <group>
```

When you create an AP group with the CLI, you can specify the virtual AP definitions and configuration profiles you want applied to the APs in the group.

Assigning APs to an AP group

Although you will assign an AP to an AP group when you first deploy the device, you can assign an AP to a different AP group at any time.

CAUTION: Once the ap-regroup command is executed, the AP automatically reboots. If the AP is powered off or otherwise not connected to the network or controller, the executed command is queued until the AP is powered on or reconnected. Again, the AP will automatically reboot as soon as the command is executed.

In the WebUI

1. Navigate to the Configuration > Wireless> AP Installation page. The list of discovered APs appears in this page (all discovered APs initially belong to the AP group named "default").

2. Select the AP you want to reassign, and click Provision. From the Provisioning page, select the AP group from the drop-down menu.
3. Click Apply and Reboot.

In the CLI

Use the following command to assign a single AP to an existing AP group. Use the WebUI to assign multiple APs to an AP group at the same time.

```
ap-regroup {ap-name <name>|serial-num <number>|wired-mac <macaddr>} <group>
```

AP Configuration Profiles

ArubaOS has a predefined version of each profile named "default." You can use these default profiles or create new profiles that you can edit as required. You can also change the values of any parameter in a profile. ArubaOS gives you the flexibility of applying the default versions of profiles in addition to customizing profiles that are necessary for the AP or AP group to function.

For example, if your wireless network includes a master controller in Boston and a local controller in Toronto, you may want to segregate the APs into two AP groups: an AP group named "default" for the APs in Boston, and an AP group named "Toronto" for the APs in Toronto. Now, suppose you wanted the APs in Boston to boot from the master controller and the APs in Toronto to boot from their local controller. You would need to create a second instance of the AP system profile, configure that profile to allow the APs to boot from the local controller, then apply it to the "Toronto" AP group. If no other differences between the two AP groups are required, both groups could use the same "default" profiles for other configuration profile types.

Each of the profiles described can be configured via the CLI or the WebUI. To see a full list of profiles available in ArubaOS, select the Configuration tab in the WebUI and navigate to Advanced Services>All Profiles. The All Profiles arranges group configuration profiles into six categories:

- "Wireless LAN Profiles" on page 110
- "AP Profiles" on page 112
- "QoS Profiles" on page 113
- "RF Management Profiles" on page 113
- "Mesh Profiles" on page 114
- "Other Profiles" on page 114

Wireless LAN Profiles

The Wireless LAN collection of profiles configure WLANs in the form of virtual AP profiles. A virtual AP profile contains an SSID profile which defines the WLAN, the high-throughput SSID profile, and an AAA profile that defines the authentication for the WLAN.

Unlike other profile types, you can configure and apply multiple instances of virtual AP profiles to an AP group or to an individual AP.

- 802.11k profile—Manages settings for the 802.11k protocol. The 802.11k protocol allows APs and clients to dynamically query their radio environment and take appropriate connection actions. For example: In a 802.11k network if the AP with the strongest signal reaches its CAC (Call Admission Control) limits for voice calls, then *on-hook* voice clients may connect to an under utilized AP with a weaker signal. You can configure the following options in 802.11k profile:
  - Enable or disable 802.11K support on the AP
  - Forceful disassociation of on-hook voice clients
  - Measurement mode for beacon reports.

For more details, see "Enable 802.11k Support" on page 155.

- SSID profile—Configures network authentication and encryption types. This profile also includes references to the EDCA (enhanced distributed channel access) Parameters Station Profile, the EDCA Parameters AP Profile and a High-throughput SSID profile.

  Use this profile to configure basic settings such as 802.11 authentication and encryption settings, or advanced settings such as DTIM (delivery traffic indication message) intervals, 802.11a/802.11g basic and transmit rates, DHCP settings and WEP keys. The advanced SSID profile settings allows you to deny broadcast probes and hide the SSID. For details on configuring an SSID profile, see "Creating a new SSID Profile" on page 148.

CAUTION: Configuring the 802.11a and 802.11g beacon rates should only be used in conjunction with Distributed Antenna Systems (DAS). Configuring beacon rates during normal operation may cause connectivity problems.

- High-throughput SSID profile—High-throughput APs support additional settings not available in legacy APs. A High-throughput SSID profile enables/disables high-throughput (802.11n) features with 40 MHz channel usage, and define values for aggregated MAC protocol data units (MDPUs) and Modulation and Coding Scheme (MCS) ranges. If you modify a currently provisioned and running high-throughput SSID profile, your changes take effect immediately; rebooting is not required. For details on configuring a high-throughput SSID profile, see Table 35 on page 159.
- Virtual AP profile—This profile defines your WLAN by enabling or disabling the bandsteering, fast roaming and DoS prevention features. It defines radio band, forwarding mode and blacklisting parameters, and includes references to an AAA Profile, 802.11K Profile, and a High-throughput SSID profile. You can apply multiple virtual AP profiles to an AP group or to an individual AP; for most other profiles, you can apply only one instance of the profile to an AP group or AP at a time.
- AAA profile—This defines authentication settings for the WLAN users, including the role for unauthenticated users, and the different roles that should be assigned to users authenticated via 802.1x, MAC or SIP authentication. This profile includes references to:
  - MAC Authentication Profile
  - MAC Authentication Server Group
  - 802.1X Authentication Profile
  - 802.1X Authentication Server Group
  - RADIUS Accounting Server Group

  For details on configuring an AAA profile, see "AAA Profile Parameters" on page 143.
- XML API server profile—Specifies the IP address of an external XML API server.
- RFC 3576 server—Specifies the IP address of a RFC 3576 RADIUS server.
- MAC authentication profile—Defines parameters for MAC address authentication, including upper- or lower-case MAC string, the diameter format in the string, and the maximum number of authentication failures before a user is blacklisted.
- Captive portal authentication profile—This profile directs clients to a web page that requires them to enter a username and password before being granted access to the network. This profile defines login wait times, the URLs for login and welcome pages, and manages the default user role for authenticated captive portal clients.

  You can also set the maximum number of authentication failures allowed per user before that user is blacklisted. This profile includes a reference to a Server group profile. For complete information on configuring a Captive portal authentication profile, see Chapter 15, "Captive Portal" on page 351.
- 802.1x authentication profile—Defines default user roles for machine or 802.1x authentication, and parameters for 8021.x termination and failed authentication attempts. For a list of the basic parameters in the 802.1x authentication profile, see Chapter 10, "802.1x Authentication" on page 285

- RADIUS server profile—Identifies the IP address of a RADIUS server and sets RADIUS server parameters such as authentication and accounting ports and the maximum allowed number of authentication retries. For a list of the parameters in the RADIUS profile, see "Configuring a RADIUS Server" on page 264
- LDAP server profile—Defines an external LDAP authentication server that processes requests from the controller. This profile specifies the authentication and accounting ports used by the server, as well as administrator passwords, filters and keys for server access. For a list of the parameters in the LDAP profile, see "Configuring an LDAP Server" on page 266.
- TACACS server profile—Specifies the TCP port used by the server, the timeout period for a TACACS+ request, and the maximum number of allowed retries per user. For a list of the parameters in the TACACS profile, see "Configuring a TACACS+ Server" on page 268.
- Server group—This profile manages groups of servers for specific types of authentication. Server Groups identify individual authentication servers and let you create rules for clients based on attributes returned for the client by the server during authentication. For additional information on configuring server rules, see "Configuring Server-Derivation Rules" on page 277
- VPN Authentication profile—This profile identifies the default role for authenticated VPN clients and also references a server group. It also provides a separate VPN AAA authentication for a terminating remote AP (default-rap) and a campus AP (default-CAP). If you want to simultaneously deploy various combinations of a VPN client, RAP-psk, RAP-certs and CAP on the same controller, see Table 70 on page 391.
- Management authentication profile—Enables or disables management authentication, and identifies the default role for authenticated management clients. This profile also references a server group.
- Wired authentication profile—This profile merely references an AAA profile to be used for wired authentication.
- Stateful 802.1x authentication Profile—Enables or disables 802.1x authentication for clients on non-Dell APs, and defines the default role for those users once they are authenticated. This profile also references a server group to be used for authentication.
- Stateful NTLM authentication Profile—Monitor the NTLM (NT LAN Manager) authentication messages between clients and an authentication server. If the client authenticates via an NTLM authentication server, the controller can recognize that the client has been authenticated and assign that client a specified user role

AP Profiles

The AP profiles configure AP operation parameters, radio settings, port operations, regulatory domain, and SNMP information.

- AP system profile—Defines administrative options for the controller, including the IP addresses of the local, backup, and master controllers, Real-time Locating Systems (RTLS) server values and the number of consecutive missed heartbeats on a GRE tunnel before an AP reboots.
- Regulatory domain—Defines the AP's country code and valid channels for both legacy and high-throughput 802.11a and 802.11b/g radios.
- Wired AP profile—Determines if 802.11 frames are tunneled to the controller using Generic Routing Encapsulation (GRE) tunnels, bridged into the local Ethernet LAN, or configured for a combination of the two (split-mode). In tunnel forwarding mode, the AP handles all 802.11 association requests and responses, but sends all 802.11 data packets, action frames and EAPOL frames over a GRE tunnel to the controller for processing. When a remote AP or campus AP is in bridge mode, the AP handles all 802.11 association requests and responses, encryption/decryption processes, and firewall enforcement. In split-tunnel mode, 802.11 frames are either tunneled or bridged, depending on the destination (corporate traffic goes to the controller, and Internet access remains local). For details, see "Ethernet Ports for Mesh" on page 249
- Ethernet interface profile—Sets the duplex mode and speed of the AP's Ethernet link. The configurable speed is dependent on the port type, and you can define a separate Ethernet Interface profile for each Ethernet link.

- Ethernet Interface Port/Wired Port Profile—Specifies a AAA profile for users connected to the wired port on an AP. For details on configuring this profile, see "Securing Clients on an AP Wired Port" on page 382.
- AP Provisioning profile—Defines a group of provisioning parameters for an AP or AP group.
- AP Authorization Profile—Allows you to assign an to a provisioned but unauthorized AP to a AP group with a restricted configuration profile.
- EDCA parameters profile (Station)—Client to AP traffic prioritization parameters, including Enhanced Distributed Channel Access (EDCA) parameters for background, best-effort, voice and video queues. For additional information on configuring this profile, see "Using the WebUI to configure EDCA parameters" on page 693.
- EDCA parameters profile (AP)—AP to client traffic prioritization, including EDCA parameters for background, best-effort, voice and video queues. For additional information on configuring this profile, see "Using the WebUI to configure EDCA parameters" on page 693.

QoS Profiles

The QoS profiles configure traffic management and VoIP functions.

- VoIP call admission control profile— Dell's Voice Call Admission Control limits the number of active voice calls per AP by load-balancing or ignoring excess call requests. This profile enables active load balancing and call admission controls, and sets limits for the numbers of simultaneous Session Initiated Protocol (SIP), SpectraLink Voice Priority (SVP), Cisco Skinny Client Control Protocol (SCCP), Vocera or New Office Environment (NOE) calls that can be handled by a single radio. For additional information on configuring this profile, see "VoIP-Aware ARM Scanning" on page 696.
- Traffic management profile—Specifies the minimum percentage of available bandwidth to be allocated to a specific SSID when there is congestion on the wireless network, and sets the interval between bandwidth usage reports.

RF Management Profiles

The profiles configure radio tuning and calibration, AP load balancing, and RSSI metrics.

- 802.11a radio profile—Defines AP radio settings for the 5 GHz frequency band, including the Adaptive Radio Management (ARM) profile and the high-throughput (802.11n) radio profile.
- 802.11g radio profile—Defines AP radio settings for the 2.4 GHz frequency band, including the Adaptive Radio Management (ARM) profile and the high-throughput (802.11n) radio profile. Each 802.11a and 802.11b radio profile includes a reference to an Adaptive Radio Management (ARM) profile.

  If you want the ARM feature to dynamically select the best channel and transmission power for the radio, verify that the 802.11a/802.11g radio profile references an active and enabled ARM profile. If you want to manually select a channel for each AP group, create separate 802.11a and 802.11g profiles for each AP group and assign a different transmission channel for each profile.
- ARM profile—Defines the Adaptive Radio Management (ARM) settings for scanning, acceptable coverage levels, transmission power and noise thresholds. In most network environments, ARM does not need any adjustments from its factory-configured settings. However, if you are using VoIP or have unusually high security requirements you may want to manually adjust the ARM thresholds. For complete details on Adaptive Radio Management, see Chapter 6, "Adaptive Radio Management (ARM)" on page 163.
- High-throughput radio profile—Manages high-throughput (802.11n) radio settings for 802.11n-capable APs. A high-throughput profile determines 40 Mhz tolerance settings, and controls whether or not the APs using this profile will advertise intolerance of 40 MHz operation. (This option is disabled by default, allowing 40 MHz operation.)
- RF optimization profile—Enables or disables load balancing based on a user-defined number of clients or degree of AP utilization on an AP. Use this profile to detect coverage holes, radio interference and STA association failures and configure Received signal strength indication (RSSI) metrics.

- RF event thresholds profile—Defines error event conditions, based on a customizable percentage of low-speed frames, non-unicast frames, or fragmented, retry or error frames.
- Spectrum Profile—Defines the spectrum band monitored by a spectrum monitor, or the individual channel monitored by a hybrid AP. For details on the spectrum analysis feature, see "Configuring the Spectrum Profile" on page 613.

Mesh Profiles

You can provision Dell APs to operate as mesh points, mesh portals or remote mesh portals. The secure enterprise mesh environment routes network traffic between APs over wireless hops to join multiple Ethernet LANs or to extend wireless coverage. The Mesh profiles are:

- Mesh high-throughput SSID profile—Enables or disables high-throughput (802.11n) features and 40 Mhz channel usage, and define values for aggregated MAC protocol data units (MDPUs) and Modulation and Coding Scheme (MCS) ranges. If none of the APs in your Mesh deployment are 802.11n-capable, you do not need to configure a mesh high-throughput SSID profile.
- Mesh radio profile—Determines many of the settings used by mesh nodes to establish mesh links and the path to the mesh portal, including the maximum number of children a mesh node can accept, and transmit rates for the 802.11a and 802.11g radios.
- Mesh cluster profile—Contains the mesh cluster name (MSSID), authentication methods, security credentials, and cluster priority.

Other Profiles

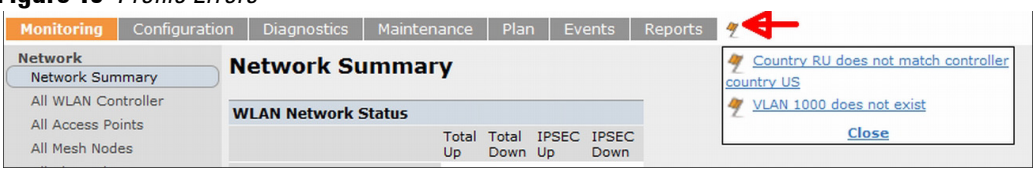
These controller profiles set the management password policy, define equipment OUIs, or configure VIA authentication and connection settings.

- Valid Equipment OUI Profile—Set one or more Dell OUIs for the controller.
- VIA Authentication Profile—Define an authentication profile for the VIA feature.
- VIA Connection Profile—Define authentication and connection settings profile for the VIA feature.
- VIA Web Authentication—Define a VIA authentication profile to be used for Web authentication.
- VIA Global Configuration—Select whether or not the controller should allow VIA SSL fallback.
- Management Password Policy—Define a policy for creating management passwords.
- Dialplan Profile—Define SIP dial plans on the controller to provide outgoing PSTN calls.
- Spectrum Local Override Profile—Configure an individual AP radio as a spectrum monitor, For details, see "Converting an Individual AP to a Spectrum Monitor" on page 612.

Viewing Profile Errors

To view the list of profile errors using the CLI, use the show profile-errors command. The WebUI displays them with a *flag* icon next to the main horizontal menu (Figure 19). Click the flag to view the list of errors.

Figure 19 *Profile Errors*



Profile Hierarchy

ArubaOS WebUI includes several wizards that allow you to configure an AP, controller, WLAN, or License installation. You can also configure profiles using the WebUI Profile list or via the command line interface. Best

practices is to configure the lowest-level settings first. For example, if you are defining a virtual AP profile, you should first define a session policy, then define your server group, then create an AAA profile that references the session policy and your server group.

Figure 20 represents the AP and AP Group profile hierarchy in the WebUI (navigate to Configuration>AP configuration).

Figure 20 *AP Specific and AP Group Profile Hierarchies*

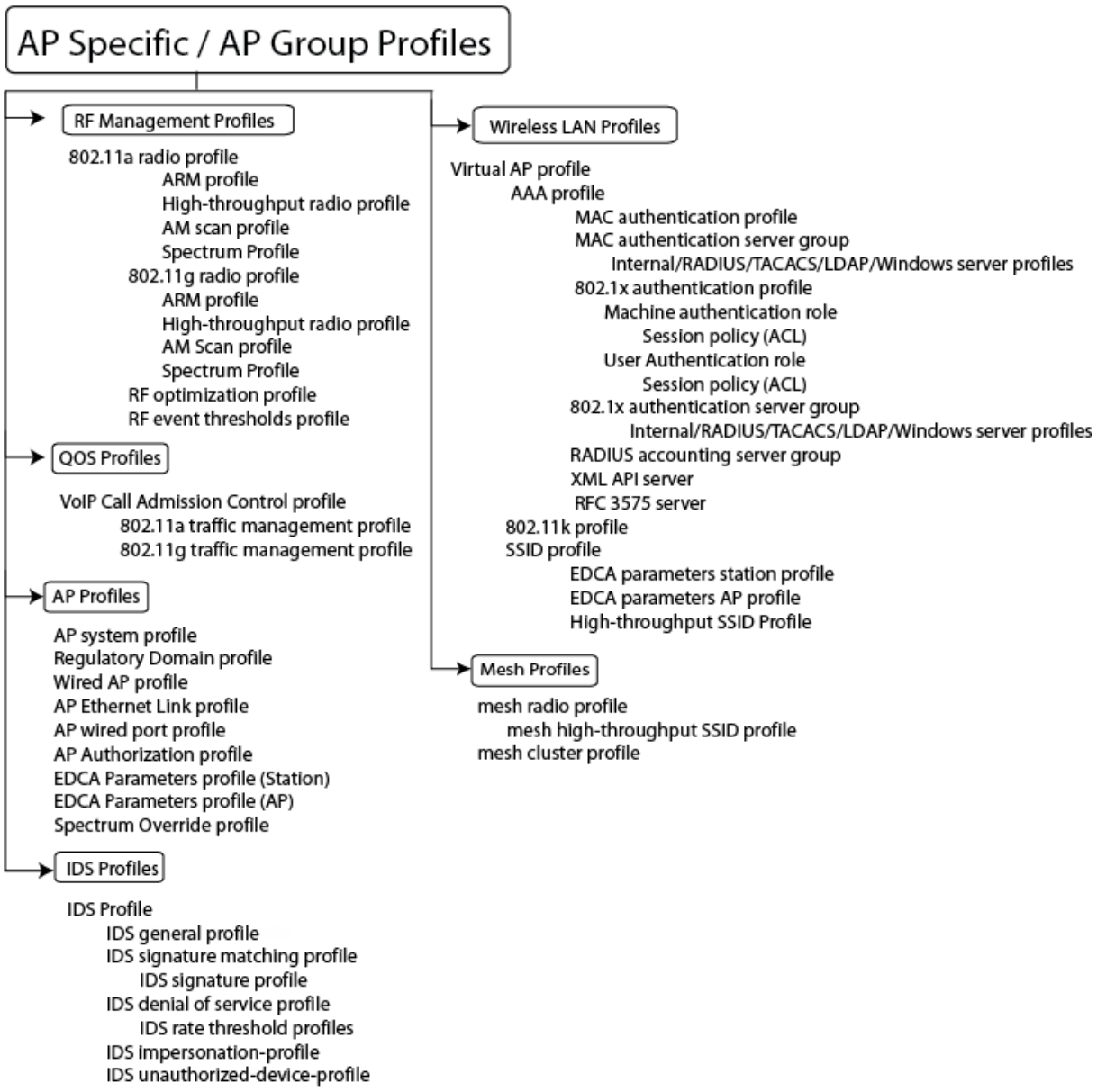
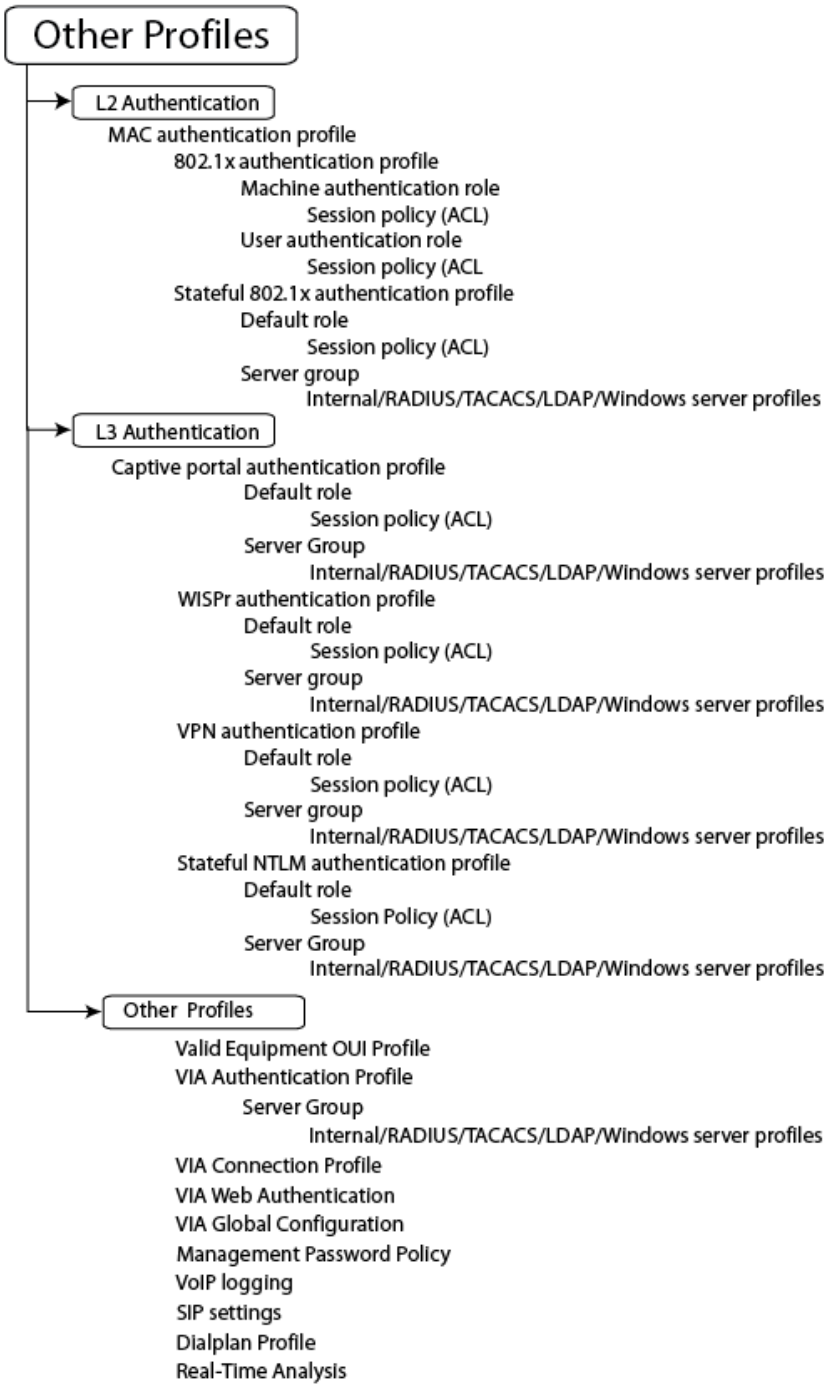


Figure 21 displays how other higher-level configuration profiles reference other profiles. To view the profile hierarchy for Layer 2 authentication profiles in the WebUI, navigate to Configuration>Authentication and select the L2 Authentication tab. To view the profile hierarchy for Layer 3 authentication profiles, navigate to Configuration>Authentication and select the L3 Authentication tab.

Figure 21 *Other Profile Hierarchies*



Deploying APs

Dell APs and AMs are designed to require only minimal setup to make them operational in an user-centric network. Once APs have established communication with the controller, you can apply advanced configuration to individual APs or groups of APs in the network using the WebUI on the controller.

Deploy APs on your network using the following steps:

1. Run the Java-based RF Plan tool to help position APs and import floorplans for your installation.
2. Prior to installation, configure firewall settings and enable controller discovery so the APs can locate and identify the controller.
3. Ensure that APs will be able to obtain an IP address once they are connected to the network.

NOTE: If you are deploying APs in a mesh networking environment, best practices are to define the mesh cluster profile and mesh radio profiles *before* you install and provision the AP as a mesh portal or mesh point. Note that this step is required only if you are configuring a mesh node. For further information on configuring a Mesh network, see "Secure Enterprise Mesh" on page 217

4. Install the APs by connecting the AP to an Ethernet port on the controller. If the AP does not use Power over Ethernet (PoE) is not used, connect the AP to a power source.
5. On the controller, provision the installed APs.

The following sections explain each of the above steps.

Running the RF Plan

The Java-based RF Plan tool is an application that allows you to determine AP placement based on your specified coverage and capacity requirements without impacting the live network. For more information about using RF Plan, see the *RF Plan Installation and User Guide*.

Ensure APs Can Connect to the Controller

Before you install APs in a network environment, you must ensure that the APs are able to locate and connect to the controller. Specifically, you must ensure the following:

- When connected to the network, each AP is assigned a valid IP address
- APs are able to locate the controller

NOTE: In a network with a master and local controllers, an AP will initially connect to the master controller. Alternatively, you can instruct your AP to download its configuration (and ArubaOS) from a local controller (see Chapter 21, "Adding Local Controllers" for details).

Configure Firewall Settings

APs use Trivial File Transfer Protocol (TFTP) during their initial boot to grab their software image and configuration from the controller. After the initial boot, the APs use FTP to grab their software images and configurations from the controller.

In many deployment scenarios, an external firewall is situated between various Dell devices. Appendix B, "External Firewall Configuration" describes the network ports that must be configured on the external firewall to allow proper operation of the network.

Enable Controller Discovery

An AP can discover the IP address of the controller in the following ways:

- From a DNS server
- From a DHCP server
- Using the Aruba Discovery Protocol (ADP)

At boot time, the AP builds a list of controller IP addresses and then tries these addresses in order until a controller is reached successfully. The list of controller addresses is constructed as follows:

1. If the master provisioning parameter is set to a DNS name, that name is resolved and all resulting addresses are put on the list. If master is set to an IP address, that address is put on the list.
2. If the master provisioning parameter is not set and a controller address was received in DHCP Option 43, that address is put on the list.
3. If the master provisioning parameter is not set and no address was received via DHCP option 43, ADP is used to discover a controller address and that address is put on the list.
4. Controller addresses derived from the server-name and server-ip provisioning parameters and the default controller name aruba-master are added to the list. Note that if a DNS name resolves to multiple addresses, all addresses are added to the list.

This list of controller IP addresses provides an enhanced redundancy scheme for controllers that are located in multiple data centers separated across Layer-3 networks.

From a DNS Server

APs are factory-configured to use the host name aruba-master for the master controller. For the DNS server to resolve this host name to the IP address of the master controller, you must configure an entry on the DNS server for the name aruba-master.

For information on how to configure a host name entry on the DNS server, refer to the vendor documentation for your server.

NOTE: Dell recommends using a DNS server to provide APs with the IP address of the master controller because it involves minimal changes to the network and provides the greatest flexibility in the placement of APs.

When using DNS, the AP can learn multiple IP addresses to associate with a controller. If the primary controller is unavailable or does not respond, the AP continues through the list of learned IP addresses until it establishes a connection with an available controller. This takes approximately 3.5 minutes per LMS.

From a DHCP Server

You can configure a DHCP server to provide the master controller's IP address. You must configure the DHCP server to send the controller's IP address using the DHCP vendor-specific attribute option 43. APs identify themselves with a vendor class identifier set to Dell AP in their DHCP request. When the DHCP server responds to the request, it will send the controller's IP address as the value of option 43.

When using DHCP option 43, the AP accepts only one IP address. If the IP address of the controller provided by DHCP is not available, the AP can use the other IP addresses provisioned or learned by DNS to establish a connection.

For more information on how to configure vendor-specific information on a DHCP server, see Appendix A, "" on page 765 or refer to the vendor documentation for your server.

Using the Aruba Discovery Protocol (ADP)

ADP is enabled by default on all Dell APs and controllers. To use ADP, all APs and controllers must be connected to the same Layer-2 network. If the devices are on different networks, a Layer-3 compatible discovery mechanism, such as DNS, DHCP, or IGMP forwarding, must be used instead.

With ADP, APs send out periodic multicast and broadcast queries to locate the master controller. You might need to perform additional network configuration, depending on whether the APs are in the same broadcast domain as the controller:

- If the APs are in the same broadcast domain as the master controller, the controller automatically responds to the APs' queries with its IP address.

- If the APs are not in the same broadcast domain as the master controller, you must enable multicast on the network (ADP multicast queries are sent to the IP multicast group address 239.0.82.11) for the controller to respond to the APs' queries. You also must make sure that all routers are configured to listen for Internet Group Management Protocol (IGMP) join requests from the controller and can route these multicast packets.

  To verify that ADP and IGMP join options are enabled on the controller, use the following CLI command:

```
(host) #show adp config
ADP Configuration
-----------------
key         value
---         -----
discovery  enable
igmp-join  enable
```

If ADP or IGMP join options are not enabled, use the following CLI commands:

```
(host) (config) #adp discovery enable
(host) (config) #adp igmp-join enable
```

Ensure APs Can Obtain IP Addresses

Each AP requires a unique IP address on a subnetwork that has connectivity to a controller. Dell recommends using the Dynamic Host Configuration Protocol (DHCP) to provide IP addresses for APs; the DHCP server can be an existing network server or an controller configured as a DHCP server.

You can use an existing DHCP server in the same subnetwork as the AP to provide the AP with its IP information. You can also configure a device in the same subnetwork to act as a relay agent for a DHCP server on a different subnetwork. Refer to the vendor documentation for the DHCP Server or relay agent for information.

If an AP is on the same subnetwork as the master controller, you can configure the controller as a DHCP server to assign an IP address to the AP. The controller must be the only DHCP server for this subnetwork.

Enabling the DHCP server on the controller in the WebUI

1. Navigate to the Configuration > Network > IP > DHCP Server window.
2. Select the Enable DHCP Server checkbox.
3. In the Pool Configuration section, click Add.
4. Enter information about the subnetwork for which IP addresses are to be assigned. Click Done.
5. If there are addresses that should not be assigned in the subnetwork:
   a. Click Add in the Excluded Address Range section.
   b. Enter the address range in the Add Excluded Address section.
   c. Click Done.
6. Click Apply at the bottom of the window.

Enable the DHCP server on the controller in the CLI

```
(host)(config)# ip dhcp excluded-address ipaddr ipaddr2
(host)(config)# ip dhcp pool name
      default-router ipaddr
      dns-server ipaddr
      domain-name name
      network ipaddr mask
(host)(config)# service dhcp
```

Provisioning APs for Mesh

The information in this section applies only if you are configuring and deploying APs in a mesh networking environment. If you are not, proceed to "Installing APs on the Network" on page 120.

Before you install APs in a mesh networking environment, you must do the following:

- Define and configure the mesh cluster profile and mesh radio profile before configuring an AP to operate as a mesh node. An AP configured for mesh is also known as a mesh node.
- Provision one of the following mesh roles on the AP:
  - Mesh portal—The gateway between the wireless mesh network and the enterprise wired LAN.
  - Mesh point—APs that can provide traditional Dell WLAN services (such as client connectivity, intrusion detection system (IDS) capabilities, user roles association, LAN-to-LAN bridging, and Quality of Service (QoS) for LAN-to-mesh communication) to clients on one radio and perform mesh backhaul/network connectivity on the other radio. Mesh points can also provide LAN-to-LAN bridging through their Ethernet interfaces and provide WLAN services on the backhaul radio
  - Remote Mesh Portal: The Remote Mesh Portal feature allows you to configure a remote AP at a branch office to operate as a mesh portal for a mesh cluster.

For detailed provisioning guidelines, caveats, and instructions, see Chapter 8, "Secure Enterprise Mesh" on page 217.

Installing APs on the Network

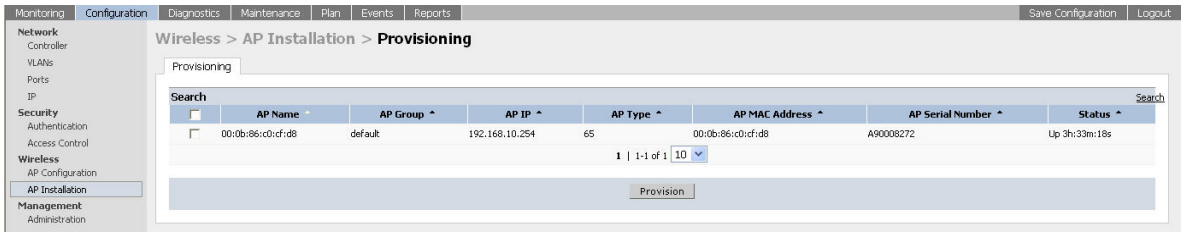
Use the AP placement map generated by RF Plan to install APs. You can either connect the AP directly to a port on the controller, or connect the AP to another switch or router that has layer-2 or layer-3 connectivity to the controller.

If the Ethernet port on the controller is an 802.3af Power over Ethernet (PoE) port, the AP automatically uses it to power up. If a PoE port is not available, you must get an AC adapter for the AP from Dell. For more information, see the *Installation Guide* for the specific AP.

Once an AP is connected to the network and powered up, it attempts to locate the master controller using one of the methods described in "Enable Controller Discovery" on page 117.

On the master controller, you can view the APs that have connected to the controller in the WebUI. Navigate to the Configuration > Wireless > AP Installation window. Figure 22 shows an example of this window.

Figure 22 *APs Connected to Controller*



Updating the RF Plan

After installing APs, update the AP placement map in RF Plan. This allows more accurate reconciliation of location tracking features provided by the user-centric network—for example, locating users, intruders, rogue APs and other security threats, assets, and sources of RF interference—with the physical environment.

Provisioning Installed APs

The two most common ways to provision an AP for remote authentication are certificate-based AP provisioning and provisioning using a pre-shared key. Although both options allow for a simple secure setup of your remote network, you should make sure that the procedure you select is supported by your controller, the AP model type

and the end user's client software. If you must provision your APs using a pre-shared key, you need to know which controller models you have that do not support certificate-based provisioning.

Remote AP (RAP) vs Campus AP (CAP)

Before you provision an AP, you should decide whether you want it to function as a Remote AP (RAP) or a Campus AP (CAP).

- When the network between the AP and controller is an un-trusted/non-routable network, such as the Internet, a RAP is recommended; in cases where the AP needs to connect over private links (LAN, WAN, MPLS), a CAP is recommended. The reason that CAP is not recommended over a non-routable network is because the IPsec within control plane security is in tunnel mode.
- RAP supports internal DHCP server; CAP does not.

For both RAPs and CAPs, tunneled SSIDs will be brought down eight (8) seconds after the AP detects that there is no connectivity to the controller. For CAP bridge-mode SSIDs, the CAP will be brought down after the keepalive times out (default 3.5 minutes). RAP bridge mode SSIDs are configurable to stay up indefinitely (always-on / persistent). Backup mode SSID is supported on the RAP only.

AP Provisioning Wizard

The easiest way to provision any remote AP is to use the ArubaOS AP Wizard in the WebUI. This wizard will walk you through the specific steps required to provision a remote AP (or any other AP type). To access the AP wizard to provision a remote AP:

1. Select Configuration>Wizards>AP Wizard. The Specify Deployment Scenario window appears.
2. Select the Remote deployment scenario option.
3. The wizard allows you to configure remote APs to be provisioned by a user at a remote location, or provisioned by a network administrator who will connect those APs directly to the controller as the wizard is being run.
   - Select the User-Provisioned option to provision AP models using certificate-based AP provisioning.
   - Select the Administrator-Provisioned option to provision any AP model authenticated using a Pre-Shared Key (PSK).
4. Click Next to continue to the next window in the Wizard. Continue working your way through the wizard to complete the provisioning process.

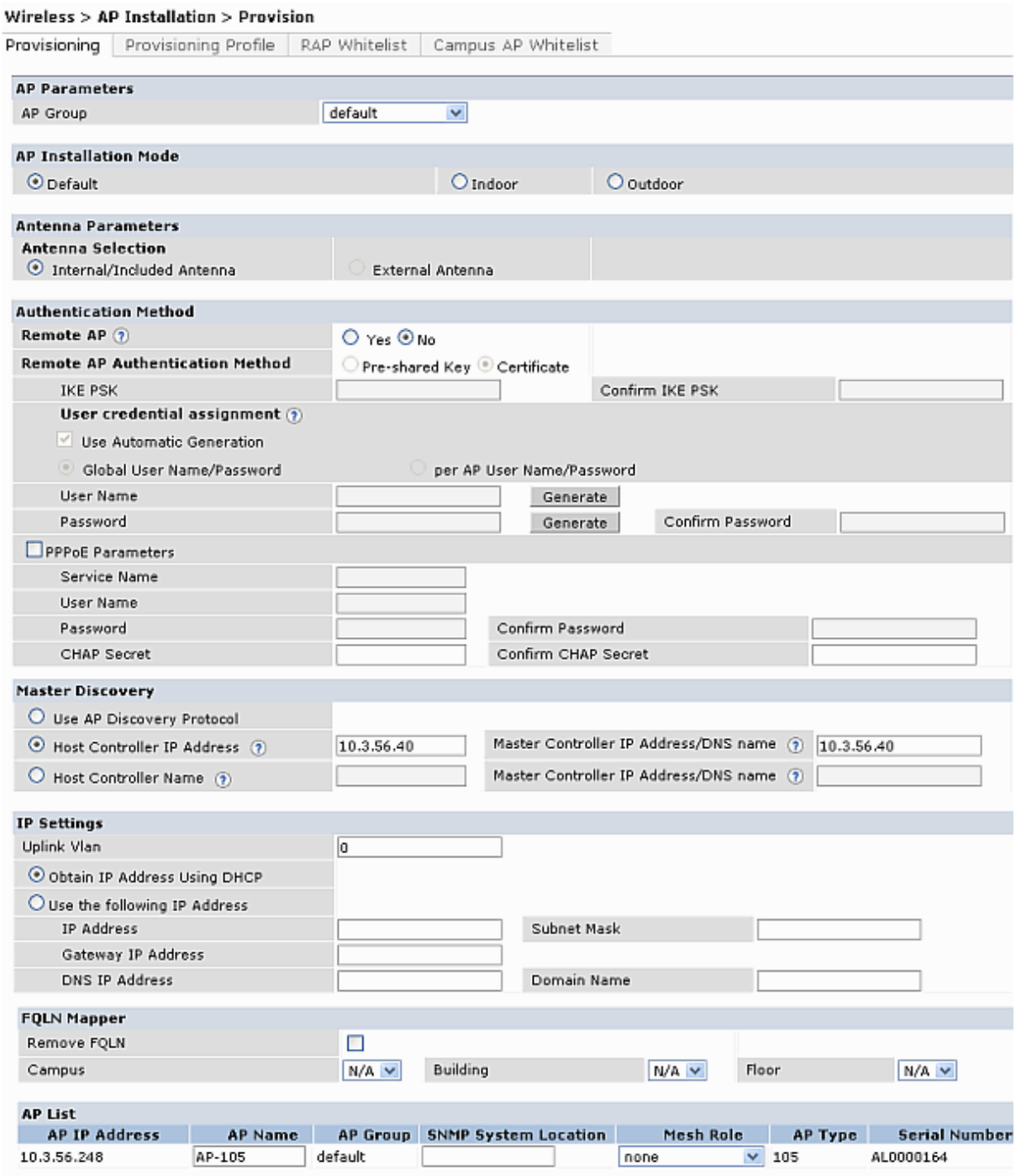
If you do not want to use the provisioning wizard, you can also define certificate-based and PSK provisioning parameters for a remote AP using the Configuration > Wireless > AP Installation > Provisioning window in the WebUI.

Provisioning an Individual AP

The following steps describe the process to provision a AP:

1. If you are provisioning a new AP that has never been provisioned before, connect the AP to the controller according the instructions included with that AP. If you are reprovisioning existing active APs as remote APs, this step is not necessary, as the APs are already communicating with the controller.
2. Navigate to the Configuration > Wireless > AP Installation > Provisioning window.

3. Click the checkbox by the AP you want to provision, then click Provision. The Provisioning window opens.



4. In the AP Parameters section, click the AP Group drop-down list and select the AP group to which this AP should be assigned.
5. (Optional) Some AP models support an external antenna in addition to their internal antenna. If the AP you are provisioning supports an external antenna, the Provisioning window displays an additional Antenna Parameters section. If you want to use an External antenna for the remote AP you are provisioning, select External Antenna and define settings for that antenna. Otherwise, the remote AP will use its internal antenna by default.
6. If you are provisioning a remote AP, select Yes for the Remote AP option.
7. (For Remote APs only) In the Remote IP Authentication Method section, select either Pre-shared key or certificate authentication type.

Certificate based authentication allows a controller to authenticate a AP using its certificates instead of a PSK. You can manually provision an individual AP with a full set of provisioning parameters, or simultaneously provision an entire group of APs by defining a provisioning profile which contains a smaller set of provisioning parameters that can be applied the entire AP group. When you manually provision an individual AP to use certificated-based authentication, you must connect that AP to the controller before you can define its provisioning settings.

Use Pre-Shared Key (PSK) authentication to provision an individual remote AP or a group of remote APs using an Internet Key Exchange Pre-Shared Key (IKE PSK). This option requires you to perform the following additional steps:

a. Enter and confirm the pre-shared key (IKE PSK).
b. In the User credential assignment section, specify if you want to use a Global User Name/password or a Per AP User Name/Password.
   - If you use the Per AP User Names/Passwords option, each RAP is given its own user name and password. I
   - If you use the Global User Name/Password option, all selected RAPs are given the same (shared) user name and password.
c. Enter the user name, and enter and confirm the password. If you want the controller to automatically generate a user name and password, select Use Automatic Generation, then click Generate by the User Name and Password fields.

8. (Optional) If your AP will use Point-to-Point Protocol over Ethernet (PPPoE) to authenticate itself to a service provider, select the PPPoE Parameters checkbox and enter the following PPPoE values:
   - Service Name: Either an ISP name or a class of service configured on the PPPoE server.
   - User Name: Set the PPPoE User Name for this remote AP.
   - Password: Enter and then confirm the PPPoE password for this remote AP.
9. In the Master Discovery section, set the Master IP Address.
   - For a campus AP or a remote AP on a private network, enter the controller's IP address
   - For a Remote AP with the controller on a public network, enter the controller's public IP address
   - For a remote AP with a controller behind a firewall, enter the public address of the NAT device to which the controller is connected
10. (Optional) In the IP Settings section, specify a trunk VLAN by entering a VLAN ID from 1-4095, inclusive. If you configure an uplink VLAN on an AP connected to a port in trunk mode, the AP sends and receives frames tagged with this VLAN on its Ethernet uplink.

    By default, an AP has an uplink vlan of 0, which disables this feature. Note that if an AP is provisioned with an uplink VLAN, it must be connected to a trunk mode port or the AP's frames will be dropped.
11. Under IP Settings, select Obtain IP Address Using DHCP to obtain an IP address for your AP using DHCP.

    or

    select Use the Following IP address and enter the appropriate values in the following fields:
    - IP address: IP address for the AP, in dotted-decimal format
    - Subnet mask: Subnet mask for the IP, in dotted-decimal format.
    - Gateway IP address: The IP address the AP uses to reach other networks.
    - DNS IP address: The IP address of the Domain Name Server.
    - Domain name: (optional) The default domain name.
12. (Optional) In the FQLN Mapper section, you may click the Campus, Building and Floor drop-down lists to identify a fully qualified location name (FQLN) for the AP. To clear an existing FQLN, click the Remove FQLN checkbox.

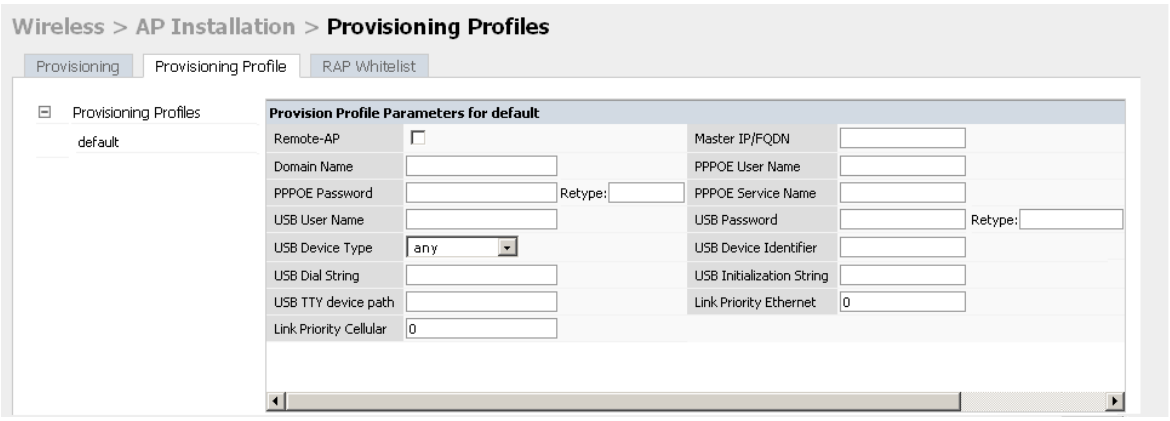
13. The AP list section displays current information for the AP you are provisioning or reprovisioning, and allows you to define additional parameters for your remote AP, such as AP Name, SNMP System Location and (if you are provisioning a Mesh Point or Portal) the AP's Mesh role.
14. Click Apply and Reboot. (Reprovisioning the AP causes it to automatically reboot).

Provisioning Multiple APs using a Provisioning Profile

When you create a provisioning profile, you can then apply that profile to an AP group and provision that entire group of campus or remote APs with the settings in that profile.

By default, an AP group does not have a provisioning profile. Make sure that any provisioning profiles you create are complete and accurate before you assign that profile to an AP group. If a misconfigured provisioning profile is assigned to a group of APs, the APs in that group may be automatically provisioned with erroneous parameters and become lost.

1. Navigate to the Configuration > Wireless > AP Installation > Provisioning window.
2. Next, select the Provisioning Profile tab and enter a provisioning profile name in the text box (next to the Add button).
3. Click the Add button to add the profile name.
4. Select your new provisioning profile name from the list at the left.
5. (Optional) If you are provisioning a remote AP, select the Remote-AP checkbox.
6. Enter the IP address or the fully qualified domain name of the master controller in the Master IP/FQDN field.



7. If your AP will use Point-to-Point Protocol over Ethernet (PPPoE) to authenticate itself to a service provider, select the PPPoE Parameters checkbox and enter the following PPPoE values:
   - PPPoE User Name: Set the PPPoE User Name for this remote AP.
   - PPPoE Password: Enter and then confirm the PPPoE password for this remote AP.
   - PPPoE Service Name: Either an ISP name or a class of service configured on the PPPoE server.
8. (Optional) If you want to use this provisioning profile to provision APs with more than one interface, you must also configure the USB settings and priority levels for this profile.
9. Click Apply.

Assigning Provisioning Profiles

Once you have defined a provisioning profile, you must assign that profile to an AP group.

1. Navigate to the Configuration>AP configuration window and select the AP group tab.
2. Click the Edit button by the name of the AP group to which you want to assign the provisioning profile.
3. In the profiles list, expand the AP menu, and select Provisioning Profile. The Profile Details window appears.

4. Click the Provisioning Profile drop-down list and select the name of the provisioning profile you want to assign to this AP group.
5. Click Apply.

If you are provisioning remote APs, you must also add the remote APs to the RAP whitelist. For details, see "Remote Access Points" on page 179.

Troubleshooting

After the AP has been provisioned, navigate to Monitoring>All Access Points window and verify that the AP has an up status. The AP on your network *does not* appear in this table, it may have been classified as an inactive AP for any of the following reasons:

- The AP is configured with a missing or incorrect VLAN. (For example, the AP is configured to use a tunneled SSID of VLAN 2 but the controller doesn't have a VLAN 2.)
- The AP has an unknown AP group.
- The AP has a duplicate AP name.
- An AP with an external antenna is not provisioned with external antenna gain settings.
- Both radios on the AP are disabled.
- No virtual APs are defined on the AP.
- The AP has profile errors. For details, access the command-line interface and issue the command "show profile errors".
- The GRE tunnel between the AP and the controller was blocked by a firewall after the AP became active.
- The AP is temporarily down while it is upgrading its software. The AP will become active again after upgrading.

Configuring a Provisioned AP

Once the AP has been installed and provisioned, you can use the WebUI or CLI to configure the optional AP settings described in the following sections:

- "AP Installation Modes" on page 125
- "RF Event Configuration" on page 133
- "20 MHz and 40 MHz Static Channel Assignments" on page 135
- "Automatic Channel and Transmit Power Selection" on page 137
- "Optimize APs Over Low-Speed Links" on page 127
- "AP Redundancy" on page 130
- "Managing AP LEDs" on page 131

AP Installation Modes

By default, all AP models initially ship with an indoor or outdoor installation mode. This means that APs with an indoor installation mode are normally placed in enclosed, protected environments and those with an outdoor installation mode are used in outdoor environments and exposed to harsh elements.

In most countries, there are different channels and power that are allowed for indoor and outdoor operation. You may want to change an AP's installation mode from indoor to outdoor or vice versa.

In the WebUI

To configure the installation mode for an AP, follow these steps:

1. Navigate to the Configuration > Wireless> AP Installation page. The list of discovered APs are displayed on this page.
2. Select the AP you want to change.
3. Click Provision to reveal the Provisioning page.

   Locate the AP Installation Mode section. By default, the Default mode is selected. This means that the AP installation type is based on the AP model.
4. Select the Indoor option to change the installation to Indoor mode. Select the Outdoor option to change the to Outdoor mode.
5. Click Apply and Reboot (at the bottom of the page).

In the CLI

This example displays the AP installation mode options and sets the AP to indoor installation mode.

```
(host) (config) #provision-ap
(host) (AP provisioning) #installation ?
  default                  Decide by AP model
  indoor                   Indoor installation
  outdoor                  Outdoor installation
(host) (AP provisioning) #installation indoor
```

This example shows basic information details about the configuration of an AP named “MyAP.” The AP installation mode is indoor.

```
(host) #show ap details ap-name myAP

AP "MyAP" Basic Information
---------------------------
Item            Value
----            -----
AP IP Address   10.0.0.253
LMS IP Address  10.0.0.1
Group           default
Location Name   N/A
Status          Up; Mesh
Up time         9m:55s
Installation    indoor
```

Renaming an AP

You can display the status of APs in your database by executing the show ap database long command. The output will flag an AP that has a duplicate name (N flag).

To clear the AP with the duplicate name (assuming it is no longer connected to your network), use the command clear gap-db wired-mac.

Renaming in the WebUI

1. Navigate to the Configuration > Wireless> AP Installation page. A list of discovered APs are on this page.
2. Select the AP you want to rename, and click Provision.
3. On the Provisioning page, scroll to the AP list at the bottom of the page and find the AP you want to rename.
4. In the AP Name field, enter the new unique name for the AP.
5. Click Apply and Reboot.

Renaming in the CLI

Execute the following command (from enable mode) only on a master controller. Executing the command causes the AP to automatically reboot.

```
ap-rename {ap-name <name>|serial-num <number>|wired-mac <macaddr>} <new-name>
```

If an AP is recognized by the controller but is powered off or not connected to the network or controller when you execute the command, the request is queued until the AP is powered back on or reconnected.

Optimize APs Over Low-Speed Links

Depending on your deployment scenario, you may have APs or remote APs that connect to a controller located across low-speed (less than 1 Mbps capacity) or high-latency (greater than 100 ms) links.

With low-speed links, if heartbeat or keep alive packets are not received between the AP and controller during the defined interval, APs may reboot causing clients to re-associate. You can adjust the bootstrap threshold and prioritize AP heartbeats to optimize these types of links. In addition, high bandwidth applications may saturate low-speed links. For example, if you have tunnel-mode SSIDs, use them with low-bandwidth applications such as barcode scanning, small database lookups, and Telnet to avoid saturating the link. If you have traffic that will remain local, deploying remote APs and configuring SSIDs as bridge-mode SSIDs can also prevent link saturation.

With high-latency links, consider the amount and type of client devices accessing the links. Dell APs locally process 802.11 probe-requests and probe-responses, but the 802.11 association process requires interaction with the controller.

When deploying APs across low-speed or high-latency links, Dell recommends the following best practices:

- Connect APs and controllers over a link with a capacity of 1 Mbps or greater.
- Maintain a minimum link speed of 64 Kbps per GRE tunnel and per bridge-mode SSID. This is the minimum speed required for downloading software images.
- Adjust the bootstrap threshold to 30 if the network experiences packet loss. This makes the AP recover more slowly in the event of a failure, but it will be more tolerant to heartbeat packet loss.
- Prioritize AP heartbeats to prevent losing connectivity with the controller.
- If possible, reduce the number of tunnel-mode SSIDs. Each SSID creates a tunnel to the controller with its own tunnel keep alive traffic.
- If most of the data traffic will remain local to the site, deploy remote APs in bridging mode. For more information about remote APs, see Chapter 4, “Access Points” .
- If high-latency links such as transoceanic or satellite links are used in the network, deploy a controller geographically close to the APs.
- If high-latency causes association issues with certain handheld devices or barcode scanners, check the manufacturer of the device for recent firmware and driver updates.

Configuring the Bootstrap Threshold

To configure the bootstrap threshold using the WebUI:

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit by the AP group or AP name.

3. Under Profiles, select AP, then AP system profile. The configuration settings displayed in the Profile Details window are described in Table 22.

Table 22 *AP System Profile Configuration*

Parameter	Description
LMS IP	In multi-controller networks, this parameter specifies the IP address of the local management switch (LMS)—the Dell controller—which is responsible for terminating user traffic from the APs, and processing and forwarding the traffic to the wired network. This can be the IP address of the local or master controller. When using redundant controllers as the LMS, set this parameter to be the VRRP IP address to ensure that APs always have an active IP address with which to terminate sessions.
LMS IPv6	The IPv6 address of the LMS for this AP or group
Backup LMS IP	In multi-controller networks, specifies the IP address of a *backup* to the IP address specified with the lms-ip parameter.
Backup LMS IPv6	The IPv6 address of the backup LMS for this AP or group
LMS Preemption	When this parameter is enabled, the AP automatically reverts to the primary LMS IP address when it becomes available.
LMS Hold-down Period	Time, in seconds, that the primary LMS must be available before an AP returns to that LMS after failover.
Number of IPSEC retries	Number of times the AP will try to create an IPsec tunnel with the master controller before the AP will reboot. If you specify a value of 0, and AP will not reboot if it cannot create the IPsec tunnel. The supported range of values is 0-1000 retries, and the default value is 360 retries.
LED operating mode (11n APs only)	The operating mode for the AP LEDs (W-AP120, W-AP124 and W-AP125 only)
RF Band	For APs that support both a and b/g RF bands, RF band in which the AP should operate: • g = 2.4 GHz • a = 5 GHz
Double Encrypt	This parameter applies only to remote APs. Use double encryption for traffic to and from a wireless client that is connected to a tunneled SSID. When enabled, all traffic is re-encrypted in the IPsec tunnel. When disabled, the wireless frame is only encapsulated inside the IPsec tunnel. All other types of data traffic between the controller and the AP (wired traffic and traffic from a split-tunneled SSID) are always encrypted in the IPsec tunnel.
Native VLAN ID	Native VLAN for bridge mode virtual APs (frames on the native VLAN are not tagged with 802.1q tags).
SAP MTU	MTU, in bytes, on the wired link for the AP.
Bootstrap threshold	Number of consecutive missed heartbeats on a GRE tunnel (heartbeats are sent once per second on each tunnel) before an AP rebootstraps. On the controller, the GRE tunnel timeout is 1.5 x bootstrap-threshold; the tunnel is torn down after this number of seconds of inactivity on the tunnel. The supported range is 1-65535, and the default value is 8.
Request Retry Interval	Interval, in seconds, between the first and second retries of AP-generated requests. If the configured interval is less than 30 seconds, the interval for subsequent retries is increased up to 30 seconds.
Maximum Request Retries	Maximum number of times to retry AP-generated requests, including keepalive messages. After the maximum number of retries, the AP either tries the IP address specified by the bkup-lms-ip (if configured) or reboots.
Dump Server	(For debugging purposes.) Specifies the server to receive a core dump generated when an AP process crashes.

Table 22 *AP System Profile Configuration (Continued)*

Parameter	Description
Telnet	Select this checkbox to enable telnet to the AP.
SNMP sysContact	SNMP system contact information.
AeroScout RTLS Server	Enables the AP to send RFID tag information to an AeroScout real-time asset location (RTLS) server. Specify the IP address and port number of the AeroScout server to which location reports should be sent.
RF Band for AM mode scanning	Scanning band for multiple RF radios.
RTLS Server configuration	Enables the AP to send RFID tag information to an RTLS server. You must specify the IP address and port number of the server to which location reports are sent, a shared secret key, and the frequency at which packets are sent to the server.
Remote-AP DHCP Server VLAN	VLAN ID of the remote AP DHCP server used if the controller is unavailable. This VLAN enables the DHCP server on the AP (also known as the remote AP DHCP server VLAN). If you enter the native VLAN ID, the DHCP server is unavailable.
Remote-AP DHCP Server Id	IP address used as the DHCP server identifier.
Remote-AP DHCP Default Router	IP address for the default DHCP router.
Remote-AP DHCP DNS Server	IP address of the DNS server.
Remote-AP DHCP Pool Start	Configures a DHCP pool for remote APs. This is the first IP address of the DHCP pool.
Remote-AP DHCP Pool End	Configures a DHCP pool for remote APs. This is the last IP address of the DHCP pool.
Remote-AP DHCP Pool Netmask	Configures a DHCP pool for remote APs. This is the netmask used for the DHCP pool.
Remote-AP DHCP Lease Time	The amount of days that the assigned IP address is valid for the client. Specify the lease in <days>. A value of 0 indicates the IP address is always valid; the lease does not expire.
Remote-AP uplink total bandwidth	This is the total reserved uplink bandwidth (in Kilobits per second).
Remote-AP bw reservation 1 Remote-AP bw reservation 2 Remote-AP bw reservation 3	Session ACLs with uplink bandwidth reservation in kilobits per second. You can specify up to three session ACLs to reserve uplink bandwidth. The sum of the three uplink bandwidths should not exceed the Remote-AP uplink total bandwidth.
Heartbeat DSCP	DSCP value of AP heartbeats. The supported range is 0-63, and the default value is 0.
Session ACL	Session ACL configured with the ip access-list session command. NOTE: This parameter requires the PEFNG license.
Corporate DNS Domain	Name of domain that is resolved by corporate DNS servers. Use this parameter when configuring split tunnel.
Maintenance Mode	Enable or disable AP maintenance mode. This setting is useful when deploying, maintaining, or upgrading the network. If enabled, APs stop flooding unnecessary traps and syslog messages to network management systems or network operations centers when deploying, maintaining, or upgrading the network. The controller still generates debug syslog messages if debug logging is enabled.
Remote-AP Local Network Access	Enable or disable local network access across VLANs in a Remote-AP.

4. In the Bootstrap threshold field, enter 30.
5. Click Apply.

To configure the bootstrap threshold using the command-line interface, access the CLI in config mode and issue the following command:

```
ap system-profile <profile>
   bootstrap-threshold 30
```

Prioritizing AP heartbeats

To prioritize AP heartbeats using the WebUI:

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP, then AP system profile. The configuration settings are displayed in Profile Details.
4. Under Profile Details:
   a. In the Heartbeat DSCP field, enter a value greater than zero.
   b. Click Apply.

To prioritize AP heartbeats using the command-line interface, access the CLI in config mode and issue the following command:

```
ap system-profile <profile>
   heartbeat-dscp <number>
```

AP Redundancy

In conjunction with the controller redundancy features described in Chapter 24, "VRRP" the information in this section describes redundancy for APs. Remote APs also offer redundancy solutions via a backup configuration, backup controller list, and remote AP failback. For more information relevant to remote APs, see Chapter 7, "Remote Access Points" .

The AP failback feature allows an AP associated with the backup controller (backup LMS) to fail back to the primary controller (primary LMS) if it becomes available.

If configured, the AP monitors the primary controller by sending probes every 600 seconds by default. If the AP successfully contacts the primary controller for the entire hold-down period, it will fail back to the primary controller. If the AP is unsuccessful, the AP maintains its connection to the backup controller, restarts the LMS hold-down timer, and continues monitoring the primary controller.

The following example assumes:

- You have not configured the LMS or backup LMS IP addresses
- Default values unless otherwise noted.

In the WebUI

Follow the procedure below to use the AP system profile to configure a redundant controller. For additional information on AP system profile settings, see Table 22 on page 128.

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP to display the AP profiles.
4. Select the AP system profile you want to modify.
5. Under Profile Details:
   a. At the LMS IP field, enter the primary controller IP address.
   b. At the Backup LMS IP field, enter the backup controller IP address.
   c. Click (select) LMS Preemption. This is disabled by default.
6. Click Apply.

In the CLI

```
ap system-profile <profile>
   lms-ip <ipaddr>
   bkup-lms-ip <ipaddr>
```

```
   lms-preemption

ap-group <group>
   ap-system-profile <profile>

ap-name <name>
   ap-system-profile <profile>
```

AP Maintenance Mode

You can configure APs to suppress traps and syslog messages related to those APs. Known as AP maintenance mode, this setting in the AP system profile is particularly useful when deploying, maintaining, or upgrading the network. If enabled, APs stop flooding unnecessary traps and syslog messages to network management systems or network operations centers during a deployment or scheduled maintenance. The controller still generates debug syslog messages if debug logging is enabled. After completing the network maintenance, disable AP maintenance mode to ensure all traps and syslog messages are sent. AP maintenance mode is disabled by default.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP to display the AP profiles.
4. Select the AP system profile you want to modify.
5. Under Profile Details, do the following:
   - To enable AP maintenance mode, check (select) the Maintenance Mode checkbox.
   - To disable AP maintenance mode, clear (deselect) the Maintenance Mode checkbox.
6. Click Apply.

In the CLI

To enable AP maintenance mode:

```
ap system-profile <profile>
   maintenance-mode
To disable AP maintenance mode:
ap system-profile <profile>
   no maintenance-mode
```

To view the maintenance mode status of APs, use the following commands:

```
show ap config {ap-group <name>|ap-name <name>|essid <name>}
show ap debug system-status {ap-name <name>|bssid <name>| ip-addr <ipaddr>}
```

On the local controller, you can also view maintenance mode status using the following commands:

```
show ap active {ap-name <name>|essid <name>|ip-addr <ipaddr>}
show ap database
show ap details {ap-name <name>|bssid <name>|ip-addr <ipaddr>}
```

Managing AP LEDs

AP LEDs can be configured in two modes: normal and off. In normal mode, the AP LEDs will light as expected. When the mode is set to off, all of the LEDs on the affected APs are disabled.

Disabling LEDs in the WebUI

An AP system profile's LED operating mode affects LEDS on all APs using that profile.

NOTE: This option is available on the W-AP120 Series, AP-90 Series, AP-105, and the RAP-5.

1. Navigate to the Configuration > Advanced Services> All Profiles page.
2. Select the AP tab and then select the AP system profiles tab.
3. Select the AP system profile you want to modify.
4. Locate the LED operating mode (W-AP120 series only) parameter.
5. From the drop-down list, select off.
6. Click Apply.

Enable or Disable LEDs in the CLI

Use the ap system-profile command to disable LEDs for all APs using a particular system profile.

```
(host) (config)# ap system-profile <profile-name> led-mode {normal | off}
```

Configuring Blinking LEDs in the CLI

Use the ap-leds command to make the LEDs on a defined set of APs either blink or display in the currently configured LED operating mode. Note that if the LED operating mode defined in the AP's system profile is set to "off", then the normal parameter in the ap-leds command will disable the LEDs. If the LED operating mode in the AP system profile is set to "normal" then the normal parameter in this command will allow the LEDs light as usual.

```
(host) (config)# ap-leds {all | ap-group <ap-group> | ap-name <ap-name> | ip-addr <ip
address> | wired-mac <mac address>} {global blink|normal}|{local blink|normal}
```

Managing RF Interference

RF Optimization

Each AP includes an RF Optimization profile that allows you to configure settings for detecting interference. The controller can detect interference near a wireless client station or AP is based on an increase in the frame retry rate or frame receive error rate.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name for which you want to configure the RF Optimization profile.
   - If you selected the AP Specific tab, click the Edit button by the AP for which you want to create the RF Optimization profile.
2. Expand the RF Management menu, then expand the RF Optimization Profile menu.
3. Select the profile you want to edit from the Profile Details window pane.

   or

   Enter a new RF Optimization profile name in the field at the bottom of the Profile Details window, then click Add. Next, select that profile name from the profile list to edit its parameters.

4. Configure your RF Optimization radio settings. Table 23 describes the parameters. Click Apply to save your settings.

Table 23 *RF Optimization Profile Parameters*

Parameter	Description
Station Handoff Assist	Allows the controller to force a client off an AP when the RSSI drops below a defined minimum threshold. Default: Disabled
Detect Association Failure	Enables or disables detection of station association failures. Default: Disabled
Detect interference	Select this checkbox to enable the interference detection. Default: Disabled
Interference Threshold	Percentage increase in the frame retry rate or frame receive error rate before interference monitoring begins on a given channel.
Interference Threshold Exceed Time	Amount of time the frame retry rate or frame receive error rate should be exceed by the threshold before interference is reported. Max 360000.
Interference Baseline Time	Time, in seconds, the air monitor should learn the state of the link between the AP and client to create frame retry rate (FRR) and frame receive error rate (FRER) baselines.
RSSI Falloff Wait Time	Time, in seconds, to wait with decreasing RSSI before a de-authorization message is sent to the client. Maximum value: 8 seconds Default value: 0 seconds
Low RSSI Threshold	Minimum RSSI above which de-authorization messages should never be sent.
RSSI Check Frequency	Interval, in seconds, to sample RSSI.

In the CLI

Use the following command to configure RF Optimization profiles. The parameters described in Table 23.

```
rf optimization-profile <profile>
clone <profile>
detect-association-failure
detect-interference
handoff-assist
interference-baseline <seconds>
interference-exceed-threshold <seconds>
interference-threshold <percent>
low-rssi-threshold <number>
no ...
rssi-check-frequency <number>
rssi-falloff-wait-time <seconds>
```

RF Event Configuration

An AP's event threshold profile configures Received Signal Strength Indication (RSSI) metrics, including high and low watermarks for frame error rates and frame retry rates. When certain RF parameters are exceeded, these events can signal excessive load on the network, excessive interference, or faulty equipment.

NOTE: This profile and many of the detection parameters are disabled (value is 0) by default.

The following procedure details the steps to configure RF Event parameters.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name for which you want to configure the RF Event profile.
   - If you selected the AP Specific tab, click the Edit button by the AP for which you want to create the RF Event profile.
2. In the Profiles list, expand the RF Management menu, then expand the RF Event Profile menu.
3. To edit an existing RF Event profile, select the profile you want to edit from the Profile Details window pane.

   -or-
4. To create a new profile, enter a new RF Event profile name in the field at the bottom of the Profile Details window, then click Add. Next, select that profile name from the profile list to edit its parameters.
5. Configure your settings as detailed in Table 24 and click Apply to save your settings.

Table 24 *RF Event Profile Parameters*

Parameter	Description
Detect Frame Rate Anomalies	Enable or disables detection of frame rate anomalies. This feature is disabled by default.
Bandwidth Rate High Watermark	If bandwidth in an AP exceeds this value, a bandwidth exceeded condition exists. The value represents the percentage of maximum for a given radio. (For 802.11b, the maximum bandwidth is 7 Mbps. For 802.11 a and g, the maximum is 30 Mbps.) The recommended value is 85%.
Bandwidth Rate Low Watermark	After a bandwidth exceeded condition exists, the condition persists until bandwidth drops below this value. The recommended value is 70%.
Frame Error Rate High Watermark	If the frame error rate (as a percentage of total frames in an AP) exceeds this value, a frame error rate exceeded condition exists. The recommended value is 16%.
Frame Error Rate Low Watermark	After a frame error rate exceeded condition exists, the condition persists until the frame error rate drops below this value. The recommended value is 8%.
Frame Fragmentation Rate High Watermark	If the frame fragmentation rate (as a percentage of total frames in an AP) exceeds this value, a frame fragmentation rate exceeded condition exists. The recommended value is 16%.
Frame Fragmentation Rate Low Watermark	After a frame fragmentation rate exceeded condition exists, the condition persists until the frame fragmentation rate drops below this value. The recommended value is 8%
Frame Low Speed Rate High Watermark	If the rate of low-speed frames (as a percentage of total frames in an AP) exceeds this value, a low-speed rate exceeded condition exists. This could indicate a coverage hole. The recommended value is 16%.
Frame Low Speed Rate Low Watermark	After a low-speed rate exceeded condition exists, the condition persists until the percentage of low-speed frames drops below this value. The recommended value is 8%.
Frame Non Unicast Rate High Watermark	If the non-unicast rate (as a percentage of total frames in an AP) exceeds this value, a non-unicast rate exceeded condition exists. This value depends upon the applications used on the network.
Frame Non Unicast Rate Low Watermark	After a non-unicast rate exceeded condition exists, the condition persists until the non-unicast rate drops below this value.
Frame Receive Error Rate High Watermark	If the frame receive error rate (as a percentage of total frames in an AP) exceeds this value, a frame receive error rate exceeded condition exists. The recommended value is 16%

Table 24 *RF Event Profile Parameters (Continued)*

Parameter	Description
Frame Receive Error Rate Low Watermark	After a frame receive error rate exceeded condition exists, the condition persists until the frame receive error rate drops below this value. The recommended value is 8%.
Frame Retry Rate High Watermark	If the frame retry rate (as a percentage of total frames in an AP) exceeds this value, a frame retry rate exceeded condition exists. The recommended value is 16%.
Frame Retry Rate Low Watermark	After a frame retry rate exceeded condition exists, the condition persists until the frame retry rate drops below this value. The recommended value is 8%.

In the CLI

Use the following command to configure RF event profiles. The available parameters for this profile are detailed in Table 24.

```
rf event-thresholds-profile <profile>
bwr-high-wm <percent>
bwr-low-wm <percent>
clone <profile>
detect-frame-rate-anomalies
fer-high-wm <percent>
fer-low-wm <percent>
ffr-high-wm <percent>
ffr-low-wm <percent>
flsr-high-wm <percent>
flsr-low-wm <percent>
fnur-high-wm <percent>
fnur-low-wm <percent>
frer-high-wm <percent>
frer-low-wm <percent>
frr-high-wm <percent>
frr-low-wm <percent>
```

AP Channel Assignments

20 MHz and 40 MHz Static Channel Assignments

With the implementation of the high-throughput IEEE 802.11n standard, 40 MHz channels were added in addition to the existing 20 MHz channel options. Available 20 MHz and 40 MHz channels are dependent on the country code entered in the regulatory domain profile.

The following channel configurations are now available in ArubaOS:

- A 20 MHz channel assignment consists of a single 20 MHz channel assignment. This channel assignment is valid for 802.11a/b/g and for 802.11n 20 MHz mode of operation.
- A 40 MHz channel assignment consists of two 20 MHz channels bonded together (a bonded pair). This channel assignment is valid for 802.11n 40 MHz mode of operation and is most often utilized on the 5 GHz frequency band.

  If high-throughput is disabled, a 40 MHz channel assignment can be configured, but only the primary channel assignment is utilized. The 20 MHz clients can also associate using this configuration, but only the primary channel is utilized.

Table 25 *20 MHz and 40 MHz Static Channel Configuration Options*

WebUI	CLI	Definition
Channel Text Field None Radio Button	`channel <num>`	Entering a channel number in the CLI, or entering a channel number in the WebUI and selecting the None radio button, disables 40 MHz mode and activates 20 MHz mode for the entered channel.
Channel Text Field Above Radio Button	`channel <num>+`	Entering a channel number with a plus (+) sign in the CLI, or entering a channel number and selecting the Above radio button in the WebUI, selects a primary and secondary channel for 40 MHz mode. The number entered becomes the primary channel and the secondary channel is determined by increasing the primary channel number by 4. Example: 157+ represents 157 as the primary channel and 161 as the secondary channel.
Channel Text Field Below Radio Button	`channel <num>-`	Entering a channel number with a minus (-) sign in the CLI, or entering a channel number and selecting the Below radio button in the WebUI, selects a primary and secondary channel for 40 MHz mode. The number entered becomes the primary channel and the secondary channel is determined by decreasing the primary channel number by 4. Example: 157- represents 157 as the primary channel and 153 as the secondary channel.

The example in this section illustrates a static channel assignment and assumes that the radio and regulatory domain profiles being configured were previously created and assigned to an existing AP group named “ht-corpnet-ap.” These settings also allow for the default ARM profile settings, see “Automatic Channel and Transmit Power Selection Using ARM” on page 159, and Dell’s recommended high-throughput channel assignments for the 802.11a and 802.11b/g bands:

1. Enter a valid country code (US) for the “default” regulatory domain profile. This will determine the available channels.
2. Configure a 40 MHz channel (bonded pair) for an 802.11a (5 GHz) radio profile named “ht-corpnet-a.”
3. Configure a 20 MHz channel for an 802.11g (2.4 GHz) radio profile named “ht-corpnet-g.”

NOTE: If you want the channel assignments to utilize high-throughput, ensure that high-throughput is enabled within the radio profile. For details, see “force-disassoc” on page 156.

In the WebUI

1. Navigate to Configuration > Wireless > AP Configuration > AP Group page.
2. Click Edit for the AP group ht-corpnet-ap.
3. Under the Profiles list, select AP to display the AP profiles.
4. Select the Regulatory Domain profile named “default.”
5. Select US - United States from the Country Code drop-down menu.
6. Click Apply.
7. Under the Profiles list, select RF Management to display the radio profiles.
8. Select the 802.11a radio profile named “ht-corpnet-a.”
9. Enter `36` in the Channel text field and select the Above radio button. In this instance, channel 36 becomes the primary channel and the secondary channel is 40.
10. Click Apply.
11. Select the 802.11g radio profile named “ht-corpnet-g.”

12. Enter `1` in the Channel text field and select the None radio button. In this instance, channel 1 is the assigned 20 MHz channel and 40 MHz mode is disabled and click Apply.

In the CLI

```
ap regulatory-domain-profile default
   country-code US
rf dot11a-radio-profile ht-corpnet-a
   channel 36+
rf dot11g-radio-profile ht-corpnet-g
   channel 1
```

Channel Switch Announcement (CSA)

When an AP changes its channel, an existing wireless clients may “time out” while waiting to receive a new beacon from the AP; the client must begin scanning to discover the new channel on which the AP is operating. If the disruption is long enough, the client may need to reassociate, reauthenticate, and re-request an IP address. Channel Switch Announcement (CSA), as defined by IEEE 802.11h, enables an AP to announce that it is switching to a new channel before it begins transmitting on that channel. This allows the clients, who support CSA, to transition to the new channel with minimal downtime.

When CSA is enabled, the AP does not change to a new channel immediately. Instead, it sends a number of beacons (the default is 4) which contain the CSA announcement before it switches to the new channel. You can configure the number of announcements sent before the change.

NOTE: Clients must support CSA in order to track the channel change without experiencing disruption.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Select RF Management in the Profile list.
4. Select the 802.11a or 802.11g radio profile.
5. Select Enable CSA. You can configure a different value for CSA Count.
6. Click Apply.

In the CLI

```
rf radio-profile <profile>
   csa
   csa-count <number>
```

Automatic Channel and Transmit Power Selection

To allow automatic channel and transmit power selection based on the radio environment, enable Adaptive Radio Management (ARM). Note that ARM assignments will override the static channel and power configurations done using the radio profile. For complete information on the Adaptive Radio Management feature, see Chapter 6, “Adaptive Radio Management (ARM)” on page 163.

AP Console Settings

An AP’s provisioning parameters are unique to each AP. These parameters are initially configured on the controller and then pushed out to the AP and stored on the AP itself. Best practices are to configure an AP’s provisioning settings using the controller WebUI. If you find it necessary to alter an AP’s provisioning settings

for troubleshooting purposes, you can do so using the controller WebUI and CLI, or alternatively, through a console connection to the AP itself.

To create a console connection to the AP:

1. Connect a local console to the serial port on the AP. You can connect the AP's serial port to a terminal or terminal server using an Ethernet cable, or connect the serial console port to a DB-9 adapter, then connect the adapter to a laptop using an RS-232 cable. For details on connecting to an AP's serial console port, refer to the Installation Guide included with the AP.
2. Establish a console communication to the AP, then power-cycle the AP to reboot it.
3. To access the AP console command prompt, press Enter when the AP displays the message "*Hit <Enter> to stop autoboot.*" If the autoboot countdown expires before you can interrupt it, turn the device off and then back on.
4. Once the AP boot prompt appears, you can issue any of the AP provisioning commands described in the Table 26. Remember, though these commands may be useful for troubleshooting, they are all optional and are *not* necessary for normal AP provisioning.

Table 26 *AP Console Commands*

Command	Description
setenv ipaddr <ipaddr>	IP address to be assigned to the AP.
setenv netmask <netmaskip>	Netmask to be assigned to the AP.
setenv gatewayip <ipaddr>	IP address of the internet gateway used by the AP.
setenv name <ap name>	Name of the AP.
setenv group <group name>	Name of the AP group to which the AP should belong.
setenv master <ipaddr>	IP address of the AP's master controller.
setenv serverip <ipaddr>	IP address of the TFTP server from which the AP can download its boot image.
setenv dnsip <ipaddr>	IP address of the DNS server used by the AP.
setenv domainname <domain>	Domain name used by the AP.

CAUTION: Other AP console commands may be available when accessing an AP directly through its console port, but these commands can cause configuration errors if used improperly and should only be issued under the direct supervision of Dell technical support.

5. When you are finished, type Save and then press Enter to save your settings.

The example below configures an AP location and domain name using an AP console connection:

```
Hit <Enter> to stop autoboot:  0
apboot> <INTERRUPT>
apboot>setenv group corporate2
apboot>setenv domainname mycompany.com
apboot>save
apboot>reboot
```

To view current AP settings using the AP console, issue the command printenv <name> where <name> is one of the variable names listed in Table 26, such as ipaddr, dnsip or gatewayip.

```
apboot> printenv domainname
domainname=mycompany.com
```

Chapter 5

Virtual APs

APs advertise WLANs to wireless clients by sending out beacons and probe responses that contain the WLAN's SSID and supported authentication and data rates. When a wireless client associates to an AP, it sends traffic to the AP's Basic Service Set Identifier (BSSID) which is usually the AP's MAC address.

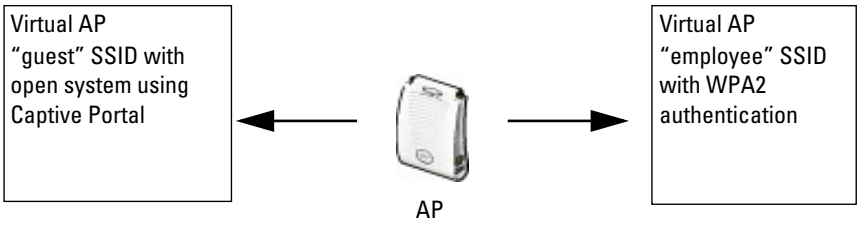
In the Dell network, an AP uses a unique BSSID for each WLAN. Thus a physical AP can support multiple WLANs. The WLAN configuration applied to a BSSID on an AP is called a *virtual AP*. You can configure and apply multiple virtual APs to an AP group or to an individual AP by defining one or more virtual AP profiles.

This chapter describes the following topics:

Virtual AP Profiles

You can configure virtual AP profiles to provide different network access or services to users on the same physical network. For example, you can configure a WLAN to provide access to guest users and another WLAN to provide access to employee users through the same APs. You can also configure a WLAN that offers open authentication and Captive Portal access with data rates of 1 and 2 Mbps and another WLAN that requires WPA authentication with data rates of up to 11 Mbps. You can apply both virtual AP configurations to the same AP or an AP group (see Figure 23).

Figure 23 *Virtual AP Configurations Applied to the same AP*



You can apply the same virtual AP profiles to one or more AP groups. For example, there are users in both Edmonton and Toronto that access the same "Corpnet" WLAN. Note that if your WLAN requires authentication to an external server, you may want to have users who associate with the APs in Toronto authenticate with their local servers. In this case, you can configure a slightly different AAA profiles; one that references authentication servers in the Edmonton and the other that references servers in Toronto (see to Table 27).

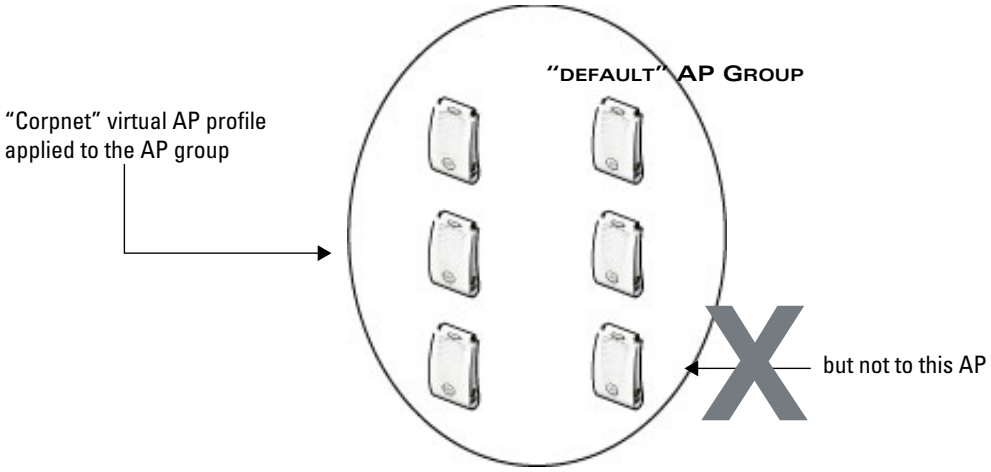
Table 27 *Applying WLAN Profiles to AP Groups*

WLAN Profiles	"default" AP Group	"Toronto" AP Group
Virtual AP	"Corpnet-E"	"Corpnet-T"
SSID	"Corpnet"	"Corpnet"
AAA	"E-Servers"	"T-Servers"

When you assign a profile to an individual AP, the values in the profile override the profile assigned to the AP group to which the AP belongs. The exception is the virtual AP profile. You can apply multiple virtual AP profiles to individual APs, as well as to AP groups.

You can exclude one or more virtual AP profiles from an individual AP. This prevents a virtual AP, defined at the AP group level, from being applied to a specific AP. For example, you can apply the virtual AP profile that corresponds to the "Corpnet" SSID to the "default" AP group. If you do not want the "Corpnet" SSID to be advertised on the AP in the lobby, you can specify the virtual AP profile that contains the "Corpnet" SSID configuration be excluded from that AP.

Figure 24 *Excluding a Virtual AP Profile from an AP*



Excluding a virtual AP profile from an AP in the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration > AP Specific page.
2. Do one of the following:
   - If the AP you want to exclude is in included in the list, click Edit for the AP.
   - If the AP does not appear in the list, click New. Either type in the name of the AP, or select the AP from the drop-down list. Then click Add.
3. Select Wireless LAN under the Profiles list, then select Excluded Virtual AP.
4. Select the name of the virtual AP profile you want to exclude from the drop down menu (under Profile Details) and click Add. The profile name appears in the Excluded Virtual APs list. You can add multiple profile names in the same way.
5. To remove a profile name from the Excluded Virtual APs list, select the profile name and click Delete.
6. Click Apply.

Excluding a virtual AP profile from an AP in the CLI

```
ap-name <name<
   exclude-virtual-ap <profile>
```

Configuring a Virtual AP

This section includes examples of how to create virtual APs for a specific AP as well as for the "default" AP group, which includes all APs discovered by the controller. The configuration in this example contain the following WLANs:

- An 802.11a/b/g SSID called "Corpnet" that uses WPA2 and is available on all APs in the network

- An 802.11a/b/g SSID called “Guest” that uses open system and is only available on the AP “building3-lobby” (this AP will support both the “Corpnet” and “Guest” SSIDs)

Each WLAN requires a different SSID profile that maps into a separate virtual AP profile. For the SSID “Corpnet”, which will use WPA2, you need to configure an AAA profile that includes 802.1x authentication and an 802.1x authentication server group.

Because all APs discovered by the controller belong to the AP group called “default”, you assign the virtual AP profile that contains the SSID profile “Corpnet” to the “default” AP group. For the “Guest” SSID, you configure a new virtual AP profile that you assign to the AP named “building3-lobby”. Table 28 lists the profiles that you need to modify or create for these examples.

Table 28 *Profiles for Example Configuration*

AP Group/Name	Virtual AP Profile	SSID Profile	AAA Profile
“default”	“corpnet” • VLAN: 1 • SSID profile: “corpnet” • AAA profile: “corpnet”	“corpnet” • SSID: Corpnet • WPA2	“corpnet” • 802.1x authentication default role: “employee” • 802.1x authentication server group: “corpnet” - Radius1 - Radius2
“building3-lobby”	“guest” • VLAN: 2 • Deny Time Range • SSID profile: “guest” • AAA profile: “default-open”	“guest” • SSID: Guest • Open system	“default-open” (This is a predefined, read-only AAA profile that specifies open system authentication)

Configuring the WLAN

In this example WLAN, users are validated against a corporate database on a RADIUS authentication server before they are allowed access to the network. Once validated, users are placed into a specified VLAN (VLAN 1 in this example) and assigned the user role “employee” that permits access to the corporate network.

NOTE: Dell recommends that you assign a unique name to each virtual AP, SSID, and AAA profile that you modify. In this example, you use the name “corpnet” to identify each of the profiles.

Follow the steps below to configure the Corpnet WLAN. Each of these steps are described in further detail later in this document.

1. Configure a policy for the user role employee and configure the user role employee with the specified policy.
2. Configure RADIUS authentication servers and assign them to the corpnet 802.1x authentication server group.
3. Configure authentication for the WLAN.
   a. Create the corpnet 802.1x authentication profile.
   b. Create the AAA profile corpnet and specify the previously-configured employee user role for the 802.1x authentication default role.
   c. Specify the previously-configured corpnet 802.1x authentication server group.
4. For the AP group “default”, create and configure the virtual AP corpnet.
   a. Create a new virtual AP profile corpnet.
   b. Select the previously-configured corpnet AAA profile for this virtual AP.
   c. Create a new SSID profile corpnet to configure “Corpnet” for the SSID name and WPA2 for the authentication.

The following sections describe how to do this using the WebUI and the CLI.

Configuring the User Role

In this example, the employee user role allows unrestricted access to network resources and is granted only to users who have been successfully authenticated with an external RADIUS server. You can configure a more restrictive user role by specifying allowed or disallowed source and destination, protocol, and service for the traffic. For more information about configuring user roles, see "User Roles" on page 326.

In the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to add a new policy. Enter the name of the policy.

   Default settings for a policy rule permit all traffic from any source to any destination, but you can make a rule more restrictive. You can also configure multiple rules; the first rule in a policy that matches the traffic is applied. Click Add to add a rule. When you are done adding rules, click Apply.
3. Click the User Roles tab. Click Add to add a new user role. Enter the name of the role. Under Firewall Policies, click Add. In the Choose from Configured Policies drop-down list, select the policy you previously created. Click Done.
4. Click Apply.

In the CLI

```
ip access-list session <policy>
   <source> <dest> <service> <action>
user-role employee
   access-list session <policy>
```

Configuring Authentication Servers

This example uses RADIUS servers for the client authentication. You need to specify the hostname and IP address for each RADIUS server and the shared secret used to authenticate communication between the server and the controller. After configuring authentication servers, assign them to the corpnet server group, an ordered list of the servers to be used for 802.1x authentication.

For more information about configuring authentication servers, see "Configuring Servers" on page 264.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Radius Server to display the Radius Server List.
3. Enter the name of the server, and click Add. The server name appears in the list of servers.
4. Select the server name. Enter the IP address and shared secret for the server. Select the Mode checkbox to activate the authentication server.
5. Click Apply to apply the configuration.
6. Select Server Group on the Servers page.
7. Enter the name of the group, and click Add. The server group name appears in the list of server groups.
8. Select the server group name. Click New to add a server to the group. Under Server Name, select the server you just configured and click Add.
9. Click Apply to apply the configuration.

In the CLI

```
aaa authentication-server radius Radius1
   host <ipaddr>
```

```
   key <key>
   enable
aaa server-group corpnet
   auth-server Radius1
```

Configuring Authentication

In this example, you create the 802.1x authentication profile corpnet. The AAA profile configures the authentication for a WLAN. The AAA profile defines the type of authentication (802.1x in this example), the authentication server group, and the default user role for authenticated users.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page. Select 802.1x Authentication Profile.
   a. In the 802.1x Authentication Profile list on the right window pane, enter corpnet in the entry blank at the bottom of the list, and click Add.
   b. Select the corpnet 802.1x authentication profile you just created.
   c. You can configure parameters in the Basic or Advanced tabs. These parameters are described in detail in Table 55. For this example, you use the default values, so click Apply.
2. Select the AAA Profiles tab.
   a. Scroll down to the bottom of the AAA Profiles Summary pane, then click Add. An entry blank appears.
   b. Enter corpnet, then click Add.
   c. Scroll back up the AAA Profiles Summary pane, and select the corpnet AAA profile you just created.
   d. For this example, change the 802.1x Authentication Default Role, select the employee role you previously configured. You can also configure other the AAA profile parameters (see Table 29).
   e. Click Apply.

Table 29 *AAA Profile Parameters*

Parameter	Description
Initial role	Click the Initial Role drop-down list and select a role for unauthenticated users. The default role for unauthenticated users is logon.
MAC Authentication Default Role	Click the MAC Authentication Default Role drop-down list and select the role assigned to the user when the device is MAC authenticated. The default role for MAC authentication is the guest user role. If derivation rules are present, the role assigned to the client through these rules take precedence over the default role. NOTE: This feature requires the PEFNG license.
802.1X Authentication Default Role	Click the 802.1X Authentication Default Role drop-down list and select the role assigned to the client after 802.1x authentication. The default role for 802.1x authentication is the guest user role. If derivation rules are present, the role assigned to the client through these rules take precedence over the default role. NOTE: This feature requires the PEFNG license.
RADIUS Interim Accounting	When this option is enabled, the RADIUS accounting feature allows the controller to send Interim-Update messages with current user statistics to the server at regular intervals. This option is disabled by default, allowing the controller to send only start and stop messages to the RADIUS accounting server.
User derivation rules	Click the User derivation rules drop-down list and specify a user attribute profile from which the user role or VLAN is derived.
Wired to Wireless Roaming	Enable this feature to keep users authenticated when they roam from the wired side of the network. This feature is enabled by default.

Table 29 *AAA Profile Parameters (Continued)*

Parameter	Description
SIP authentication role	Click the SIP authentication role drop-down list and specify the role assigned to a session initiation protocol (SIP) client upon registration. NOTE: This feature requires the PEFNG license.
Device Type Classification	When you select this option, the controller will parse user-agent strings and attempt to identify the type of device connecting to the AP. When the device type classification is enabled, the Global client table shown in the Monitoring>Network > All WLAN Clients window shows each client's device type, if that client device can be identified.
Enforce DHCP	When you select this option, clients must obtain an IP using DHCP before they are allowed to associate to an AP. Enable this option when you create a user rule that assigns a specific role or VLAN based upon the client device's type. For details, see "User-Derived Roles or VLANs" on page 330. NOTE: If a client is removed from the user table by the "Logon user lifetime" AAA timer, then that client will not be able to send traffic until it renews it's DHCP.

3. Select the 802.1x Authentication Profile under the corpnet AAA profile to reveal the 802.1X Authentication Profile pane.
   a. Click the 802.1X Authentication Profile drop-down list and select corpnet.
   b. Click Apply.
4. Select the 802.1x Authentication Server Group under the corpnet AAA profile to reveal the 802.1X Authentication Server Group pane.
   a. Click the 802.1X Authentication Server Group drop-down list and select the corpnet server group you previously configured.
   b. Click Apply.

In the CLI

```
aaa authentication dot1x corpnet
aaa profile corpnet
   authentication-dot1x corpnet
   dot1x-default-role employee
   dot1x-server-group corpnet
   radius-interim-accounting
```

Applying the Virtual AP

In this example, you apply the corpnet virtual AP to the "default" AP group which consists of all APs.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration > AP Group page.
2. Click Edit for the "default" AP group.
3. Select Wireless LAN (under Profiles), then select Virtual AP.
4. Select New from the Add a profile drop-down menu. Enter the name for the virtual AP profile (for example, corpnet), and click Add.

NOTE: Whenever you create a new virtual AP profile in the WebUI, the profile automatically contains the "default" SSID profile with the default "Dell-ap" ESSID. You must configure a new ESSID and SSID profile for the virtual AP profile before you apply the profile.

5. Click the new Virtual AP name in the Profiles list or the Profile Details to display the configuration parameters defined in Table 30.
6. Verify that Virtual AP enable is selected; select 1 for the VLAN.
7. Click Apply.

Table 30 *Virtual AP Profile Parameters*

Parameter	Description
Virtual AP enable	Select the Virtual AP enable checkbox to enable or disable the virtual AP.
Allowed band	The band(s) on which to use the virtual AP: • a—802.11a band only (5 GHz). • g—802.11b/g band only (2.4 GHz). • all—both 802.11a and 802.11b/g bands (5 GHz and 2.4 GHz). This is the default setting.
VLAN	The VLAN(s) into which users are placed in order to obtain an IP address. Click the drop-down list to select a configured VLAN, the click the arrow button to associate that VLAN with the virtual AP profile.
Forward mode	This parameter controls whether data is tunneled to the controller using generic routing encapsulation (GRE), bridged into the local Ethernet LAN (for remote APs), or a combination thereof depending on the destination (corporate traffic goes to the controller, and Internet access remains local). All forwarding modes support band steering, TSPEC/TCLAS enforcement, 802.11k and station blacklisting. Click the drop-down list to select one of the following forward modes: • Tunnel: The AP handles all 802.11 association requests and responses, but sends all 802.11 data packets, action frames and EAPOL frames over a GRE tunnel to the controller for processing. The controller removes or adds the GRE headers, decrypts or encrypts 802.11 frames and applies firewall rules to the user traffic as usual. Both remote and campus APs can be configured in tunnel mode. • Bridge: 802.11 frames are bridged into the local Ethernet LAN. When a remote AP or campus AP is in bridge mode, the AP (and not the controller) handles all 802.11 association requests and responses, encryption/decryption processes, and firewall enforcement. The 802.11e and 802.11k action frames are also processed by the AP, which then sends out responses as needed. An AP in bridge mode does not support captive portal authentication. Both remote and campus APs can be configured in bridge mode. Note that you must enable the control plane security feature on the controller before you configure campus APs in bridge mode. • Split-Tunnel: 802.11 frames are either tunneled or bridged, depending on the destination (corporate traffic goes to the controller, and Internet access remains local). A remote AP in split-tunnel forwarding mode handles all 802.11 association requests and responses, encryption/decryption, and firewall enforcement. the 802.11e and 802.11k action frames are also processed by the remote AP, which then sends out responses as needed. • Decrypt-Tunnel: Both remote and campus APs can be configured in decrypt-tunnel mode. When an AP uses decrypt-tunnel forwarding mode, that AP decrypts and decapsulates all 802.11 frames from a client and sends the 802.3 frames through the GRE tunnel to the controller, which then applies firewall policies to the user traffic. When the controller sends traffic to a client, the controller sends 802.3 traffic through the GRE tunnel to the AP, which then converts it to encrypted 802.11 and forwards to the client. This forwarding mode allows a network to utilize the encryption/decryption capacity of the AP while reducing the demand for processing resources on the controller. APs in decrypt-tunnel forwarding mode also manage all 802.11 association requests and responses, and process all 802.11e and 802.11k action frames. APs using decrypt-tunnel mode do have some limitations that not present for APs in regular tunnel forwarding mode. You must enable the control plane security feature on the controller before you configure campus APs in decrypt-tunnel forward mode. NOTE: Virtual APs in bridge or split-tunnel mode using static WEP should use key slots 2-4 on the controller. Key slot 1 should only be used with Virtual APs in tunnel mode.
Deny time range	Click the drop-down list and select a configured time range for which the AP will deny access. If you have not yet configured a time range, navigate to Configuration > Security > Access Control > Time Ranges to define a time range before configuring this setting in the virtual AP profile.

Table 30 *Virtual AP Profile Parameters (Continued)*

Parameter	Description
Mobile IP	Enables or disables IP mobility for this virtual AP. Default: Enabled
HA Discovery on-association	If enabled, all clients of a virtual AP will receive mobility service on association. Default: Disabled
DoS Prevention	If enabled, APs ignore deauthentication frames from clients. This prevents a successful deauthorization attack from being carried out against the AP. This does not affect third-party APs. Default: Disabled
Station Blacklisting	Select the Station Blacklisting checkbox to enable detection of denial of service (DoS) attacks, such as ping or SYN floods, that are not spoofed deauthorization attacks. Default: Enabled
Blacklist Time	Number of seconds that a client is quarantined from the network after being blacklisted. Default: 3600 seconds (1 hour)
Multicast Optimization for Video	Enable/Disable dynamic multicast optimization. This parameter is disabled by default, and cannot be enabled without the PEFNG license.
Multicast Optimization Threshold	Maximum number of high-throughput stations in a multicast group beyond which dynamic multicast optimization stops. Range: 2-255 stations Default: 6 stations.
Authentication Failure Blacklist Time	Time, in seconds, a client is blocked if it fails repeated authentication. The default setting is 3600 seconds (1 hour). A value of 0 blocks the client indefinitely.
Multi Association	Enables or disables multi-association for this virtual AP. When enabled, this feature allows a station to be associated to multiple APs. If this feature is disabled, when a station moves to new AP it will be de-authorized by the AP to which it was previously connected, deleting station context and flushing key caching information. Important things to know when using the Multi Association feature: • When enabled, the system allows multiple associations per client. If the maximum number of clients allowed per AP is limited to a small number there is a risk of increased association failures. • If a client has multiple associations, it may not do active scanning before roaming event which could result in it not being associated to nearest AP. • Multiple associations may result in more frequent roaming.
Strict Compliance	If enabled, the AP denies client association requests if the AP and client station have no common rates defined. Some legacy client stations which are not fully 802.11-compliant may not include their configured rates in their association requests. Such non-compliant stations may have difficulty associating with APs unless strict compliance is disabled. This parameter is disabled by default.
VLAN Mobility	Enable or disable VLAN (Layer-2) mobility. Default: Disabled
Remote-AP Operation	Configures when the virtual AP operates on a remote AP: • always—Permanently enables the virtual AP (Bridge Mode only). No authentication supported. • backup—Enables the virtual AP if the remote AP cannot connect to the controller (Bridge Mode only). No authentication supported. • persistent—Permanently enables the virtual AP after the remote AP initially connects to the controller (Bridge Mode only). • standard—Enables the virtual AP when the remote AP connects to the controller. Use standard option for tunneled, split-tunneled, and Bridge SSIDs. NOTE: Only open/PSK security mode is allowed for always/backup RAP operation. No authentication is supported for always/backup.

Table 30 *Virtual AP Profile Parameters (Continued)*

Parameter	Description
Drop Broadcast and Multicast	Select the Drop Broadcast and Multicast checkbox to filter out broadcast and multicast traffic in the air. Do not enable this option for virtual APs configured in bridge forwarding mode. This configuration parameter is only intended for use for virtual APs in tunnel mode. In tunnel mode, all packets travel to the controller, so the controller is able to drop all broadcast traffic. When a virtual AP is configured to use bridge forwarding mode, most data traffic stays local to the AP, and the controller is not able to filter out that broadcast traffic. IMPORTANT: If you enable this option, you must also enable the Broadcast-Filter ARP parameter in the stateful firewall configuration to prevent ARP requests from being dropped. To enable this setting: 1. Navigate to **Configuration > Stateful Firewall**. 2. Click the **Global Setting** tab. 3. Select the **Broadcast-Filter ARP** checkbox. 4. Click **Apply** to save your settings before you return to the Virtual AP Profile. Note also that although a virtual AP profile can be replicated from a master controller to local controllers, stateful firewall settings do not. If you select the Drop Broadcast and Multicast option for a Virtual AP Profile on a master controller, you must enable the Broadcast-Filter ARP setting on each individual local controller.
Convert Broadcast ARP requests to unicast	If enabled, all broadcast ARP requests are converted to unicast and sent directly to the client. You can check the status of this option using the show ap active and the show datapath tunnel command. If enabled, the output will display the letter a in the flags column. This parameter is disabled by default. Do not enable this option for virtual APs configured in bridge forwarding mode. This configuration parameter is only intended for use for virtual APs in tunnel mode. In tunnel mode, all packets travel to the controller, so the controller is able to convert ARP requests directed to the broadcast address into unicast. When a virtual AP is configured to use bridge forwarding mode, most data traffic stays local to the AP, and the controller is not able to convert that broadcast traffic.
Deny inter user traffic	Select this checkbox to deny traffic between the clients using this virtual AP profile. The global firewall shown the Configuration>Advanced Services > Stateful Firewall > Global window also include an option to deny all inter-user traffic, regardless of the Virtual AP profile used by those clients. If the global setting to deny inter-user traffic is enabled, all inter-user traffic between clients will be denied, regardless of the settings configured in the virtual AP profiles. If the setting to deny inter-user traffic is disabled globally but enabled on an individual virtual ap, only the traffic between un-trusted users and the clients on that particular virtual AP will be blocked.
Band Steering	ARM's band steering feature encourages dual-band capable clients to stay on the 5GHz band on dual-band APs. This frees up resources on the 2.4GHz band for single band clients like VoIP phones. Band steering reduces co-channel interference and increases available bandwidth for dual-band clients, because there are more channels on the 5GHz band than on the 2.4GHz band. Dual-band 802.11n-capable clients may see even greater bandwidth improvements, because the band steering feature will automatically select between 40MHz or 20MHz channels in 802.11n networks. This feature is disabled by default, and must be enabled in a Virtual AP profile. The band steering feature supports both campus APs and remote APs that have a virtual AP profile set to tunnel, split-tunnel or bridge forwarding mode. Note, however, that if a campus or remote APs has virtual AP profiles configured in bridge or split-tunnel forwarding mode but no virtual AP in tunnel mode, those APs will gather information about 5G-capable clients independently and will not exchange this information with other APs that also have bridge or split-tunnel virtual APs only. 5.

Table 30 *Virtual AP Profile Parameters (Continued)*

Parameter	Description
Steering Mode	Band steering supports the following three different band steering modes. • Force-5GHz: When the AP is configured in force-5GHz band steering mode, the AP will try to force 5Ghz-capable APs to use that radio band. • Prefer-5GHz (Default): If you configure the AP to use prefer-5GHz band steering mode, the AP will try to steer the client to 5G band (if the client is 5G capable) but will let the client connect on the 2.4G band if the client persists in 2.4G association attempts. • Balance-bands: In this band steering mode, the AP tries to balance the clients across the two radios in order to best utilize the available 2.4G bandwidth. This feature takes into account the fact that the 5Ghz band has more channels than the 2.4 Ghz band, and that the 5Ghz channels operate in 40MHz while the 2.5Ghz band operates in 20MHz.

In the Profile Details entry for the new virtual AP profile, navigate to the AAA Profile drop-down list and select the AAA profile you previously configured to reveal the AAA Profile pop-up window. Click Apply to set the AAA profile and close the pop-up window.

In the CLI

```
wlan virtual-ap corpnet
   vlan 1
   aaa-profile corpnet
ap-group default
virtual-ap corpnet
```

Creating a new SSID Profile

Follow the procedures below to create a new SSID profile and associate that profile to your Virtual AP.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration > AP Group page.
2. Click Edit for the “default” AP group.
3. Select Wireless LAN (under Profiles), then select Virtual AP.
4. Click the new Virtual AP name in the Profiles list.
5. Select New from the SSID Profile drop-down menu in the Profile Details entry for the new virtual AP profile. This launches an SSID profile pop-up window.
6. Click the Basic tab, and enter the name for the SSID profile (for example, SSIDprofile).
7. Enter a name in the Network Name (SSID) field (for example, Corpnet).
8. Select WPA2 for Network Authentication.
9. Configure other basic SSID profile settings, as described in Table 31.
10. Click the Advanced tab and click SSID Enable to enable the SSID.
11. (Optional) Configure advanced SSID profile settings, as described in Table 32.
12. Click Apply to set the SSID profile and close the pop-up window.
13. Click Apply again at the bottom of the Profile Details window.

Table 31 *Basic SSID Profile Parameters*

Parameter	Description
Network Name	Name that uniquely identifies a wireless network. The network name, or *ESSID* can be up to 31 characters. If the ESSID includes spaces, you must enclose it in quotation marks.

Table 31 *Basic SSID Profile Parameters (Continued)*

Parameter	Description
Network Authentication	The layer-2 authentication to be used on this ESSID to protect access and ensure the privacy of the data transmitted to and from the network. • None • 802.1x/WEP • WPA • WPA-PSK • WPA2 • WPA2-PSK • xSec • Mixed If you select the Mixed authentication option, a drop-down list will appear in the Network Authentication section. Click this drop-down list and select the combination of authentication types supported by APs using this SSID profile.
Encryption	This field shows the default encryption type used on this ESSID. Unselect the default encryption type if you do not want encryption, or click the Advanced tab to define a new encryption type.
Keys	If you selected WPA-PSK or WPA2-PSK authentication or a mixed authentication type that supports pre-shared keys, enter and confirm the Hex Key or PSK passphrase in the PSK Key/ Passphrase and Confirm PSK Key/Passphrase fields. • To define a hex key, enter a 64-character hexadecimal string. • To define a PSK passphrase, enter san ASCII string 8-63 characters in length. Next click the Format drop-down list and select Hex or PSK Passphrase to select the format for the key or passphrase. T

Table 32 *Advanced SSID Profile Parameters*

Parameter	Description
SSID Enable	Click this checkbox to enable or disable the SSID.
Encryption	Select one of the following encryption types
xSec	Encryption and tunneling of Layer-2 traffic between the controller and wired or wireless clients, or between controllers. To use xSec encryption, you must use a RADIUS authentication server. For clients, you must install the Funk Odyssey client software. Requires installation of the xSec license. For xSec between controllers, you must install an xSec license in each controller.
opensystem	No authentication and encryption.
static-wep	WEP with static keys.
dynamic-wep	WEP with dynamic keys.
wpa-tkip	WPA with TKIP encryption and dynamic keys using 802.1x.
wpa-aes	WPA with AES encryption and dynamic keys using 802.1x.
wpa-psk-tkip	WPA with TKIP encryption using a preshared key.
wpa-psk-aes	WPA with AES encryption using a preshared key.
wpa2-aes	WPA2 with AES encryption and dynamic keys using 802.1x.
wpa2-psk-aes	WPA2 with AES encryption using a preshared key.
wpa2-psk-tkip	WPA2 with TKIP encryption using a preshared key.
wpa2-tkip	WPA2 with TKIP encryption and dynamic keys using 802.1x.

Table 32 *Advanced SSID Profile Parameters (Continued)*

Parameter	Description
wpa2-aes-gcm-128	WPA2 with AES GCM-128 (Suite-b) encryption and dynamic keys using 802.1X. NOTE: This parameter requires the ACR license. For further information on Suite-B encryption, see "Configuring an SSID for Suite-B cryptography" on page 152.
wpa2-aes-gcm-256	WPA2 with AES GCM-256 (Suite-b) encryption and dynamic keys using 802.1X. NOTE: This parameter requires the ACR license. For further information on Suite-B encryption, see "Configuring an SSID for Suite-B cryptography" on page 152.
DTIM Interval	Specifies the interval, in milliseconds, between the sending of Delivery Traffic Indication Messages (DTIMs) in the beacon. This is the maximum number of beacon cycles before unacknowledged network broadcasts are flushed. When using wireless clients that employ power management features to sleep, the client must revive at least once during the DTIM period to receive broadcasts
Station Ageout Time	Time, in seconds, that a client is allowed to remain idle before being aged out.
802.11g Transmit Rates	Select the set of 802.11b/g rates at which the AP is allowed to send data. The actual transmit rate depends on what the client is able to handle, based on information sent at the time of association and on the current error/loss rate of the client.
802.11g Basic Rates	Select the set of supported 802.11b/g rates that are advertised in beacon frames and probe responses.
802.11a Transmit Rates	Select the set of 802.11a rates at which the AP is allowed to send data. The actual transmit rate depends on what the client is able to handle, based on information sent at the time of association and on the current error/loss rate of the client.
802.11a Basic Rates	Select the set of supported 802.11a rates, in Mbps, that are advertised in beacon frames and probe responses.
Max Transmit Attempts	Maximum number of retries allowed for the AP to send a frame.
RTS Threshold	Wireless clients transmitting frames larger than this threshold must issue Request to Send (RTS) and wait for the AP to respond with Clear to Send (CTS). This helps prevent mid-air collisions for wireless clients that are not within wireless peer range and cannot detect when other wireless clients are transmitting. The default value is 2333 bytes.
Short Preamble	Click this checkbox to enable or disable a short preamble for 802.11b/g radios. Network performance may be higher when short preamble is enabled. In mixed radio environments, some 802.11b wireless client stations may experience difficulty associating with the AP using short preamble. To use only long preamble, disable short preamble. Legacy client devices that use only long preamble generally can be updated to support short preamble.
Max Associations	Maximum number of wireless clients for the AP. The supported range is 0-256 clients.
Wireless Multimedia (WMM)	Enables or disables WMM, also known as IEEE 802.11e Enhanced Distribution Coordination Function (EDCF). WMM provides prioritization of specific traffic relative to other traffic in the network.
Wireless Multimedia U-APSD (WMM-UAPSD) Powersave	Enable Wireless Multimedia (WMM) UAPSD powersave.
WMM TSPEC Min Inactivity Interval	Specify the minimum inactivity time-out threshold of WMM traffic. This setting is useful in environments where low inactivity interval time-outs are advertised, which may cause unwanted timeouts. The supported range is 0-3,600,000 milliseconds, and the default value is 0 milliseconds.
Override DSCP mappings for WMM clients	Override the default DSCP mappings in the SSID profile with the ToS value. This setting is useful when you want to set a non-default ToS value for a specific traffic.

Table 32 *Advanced SSID Profile Parameters (Continued)*

Parameter	Description
DSCP mapping for WMM voice AC	DSCP used to map WMM voice traffic. The supported range is 0-255, and the default is 56.
DSCP mapping for WMM video AC	Select the DSCP used to map WMM video traffic. The supported range is 0-255, and the default is 40.
DSCP mapping for WMM best-effort AC	Select the DSCP value used to map WMM best-effort traffic. The supported range is 0-255, and the default is 24.
DSCP mapping for WMM background AC	Select the DSCP used to map WMM background traffic. The supported range is 0-255, and the default is 8.
Hide SSID	Select this checkbox to enable or disable the hiding of the SSID name in beacon frames. Note that hiding the SSID does very little to increase security.
Deny_Broadcast Probes	When a client sends a broadcast probe request frame to search for all available SSIDs, this option controls whether or not the system responds for this SSID. When enabled, no response is sent and clients have to know the SSID in order to associate to the SSID. When disabled, a probe response frame is sent for this SSID.
Local Probe Request Threshold (dB)	Enter the SNR threshold below which incoming probe requests will get ignored. The supported range of values is 0-100 dB. A value of 0 disables this feature.
Disable Probe Retry	Click this checkbox to enable or disable battery MAC level retries for probe response frames. By default this parameter is enabled, which mean that MAC level retries for probe response frames is disabled.
Battery Boost	Converts multicast traffic to unicast before delivery to the client, thus allowing you to set a longer DTIM interval. The longer interval keeps associated wireless clients from activating their radios for multicast indication and delivery, leaving them in power-save mode longer and thus lengthening battery life. This parameter requires the PEFNG license.
WEP Key 1	First static WEP key associated with the key index. Can be 10 or 26 hex characters in length.
WEP Key 2	Second static WEP key associated with the key index. Can be 10 or 26 hex characters in length.
WEP Key 3	Third Static WEP key associated with the key index. Can be 10 or 26 hex characters in length.
WEP Key 4	Fourth Static WEP key associated with the key index. Can be 10 or 26 hex characters in length.
WEP Transmit Key Index	Key index that specifies which static WEP key is to be used. Can be 1, 2, 3, or 4.
WPA Hexkey	WPA pre-shared key (PSK).
WPA Passphrase	WPA passphrase with which to generate a pre-shared key (PSK).
Maximum Transmit Failures	Maximum transmission failures allowed before the client gives up
BC/MC Rate Optimization	Click this checkbox to enable or disable scanning of all active stations currently associated to an AP to select the lowest transmission rate for broadcast and multicast frames. This option only applies to broadcast and multicast data frames; 802.11 management frames are transmitted at the lowest configured rate. NOTE: Do not enable this parameter unless instructed to do so by your Dell technical support representative.
Strict Spectralink Voice Protocol (SVP)	Click this checkbox to enable Strict Spectralink Voice Protocol (SVP)
802.11g Beacon Rate	Click this drop-down list to select the beacon rate for 802.11g (use for Distributed Antenna System (DAS) only). Using this parameter in normal operation may cause connectivity problems.
802.11a Beacon Rate	Click this drop-down list to select the beacon rate for 802.11a (use for Distributed Antenna System (DAS) only). Using this parameter in normal operation may cause connectivity problems.

Table 32 *Advanced SSID Profile Parameters (Continued)*

Parameter	Description
Advertise QBSS Load IE	Click this checkbox to enable the AP to advertise the QBSS load element. The element includes the following parameters that provide information on the traffic situation: • Station count: The total number of stations associated to the QBSS. • Channel utilization: The percentage of time (normalized to 255) the channel is sensed to be busy. The access point uses either the physical or the virtual carrier sense mechanism to sense a busy channel. • Available admission capacity: The remaining amount of medium time (measured as number of 32us/s) available for a station via explicit admission control. The QAP uses these parameters to decide whether to accept an admission control request. A wireless station uses these parameters to choose the appropriate access points. NOTE: Ensure that wmm is enabled for legacy APs to advertize the QBSS load element. For 802.11n APs, ensure that either wmm or high throughput is enabled.

In the CLI

```
wlan ssid-profile SSIDprofile
   essid Corpnet
   opmode wpa2-aes
wlan virtual-ap corpnet
   ssid-profile SSIDprofile
ap-group default
   virtual-ap corpnet
```

Configuring an SSID for Suite-B cryptography

Suite-B AES-128-GCM and AES-256-GCM encryption is supported by the ArubaOS hardware, and requires the ACR license. Note, however, that not all controllers support Suite-B encryption. The table below describes the controller support for Suite-B encryption in ArubaOS.

Controller	Serial Number Prefix	ACR License Support
W-600 Series	All serial numbers supported	Yes
W-3000 Series	AK	Yes
W-3000 Series	A	No
W-6000M3	FC	Yes
W-6000M3	F	No

To determine the serial number prefix for your controller, issue the CLI command show inventory and note the prefix before the system serial number. The serial number prefix in the example below appears in bold.

```
(host) #show inventory
Supervisor Card slot            : 0
System Serial#                  : AK0093676
SC      Assembly#               : 2010052B (Rev:02.01)
SC      Serial#                 : F01629529 (Date:03/29/10)
SC      Model#                  : W-3600-US
```

Guest WLAN

To configure Guest WLAN, the following basic steps are required.

- Configure the VLAN for guest users.
- Configure the guest role which only allows HTTP and HTTPS traffic from 9:00 a.m. to 5 p.m. on weekdays.
- Create and configure the virtual AP profile guest for the AP named “building3-lobby”:

- Create a new virtual AP profile guest.
- Select the predefined AAA profile default-open.
- Create a new SSID profile guest to configure “Guest” for the SSID name and open system for the authentication.

The following sections describe how to do this using the WebUI and the CLI.

Configuring the VLAN

In this example, users on the “Corpnet” WLAN are placed into VLAN 1, which is the default VLAN configured on the controller. For guest users, you need to create another VLAN and assign the VLAN interface an IP address.

In the WebUI

1. Navigate to the Configuration > Network > VLANs page.
2. Click Add to add a VLAN. Enter 2 in the VLAN ID, and click Apply.
3. To assign an IP address and netmask to the VLAN you just created, navigate to the Configuration > Network > IP > IP Interfaces page. Click Edit for VLAN 2. Enter an IP address and netmask for the VLAN interface, and then click Apply.

In the CLI

```
vlan 2
interface vlan 2
   ip address <address> <netmask>
```

Configuring the Guest Role

The guest role allows web (HTTP and HTTPS) access only during normal business hours (9:00 a.m. to 5:00 p.m. Monday through Friday).

In the WebUI

1. Navigate to the Configuration > Security > Access Control > Time Ranges page.
2. Click Add. Enter a name, such as “workhours”. Select Periodic. Click Add. Under Add Periodic Rule, select Weekday. For Start Time, enter 9:00. For End Time, enter 17:00. Click Done. Click Apply.
3. Select the Policies tab. Click Add. Enter a policy name, such as “restricted”. From the Policy Type drop-down list, select Session.
4. Click Add.
5. *(Optional)* By default, firewall policies apply to IPv4 clients only. To configure a firewall policy for IPv6 clients, click the IP Version drop-down list and select IPv6.
6. Click the Service drop-down list, select service, then select svc-http.
7. Click the Time Range drop-down list and select the time range you previously configured.
8. Click Add.
9. Repeat steps 4-8 to add another rule for the *svc-https* service. Click Apply.
10. Select the User Roles tab. Click Add. Enter guest for Role Name. Under Firewall Policies, click Add. Select Choose from Configured Policies and select the policy you previously configured. Click Done.
11. Click Apply.

In the CLI

```
time-range workhours periodic
   weekday 09:00 to 17:00
ip access-list session restricted
   any any svc-http permit time-range workhours
```

```
   any any svc-https permit time-range workhours
user-role guest
   session-acl restricted
```

Configuring the Guest Virtual AP

In this example, you apply the guest virtual AP profile to a specific AP.

NOTE: Best practices are to assign a unique name to each virtual AP, SSID, and AAA profile that you modify. In this example, you use the name guest to identify the virtual AP and SSID profiles.

In the WebUI

1. Navigate to Configuration > Wireless > AP Configuration > AP Specific page.
2. Click New. Either enter the AP name or select an AP from the list of discovered APs. Click Add. The AP name appears in the list.
3. Click Edit by the AP name to display the profiles that you can configure for the AP.
4. Expand the Wireless LAN profile menu.
5. Select Virtual AP.
   a. Click the Add a profile drop down list in the Profile Details window and select NEW.
   b. Enter guest, and click Add.
   c. Click Apply.
6. Click the guest virtual AP to display profile details.
   a. Make sure Virtual AP Enable is selected.
   b. Select 2 for the VLAN.
   c. Click Apply.
7. Under Profiles, select the AAA profile under the guest virtual AP profile.
   a. In the Profile Details, select default-open from the AAA Profile drop-down list.
   b. Click Apply.
8. Under Profiles, select the SSID profile under the guest virtual AP profile.
   a. Select NEW from the SSID Profile drop-down menu.
   b. Enter guest.
   c. In the Profile Details, enter Guest for the Network Name.
   d. Select None for Network Authentication and Open for Encryption.
   e. Click Apply.

In the CLI

```
wlan ssid-profile guest
   opmode opensystem
wlan virtual-ap guest
   vap-enable
   vlan 2
   deny-time-range workhours
   ssid-profile guest
   aaa-profile default-open
ap-name building3-lobby
   virtual-ap guest
```

Enable 802.11k Support

The 802.11k protocol provides mechanisms for APs and clients to dynamically measure the available radio resources. In an 802.11k enabled network, APs and clients can send neighbor reports, beacon reports, and link measurement reports to each other. This allows the APs and clients to take appropriate connection actions. The following procedure outlines the steps to configure 802.11k parameters.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name for which you want to configure the new 802.11K profile.
   - If you selected the AP Specific tab, click the Edit button by the AP for which you want to create the 802.11K profile.
2. In the Profiles list, expand the Wireless LAN menu, then expand the Virtual AP menu.
3. Select the Virtual AP profile for which you want to configure 802.11k settings.

   To edit an existing 802.11k profile, click the 802.11K Profile drop-down list In the Profile Details window pane and select the 802.1x profile you want to edit.

   or

   To create a new 802.11k Profile, click the 802.11K Profile drop-down list and select New. Enter a new 802.11k profile name in the field to the right of the drop-down list.

NOTE: You cannot use spaces in profile names.

4. Configure your 802.11k radio settings. Table 33 outlines the parameters you can configure in the 802.11k profile. Click Apply to save your settings.

Table 33 *802.11k Profile Parameters*

Parameter	Description
Advertise 802.11K Capability	Select this option to allow Virtual APs using this profile to advertise 802.11K capability. Default: Disabled
Forcefully disassociate on-hook voice clients	Select this option to allow the AP to forcefully disassociate *on-hook* voice clients (clients that are not on a call) after period of inactivity. Without the forced disassociation feature, if an AP has reached its call admission control limits and an on-hook voice client wants to start a new call, that client may be denied. If forced disassociation is enabled, those clients can associate to a neighboring AP that can fulfill their QoS requirements. Default: Disabled

Table 33 *802.11k Profile Parameters (Continued)*

Parameter	Description
Measurement Mode for Beacon Reports	Click the Measurement Mode for Beacon Reports drop-down list and specify one of the following measurement modes: • active—Enables active beacon measurement mode. In this mode, the client sends a probe request to the broadcast destination address on all supported channels, sets a measurement duration timer, and, at the end of the measurement duration, compiles all received beacons or probe response with the requested SSID and BSSID into a measurement report. • beacon-table—Enables beacon-table beacon measurement mode. In this mode, the client measures beacons and returns a report with stored beacon information for any supported channel with the requested SSID and BSSID. The client does not perform any additional measurements. • passive—Enables passive beacon measurement mode. In this mode, the client sets a measurement duration timer, and, at the end of the measurement duration, compiles all received beacons or probe response with the requested SSID and BSSID into a measurement report. NOTE: If a station doesn't support the selected measurement mode, it returns a Beacon Measurement Report with the Incapable bit set in the Measurement Report Mode field. Default Mode: beacon-table

In the CLI

Use the following command to configure 802.11k profiles. The available parameters for this profile are described in Table 33.

```
wlan dotllk <profile>
   bcn-measurement-mode {active|beacon-table|passive}
   clone <profile>
   dot11k-enable
   force-disassoc
```

Example Configuration

The example below follows the suggested order of steps to configure a virtual AP using the command-line interface.

```
vlan 60
!
ip access-list session THR-POLICY-NAME-WPA2
   user any any permit
!
user-role THR-ROLE-NAME-WPA2
   session-acl THR-POLICY-NAME-WPA2
!
aaa authentication dot1x "THR-DOT1X-AUTH-PROFILE-WPA2"
   termination enable
!
aaa server-group "THR-DOT1X-SERVER-GROUP-WPA2"
   auth-server Internal
!
aaa profile "THR-AAA-PROFILE-WPA2"
   authentication-dot1x "THR-DOT1X-AUTH-PROFILE-WPA2"
   dot1x-default-role "THR-ROLE-NAME-WPA2"
   dot1x-server-group "THR-DOT1X-SERVER-GROUP-WPA2"
!
wlan ssid-profile "THR-SSID-PROFILE-WPA2"
   essid "THR-WPA2"
   opmode wpa2-aes
```

```
!
wlan virtual-ap "THR-VIRTUAL-AP-PROFILE-WPA2"
   ssid-profile "THR-SSID-PROFILE-WPA2"
   aaa-profile "THR-AAA-PROFILE-WPA2"
   vlan 60
!
ap system-profile "THR-AP-SYSTEM-PROFILE"
   lms-ip 1.1.1.1
   bkup-lms-ip 2.2.2.2
!
ap-group "THRHQ1-STANDARD"
   virtual-ap "THR-VIRTUAL-AP-PROFILE-WPA2"
ap-system-profile "THR-AP-SYSTEM-PROFILE"
```

Configuring a High-Throughput Virtual AP

With the implementation of the IEEE 802.11n standard, high-throughput can be configured to operate on the 5 GHz and/or 2.4 GHz frequency band.

For high-throughput to function on a virtual AP profile for the assigned AP group or specific AP, high-throughput must be enabled within the assigned ht-ssid-profile and the radio-profile(s) for the desired frequency band(s).

By default, high-throughput is enabled; however, the examples in this section guide you through manually creating profiles and enabling high-throughput on the 5 GHz and 2.4 GHz frequency bands to ensure proper functionality of a virtual AP profile named "ht-vap-corpnet" assigned to an existing AP group named "ht-corpnet-aps."

NOTE: For an example of 20 MHz channel versus 40 MHz channel pair configuration, see "20 MHz and 40 MHz Static Channel Assignments" on page 157.

This example includes the following tasks:

- Create two high-throughput radio profiles named "ht-radioa-corpnet" and "ht-radiog-corpnet."
- Create and configure a 5 GHz radio profile named "ht-corpnet-a" and assign the high-throughput radio profile named "ht-radioa-corpnet."
- Create and configure a 2.4 GHz radio profile named "ht-corpnet-g" and assign the high-throughput radio profile named "ht-radiog-corpnet."
- Create and configure a high-throughput SSID profile named "ht-ssid-corpnet."
- Create an SSID profile named "ht-corpnet" and assign the high-throughput SSID profile named "ht-ssid-corpnet."
- Create a virtual AP profile named "ht-vap-corpnet" and assign the SSID profile named "ht-corpnet."
- Assign the required profiles to an existing AP group named "ht-corpnet-ap."

The following procedures are presented for the WebUI and the CLI.

In the WebUI

1. Navigate to Configuration > Wireless > AP Configuration > AP Group page.
2. Click Edit for the AP group ht-corpnet-ap.
3. Under the Profiles list, select RF Management to display the radio profiles.

4. Select the 802.11a radio profile.

NOTE: This radio profile represents activity on the 5 GHz frequency band. Since the high-throughput IEEE 802.11n standard operates on the 5 GHz and/or 2.4 GHz frequency band, high-throughput can be enabled on 802.11a or 802.11g radio profiles.

   a. Select New from the 802.11a radio profile drop-down menu.
   b. Enter ht-corpnet-a for the 802.11a radio profile name.
   c. Select (check) the High Throughput enable (radio) checkbox to enable high-throughput. By default, this is enabled (checked).
   d. Click Apply.
5. Select the High-throughput Radio Profile under the 802.11a radio profile.
   a. Select New from the High-throughput Radio Profile drop-down menu.
   b. Enter ht-radioa-corpnet for the high-throughput radio profile name.
   c. Configure the high-throughput radio settings (see Table 34 for details) and click Apply.

Table 34 *High-Throughput Radio Profile Configuration Parameters*

Parameter	Description
40MHz intolerance	This parameter controls whether or not APs using this radio profile will advertise intolerance of 40 MHz operation. By default, this option is disabled, and 40 MHz operation is allowed. If you do not want to use 40 Mhz operation, select the 40MHz intolerance checkbox to enable this feature.
honor 40MHz intolerance	When enabled, the radio will stop using the 40 MHz channels if the 40 MHz intolerance indication is received from another AP or station. Uncheck the Honor 40 Mhz intolerance checkbox to disable this feature. Default: Enabled
Legacy station workaround	Select this option to enable interoperability for misbehaving legacy stations. This option is disabled by default, and should only be enabled under the supervision of Dell technical support.

6. Select the 802.11g radio profile.

NOTE: This radio profile represents activity on the 2.4 GHz frequency band. Since the high-throughput IEEE 802.11n standard operates on the 5 GHz and/or 2.4 GHz frequency band, high-throughput can be enabled on 802.11a or 802.11g radio profiles.

   a. Select New from the 802.11g radio profile drop-down menu.
   b. Enter ht-corpnet-g for the 802.11a radio profile name.
   c. Select (check) the High Throughput enable (radio) checkbox to enable high-throughput. By default, this is enabled (checked).
   d. Click Apply.
7. Select the High-throughput Radio Profile under the 802.11g radio profile.
   a. Select New from the High-throughput Radio Profile drop-down menu.
   b. Enter ht-radiog-corpnet for the high-throughput radio profile name.
   c. Configure the high-throughput radio settings (see Table 34 for details) and Click Apply.
8. Select Wireless LAN, under the Profiles list, to reveal the WLAN profiles.
9. Select the Virtual AP profile.
   a. Select New from the Add a Profile drop-down menu.
   b. Enter ht-vap-corpnet for the virtual AP profile name.

c. Click Add.

d. Select New from the SSID Profile drop-down menu associated with the “ht-vap-corpnet” virtual AP profile. The SSID Profile dialog box appears.

e. Enter ht-corpnet for the SSID profile name.

f. Click Apply to create the SSID profile and return to the virtual AP profile page.

g. Click Apply on the virtual AP profile page.

10. Select the ht-vap-corpnet virtual AP profile.
    a. Select all from the Allowed band drop-down menu.
    b. Click Apply.
11. Select the SSID profile ht-corpnet. The High-throughput SSID profile option will appear below ht-corpnet in the profiles list.
12. Select the High-throughput SSID Profile.
    a. Select New from the High-throughput SSID Profile drop-down menu.
    b. Enter ht-ssid-corpnet for the high-throughput SSID profile name.
    c. Configure the high-throughput SSID profile settings (see Table 35 for details) and click Apply to assign it to the SSID profile.

Table 35 *High-Throughput SSID Profile Parameters*

High throughput enable (SSID)	Enable or disable high-throughput (802.11n) features on this SSID. This parameter is enabled by default.
40 MHz channel usage	Enable or disable the use of 40 MHz channels. This parameter is enabled by default.
Low-density Parity Check	If enabled, the AP will advertise Low-density Parity Check (LDPC) support. LDPC improves data transmission over radio channels with high levels of background noise.
MPDU Aggregation	Enable or disable MAC protocol data unit (MPDU) aggregation. High-throughput mesh APs are able to send aggregated MAC protocol data units (MDPUs), which allow an AP to receive a single block acknowledgment instead of multiple ACK signals. This option, which is enabled by default, reduces network traffic overhead by effectively eliminating the need to initiate a new transfer for every MPDU.
Max transmitted A-MPDU size	Maximum size of a transmitted aggregate MPDU, in bytes. Range: 1576–65535
Max received A-MPDU size	Maximum size of a received aggregate MPDU, in bytes. Allowed values: 8191, 16383, 32767, 65535.
Min MPDU start spacing	Minimum time between the start of adjacent MPDUs within an aggregate MPDU, in microseconds. Allowed values: 0 (No restriction on MDPU start spacing), .25 µsec, .5 µsec, 1 µsec, 2 µsec, 4 µsec.
Supported MCS set	A list of Modulation Coding Scheme (MCS) values or ranges of values to be supported on this SSID. The MCS you choose determines the channel width (20MHz vs. 40MHz) and the number of spatial streams used by the mesh node. The default value is 1–15; the complete set of supported values. To specify a smaller range of values, enter a hyphen between the lower and upper values. To specify a series of different values, separate each value with a comma. Examples: 2–10 1,3,6,9,12 Range: 0–15.

Table 35 *High-Throughput SSID Profile Parameters (Continued)*

Short guard interval in 20 MHz mode	Enable or disable use of short (400ns) guard interval in 20 MHz mode. This parameter is enabled by default. A guard interval is a period of time between transmissions that allows reflections from the previous data transmission to settle before an AP transmits data again. An AP identifies any signal content received inside this interval as unwanted inter-symbol interference, and rejects that data. The 802.11n standard specifies two guard intervals: 400ns (short) and 800ns (long). Enabling a short guard interval can decrease network overhead by reducing unnecessary idle time on each AP. Some outdoor deployments, may, however require a longer guard interval. If the short guard interval does not allow enough time for reflections to settle in your mesh deployment, inter-symbol interference values may increase and degrade throughput.
Short guard interval in 40 MHz mode	Enable or disable use of short (400ns) guard interval in 40 MHz mode. This parameter is enabled by default. A guard interval is a period of time between transmissions that allows reflections from the previous data transmission to settle before an AP transmits data again. An AP identifies any signal content received inside this interval as unwanted inter-symbol interference, and rejects that data. The 802.11n standard specifies two guard intervals: 400ns (short) and 800ns (long). Enabling a short guard interval can decrease network overhead by reducing unnecessary idle time on each AP. Some outdoor deployments, may, however require a longer guard interval. If the short guard interval does not allow enough time for reflections to settle in your mesh deployment, inter-symbol interference values may increase and degrade throughput.
Maximum number of spatial streams usable for STBC reception	Controls the maximum number of spatial streams usable for STBC reception. 0 disables STBC reception, 1 uses STBC for MCS 0-7. Higher MCS values are not supported. (Supported on the W-AP90 Series series, W-AP130 Series, W-AP68, W-AP175 and W-AP105 only. The configured value will be adjusted based on AP capabilities.)
Maximum number of spatial streams usable for STBC transmission.	Controls the maximum number of spatial streams usable for STBC transmission. 0 disables STBC transmission, 1 uses STBC for MCS 0-7. Higher MCS values are not supported. (Supported on W-AP90 Series series, W-AP175, W-AP130 Seriesand W-AP105 only. The configured value will be adjusted based on AP capabilities.)
Legacy stations	Allow or disallow associations from legacy (non-HT) stations. By default, this parameter is enabled (legacy stations are allowed).

In the CLI

```
rf ht-radio-profile ht-radioa-corpnet
rf ht-radio-profile ht-radiog-corpnet
rf dot11a-radio-profile ht-corpnet-a
   high-throughput-enable
   ht-radio-profile ht-radioa-corpnet
rf dot11g-radio-profile ht-corpnet-g
   high-throughput-enable
   ht-radio-profile ht-radiog-corpnet
wlan ht-ssid-profile ht-ssid-corpnet
   high-throughput-enable
wlan ssid-profile ht-corpnet
   ht-ssid-profile ht-ssid-corpnet
wlan virtual-ap ht-vap-corpnet
   allowed-bands all
   ssid-profile ht-corpnet
ap-group ht-corpnet-ap
   dot11a-radio-profile ht-corpnet-a
   dot11g-radio-profile ht-corpnet-g
   virtual-ap ht-vap-corpnet
```

Managing High-throughput Profiles

Use the following commands to create a high-throughput radio profile or edit an existing profile. For details, see Table 34.

```
rf ht-radio-profile <profile>
   40MHz-intolerance
   clone <profile>
   honor-40MHz-intolerance
   no
single-chain-legacy
```

Use the following commands to create a high-throughput SSID profile or edit an existing profile. For details, see Table 35.

```
wlan ht-ssid-profile <profile>
   40MHz-enable
   clone <profile>
   high-throughput-enable
   ldpc
   legacy-stations
   max-rx-a-mpdu-size {8191|16383|32767|65535}
   max-tx-a-mpdu-size <bytes>
   min-mpdu-start-spacing {0|.25|.5|1|2|4|8|16}
   mpdu-agg
   no...
   short-guard-intvl-20MHz
   short-guard-intvl-40MHz
   STBC-rx-streams
   STBC-tx-streams
   supported-mcs-set <mcs-list>
```

Chapter 6

Adaptive Radio Management (ARM)

This document describes how to configure the ARM function to automatically select the best channel and transmission power settings for each AP on your WLAN. After completing the tasks described in the following pages, you can continue configuring your APs as described in the Dell User Guide.

This document includes the following topics:

ARM Overview

Dell's Adaptive Radio Management (ARM) technology maximizes WLAN performance even in the highest traffic networks by dynamically and intelligently choosing the best 802.11 channel and transmit power for each Dell AP in its current RF environment.

Dell's ARM technology solves wireless networking challenges such as large deployments, dense deployments, and installations that must support VoIP or mobile users. Deployments with dozens of users per access point can cause network contention and interference, but ARM dynamically monitors and adjusts the network to ensure that all users are allowed ready access. ARM provides the best voice call quality with voice-aware spectrum scanning and call admission control.

With earlier technologies, network administrators would have to perform a site survey at each location to discover areas of RF coverage and interference, and then manually configure each AP according to the results of this survey. Static site surveys can help you choose channel and power assignments for APs, but these surveys are often time-consuming and expensive, and only reflect the state of the network at a single point in time. ARM is more efficient than static calibration, and, unlike older technologies, it continually monitors and adjusts radio resources to provide optimal network performance. Automatic power control can adjust AP power settings if adjacent APs are added, removed, or moved to a new location within the network, minimizing interference with other WLAN networks. ARM adjusts only the affected APs, so the entire network does not require systemic changes.

ARM Support for 802.11n

ArubaOS version 3.3.x or later supports APs with the 802.11n standard, ensuring seamless integration of 802.11n devices into your RF domain. An Dell AP's 5 Ghz band capacity simplifies the integration of new APs into your legacy network. You can also replace older APs with newer 802.11n-compliant APs while reusing your existing cabling and PoE infrastructure.

A high-throughput (802.11n) AP can use a 40 MHz channel pair comprised of two adjacent 20 MHz channels available in the regulatory domain profile for your country. When ARM is configured for a dual-band AP, it will dynamically select the primary and secondary channels for these devices. It can, however, continue to scan all changes in the a+b/g bands to calculate interference and detect rogue APs.

Monitoring Your Network with ARM

When ARM is enabled, an Dell AP will dynamically scan all 802.11 channels in its regulatory domain at regular intervals and will report everything it sees to the controller on each channel it scans. (By default, 802.11n-capable APs scan channels in all regulatory domains.) This includes, but is not limited to, data regarding WLAN coverage, interference, and intrusion detection. You can retrieve this information from the controller to get a quick health check of your WLAN deployment without having to walk around every part of a building with a network analyzer. (For additional information on the individual matrix gathered on the AP's current assigned RF channel, see "ARM Metrics" on page 175.)

Noise and Error Monitoring

An AP configured with ARM is aware of both 802.11 and non-802.11 noise, and will adjust to a better channel if it reaches a configured threshold for either noise, MAC errors or PHY errors. The ARM algorithm is based on what the individual AP hears, so each AP on your WLAN can effectively "self heal" by compensating for changing scenarios like a broken antenna or blocked signals from neighboring APs. Additionally, ARM periodically collects information about neighboring APs to help each AP better adapt to its own changing environment.

Application Awareness

Dell APs keep a count of the number of data bytes transmitted and received by their radios to calculate the traffic load. When a WLAN gets very busy and traffic exceeds a predefined threshold, load-aware ARM dynamically adjusts scanning behavior to maintain uninterrupted data transfer on heavily loaded systems. ARM-enabled APs will resume their complete monitoring scans when the traffic has dropped to normal levels. You can also define a firewall policy that pauses ARM scanning when the AP detects critically important or latency-sensitive traffic from a specified host or network.

ARM's band steering feature encourages dual-band capable clients to stay on the 5GHz band on dual-band APs. This frees up resources on the 2.4GHz band for single band clients like VoIP phones.

The ARM "Mode Aware" option is a useful feature for single radio, dual-band WLAN networks with high density AP deployments. If there is too much AP coverage, those APs can cause interference and negatively impact your network. Mode aware ARM can turn APs into Air Monitors if necessary, then turn those Air Monitors back into APs when they detect gaps in coverage. Note that an Air Monitor will not turn back into an AP if it detects client traffic (or client traffic increases), but will change to an AP only if it detects coverage holes.

ARM Profiles

You configure ARM by defining ARM *profiles*, a set of configuration parameters that you can apply as needed to an AP group or to individual APs. Dell controllers have one preconfigured ARM profile, called default. Most network administrators will find that this one default ARM profile is sufficient to manage all the Dell APs on their WLAN. Others may want to define multiple profiles to suit their APs' varying needs.

When managing ARM profiles, you should first consider whether or not all the APs on your WLAN operate in similar environments and manage similar traffic loads and client types.

If your APs' environment and traffic loads are mostly the same, you can use the default ARM profile to manage all the APs on your WLAN. If you ever modify the default profile, all APs on the WLAN will be updated with the new settings. If, however, you have APs on your WLAN that are in different physical environments, or your APs each manage widely varying client loads or traffic types, you should consider defining additional ARM profiles for

your AP groups. The following table describes different WLAN environments, and the type of ARM profiles appropriate for each.

Table 36 *ARM Profile Types*

ARM Profiles	Example WLAN Description
default profile only	• A warehouse where the physical environment is nearly the same for all APs, and each AP manages the same number of clients and traffic load. • A training room, where the clients are evenly spaced throughout the room, have the same security requirements and are using the same amount of network resources.
multiple profiles	• Universities where APs are in different building types (open auditoriums, small brick classrooms), some APs must support VoIP or video streaming, and mobile clients are constantly moving from one AP coverage area to another. • Healthcare environments where some APs must balance the network demands of large digital radiology files, secure electronic patient record transfers, diagnostic videos, and collaborative VoIP sessions, while other APs (like those in a lobby or cafeteria) support only lower-priority traffic like Internet browsing.

You assign ARM profiles to AP groups by associating an ARM profile with that AP group's 802.11a or 802.11g RF management profile. For details on associating an ARM profile with an AP group, see "Assigning an ARM Profile to an AP Group" on page 170.

There are two ways to create a new ARM profile. You can make an entirely new profile with all default settings, or you can create a new profile based upon the settings of an existing profile by making a copy of that other profile.

Creating a New ARM Profile

To create a new ARM profile with all default settings via the WebUI:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select RF Management to expand the RF Management section.
3. Select Adaptive Radio Management (ARM) Profile. Any currently defined ARM profiles appears in the right pane of the window. If you have not yet created any ARM profiles, this pane displays the default profile only.
4. To create a new profile with all default settings, enter a name in the entry blank. The name must be 1–63 characters, and can be composed of alphanumeric characters, special characters and spaces. If your profile name includes a space, it must be enclosed within quotation marks.
5. Click Add.

To create a new ARM profile via the command-line interface, access the CLI in config mode and issue the following command.

```
rf arm-profile <profile>
```

where <profile> is a unique name for the new ARM profile. The name must be 1–63 characters, and can be composed of alphanumeric characters, special characters and spaces. If your profile name includes a space, it must be enclosed within quotation marks

Copying an Existing Profile

To create a new ARM profile based upon the settings of another existing profile:

1. Follow steps 1–3 in the above procedure to access the Adaptive Radio Management (ARM) profile window.
2. From the list of profiles, select the profile with the settings you would like to copy.
3. Click Save As.
4. Enter a name for the new profile in the entry blank. The name must be 1–63 characters, and can be composed of alphanumeric characters, special characters and spaces.
5. Click Apply.

To create a copy of an existing ARM profile via the command-line interface, access the CLI in config mode and issue the following command.

```
rf arm-profile <newprofile> clone <profile>
```

where <newprofile> is a unique name for the new ARM profile, and <profile> is the name of the existing profile whose setting you want to copy. The name must be 1–63 characters, and can be composed of alphanumeric characters, special characters and spaces. If your profile name includes a space, it must be enclosed within quotation marks

Deleting a Profile

You can only delete unused ARM profiles; Dell will not let you delete an ARM profile that is currently assigned to an AP group.

To delete an ARM profile In the WebUI:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select RF Management to expand the RF Management section.
3. Select Adaptive Radio Management (ARM) Profile.
4. Select the name of the profile you want to delete.
5. Click Delete.

To delete an ARM profile using the CLI, issue the command

```
no rf arm-profile <profile>
```

where <profile> is the name of the ARM profile you wish to remove.

Configuring ARM Settings

In most network environments, ARM does not need any adjustments from its factory-configured settings. However, if you are using VoIP or have unusually high security requirements you may want to manually adjust the ARM thresholds.

In the WebUI

To change an ARM profile:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select RF Management to expand the RF Management section.
3. Select Adaptive Radio Management (ARM) Profile.
4. Select the name of the profile you want to edit. The Adaptive Radio Management (ARM) profile window opens.
5. Change any of the ARM settings described in the table below, then click Apply to save your changes.

Table 37 *ARM Profile Configuration Parameters*

Setting	Description
Assignment	Activates one of four ARM channel/power assignment modes. • disable: Disables ARM calibration and reverts APs back to default channel and power settings specified by the AP's radio profile • maintain: APs maintain their current channel and power settings. This setting can be used to maintain AP channel and power levels after ARM has initially selected the best settings. • multi-band: For single-radio APs, this value computes ARM assignments for both 5 GHZ (802.11a) and 2.4 GHZ (802.11b/g) frequency bands. • single-band: For dual-radio APs, this value enables APs to change transmit power and channels within their same frequency band, and to adapt to changing channel conditions. Default: single-band

Table 37 *ARM Profile Configuration Parameters (Continued)*

Setting	Description
Allowed bands for 40MHz channels	The specified setting allows ARM to determine if 40 MHz mode of operation is allowed on the 5 GHz or 2.4 GHz frequency band only, on both frequency bands, or on neither frequency band.
Client Aware	If the Client Aware option is enabled, the AP does not change channels if there is an active client associated to that AP. (Activity is defined by the sta-inactivity-time parameter in the IDS general profile. By default, a client is considered active if it has sent or received traffic within the last 60 seconds.) If Client Aware is disabled, the AP may change to a more optimal channel, but this change may also disrupt current client traffic. Default: enabled
Min Tx EIRP	Minimum effective isotropic radiated power (EIRP) from 3 to 33 dBm in 3 dBm increments. You may also specify a special value of 127 dBm for regulatory maximum to disable power adjustments for environments such as outdoor mesh links. Note that power settings will not change if the Assignment option is set to disabled or maintain. Higher power level settings may be constrained by local regulatory requirements and AP capabilities. In the event that an AP is configured for a Min Tx EIRP setting it cannot support, this value will be reduced to the highest supported power setting. Default: 9 dBm NOTE: Consider configuring a Min Tx Power setting higher than the default value if most of your APs are placed on the ceiling. APs on a ceiling often have good line of sight between them, which will cause ARM to decrease their power to prevent interference. However, if the wireless clients down on the floor do not have such a clear line back to the AP, you could end up with coverage gaps.
Max Tx EIRP	Maximum effective isotropic radiated power (EIRP) from 3 to 33 dBm in 3 dBm increments. You may also specify a special value of 127 dBm for regulatory maximum. Higher power level settings may be constrained by local regulatory requirements and AP capabilities. In the event that an AP is configured for a Max Tx EIRP setting it cannot support, this value will be reduced to the highest supported power setting. Default: 127 dBm NOTE: Power settings will not change if the Assignment option is set to disabled or maintain.
Multi Band Scan	If enabled, single radio channel APs scans for rogue APs across multiple channels. This option requires that Scanning is also enabled. (The Multi Band Scan option does not apply to APs that have two radios, as these devices already scan across multiple channels. If one of these dual-radio devices are assigned an ARM profile with Multi Band enabled, that device will ignore this setting.) Default: disabled
Rogue AP Aware	If you have enabled both the Scanning and Rogue AP options, Dell APs may change channels to contain off-channel rogue APs with active clients. This security features allows APs to change channels even if the Client Aware setting is disabled. This setting is disabled by default, and should only be enabled in high-security environments where security requirements are allowed to consume higher levels of network resources. You may prefer to receive Rogue AP alerts via SNMP traps or syslog events. Default: disabled
Scan Interval	If Scanning is enabled, the Scan Interval defines how often the AP will leave its current channel to scan other channels in the band. Off-channel scanning can impact client performance. Typically, the shorter the scan interval, the higher the impact on performance. If you are deploying a large number of new APs on the network, you may want to lower the Scan Interval to help those APs find their optimal settings more quickly. Raise the Scan Interval back to its default setting after the APs are functioning as desired. The supported range for this setting is 0–2,147,483,647 seconds. Default: 10 seconds
Active Scan	When the Active Scan checkbox is selected, an AP initiates active scanning via probe request. This option elicits more information from nearby APs, but also creates additional management traffic on the network. Active Scan is disabled by default, and should *not be enabled* except under the direct supervision of Dell Support. Default: disabled

Table 37 *ARM Profile Configuration Parameters (Continued)*

Setting	Description
Scanning	The Scanning checkbox enables or disables AP scanning across multiple channels. Disabling this option also disables the following scanning features: • Multi Band Scan • Rogue AP Aware • Voip Aware Scan • Power Save Scan Do not disable Scanning unless you want to disable ARM and manually configure AP channel and transmission power. Default: enabled
Scan Time	The amount of time, in milliseconds, an AP will step out of the current channel to scan another channel. The supported range for this setting is 0–2,147,483,647 seconds. Dell recommends a scan time between 50–200 msec. Default: 110 msec
VoIP Aware Scan	Dell's VoIP Call Admission Control (CAC) prevents any single AP from becoming congested with voice calls. When you enable CAC, you should also enable VoIP Aware Scan in the ARM profile, so the AP will not attempt to scan a different channel if one of its clients has an active VoIP call. This option requires that Scanning is also enabled. Default: disabled
Power Save Aware Scan	If enabled, the AP will not scan a different channel if it has one or more clients that is in power save mode. Default: disabled
Video Aware Scan	As long as there is at least one video frame every 100 mSec the AP will reject an ARM scanning request. Note that for each radio interface, video frames must be defined in one of two ways: • Classify the frame as video traffic via a session ACL. • Enable WMM on the WLAN's SSID profile and define a specific DSCP value as a video stream. Next, create a session ACL to tag the video traffic with the that DSCP value.
Ideal Coverage Index	The Dell coverage index metric is a weighted calculation based on the RF coverage for all DellAPs and neighboring APs on a specified channel. The Ideal Coverage Index specifies the ideal coverage that an AP should try to achieve on its channel. The denser the AP deployment, the lower this value should be. The range of possible values is 2–20. Default: 10 For additional information on how this the Coverage Index is calculated, see "ARM Metrics" on page 175
Acceptable Coverage Index	For multi-band implementations, the Acceptable Coverage Index specifies the minimal coverage an AP it should achieve on its channel. The denser the AP deployment, the lower this value should be. The range of possible values is 1–6. Default: 4
Free Channel Index	The Dell Interference index metric measures interference for a specified channel and its surrounding channels. This value is calculated and weighted for all APs on those channels (including 3rd-party APs). An AP will only move to a new channel if the new channel has a lower interference index value than the current channel. Free Channel Index specifies the required difference between the two interference index values before the AP moves to the new channel. The lower this value, the more likely it is that the AP will move to the new channel. The range of possible values is 10–40. Default: 25 For additional information on how this the Channel Index is calculated, see "ARM Metrics" on page 175
Backoff Time	After an AP changes channel or power settings, it waits for the backoff time interval before it asks for a new channel/power setting. The range of possible values is 120–3600 seconds. Default: 240 seconds
Error Rate Threshold	The minimum percentage of PHY errors and MAC errors in the channel that will trigger a channel change. Default: 50%
Error Rate Wait Time	Minimum time in seconds the error rate has to exceed the Error Rate Threshold before it triggers a channel change. Default: 30 seconds

Table 37 *ARM Profile Configuration Parameters (Continued)*

Setting	Description
Noise Threshold	Maximum level of noise in channel that triggers a channel change. The range of possible 0–2,147,483,647 dBm. Default 75 dBm
Noise Wait Time	Minimum time in seconds the noise level has to exceed the Noise Threshold before it triggers a channel change. The range of possible values is 15–3600 seconds. Default: 120 seconds
Minimum Scan Time	Minimum number of times a channel must be scanned before it is considered for assignment. The supported range for this setting is 0–2,147,483,647 scans. Dell recommends a Minimum Scan Time between 1–20 scans. Default: 8 scans
Load Aware Scan Threshold	Load aware ARM preserves network resources during periods of high traffic by temporarily halting ARM scanning if the load for the AP gets too high. The Load Aware Scan Threshold is the traffic throughput level an AP must reach before it stops scanning. The supported range for this setting is 0–20000000 bytes/second. (Specify 0 to disable this feature.) Default: 1250000 Bps
Mode Aware ARM	If enabled, ARM will turn APs into Air Monitors (AMs) if it detects higher coverage levels than necessary. This helps avoid higher levels of interference on the WLAN. Although this setting is disabled by default, you may want to enable this feature if your APs are deployed in close proximity (e.g. less than 60 feet apart). Mode aware ARM turns Air Monitors back into APs when they detect gaps in coverage. Note that an Air Monitor will not turn back into an AP if it detects client traffic (or client traffic increases), but will change to an AP only if it detects coverage holes. Default: disabled
Scan Mode	By default, 802.11n-capable APs scan channels within all regulatory domains. To limit the AP scans to just the regulatory domain for that AP, click the Scan Mode drop-down list and select reg-domain. NOTE: This setting does not apply to APs that do not support 802.11n; these APs will scan their regulatory domain only.

In the CLI

You must be in config mode to create, modify or delete an ARM profile using the CLI. Specify an existing ARM profile with the <profile-name> parameter to modify an existing ARM profile, or enter a new name to create an entirely new profile.

Configuration details and any default values for each of these parameters are described in Table 37 on page 166. If you do not specify a parameter for a new profile, that profile uses the default value for that parameter. Put the no option before any parameter to remove the current value for that parameter and return it to its default setting. Enter exit to leave the ARM profile mode.

Use the following command to create or modify an ARM profile:

```
rf arm-profile <profile>
   40MHz-allowed-bands {All|None|a-only|g-only}
   acceptable-coverage-index <number>
   active-scan (not intended for use)
   assignment {disable|maintain|multi-band|single-band}
   backoff-time <seconds>
   client-aware
   clone <profile>
   error-rate-threshold <percent>
   error-rate-wait-time <seconds>
   free-channel-index <number>
   ideal-coverage-index <number>
   load-aware-scan-threshold <Mbps>
   max-tx-power <dBm>
   min-scan-time <# of scans>
   min-tx-power <dBm>
```

```
mode-aware
multi-band-scan
no
noise-threshold <number>
noise-wait-time <seconds>
ps-aware-scan
rogue-ap-aware
scan-interval <seconds>
scan mode all-reg-domain|reg-domain
scan-time <milliseconds>
scanning
voip-aware-scan
```

Assigning an ARM Profile to an AP Group

Once you have created a new ARM profile, you must assign it to a group of APs before those ARM settings go into effect. Each AP group has a separate set of configuration settings for its 802.11a radio profile and its 802.11g radio profile. You can assign the same ARM profile to each radio profile, or select different ARM profiles for each radio.

In the WebUI

To assign an ARM profile to an AP group via the Web User Interface:

1. Select Configuration > AP Configuration.
2. If it is not already selected, click the AP Group tab.
3. Click the Edit button beside the AP group to which you want to assign the new ARM profile.
4. Expand the RF Management section in the left window pane.
5. Select a radio profile for the new ARM profile.
   - To assign a new profile to an AP group's 802.11a radio profile, expand the 802.11a radio profile section.
   - To assign a new profile to an AP group's 802.11g radio profile, expand the 802.11g radio profile section.
6. Select Adaptive Radio management (ARM) Profile.
7. Click the Adaptive Radio Management (ARM) Profile drop-down list in the right window pane, and select a new ARM profile.
8. (Optional) repeat steps 6–8 to select an ARM profile for another profile.
9. Click Apply to save your changes.

You can also assign an ARM profile to an AP group by selecting a radio profile, identifying an AP group assigned to that radio profile, and then assigning an ARM profile to one of those groups.

1. Select Configuration > All Profiles.
2. Select RF Management and then expand either the 802.11a radio profile or 802.11b radio profile.
3. Select an individual radio profile name to expand that profile.
4. Click Adaptive Radio Management (ARM) Profile, and then use the Adaptive Radio management (ARM) Profile drop-down list in the right window pane to select a new ARM profile for that radio.

In the CLI

To assign an ARM profile to an AP group via the command-line interface, access the CLI in config mode and issue the following commands:

```
rf dot11a-radio-profile <ap_profile>
   arm-profile <arm_profile>
```

and

```
rf dot11g-radio-profile <ap_profile>
   arm-profile <arm_profile>
```

Where <ap_profile> is the name of the AP group, and <arm_profile> is the name of the ARM profile you want to assign to that radio band.

Multi-Band ARM and 802.11a/802.11g Traffic

Dell recommends using the multi-band ARM assignment and Mode Aware ARM feature for single-radio APs in networks with traffic in the 802.11a and 802.11g bands. This feature allows a single-radio AP to dynamically change its radio bands based on current coverage on the configured band. This feature is enabled via the AP's ARM profile.

When you first provision a single-radio AP, it initially operates in the radio band specified in its AP system profile. If the AP finds adequate coverage on multiple channels in its current band of operation, the mode-aware feature allows the AP to temporarily turn itself off and become an AP Air Monitor (APM). In AP Monitor mode, the AP scans all channels across both bands to verify that each channel meets or exceeds its required level of acceptable radio coverage (as defined by the in the ARM profile).

If the AP Monitor detects that a channel on the 802.11g band does not have adequate radio coverage, it will convert back to an AP on that 802.11 channel. If the 802.11g band is adequately covered, the AP Monitor will next check the 802.11a band. If a channel on the 802.11a band lacks coverage, the AP Monitor will convert back to an AP on that 802.11a channel.

Band Steering

ARM's band steering feature encourages dual-band capable clients to stay on the 5GHz band on dual-band APs. This frees up resources on the 2.4GHz band for single band clients like VoIP phones.

Band steering reduces co-channel interference and increases available bandwidth for dual-band clients, because there are more channels on the 5GHz band than on the 2.4GHz band. Dual-band 802.11n-capable clients may see even greater bandwidth improvements, because the band steering feature will automatically select between 40MHz or 20MHz channels in 802.11n networks. This feature is disabled by default, and must be enabled in a Virtual AP profile.

The band steering feature supports both campus APs and remote APs that have a virtual AP profile set to tunnel, split-tunnel or bridge forwarding mode. Note, however, that if a campus or remote AP has virtual AP profiles configured in bridge or split-tunnel forwarding mode *but no virtual AP in tunnel mode*, those APs will gather information about 5G-capable clients independently and will not exchange this information with other APs that also have bridge or split-tunnel virtual APs only. The band steering feature will not proactively disconnect clients that are already associated with a radio. All band steering occurs when a client is trying to associate to a new AP radio.

NOTE: Best practices is to use either the Band Steering or the Spectrum Load Balancing feature to balance client load across channels, but not both at the same time.

Steering Modes

Band steering supports the following three different band steering modes.

- Prefer-5GHz *(Default)*: If you configure the AP to use prefer-5GHz band steering mode, the AP will not respond to 2.4 Ghz probe requests from a client if all the following conditions are met.
  - The client has already probed the AP on the 5Ghz band and therefore is known to be capable of sending probes on the 5Ghz band.
  - The client is not currently associated on the 2.4Ghz radio to this AP.

- The client has sent less than 8 probes requests/auth in the last 10 seconds. If the client has sent more than 8 probes in the last 10 seconds, the client will be able to connect using whatever band it prefers

- Force-5GHz: When the AP is configured in force-5GHz band steering mode, the AP will not respond to 2.4 Ghz probe requests from a client if all the following conditions are met.
  - The client has already probed the AP on the 5Ghz band and therefore is known to be capable of sending probes on the 5Ghz band.
  - The client is not currently associated on the 2.4Ghz radio of this AP.
- Balance-bands: In this band steering mode, the AP tries to balance the clients across the two radios in order to best utilize the available 2.4G bandwidth. This feature takes into account the fact that the 5Ghz band has more channels than the 2.4 Ghz band, and that the 5Ghz channels operate in 40MHz while the 2.4Ghz band operates in 20MHz.

NOTE: The band steering feature in ArubaOS versions 3.3.2.x-3.4.2.x does not support multiple bandsteering modes. The band-steering feature in these versions of ArubaOS functions the same way as the default prefer-5GHz steering mode available in ArubaOS 3.4.3.x and later.

Enabling Band Steering

Band steering is configured in a virtual AP profile. Use the following procedures to enable or disable Band Steering using the WebUI or command-line interfaces.

In the WebUI

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select Wireless LAN to expand the Wireless LAN section.
3. Select Virtual AP profile to expand the Virtual AP Profile section.
4. Select the name of the Virtual AP profile for which you want to enable band steering.

   (To create a new virtual AP profile, enter a name for a new profile in the Profile Details window, then click Add button. The new profile will appear in the Profiles list. Select that profile to open the Profile Details pane.)
5. In the Profile Details pane, select Band Steering. to enable this feature, or uncheck the Band Steering checkbox to disable this feature.
6. Once band steering is enabled, click the steering mode drop-down list and select the desired steering mode.
7. Click Apply to save your changes.

In the CLI

Use the following commands to enable band steering via the command-line interface. Access the CLI in config mode then specify an existing virtual AP with the <name> parameter to modify an existing profile, or enter a new name to create an entirely new virtual AP profile.

```
wlan virtual-ap <profile> band-steering
wlan virtual-ap <profile> steering-mode balance-bands|force-5ghz|prefer-5ghz
```

To disable band steering, include the no parameter

```
wlan virtual-ap <profile> no band-steering
```

You can also use the command-line interface to configure and apply multiple instances of virtual AP profiles to an AP group or to an individual AP. Use the following commands to apply a virtual AP profile to an AP group or an individual AP.

```
ap-group <name> virtual-ap <profile>
ap-name <name> virtual-ap <profile>
```

Traffic Shaping

In a mixed-client network, it is possible for slower clients to bring down the performance of the whole network. To solve this problem and ensure fair access to all clients independent of their WLAN or IP stack capabilities, an AP can implement the traffic shaping feature. This feature has the following three options:

- default-access: Traffic shaping is disabled, and client performance is dependent on MAC contention resolution. This is the default traffic shaping setting.
- fair-access: Each client gets the same airtime, regardless of client capability and capacity. This option is useful in environments like a training facility or exam hall, where a mix of 802.11a/g, 802.11g and 802.11n clients need equal to network resources, regardless of their capabilities.
- preferred-access: High-throughput (802.11n) clients do not get penalized because of slower 802.11a/g or 802.11b transmissions that take more air time due to lower rates. Similarly, faster 802.11a/g clients get more access than 802.11b clients

With this feature, an AP keeps track of all BSSIDs active on a radio, all clients connected to the BSSID, and 802.11a/g, 802.11b, or 802.11n capabilities of each client. Every sampling period, airtime is allocated to each client, giving it opportunity to get and receive traffic. The specific amount of airtime given to an individual client is determined by the following factors:

- Client capabilities (802.11a/g, 802.11b or 802.11n)
- Amount of time the client spent receiving data during the last sampling period
- Number of active clients in the last sampling period
- Activity of the current client in the last sampling period

The bw-alloc parameter of a traffic management profile allows you to set a minimum bandwidth to be allocated to a virtual AP profile when there is congestion on the wireless network. You must set traffic shaping to fair-access to use this bandwidth allocation value for an individual virtual AP.

Enabling Traffic Shaping

Traffic shaping is configured in an traffic management profile.

In the WebUI

To configure traffic shaping via the WebUI:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select QoS to expand the QoS section.
3. Select Traffic management profile.
4. In the Profiles Details window, select the name of the traffic management profile for which you want to configure traffic shaping.

   (If you do not have any traffic management profiles configured, enter a name for a new profile in the Profile Details pane, then click Add. Select the new profile from the profiles list.)
5. In the Profile Details pane, click the Station Shaping Policy drop-down list and select either default-access, fair-access or preferred-access.
6. Click Apply to save your changes.

In the CLI

To enable and configure traffic shaping via the command-line interface, access the CLI in config mode and issue the following commands:

```
wlan traffic-management-profile <profile> shaping-policy fair-access|preferred-
access
```

To disable traffic shaping, use the default-access parameter:

```
wlan traffic-management-profile <profile> shaping-policy default-access
```

Use the following commands to apply an 802.11a or 802.11g traffic management profile to an AP group or an individual AP.

```
ap-group <name> dot11a-traffic-mgmt-profile|dot11g-traffic-mgmt-profile <profile>
ap-name <name> dot11a-traffic-mgmt-profile|dot11g-traffic-mgmt-profile <profile>
```

Spectrum Load Balancing

The spectrum load balancing feature helps optimize network resources by balancing clients across channels, regardless of whether the AP or the controller is responding to the wireless clients' probe requests. The controller uses the ARM neighbor update messages that pass between APs and the controller to determine the distribution of clients connected to each AP's immediate (one-hop) neighbors. This feature also takes into account the number of APs visible to the clients in the RF neighborhood and can factor the client's perspective on the network into its coverage calculations.

The controller compares whether or not an AP has more clients than its neighboring APs on other channels. If an AP's client load is at or over a predetermined threshold as compared to its immediate neighbors, or if a neighboring Dell AP on another channel does not have any clients, load balancing will be enabled on that AP.

When an AP has the spectrum load balancing feature enabled, the AP will send an association response with error code 17 to new clients trying to associate. If the client receiving the error code tries to associate to the AP a second time, it will be admitted. If a client is rejected by two APs in a row, it will be admitted by any AP on its third try. Note that the load balancing feature only affects the association of new clients; this feature does not reject or attempt to balance clients that are already associated to the AP.

Spectrum load balancing is disabled by default, and can be enabled for 2.4G traffic through an 802.11g profile or for 5G traffic through an 802.11a RF management profile. The spectrum load balancing feature also requires that the 802.11a or 802.11g RF management profiles reference an ARM profile with ARM scanning enabled.

NOTE: The spectrum load balancing feature available in ArubaOS 3.4.x and later releases completely replaces the AP load balancing feature available earlier versions of ArubaOS. When you upgrade to ArubaOS 3.4.x or later, you must manually configure the spectrum load balancing settings, as the AP load balancing feature can no longer be used, and any previous AP load balancing settings will not be preserved.

For details on modifying 802.11a or 802.11g RF management profiles, refer to "RF Management (802.11a and 802.11g) Profiles" on page 232.

RX Sensitivity Tuning Based Channel Reuse

In some dense deployments, it is possible for APs to hear other APs on the same channel. This creates co-channel interference and reduces the overall utilization of the channel in a given area. Channel reuse enables dynamic control over the receive (Rx) sensitivity in order to improve spatial reuse of the channel.

NOTE: The channel reuse feature applies to non-DFS channels only. It is internally disabled for DFS channels and is does not affect DFS radar signature detection.

You can configure the channel reuse feature to operate in either of the following three modes; *static, dynamic or disable*. (This feature is disabled by default.)

- Static mode: This mode of operation is a coverage-based adaptation of the Clear Channel Assessment (CCA) thresholds. In the static mode of operation, the CCA is adjusted according to the configured transmission power level on the AP, so as the AP transmit power decreases as the CCA threshold increases, and vice versa.

- Dynamic mode: In this mode, the Clear Channel Assessment (CCA) thresholds are based on channel loads, and take into account the location of the associated clients. When you set the Channel Reuse feature to dynamic mode, this feature is automatically enabled when the wireless medium around the AP is busy greater than half the time, and the CCA threshold adjusts to accommodate transmissions between the AP its most distant associated client.
- Disable mode: This mode does not support the tuning of the CCA Detect Threshold.

The channel reuse mode is configured through an 802.11a or 802.11g RF management profile. For details on modifying 802.11a or 802.11g RF management profiles, refer to "RF Management (802.11a and 802.11g) Profiles" on page 232.

Non-802.11 Noise Interference Immunity

When an AP attempts to decode a non-802.11 signal, that attempt can momentarily interrupt its ability to receive traffic. The noise immunity feature can help improve network performance in environments with a high level of non-802.11 noise from devices such as Bluetooth headsets, video monitors and cordless phones.

You can configure the noise immunity feature for any one of the following levels of noise sensitivity. Note that increasing the level makes the AP slightly "deaf" to its surroundings, causing the AP to lose a small amount of range.

- Level 0: no ANI adaptation.
- Level 1: Noise immunity only. This level enables power-based packet detection by controlling the amount of power increase that makes a radio aware that it has received a packet.
- Level 2: Noise and spur immunity. This level also controls the detection of OFDM packets, and is the default setting for the Noise Immunity feature.
- Level 3: Level 2 settings and weak OFDM immunity. This level minimizes false detects on the radio due to interference, but may also reduce radio sensitivity. This level is recommended for environments with a high-level of interference related to 2.4Ghz appliances such as cordless phones.
- Level 4: Level 3 settings, and FIR immunity. At this level, the AP adjusts its sensitivity to in-band power, which can improve performance in environments with high and constant levels of noise interference.
- Level 5: The AP completely disables PHY error reporting, improving performance by eliminating the time the controller would spend on PHY processing.

You can manage Non-802.11 Noise Immunity settings through the 802.11g RF management profile. Do not raise the noise immunity feature's default setting if the RX Sensitivity Tuning Based Channel Reuse feature is also enabled. A level-3 to level-5 Noise Immunity setting is not compatible with the Channel Reuse feature. For details refer to "Mesh Radio Profiles" on page 227.

ARM Metrics

ARM computes coverage and interference metrics for each valid channel and chooses the best performing channel and transmit power settings for each AP's RF environment. Each AP gathers other metrics on their ARM-assigned channel to provide a snapshot of the current RF health state.

The following two metrics help the AP decide which channel and transmit power setting is best.

- Coverage Index: The AP uses this metric to measure RF coverage. The coverage index is calculated as x/y, where "x" is the AP's weighted calculation of the Signal-to-Noise Ratio (SNR) on all valid APs on a specified 802.11 channel, and "y" is the weighted calculation of the Dell APs SNR the neighboring APs see on that channel.

  To view these values for an AP in your current WLAN environment issue the CLI command show ap arm rf-summary ap-name <ap-name>, where <*ap-name*> is the name of an AP for which you want to view information.

- Interference Index: The AP uses this metric to measure co-channel and adjacent channel interference. The Interference Index is calculated as a/b//c/d, where:
  - Metric value “a” is the channel interference the AP sees on its selected channel.
  - Metric value “b” is the interference the AP sees on the adjacent channel.
  - Metric value “c” is the channel interference the AP’s neighbors see on the selected channel.
  - Metric value “d” is the interference the AP’s neighbors see on the adjacent channel

  To manually calculate the total Interference Index for a channel, issue the CLI command show ap arm rf-summary ap-name <ap-name>, then add the values $a+b+c+d$.

Each AP also gathers the following additional metrics, which can provide a snapshot of the current RF health state. View these values for each AP using the CLI command show ap arm rf-summary ip-addr <ap ip address>.

- Amount of Retry frames (measured in %)
- Amount of Low-speed frames (measured in %)
- Amount of Non-unicast frames (measured in %)
- Amount of Fragmented frames (measured in %)
- Amount of Bandwidth seen on the channel (measured in kbps)
- Amount of PHY errors seen on the channel (measured in %)
- Amount of MAC errors seen on the channel (measured in %)
- Noise floor value for the specified AP

ARM Troubleshooting

If the APs on your WLAN do not seem to be operating at an optimal channel or power setting, you should first verify that both the ARM feature and ARM scanning have been enabled. Optimal ARM performance requires that the APs have IP connectivity to their master controller, as it is the master controller that gives each AP the global classification information required to keep accurate coverage index values. If ARM is enabled but does not seem to be working properly, try some of the following troubleshooting tips.

Too many APs on the Same Channel

If many APs are selecting the same RF channel, there may be excessive interference on the other valid 802.11 channels. Issue the CLI commands show ap arm rf-summary ap-name <ap-name> or show ap arm rf-summary ip-addr <ap ip address> and calculate the Interference index (*intf_idx*) for all the valid channels.

An AP will only move to a new channel if the new channel has a lower interference index value than the current channel. The ARM Free Channel Index parameter specifies the required difference between two interference index values. If this value is set too high, the AP will not switch channels, even if the interference is slightly lower on another channel. Lower the Free Channel Index to improve the likelihood that the AP will switch to a better channel.

Wireless Clients Report a Low Signal Level

If APs detect strong signals from other APs on the same channel, they may decrease their power levels accordingly. Issue the CLI commands show ap arm rf-summary ap-name <ap-name> or show ap arm rf-summary ip-addr <ap ip address> for all APs and check their current coverage index (*cov-idx*). If the AP’s coverage index is at or higher than the configured coverage index value, then the APs have correctly chosen the transmit power setting. To manually increase the minimum power level for the APs using a specific ARM profile, define a higher minimum value with the command
rf arm-profile <profile> min-tx-power <dBm>.

If wireless clients still report that they see low signal levels for the APs, check that the AP’s antennas are correctly connected to the AP and correctly placed according to the manufacturer’s installation guide.

Transmission Power Levels Change Too Often

Frequent changes in transmission power levels can indicate an unstable RF environment, but can also reflect incorrect ARM or AP settings. To slow down the frequency at which the APs change their transmit power, set the ARM Backoff Time to a higher value. If APs are using external antennas, check the Configuration > Wireless > AP Installation > Provisioning window to make sure the APs are statically configured for the correct dBi gain, antenna type, and antenna number. If only one external antenna is connected to its radio, you must select either antenna number 1 or 2.

APs Detect Errors but Do Not Change Channels

First, ensure that ARM error checking is not disabled. The ARM Error Rate Threshold should be set to a percentage higher than zero. The suggested configuration value for the ARM Error Rate Threshold is 30–50%.

APs Don't Change Channels Due to Channel Noise

APs will only change channels due to interference if ARM noise checking is enabled. Check to verify that the ARM Noise Threshold is set to a value higher than 0 dBm. The suggested setting for this threshold is 75 dBm.

Chapter 7

Remote Access Points

The Secure Remote Access Point Service allows AP users, at remote locations, to connect to an Dell controller over the Internet. Since the Internet is involved, data traffic between the controller and the remote AP is VPN encapsulated. That is, the traffic between the controller and AP is encrypted. Remote AP operations are supported on all of Dell's APs. This chapter discusses the following topics:

Overview

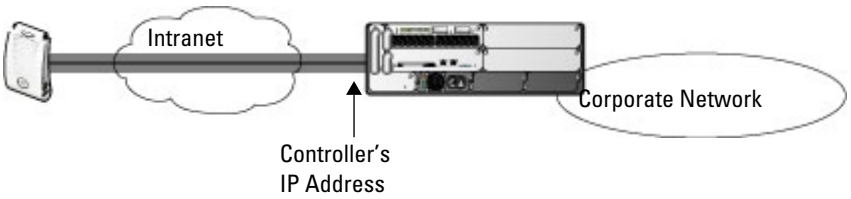
Remote APs connect to a controller using Extended Authentication and Internet Protocol Security (XAuth/IPSec). AP control and 802.11 data traffic are carried through this tunnel. Secure Remote Access Point Service extends the corporate office to the remote site. Remote users can use the same features as corporate office users. For example, voice over IP (VoIP) applications can be extended to remote sites while the servers and the PBX remain secure in the corporate office.

Secure Remote Access Point Service can also be used to secure control traffic between an AP and the controller in a corporate environment. In this case, both the AP and controller are in the company's private address space.

The remote AP must be configured with the IPSec VPN tunnel termination point. Once the VPN tunnel is established, the AP bootstraps and becomes operational. The tunnel termination point used by the remote AP depends upon the AP deployment, as shown in the following scenarios:

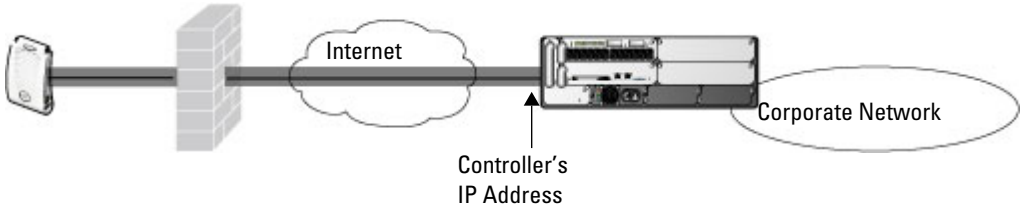
- Deployment Scenario 1: The remote AP and controller reside in a private network which is used to secure AP-to-controller communication. (Dell recommends this deployment when AP-to-controller communications on a private network need to be secured.) In this scenario, the remote AP uses the controller's IP address on the private network to establish the IPSec VPN tunnel.

Figure 25 *Remote AP with a Private Network*



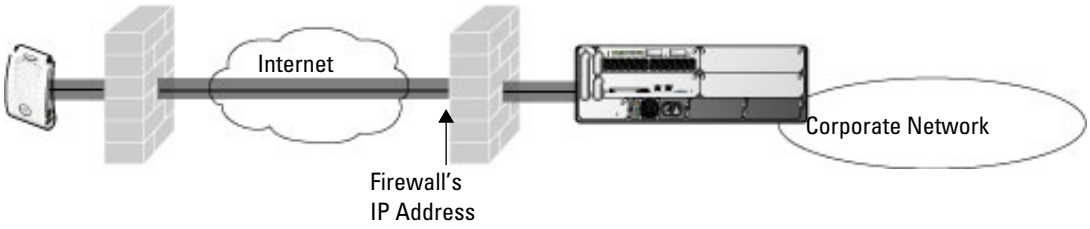
- Deployment Scenario 2: The remote AP is on the public network or behind a NAT device and the controller is on the public network. The remote AP must be configured with the tunnel termination point which must be a publicly-routable IP address. In this scenario, a routable interface is configured on the controller in the DMZ. The remote AP uses the controller's IP address on the public network to establish the IPSec VPN tunnel.

Figure 26 *Remote AP with Controller on Public Network*



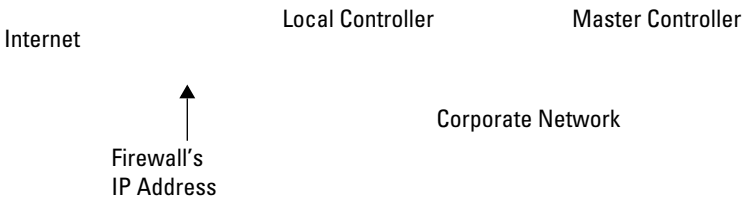
- Deployment Scenario 3: The remote AP is on the public network or behind a NAT device and the controller is also behind a NAT device. (Dell recommends this deployment for remote access.) The remote AP must be configured with the tunnel termination point which must be a publicly-routable IP address. In this scenario, the remote AP uses the public IP address of the corporate firewall. The firewall forwards traffic to an existing interface on the controller. (The firewall must be configured to pass NAT-T traffic (UDP port 4500) to the controller.)

Figure 27 *Remote AP with Controller Behind Firewall*



In any of the described deployment scenarios, the IPSec VPN tunnel can be terminated on a local controller, with a master controller located elsewhere in the corporate network (Figure 28). The remote AP must be able to communicate with the master controller after the IPSec tunnel is established. Make sure that the L2TP IP pool configured on the local controller (from which the remote AP obtains its address) is reachable in the network by the master controller.

Figure 28 *Remote AP in a Multi-Controller Environment*



Configuring the Secure Remote Access Point Service

The tasks for configuring an Dell Access Points as a Secure Remote Access Point Service are:

- Configure a public IP address for the controller.

  You must install one or more AP licenses in the controller. There are several AP licenses available that support different maximum numbers of APs. The licenses are cumulative; each additional license installed increases the maximum number of APs supported by the controller.
- Configure the VPN server on the controller. The remote AP will be a VPN client to the server.
- Provision the AP with IPSec settings, including the username and password for the AP, before you install it at the remote location.

  ArubaOS supports multiple remote AP modes of operation. By default, the remote AP operates in standard mode. This mode enables the virtual AP when the remote AP connects to the controller. The information in

this section assumes the default mode of operation. For information on remote AP modes of operation, refer to "Advanced Configuration Options" on page 194.

Configure a Public IP Address for the Controller

The remote AP requires an IP address to which it can connect in order to establish a VPN tunnel to the controller. This can be either a routable IP address that you configure on the controller, or the address of an external router or firewall that forwards traffic to the controller. The following procedure describes how to create a DMZ address on the controller.

Using the WebUI to Create a DMZ Address

1. Navigate to the Configuration > Network > VLANs page.
2. Click Add to add a VLAN.
3. Enter the VLAN ID.
4. Select the port that belongs to this VLAN.
5. Click Apply.
6. Navigate to the Configuration > Network > IP page.
7. Click Edit for the VLAN you just created.
8. Enter the IP Address and Net Mask fields.
9. Click Apply.

Using CLI

```
vlan <id>
interface fastethernet <slot>/<port>
   switchport access vlan <id>
interface vlan <id>
   ip address <ipaddr> <mask>
```

Configure the NAT Device

Communication between the AP and secure controller uses the UDP 4500 port. When both the controller and the AP are behind NAT devices, configure the AP to use the NAT device's public address as its master address. On the NAT device, you must enable NAT-T (UDP port 4500 only) and forward all packets to the public address of the NAT device on UDP port 4500 to the controller to ensure that the remote AP boots successfully.

Configure the VPN Server

This section describes how to configure the IPSec VPN server on the controller. For more details, see Chapter 17, "Virtual Private Networks" on page 389. The remote AP will be a VPN client that connects to the VPN server on the controller.

Using the WebUI

1. Navigate to the Configuration > Advanced Services > VPN Services > IPSec page.
2. Select (check) Enable L2TP.
3. Make sure that only PAP (Password Authentication Protocol) is selected for Authentication Protocols.
4. To configure the L2TP IP pool, click Add in the Address Pools section. Configure the L2TP pool from which the APs will be assigned addresses, then click Done.

NOTE: The size of the pool should correspond to the maximum number of APs that the controller is licensed to manage.

5. To configure an Internet Security Association and Key Management Protocol (ISAKMP) encrypted subnet and preshared key, click Add in the IKE Shared Secrets section and configure the preshared key. Click Done to return to the IPSec page.
6. Click Apply.

Using CLI

```
vpdn group l2tp
   ppp authentication PAP

ip local pool <pool> <start-ipaddr> <end-ipaddr>
crypto isakmp key <key> address <ipaddr> netmask <mask>
```

CHAP Authentication Support over PPPoE

RAPs can now establish a PPPoE session with a PPPoE server at the ISP side and get authenticated using the Challenge Handshake Authentication Protocol (CHAP). The PPPoE client running on a RAP is capable of handling the CHAP authentication requests from the PPPoE server.

NOTE: The PPPoE client selects either the PAP or the CHAP credentials for the RAP authentication depending upon the request from the PPPoE server.

You can use the CLI or the WebUI to configure CHAP.

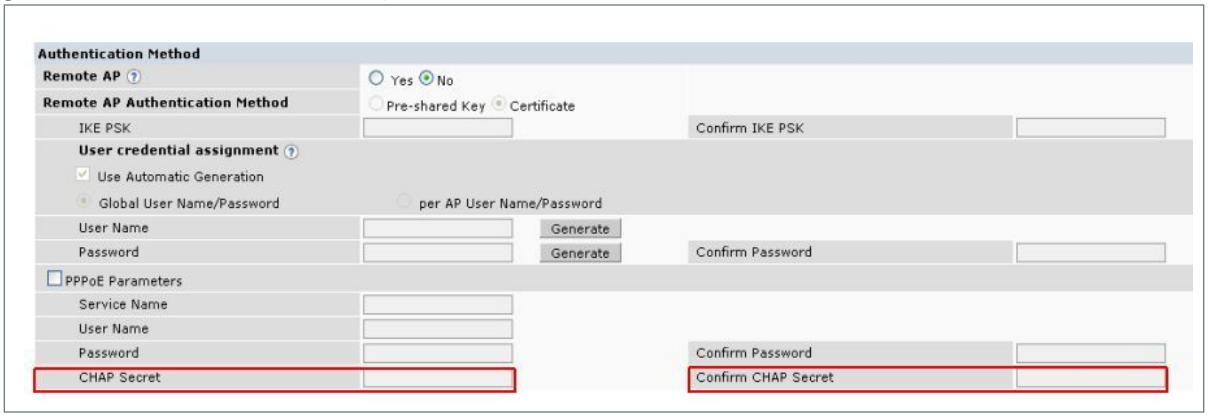
Using the WebUI to Configure CHAP

1. Navigate to the Configuration > Wireless > AP Installation page. The list of discovered APs are displayed on this page.
2. Select the AP you want to configure using CHAP and click Provision button.
3. Enter the CHAP Secret in the text box under Authentication Method.

NOTE: You can use all the special characters except question mark (?) and the space can be used within double quotes (" ").

4. Enter the CHAP Secret again in the Confirm CHAP Secret text box for confirmation.

Figure 29 *CHAP Authentication Using CHAP Secret*



5. Click Apply and Reboot.

Using the CLI to Configure CHAP

```
provision-ap pppoe-chap-secret <KEY>
         reprovision ap-name <name>
```

Configure the Remote AP User Role

Once the remote AP is authenticated for the VPN and established a IPSec connection, it is assigned a role. This role is a temporary role assigned to the AP until it completes the bootstrap process after which it inherits the ap-role. The appropriate ACLs need to be enabled to permit traffic from the controller to the AP and back to facilitate the bootstrap process.

NOTE: User roles and policies require the PEFNG license. You must install the PEFNG license, as described in Chapter 34, “Software Licenses” .

To configure the user role, you create a policy that permits the following traffic:

- AP control traffic via the Dell PAPI protocol
- GRE tunnel traffic
- Layer-2 Tunneling Protocol (L2TP) traffic
- TFTP traffic from the remote AP to the controller
- FTP traffic from the remote AP to the controller

Then, you create a user role that contains this policy.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to create a policy.
3. Enter the Policy Name (for example, remote-AP-access).
4. From the Policy Type drop-down list, select IPv4 Session.
5. To create the first rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-papi.
   e. Click Add.
6. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-gre.
   e. Click Add.
7. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-l2tp.
   e. Click Add.
8. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.

c. For Destination, select alias, then select mswitch.
d. For Service, select service, then select svc-tftp.
e. Click Add.

9. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select alias, then select mswitch.
   d. For Service, select service, then select svc-ftp.
   e. Click Add.
10. Click Apply.
11. Click the User Roles tab.
   a. Click Add.
   b. Enter the Role Name (for example, RemoteAP).
   c. Click Add under Firewall Policies.
   d. In the Choose from Configured Policies menu, select the policy you just created.
   e. Click Done.
12. Click Apply.

Using CLI

```
ip access-list session <policy>
   any any svc-papi permit
   any any svc-gre permit
   any any svc-l2tp permit
   any alias mswitch svc-tftp permit
   any alias mswitch svc-ftp permit

user-role <role>
   session-acl <policy>
```

Configure VPN Authentication

Before you enable VPN authentication, you must configure the authentication server(s) and server group that the controller will use to validate the remote AP. When you provision the remote AP, you configure IPSec settings for the AP, including the username and password. This username and password must be validated by an authentication server before the remote AP is allowed to establish a VPN tunnel to the controller. The authentication server can be any type of server supported by the controller, including the controller's internal database.

CAUTION: For security purposes, Dell best practices is to assign a unique username and password for each remote AP.

For more information about configuring authentication servers and server groups, refer to Chapter 9, "Authentication Servers" .

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. In the Profiles list, select the VPN Authentication Profile> default-rap.

3. For Default Role, enter the user role you created previously (for example, RemoteAP).

NOTE: User roles and policies require the PEFNG and PEFV license. You must install the PEFNG and PEFV license, as described in Chapter 34, "Software Licenses" .

4. Click Apply.
5. In the Profile list, under VPN Authentication Profile, select Server Group.
6. Select the server group from the drop-down menu.
7. Click Apply.

Using CLI

```
aaa server-group <group>
   auth-server <server>
aaa authentication vpn default-rap
   default-role <role>
   server-group <group>
```

Configuring Internal Database for Authentication

You can use the controller's internal database as an authentication server. To configure the internal database for a remote AP user, do the following:

1. Configure a public IP address for the controller.
2. Configure the VPN server on the controller.
3. Configure the remote AP user role.
4. Configure VPN authentication using the internal database.
5. Add the user to the internal database.

The information in this section assumes you have configured a public IP address for the controller and the VPN server. For information about configuring the public IP address, see "Configure a Public IP Address for the Controller" on page 181. For information about configuring the VPN server, see "Configure the VPN Server" on page 181.

Using the WebUI

The following procedure illustrates the steps to configure an internal database for a remote AP user. To configure the user role, you first create a policy that permits the following traffic:

- AP control traffic via the Dell PAPI protocol
- GRE tunnel traffic
- ESP tunnel traffic
- Layer-2 Tunneling Protocol (L2TP) traffic
- TFTP traffic
- FTP traffic

Then, you create a user role that contains this policy.

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to create a policy.
3. Enter the Policy Name (for example, rap_policy).
4. From the Policy Type drop-down list, select IPv4 Session.
5. To create the first rule:

f. Under Rules, click Add.
g. For Source, select any.
h. For Destination, select any.
i. For Service, select service, then select svc-papi.
j. Click Add.

6. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-l2tp.
   e. Click Add.
7. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-gre.
   e. Click Add.
8. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-esp.
   e. Click Add.
9. To create the next rule:
   a. Under Rules, click Add.
   b. For Source, select any.
   c. For Destination, select any.
   d. For Service, select service, then select svc-tftp.
   e. Click Add.
10. To create the next rule:
    a. Under Rules, click Add.
    b. For Source, select any.
    c. For Destination, select any.
    d. For Service, select service, then select svc-ftp.
    e. Click Add.
11. Click Apply.
12. Click the User Roles tab.
    a. Click Add.
    b. Enter the Role Name (for example, rap_role).
    c. Click Add under Firewall Policies.
    d. In the Choose from Configured Policies menu, select the policy you just created.

e. Click Done.

13. Click Apply.

Configure VPN authentication using the internal database

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. In the Profiles list, select VPN Authentication Profile.
3. For Default Role, enter the user role you created previously (for example, rap_role).
4. Click Apply.
5. In the Profile list, under VPN Authentication Profile, select Server Group.
6. Select the internal server group from the drop-down menu.
7. Click Apply.

Add the user to the internal database

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Internal DB.
3. Click Add User in the Users section. The user configuration page displays.
4. Enter the user name and password.
5. Click Enabled to activate this entry on creation.
6. Click Apply to apply the configuration. Note that the configuration does not take effect until you perform this step.
7. At the Servers page, click Apply.

Using CLI to configure the internal DB for a RAP user

```
ip access-list session rap_policy
   any any svc-papi permit
   any any svc-l2tp permit
   any any svc-gre permit
   any any svc-esp permit
   any any svc-tftp permit
   any any svc-ftp permit

user-role rap_role
   session-acl rap_policy
```

Configure VPN authentication using the internal database:

```
aaa authentication vpn
   default-role rap_role
   server-group internal
```

Add the user to the internal database:

```
local-userdb add username rapuser1 password <password>
```

Provision the AP

You need to configure the VPN client settings on the AP to instruct the AP to use IPSec to connect to the controller. You can provision the remote AP and give it to users and allow remote users to provision AP at their home. See Appendix H, “Provisioning RAP at Home” for more information about provisioning remote AP at home.

You must provision the AP before you install it at its remote location. To provision the AP, the AP must be physically connected to the local network or directly connected to the controller. When connected and powered

on, the AP must also be able to obtain an IP address from a DHCP server on the local network or from the controller.

If your configuration has an internal LMS IP address, remote APs may attempt to switch over to the LMS IP address, which is not reachable from the Internet. For remote APs, ensure that the LMS IP address in the AP system profile for the AP group has an externally routable IP address.

Reprovisioning the AP causes it to automatically reboot. The easiest way to provision an AP is to use the Provisioning page in the WebUI, as described in the following steps:

1. Navigate to the Configuration > Wireless > AP Installation > Provisioning page. Select the remote AP and click Provision.
2. Under Authentication Method, select IPSec Parameters. Enter the Internet Key Exchange (IKE) Pre-Shared Key (PSK), username, and password.

NOTE: The username and password you enter must match the username and password configured on the authentication server for the remote AP

3. Under Master Discovery, set the Master IP Address as shown below:

Deployment Scenario	Master IP Address Value
Deployment 1	Controller IP address
Deployment 2	Controller public IP address
Deployment 3	Public address of the NAT device to which the controller is connected

NOTE: The username and password you enter must match the username and password configured on the authentication server for the remote AP

4. Under IP Settings, make sure that Obtain IP Address Using DHCP is selected.
5. Click Apply and Reboot.

Creating a Remote AP Whitelist

Remote AP whitelist is the list of approved AP's that can be provisioned on your controller. To create a remote AP whitelist:

1. Navigate to Configuration > AP Installation (under Wireless) and then click the RAP Whitelist tab on the right side.
2. Click the New button and provide the following details:
   - AP MAC Address—Mandatory parameter. Enter the MAC address of the AP.
   - Username—Enter a username that will be used when the AP is provisioned.
   - AP Group—Select a group to add the AP.
   - AP Name—Enter a name for the AP. If an AP name is not entered, the MAC address will be used instead.
   - Description—Enter a text description for the AP
   - IP-Address—Enter an IP address for the AP.
3. Click the Add button to add the remote AP to the whitelist.

Revoking an AP

In some cases, if an AP in the whitelist is retired from active usage, you can set the AP as revoked. This option restricts the AP from connecting to your controller. To revoke a remote AP:

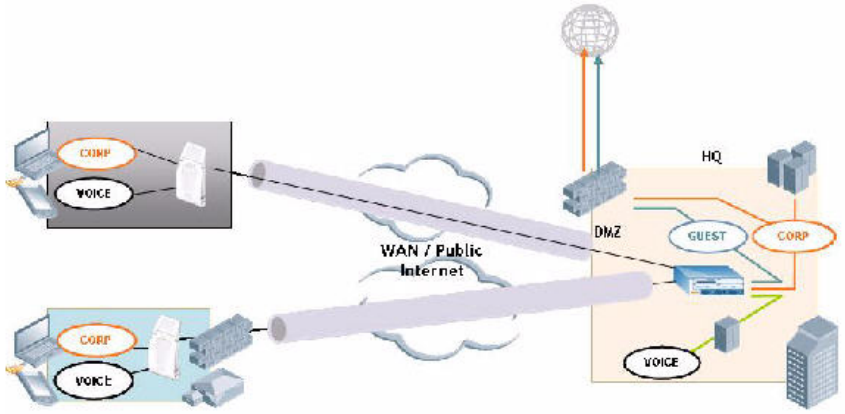
1. Select an AP from the whitelist by selecting the checkbox.
2. Click the Modify button.
3. Select the checkbox under the Revoked column.
4. Click the Update button.

Deploying a Branch Office/Home Office Solution

In a branch office, the AP is deployed in a separate IP network from the corporate network. Typically, there are one or two NAT devices between the two networks. Branch office users need access to corporate resources like printers and servers but traffic to and from these resources must not impact the corporate head office.

The Figure 30 is a graphic representation of a remote AP in a branch or home office with a single controller providing access to both a corporate WLAN and a branch office WLAN.

Figure 30 *Remote AP with Single Controller*



Branch office users want continued operation of the branch office WLAN even if the link to the corporate network goes down. The branch office AP solves these requirements by providing the following capabilities on the branch office WLAN:

- Local termination of 802.11 management frames which provides survivability of the branch office WLAN.
- All 802.1x authenticator functionality is implemented in the AP. The controller is used as a RADIUS pass-through when the authenticator has to communicate with a RADIUS server (which also supports survivability).
- 802.11 encryption/decryption is in the AP to provide access to local resources.
- Local bridging of client traffic connected to the WLAN or to an AP 70 enet1 port to provide access to local resources.

Configuring the branch office AP

- Specify forward mode for the Extended Service Set Identifier (ESSID) in the virtual AP profile
- Specify remote AP operation in the virtual AP profile (by default, the remote AP operates in standard mode)
- Set how long the AP stays up after connectivity to controller has gone down in the SSID profile
- Set the VLAN ID in the virtual AP profile
- Set the native VLAN ID in the AP system profile

- Set forward mode for enet1 port

NOTE: Remote APs support 802.1q VLAN tagging. Data from the remote AP will be tagged on the wired side.

Troubleshooting Remote AP

The following WebUI options are available to troubleshoot issues with remote AP:

- Using local debugging feature
- Viewing the remote AP summary report
- Viewing remote AP connectivity report
- Using remote AP diagnostic options

Local Debugging

Local Debugging is A WebUI feature that allows end users to perform diagnostics and view the status of their remote AP through a wired or wireless client. This feature is useful for troubleshooting connectivity problems on remote AP and to performing throughput tests. There are three tabs in the Local Debugging WebUI window, Summary, Connectivity and Diagnostics. Each tab displays different information for the AP, but all three tabs include a Generate & save support file link that, when clicked, will automatically generate a support.tgz file that can be sent to a corporate IT department for additional analysis and debugging.

Remote AP Summary

The Summary tab has two views; basic and advanced. Click the basic or advanced links at the top of this tab to toggle between the two views. The table below shows the information displayed for both the basic and advanced views of the Summary tab.

Table 38 *RAP Console Summary Tab Information*

Summary Table Name	Basic View Information	Advanced View Information
Wired Ports Status	• Port: Port numbers of the wired ports on the AP. • Status: Current status of each port (*Connected*, *Link Down* or *Disabled*).	The advanced view of the Wired Access Ports table displays the following data: • Port: Port numbers of the wired ports on the AP. • Status: Current status of each port (*Connected*, *Link Down* or *Disabled*). • MAC Address: MAC address of the wired port. • Speed: Speed of the link. • Duplex Type: Duplex mode of the link, full or half. • Forwarding mode: Forwarding mode for the port: *Bridge*, *Tunnel* or *Split Tunnel*. • Users: Number of users accessing each port. • Rx Packets: Number of packets received on the port. • Tx packets: Number of packets transmitted via the port.

Table 38 *RAP Console Summary Tab Information (Continued)*

Summary Table Name	Basic View Information	Advanced View Information
Wireless SSIDs	• SSID: Name of the SSID. • Status: SSID Status (up, down, or disabled). • Band: Radio band available on the SSID.	• SSID: Name of the SSID. • Status: SSID Status (up, down, or disabled). • Band: Radio band available on the SSID. • Channel: Channel used on the radio band. • BSSID: BSSID of the wireless SSID. • Forwarding Mode: Forwarding mode used by the Wireless SSID (Bridge, Tunnel or Split-Tunnel). • EIRP: Equivalent Isotropic Radiated Power, in dBm. • Noise floor: The residual background noise detected by an AP. Noise seen by an AP is reported as -dBm. Therefore, a noise floor of -100 dBm is smaller (lower) than a noise floor of -50 dBm. • Users: Number of users on the radio band. • Rx Packets: Number of packets received on the BSSID. • Tx packets: Number of packets transmitted via the BSSID.
Wired Users	• MAC Address: MAC address of the wired user. • IP address: IP address of the wired user.	• MAC Address: MAC address of the wired user. • IP address: IP address of the wired user. • Port: AP port used by the wired user.
Wireless User	• MAC Address: MAC address of the wireless user. • IP address: IP address of the wireless user.	• MAC Address: MAC address of the wired user. • IP address: IP address of the wired user. • SSID: Name of the SSID. • BSSID: BSSID of the wireless user. • Assoc State: Shows if the user is associated or just authorized. • Auth: Type of authentication: WPA, 802.1x, none, open, or shared. • Encryption: Encryption type used by the wireless user. • Band: Radio band used by the wireless client. • RSSI: The Receive Signal Strength Indicator (RSSI) value displayed in the output of this command represents signal strength as a signal to noise ratio.
Device Info	• Type: AP device/model type. • Name: Name assigned to the AP. • Wired MAC address: MAC address of the wired port. • Serial #: AP serial number. • Tunnel IP address: IP address of the tunnel between the AP and controller. • Software Version: Software version currently running on the AP. • Uptime: Amount of time the AP has been active since it was last reset. • Master: IP address of the master controller. • lms: IP address of the local controller.	N/A

Table 38 *RAP Console Summary Tab Information (Continued)*

Summary Table Name	Basic View Information	Advanced View Information
Uplink Info	The Uplink Info table can display some or all of the following information for your remote AP, depending upon whether a link is active and the number of links supported by the AP. Active uplink information, including: • Interface name • Port speed • IP address Standby link information, including: • Name (3G) • Device connected (yes/no) • Provisioned (yes/no) • IP address • Device • User • Password	N/A

Multihoming on remote AP (RAP)

You can uplink a RAP as an Ethernet or a USB based modem. These uplinks can be used as a backup link if the primary link fails. The uplink becomes active based on the order of the priority configured on the RAP. The RAP switches back to the primary link when the primary connection is restored.

For information on provisioning the RAP using the USB based modem, see , "Provisioning RAP at Home" on page 819.

Seamless failover from backup link to primary link on RAP

RAPs can failover from a backup link to a primary link without much disruption to traffic. Also the failover is performed only if the controller is reachable via the primary link.

Remote AP Connectivity

The information shown on the Connectivity tab will vary, depending upon the current status of the remote AP. If a remote AP has been successfully provisioned and connected, it should display some or all of the information in Table 39.

Table 39 *RAP Console Connectivity Tab Information*

Data	Description
Uplink status	Shows if the link connected failed. If the link is connected, the Uplink status also displays the name of the interface.
IP Information	If the AP has successfully received an IP address, this data row will show the AP's IP address, subnet mask, and gateway IP address.
Gateway Connectivity	If successful, this item also shows the percentage of packet loss for data received from the gateway
TPM Certificates	If successful, the AP has a Trusted Platform Module (TPM) certificate.
Master Connectivity	Shows if the AP was able to connect to the master controller. This item also shows the IP address to which the AP attempted to connect, and, if the AP did connect successfully, the link that was used to connect to that controller.

Table 39 *RAP Console Connectivity Tab Information (Continued)*

Data	Description
LMS Connectivity	Shows if the AP was able to connect to a local controller. This item also shows the IP address to which the AP attempted to connect, and, if the AP did connect successfully, the link that was used to connect to that controller.

The top of the Connectivity tab has a Refresh link that allows users to refresh the data on their screen. Additional information at the bottom of this tab shows the date, time and reason the remote AP last rebooted. The Reboot RAP Now button reboots the remote AP.

Remote AP Diagnostics

Use the Diagnostics tab to view log files, or run diagnostic tests that can help the IT department troubleshoot errors. You can also use the Reboot AP Now button at the bottom of the Diagnostic window reboots the remote AP.

To run a diagnostic test on a remote AP:

1. Access the RAP console, and click the Diagnostics tab
2. Click the Test drop-down list and select Ping, Traceroute, NSLookup or Throughput.

   The *ping* and *traceroute* tests require that you enter a network destination in the form of an IP address or fully-qualified domain name, and select either bridge or tunnel mode for the test. The *NSLookup* diagnostic test requires that you enter a destination only. The *throughput* test checks the throughput of the link between the AP and the controller, and does not require any additional test configuration settings.
3. Click OK to start the test. The results of the test will appear in the Diagnostics window.

To display log files in a separate browser window, click the logs drop-down list at the upper right corner of the Diagnostics window, and select any of the log file name. The type of log files available will vary, depending upon your remote AP configuration.

Enabling Double Encryption

The double encryption feature applies only for traffic to and from a wireless client that is connected to a tunneled SSID. When this feature is enabled, all traffic (which is already encrypted using Layer-2 encryption) is re-encrypted in the IPSec tunnel. When this feature is disabled, the wireless frame is only encapsulated inside the IPSec tunnel.

All other types of data traffic between the controller and the AP (wired traffic and traffic from a split-tunneled SSID) are always encrypted in the IPSec tunnel.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration > AP Specific page. Click Edit for the remote AP.
2. Under Profiles, select AP, then select AP system profile.
3. Under Profile Details, select the AP system profile for this AP from the drop-down menu. Select Double Encrypt. Click Apply.

Using CLI

```
ap system-profile <profile>
   double-encrypt
ap-name <name>
   ap-system-profile <profile>
```

NOTE: Dell recommends that double-encryption not be turned on for inter-device communication over untrusted networks, as doing so is redundant and adds significant processing overhead for APs.

Advanced Configuration Options

This section describes the following features designed to enhance your remote AP configuration:

NOTE: The information in this section assumes you have already configured the remote AP functionality, as described "Configuring the Secure Remote Access Point Service" on page 180.

Understanding Remote AP Modes of Operation

Table 40 summarizes the different remote AP modes of operation. You specify both the forward mode setting (which controls whether 802.11 frames are tunneled to the controller using GRE, bridged to the local Ethernet LAN, or a combination thereof) and the remote AP mode of operation (when the virtual AP operates on a remote AP) in the virtual AP profile.

The column on the left of the table lists the remote AP operation settings. The row across the top of the table lists the forward mode settings. To understand how these settings work in concert, scan the desired remote AP operation with the forward mode setting and read the information in the appropriate table cell.

The "all" column and row lists features that all remote AP operation and forward mode settings have in common regardless of other settings. For example, at the intersection of "all" and "bridge," the description outlines what happens in bridge mode regardless of the remote AP mode of operation.

NOTE: 802.1x and PSK authentication is supported when you configure the remote AP to operate in bridge or split-tunnel mode.

Table 40 *Remote AP Modes of Operation and Behavior*

Remote AP Operation Setting	Forward Mode Setting				
	all	bridge	split-tunnel	tunnel	decrypt-tunnel
all		Management frames on AP. Frames are bridged between wired and wireless interfaces. No frames are tunneled to the controller. Station acquires its IP address locally from an external DHCP server.	Management frames on AP. Frames are either GRE tunneled to the controller to a trusted tunnel or NATed and bridged on the wired interface according to user role and session ACL. Typically, the station obtains an IP address from a VLAN on the controller. Typically, the AP has ACLs that forward corporate traffic through the tunnel and source NAT the non-corporate traffic to the Internet.	Frames are GRE tunneled to the controller to an untrusted tunnel. 100% of station frames are tunneled to the controller.	Management frames on AP. Frames are always GRE tunneled to controller.
always	ESSID is always up when the AP is up regardless if the controller is reachable. Supports PSK ESSID only. SSID configuration stored in flash on AP.	Provides an SSID that is always available for local access.	Not supported	Not supported	Not supported
	all	bridge	split-tunnel	tunnel	
backup	ESSID is only up when controller is unreachable. Supports PSK ESSID only. SSID configuration stored in flash on AP.	Provides a backup SSID for local access only when the controller is unreachable.	Not supported	Not supported	Not supported

Table 40 *Remote AP Modes of Operation and Behavior (Continued)*

Remote AP Operation Setting	Forward Mode Setting				
persistent	ESSID is up when the AP contacts the controller and stays up if connectivity is disrupted with the controller. SSID configuration obtained from the controller. Designed for 802.1x SSIDs.	Same behavior as standard, described below, except the ESSID is up if connectivity to the controller is lost.	Not supported	Not supported	Not supported
standard	ESSID is up only when there is connectivity with the controller. SSID configuration obtained from the controller.	Behaves like a classic Dell branch office AP. Provides a bridged ESSID that is configured from the controller and stays up if there is controller connectivity.	Split tunneling mode.	Classic Dell thin AP operation.	Decrypt tunnel mode

Fallback Mode

The fallback mode (also known as backup configuration) operates the remote AP if the master controller or the configured primary and backup LMS are unreachable. The remote AP saves configuration information that allows it to operate autonomously using one or more SSIDs in local bridging mode while supporting open association or encryption with PSKs. You can also use the backup configuration if you experience network connectivity issues, such as the WAN link or the central data center becomes unavailable. With the backup configuration, the remote site does not go down if the WAN link fails or the data center is unavailable.

You define the backup configuration in the virtual AP profile on the controller. The remote AP checks for configuration updates each time it establishes a connection with the controller. If the remote AP detects a change, it downloads the configuration changes.

The following remote AP backup configuration options define when the SSID is advertised (refer to Table 40 for more information):

- Always—Permanently enables the virtual AP. Recommended for bridge SSIDs.
- Backup—Enables the virtual AP if the remote AP cannot connect to the controller. This SSID is advertised until the controller is reachable. Recommended for bridge SSIDs.
- Persistent—Permanently enables the virtual AP after the remote AP initially connects to the controller. Recommended for 802.1x SSIDs.
- Standard—Enables the virtual AP when the remote AP connects to the controller. Recommended for 802.1x, tunneled, and split-tunneled SSIDs. This is the default behavior.

While using the backup configuration, the remote AP periodically retries its IPSec tunnel to the controller. If you configure the remote AP in backup mode, and a connection to the controller is re-established, the remote AP stops using the backup configuration and immediately brings up the standard remote AP configuration. If you configure the remote AP in always or persistent mode, the backup configuration remains active after the IPSec tunnel to the controller has been re-established.

Backup Configuration Behavior for Wired Ports

If the connection between remote AP and the controller is disconnected, the remote AP will be exhibit the following behavior:

- All access ports on the remote AP, irrespective of their original forwarding mode will be moved to bridge forwarding mode.
- Clients will receive IP address from the remote AP's DHCP server.
- Client will have complete access to Remote AP's uplink network. You cannot enforce or modify any access control policies on the clients connected in this mode.

This section describes the following topics:

Configuring the fallback mode

To configure the fallback mode, you must

- Configure the AAA profile.
- Configure the virtual AP profile

Using WebUI to configure the AAA profile

The AAA profile defines the authentication method and the default user role for unauthenticated users.

NOTE: 802.1x and PSK authentication is supported when configuring bridge or split tunnel mode.

1. Navigate to the Security > Authentication > AAA Profiles page. From the AAA Profiles Summary list, click Add.
2. Enter the AAA profile name, then click Add.
3. Select the AAA profile that you just created:
   a. For Initial role, select the appropriate role (for example, "logon").
   b. For 802.1X Authentication Default Role, select the appropriate role (for example, "default"), then click Apply.
   c. Under the AAA profile that you created, locate 802.1x Authentication Server Group, and select the authentication server group to use (for example "default"), then click Apply.

NOTE: If you need to create an 802.1x authentication server group, select new from the 802.1X Authentication Server Group drop-down list, and enter the appropriate parameters.

   d. Under the AAA profile that you created, locate 802.1X Authentication Profile, and select the profile to use (for example, "default"), then click Apply.

NOTE: If you need to create an 802.1x authentication profile, select new from the 802.1X Authentication Profile drop-down list, and enter the appropriate parameters.

Using CLI

```
aaa profile <name>
   initial-role <role>
   authentication-dot1x <dot1x-profile>
   dot1x-default-role <role>
   dot1x-server-group <group>
```

Using the WebUI to configure virtual AP profile

To configure virtual AP profile:

- Set the remote AP operation to “always,” “backup,” or “persistent.”
- Create and apply the applicable SSID profile.

  The SSID profile for the backup configuration in always, backup, or persistent mode must be a bridge SSID. When configuring the virtual AP profile, specify forward mode as “bridge.”

  The SSID profile for the backup configuration in standard mode can be a bridge, tunnel, or split tunnel SSID. When configuring the virtual AP profile, specify forward mode as “bridge,” “tunnel,” or “split tunnel.”

NOTE: When creating a new virtual AP profile In the WebUI, you can also configure the SSID at the same time. For information about AP profiles, see “AP Configuration Profiles” on page 110.

1. Navigate to the Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
2. Under Profiles, select Wireless LAN, then Virtual AP.
3. To create a new virtual AP profile in the WebUI, select New from the Add a profile drop-down menu. Enter the name for the virtual AP profile, and click Add.

NOTE: Whenever you create a new virtual AP profile in the WebUI, the profile automatically contains the “default” SSID profile with the default ESSID. You must configure a new ESSID and SSID profile for the virtual AP profile before you apply the profile.

   a. In the Profile Details entry for the new virtual AP profile, go to the AAA Profile drop-down list and select the previously configured AAA profile (for example, “logon”). The AAA Profile pop-up window appears.
   b. To set the AAA profile and close the pop-up window, Click Apply.
   c. In the Profile Details entry for the new virtual AP profile, select NEW from the SSID Profile drop-down menu. The SSID Profile pop-up window displays to allow you to configure the SSID profile.
   d. Enter the name for the SSID profile (for example, “backup”).
   e. Under Network, enter a name in the Network Name (SSID) field (for example, “backup-psk”).
   f. Under Security, select the network authentication and encryption methods (for example, wpa-psk-tkip, with the passphrase “remote123”).
   g. To set the SSID profile and close the pop-up window, click Apply.
4. At the bottom of the Profile Details window, Click Apply.
5. Click the new virtual AP name in the Profiles list or the Profile Details to display configuration parameters.
6. Under Profile Details, do the following:
   a. Make sure Virtual AP enable is selected.
   b. From the VLAN drop-down menu, select the VLAN ID to use for the virtual AP profile.
   c. From the Forward mode drop-down menu, select bridge.
   d. From the Remote-AP Operation drop-down menu, select always, backup, or persistent. The default is standard. Click Apply.

Using CLI

```
wlan ssid-profile <profile>
   essid <name>
   opmode <method>
```

```
   wpa-passphrase <string> (if necessary)

wlan virtual-ap <name>
   ssid-profile <profile>
   vlan <vlan>
   forward-mode bridge
   aaa-profile <name>
   rap-operation {always|backup|persistent}

ap-group <name>
   virtual-ap <name>
```

or

```
ap-name <name>
virtual-ap <name>
```

Configuring the DHCP Server on the Remote AP

You can configure the internal DHCP server on the remote AP to provide an IP address for the "backup" SSID if the controller is unreachable. If configured, the remote AP DHCP server intercepts all DHCP requests and assigns an IP address from the configured DHCP pool.

To configure the remote AP DHCP server:

- Enter the VLAN ID for the remote AP DHCP VLAN in the AP system profile. This VLAN enables the DHCP server on the AP (also known as the remote AP DHCP server VLAN). If you enter the native VLAN ID, the DHCP server is not configured and is unavailable.
- Specify the DHCP IP address pool and netmask. By default, the AP assigns IP addresses from the DHCP pool 192.168.11.0/24, with an IP address range from 192.168.11.2 through 192.168.11.254. You can manually define the DHCP IP address pool and netmask based on your network design and IP address scheme.
- Specify the IP address of the DHCP server, DHCP router, and the DHCP DNS server. By default, the AP uses IP address 192.168.11.1 for the DHCP server, the DHCP router and the DHCP DNS server.
- Enter the amount of days the assigned IP address is valid (also known as the remote AP DHCP lease). By default, the lease does not expire, which means the IP address is always valid.
- Assign the VLAN ID for the remote AP DHCP VLAN to a virtual AP profile. When a client connects to that virtual AP profile, the AP assigns the IP address from the DHCP pool.

NOTE: The following is a high-level description of the steps required to configure the DHCP server on the remote AP. The steps assume you have already created the virtual AP profile, AAA profile, SSID profile, and other settings for your remote AP operation (for information about the backup configuration, see "Configuring the fallback mode" on page 197).

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP to display the AP profiles.
4. Select the AP system profile you want to modify.
5. Under Profile Details:
   a. At the LMS IP field, enter the LMS IP address.
   b. At the Master controller IP address field, enter the master controller IP address.
   c. At the Remote-AP DHCP Server VLAN field, enter the VLAN ID of the backup configuration virtual AP VLAN.

d. At the Remote-AP DHCP Server ID field, enter the IP address for the DHCP server.

e. At the Remote-AP DHCP Default Router field, enter the IP address for the default DHCP router.

f. At the Remote-AP DHCP DNS Server list, enter an IP address in the field to right and click Add. You can add multiple IP addresses the same way. To delete an IP address, select an IP address from the list and click Delete.

g. Specify the DHCP IP address pool. This configures the pool of IP addresses from which the remote AP uses to assign IP addresses.

—At the Remote-AP DHCP Pool Start field, enter the first IP address of the pool.

—At the Remote-AP-DHCP Pool End field, enter the last IP address of the pool.

—At the Remote-AP-DHCP Pool Netmask field, enter the netmask.

h. At the Remote-AP DHCP Lease Time field, specify the amount of time the IP address is valid.

6. Click Apply.
7. Under Profiles, select Wireless LAN, then Virtual AP, then the virtual AP profile you want to configure.
8. Under Profile Details, at the VLAN drop-list, select the VLAN ID of the remote AP DHCP VLAN, click the left arrow to move the VLAN ID to the VLAN field, and click Apply.

Using CLI

```
ap system-profile <name>
   lms-ip <ipaddr>
   master-ip <ipaddr>
   rap-dhcp-default-router <ipaddr>
   rap-dhcp-dns-server <ipaddr>
   rap-dhcp-lease <days>
   rap-dhcp-pool-end <ipaddr>
   rap-dhacp-pool-netmask <netmask>
   rap-dhcp-pool-start <ipaddr>
   rap-dhcp-server-id <ipaddr>
   rap-dhcp-server-vlan <vlan>

wlan virtual-ap <name>
   ssid-profile <profile>
   vlan <vlan>
   forward-mode bridge
   aaa-profile <name>
   rap-operation {always|backup|persistent}

ap-group <name>
   ap-system-profile <name>
   virtual-ap <name>
```

or

```
ap-name <name>
   ap-system-profile <name>
   virtual-ap <name>
```

Advanced Backup Configuration Options

You can also use the backup configuration (fallback mode) to allow the remote AP to pass through a captive portal, such as network access in a hotel, airport, or other public network, to access the corporate network. For this scenario:

- Define a session ACL for the bridge SSID to source NAT all user traffic, except DHCP. For example, use any any svc-dhcp permit followed by any any any route src-nat. Apply the session ACL to a remote AP user role.

- Configure the AAA profile. Make sure the initial role contains the session ACL previously configured.

  The AAA profile defines the authentication method and the default user role.

NOTE: 802.1x and PSK authentication is supported when configuring bridge or split tunnel mode.

- Configure the virtual AP profile for the backup configuration.
  - Set the remote AP operation to “always” or “backup.”
  - Create and apply the applicable SSID profile.
  - Configure a bridge SSID for the backup configuration. In the virtual AP profile, specify forward mode as “bridge.”

  For more information about the backup configuration, see “Configuring the fallback mode” on page 197.
- Enter the remote AP DHCP server parameters in the AP system profile. For more information about the parameters, see “Configuring the DHCP Server on the Remote AP” on page 199.

  If you use a local DHCP server to obtain IP addresses, you must define one additional ACL to permit traffic between clients without source NATing the traffic. Using the previously configured ACL, add user alias internal-network any permit before any any any route src-nat.
- Connect the remote AP to the available public network (for example, a hotel or airport network).

  The remote AP advertises the backup SSID so the wireless client can connect and obtain an IP address from the available DHCP server.

NOTE: The client can obtain an IP address from the public network, for example a hotel or airport, or from the DHCP server on the remote AP.

After obtaining an IP address, the wireless client can connect and access the corporate network and bring up the configured corporate SSIDs.

The following is a high-level description of what is needed to configure the remote AP to pass through a captive portal and access the corporate controller This information assumes you are familiar with configuring session ACLs, AAA profiles, virtual APs, and AP system profiles and highlights the modified parameters.

Using the WebUI to configure the session ACL

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to crete a new policy.
3. Enter the policy name in the Policy Name field.
4. From the Policy Type drop-down list, select IPv4 Session.
5. To create the first rule:
   a. Under Rules, click Add.
   b. Under Source, select any.
   c. Under Destination, select any.
   d. Under Service, select service. In the service drop-down list, select svc-dhcp.
   e. Under Action, select permit.
   f. Click Add.
6. To create the next rule:
   a. Under Rules, click Add.
   b. Under Source, select any.

c. Under Destination, select any.

d. Under Service, select any.

e. Under Action, select route, and select the src-nat checkbox.

f. Click Add.

7. Click Apply

NOTE: If you use a local DHCP server to obtain IP addresses, you must define one additional ACL to permit traffic between clients without source NATing the traffic. Add user alias internal-network any permit before any any any route src-nat.

8. Click the User Roles tab.

a. Click Add.

b. Enter the Role Name.

c. Click Add under Firewall Policies.

d. In the Choose from Configured Policies menu, select the policy you just created.

e. Click Done.

Using the WebUI to configure the AAA profile

1. Navigate to the Security > Authentication > AAA Profiles page. From the AAA Profiles Summary list, click Add.
2. Enter the AAA profile name, then click Add.
3. Select the AAA profile that you just created:

a. For Initial role, select the user role you just created.

b. For 802.1X Authentication Default Role, select the appropriate role for your remote AP configuration, then click Apply.

c. Under the AAA profile that you created, locate 802.1x Authentication Server Group, and select the authentication server group to use for your remote AP configuration, then click Apply.

NOTE: If you need to create an 802.1x authentication server group, select new from the 802.1X Authentication Server Group drop-down list, and enter the appropriate parameters.

d. Under the AAA profile that you created, locate 802.1X Authentication Profile, and select the profile to use for your remote AP configuration, then click Apply.

Using the WebUI to define the backup configuration

1. Navigate to the Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
2. Under Profiles, select Wireless LAN, then Virtual AP.
3. To create a new virtual AP profile in the WebUI, select New from the Add a profile drop-down menu. Enter the name for the virtual AP profile, and click Add.

NOTE: Whenever you create a new virtual AP profile in the WebUI, the profile automatically contains the “default” SSID profile with the default ESSID. You must configure a new ESSID and SSID profile for the virtual AP profile before you apply the profile.

a. In the Profile Details entry for the new virtual AP profile, go to the AAA Profile drop-down list and select the previously configured AAA profile. The AAA Profile pop-up window appears.

b. To set the AAA profile and close the pop-up window, Click Apply.
c. In the Profile Details entry for the new virtual AP profile, select NEW from the SSID Profile drop-down menu. The SSID Profile pop-up window displays to allow you to configure the SSID profile.
d. Enter the name for the SSID profile.
e. Under Network, enter a name in the Network Name (SSID) field.
f. Under Security, select the network authentication and encryption methods.
g. To set the SSID profile and close the pop-up window, click Apply.

4. At the bottom of the Profile Details window, Click Apply.
5. Click the new virtual AP name in the Profiles list or the Profile Details to display configuration parameters.
6. Under Profile Details, do the following:
   a. Make sure Virtual AP enable is selected.
   b. From the VLAN drop-down menu, select the VLAN ID to use for the Virtual AP profile.
   c. From the Forward mode drop-down menu, select bridge.
   d. From the Remote-AP Operation drop-down menu, select always or backup.
   e. Click Apply.
7. Under Profiles, select AP, then AP system profile.
8. Under Profile Details, do the following:
   a. Select the AP system profile to edit.
   b. At the LMS IP field, enter the LMS IP address.
   c. At the Master controller IP address field, enter the master controller IP address.
   d. Configure the Remote-AP DHCP Server fields.
   e. Click Apply.

Using the CLI to configure the session ACL

```
ip access-list session <policy>
   any any svc-dhcp permit
   any any any route src-nat
```

If you use a local DHCP server to obtain IP addresses, you must define one additional ACL to permit traffic between clients without source NATing the traffic. Add user alias internal-network any permit before any any any route src-nat.

```
user-role <role>
   session-acl <policy>
```

Using the CLI to configure the AAA profile

```
aaa profile <name>
   initial-role <role>
```

You can define other parameters as needed.

Using the CLI to define the backup configuration

```
wlan ssid-profile <profile>
   essid <name>
   opmode <method>
   wpa-passphrase <string> (if necessary)

wlan virtual-ap <name>
   ssid-profile <profile>
   vlan <vlan>
```

```
      forward-mode bridge
      aaa-profile <name>
      rap-operation {always|backup}

   ap system-profile <name>
      lms-ip <ipaddr>
      master-ip <ipaddr>
      rap-dhcp-default-router <ipaddr>
      rap-dhcp-dns-server <ipaddr>
      rap-dhcp-lease <days>
      rap-dhcp-pool-end <ipaddr>
      rap-dhacp-pool-netmask <netmask>
      rap-dhcp-pool-start <ipaddr>
      rap-dhcp-server-id <ipaddr>
      rap-dhcp-server-vlan <vlan>

   ap-group <name>
      virtual-ap <name>
      ap-system-profile <name>
```

or

```
   ap-name <name>
      virtual-ap <name>
      ap-system-profile <name>
```

DNS Controller Setting

In addition to specifying IP addresses for controllers, you can also specify the master DNS name for the controller when provisioning the remote AP. The name must be resolved to an IP address when attempting to setup the IPSec tunnel. For information on how to configure a host name entry on the DNS server, refer to the vendor documentation for your server. Dell recommends using a maximum of 8 IP addresses to resolve a controller name.

If the remote AP gets multiple IP addresses responding to a host name lookup, the remote AP can use one of them to establish a connection to the controller. For more detailed information, see the next section "Backup Controller List" on page 205.

Specifying the name also lets you move or change remote AP concentrators without reprovisioning your APs. For example, in a DNS load-balancing model, the host name resolves to a different IP address depending on the location of the user. This allows the remote AP to contact the controller to which it is geographically closest.

The DNS setting is part of provisioning the AP. The easiest way to provision an AP is to use the Provisioning page in the WebUI. These instructions assume you are only modifying the controller information in the Master Discovery section of the Provision page.

NOTE: Reprovisioning the AP causes it to automatically reboot.

Specify the DNS name using the WebUI

1. Navigate to the Configuration > Wireless > AP Installation > Provisioning page. Select the remote AP and click Provision.
2. Under Master Discovery enter the master DNS name of the controller.
3. Click Apply and Reboot.

For more information, see "Provision the AP" on page 187.

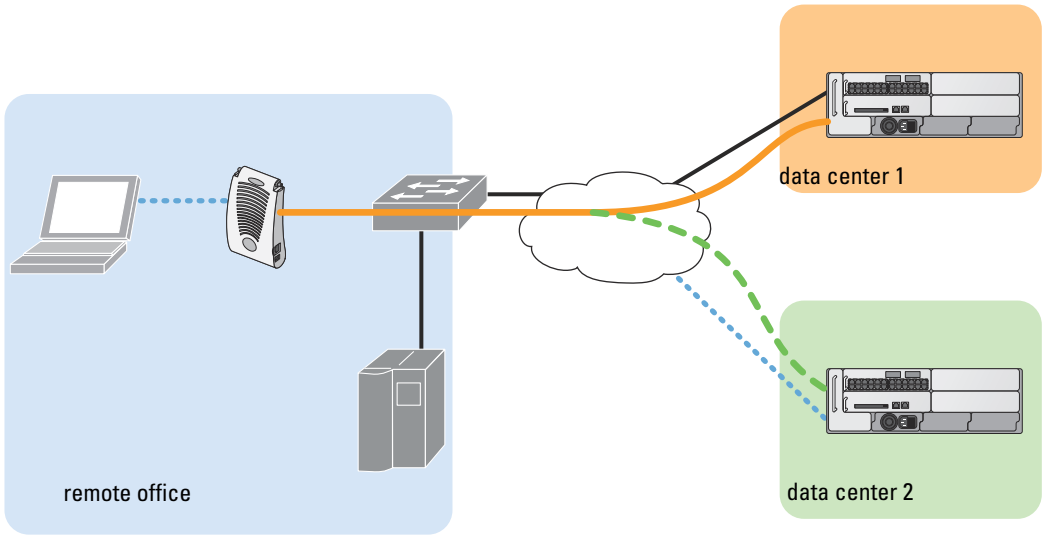
Backup Controller List

Using DNS, the remote AP receives multiple IP addresses in response to a host name lookup. Known as the backup controller list, remote APs go through this list to associate with a controller. If the primary controller is unavailable or does not respond, the remote AP continues through the list until it finds an available controller. This provides redundancy and failover protection.

If the remote AP loses connectivity on the IPSec tunnel to the controller, the remote AP establishes connectivity with a backup controller from the list and automatically reboots. Network connectivity is lost during this time. As described in the section "Remote AP Failback" on page 206, you can also configure a remote AP to revert back to the primary controller when it becomes available. To complete this scenario, you must also configure the LMS IP address and the backup LMS IP address.

For example, assume you have two data centers, data center 1 and data center 2, and each data center has one master controller in the DMZ. You can provision the remote APs to use the controller in data center 1 as the primary controller, and the controller in data center 2 as the backup controller. If the remote AP loses connectivity to the primary, it will attempt to establish connectivity to the backup. You define the LMS parameters in the AP system profile.

Figure 31 Sample Backup Controller Scenario



Configuring the LMS and backup LMS IP addresses using WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP to display the AP profiles.
4. Select the AP system profile you want to modify.
5. Under Profile Details:
   a. At the LMS IP field, enter the primary controller IP address.
   b. At the Backup LMS IP field, enter the backup controller IP address.
6. Click Apply.

Configuring the LMS and Backup LMS IP Addresses Using CLI

```
ap system-profile <profile>
   lms-ip <ipaddr>
   bkup-lms-ip <ipaddr>
```

```
ap-group <group>
   ap-system-profile <profile>

ap-name <name>
   ap-system-profile <profile>
```

Remote AP Failback

In conjunction with the backup controller list, you can configure remote APs to revert back (failback) to the primary controller if it becomes available. If you do not explicitly configure this behavior, the remote AP will keep its connection with the backup controller until the remote AP, controller, or both have rebooted or some type of network failure occurs. If any of these events occur, the remote AP will go through the backup controller list and attempt to connect with the primary controller.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP to display the AP profiles.
4. Select the AP system profile you want to modify.
5. Under Profile Details:
   a. Click (select) LMS Preemption. This is disabled by default.
   b. At the LMS Hold-down period field, enter the amount of time the remote AP must wait before moving back to the primary controller.
6. Click Apply.

Using the CLI

```
ap system-profile <profile>
   lms-preemption
   lms-hold-down period <seconds>
```

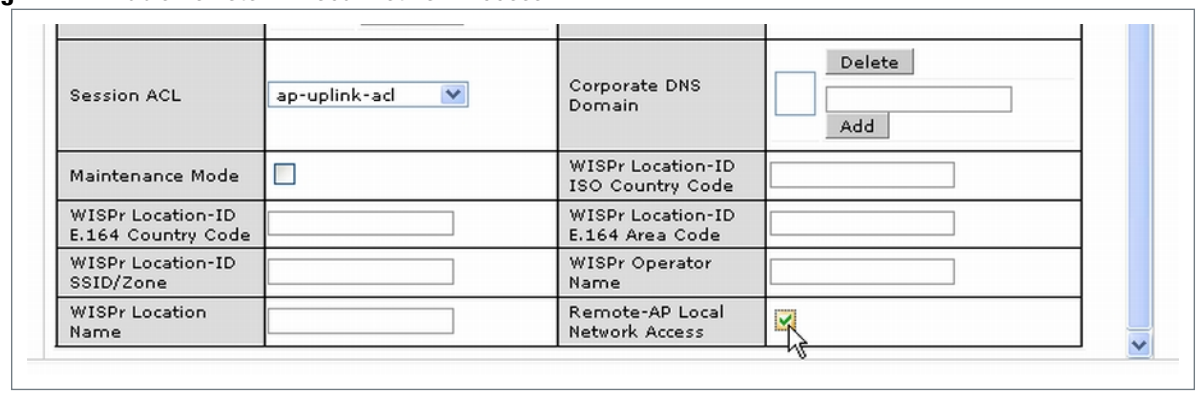
RAP Local Network Access

You can enable local network access between the clients (from same or different subnets and VLANs) connected to a RAP through wired or wireless interfaces in split-tunnel/bridge forwarding modes. This allows the clients to effectively communicate with each other without routing the traffic via the controller. You can use CLI or the WebUI to enable the local network access.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select the AP Group tab. Click Edit for the AP group or AP name.
3. Under Profiles, expand the **AP menu,** then select **AP system profile**.
4. To enable remote network access, select the Remote-AP Local Network Access check box.

Figure 32 *Enable Remote AP Local Network Access*



5. Click Apply.

Using CLI

- To enable, enter:

```
ap system-profile <ap-profile> rap-local-network-access
```

- To disable, enter:

```
ap system-profile <ap-profile> no rap-local-network-access
```

See the for detailed information on the command options.

Remote AP Authorization Profiles

Remote AP configurations include an authorization profile that specifies which profile settings should be assigned to a remote AP that has been provisioned but not yet authenticated at the remote site. By default, these yet-unauthorized APs are put into the temporary AP group authorization-group and assigned the predefined profile NoAuthApGroup. This configuration allows the user to connect to an unauthorized remote AP via a wired port then enter a corporate username and password. Once a valid user has authorized the AP and the remote AP will be marked as authorized on the network. The remote AP will then download the configuration assigned to that AP by it's permanent AP group.

Add or Edit a Remote AP Authorization Profile

To create a new authorization profile or edit an existing authorization profile via the WebUI:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select AP to expand the AP profile menu.
3. Select AP Authorization Profile. The Profile Details pane appears and displays the list of existing AP authorization profiles.
   - To edit an existing profile, select a profile from from the Profile Details pane.
   - To create a new authorization profile, enter a new profile name in the entry blank on the Profile Details pane, then click Add.
4. The Profile Details window will display the AP group currently defined for that authorization profile. To select a new AP group, click the drop-down list and select a different AP group name.
5. Click Apply to save your changes.

To create a new authorization profile or edit an existing authorization profile via the command-line interface, access the command-line interface in enable mode, and issue the following commands.

```
ap authorization-profile <profile>
   authorization-group <ap-group>
```

Access Control Lists and Firewall Policies

Remote APs support the following access control lists (ACLs); unless otherwise noted, you apply these ACLS to user roles:

- Standard ACLs—Permit or deny traffic based on the source IP address of the packet.
- Ethertype ACLs—Filter traffic based on the Ethertype field in the frame header.
- MAC ACLs—Filter traffic on a specific source MAC address or range of MAC addresses.
- Firewall policies (session ACLs)—Identifies specific characteristics about a data packet passing through the Dell controller and takes some action based on that identification. You apply these ACLs to user roles or uplink ports.

NOTE: To configure firewall policies, you must install the PEFNG license.

For more information about ACLs and firewall policies, see "Configuring the fallback mode" on page 197.

Split Tunneling

The split tunneling feature allows you to optimize traffic flow by directing only corporate traffic back to the controller, while local application traffic remains local. This ensures that local traffic does not incur the overhead of the round trip to the controller, which decreases traffic on the WAN link and minimizes latency for local application traffic. This is useful for sites that have local servers and printers. With split tunneling, a remote user associates with a single SSID, not multiple SSIDs, to access corporate resources (for example, a mail server) and local resources (for example, a local printer). The remote AP examines session ACLs to distinguish between corporate traffic destined for the controller and local traffic.

Figure 33 Sample Split Tunnel Environment

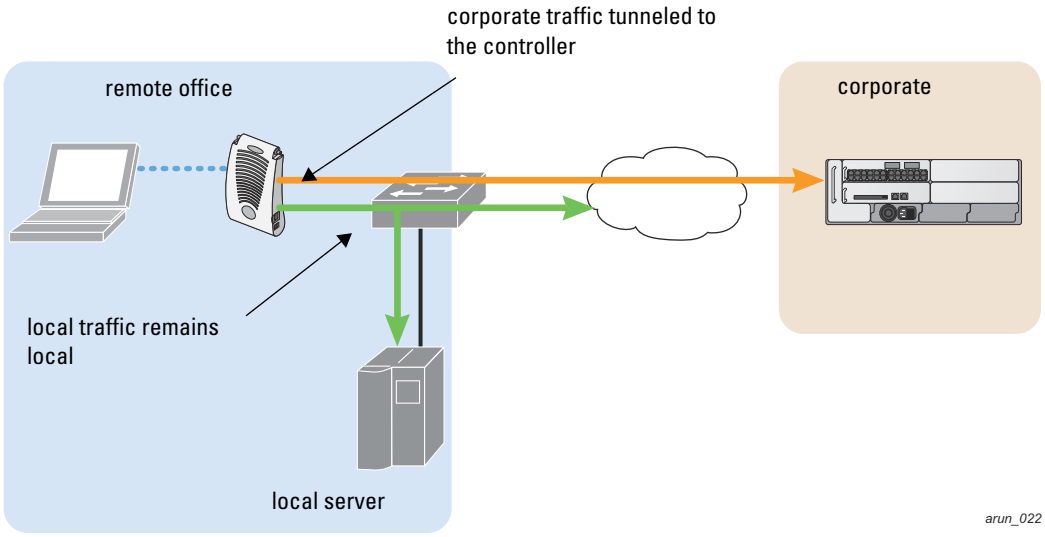


Figure 33 displays corporate traffic is GRE tunneled to the controller through a trusted tunnel and local traffic is source NATed and bridged on the wired interface based on the configured user role and session ACL.

Configuring Split Tunneling

To configure split tunneling:

- Define a session ACL that forwards only corporate traffic to the controller.
  - Configure a netdestination for the corporate subnets.

- Create rules to permit DHCP and corporate traffic to the corporate controller. When specifying the action that you want the controller to perform on a packet that matches the specified criteria, “permit” implies tunneling, which is used for corporate traffic, and “route” implies local bridging, which is used for local traffic.

  You must install the PEFNG license in the controller. For information about user roles and policies, see Chapter 12, “Roles and Policies” .
- Apply the session ACL to a user role.

- Configure the AAA profile.

  The AAA profile defines the authentication method and the default user role for authenticated users. The configured user role contains the split ACL.

NOTE: 802.1x and PSK authentication is supported when configuring split tunnel mode.

- Configure the virtual AP profile:

  When configuring the virtual AP profile, you specify which AP group or AP the profile applies to.
  - Set the VLAN used for split tunneling. Only one VLAN can be configured for split tunneling; VLAN pooling is not allowed.
  - When specifying the use of a split tunnel configuration, use “split-tunnel” forward mode.
  - Create and apply the applicable SSID profile.

NOTE: When creating a new virtual AP profile In the WebUI, you can also configure the SSID at the same time. For information about AP profiles, see “AP Configuration Profiles” on page 110 .

- Optionally, create a list of network names resolved by corporate DNS servers.

  Clients send DNS requests to the corporate DNS server address that it learned from DHCP. If configured for split tunneling, corporate domains and traffic destined for corporate use the corporate DNS server. For non-corporate domains and local traffic, other DNS servers can be used.

Configuring the Session ACL

First you need to configure the session ACL. By applying this policy, local traffic remains local, and corporate traffic is forwarded (tunneled) to the controller.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to crete a new policy.
3. Enter the policy name in the Policy Name field.
4. From the Policy Type drop-down list, select Session.
5. From the IP Version drop-down list, select IPv4 or IPv6.
6. To create the first rule:
   a. Under Rules, click Add.
   b. Under Source, select any.
   c. Under Destination, select any.
   d. Under Service, select service. In the service drop-down list, select svc-dhcp.
   e. Under Action, select permit for IPv4 or captive for IPv6.

f. Click Add.

7. To create the next rule:
   a. Under Rules, click Add.
   b. Under Source, select any.
   c. Under Destination, select alias.

      The following steps define an alias representing the corporate network. Once defined, you can use the alias for other rules and policies. You can also create multiple destinations the same way.
8. Under the alias section, click New. Enter a name in the Destination Name field.
   a. Click Add.
   b. For Rule Type, select Network.
   c. Enter the public IP address of the controller.
   d. Enter the Network Mask/Range.
   e. Click Add to add the network range.
   f. Click Apply. The new alias appears in the Destination menu.
9. Under Destination, select the alias you just created.
10. Under Service, select any.
11. Under Action, select permit for IPv4 or captive for IPv6.
12. Click Add.
13. To create the next rule:
   a. Under Rules, click Add.
   b. Under Source, select user.
   c. Under Destination, select any.
   d. Under Service, select any.
   e. Under Action, select any and check src-nat.
   f. Click Add.
14. Click Apply.
15. Click the User Roles tab.
   a. Click Add to create and configure a new user role.
   b. Enter the desired name for the role in the Role Name field.
   c. Under Firewall Policies, click Add.
   d. From the Choose from Configured Policies drop-down menu, select the policy you just configured.
   e. Click Done.
16. Click Apply.

Using the CLI

```
netdestination <policy>
   network <ipaddr> <netmask>
   network <ipaddr> <netmask>

ip access-list session <policy>
   any any svc-dhcp permit
   any alias <name> any permit
   user any any route src-nat

user-role <role>
```

```
session-acl <policy>
```

When defining the alias, there are a number of other session ACLs that you can create to define the handling of local traffic, such as:

```
ip access-list session <policy>
   user alias <name> any redirect 0
   user alias <name> any route
   user alias <name> any route src-nat
```

Configuring ACL for restricted LD homepage access

A user in split or bridge role using a remote AP (RAP) can log on to the local debug (LD) homepage and perform a reboot or reset operations. The LD homepage provides various information about the RAP and also has a button to reboot the RAP. You can now restrict a RAP user from resetting or rebooting a RAP by using the new `localip` keyword in the in the user role ACL .

NOTE: You will require the PEF license to use this feature. See Chapter 34, "Software Licenses" for more information on licensing requirements.

Any user associated to that role can be allowed or denied access to the LD homepage. You can use the `localip` keyword in the ACL rule to identify the local IP address on the RAP. The `localip` keyword identifies the set of all local IP addresses on the system to which the ACL is applied. The existing keywords controller and `mswitch` indicate only the primary IP address on the controller.

Using CLI

Use the `localip` keyword in the user role ACL.

By default, all users have an ACL entry of type `any any deny`. This rule restricts access to all users. When the ACL is configured for a user role, if a `user any permit` ACL rule is configured, add a deny ACL before that for `localip` for restricting the user from accessing the LD homepage.

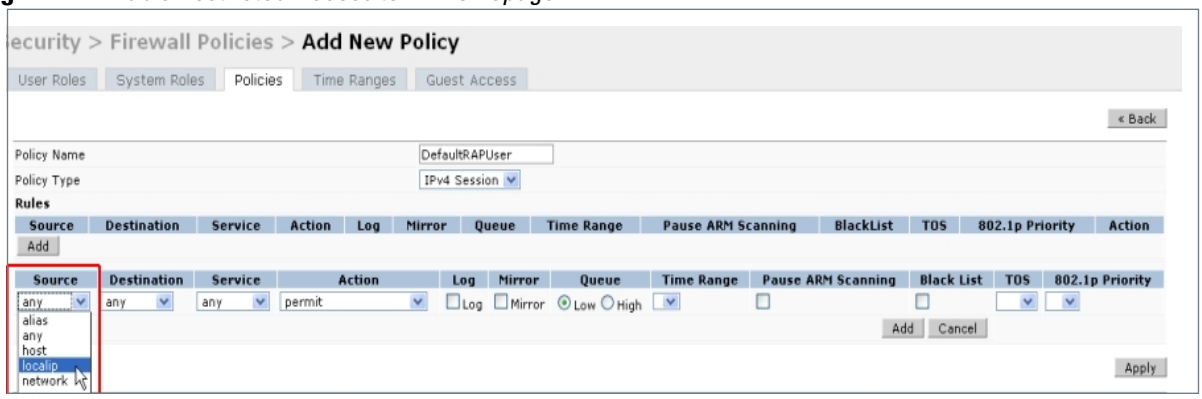
Example:

```
ip access-list session logon-control
   user localip svc-http deny
   user any permit
```

Using WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to crete a new policy.
3. Enter the policy name in the Policy Name field.
4. From the Policy Type drop-down list, select IPv4 Session.
5. To create the first rule:
   a. Under Rules, click Add.
   b. Under Source, select localip.
   c. Under Destination, select any.
   d. Under Action, select permit.
   e. Click Apply.

Figure 34 *Enable Restricted Access to LD Homepage*



Configuring the AAA Profile and the Virtual AP Profile

After you configure the session ACL, you define the AAA profile and virtual AP used for split tunneling. When defining the AAA parameters, specify the previously configured user role that contains the session ACL used for split tunneling.

Using the WebUI

1. Navigate to the Security > Authentication > AAA Profiles page. From the AAA Profiles Summary list, click Add.
2. Enter the AAA profile name, then click Add.
3. Select the AAA profile that you just created:
   a. For 802.1X Authentication Default Role, select the user role you previously configured for split tunneling, then click Apply.
   b. Under the AAA profile that you created, locate 802.1x Authentication Server Group, and select the authentication server group to use, then click Apply.

If you need to create an authentication server group, select new and enter the appropriate parameters.

Using CLI

```
aaa profile <name>
   authentication-dot1x <dot1x-profile>
   dot1x-default-role <role>
   dot1x-server-group <group>
```

Configuring split tunneling in the virtual AP profile

1. Navigate to Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the applicable AP group name or AP name.
2. Under Profiles, select Wireless LAN, then Virtual AP.
3. To create a new virtual AP profile in the WebUI, select New from the Add a profile drop-down menu. Enter the name for the virtual AP profile, and click Add.

NOTE: Whenever you create a new virtual AP profile in the WebUI, the profile automatically contains the "default" SSID profile with the default ESSID. You must configure a new ESSID and SSID profile for the virtual AP profile before you apply the profile.

   a. In the Profile Details entry, go to the AAA Profile drop-down list and select the previously configured AAA profile. The AAA Profile pop-up window appears.
   b. To set the AAA profile and close the window, click Apply.

c. In the Profile Details entry for the new virtual AP profile, select NEW from the SSID Profile drop-down menu. A pop-up window displays to allow you to configure the SSID profile.

d. Enter the name for the SSID profile.

e. Under Network, enter a name in the Network Name (SSID) field.

f. Under Security, select the network authentication and encryption methods.

g. To set the SSID profile and close the window, click Apply.

4. Click Apply at the bottom of the Profile Details window.
5. Click the new virtual AP name in the Profiles list or the Profile Details to display configuration parameters.
6. Under Profile Details:
   a. Make sure Virtual AP enable is selected.
   b. From the VLAN drop-down menu, select the VLAN ID for the VLAN to be used for split tunneling.
   c. From the Forward mode drop-down menu, select split-tunnel.
   d. Click Apply.

Using the CLI to configure split tunneling in the virtual AP profile

```
wlan ssid-profile <profile>
   essid <name>
   opmode <method>

wlan virtual-ap <profile>
   ssid-profile <name>
   forward-mode split-tunnel
   vlan <vlan id>
   aaa-profile <profile>

ap-group <name>
   virtual-ap <profile>
```

or

```
ap-name <name>
virtual-ap <profile>
```

Using the WebUI to list the corporate DNS servers

1. Navigate to Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. Under Profiles, select AP, then AP system profile.
4. Under Profile Details:
   a. Enter the corporate DNS servers.
   b. Click Add.

   The DNS name appears in Corporate DNS Domain list. You can add multiple names the same way.
5. Click Apply.

Using the CLI to list the corporate DNS servers

```
ap system-profile <profile>
   dns-domain <domain name>
```

Wi-Fi Multimedia

Wi-Fi Multimedia (WMM) is a Wi-Fi Alliance specification based on the IEEE 802.11e wireless Quality of Service (QoS) standard. WMM works with 802.11a, b, g, and n physical layer standards. The IEEE 802.11e standard also defines the mapping between WMM access categories (ACs) and Differentiated Services Codepoint (DSCP) tags. Remote APs support WMM.

WMM supports four ACs: voice, video, best effort, and background. You apply and configure WMM in the SSID profile.

When planning your configuration, make sure that immediate switches or routers do not have conflicting 802.1p or DSCP configurations/mappings. If this occurs, your traffic may not be prioritized correctly.

For more detailed information about WMM and the applicable configuration commands, see Chapter 36, "Voice and Video" .

Uplink Bandwidth Reservation

You can reserve and prioritize uplink bandwidth traffic to provide higher QoS for specific applications, traffic or ports. This is done by applying bandwidth reservation on existing session ACLs. Typically, the bandwidth reservation is applied for uplink voice traffic.

The following must be noted before you configure bandwidth reservation:

- You must know the total bandwidth available.
- The bandwidth reservation are applicable only on session ACLs.
- Bandwidth reservation on voice traffic ACLs receives higher priority over other reserved traffic.
- You can configure up to three unique priority for bandwidth reservation.
- The bandwidth reservation must be specified in absolute value (kbps).
- Priorities for bandwidth reservation are optional and bandwidth reservations without priorities will be treated equal.

Bandwidth Reservation for Uplink Voice Traffic

The voice ACLs are applicable on the voice signalling traffic used to establish voice call through a firewall. When a voice ACL is executed, a dynamic session is introduced to allow voice traffic through the firewall. This prevents the re-use of voice ACLs for bandwidth reservation. However, you can create bandwidth reservation rules that can be applied on voice signalling traffic and also on ports used for voice data traffic. This mechanism filters traffic as per the security requirements.

Configuring Bandwidth Reservation

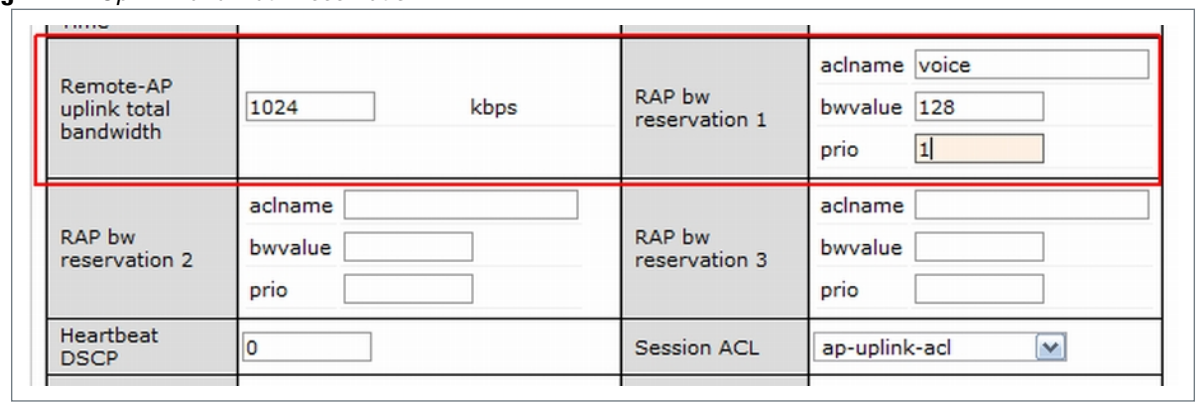
You can configure bandwidth reservation ACLs using CLI or the WebUI.

Using the WebUI

To configure bandwidth reservation

1. Navigate to Configuration > Advanced Services > All Profiles
2. Under *Profiles*, navigate to AP > AP System Profile. You can create a new AP system profile to configure bandwidth reservation or edit an existing AP system profile. Under the *Profile Details* page, specify bandwidth reservation values.

Figure 35 *Uplink Bandwidth Reservation*



Using CLI

```
(host) (config)#ap system-profile remotebw
(host) (AP system profile "remotebw") #rap-bw-total 1024
(host) (AP system profile "remotebw") #rap-bw-resv-1 acl voice 128 priority 1
```

To view bandwidth reservations:

```
(host) #show datapath rap-bw-resv ap-name remote-ap-1

RAP Uplink BW reservation statistics
------------------------------------
Pos: Acl     Resv Prio XmitPkts XmitByte   Marked Enqueued  Onqueue    Drops TokenFin
-------------------------------------------------------------------------------------
1  :  11      200    0        0        0        3        0        0        0         0
2  :   0        0    0        0        0        0        0        0        0         0
3  :   0        0    0        0        0        0        0        0        0         0
4  :   0        0    0     1524   370962        0     1524        0        0         0
```

Chapter 8

Secure Enterprise Mesh

The Dell secure enterprise mesh solution is an effective way to expand network coverage for outdoor and indoor enterprise environments without any wires. Using mesh, you can bridge multiple Ethernet LANs or you can extend your wireless coverage. As traffic traverses across mesh APs, the mesh network automatically reconfigures around broken or blocked paths. This self-healing feature provides increased reliability and redundancy: the network continues to operate if an AP stops functioning or a connection fails.

Dell controllers provide centralized configuration and management for APs in a mesh environment; local mesh APs provide encryption and traffic forwarding for mesh links. This chapter describes the Dell secure enterprise mesh architecture, in the following topics:

CAUTION: Dell strongly recommends staging mesh APs before you deploy them. Identify the physical location of the APs, configure them for mesh, provision the APs and verify connectivity before physically deploying them in a live network. For other pre-installation considerations, see "Before You Begin" on page 226.

Mesh Access Points

Mesh APs learn about their environment when they boot up. Mesh APs are either configured as a mesh portal (MPP), an AP that uses its wired interface to reach the controller, or a mesh point (MP), an AP that establishes an all-wireless path to the mesh portal. Mesh APs locate and associate with their nearest neighbor, which provides the best path to the mesh portal. Mesh portals and mesh points are also known as mesh nodes, a generic term used to describe APs configured for mesh.

A mesh radio's bandwidth can be shared between mesh-backhaul traffic and client traffic. You can, however, configure a radio for mesh services only. If you have a dual-radio AP, a mesh node can be configured to deliver client services on one radio and both mesh and WLAN services to clients on the other. If you configure a single-radio AP to deliver mesh services only (by disabling the mesh radio in its 802.11a or 802.11g radio profile) that mesh node will not deliver WLAN services to its clients.

For mesh as well as traditional thin AP deployments, the Dell controller provides centralized provisioning, configuration, policy definition, ongoing network management and wireless and security services. However, unlike the traditional thin AP case, mesh nodes also perform network traffic encryption and decryption, and packet forwarding over wired and wireless links.

You configure the AP for mesh on the controller using either the WebUI or the CLI. All mesh related configuration parameters are grouped into mesh profiles that you can apply as needed to an AP group or to individual APs.

By default, APs operate as thin APs, which means their primary function is to receive and transmit electromagnetic signals; other WLAN processing is left to the controller. When planning a mesh network, you manually configure APs to operate in mesh portal or mesh point roles. Unlike a traditional WLAN environment, local mesh nodes provide encryption and traffic forwarding for mesh links in a mesh environment. Virtual APs are still applied to non-mesh radios.

Provisioning mesh APs is similar to thin APs; however, there are some key differences. Thin APs establish a channel to the controller from which they receive the configuration for each radio interface. Mesh nodes, in contrast, get their radio interfaces up and running *before* making contact with the controller. This requires a minimum set of parameters from the AP group and mesh cluster that enables the mesh node to discover a neighbor to create a mesh link and subsequent channel with the controller. To do this, you must first define and configure the mesh cluster profile *before* configuring an AP to operate as a mesh node. This chapter first describes how to configure the mesh profile, then describes how to configure APs to operate in mesh mode. If you have already configured a complete mesh profile, continue to “Ethernet Ports for Mesh” or “Provisioning Mesh Nodes”.

Mesh Portals

The mesh portal (MPP) is the gateway between the wireless mesh network and the enterprise wired LAN. You configure an Dell AP to perform the mesh portal role, which uses its wired interface to establish a link to the wired LAN. You can deploy multiple mesh portals to support redundant mesh paths (mesh links between neighboring mesh points that establish the best path to the mesh portal) from the wireless mesh network to the wired LAN.

The mesh portal broadcasts the configured mesh service set identifier (MSSID/mesh cluster name), and advertises the mesh network service to available mesh points. Neighboring mesh points that have been provisioned with the same MSSID authenticate to the portal and establish a secure mesh link over which traffic is forwarded. The authentication process requires secure key negotiation, common to all APs, and the mesh link is established and secured using Advanced Encryption Standard (AES) encryption. Mesh portals also propagate channel information, including CSAs.

Mesh Points

The mesh point (MP) is an Dell AP configured for mesh and assigned the mesh point role. Depending on the AP model, configuration parameters, and how it was provisioned, the mesh point can perform multiple tasks. The mesh point provides traditional Dell WLAN services (such as client connectivity, intrusion detection system (IDS) capabilities, user role association, LAN-to-LAN bridging, and Quality of Service (QoS) for LAN-to-mesh communication) to clients and performs mesh backhaul/network connectivity. A mesh radio can be configured to carry mesh-backhaul traffic only. Additionally, a mesh point can provide LAN-to-LAN Ethernet bridging by sending tagged/untagged VLAN traffic across a mesh backhaul/network to a mesh portal.

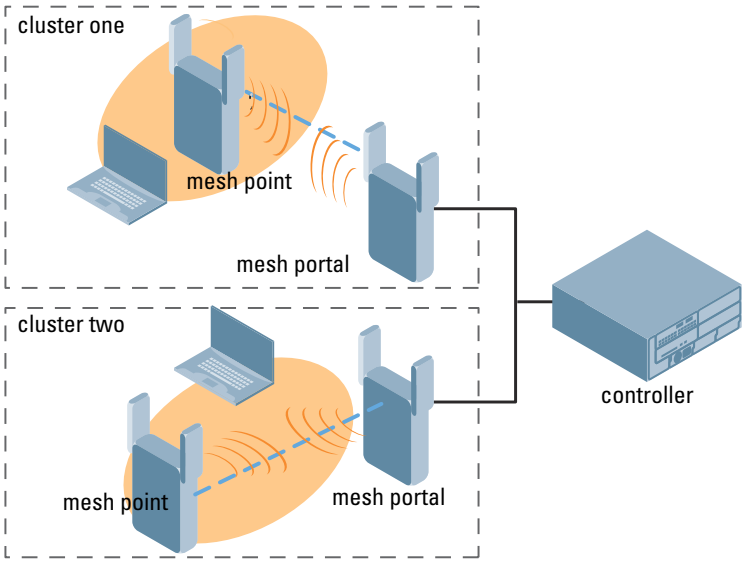
Mesh points use one of their wireless interfaces to carry traffic and reach the controller. Mesh points are also aware of potential neighbors and can form new mesh links if the current mesh link is no longer preferred or available.

Mesh Clusters

Mesh clusters are similar to an Extended-Service Set (ESS) in a WLAN infrastructure. A mesh cluster is a logical set of mesh nodes that share the common connection and security parameters required to create mesh links. Mesh clusters are grouped and defined by a mesh cluster profile, as described in “Mesh Cluster Profile”.

Mesh clusters may enforce predictability in mesh networking by limiting the amount of concurrent mesh points, hop counts, and bandwidth used in the mesh network. A mesh cluster can have multiple mesh portals and mesh points that facilitate wireless communication between wired LANs. Mesh portals in a mesh cluster do not need to be on the same VLAN. Figure 36 shows two mesh clusters and their relationship to the controller.

Figure 36 *Sample Mesh Clusters*



Mesh Links

In simple terms, the mesh link is the data link between a mesh point and its parent. A mesh point uses the parameters defined in the mesh cluster, specifically the mesh cluster profile, to establish a mesh link with a neighboring mesh point. The mesh link uses a series of metrics to establish the best path to the mesh portal.

NOTE: Through out the rest of this chapter, the term “uplink” is also used to distinguish the active association between a mesh point and its parent.

The following list describes how mesh links are created.

- Creating the initial mesh link

  When creating the initial mesh link, mesh points look for others advertising the same MSSID as the one contained in its mesh cluster profile. The mesh point scans the channels in its provisioned band of operation to identify a list of neighbors that match its mesh cluster profile. The mesh point then selects the from highest priority neighbors based on the least expected path cost.

  If no provisioned mesh cluster profile is unavailable, mesh points use the recovery profile to establish an uplink. If multiple cluster profiles are configured. mesh points search in order of priority their list of provisioned backup mesh cluster profiles to establish an uplink. If the configured profiles are unavailable after searching for 5 minutes, the recovery profile is used.

- Moving to a better mesh link

If the existing uplink quality degrades below the configured threshold, and a lower cost or more preferable uplink is available on the same channel and cluster, the mesh point reselects that link without re-scanning. In some cases, this invalidates all of the entries that have this mesh point as a next hop to the destination and triggers new learning of the bridge tables.

- Using a new mesh link if the current mesh link goes down

  If an uplink goes down, the affected mesh nodes re-establish a connection with the mesh portal by re-scanning to choose a new path to the mesh portal. If a mesh portal goes down, and a redundant mesh portal is available, the affected mesh nodes update their forwarding tables to reflect the path to the new mesh portal.

Link Metrics

Mesh points use the configured algorithm to compute a metric value, or "path cost," for each potential uplink and select the one with the lowest value as the optimal path to the mesh portal.Table 41 describes the components that make up the metric value: node cost, hop count, link cost and 802.11 capacity.

The link metrics indicate the relative cost of a path to the mesh portal. The best path (lowest metric value) is used to create the uplink.

Table 41 *Mesh Link Metric Computation*

Component	Description
Node cost	Indicates the amount of traffic expected to traverse the mesh node. The more traffic, the higher the node cost. When establishing a mesh link, nodes with less traffic take precedence. The node cost is dependent on the number of children a mesh node supports. It can change as the mesh network topology changes, for example if new children are added to the network or old children disconnect from the network.
Hop count	Indicates the number of hops it takes the mesh node to get to the mesh portal. The mesh portal advertises a hop count of 0, while all other mesh nodes advertise a cumulative count based on the parent mesh node.
Link cost	Represents the quality of the link to an active neighbor. The higher the Received Signal Strength Indication (RSSI), the better the path to the neighbor and the mesh portal. If the RSSI value is below the configured threshold, the link cost is penalized to filter marginal links. A less direct, higher quality link may be preferred over the marginal link. The following factors also affect mesh link metrics • High-throughput APs add a high cost penalty for links to non-high-throughput APs. • Multi-stream high-through APs add proportional cost penalties for links to high-throughput APs that support fewer streams.
802.11 capacity	High-throughput APs can send 802.11 information elements (IEs) in their management frames, allowing high-throughput mesh nodes to identify other mesh nodes with a high-throughput capacity. High-throughput mesh points prefer to select other 802.11-capable mesh points in their path to the mesh portal, but will use a legacy path if no high-throughput path is available.
Path Cost	Path cost is calculated by analyzing the other components in this table, and adding the link cost plus mesh parent's path cost plus the parent's node cost. Mesh portals typically advertise a path-cost of zero, but high-throughput portals will add an offset penalty if they are connected to a 10/100mbps port that is too slow to for the high-throughput link capacity.

Optimizing Links

You can configure and optimize operation of the link metric algorithm via the mesh radio profile. These configurable mesh link trigger thresholds can determine when the uplink or mesh path is dropped and another is chosen, provide enhanced network reliability, and contain flapping links. Although you can modify the behavior of the link metric algorithm, Dell recommends the default values for most deployments. For information, see "metric algorithm" on page 229.

Mesh Profiles

Mesh profiles help define and bring-up the mesh network. The following sections describe the mesh cluster, mesh radio, and mesh recovery profiles in more detail.

The complete mesh profile consists of a mesh radio profile, RF management (802.11a and 802.11g) radio profiles, a high-throughput SSID profile (if your deployment includes 802.11n-capable APs), a mesh cluster profile, and a read-only recovery profile. The recovery profile is dynamically generated by the master controller; you do not explicitly configure the recovery profile.

Dell provides a "default" version of the mesh radio, RF management, high-throughput SSID and cluster profiles with default values for most parameters. You can use the "default" version of a profile or create a new instance of a profile which you can then edit as you need. You can change the values of any parameter in a profile. You have the flexibility of applying the "default" versions of profiles in addition to customizing profiles that are necessary for the AP or AP group to function.

If you assign a profile to an individual AP, the values in the profile override the profile assigned to the AP group to which the AP belongs. The exception is the mesh cluster profile—you can apply multiple mesh cluster profiles to individual APs, as well as to AP groups.

Mesh Cluster Profile

Mesh clusters are grouped and defined by a mesh cluster profile, which provides the framework of the mesh network. Similar to virtual AP profiles, the mesh cluster profile contains the MSSID (mesh cluster name), authentication methods, security credentials, and cluster priority required for mesh nodes to associate with their neighbors and join the cluster. Associated mesh nodes store this information in flash memory. Although most mesh deployments will require only a single mesh cluster profile, you can configure and apply multiple mesh cluster profiles to an AP group or an individual AP. If you have multiple cluster profiles, the mesh portal uses the profile with the highest priority to bring up the mesh network. Mesh points, in contrast, go through the list of mesh cluster profiles in order of priority to decide which profile to use to associate themselves with the network. The mesh cluster priority determines the order by which the mesh cluster profiles are used. This allows you, rather than the link metric algorithm, to explicitly segment the network by defining multiple cluster profiles.

Dell provides a "default" version of the mesh cluster profile. You can use the "default" version or create a new instance of a profile which you can then edit as you need. You can configure a maximum of 16 mesh cluster profiles on a mesh node. For details about configuring mesh cluster profiles, see "Mesh Cluster Profiles".

Mesh Radio Profile

Dell provides a "default" version of the mesh radio profile. You can use the "default" version or create a new instance of a profile which you can then edit as you need. The mesh radio profile allows you to specify the set of rates used to transmit data on the mesh link. For information about configuring mesh radio profiles, see "Mesh Radio Profiles".

RF Management (802.11a and 802.11g) Profiles

The two 802.11a and 802.11g RF management profiles for an AP configure its 802.11a (5 Ghz) and 802.11b/g (2.4 GHz) radio settings. Use these profile settings to determine the channel, beacon period, transmit power, and ARM profile for a mesh AP's 5 GHz and 2.5 Ghz frequency bands. You can either use the "default" version of each profile, or create a new 802.11a or 802.11g profile which you can then configure as necessary. Each RF management profile also has a radio-enable parameter that allows you to enable or disable the AP's ability to simultaneously carry WLAN client traffic and mesh-backhaul traffic on that radio. This value is enabled by

default. For information about configuring RF Management Radio profiles, see “RF Management (802.11a and 802.11g) Profiles”.

NOTE: If you do not want the mesh radios carrying mesh-backhaul traffic to support client traffic, consider using a dedicated 802.11a/80211/g radio profile with the mesh radio disabled: in this scenario, the radio will carry mesh backhaul traffic but will not support client Virtual APs.

Mesh nodes operating in different cluster profiles can share the same radio profile. Conversely, mesh portals using the same cluster profile can be assigned different RF Management Radio profiles to achieve frequency separation (for more information, see “Deployments with Multiple Mesh Cluster Profiles”).

Adaptive Radio Management Profiles

Each 802.11a and 802.11g radio profile references an Adaptive Radio Management (ARM) profile. When you assign an active ARM profile to a mesh radio, ARM's automatic power-assignment and channel-assignment features will automatically select the radio channel with the least amount of interference for each mesh portal, maximizing end user performance. In earlier versions of this software, an AP with a mesh radio received its beacon period, transmission power and 11a/11g portal channel settings from its mesh radio profile. Mesh-access AP portals now inherit these radio settings from their dot11a or dot11g radio profiles.

Each ARM-enabled mesh portal monitors defined thresholds for interference, noise, errors, rogue APs and radar settings, then calculates interference and coverage values and selects the best channel for its radio band(s). The mesh portal communicates its channel selection to its mesh points via Channel Switch Announcements (CSAs), and the mesh points will change their channel to match their mesh portal. Although channel settings can still be defined for a mesh point via that mesh point's 802.11a and 802.11g radio profiles, these settings will be overridden by any channel changes from the mesh portal. A mesh point will take the same channel setting as its mesh portal, regardless of its associated clients. If you want to manually assign channels to mesh portals or mesh points, disable the ARM profile associated with the 802.11a or 802.11g radio profile by setting the ARM profile’s assignment parameter to disable.

Mesh points, unlike mesh portals, do not scan channels. This means that once a mesh point has selected a mesh portal or an upstream mesh point, it will tune to this channel, form the link, and will not scan again unless the mesh link gets broken. This provides good mesh link stability, but may adversely affect system throughput in networks with mesh portals and mesh points. When ARM assigns optimal channels to mesh portals, those portals use different channels, and once the mesh network has formed and all the mesh points have selected a portal (or upstream mesh point), those mesh points will not be able to detect other portals on other channels that could offer better throughput. This type of suboptimal mesh network may form if, for example, two or three mesh points select the same mesh portal after booting, form the mesh network, and leave a nearby mesh portal without any mesh points. Again, this will not affect mesh functionality, but may affect total system throughput. For details about associating an ARM profile with a mesh AP, see “Assigning an ARM Profile”.

High-Throughput Profiles

Each 802.11a and 802.11g radio profile also references a high-throughput profile that manages an AP or AP group’s 40Mhz tolerance settings. For information about referencing a high-throughput profile, see “Assigning a High-throughput Profile”.

Mesh High-Throughput SSID Profile

High-throughput APs support additional settings not available in legacy APs. A mesh high-throughput SSID profile can enable or disable high-throughput (802.11n) features and 40 MHz channel usage, and define values for aggregated MAC protocol data units (MDPUs) and Modulation and Coding Scheme (MCS) ranges.

Dell provides a “default” version of the mesh high-throughput SSID profile. You can use the “default” version or create a new instance of a profile which you can then edit as you need. High-throughput Mesh nodes operating in different cluster profiles can share the same high-throughput SSID radio profile. For information about configuring mesh high-throughput SSID profiles, see “Mesh High-Throughput SSID Profiles”.

Wired AP Profile

The wired AP profile controls the configuration of the Ethernet port(s) on your AP. You can use the wired AP profile to configure Ethernet ports for bridging or secure jack operation using the wired AP profile. For details, see "Ethernet Ports for Mesh" on page 249

Mesh Recovery Profile

In addition to the "default" and user-defined mesh cluster profiles, mesh nodes also have a recovery profile. The master controller dynamically generates a recovery profile, and each mesh node provisioned by the same master controller has the same recovery profile. The recovery profile is based on a pre-shared key (PSK), and mesh nodes use the recovery profile to establish a link to the controller if the mesh link is broken and no other mesh cluster profiles are available.

The mesh portal advertises the provisioned cluster profile. If a mesh point is unaware of the active mesh cluster profile, but is aware of and has the same recovery profile as the mesh portal, the mesh point can use the recovery profile to connect to the mesh portal.

NOTE: The mesh point must have the same recovery profile as the parent to which it connects. If you provision the mesh points with the same master controller, the recovery profiles should match.

To verify that the recovery profile names match, use the following command: show ap mesh debug provisioned-clusters {ap-name <name> | bssid <bssid> | ip-addr <ipaddr>}.

To view the recovery profile on the controller, use the following command: show running-config | include recovery.

If a mesh point connects to a parent using the recovery profile, it may immediately exit recovery if the parent is actively using one of its provisioned mesh cluster profiles. Once in recovery, a mesh point periodically exits recovery to see if it can connect using an available provisioned mesh cluster profile. The recovery profile is read-only; it cannot be modified or deleted.

The recovery profile is stored in the master controllers' configuration file and is unique to that master controller. If necessary, you can transfer your configuration to another controller. If you do this, make sure your new mesh cluster is running and you have re-provisioned the mesh nodes before deleting your previous configuration. The APs will learn the new recovery profile after they are provisioned with the new controller. This is also true if you provision a mesh node with one master controller and use it with a different master controller. In this case, the recovery profile will not work on the mesh node until you re-provision it with the new master controller.

Mesh Solutions

You can configure the following single-hop and multi-hop solutions:

- Thin AP services with wireless backhaul deployment
- Point-to-point deployment
- Point-to-multipoint deployment
- High-availability deployment

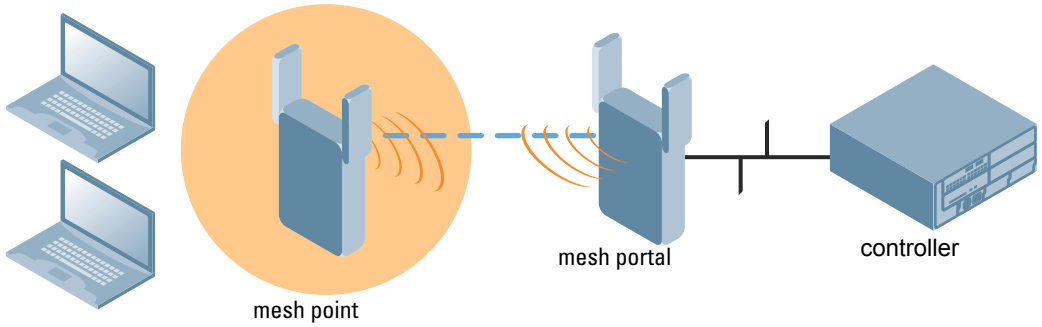
With a thin AP wireless backhaul deployment, mesh provides services and security to remote wireless clients and sends all control and user traffic to the master controller over a wireless backhaul mesh link.

The remaining deployments allow you to extend your existing wired network by providing a wireless bridge to connect Ethernet LAN segments. You can use these deployments to bridge Ethernet LANs between floors, office buildings, campuses, factories, warehouses and other environments where you do not have access to physical ports or cable to extend the wired network. In these scenarios, a wireless backhaul carries traffic between the Dell APs configured as the mesh portal and the mesh point, to the Ethernet LAN.

Thin AP Services with Wireless Backhaul Deployment

To expand your wireless coverage without bridging Ethernet LAN segments, you can use thin AP services with a wireless backhaul. In this scenario, the mesh point provides network access for wireless clients and establishes a mesh path to the mesh portal, which uses its wired interface to connect to the controller. Use the 802.11g radio for WLAN and controller services and the 802.11a radio for mesh services. Figure 37 shows the wireless backhaul between the mesh portal to the mesh point that services the wireless clients.

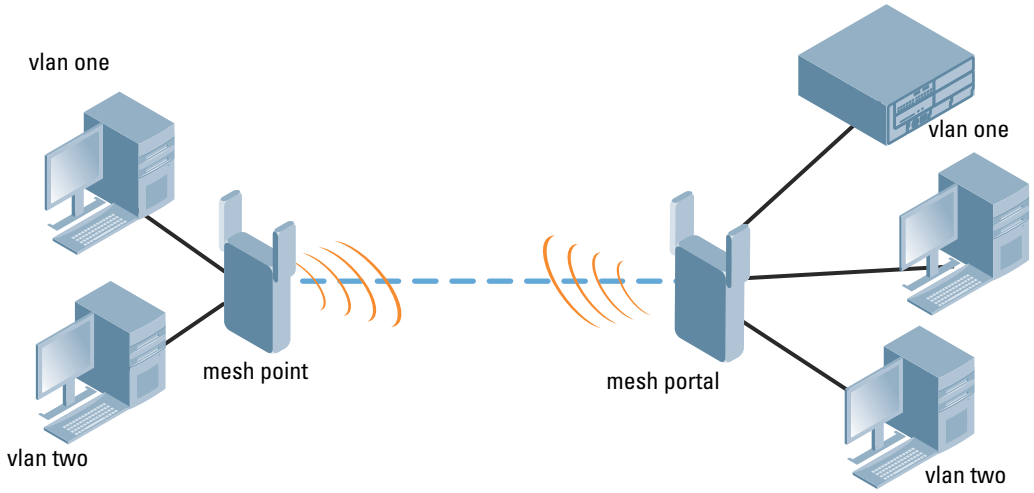
Figure 37 *Sample Wireless Backhaul Deployment*



Point-to-Point Deployment

In this point-to-point scenario, two Ethernet LAN segments are bridged via a wireless connection that carries both client services traffic and mesh-backhaul traffic between the mesh portal and the mesh point. This provides communication from one LAN to another. Figure 38 shows a single-hop point-to-point deployment.

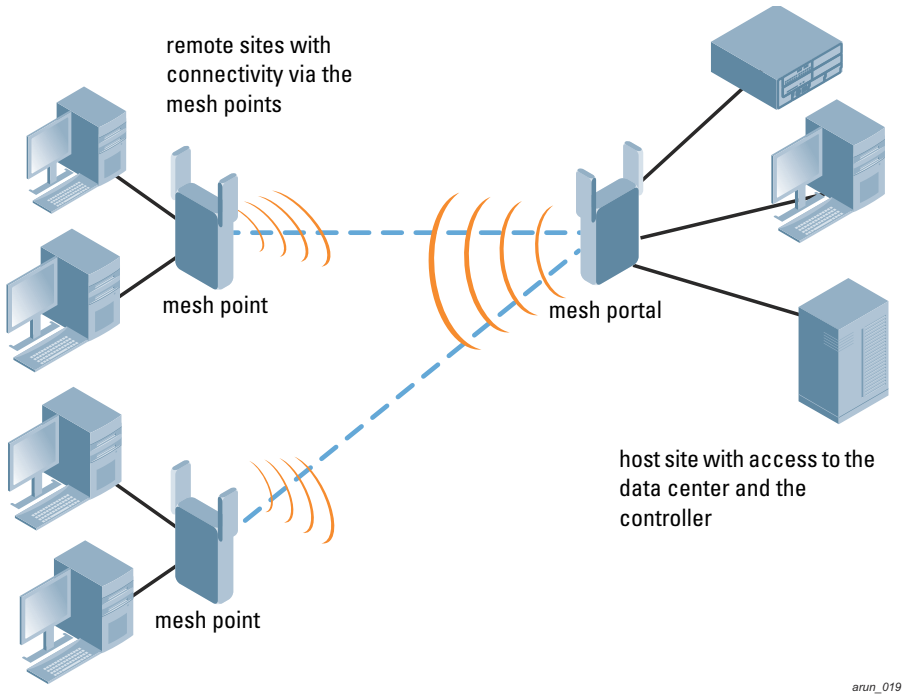
Figure 38 *Sample Point-to-Point Deployment*



Point-to-Multipoint Deployment

In a point-to-multipoint scenario, multiple Ethernet LAN segments are bridged via multiple wireless/mesh backhauls that carry traffic between the mesh portal and the mesh points. This provides communication from the local LAN to multiple remote LANs. Figure 39 shows a single-hop point-to-multipoint deployment.

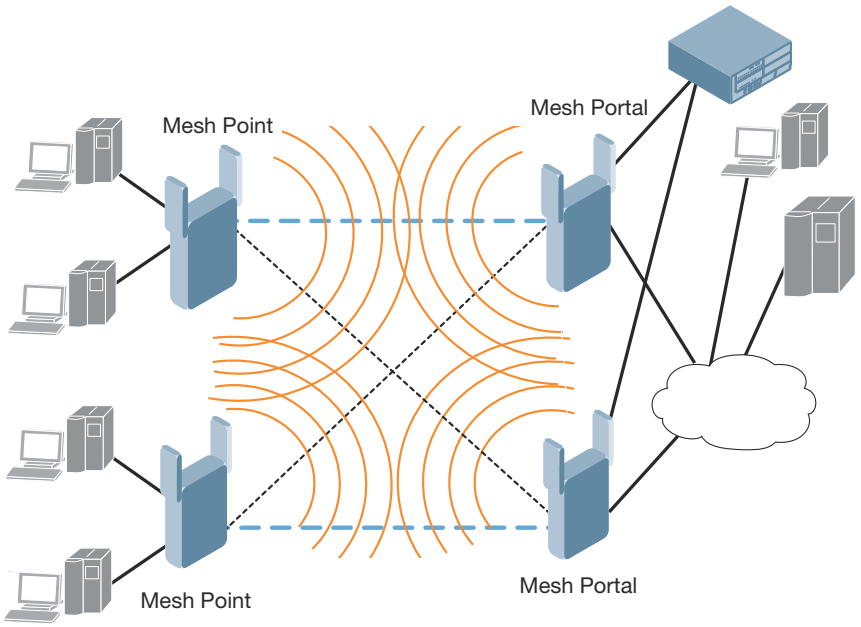
Figure 39 *Sample Point-to-Multipoint Deployment*



High-Availability Deployment

In this high-availability scenario, multiple Ethernet LAN segments are bridged via multiple wireless backhauls that carry traffic between the mesh portal and the mesh points. You configure one mesh portal for each remote LAN that you are bridging with the host LAN. This provides communication from the host LAN to multiple remote LANs. In the event of a link failure between a mesh point and its mesh portal, the affected mesh point could create a link to the other mesh portal. Figure 40 shows a sample single-hop high-availability deployment. The dashed lines represent the current mesh link between the mesh points and their mesh portals. The diagonal dotted lines represent possible links that could be formed in the event of a mesh link or mesh portal failure.

Figure 40 *Sample High-Availability Deployment*



Before You Begin

Dell recommends the following when planning and deploying a mesh solution:

Pre-Deployment Considerations

- Stage the APs before deployment. Identify the location of the APs, configure them for mesh, provision them and verify connectivity before physically deploying the mesh APs in a live network.
- Ensure the controller has Layer-2/3 network connectivity to the network segment where the mesh portal will be installed.
- Keep the AP packaging materials and reuse them to send the APs to the installation location.
- Verify the layout of the physical location to determine the appropriate configuration and placement of the APs. Use this information to avoid problems that would necessitate a physical recovery.
- Label the AP before sending it to the physical location for installation.

Outdoor-Specific Deployment Considerations

- Provision the AP with the latitude and longitude coordinates of the installation location. This allows you to more easily identify the AP for inventory and troubleshooting purposes.
- Identify a "radio line of sight" between the antennas for optimum performance. The radio line of sight involves the area along a link through which the bulk of the radio signal power travels.
- Identify the minimum antenna height required to ensure a reliable mesh link.
- Scan your proposed site to avoid radio interference caused by other radio transmissions using the same or an adjacent frequency.
- Consider extreme weather conditions known to affect your location, including: temperature, wind velocity, lightning, rain, snow, and ice.
- Allow for seasonal variations, such as growth of foliage.

For more detailed outdoor deployment information, refer to the *Installation Guide* that came with your outdoor AP.

Configuration Considerations.

- On dual-radio APs, you can configure only one of the radio for mesh. If you want a dual-radio AP to carry mesh backhaul traffic and client services traffic on separate radios, Dell recommends using 802.11a radios for mesh-backhaul traffic and 802.11g radios for traditional WLAN access.
- If you configure more than one mesh node in the same VLAN, prevent network loops by enabling STP on the Layer-2 switch used to connect the mesh nodes.
- Mesh nodes learn a maximum of 1024 source MAC addresses; this cannot be changed.
- Place all APs for a specific mesh cluster in the same AP group.
- Create and keep separate mesh cluster profiles for specific mesh clusters. Do not overwrite or delete the cluster profiles.
- Enable bridging on mesh point Ethernet ports when deploying LAN bridging solutions.
- APs configured as mesh points support secure jack operation on enet0. APs with multiple ethernet ports configured as mesh *portals* support secure jack operation on enet1. If an AP with multiple ethernet ports is configured as a mesh *point*, it supports secure jack operation on enet1 and enet0.
- Mesh networks forward tagged/untagged VLAN traffic, but do not tag traffic. The allowed VLANS are controlled by the wired ap profile.

Post-Deployment Considerations

- Do not connect mesh point Ethernet ports in such a way that causes a network loop.

- Have a trained professional install the AP. After installation, check to ensure the AP receives power and boots up, enabling RSSI outputs.

NOTE: Although the AP is up and operational, it is not connected to the network.

- Align the AP antenna for optimal RSSI.
- Do not delete or modify mesh cluster profiles once you use them to provision mesh nodes. You can recover the mesh point if the original cluster profile is still available. Dell recommends creating a new mesh cluster profile if needed.
- If you create a new mesh cluster profile for an existing deployment, you must re-provision the AP for the new profile to take effect. If you re-provision mesh nodes that are already operating, re-provision the most distant (highest hop count) mesh points first followed by the mesh portals. If you re-provision the mesh portal first, the mesh points may be unable to form a mesh link. Note that re-provisioning the AP causes it to automatically reboot, which may cause a disruption of service to the network.

Dual-Port AP Considerations

The W-AP130 Series and W-AP120 Series models have The AP-12x model has two 10/100 Mbps Ethernet ports (enet0 and enet1, respectively). When using these APs in a mesh environment, note the following Ethernet port requirements:

- If configured as a mesh portal:
  - Connect enet0 to the controller to obtain an IP address. The wired AP profile controls enet1.
  - Only enet1 supports secure jack operation.
- If configured as a mesh point, enet0 and enet1 can be configured using separate wired-port-profiles. However, the wired-ap-profile for enet0 is also applied to enet1.

Mesh Radio Profiles

The mesh radio profile determines many of the settings used by mesh nodes to establish mesh links and the path to the mesh portal, including the maximum number of children a mesh node can accept, and transmit rates for the 802.11a and 802.11g radios. The attributes of the mesh radio profile are applied to a mesh point upon receiving its configuration from the controller. You can configure multiple radio profiles; however, you select and deploy only *one* radio profile per AP group. Radio profiles, including the "default" profile, are not active until you provision your APs for mesh.

If you modify a currently provisioned and running radio profile, your changes take effect immediately. You do not reboot the controller or the AP.

Managing Mesh Profiles In the WebUI

Use the following procedures to define and manage mesh radio profiles using the WebUI.

Creating a New Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name for which you want to configure the new mesh radio profile.
   - If you selected the AP Specific tab, click the Edit button by the AP for which you want to create the mesh radio profile.
2. In the Profiles list, expand the Mesh menu, then select Mesh radio profile.

3. In the Profile Details window pane, click the Mesh radio profile drop-down list and select New. Enter a new mesh radio profile name in the field to the right of the drop-down list. You cannot use spaces in radio profile names.
4. Configure your desired mesh radio settings. Table 42 describes the parameters you can configure in the mesh radio profile

Table 42 *Mesh Radio Profile Configuration Parameters*

Parameter	Description
Mesh radio profile	Select an existing radio profile to modify or create a new radio profile. The radio profile can have a maximum of 32 characters. Default: Mesh radio profile named "default."
Maximum Children	Indicates the maximum number of children a mesh node can accept. Default: 64 children. The range is 1–64.
Maximum Hop Count	Indicates the maximum hop count from the mesh portal. Default: 8 hops. The range is 1–32.
Heartbeat threshold	Indicates the maximum number of heartbeat messages that can be lost between neighboring mesh nodes. Default: 10 missed heartbeats. The range is 1–255.
Link Threshold	Use this setting to optimize operation of the link metric algorithm. Indicates the minimal RSSI value. If the RSSI value is below this threshold, the link may be considered a sub-threshold link. A sub-threshold link is one whose average RSSI value falls below the configured link threshold. If this occurs, the mesh node may try to find a better link on the same channel and cluster (only neighbors on the same channel are considered). Default: 12. The supported threshold is hardware dependent, with a practical range of 10–90.
Reselection mode	Use this setting to optimize operation of the link metric algorithm. The reselection mode specifies the method a mesh node uses to find a better uplink to create a path to the mesh portal. Only neighbors on the same channel in the same mesh cluster are considered. Available options are: • reselect-anytime—Mesh points using the reselect-anytime reselection mode perform a single topology readjustment scan within 9 minutes of startup and 4 minutes after a link is formed. If no better parent is found, the mesh point returns to its original parent. This initial scan evaluates more distant mesh points before closer mesh points, and incurs a dropout of 5–8 seconds for each mesh point. After the initial startup scan is completed, connected mesh nodes evaluate mesh links every 30 seconds. If a mesh node finds a better uplink, the mesh node connects to the new parent to create an improved path to the mesh portal. • reselect-never—Connected mesh nodes do not evaluate other mesh links to create an improved path to the mesh portal. • startup-subthreshold—Mesh points using the startup-subthreshold reselection mode perform a single topology readjustment scan within 9 minutes of startup and 4 minutes after a link is formed. If no better parent is found, the mesh point returns to its original parent. This initial startup scan evaluates more distant mesh points before closer mesh points, and incurs a dropout of 5–8 seconds for each mesh point. After that time, each mesh node evaluates alternative links if the existing uplink falls below the configured threshold level (the link becomes a sub-threshold link). Dell recommends using this default startup-subthreshold value. • subthreshold-only—Connected mesh nodes evaluate alternative links only if the existing uplink becomes a sub-threshold link. NOTE: Starting with ArubaOS 3.4.1, if a mesh point using the startup-subthreshold or subthreshold-only mode reselects a more distant parent because its original, closer parent falls below the acceptable threshold, then as long as that mesh point is connected to that more distant parent, it will seek to reselect a parent at the earlier, shorter distance (or less) with good link quality. For example, if a mesh point disconnects from a mesh parent 2 hops away and subsequently reconnects to a mesh parent 3 hops away, then the mesh point will continue to seek a connection to a mesh parent with both an acceptable link quality and a distance of two hops or less, even if the more distant parent also has an acceptable link quality.

Table 42 *Mesh Radio Profile Configuration Parameters (Continued)*

Parameter	Description
metric algorithm	Use this setting to optimize operation of the link metric algorithm. Specifies the algorithm used by a mesh node to select its parent. Available options are: • best-link-rssi—Selects the parent with the strongest RSSI, regardless of the number of children a potential parent has. • distributed-tree-rssi—Selects the parent based on link-RSSI and node cost based on the number of children. This option evenly distributes the mesh points over high quality uplinks. Low quality uplinks are selected as a last resort. NOTE: Dell recommends using the default value. Default: distributed-tree-rssi.
Retry Limit	Indicates the number of times a mesh node can re-send a packet. Default: 4 times. The range is 0– 15.
RTS Threshold	Defines the packet size sent by mesh nodes. Mesh nodes transmitting frames larger than this threshold must issue request to send (RTS) and wait for other mesh nodes to respond with clear to send (CTS) to begin transmission. This helps prevent mid-air collisions. Default: 2,333 bytes. The range is 256– 2,346.
802.11a Transmit Rates	Indicates the transmit rates for the 802.11a radio. The AP attempts to use the highest transmission rate to establish a mesh link. If a rate is unavailable, the AP goes through the list and uses the next highest rate. To modify transmit rates, do one of the following: • In the WebUI, deselect (uncheck) a specific rate box to use fewer rates when establishing a mesh link. • In the CLI, enter the specific rates to use. Default: All transmission rates are selected and used. If you do not select 802.11a or 802.11g transmit rates, all rates are selected by default when you click Apply.
802.11g Transmit Rates	Indicates the transmit rates for the 802.11g radio. The AP attempts to use the highest transmission rate to establish a mesh link. If a rate is unavailable, the AP goes through the list and uses the next highest rate. To modify transmit rates, do one of the following: • In the WebUI, deselect (uncheck) a specific rate box to use fewer rates when establishing a mesh link. • In the CLI, enter the specific rates to use. Default: All transmission rates are selected and used. If you do not select 802.11a or 802.11g transmit rates, all rates are selected by default when you click Apply.
Mesh Private VLAN	A VLAN ID for control traffic between an remote mesh portal and mesh nodes. This VLAN ID must not be used for user traffic. Range: 0–4094. Default: 0 (disabled). For further information on configuring a remote mesh portal, see "Remote Mesh Portals" on page 256
Allowed VLANs on Mesh Link	(For the internal AP on W-651 controllers only): List the VLAN ID numbers of VLANs allowed on the mesh link.
Mesh Survivability	This feature is currently not supported and should only be enabled under the supervision of Dell technical support.

Table 42 *Mesh Radio Profile Configuration Parameters (Continued)*

Parameter	Description
BC/MC Rate Optimization	Broadcast/Multicast Rate Optimization dynamically selects the rate for sending broadcast/multicast frames on any BSS. This feature determines the optimal rate for sending broadcast and multicast frames based on the lowest of the unicast rates across all associated clients. When the Multicast Rate Optimization feature is enabled, the controller scans the list of all associated stations in that BSS and finds the lowest transmission rate as indicated by the rate adaptation state for each station. If there are no associated stations in the BSS, it selects the lowest configured rate as the transmission rate for broadcast and multicast frames. This feature is enabled by default. Multicast Rate Optimization applies to broadcast and multicast frames only. 802.11 management frames are not affected by this feature and will be transmitted at the lowest configured rate. When enabled, this setting dynamically adjusts the multicast rate to that of the slowest connected mesh child. Multicast frames are not sent if there are no mesh children. NOTE: This feature should only be enabled on a BSS where all associated stations are sending or receiving unicast data. If there is no unicast data to or from a particular station, then the rate adaptation state may not accurately reflect the current sustainable transmission rate for that station. This could result in a higher packet error rate for broadcast/multicast packets at that station. Default: Enabled.

5. Click Apply. The profile name appears in the Mesh Radio Profile list with your configured settings.

   If you configure this for the AP group, this profile also becomes the selected radio profile used by the mesh portal for your mesh network.

Assigning a Profile to a Mesh AP or AP Group

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group to which you want to assign a new mesh radio profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new mesh radio profile.
2. Under the Profiles list, expand the Mesh menu, then select Mesh radio profile.
3. In the Profile Details window pane, click the Mesh radio profile drop-down list and select the desired mesh radio profile from the list.
4. Click Apply. The profile name appears in the Mesh Radio Profile list with your configured settings. If you configure this for the AP group, this profile also becomes the selected radio profile used by the mesh portal for your mesh network.

Editing a Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name with the profile you want to edit.
   - If you selected the AP Specific tab, click the Edit button by the AP with the profile you want to edit.
2. In the Profiles list, expand the Mesh menu, then select Mesh radio profile.
3. In the Profile Details window pane, click the Mesh radio profile drop-down list and select the name of the profile you want to edit.
4. Change the mesh radio settings as desired. Table 42 describes the parameters you can configure in the mesh radio profile.
5. Click Apply to save your changes.

Deleting a Profile

Use the following procedure to delete an existing mesh radio profile using the WebUI. You can delete a mesh radio profile only if no other APs or AP groups are using that profile.

1. Navigate to the Configuration > Advanced Services> All Profiles window.
2. Expand the Mesh menu, then select Mesh radio profile. A list of mesh radio profiles appears in the Profile Details window pane.
3. Click the Delete button by the name of the profile you want to delete.

Managing Mesh Profiles In the CLI

You must be in config mode to create, modify or delete a mesh radio profile using the CLI. Specify an existing mesh profile with the <profile-name> parameter to modify an existing profile, or enter a new name to create an entirely new profile.

Creating or Modifying a Profile

Configuration details and any default values for each of these parameters are described in Table 42 on page 228. If you do not specify a parameter for a new profile, that profile uses the default value for that parameter. Put the no option before any parameter to remove the current value for that parameter and return it to its default setting. Enter exit to leave the mesh radio profile mode.

```
ap mesh-radio-profile <profile-name>
      a-tx-rates
      allowed-vlans
      children <children>
      clone <source-profile-name>
      g-tx-rates [1|2|5|6|9|11|12|18|24|36|48|54]
      heartbeat-threshold <count>
      hop-count <hop-count>
      link-threshold <count>
      max-retries <max-retries>
      mesh-ht-ssid-profile
      mesh-mcast-opt
      metric-algorithm {best-link-rssi|distributed-tree-rssi}
      mpv <vlan-id>
      no
      reselection-mode
      rts-threshold <rts-threshold>
      tx-power <tx-power>>
```

You can also create a new mesh radio profile by copying the settings of an existing profile using the clone parameter. Using the clone command to create a new profile makes it easier to keep constant attributes in common within multiple profiles.

```
ap mesh-radio-profile <profile-name>
   clone <source-profile-name>
```

Viewing Profile Settings

To view a complete list of mesh radio profiles and their status:

```
show ap mesh-radio-profile
```

To view the settings of a specific mesh radio profile:

```
show ap mesh-radio-profile <name>
```

Assigning a Profile to an AP Group

To associate a mesh radio profile with an AP group, use the following commands. When you add the mesh cluster profile to the AP group, you must also define the cluster priority.

```
ap-group <group>
   mesh-radio-profile <profile-name> priority <priority>
```

To associate a mesh radio profile with an individual AP:

```
ap-name <name>
   mesh-radio-profile <profile-name> priority <priority>
```

The following examples assign the mesh cluster profiles cluster1 and cluster2 to two different AP groups. In the AP group group1, cluster1 has a priority of 5, and cluster2 has a priority of 10, so cluster1 has the higher priority. In the AP group group2, cluster1 has a priority of 10, and cluster2 has a priority of 5, so cluster5 has the higher priority.

```
group2—cluster1 has a priority of 10, and cluster2 has a priority of 5.
ap-group group1
      mesh-cluster-profile cluster1 priority 5
      mesh-cluster-profile cluster2 priority 10

ap-group2
      mesh-cluster-profile cluster1 priority 10
      mesh-cluster-profile cluster2 priority 5
```

Deleting a Mesh Radio Profile

If no AP or AP group is using a mesh radio profile, you can delete that profile using the no parameter:

```
    no ap mesh-radio-profile <profile-name>
```

RF Management (802.11a and 802.11g) Profiles

The two 802.11a and 802.11g RF management profiles for an AP configure its 802.11a (5 Ghz) and 802.11b/g (2.4 GHz) radio settings. You can either use the "default" version of each profile, or create a new 802.11a or 802.11g profile using the procedures below. Each RF management radio profile includes a reference to an Adaptive Radio Management (ARM) profile. If you would like the ARM feature to dynamically select the best channel and transmission power for the radio, verify that the RF management profile references an active and enabled ARM profile. It can be useful to set the Max Tx EIRP parameter in the ARM profile to 127 (the maximum power level permissible) until it determines the signal-to-noise radio on the links. If ARM is active, the Max Tx EIRP can also be set to 127 to allow maximum power levels.

If you want to manually select a channel for each AP group, create separate 802.11a and 802.11g profiles for each AP group and assign a different transmission channel for each profile. For example, one AP group could have an 802.11a profile that uses channel 36 and an 802.11g profile that uses channel 11, and another AP group could have an 802.11a profile that uses channel 40 and an 802.11g profile that uses channel 9.

Managing 802.11a/802.11g Profiles In the WebUI

Use the following procedures to define and manage 802.11a and 802.11g RF management profiles via the WebUI.

Creating a Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group for which you want to create a new RF management profile.
   - If you selected AP Specific, click the Edit button by the AP for which you want to create a new RF management profile.
2. In the Profiles list, expand the RF Management menu, then select either 802.11a radio profile or 802.11g radio profile.

3. If you selected 802.11a radio profile, click the 802.11a radio profile drop-down list in the Profile Details window pane and select NEW.
   -or-
   If you selected 802.11g radio profile, click the 802.11g radio profile drop-down list in the Profile Details window pane and select NEW.
4. Enter a name for your new 802.11a or 802.11g radio profile.
5. Configure the radio settings described in Table 43, then click Apply to save your settings. The profile name appears in the Profile list with your configured settings.

Table 43 *802.11a/802.11g RF Management Configuration Parameters*

Parameter	Description
Radio Enable	Enable transmissions on this radio band.
Mode	Access Point operating mode. Available options are: • am-mode: Air Monitor mode • ap-mode: Access Point mode • spectrum-mode: Spectrum Monitor mode The default settings is ap-mode.
High throughput enable (Radio)	Enable/Disable high-throughput (802.11n) features on the radio. This option is enabled by default.
Channel	Transmit channel for this radio. The available channels depend on the regulatory domain (country). This parameter includes the following channel number configuration options for 20 MHz and 40 MHz modes: • none: Select this option to disable 40 MHz mode and activate 20 MHz mode for the entered channel. • above: When you select this option, the number entered becomes the primary channel and the secondary channel is determined by increasing the primary channel number by 4. For example, if you entered 157 into the Channel field and selected the above option, radios using that profile would select 157 as the primary channel and 153 as the secondary channel. • below: When you select this option, the number entered becomes the primary channel and the secondary channel is determined by decreasing the primary channel number by 4. For example, if you entered 157 into the Channel field and selected the below option, radios using that profile would select 157 as the primary channel and 153 as the secondary channel. If you select the Spectrum Monitoring checkbox on this profile page, the AP will operate as a hybrid AP and scan the selected channel for spectrum analysis data.
Beacon Period	Beacon Period for the AP in msec. The minimum value is 60 msec, and the default value is 100 msec.
Beacon Regulate	Enable this setting to introduce randomness in the beacon generation so that multiple APs on the same channel do not send beacons at the same time.
Transmit EIRP	Maximum transmit EIRP in dBm from 0 to 51 in .5 dBm increments, or 127 for regulatory maximum. Transmit power may be further limited by regulatory domain constraints and AP capabilities.
Advertise 802.11d and 802.11h Capabilities	Enable the radio to advertise its 802.11d (Country Information) and 802.11h (Transmit Power Control) capabilities. This option is disabled by default.
TPC power	The transmit power advertised in the TPC IE of beacons and probe responses. The supported range is 0-51 dBm, and the default value is 15 dBm.
Spectrum load balancing	The Spectrum Load Balancing feature helps optimize network resources by balancing clients across channels, regardless of whether the AP or the controller is responding to the wireless clients' probe requests. If enabled, the controller compares whether or not an AP has more clients than its neighboring APs on other channels. If an AP's client load is at or over a predetermined threshold as compared to its immediate neighbors, or if a neighboring Dell AP on another channel does not have any clients, load balancing will be enabled on that AP. This feature is disabled by default. For details, see "Spectrum Load Balancing".

Table 43 *802.11a/802.11g RF Management Configuration Parameters (Continued)*

Parameter	Description
Spectrum load balancing mode	The spectrum load balancing mode allows you to allows control over how to balance clients. Select one of the following options: • channel: Channel-based load-balancing balances clients across channels. This is the default load-balancing mode • radio: Radio-based load-balancing balances clients across APs.
Spectrum Load Balancing Interval	Specify how often spectrum load balancing calculations are made (in seconds). The supported range is 1-2147483647 seconds and the default value is 30 seconds.
Spectrum Load Balancing threshold	If the spectrum load balancing feature is enabled, this parameter controls the percentage difference between number of clients on a channel that triggers load balancing. The default value is 20%, meaning that spectrum load balancing is activated when there are 20% more clients on one channel than on another channel used by the AP radio.
Advertised Regulatory Max EIRP	Work around a known issue on Cisco 7921G telephones by specifying a cap for a radio's maximum equivalent isotropic radiated power (EIRP). When you enable this parameter, even if the regulatory approved maximum for a given channel is higher than this EIRP cap, the AP radio using this profile will advertise only this capped maximum EIRP in its radio beacons. The supported range is 1-31dBm.
Spectrum Load Balancing Domain	Enter a spectrum load balancing domain name to manually create RF neighborhoods. Use this option to create RF neighborhood information for networks that have disabled Adaptive Radio Management (ARM) scanning and channel assignment. • If spectrum load balancing is enabled in a 802.11a or 802.11g radio profile but the spectrum load balancing domain is *not* defined, ArubaOS uses the ARM feature to calculate RF neighborhoods. • If spectrum load balancing is enabled in a 802.11a or 802.11g radio profile and a spectrum load balancing domain *is also* defined, AP radios belonging to the same spectrum load balancing domain will be considered part of the same RF neighborhood for load balancing, and will not recognize RF neighborhoods defined by the ARM feature.
RX Sensitivity Tuning Based Channel Reuse	In some dense deployments, it is possible for APs to hear other APs on the same channel. This creates co-channel interference and reduces the overall utilization of the channel in a given area. Channel reuse enables dynamic control over the receive (Rx) sensitivity in order to improve spatial reuse of the channel. This feature is disabled by default. To enable this feature, click the RX Sensitivity Tuning Based Channel Reuse drop-down list and select either static or dynamic. To disable this feature, click the RX Sensitivity Tuning Based Channel Reuse drop-down list and select disable. For details on each of these modes, see "RX Sensitivity Tuning Based Channel Reuse". NOTE: Do not enable the Channel Reuse feature if Non 802.11 Interference Immunity is set to level 3 or higher. A level-3 to level-4 Noise Immunity setting is not compatible with the Channel Reuse feature. The channel reuse feature applies to non-DFS channels only. It is internally disabled for DFS channels and is does not affect DFS radar signature detection.
RX Sensitivity Threshold	RX sensitivity tuning based channel reuse threshold, in - dBm. If the Rx Sensitivity Tuning Based Channel reuse feature is set to static mode, this parameter manually sets the AP's Rx sensitivity threshold (in -dBm). The AP will filter out and ignore weak signals that are below the channel threshold signal strength. If the value for this parameter is set to zero, the feature will automatically determine an appropriate threshold.

Table 43 *802.11a/802.11g RF Management Configuration Parameters (Continued)*

Parameter	Description
Non 802.11 Interference Immunity	Set a value for 802.11 Interference Immunity. The default setting for this parameter is level 2. When performance drops due to interference from non-802.11 interferers (such as DECT or Bluetooth devices), the level can be increased up to level 5 for improved performance. However, increasing the level makes the AP slightly "deaf" to its surroundings, causing the AP to lose a small amount of range. The levels for this parameter are: • Level 0: no ANI adaptation. • Level 1: noise immunity only. • Level 2: noise and spur immunity. • Level 3: level 2 and weak OFDM immunity. • Level 4: level 3 and FIR immunity. • Level 5: disable PHY reporting. NOTE: Do not raise the noise immunity feature's default setting if the RX Sensitivity Tuning Based Channel Reuse feature is also enabled. A level-3 to level-5 Noise Immunity setting is not compatible with the Channel Reuse feature.
Enable CSA	Channel Switch Announcements (CSAs), as defined by IEEE 802.11h, enable an AP to announce that it is switching to a new channel before it begins transmitting on that channel. This allows clients that support CSA to transition to the new channel with minimal downtime.
CSA Count	Number of channel switch announcements that must be sent prior to switching to a new channel. The default CSA count is 4 announcements.
Management Frame Throttle Interval	Averaging interval for rate limiting management frames from this radio, in seconds. A management frame throttle interval of 0 seconds disables rate limiting.
Management Frame Throttle Limit	Maximum number of management frames that can come in from this radio in each throttle interval.
ARM/WIDS Override	If selected, this option disables Adaptive Radio Management (ARM) and Wireless IDS functions and slightly increases packet processing performance. If a radio is configured to operate in Air Monitor mode, then the ARM/WIDS override functions are always enabled, regardless of whether or not this check box is selected.
Protection for 802.11b Clients	(For 802.11g RF Management Profiles only) Enable or disable protection for 802.11b clients. This parameter is enabled by default. Disabling this feature may improve performance if there are no 802.11b clients on the WLAN. WARNING: Disabling protection violates the 802.11 standard and may cause interoperability issues. If this feature is disabled on a WLAN with 802.11b clients, the 802.11b clients will not detect an 802.11g client talking and can potentially transmit at the same time, thus garbling both frames.
Maximum Distance	Maximum client distance, in meters. This value is used to derive ACK and CTS timeout times. A value of 0 specifies default settings for this parameter, where timeouts are only modified for outdoor mesh radios which use a distance of 16km. The upper limit for this parameter varies from 24–58km, depending on the radio's band (a/g) and 20/40 MHz mode. Note that if you configure a value above the supported maximum, the maximum supported value will be used instead. Values below 600m will use default settings.
Spectrum Monitoring	Select this option to convert APs using this radio profile to a hybrid APs that will continue to serve clients as an Access Point, but will also scan and analyze spectrum analysis data for a single radio channel. For more details on hybrid APs, see "Spectrum Analysis" on page 607.

Table 43 *802.11a/802.11g RF Management Configuration Parameters (Continued)*

Parameter	Description
ARM profile	Dell's proprietary Adaptive Radio Management (ARM) technology maximizes WLAN performance by dynamically and intelligently choosing the best 802.11 channel and transmit power for each Dell AP in its current RF environment. Every RF management profile references an ARM profile. If you specify an active and enabled ARM profile, you do not need to manually configure the Channel and Transmit Power parameters for this 802.11a or 802.11g profile. For details on referencing an ARM profile, see "Assigning an ARM Profile". The Adaptive Radio Management (ARM) profile associated with this 802.11a or 802.11g radio profile appears beneath the 802.11a/802.11g radio profile name in the profiles list. To change the ARM profile associated with an 802.11a or 802.11g radio profile, select the associated ARM profile in the profiles list then click the drop-down list in the Profile Details section of the page to select a new profile.
High-throughput radio profile	A high-throughput profile manages 40 MHz tolerance settings, and controls whether or not APs using this profile will advertise intolerance of 40 MHz operation. (This option is disabled by default, allowing 40 MHz operation.) A high-throughput profile also determines whether an AP radio using the profile will stop using the 40 MHz channels surrounding APs or stations advertise 40 MHz intolerance. This option is enabled by default. For details on referencing a high-throughput radio profile, see "Assigning a High-throughput Profile". The high-throughput radio profile associated with this 802.11a or 802.11g radio profile appears beneath the 802.11a/802.11g radio profile name in the profiles list. To change the high-throughput radio profile associated with an 802.11a or 802.11g radio profile, select the associated high-throughput radio profile in the profiles list then click the drop-down list in the Profile Details section of the page to select a new profile.
Spectrum Monitoring Profile	The spectrum monitoring profile defines the spectrum band and device ageout times used by a spectrum monitor radio. The spectrum monitoring profile associated with this 802.11a or 802.11g radio profile appears beneath the 802.11a/802.11g radio profile name in the profiles list. To change the spectrum monitoring profile associated with an 802.11a or 802.11g radio profile, select the associated spectrum monitoring profile in the profiles list then click the drop-down list in the Profile Details section of the page to select a new profile.
AM Scanning Profile	The AM scanning profile associated with this 802.11a or 802.11g radio profile appears beneath the 802.11a/802.11g radio profile name in the profiles list. To change the AM scanning profile associated with an 802.11a or 802.11g radio profile, select the associated AM scanning profile in the profiles list then click the drop-down list in the Profile Details section of the page to select a new profile.

Assigning an 802.11a/802.11g Profile

Use the following procedure to assign an 802.11a or 802.11g RF management profile to an AP group or individual AP using the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new 802.11a or 802.11g RF management profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new 802.11a or 802.11g RF management profile
2. Under the Profiles list, expand the RF management menu.
3. To select a 802.11a radio profile for an AP or AP group, click 802.11a radio profile. In the Profile Details window pane, click the 802.11a radio profile drop-down list and select the desired profile from the list
   -or-
   To select a 802.11g radio profile for an AP or AP group, click 802.11g radio profile. In the Profile Details window pane, click the 802.11g radio profile drop-down list and select the desired profile from the list

4. Click Apply. The profile name appears in the Profile list with your configured settings. If you configure this for the AP group, this profile also becomes the selected 802.11a or 802.11g RF management profile used by the mesh portal for your mesh network.

Assigning a High-throughput Profile

Each 802.11a or 802.11g RF management radio profile references a high-throughput profile that manages the AP group's 40Mhz tolerance settings. By default, an 802.11a profile references a high-throughput profile named default-a and an 802.11g profile references a high-throughput profile named default-g. If you do not want to use these default profiles, use the procedure below to reference a different high-throughput profile for your 802.11a or 802.11g RF management profiles.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new high-throughput profile.
   - If you selected AP Specific, click the Edit button by the AP which you want to assign a new high-throughput profile.
2. In the Profiles list, expand the RF Management menu.
3. To reference a new high-throughput profile for an *802.11a* RF management profile, expand the 802.11a radio profile menu, then select High-throughput radio profile.
   -or-
   To reference a new high-throughput profile for an *802.11g* RF management profile, expand the 802.11g radio profile menu, then select High-throughput radio profile.
4. The Profile Details pane appears and displays information for the currently referenced high-throughput profile. Use this window pane to select a different high-throughput profile, or to create an entirely new high-throughput profile for that 802.11a or 802.11g radio.
   - To reference a different high-throughput profile, click the High-throughput Radio Profile drop-down list and select a new profile name from the list. Click Apply to save your changes.
   - To create a new high-throughput profile, click the High-throughput Radio Profile drop-down list and select NEW.
     a. Enter a name for the new high-throughput profile.
     b. *(Optional)* Select 40 MHz intolerance if you want to enable 40 MHz intolerance. This parameter controls whether or not APs using this high-throughput profile will advertise intolerance of 40 MHz operation. By default, this option is disabled and 40 MHz operation is allowed.
     d. *(Optional)* Select honor 40 MHz intolerance to allow a radio using this profile to stop using the 40 MHz channels if the 40 MHz intolerance indication is received from another AP or station. This option is enabled by default.
     d. Click Apply to save your settings.
5. The high-throughput profile name appears in the Profile list with your configured settings.

Assigning an ARM Profile

By default, an 802.11a or 802.11g profile references an ARM profile named default. Most network administrators will find that this one default ARM profile is sufficient to manage all the Dell APs on their WLAN. If, however, you do not want to use this default ARM profile, use the procedure below to reference a different ARM profile for your 802.11a or 802.11g RF management profiles.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new ARM profile.

- If you selected AP Specific, click the Edit button by the AP to which you want to assign a new ARM profile

2. Under the Profiles list, expand the RF Management menu.
3. To reference an ARM profile for a 802.11a radio profile, expand the 802.11a radio profile menu.

   -or-

   To reference an ARM profile for a 802.11g radio profile, expand the 802.11g radio profile menu.
4. The Profile Details pane appears and displays information for the currently referenced ARM profile. You can now select a different profile, or create an entirely new ARM profile for that 802.11a or 802.11g radio.
   - To reference a different ARM profile, click the Adaptive Radio Management (ARM) Profile drop-down list and select a new profile name from the list. Click Apply to save your changes.
   - To create a new ARM profile, click the Adaptive Radio Management (ARM) Profile drop-down list and select NEW.
     a. Enter a name for your new ARM profile.
     b. (Optional) If you are not configuring ARM for a mesh node, select 40 MHz intolerance if you want to enable 40 MHz intolerance. This parameter controls whether or not APs using this high-throughput profile will advertise intolerance of 40 MHz operation. By default, this option is disabled and 40 MHz operation is allowed.
     c. (Optional) If you are not configuring ARM for a mesh node, select honor 40 MHz intolerance to allow a radio using this profile to stop using the 40 MHz channels if the 40 MHz intolerance indication is received from another AP or station. This option is enabled by default.
5. Click Apply to save your settings.

The ARM profile name appears in the Profile list with your configured settings. If you configured this profile for the AP group, this ARM profile becomes part of the selected 802.11a or 802.11g RF management profile used by the mesh portal for your mesh network.

Editing an 802.11a/802.11g Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name using the 802.11a or 802.11g RF management profile you want to edit.
   - If you selected AP Specific, click the Edit button by the AP using the 802.11a or 802.11g RF management profile you want to edit.
2. Under the Profiles list, expand the RF menu.
3. To edit an 802.11a radio profile for an AP or AP group, click 802.11a radio profile. In the Profile Details window pane, click the 802.11a radio profile drop-down list and select the desired profile from the list
   -or-
   To select a 802.11g radio profile for an AP or AP group, click 802.11g radio profile. In the Profile Details window pane, click the 802.11g radio profile drop-down list and select the desired profile from the list
4. Change the profile settings as desired. Table 43 describes the parameters you can configure in the mesh 802.11a or 802.11g RF management profile.
5. Click Apply to save your changes.

Deleting a Profile

You can delete a mesh high-throughput SSID profile only if no APs or AP groups are associated with that profile. To delete a 802.11a or 802.11g radio profile using the WebUI.

1. Navigate to the Configuration > Advanced Services> All Profiles window.

2. Expand the RF menu, then select 802.11a radio profile or 802.11g radio profile. A list of profiles of the specified type appears in the Profile Details window pane.
3. Click the Delete button by the name of the profile you want to delete.

Managing 802.11a/802.11g Profiles In the CLI

You must be in config mode to create, modify or delete a 802.11a or 802.11g RF management radio profile using the CLI. Specify an existing mesh profile with the <profile-name> parameter to modify an existing profile, or enter a new name to create an entirely new profile.

Creating or Modifying a Profile

Configuration details and any default values for each of these parameters are described in Table 43 on page 233. This CLI command also allows you to reference an ARM profile and high-throughput radio profile for the 802.11a or 802.11g radio. If you do not specify a parameter for a new profile, that profile uses the default value for that parameter. Put the no option before any parameter to remove the current value for that parameter and return it to its default setting. Enter exit to leave the 802.11a or 802.11g profile mode.

```
rf dot11a-radio-profile|dot11g-radio-profile <profile-name>
   am-scan-profile
   arm-profile
   beacon-period
   beacon-regulate
   cap-reg-eirp
   channel
   channel-reuse
   channel-reuse-threshold
   clone
   csa
   csa-count
   disable-arm-wids-function
   dot11b-protection (for 802.11g radio profiles only)
   dot11h
   high-throughput-enable
   ht-radio-profile
   interference-immunity
   maximum-distance
   mgmt-frame-throttle-interval
   mgmt-frame-throttle-limit
   mode {ap-mode|am-mode|spectrum-mode}
   no
   radio-enable
   slb-mode
   slb-threshold
   slb-update-interval
   spectrum-load-bal-domain
   spectrum-load-balancing
   spectrum-monitoring
   spectrum-profile
   tpc-power
   tx-power
```

You can also create a new 802.11a or 802.11g RF management profile by copying the settings of an existing profile using the clone parameter. Using the `clone` command to create a new profile makes it easier to keep constant attributes in common within multiple profiles.

```
rf dot11a-radio-profile <profile-name>
   clone <source-profile-name>
rf dot11g-radio-profile <profile-name>
   clone <source-profile-name>
```

Viewing RF Management Settings

To view a complete list of 802.11a or 802.11g RF management profiles and their status:

```
show rf dot11a-radio-profile|dot11g-radio-profile
```

To view the settings of a specific RF management profile:

```
show rf dot11a-radio-profile|dot11g-radio-profile <profile-name>
```

Assigning a 802.11a/802.11g Profile

To assign an 802.11a or 802.11g RF management profile to an AP group:

```
ap-group <group> dot11a-radio-profile <profile-name>
```

-or-

```
ap-group <group> dot11g-radio-profile <profile-name>
```

To assign an 802.11a or 802.11g RF management profile to an individual AP:

```
ap-name <name> dot11a-radio-profile <profile-name>
```

-or-

```
ap-name <name> dot11g-radio-profile <profile-name>
```

Deleting a Profile

If no AP or AP group is using an RF management profile, you can delete that profile using the no parameter:

```
no rf dot11a-radio-profile <profile-name>
```

Mesh High-Throughput SSID Profiles

The mesh high-throughput SSID profile defines settings unique to 802.11n-capable, high-throughput APs. If none of the APs in your mesh deployment are 802.11n-capable APs, you do not need to configure a high-throughput SSID profile.

If you modify a currently provisioned and running high-throughput SSID profile, your changes take effect immediately. You do not reboot the controller or the AP.

Managing Profiles In the WebUI

Use the following procedures to manage your high-throughput SSID profiles using the WebUI.

Creating a Profile

To create a high-throughput SSID profile:

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group for which you want to create the new high-throughput SSID profile.
   - If you selected AP Specific, click Edit button by the AP for which you want to create the new high-throughput SSID profile.
2. In the Profiles list, expand the Mesh menu, then select Mesh High-throughput SSID profile.
3. In the Profile Details window pane, click the Mesh High-throughput SSID profile drop-down list and select NEW.

4. Enter a name for the new profile.
5. Configure the high-throughput SSID described in Table 44, then click Apply to save your settings. The profile name appears in the Mesh High-throughput SSID Profile list with your configured settings.

Table 44 *Mesh High-Throughput SSID Profile Configuration Parameters*

Parameter	Description
Mesh high-throughput SSID profile	Enter the name of an existing mesh high-throughput SSID profile to modify that profile, or enter a new name or create a new mesh high-throughput profile. The mesh high-throughput profile can have a maximum of 32 characters. To view existing high-throughput SSID radio profiles, use the command: `show ap mesh-radio-profile`.
High throughput enable (SSID)	Enable or disable high-throughput (802.11n) features on this SSID. This parameter is enabled by default.
40 MHz channel usage	Enable or disable the use of 40 MHz channels. This parameter is enabled by default.
Low-density Parity Check	If enabled, the AP will advertise Low-density Parity Check (LDPC) support. LDPC improves data transmission over radio channels with high levels of background noise.
MPDU Aggregation	Enable or disable MAC protocol data unit (MPDU) aggregation. High-throughput mesh APs are able to send aggregated MAC protocol data units (MDPUs), which allow an AP to receive a single block acknowledgment instead of multiple ACK signals. This option, which is enabled by default, reduces network traffic overhead by effectively eliminating the need to initiate a new transfer for every MPDU.
Max transmitted A-MPDU size	Maximum size of a transmitted aggregate MPDU, in bytes. Range: 1576–65535
Max received A-MPDU size	Maximum size of a received aggregate MPDU, in bytes. Allowed values: 8191, 16383, 32767, 65535.
Min MPDU start spacing	Minimum time between the start of adjacent MPDUs within an aggregate MPDU, in microseconds. Allowed values: 0 (No restriction on MDPU start spacing), .25 µsec, .5 µsec, 1 µsec, 2 µsec, 4 µsec.
Supported MCS set	A list of Modulation Coding Scheme (MCS) values or ranges of values to be supported on this SSID. The MCS you choose determines the channel width (20MHz vs. 40MHz) and the number of spatial streams used by the mesh node. The default value is 1–15; the complete set of supported values. To specify a smaller range of values, enter a hyphen between the lower and upper values. To specify a series of different values, separate each value with a comma. Examples: 2–10 1,3,6,9,12 Range: 0–15.
Short guard interval in 20 MHz mode	Enable or disable use of short (400ns) guard interval for a W-AP130 Series AP in 20 MHz mode. This parameter is enabled by default. A guard interval is a period of time between transmissions that allows reflections from the previous data transmission to settle before an AP transmits data again. An AP identifies any signal content received inside this interval as unwanted inter-symbol interference, and rejects that data. The 802.11n standard specifies two guard intervals: 400ns (short) and 800ns (long). Enabling a short guard interval can decrease network overhead by reducing unnecessary idle time on each AP. Some outdoor deployments, may, however require a longer guard interval. If the short guard interval does not allow enough time for reflections to settle in your mesh deployment, inter-symbol interference values may increase and degrade throughput.

Table 44 *Mesh High-Throughput SSID Profile Configuration Parameters (Continued)*

Parameter	Description
Short guard interval in 40 MHz mode	Enable or disable use of short (400ns) guard interval in 40 MHz mode. This parameter is enabled by default. A guard interval is a period of time between transmissions that allows reflections from the previous data transmission to settle before an AP transmits data again. An AP identifies any signal content received inside this interval as unwanted inter-symbol interference, and rejects that data. The 802.11n standard specifies two guard intervals: 400ns (short) and 800ns (long). Enabling a short guard interval can decrease network overhead by reducing unnecessary idle time on each AP. Some outdoor deployments, may, however require a longer guard interval. If the short guard interval does not allow enough time for reflections to settle in your mesh deployment, inter-symbol interference values may increase and degrade throughput.
Maximum number of spatial streams usable for STBC reception	Controls the maximum number of spatial streams usable for STBC reception. 0 disables STBC reception, 1 uses STBC for MCS 0-7. Higher MCS values are not supported. (Supported on the W-AP90 Series series, W-AP130 Series, W-AP68, W-AP175 and W-AP105 only. The configured value will be adjusted based on AP capabilities.)
Maximum number of spatial streams usable for STBC transmission.	Controls the maximum number of spatial streams usable for STBC transmission. 0 disables STBC transmission, 1 uses STBC for MCS 0-7. Higher MCS values are not supported. (Supported on W-AP90 Series series, W-AP175, W-AP130 Seriesand W-AP105 only. The configured value will be adjusted based on AP capabilities.)
Legacy stations	Allow or disallow associations from legacy (non-HT) stations. By default, this parameter is enabled (legacy stations are allowed).

Assigning a Profile to an AP Group

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new high-throughput SSID profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new high-throughput SSID profile
2. Under the Profiles list, expand the Mesh menu, then select Mesh High-throughput SSID profile.
3. In the Profile Details window pane, click the Mesh High-throughput SSID profile drop-down list and select the desired profile from the list.
4. Click Apply. The profile name appears in the Mesh High-throughput SSID Profile list with your configured settings. If you configure this for the AP group, this profile also becomes the selected high-throughput SSID profile used by the mesh portal for your mesh network.

Editing a Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name with the profile you want to edit.
   - If you selected the AP Specific tab, click the Edit button by the AP with the profile you want to edit.
2. In the Profiles list, expand the Mesh menu, then select Mesh High-throughput SSID profile.
3. In the Profile Details window pane, click the Mesh High-throughput SSID profile drop-down list and select the name of the profile you want to edit.
4. Change the settings as desired. Table 44 describes the parameters you can configure in this profile.
5. Click Apply to save your changes.

Deleting a Profile

You can delete a mesh high-throughput SSID profile only if no APs or AP groups are associated with that profile.

1. Navigate to the Configuration > Advanced Services> All Profiles window.
2. Expand the Mesh menu, then select Mesh High-throughput SSID profile. A list of high-throughput SSID profiles appears in the Profile Details window pane.
3. Click the Delete button by the name of the profile you want to delete.

Managing Profiles In the CLI

You must be in config mode to create, modify or delete a mesh radio profile using the CLI. Specify an existing high-throughput SSID profile with the <profile-name> parameter to modify an existing profile, or enter a new name to create an entirely new profile.

Creating or Modifying a Profile

Configuration details and any default values for each of these parameters are described in Table 44 on page 241. If you do not specify a parameter for a new profile, that profile uses the default value for that parameter. Put the no option before any parameter to remove the current value for that parameter and return it to its default setting.Enter exit to leave the high-throughput radio profile mode

```
ap mesh-ht-ssid-profile <profile-name>
   40MHz-enable
   clone
   high-throughput-enable
   legacy-stations
   max-rx-a-mpdu-size
   max-tx-a-mpdu-size
   min-mpdu-start-spacing
   mpdu-agg
   no
   short-guard-intvl-20mhz
   short-guard-intvl-40mhz
   stbc-rx-streams
   stbc-tx-streams
   supported-mcs-set
```

You can also create a new mesh high-throughput SSID profile by copying the settings of an existing profile using the clone parameter. Using the `clone` command to create a new profile makes it easier to keep constant attributes in common within multiple profiles.

```
ap mesh-ht-ssid-profile <profile-name> clone <source-profile-name>
```

Assigning a Profile to an AP Group

To associate a mesh high-throughput SSID profile with an AP group:

```
ap-group <group> mesh-ht-ssid-profile <profile-name>
```

To associate a mesh radio profile with an individual AP:

```
ap-name <name> mesh-ht-ssid-profile <profile-name>
```

Viewing High-throughput SSID Settings

To view a complete list of high-throughput profiles and their status:

```
show ap mesh-ht-ssid-profile
```

To view the settings of a specific high-throughput profile:

```
show ap mesh-ht-ssid-profile <profile-name>
```

Deleting a Profile

If no AP or AP group is using a mesh high-throughput SSID profile, you can delete that profile using the no parameter:

```
no ap mesh-ht-ssid-profile <profile-name>
```

Mesh Cluster Profiles

The mesh cluster configuration gets pushed from the controller to the mesh portal and the other mesh points, which allows them to inherit the characteristics of the mesh cluster of which they are a member. Mesh nodes are grouped according to a mesh cluster profile that contains the MSSID, authentication methods, security credentials, and cluster priority. Cluster profiles, including the "default" profile, are not applied until you provision your APs for mesh.

Since the mesh cluster profile provides the framework of the mesh network, you must define and configure the mesh cluster profile before configuring an AP to operate as a mesh node. You can use either the "default" cluster profile or create your own. If you find it necessary to define more than one mesh cluster profile, you must assign priorities to each profile to allow the Mesh AP group to identify the primary and backup mesh cluster profile(s). The primary mesh cluster profile and each backup mesh cluster profile must be configured to use the same RF channel. The APs may not provision correctly if they are assigned to a backup mesh cluster profile with a different RF channel than the primary mesh cluster profile.

If the mesh cluster profile is unavailable, the mesh node can revert to the recovery profile to bring-up the mesh network until the cluster profile is available. You can also exclude one or more mesh cluster profiles from an individual AP—this prevents a mesh cluster profile defined at the AP group level from being applied to a specific AP.

Do not delete or modify mesh cluster profiles once you use them to provision mesh nodes. You can recover the mesh point if the original cluster profile is still available. Dell recommends creating a new mesh cluster profile if needed. If you modify any mesh cluster setting, you must reprovision your AP for the changes to take effect (this also causes the AP to automatically reboot). See "Provisioning Mesh Nodes" for more information.

Deployments with Multiple Mesh Cluster Profiles

If you configure multiple cluster profiles with different cluster priorities, you manually override the link metric algorithm because the priority takes precedence over the path cost. In this scenario, the mesh portal uses the profile with the highest priority to bring-up the mesh network. The mesh portal stores and advertises that one profile to neighboring mesh nodes to build the mesh network. This profile is known as the "primary" cluster profile. Mesh points, in contrast, go through the list of configured mesh cluster profiles in order of priority to find the profile being advertised by the mesh portal. Once the primary profile has been identified, the other profiles are considered "backup" cluster profiles. Use this deployment if you want to enforce a particular mesh topology rather than allowing the link metric algorithm to determine the topology.

For this scenario, do the following:

- Configure multiple mesh cluster profiles with different priorities. The primary cluster profile has a lower priority number, which gives it a higher priority.
- Configure the mesh radio profile.
- Create an AP group for 802.11a radios and 802.11g radios
- Configure the 802.11a or 802.11g RF management profiles for each AP group.
- If your deployment includes high-throughput APs, configure the mesh high-throughput SSID profile. The mesh radio profile will use the default high-throughput SSID profile unless you specifically configure the mesh radio profile to use a different high-throughput SSID profile
- Create an AP group for each 802.11a channel.

If a mesh link breaks or the primary cluster profile is unavailable, mesh nodes use the highest priority backup cluster profile to re-establish the uplink or check for parents in the backup profiles. If these profiles are unavailable, the mesh node can revert to the recovery profile to bring up the mesh network until a cluster profile is available. For a sample configuration, see "show ap mesh topology".

Managing Mesh Cluster Profiles In the WebUI

Use the following procedures to define and manage mesh cluster profiles using the WebUI.

Creating a Profile

1. Navigate to the Configuration > Wireless > AP Configuration window. Select the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name for which you want to create the new mesh cluster profile.
   - If you selected AP Specific, click the Edit button by AP for which you want to create the new mesh cluster profile.
2. In the Profiles list, expand the Mesh menu, then select Mesh Cluster profile.
3. In the Profile Details window pane, click the Add a profile drop-down list and select NEW.
4. Enter a name for the new profile.
5. Configure the mesh cluster settings described in Table 45, then click Apply to save your settings.

Table 45 *Mesh Cluster Profile Configuration Parameters*

Parameter	Description
Profile Name	Name of the mesh cluster profile. The name must be 1–63 characters. Default: Mesh cluster profile named "default."
Cluster Name	Indicates the mesh cluster name. The name can have a maximum of 32 characters, and is used as the MSSID for the mesh cluster. When you first create a new mesh cluster profile, the profile uses the default cluster name "Dell-mesh". Use the Cluster Name parameter to define a new, unique MSSID before you assign APs or AP groups to the mesh cluster profile. NOTE: If you want a mesh cluster to use WPA2-PSK-AES encryption, *do not use spaces in the mesh cluster name*, as this may cause errors in mesh points associated with that mesh cluster. To view existing mesh cluster profiles, use the CLI command: `show ap mesh-cluster-profile`. A mesh portal chooses the best cluster profile and provisions it for use. A mesh point can have a maximum of 16 cluster profiles. Default: Mesh cluster named "Dell-mesh."
RF Band	Indicates the band for mesh operation for multiband radios. Select a or g. Important: If you create more than one mesh cluster profile for an AP or AP group, *each mesh cluster profile must use the same band*.
Encryption	Configures the data encryption, which can be either opensystem (no authentication or encryption) or wpa2-psk-aes (WPA2 with AES encryption using a preshared key). Dell recommends selecting wpa2-psk-aes and using the wpa-passphrase parameter to select a passphrase. Keep the passphrase in a safe place. Default: opensystem.
WPA Hexkey	Configures a WPA pre-shared key. This key must be 64 hexadecimal characters
WPA Passphrase	Sets the WPA password that generates the PSK. The passphrase must be between 8–63 characters, inclusive.

Table 45 *Mesh Cluster Profile Configuration Parameters (Continued)*

Parameter	Description
Priority	Indicates the priority of the cluster profile. The mesh cluster priority determines the order by which the mesh cluster profiles are used. This allows you, rather than the link metric algorithm, to control the network topology by defining the cluster profiles to use if one becomes unavailable Specify the cluster priority when creating a new profile or adding an existing profile to a mesh cluster. If more than two mesh cluster profiles are configured, mesh points use the priority numbers to identify primary and backup profile(s). NOTE: The lower the number, the higher the priority. Therefore, the profile with the lowest number is the primary profile. Each profile must use a unique priority value to ensure a deterministic mesh path. Default: 1 for the "default" mesh cluster profile and all user-created cluster profiles. The recovery profile has a priority of 255 (this is not a user-configured profile). The range is 1–16.
Cluster Name	Indicates the mesh cluster name. The name can have a maximum of 32 characters, which is used as the MSSID. When you create a new cluster profile, it is a member of the "Dell-mesh" cluster. NOTE: Each mesh cluster profile should have a unique MSSID. Configure a new MSSID before you apply the mesh cluster profile. To view existing mesh cluster profiles, use the command: `show ap mesh-cluster-profile`. A mesh portal chooses the best cluster profile and provisions it for use. A mesh point can have a maximum of 16 cluster profiles. Default: Mesh cluster named "Dell-mesh."
RF Band	Indicates the band for mesh operation for multiband radios. Select a or g.

Associating a Profile to Mesh APs

Use the following procedure to associate a mesh cluster profile to a group of mesh APs or an individual mesh AP using the WebUI. If you configure multiple cluster profiles with different cluster priorities, you manually override the link metric algorithm because the priority takes precedence over the path cost. In this scenario, the mesh portal uses the profile with the highest priority to bring-up the mesh network.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new mesh cluster profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new mesh cluster profile
2. Under the Profiles list, expand the Mesh menu, then select Mesh Cluster profile.
3. In the Profile Details window pane, click the Mesh Cluster profile drop-down list select New.
   - To add an existing mesh cluster profile to the selected AP group, click the Add a profile drop-down list and select a new profile name from the list.
   - To create a new mesh cluster profile to the selected AP group, click the Add a profile drop-down list and select NEW. Enter a name for the new mesh cluster profile.
4. Click the using priority drop-down list to select a priority for the mesh cluster profile. The lower the number, the higher the priority.
5. Click Add to add the mesh cluster profile to the AP group.
6. Click Apply. The profile name appears in the mesh cluster profile list with your configured settings. If you configure this for the AP group, this profile also becomes the mesh cluster profile used by the mesh portal for your mesh network.

Editing a Profile

If you modify any mesh cluster profile setting, you must reprovision your AP. For example, if you change the priority of a cluster profile from 5 to 2, you must reprovision the AP before you can assign priority 5 to another cluster profile. Reprovisioning the AP causes it to automatically reboot. For more information, see "Provisioning Mesh Nodes".

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the AP group name with the profile you want to edit.
   - If you selected the AP Specific tab, click the Edit button by the AP with the profile you want to edit.
2. In the Profiles list, expand the Mesh menu, then select Mesh Cluster profile.
3. In the Profile Details window pane, click the Mesh Cluster profile drop-down list and select the name of the profile you want to edit.
4. Change the desired mesh radio settings as desired. Table 44 describes the parameters you can configure in the mesh high-throughput SSID profile.

NOTE: A mesh cluster profile configured with wpa2-psk-aes encryption must have a defined WPA hexkey or a WPA passphrase (or both). If you have configured one encryption type but not the other, and want switch from a hexkey to a passphrase or vice versa, you must add the new encryption type, click Apply, then remove the encryption type you no longer want and click Apply again. You cannot delete one encryption type and add a different type in a single step.

5. Click Apply to save your changes.

Deleting a Mesh Cluster Profile

You can delete a mesh cluster profile only if no APs or AP groups are associated with that profile.

1. Navigate to the Configuration > Advanced Services> All Profiles window.
2. Expand the Mesh menu, then select Mesh Cluster profile. A list of high-throughput SSID profiles appears in the *Profile Details* window pane.
3. Click the Delete button by the name of the profile you want to delete.

Managing Mesh Cluster Profiles In the CLI

You must be in config mode to create, modify or delete a mesh cluster profile using the CLI. Specify an existing mesh cluster profile with the <profile-name> parameter to modify an existing profile, or enter a new name to create an entirely new profile.

Configuration details and any default values for each of these parameters are described in Table 45 on page 245. If you do not specify a parameter for a new profile, that profile uses the default value for that parameter.

Use the no option before any parameter to remove the current value for that parameter and return it to its default setting. Enter exit to leave the mesh cluster profile mode.

```
ap mesh-cluster-profile <profile>
   clone <profile>
   cluster <name>
   no ...
   opmode [opensystem | wpa2-psk-aes]
   rf-band {a | g}
   wpa-hexkey <wpa-hexkey>
   wpa-passphrase <wpa-passphrase>
```

The following examples create and configure the mesh cluster profiles cluster1 and cluster2.

```
ap mesh-cluster-profile cluster1
```

```
      cluster corporate
      opmode wpa2-psk-aes
      wpa-passphrase mesh_123
      rf-band a

ap mesh-cluster-profile cluster2
      cluster corporate
      opmode wpa2-psk-aes
      wpa-passphrase mesh_123
      rf-band a
```

You can also create a new mesh radio profile by copying the settings of an existing profile using the clone parameter. Using the `clone` command to create a new profile makes it easier to keep constant attributes in common within multiple profiles.

```
    ap mesh-cluster-profile <profile-name>
       clone <source-profile-name>
```

Viewing Mesh Cluster Profile Settings

To view a complete list of mesh cluster profiles and their status:

```
show mesh-cluster-profile
```

To view the settings of a specific mesh cluster profile:

```
show ap mesh-cluster-profile <profile-name>
```

Associating Mesh Cluster Profiles

The following commands associate a mesh cluster profile to an AP group or an individual AP. For deployments with multiple mesh clusters, you must also configure also the profile's priority. Remember, the lower the priority number, the high the priority. The mesh cluster priority determines the order by which the mesh cluster profiles are used. This allows you, rather than the link metric algorithm, to control the network topology by defining the cluster profiles to use if one becomes unavailable.

To associate a mesh cluster profile to an AP group in a single-cluster deployment:

```
ap-group <group> mesh-cluster-profile <profile-name>
```

To associate a mesh cluster profile to an individual AP in a single-cluster deployment:

```
ap-name <name> mesh-cluster-profile <profile-name>
```

To associate a mesh cluster profile to an AP group in a multiple-cluster deployment:

```
ap-group <group> mesh-cluster-profile <profile-name> priority <priority>
```

To associate a mesh cluster profile to an individual AP in a multiple-cluster deployment, use the command

```
ap-name <name>
   mesh-cluster-profile <profile-name> priority <priority>
```

Example:

```
ap-group group1
   mesh-cluster-profile cluster1 priority 5
   mesh-cluster-profile cluster2 priority 10
ap-group2
   mesh-cluster-profile cluster1 priority 10
   mesh-cluster-profile cluster2 priority 5
   mesh-radio-profile channel2
```

Excluding a Mesh Cluster Profile from a Mesh Node

To exclude a specific mesh cluster profile from an AP:

```
ap-name <name> exclude-mesh-cluster-profile-ap <profile-name>
```

Deleting a Mesh Cluster Profile

If no AP or is using a mesh cluster profile, you can delete that profile using the no parameter:

```
no ap mesh-cluster-profile <profile-name>
```

Ethernet Ports for Mesh

If you are using mesh to join multiple Ethernet LANs, configure and enable bridging on the mesh point Ethernet port This section describes how to configure Ethernet ports for bridging or secure jack operation using the wired AP profile. The wired AP profile controls the configuration of the Ethernet port(s) on your AP.

NOTE: Mesh nodes only support bridge mode and tunnel mode on their wired ports (enet0 or enet1). Split tunnel mode is not supported. Use bridge mode to configure bridging on the mesh point Ethernet port. Use tunnel mode to configure secure jack operation on the mesh node Ethernet port.

When configuring the Ethernet ports on the W-AP130 Series or W-AP120 Series, note the following requirements:

- If the AP is configured as a mesh portal:
  - Connect enet0 to the controller to obtain an IP address. The wired AP profile controls enet1.
  - Only enet1 supports secure jack operation.
- If the AP is configured as a mesh point, the same wired AP profile will control both enet0 and enet1.

Configure bridging on the Ethernet port

Use the following procedure to configure bridging on the Ethernet port via the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration > AP Group window.
2. Click the Edit button by the AP group name with the wired ap profile you want to edit.
3. Under the Profiles list, expand the AP menu, then select Wired AP profile. The settings for the currently selected wired AP profile appear.

   You can use a different wired AP profile by selecting a profile from the Wired AP profile drop-down list.
4. Under Profile Details, do the following:
   a. Select the Wired AP enable check box. This option is not selected by default.
   b. From the Forward mode drop-down list, select bridge.
   c. Optionally, from the Switchport mode drop-down list, select access or trunk. These options only apply to bridge mode configurations.
      - Access mode forwards untagged packets received on the port to the controller and they appear on the configured access mode VLAN. Tagged packets are dropped. All packets received from the controller and sent via this port are untagged. Define the access mode VLAN in the Access mode VLAN field.
      - Trunk mode contains a list of allowed VLANs. Any packet received on the port that is tagged with an allowed VLAN is forwarded to the controller. Untagged packets are forwarded to the controller on the configured Native VLAN. Packets received from the controller and sent out the port remain tagged unless the tag value in the packet is the Native VLAN, in which case the tag is removed. Define the Native VLAN in the Trunk mode native VLAN field and the other allowed VLANs in the Trunk mode allowed VLANs field.
   d. Optionally, select Trusted to configure this as a trusted port.
5. Click Apply.

Use the following commands to configure ethernet port bridging via the CLI.

```
ap wired-ap-profile <profile>
```

```
      forward-mode bridge
      wired-ap-enable
```

Optionally, you can configure the following wired AP profile settings:

```
ap wired-ap-profile <profile>
      switchport mode {access | trunk}
      switchport access vlan <vlan>
      switchport trunk native vlan <vlan>
      switchport trunk allowed vlan <vlan>
      trusted
```

Configuring Ethernet Ports for Secure Jack Operation

You can configure the Ethernet port(s) on mesh nodes to operate in tunnel mode. Known as secure jack operation for mesh, this configuration allows Ethernet frames coming into the specified wired interface to be generic routing encapsulation (GRE) tunneled to the controller. Likewise, Ethernet frames coming from the tunnel are bridged to the corresponding wired interface. This allows an Ethernet port on the mesh node to appear as an Ethernet port on the controller separated by one or more Layer-3 domains. You can also enable VLAN tagging.

Unlike secure jack on non-mesh APs, any mesh node configured for secure jack uses the mesh link, rather than enet0, to tunnel the frame to the controller.

When configuring mesh Ethernet ports for secure jack operation, note the following guidelines:

- Mesh points support secure jack on enet0 and enet1.
- Mesh portals only support secure jack on enet1. This function is only applicable to Dell APs that support a second Ethernet port and mesh, such as the W-AP130 Series and W-AP120 Series.

You configure secure jack operation in the wired AP profile.

NOTE: The parameters in the wired AP profile only apply to the wired AP interface to which they are applied. Two wired interfaces can have different parameter values.

In the WebUI

Use the following procedure to configure secure jack operation using the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration > AP Group window.
2. Click the Edit button by the AP group with the wired AP profile you want to edit.
3. Under the Profiles list, expand the AP menu, then select Wired AP profile. The settings for the currently selected wired AP profile appear.

   You can use a different wired AP profile by selecting a profile from the Wired AP profile drop-down list.
4. In the Profile Details window pane, do the following:
   a. Select the Wired AP enable check box. This option is not selected by default.
   b. From the Forward mode drop-down list, select tunnel.
   c. Optionally, select Trusted to configure this as a trusted port.
5. Click Apply to save your settings.

In the CLI

To configure secure jack operation using the command-line interface, access the CLI in config mode and issue the following commands:

```
ap wired-ap-profile <profile>
      forward-mode tunnel
      wired-ap-enable
```

Optionally, you can configure the following wired AP profile settings:

```
ap wired-ap-profile <profile>
      trusted
```

Extending the Life of a Mesh Network

To prevent your mesh network from going down if you experience a controller failure, modify the following settings in the AP system profile(s) used by mesh nodes to maintain the mesh network until the controller is available:

NOTE: Dell recommends the default maximum request retries and bootstrap threshold settings for most mesh networks; however, if you must keep your mesh network alive, you can modify the settings as described in this section. The modified settings are not applicable if mesh portals are directly connected to the controller.

- Maximum request retries—Maximum number of times to retry AP-generated requests. The default is 10 times. If you must modify this setting, Dell recommends a value of 10,000.
- Bootstrap threshold—Number of consecutive missed heartbeats before the AP rebootstraps. (Heartbeats are sent once per second.) The default is 9 missed heartbeats. If you must modify this setting, Dell recommends a value of 5,000.

When the controller comes back online, the affected mesh nodes (mesh portals and mesh points) will rebootstrap; however, the mesh link is not affected and will continue to be up.

In the WebUI

Use the following procedure to modify the AP system profile via the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration > AP Group window.
2. Click the Edit button by the AP group with the AP system profile you want to edit.
3. Under Profiles list, expand the AP menu, then select AP system profile. The settings for the currently selected AP system profile appear in the Profile Details window pane.
4. Make the following changes in the Profile Details window pane.
   a. Change the Maximum Request Retries to 10000.
   b. Change the Bootstrap threshold to 5000.
5. Click Apply.

In the CLI

To modify the AP system profile via the command-line interface, access the CLI in config mode and issue the following commands:

```
ap system-profile <profile>
      max-request-retries 10000
      bootstrap-threshold 5000
```

Provisioning Mesh Nodes

Provisioning mesh nodes is similar to thin APs; however, there are some key differences. Thin APs establish a channel to the controller from which they receive the configuration for each radio interface. Mesh nodes, in contrast, get their radio interfaces up and running before making contact with the controller. This requires a minimum set of parameters from the AP group and mesh cluster that enables the mesh node to discover a neighbor to create a mesh link and subsequent channel with the controller. To do this, you must first configure mesh cluster profiles for each mesh node prior to deployment. See “Mesh Radio Profiles” for more information.

On each radio interface, you provision a mode of operation: mesh node or thin AP (access) mode. If you do not specify mesh, the AP operates in thin AP (access) mode. If you configure mesh, the AP is provisioned with a minimum of two mesh cluster profiles: the "default" mesh cluster profile and an emergency read-only recovery profile, as described in the section "Mesh Clusters". If you create and select multiple mesh cluster profiles, the AP is provisioned with those as well. If you have a dual-radio AP and configure one radio for mesh and the other as a thin AP, each radio will be provisioned as configured.

Each radio provisioned in mesh mode can operate in one of two roles: mesh portal or mesh point. You explicitly configure the role, as described in this section. This allows the AP to know whether it uses the mesh link (via the mesh point/mesh portal) or an Ethernet link to establish a connection to the controller.

During the provisioning process, mesh nodes look for a mesh profile that the AP group and AP name is a member of and stores that information in flash. If you have multiple cluster profiles, the mesh portal uses the best profile to bring-up the mesh network. Mesh points in contrast go through the list of mesh cluster profiles in order of priority to decide which profile to use to associate themselves with the network. In addition, when a mesh point is provisioned, the country code is sent to the AP from its AP name or AP group along with the mesh cluster profiles. Mesh nodes also learn the recovery profile, which is automatically generated by the master controller. If the other mesh cluster profiles are unavailable, mesh nodes will use the recovery profile to establish a link to the master controller; data forwarding does not take place.

NOTE: If you create a new mesh cluster profile for an existing deployment, you must re-provision the AP for the new profile to take effect. If you re-provision mesh nodes that are already operating, re-provision the most distant (highest hop count) mesh points first followed by the mesh portals. If you re-provision the mesh portal first, the mesh points may be unable to form a mesh link. Re-provisioning the AP causes it to automatically reboot. This may cause a disruption of service to the network.

This section describes the following topics:

- "Outdoor AP Parameters"
- "Provisioning Caveats"
- "Provisioning Mesh Nodes"

Outdoor AP Parameters

If you are using outdoor APs and planning an outdoor mesh deployment, you can enter the following outdoor parameters when provisioning the AP:

- Latitude and longitude coordinates of the AP. These location identifiers allow you to more easily locate the AP for inventory and troubleshooting purposes.
- Altitude, in meters, of the AP.
- Antenna bearing to determine horizontal coverage.
- Antenna angle for optimum antenna coverage.

NOTE: The above parameters apply to all outdoor APs, not just outdoor APs configured for mesh.

Provisioning Caveats

Remember the following when provisioning APs for mesh:

- You must provision the AP before you install it as a mesh node in a mesh deployment. To provision the AP, it must be physically connected to the local network or directly connected to the controller. When connected and powered on, the AP must also be able to obtain an IP address from a DHCP server on the local network or from the controller.
- Make sure the provisioned mesh nodes form a connected mesh network before physically deploying the APs. For more information, see "Verifying the Network".

- In multi-controller networks, save your mesh cluster configuration before provisioning the mesh nodes. To save your configuration in the WebUI, at the top of any window click Save Configuration. To save your configuration in the CLI, use the command: `write memory`.
- If the same port on the controller is used to provision APs and provide PoE for mesh nodes, you must stop traffic from passing through that port after you provision the AP. To stop traffic, shut down (disable) the port either by using the CLI command interface fastethernet <slot>/<port> shutdown, or by following the procedure below.
  1. Navigate to the Configuration > Network > Ports window.
  2. Under Port Selection, click the port to configure.
  3. Under Configure Selected Port, deselect (uncheck) Enable Port.
  4. Make sure Enable 802.3af Power Over Ethernet is selected.
  5. Click Apply.

Provisioning Mesh Nodes

Reprovisioning the AP causes it to automatically reboot. The following procedures describe the process to provision a mesh portal or mesh node via the WebUI or CLI. (The easiest way to provision a mesh node is to use the Provisioning window in the WebUI.) To provision a remote mesh portal, see "Remote Mesh Portals".

In the WebUI

1. Navigate to the Configuration > Wireless > AP Installation > Provisioning window. Select the AP to provision for mesh and click Provision.
2. In the Master Discovery section, set the Master IP address as the controller IP address.
3. In the IP settings section, select Obtain IP Address Using DHCP.
4. In the AP List section, do the following:
   - Configure the Mesh Role:
     - To configure the AP as the mesh portal, select Mesh Portal.
     - To configure the AP as a mesh point, select Mesh Point
   - Configure the Outdoor Parameters, if needed. The following parameters are available only if configuring an outdoor AP:
     - Latitude coordinates (degrees, minutes, seconds, north or south)
     - Longitude coordinates (degrees, minutes, seconds, east or west)
     - Altitude (in meters)
     - Antenna bearing (horizontal coverage)
     - Antenna tilt angle (optimum coverage)
5. Click Apply and Reboot. After the controller reboots, mesh cluster profiles are extracted from the AP group and the AP name.

In the CLI

When you use the command-line interface to reprovision a mesh node, you may also provision other AP settings. To provision a remote mesh portal, see "Remote Mesh Portals".

Access the CLI in config mode and issue the following commands:

```
provision-ap
      read-bootinfo ap-name <name>
      mesh-role {mesh-point|mesh-portal}
      reprovision ap-name <name>
```

If you are provisioning an outdoor AP, you can also configure the following parameters:

```
provision-ap
      read-bootinfo ap-name <name>
      mesh-role {mesh-point|mesh-portal|remote-mesh-portal}
      a-ant-bearing <bearing>
      a-ant-tilt-angle <angle>
      g-ant-bearing <bearing>
      g-ant-tilt-angle <angle>
      altitude <altitude>
      latitude <location>
      longitude <location>
      reprovision ap-name <name>
```

AP Boot Sequence

The information in this section describes the boot sequence for mesh APs. Depending on their configured role, the AP performs a slightly different boot sequence.

Mesh Portal

When the mesh portal boots, it recognizes that one radio is configured to operate as a mesh portal. It then obtains an IP address from a DHCP server on its Ethernet interface, discovers the master controller on that interface, registers the mesh radio with the controller, and obtains regulatory domain and mesh radio profiles for each mesh point interface. A mesh virtual AP is created on the mesh portal radio interface, the regulatory domain and radio profiles are used to bring up the radio on the correct channel, and the provisioned mesh cluster profile is used to setup the mesh virtual AP with the correct announcements on beacons and probe responses. On the non-mesh radio provisioned for access mode, that radio is a thin AP and everything on that interface works as a thin AP radio interface.

If the 802.11a/802.11g radio profile assigned to the mesh radio is enabled, the radio will support both mesh backhaul and client access Virtual APs. If the mesh radio is to be used exclusively for mesh backhaul traffic, associate that radio to a dedicated 802.11a/802.11g radio profile with the radio disabled so the mesh radios will carry backhaul traffic only.

Mesh Point

When the mesh point boots, it scans for neighboring mesh nodes to establish a link to the mesh portal. All of the mesh nodes that establish the link are in the same mesh cluster. After the link is up, the mesh point uses the DHCP to obtain an IP address and uses the same master controller as their parent. The remaining boot sequence, if applicable, is similar to that of a thin AP. Remember, the priority of the mesh point is establishing a link with neighboring mesh nodes, not establishing a control link to the controller.

NOTE: In a single hop environment, the mesh point establishes a direct link with the mesh portal.

Air Monitoring and Mesh

Each mesh node has an air monitor (AM) process that registers the BSSID and the MAC address of the mesh node to distinguish it from a thin AP. This allows the WLAN management system (WMS) on the controller and AMs deployed in your network to distinguish between APs, wireless clients, and mesh nodes. The WMS tables also identify the mesh nodes.

For all thin APs and mesh nodes, the AM identifies a mesh node from other packets monitored on the air, and the AM will not trigger “wireless-bridging” events for packets transmitted between mesh nodes.

Verifying the Network

To view a list of your Mesh APs via the WebUI, navigate to the one of the following windows:

- Monitoring > Network > All Mesh Nodes
- Monitoring > Controller> Mesh Nodes

To view mesh APs and the mesh topology tree using the command line interface, access the command-line interface in enable mode and issue the following commands:

- `show ap mesh active`
- `show ap mesh topology`

Verification Checklist

After provisioning the mesh APs, follow the steps below to ensure that the mesh network is up and operating correctly.

- Issue the command show ap mesh topology to verify all the mesh APs are up and the topology is as expected. (Wait 10 minutes after startup for the topology to stabilize.)
- Verify each mesh node has the expected RSSI to its neighboring mesh nodes. The mesh topology is updated periodically, so access the command-line interface and issue the command show ap mesh neighbors for the current status. If the RSSI is low, verify that the tx-power settings in the mesh node's 802.11a/802.11g radio profiles are correct, or, if ARM is used, verify the correct minimum tx-power setting.
- Issue the command show ap mesh debug provisioned-clusters to verify that the mesh clusters are correctly defined and provisioned (with encryption if desired). Issue the show running-config | include recovery command to verify that the cluster's recovery profile matches the controller's.
- Verify antenna provisioning by issuing the show ap provisioning command and verify installation parameters for non-default installations (e.g. standard indoor APs deployed outside, or W-AP175 outdoor APs deployed inside.). Ensure all APs use the same channel list by issuing the show ap allowed-channels command.
- *If the mesh-radio is to be reserved exclusively for mesh backhaul traffic,* issue the show ap profile-usage command to identify the radio's 802.11a or 802.11g radio profile, then issue the command show rf dot11a-radio-profile <profile> or show rf dot11g-radio-profile <profile> to verify the radio is disabled in the profile. Next, use the show ap bss-table command to that verify no access Virtual APs are up on the mesh radio.

CLI Examples

Use the show ap mesh active command to verify all nodes are present and that EIRP is correct:

```
(host) # show ap mesh active

Mesh Cluster Name: ad-sw-mesh3400
---------------------------------
Name      Group    IP Address    BSSID             Band/Ch/EIRP/MaxEIRP  MTU   Enet Ports     Mesh Role  Parent
#Children  AP Type  Uptime
----      -----    ----------    -----             --------------------  --- ----------     ---------  ------    ------
---  -------  ------
point-13 default 10.3.129.140 00:1a:1e:25:99:50 802.11a/149+/19/19          Tunnel/Tunnel Point    portal-9 0
125      1h:20m:52s
point-17 default 10.3.129.31  00:0b:86:38:7a:c0 802.11a/149/23/23           Tunnel       Point     portal-9 0
60       33m:31s
point-18 default 10.3.129.29  00:24:6c:80:db:b8 802.11a/149+/24/24          Tunnel       Point     portal-9 0
105      39m:56s
portal-9 default 10.3.129.53  d8:c7:c8:80:0c:b0 802.11a/149+/21/21   1500 -/Tunnel      Portal    -        3
134      42m:48s
Total APs :4
```

Use the show ap mesh topology command to verify the cluster topology, RSSI in presence of network traffic, and Tx and Rx rates.

```
(host) # show ap mesh topology (
Mesh Cluster Name: ad-sw-mesh3400
---------------------------------
Name      Mesh Role   Parent    Path Cost  Node Cost  Link Cost  Hop Count  RSSI  Rate Tx/Rx  Last Update  Uplink Age
#Children
----      ---------   ------    ---------  ---------  ---------  ---------  ----  ----------  -----------  ----------  -
point-13  Point (N)   portal-9  3          0          0          1          66    300/300     1m:26s       9m:51s      0
point-17  Point       portal-9  2          0          0          1          46    54/54       7m:30s       32m:49s     0
point-18  Point (N)   portal-9  3          0          0          1          26    180/6       1m:36s       1m:40s      0
portal-9  Portal (N)  -         0          3          0          0          0     -           1m:40s       42m:59s     3
Total APs :4
(R): Recovery AP. (N): 11N Enabled. For Portals 'Uplink Age' equals uptime.
```

Issue the command show ap mesh neighbors ap-name <name> to verify visibility of other mesh nodes is as expected:

```
(host) # show ap mesh neighbors ap-name point-18
Neighbor list:
--------------
MAC                Portal             Channel  Age  Hops  Cost   Relation   Flags  RSSI  Rate Tx/Rx  A-Req  A-Resp  A-
Fail  HT-Details       Cluster \
ID
-----------------  -----------------  -------  ---  ----  ----   --------   -----  ----  ----------  -----  ------  ----
--  ----------       --------\
--
portal-9           Yes                149+     0    0     3.00   P 49m:28s  HL     29    180/120     1      1       0
HT-40MHzsgi-3ss  ad-sw-me\
sh3400
point-17[p]        d8:c7:c8:80:0c:b0  149      0    1     25.00  N 55m:21s  S      12    -           0      0       0
Unsupported      ad-sw-me\
sh3400
point-13[p]        d8:c7:c8:80:0c:b0  149+     0    1     3.00   N 49m:33s  HL     47    -           3      3       0
HT-40MHzsgi-2ss  ad-sw-me\
sh3400

Total count :3
Relation: P = Parent; C = Child; N = Neighbor; B = Blacklisted-neighbor.
Flags: R = Recovery-mode; S = Sub-threshold link; D = Reselection backoff; F = Auth-failure; H = High Throughput; L =
Legacy allowed; a = SAE Accepte\ d; b = SAE Blacklisted-neighbour; e = SAE Enabled
```

Remote Mesh Portals

You can deploy mesh portals to create a hybrid mesh/remote AP environment to extend network coverage to remote locations; this feature is called remote mesh portal, or RMP. The RMP feature integrates the functions of a remote AP (RAP) and the Mesh portal. As a RAP, it sets up a VPN tunnel back to the corporate switch that is used to secure control traffic between the RAP and the switch.

The Remote Mesh Portal feature allows you to configure a remote AP at a branch office to operate as a mesh portal for a mesh cluster. Other mesh points belonging to that cluster get their IP address and configuration settings from the main office via an IPsec tunnel between the remote mesh portal and the main office controller. This feature is useful for deploying an all-wireless branch office or creating a complete wireless network in locations where there is no wired infrastructure in place.

When the client at the branch office associates to a virtual AP in split-tunnel forwarding mode, the client's DHCP requests are forwarded over a GRE tunnel (split tunnel) to the corporate network. This communication is done over a secure VPN tunnel. The IPs are assigned from the corporate pool based on the VLAN tag information, which helps to determine the corresponding VLAN. The VLAN tag also determines the subnet from which the DHCP address has assigned.

A mesh point sends the DHCP request with the mesh private VLAN (MPV) parameter. The mesh point learns the MPV value from the response during the mesh association. When the split tunnel is setup for the RMP on the controller, the VLAN of the tunnel should be the MPV.A DHCP pool for the MPV should be setup on the switch. The use of MPV makes it easy for the RMP to decide which requests to forward over the split tunnel. All requests tagged with the MPV are sent over the split tunnel. Hence the MPV should be different from any user VLAN that is bridged using the mesh network.

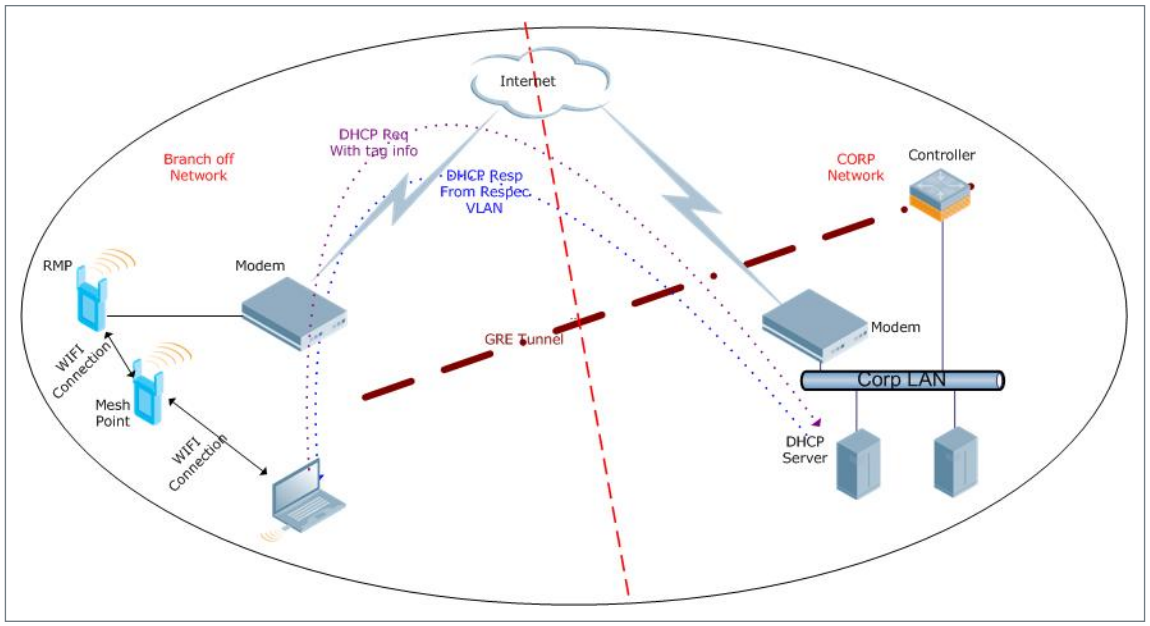
The RMP configuration requires an AP license. For more information about Dell software licenses, see Chapter 34, “Software Licenses” .”

How RMP Works

When a client at the branch office associates to a split VAP, the client’s DHCP requests are forwarded over a GRE tunnel (split tunnel) to the corporate network. This communication is done over a secure VPN tunnel. The IPs are assigned from the corporate pool based on the VLAN tag information, which helps to determine the corresponding VLAN. The VLAN tag also determines the subnet from which the DHCP address has assigned.

A mesh point sends the DHCP request with the mesh private VLAN (MPV) parameter. The mesh point learns the MPV value from the response during the mesh association. When the split tunnel is set up for the RMP on the controller, the VLAN of the tunnel should be the MPV. A DHCP pool for the MPV should be set up on the controller. The use of MPV makes it easy for the RMP to decide which requests to forward over the split tunnel. All requests tagged with the MPV are sent over the split tunnel. Hence the MPV should be different from any user VLAN that is bridged using the mesh network.

Figure 41 *Working of RMP*



Creating a Remote Mesh Portal In the WebUI

A remote mesh portal must be provisioned as both a remote access point and a mesh portal. For instructions on provisioning the remote mesh portal as a remote access point, see “Configuring the Secure Remote Access Point Service” on page 180.

Wired ports on remote mesh portals can be configured in either bridge or split-tunnel forwarding mode. There are, however, limitations to the forwarding modes that can be used by other mesh node types. Do not use bridge or split-tunnel forwarding mode for wired ports on mesh points. Virtual APs on remote mesh portals and remote mesh points also do not support bridge or split-tunnel forwarding mode.

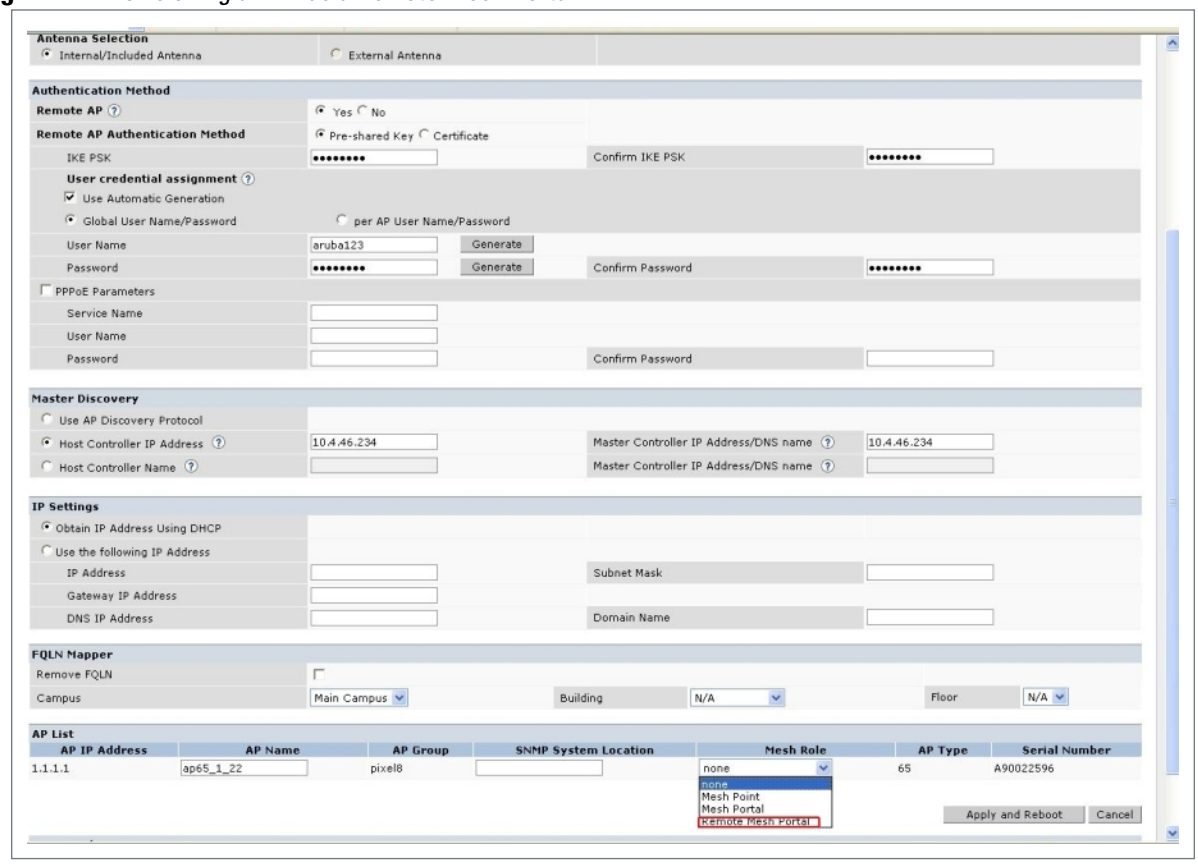
NOTE: A remote mesh portal does not support bridge mode Virtual APs or offline Virtual APs.

Provisioning the AP

1. Navigate to the Configuration > Wireless > AP Installation > Provisioning window.
2. Select the AP to provision as a remote mesh portal and click Provision. The Provisioning window appears.

3. In the Authentication section, select the Remote AP radio button.
4. In the Remote AP Authentication Method section of this window, select either Pre-shared Key or Certificate. If you selected Pre-Shared Key, enter and confirm the Internet Key Exchange Pre-Shared Key (IKE PSK).
5. In the Master Discovery section, set the Master IP address as the controller IP address.
6. In the IP settings section, select Obtain IP Address Using DHCP.
7. In the AP List section, click the Mesh Role drop-down list and select Remote Mesh Portal.

Figure 42 *Provisioning an AP as a Remote Mesh Portal*



Defining the Mesh Private VLAN

Edit the mesh radio profile for the remote mesh portal and choose a new, non-zero tag value for the mesh private VLAN. Make sure that the mesh private VLAN so that it does not conflict with any local tags assigned in the mesh network. once configured, all Mesh Points will come up in that Mesh Private Vlan. This mesh private VLAN must not be used as a VLAN for any other virtual AP.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the remote mesh portal AP group with the profile you want to edit.
   - If you selected the AP Specific tab, click the Edit button by the remote mesh portal with the profile you want to edit.
2. In the Profiles list, expand the Mesh menu, then select Mesh radio profile.
3. In the Profile Details window pane, click the Mesh radio profile drop-down list and select the name of the profile you want to edit.
4. Set the Mesh Private VLAN parameter to define a VLAN ID (0–4094) for control traffic between an remote mesh point and mesh nodes.

5. Click Apply to save your changes.

Next, assign the remote mesh points with the same mesh cluster profile, 802.11a and 802.11g RF management profiles, and mesh radio profile as the remote mesh portal. If you have defined an AP group for all your remote mesh points, you can just assign the required profiles to the remote mesh point AP group. Otherwise, you must assign the required profiles to each individual remote AP.

Selecting a Mesh Radio Profile

Use the following procedure to select a mesh radio profile for a remote mesh AP or AP group:

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group to which you want to assign a new mesh radio profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new mesh radio profile.
2. Under the Profiles list, expand the Mesh menu, then select Mesh radio profile.
3. In the Profile Details window pane, click the Mesh radio profile drop-down list and select the desired mesh radio profile from the list.
4. Click Apply. The profile name appears in the Mesh Radio Profile list with your configured settings. If you configure this for the AP group, this profile also becomes the selected radio profile used by the mesh portal for your mesh network.

Selecting an RF Management Profile

Use the following procedure to select an RF management profile for a remote mesh AP or AP group:

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new 802.11a or 802.11g RF management profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new 802.11a or 802.11g RF management profile
2. Under the Profiles list, expand the RF management menu.
3. To select a 802.11a radio profile for an AP or AP group, click 802.11a radio profile. In the Profile Details window pane, click the 802.11a radio profile drop-down list and select the desired profile from the list
   -or-
   To select a 802.11g radio profile for an AP or AP group, click 802.11g radio profile. In the Profile Details window pane, click the 802.11g radio profile drop-down list and select the desired profile from the list
4. Click Apply. The profile name appears in the Profile list with your configured settings. If you configure this for the AP group, this profile also becomes the selected 802.11a or 802.11g RF management profile used by the mesh portal for your mesh network.

Adding a Mesh Cluster Profile

Use the following procedure to add a mesh cluster profile to a remote mesh AP or AP group:

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the AP group name to which you want to assign a new mesh cluster profile.
   - If you selected AP Specific, click the Edit button by the AP to which you want to assign a new mesh cluster profile

2. Under the Profiles list, expand the Mesh menu, then select Mesh Cluster profile.
3. In the Profile Details window pane, click the Mesh Cluster profile drop-down list select New.
   - To add an existing mesh-cluster profile to the selected AP group, click the Add a profile drop-down list and select a new profile name from the list.
4. Click the using priority drop-down list to select a priority for the mesh cluster profile. The lower the number, the higher the priority.

NOTE: If you configure multiple cluster profiles with different cluster priorities, you manually override the link metric algorithm because the priority takes precedence over the path cost. In this scenario, the mesh portal uses the profile with the highest priority to bring-up the mesh network.

5. Click Add to add the mesh cluster profile to the AP group.

Configuring a DHCP Pool

In this next step, you must configure a DHCP pool where the DHCP server is on the subnet associated with mesh private VLAN. Mesh points will get their IP address from this subnet pool. To complete this task, refer to the procedure described in "Configuring the DHCP Server on the Remote AP".

Configuring the VLAN ID of the Virtual AP Profile

The VLAN of this Virtual AP must have the same VLAN ID as the mesh private VLAN.

1. Navigate to Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab. Click the Edit button by the applicable AP group name or AP name with the virtual AP profile you want to configure.
2. Under Profiles, select Wireless LAN, then Virtual AP.
3. To create a new virtual AP profile in the WebUI, select New from the Add a profile drop-down menu. Enter the name for the virtual AP profile, and click Add.

NOTE: Whenever you create a new virtual AP profile in the WebUI, the profile automatically contains the "default" SSID profile with the default "Dell-ap" ESSID. You must configure a new ESSID and SSID profile for the virtual AP profile before you apply the profile.

   a. In the Profile Details window, click the AAA Profile drop-down list and select the previously configured AAA profile. The AAA Profile pop-up window appears.
   b. To set the AAA profile and close the window, click Apply.
   c. In the Profile Details entry for the new virtual AP profile, select NEW from the SSID Profile drop-down menu. A pop-up window displays to allow you to configure the SSID profile.
   d. Enter the name for the SSID profile.
   e. Under Network, enter a name in the Network Name (SSID) field.
   f. Under Security, select the network authentication and encryption methods.
   g. To set the SSID profile and close the window, click Apply.
4. Click Apply at the bottom of the Profile Details window.
5. Click the new virtual AP name in the Profiles list or Profile Details window pane to display the configuration parameters for this profile.
6. In the Profile Details window:
   a. Make sure Virtual AP enable is selected.
   b. From the VLAN drop-down menu, select the VLAN ID for the mesh private VLAN.
   c. From the Forward mode drop-down menu, select split-tunnel.

d. Click Apply.

Provisioning a Remote Mesh Portal In the CLI

Reprovisioning the AP causes it to automatically reboot. When you use the CLI to reprovision a mesh node, you may also provision other AP settings.

```
provision-ap
   read-bootinfo ap-name <name>
   mesh-role remote-mesh-portal
   reprovision ap-name <name>
```

Additional Information

By default, the data frames the mesh portal receives on its mesh link are forwarded according to the bridge table entries on the portal. However, frames received on mesh private VLAN (MPV) are treated differently by the remote mesh portal. These frames are treated the same as frames received on a split SSID and are routed rather than bridged. Mesh points obtain DHCP addresses from the corporate network. then register with the controller using these IP addresses. When these mesh points send and receive PAPI control traffic from the main office controller, it controls these mesh points just as if they were on a local VLAN. PAPI traffic containing keys and other secret information receives IPsec encryption and decryption when it is forwarded to the controller through the VPN tunnel.

Not all traffic from a mesh point is sent on the mesh private VLAN. When a mesh point bridges data received via its Ethernet interface or from clients connected to an access radio VAP, the mesh point does not tag the frame with the mesh private VLAN tag when it sends the data through mesh link to the remote mesh portal. Note that the mesh point may still tag the frame depending on the VLAN of the virtual AP and the native VLAN specified in the system profile. Care must be taken to assign the MPV value so that it does not clash with any local tags assigned in the mesh network. In this case, the portal performs the default operation that is to bridge the frame based on its bridge table.

Traffic destined to the Internet is recognized as such by the remote mesh portal based on ACL rules. This traffic is NATed on the remote mesh portal's Ethernet interface.

Chapter 9

Authentication Servers

The ArubaOS software allows you to use an external authentication server or the controller internal user database to authenticate clients who need to access the wireless network.

Important Points to Remember

- In order for an external authentication server to process requests from the Dell controller, you must configure the server to recognize the controller. Refer to the vendor documentation for information on configuring the authentication server.
- Instructions on how to configure Microsoft's IAS and Active Directory can be viewed at:

  Microsoft's IAS

  http://technet2.microsoft.com/windowsserver/en/technologies/ias.mspx

  Active Directory

  http://technet2.microsoft.com/windowsserver/en/technologies/featured/ad/default.mspx

This chapter describes the following topics:

Servers and Server Groups

ArubaOS supports the following external authentication servers:

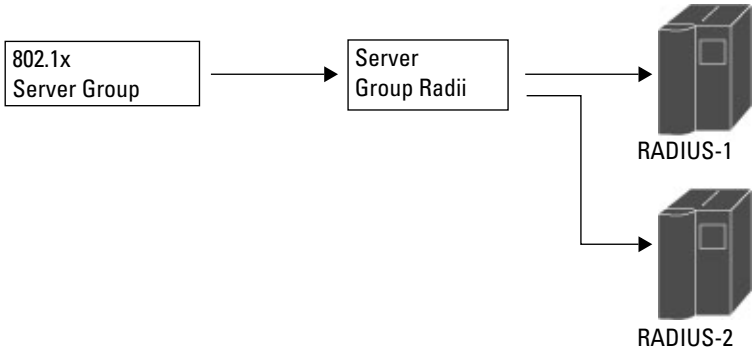
- RADIUS (Remote Authentication Dial-In User Service)
- (Lightweight Directory Access Protocol)
- TACACS+ (Terminal Access controller Access Control System)
- Windows (For stateful NTLM authentication)

Additionally, you can use the controller's internal database to authenticate users. You create entries in the database for users and their passwords and default role.

You can create *groups* of servers for specific types of authentication. For example, you can specify one or more RADIUS servers to be used for 802.1x authentication. The list of servers in a server group is an ordered list. This means that the first server in the list is always used unless it is unavailable, in which case the next server in the list is used. You can configure servers of different types in one group — for example, you can include the internal database as a backup to a RADIUS server.

Figure 43 graphically represents a server group named "Radii" that consists of two RADIUS servers, Radius-1 and Radius-2. The server group is assigned to the server group for 802.1x authentication.

Figure 43 *Server Group*



Server names are unique. You can configure the same server in multiple server groups. You must configure the server before you can add it to a server group.

NOTE: If you are using the controller's internal database for user authentication, use the predefined "Internal" server group.

You can also include conditions for server-derived user roles or VLANs in the server group configuration. The server derivation rules apply to all servers in the group.

Configuring Servers

This section describes how to configure RADIUS, LDAP, TACACS+ and Windows external authentication servers and the internal database on the controller.

Configuring a RADIUS Server

Table 46 describes the parameters you configure for a RADIUS server.

Table 46 *RADIUS Server Configuration Parameters*

Parameter	Description
Host	IP address or fully qualified domain name (FQDN) of the authentication server. The maximum supported FQDN length is 63 characters. Default: N/A
Key	Shared secret between the controller and the authentication server. The maximum length is 128 characters. Default: N/A
Authentication Port	Authentication port on the server. Default: 1812
Accounting Port	Accounting port on the server Default: 1813
Retransmits	Maximum number of retries sent to the server by the controller before the server is marked as down. Default: 3
Timeout	Maximum time, in seconds, that the controller waits before timing out the request and resending it. Default: 5 seconds
NAS ID	Network Access Server (NAS) identifier to use in RADIUS packets. Default: N/A

Table 46 *RADIUS Server Configuration Parameters (Continued)*

Parameter	Description
NAS IP	NAS IP address to send in RADIUS packets. You can configure a "global" NAS IP address that the controller uses for communications with all RADIUS servers. If you do not configure a server-specific NAS IP, the global NAS IP is used. To set the global NAS IP in the WebUI, navigate to the Configuration > Security > Authentication > Advanced page. To set the global NAS IP in the CLI, enter the ip radius nas-ip *ipaddr* command. Default: N/A
Source Interface	Enter a VLAN number ID. Allows you to use source IP addresses to differentiate RADIUS requests. Associates a VLAN interface with the RADIUS server to allow the server-specific source interface to override the global configuration. • If you associate a Source Interface (by entering a VLAN number) with a configured server, then the source IP address of the packet will be that interface's IP address. • If you do not associate the Source Interface with a configured server (leave the field blank), the IP address of the global Source Interface will be used.
Use MD5	Use MD5 hash of cleartext password. Default: disabled
Mode	Enables or disables the server. Default: enabled

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Radius Server to display the Radius Server List.
3. To configure a RADIUS server, enter the name for the server and click Add.
4. Select the name to configure server parameters. Enter parameters as described in Table 46. Select the Mode checkbox to activate the authentication server.
5. Click Apply to apply the configuration.

NOTE: The configuration does not take effect until you perform this step.

In the CLI

```
aaa authentication-server radius <name>
   host <ipaddr>
   key <key>
   enable
```

RADIUS Server Authentication Codes

A configured RADIUS server will return the following standard response codes.

Table 47 *RADIUS Authentication Response Codes*

Code	Description
0	Authentication OK.
1	Authentication failed—user/password combination not correct.
2	Authentication request timed out—No response from server.
3	Internal authentication error.

Table 47 *RADIUS Authentication Response Codes (Continued)*

Code	Description
4	Bad Response from RADIUS server. Verify shared secret is correct.
5	No RADIUS authentication server is configured.
6	Challenge from server. (This does not necessarily indicate an error condition.)

RADIUS Server Fully Qualified Domain Names

If you define a RADIUS server using the FQDN of the server rather than its IP address, the controller will periodically generate a DNS request and cache the IP address returned in the DNS response. To view the IP address that currently correlate to each RADIUS server FQDN, access the command-line interface in config mode and issue the following command:

```
show aaa fqdn-server-names
```

Set a DNS Query Interval

If you define a RADIUS server using the FQDN of the server rather than its IP address, the controller will periodically generate a DNS request and cache the IP address returned in the DNS response. By default, DNS requests are sent every 15 minutes.

You can use either the WebUI or the CLI to configure how often the controller should generate a DNS request to cache the IP address for a RADIUS server identified via its fully qualified domain name (FQDN).

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Advanced page.
2. In the DNS Query Interval (min) field, enter a new DNS query interval, from 1-1440 minutes, inclusive.
3. Click Apply to save your changes.

In the CLI

```
aaa dns-query-period <minutes>
```

Configuring an LDAP Server

Table 48 describes the parameters you configure for an LDAP server.

Table 48 *LDAP Server Configuration Parameters*

Parameter	Description
Host	IP address of the LDAP server. Default: N/A
Admin-DN	Distinguished name for the admin user who has read/search privileges across all the entries in the LDAP database (the user does need write privileges but should be able to search the database, and read attributes of other users in the database).
Admin Password	Password for the admin user. Default: N/A
Allow Clear-Text	Allows clear-text (unencrypted) communication with the LDAP server. Default: disabled
Authentication Port	Port number used for authentication. Default: 389

Table 48 *LDAP Server Configuration Parameters (Continued)*

Parameter	Description
Base-DN	Distinguished Name of the node that contains the entire user database. Default: N/A
Filter	A string that is used to search for users in the LDAP database (default filter string is: ì(objectclass=*)î). Default: N/A
Key Attribute	A string that is used to search for a LDAP server. For Active Directory, the value is sAMAccountName. Default: sAMAccountName
Timeout	Timeout period of a LDAP request, in seconds. Default: 20 seconds
Mode	Enables or disables the server. Default: enabled
Preferred Connection Type	Preferred type of connection between the controller and the LDAP server. The default order of connection type is: 1. ldap-s 2. start-tls 3. clear-text The controller first tries to contact the LDAP server using the preferred connection type, and only attempts to use a lower-priority connection type if the first attempt is not successful. NOTE: If you select clear-text as the preferred connection type, you must also enable the allow-cleartext option.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select LDAP Server to display the LDAP Server List.
3. To configure an LDAP server, enter the name for the server and click Add.
4. Select the name to configure server parameters. Enter parameters as described in Table 48. Select the Mode checkbox to activate the authentication server.
5. Click Apply to apply the configuration.

NOTE: The configuration does not take effect until you perform this step.

In the CLI

```
aaa authentication-server ldap <name>
   host <ipaddr>
   (enter parameters as described in Table 48)
   enable
```

Configuring a TACACS+ Server

Table 49 defines the TACACS+ server parameters.

Table 49 *TACACS+ Server Configuration Parameters*

Parameter	Description
Host	IP address of the server. Default: N/A
Key	Shared secret to authenticate communication between the TACACS+ client and server. Default: N/A
TCP Port	TCP port used by server. Default: 49
Retransmits	Maximum number of times a request is retried. Default: 3
Timeout	Timeout period for TACACS+ requests, in seconds. Default: 20 seconds
Mode	Enables or disables the server. Default: enabled
Session Authorization	Enables or disables session authorization. Session authorization turns on the optional authorization session for admin users. Default: disabled

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select TACACS Server to display the TACACS Server List.
3. To configure a TACACS+ server, enter the name for the server and click Add.
4. Select the name to configure server parameters. Enter parameters as described in Table 49. Select the Mode checkbox to activate the authentication server.
5. Click Apply to apply the configuration.

NOTE: The configuration does not take effect until you perform this step.

In the CLI

The following command configures, enables a TACACS+ server and enables session authorization:

```
aaa authentication-server tacacs <name>
   clone default
   host <ipaddr>
   key <key>
   enable
   session-authorization
```

Configuring a Windows Server

Table 50 defines parameters for a Windows server used for stateful NTLM authentication.

Table 50 *Windows Server Configuration Parameters*

Parameter	Description
Host	IP address of the server. Default: N/A
Mode	Enables or disables the server. Default: enabled
Windows Domain	Name of the Windows Domain assigned to the server.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Windows Server to display the Windows Server List.
3. To configure a Windows server, enter the name for the server and click Add.
4. Select the name of the server to configure its parameters. Enter the parameters as described in Table 50.
5. Select the Mode checkbox to activate the authentication server.
6. Click Apply to apply the configuration.

NOTE: The configuration does not take effect until you perform this step.

In the CLI

```
aaa authentication-server windows <windows-server-name>
   host <ipaddr>
   enable
```

Internal Database

You can create entries, in the controller's internal database, to use to authenticate clients. The internal database contains a list of clients along with the password and default role for each client. When you configure the internal database as an authentication server, client information in incoming authentication requests is checked against the internal database.

Configuring the Internal Database

By default, the internal database in the master controller is used for authentication. You can choose to use the internal database in a local controller by entering the CLI command aaa authentication-server internal use-local-switch. If you use the internal database in a local controller, you need to add clients on the local controller.

Table 51 defines the required and optional parameters used in the internal database.

Table 51 *Internal Database Configuration Parameters*

Parameters	Description
User Name	(Required) Enter a user name or select Generate to automatically generate a user name. An entered username can be up to 64 characters in length.

Table 51 *Internal Database Configuration Parameters (Continued)*

Parameters	Description
Password	(Required) Enter a password or select Generate to automatically generate a password string. An entered password must be a minimum of 6 characters and can be up to 128 characters in length.
Role	Role for the client. In order for this role to be assigned to a client, you need to configure a server derivation rule, as described in "Configuring Server-Derivation Rules" on page 277. (A user role assigned through a server-derivation rule takes precedence over the default role configured for an authentication method.)
E-mail	(Optional) E-mail address of the client.
Enabled	Select this checkbox to enable the user as soon as the user entry is created.
Expiration	Select one of the following options: • Entry does not expire: No expiration on user entry • Set Expiry time (mins): Enter the number of minutes the user will be authenticated before their user entry expires. • Set Expiry Date (mm/dd/yyyy) Expiry Time (hh:mm): To select a specific expiration date and time, enter the expiration date in mm/dd/yyyy format, and the expiration time in hh:mm format.
Static Inner IP Address (for RAPs only)	Assign a static inner IP address to a Remote AP. If this database entry is not for a remote AP, leave this field empty.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Add User in the Users section. The user configuration page displays.
4. Enter the information for the client, as described in the table above.
5. Click Enabled to activate this entry on creation.
6. Click Apply to apply the configuration. The configuration does not take effect until you perform this step
7. At the Servers page, click Apply.

NOTE: The Internal DB Maintenance window also includes a Guest User Page feature that allows you to create user entries for guests only. For details on creating guest users, see "Guest Provisioning User Tasks" on page 596.

In the CLI

Enter the following command in enable mode:

```
local-userdb add {generate-username|username <name>} {generate-password|password
<password>}L
```

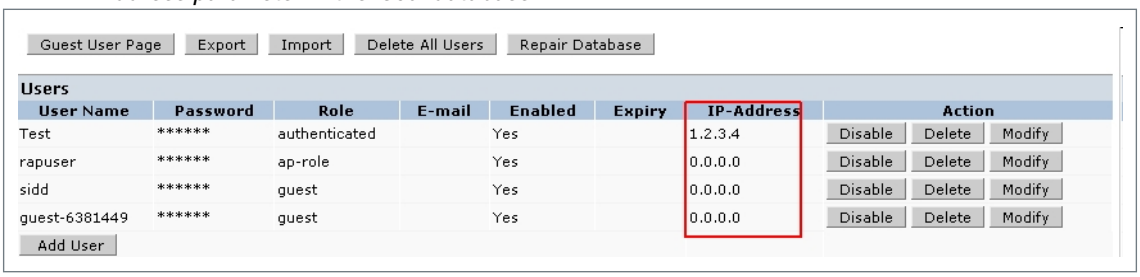
RAP Static Inner IP Address

The RAP static inner IP address feature assigns a static inner IP address to a remote access point (RAP). A new *IP address* parameter is added to the existing configuration commands: `local-userdb add`, `local-userdb modify`, `local-userdb-ap add`, and `local-userdb-ap modify`.

In the WebUI

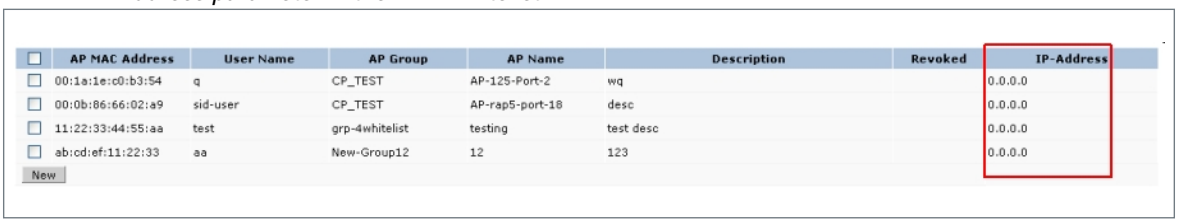
To view *IP address* parameter in the local database, navigate to the Configuration > Security > Authentication > Servers > Internal DB page.

Figure 44 *IP-Address parameter in the local database*



To view IP-address parameter in the RAP Whitelist, navigate to the Wireless > AP Installation > RAP Whitelist page.

Figure 45 *IP-Address parameter in the RAP Whitelist*



NOTE: You cannot configure the IP-Address parameter using the WebUI.

In the CLI

```
local-userdb add {generate-username|username <name>} {generate-password|password
<password>} {remote-ip<remote-ip>}
local-userdb modify {username < name>} {remote-ip<remote-ip>}
local-userdb-ap add {mac-address <address>} {ap-group|<ap_grup>} {remote-ip<remote-
ip>}
local-userdb-ap modify {mac-address <address>} {remote-ip<remote-ip>}
```

The output of **`show local-userdb`** command:

```
(host) #show local-userdb
User Summary
------------
Name    Pwd  Role              E-Mail           Enabled  Expiry  Status  Sponsor-Name  Remote-IP  Grantor-Name
----    ---  ----              ------           -------  ------  ------  ------------  ---------  ------------
John    ***  default-vpn-role  john@example.com Yes              Active                0.0.0.0    admin
user1   ***  default-vpn-role                   Yes              Active                0.0.0.0    admin
Sam     ***  default-vpn-role                   Yes              Active                0.0.0.0    admin
```

The output of **`show local-userdb-ap`** command:

```
(host) #show local-userdb-ap
AP-entry Details
----------------
Name      AP-Group AP-Name         Full-Name  Auth-Uname  Rvok-txt  AP_Auth      Descrp  Date-Added       En Rem-IP
----      -------- -------         ---------  ----------  --------  -----------  ------  ----------       --- -------
MAC-ADD  CP_TEST  AP-125-Port-2   test                             Provisioned  wq      Fri Nov 27 2009  Yes 0.0.0.0
MAC-ADD  CP_TEST  AP-rap5-port-18 John                             Provisioned  desc    Mon Nov 30 2009  Yes 0.0.0.0
```

Managing Internal Database Files

ArubaOS allows you to import and export tables of user information to and from the internal database. These files should not be edited once they are exported. ArubaOS only supports the importing of database files that

were created during the export process. Note that importing a file into the internal database overwrite and removes all existing entries.

Exporting files in the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Export in the Internal DB Maintenance section. A popup window opens.
4. Enter the name of the file you want to export
5. Click OK.

Importing files in the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Import in the Internal DB Maintenance section. A popup window opens.
4. Enter the name of the file you want to import
5. Click OK.

In the CLI

Enter the following command in enable mode:

```
local-userdb export <filename>
local-userdb import <filename>
```

Internal Database Utilities

The local internal database also includes utilities to clear all users from the database and to restart the internal database to repair internal errors. Under normal circumstances, neither of these utilities are necessary.

Deleting All User

Issue this command to remove users from the internal database after you have moved your user database from the controller's internal server to an external server.

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Delete All Users in the Internal DB Maintenance section. A popup window open and asks you to confirm that you want to remove all users.
4. Click OK.

Repairing the Internal Database

Use this utility under the supervision of Dell technical support to recreate the internal database. This may clear internal database errors, but will also remove all information from the database. Make sure you export your current user information before you start the repair procedure.

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Repair Database in the Internal DB Maintenance section. A popup window open and asks you to confirm that you want to recreate the database.
4. Click OK.

Server Groups

You can create *groups* of servers for specific types of authentication — for example, you can specify one or more RADIUS servers to be used for 802.1x authentication. You can configure servers of different types in one group — for example, you can include the internal database as a backup to a RADIUS server.

Configuring Server Groups

Server names are unique. You can configure the same server in more than one server group. The server must be configured before you can include it in a server group.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Server Group to display the Server Group list.
3. Enter the name of the new server group and click Add.
4. Select the name to configure the server group.
5. Under Servers, click New to add a server to the group.
   a. Select a server from the drop-down menu and click Add Server.
   b. Repeat the above step to add other servers to the group.
6. Click Apply.

In the CLI

```
aaa server-group <name>
   auth-server <name>
```

Configuring Server List Order and Fail-Through

The list of servers in a server group is an ordered list. By default, the first server in the list is always used unless it is unavailable, in which case the next server in the list is used. You can configure the order of servers in the server group. In the WebUI, use the up or down arrows to order the servers (the top server is the first server in the list). In the CLI, use the position parameter to specify the relative order of servers in the list (the lowest value denotes the first server in the list).

As mentioned previously, the first available server in the list is used for authentication. If the server responds with an authentication failure, there is no further processing for the user or client for which the authentication request failed. You can optionally enable *fail-through* authentication for the server group so that if the first server in the list returns an authentication deny, the controller attempts authentication with the next server in the ordered list. The controller attempts authentication with each server in the list until either there is a successful authentication or the list of servers in the group is exhausted. This feature is useful in environments where there are multiple, independent authentication servers; users may fail authentication on one server but can be authenticated on another server.

Before enabling fail-through authentication, note the following:

- This feature is not supported for 802.1x authentication with a server group that consists of external EAP-compliant RADIUS servers. You can, however, use fail-through authentication when the 802.1x authentication is terminated on the controller (AAA FastConnect).
- Enabling this feature for a large server group list may cause excess processing load on the controller. Dell recommends that you use server selection based on domain matching whenever possible (see “Configuring Dynamic Server Selection” on page 274).
- Certain servers, such as the RSA RADIUS server, lock out the controller if there are multiple authentication failures. Therefore you should not enable fail-through authentication with these servers.

In the following example, you create a server group 'corp-serv' with two LDAP servers (ldap-1 and ldap-2), each of which contains a subset of the usernames and passwords used in the network. When fail-through authentication is enabled, users that fail authentication on the first server in the server list should be authenticated with the second server.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select LDAP Server to display the LDAP Server List.
3. Enter ldap-1 for the server name and click Add.
4. Enter ldap-2 for the server name and click Add.
5. Under the Servers tab, select ldap-1 to configure server parameters. Enter the IP address for the server. Select the Mode checkbox to activate the authentication server. Click Apply.
6. Repeat step 5 to configure ldap-2.
7. Display the Server Group list: Under the Servers tab, select Server Group.
8. Enter corp-serv as the new server group and click Add.
9. Select corp-serv, under the Server tab, to configure the server group.
10. Select Fail Through.
11. Under Servers, click New to add a server to the group. Select ldap-1 from the drop-down menu and click Add Server.
12. Repeat step 11 to add ldap-2 to the group.
13. Click Apply.

In the CLI

```
aaa authentication-server ldap ldap-1
   host 10.1.1.234
aaa authentication-server ldap ldap-2
   host 10.2.2.234

aaa server-group corp-serv
   auth-server ldap-1 position 1
   auth-server ldap-2 position 2
   allow-fail-through
```

Configuring Dynamic Server Selection

The controller can dynamically select an authentication server from a server group based on the user information sent by the client in an authentication request. For example, an authentication request can include client or user information in one of the following formats:

- <domain>\<user> — for example, corpnet.com\darwin
- <user>@<domain> — for example, darwin@corpnet.com
- host/<pc-name>.<domain> — for example, host/darwin-g.finance.corpnet.com (this format is used with 802.1x machine authentication in Windows environments)

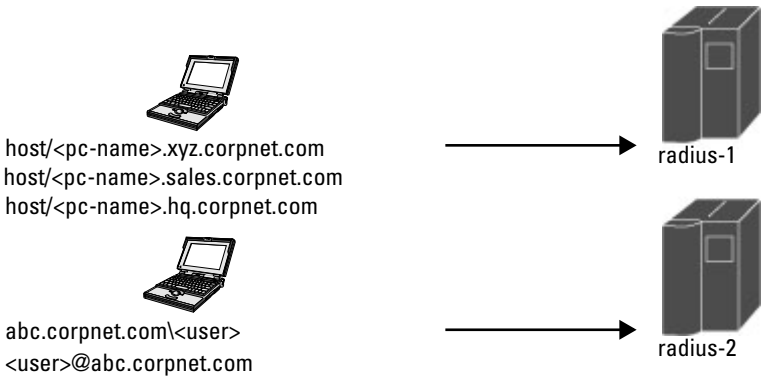
When you configure a server in a server group, you can optionally associate the server with one or more match rules. A match rule for a server can be one of the following:

- The server is selected if the client/user information *contains* a specified string.
- The server is selected if the client/user information *begins* with a specified string.
- The server is selected if the client/user information *exactly* matches a specified string.

You can configure multiple match rules for the same server. The controller compares the client/user information with the match rules configured for each server, starting with the first server in the server group. If a match is found, the controller sends the authentication request to the server with the matching rule. If no match is found before the end of the server list is reached, an error is returned and no authentication request for the client/user is sent.

For example, Figure 46 depicts a network consisting of several subdomains in corpnet.com. The server radius-1 provides 802.1x machine authentication to PC clients in xyz.corpnet.com, sales.corpnet.com, and hq.corpnet.com. The server radius-2 provides authentication for users in abc.corpnet.com.

Figure 46 *Domain-Based Server Selection Example*



You configure the following rules for servers in the corp-serv server group:

- radius-1 will be selected if the client information starts with “host/”.
- radius-2 will be selected if the client information contains “abc.corpnet.com”.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Under the Servers tab, select Server Group to display the Server Group list.
3. Enter corp-serv for the new server group and click Add.
4. Under the Servers tab, select corp-serv to configure the server group.
5. Under Servers, click New to add the radius-1 server to the group. Select radius-1 from the drop-down menu.
   a. For Match Type, select Authstring.
   b. For Operator, select starts-with.
   c. For Match String, enter host/.
   d. Click Add Rule >>.
   e. Scroll to the right and click Add Server.
6. Under Servers, click New to add the radius-2 server to the group. Select radius-2 from the drop-down menu.
   a. For Match Type, select Authstring.
   b. For Operator, select contains.
   c. For Match String, enter abc.corpnet.com.
   d. Click Add Rule >>.

e. Scroll to the right and click Add Server.

NOTE: The last server you added to the server group (radius-2) automatically appears as the first server in the list. In this example, the order of servers is not important. If you need to reorder the server list, scroll to the right and click the up or down arrow for the appropriate server.

7. Click Apply.

In the CLI

```
aaa server-group corp-serv
   auth-server radius-1 match-authstring starts-with host/ position 1
   auth-server radius-2 match-authstring contains abc.corpnet.com position 2
```

Configuring Match FQDN Option

You can also use the "match FQDN" option for a server match rule. With a match FQDN rule, the server is selected if the <domain> portion of the user information in the formats <domain>\<user> or <user>@<domain> *exactly* matches a specified string. Note the following caveats when using a match FQDN rule:

- This rule does *not* support client information in the host/<pc-name>.<domain> format, so it is not useful for 802.1x machine authentication.
- The match FQDN option performs matches on only the <domain> portion of the user information sent in an authentication request. The match-authstring option (described previously) allows you to match all or a portion of the user information sent in an authentication request.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page
2. Under the Servers tab, select Server Group to display the Server Group list.
3. Enter corp-serv for the new server group and click Add.
4. Under the Servers tab, select corp-serv to configure the server group.
5. Under Servers, click New to add the radius-1 server to the group. Select radius-1 from the drop-down menu.
   a. For Match Type, select FQDN.
   b. For Match String, enter corpnet.com.
   c. Click Add Rule >>.
   d. Scroll to the right and click Add Server.
6. Click Apply.

In the CLI

```
aaa server-group corp-serv
    auth-server radius-1 match-fqdn corpnet.com
```

Trimming Domain Information from Requests

Before the controller forwards an authentication request to a specified server, it can truncate the domain-specific portion of the user information. This is useful when user entries on the authenticating server do not include domain information. You can specify this option with any server match rule. This option is only applicable when the user information is sent to the controller in the following formats:

- <domain>\<user> — the <domain>\ portion is truncated

- <user>@<domain> — the @<domain> portion is truncated

NOTE: This option does not support client information sent in the format host/<pc-name>.<domain>

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Server Group to display the Server Group list.
3. Enter the name of the new server group and click Add.
4. Select the name to configure the server group.
5. Under Servers, click Edit for a configured server or click New to add a server to the group.
   - If editing a configured server, select Trim FQDN, scroll right, and click Update Server.
   - If adding a new server, select a server from the drop-down menu, then select Trim FQDN, scroll right, and click Add Server.
6. Click Apply.

In the CLI

```
aaa server-group corp-serv
   auth-server radius-2 match-authstring contains abc.corpnet.com trim-fqdn
```

Configuring Server-Derivation Rules

When you configure a server group, you can set the VLAN or role for clients based on attributes returned for the client by the server during authentication. The server derivation rules apply to all servers in the group. The user role or VLAN assigned through server derivation rules takes precedence over the default role and VLAN configured for the authentication method.

NOTE: The authentication servers must be configured to return the attributes for the clients during authentication. For instructions on configuring the authentication attributes in a Windows environment using IAS, refer to the documentation at http://technet2.microsoft.com/windowsserver/en/technologies/ias.mspx.

The server rules are applied based on the first match principle. The first rule that is applicable for the server and the attribute returned is applied to the client and would be the only rule applied from the server rules. These rules are applied uniformly across all servers in the server group.

Table 52 describes the server rule parameters you can configure.

Table 52 *Server Rule Configuration Parameters*

Parameter	Description
Role or VLAN	The server derivation rules can be for either user role or VLAN assignment. With Role assignment, a client can be assigned a specific role based on the attributes returned. In case of VLAN assignment, the client can be placed in a specific VLAN based on the attributes returned.
Attribute	This is the attribute returned by the authentication server that is examined for *Operation* and *Operand* match.

Table 52 *Server Rule Configuration Parameters (Continued)*

Parameter	Description
Operation	This is the match method by which the string in *Operand* is matched with the attribute value returned by the authentication server. • contains – The rule is applied if and only if the attribute value contains the string in parameter *Operand.* • starts-with – The rule is applied if and only if the attribute value returned starts with the string in parameter *Operand.* • ends-with – The rule is applied if and only if the attribute value returned ends with the string in parameter *Operand.* • equals – The rule is applied if and only if the attribute value returned equals the string in parameter *Operand.* • not-equals – The rule is applied if and only if the attribute value returned is not equal to the string in parameter *Operand.* • value-of – This is a special condition. What this implies is that the role or VLAN is set to the value of the attribute returned. For this to be successful, the role and the VLAN ID returned as the value of the attribute selected must be already configured on the controller when the rule is applied.
Operand	This is the string to which the value of the returned attribute is matched.
Value	The user role or the VLAN applied to the client when the rule is matched.
position	Position of the condition rule. Rules are applied based on the first match principle. 1 is the top. Default: bottom

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Server Group to display the Server Group list.
3. Enter the name of the new server group and click Add.
4. Select the name to configure the server group.
5. Under Servers, click New to add a server to the group.
   a. Select a server from the drop-down menu and click Add.
   b. Repeat the above step to add other servers to the group.
6. Under Server Rules, click New to add server derivation rules for assigning a user role or VLAN.
   a. Enter the attribute.
   b. Select the operation from the drop-down menu.
   c. Enter the operand.
   d. Select Set VLAN or Set Role from the drop-down menu.
   e. Enter the value (either user role or VLAN) to be assigned.
   f. Click Add.
   g. Repeat the above steps to add other rules for the server group.
7. Click Apply.

In the CLI

```
aaa server-group <name>
   auth-server <name>
   set {role|vlan} condition <condition> set-value {<role>|<vlan>}
     [position number]
```

Configuring a Role Derivation Rule for the Internal Database

When you add a user entry in the controller's internal database, you can optionally specify a user role (see "Internal Database" on page 269). In order for the role specified in the internal database entry to be assigned to the authenticated client, you must configure a server derivation rule as shown in the following sections:

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Server Group to display the Server Group list.
3. Select the internal server group.
4. Under Server Rules, click New to add a server derivation rule.
   a. For Condition, enter Role.
   b. Select value-of from the drop-down menu.
   c. Select Set Role from the drop-down menu.
   d. Click Add.
5. Click Apply.

In the CLI

```
aaa server-group internal
   set role condition Role value-of
```

Assigning Server Groups

You can create server groups for the following purposes:

- user authentication
- management authentication
- accounting

You can configure all types of servers for user and management authentication (see Table 53). Accounting is only supported with RADIUS and TACACS+ servers when RADIUS or TACACS+ is used for authentication.

Table 53 *Server Types and Purposes*

	RADIUS	TACACS+	LDAP	Internal Database
User authentication	Yes	Yes	Yes	Yes
Management authentication	Yes	Yes	Yes	Yes
Accounting	Yes	Yes	No	No

User Authentication

For information about assigning a server group for user authentication, see the configuration chapter for the authentication method.

Management Authentication

Users who need to access the controller to monitor, manage, or configure the Dell user-centric network can be authenticated with RADIUS, TACACS+, or LDAP servers or the internal database.

NOTE: Only user record attributes are returned upon a successful authentication. Therefore, to derive a different management role other than the default mgmt auth role, set the server derivation rule based on the user attributes.

In the WebUI

1. Navigate to the Configuration > Management > Administration page.
2. Under the Management Authentication Servers section, select the Server Group.
3. Click Apply.

In the CLI

```
aaa authentication mgmt
   server-group <group>
```

Accounting

You can configure accounting for RADIUS and TACACS+ server groups.

NOTE: RADIUS or TACACS+ accounting is only supported when RADIUS or TACACS+ is used for authentication.

RADIUS Accounting

RADIUS accounting allows user activity and statistics to be reported from the controller to RADIUS servers. RADIUS accounting works as follows:

1. The controller generates an Accounting Start packet when a user logs in. The code field of transmitted RADIUS packet is set to 4 (Accounting-Request). Note that sensitive information, such user passwords, are not sent to the accounting server. The RADIUS server sends an acknowledgement of the packet.
2. The controller sends an Accounting Stop packet when a user logs off; the packet information includes various statistics such as elapsed time, input and output bytes and packets. The RADIUS server sends an acknowledgement of the packet.

The following is the list of attributes that the controller can send to a RADIUS accounting server:

- Acct-Status-Type: This attribute marks the beginning or end of accounting record for a user. Currently, possible values include Start and Stop.
- User-Name: Name of user.
- Acct-Session-Id: A unique identifier to facilitate matching of accounting records for a user. It is derived from the user name, IP address and MAC address. This is set in all accounting packets.
- Acct-Authentic: This indicates how the user was authenticated. Current values are 1 (RADIUS), 2 (Local) and 3 (LDAP).
- Acct-Session-Time: The elapsed time, in seconds, that the client was logged in to the controller. This is only sent in Accounting-Request records where the Acct-Status-Type is Stop.
- Acct-Terminate-Cause: Indicates how the session was terminated and is sent in Accounting-Request records where the Acct-Status-Type is Stop. Possible values are:

  1: User logged off

  4: Idle Timeout

  5: Session Timeout. Maximum session length timer expired.

7: Admin Reboot: Administrator is ending service, for example prior to rebooting the controller.

- NAS-Identifier: This is set in the RADIUS server configuration.
- NAS-IP-Address: IP address of the master controller. You can configure a "global" NAS IP address: in the WebUI, navigate to the Configuration > Security > Authentication > Advanced page; in the CLI, use the ip radius nas-ip command.
- NAS-Port: Physical or virtual port (tunnel) number through which the user traffic is entering the controller.
- NAS-Port-Type: Type of port used in the connection. This is set to one of the following:
  - 5: admin login
  - 15: wired user type
  - 19: wireless user
- Framed-IP-Address: IP address of the user.
- Calling-Station-ID: MAC address of the user.
- Called-station-ID: MAC address of the controller.

The following attributes are sent in Accounting-Request packets when Acct-Status-Type value is Start:

- Acct-Status-Type
- User-Name
- NAS-IP-Address
- NAS-Port
- NAS-Port-Type
- NAS-Identifier
- Framed-IP-Address
- Calling-Station-ID
- Called-station-ID
- Acct-Session-Id
- Acct-Authentic

The following attributes are sent in Accounting-Request packets when Acct-Status-Type value is Stop:

- Acct-Status-Type
- User-Name
- NAS-IP-Address
- NAS-Port
- NAS-Port-Type
- NAS-Identifier
- Framed-IP-Address
- Calling-Station-ID
- Called-station-ID
- Acct-Session-Id
- Acct-Authentic
- Terminate-Cause
- Acct-Session-Time

The following attributes are sent only in Accounting Stop packets (they are not sent in Accounting Start packets):

- Acct-Input-Octets

- Acct-Output-Octets
- Acct-Input-Packets
- Acct-Output-Packets

You can use either the WebUI or CLI to assign a server group for RADIUS accounting.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > AAA Profiles page.
2. Select AAA Profile, then select the AAA profile instance.
3. (Optional) In the Profile Details pane, select RADIUS Interim Accounting to allow the controller to send Interim-Update messages with current user statistics to the server at regular intervals. This option is disabled by default, allowing the controller to send only *start* and *stop* messages RADIUS accounting server.
4. In the profile list, scroll down and select the Radius Accounting Server Group for the AAA profile. Select the server group from the drop-down menu.

   You can add additional servers to the group or configure server rules.
5. Click Apply.

In the CLI

```
aaa profile <profile>
   radius-accounting <group>
   radius-interim-accounting
```

TACACS+ Accounting

TACACS+ accounting allows commands issued on the controller to be reported to TACACS+ servers. You can specify the types of commands that are reported (action, configuration, or show commands) or have all commands reported.

You can configure TACACS+ accounting only with the CLI:

```
aaa tacacs-accounting server-group <group> command {action|all|configuration|show} mode
{enable|disable}
```

Configuring Authentication Timers

Table 54 describes the timers you can configure that apply to all clients and servers. These timers can be left at their default values for most implementations.

Table 54 *Authentication Timers*

Timer	Description
User Idle Timeout	Maximum period after which a client is considered idle if there is no user traffic from the client. The timeout period is reset if there is a user traffic. After this timeout period has elapsed, the controller sends probe packets to the client; if the client responds to the probe, it is considered active and the User Idle Timeout is reset (an active client that is not initiating new sessions is not removed). If the client does not respond to the probe, it is removed from the system. If the keyword seconds is not specified, the value defaults to minutes at the command line. Range: 1 to 255 minutes (30 to 15300 seconds) Default: 5 minutes (300 seconds)

Table 54 *Authentication Timers (Continued)*

Timer	Description
Authentication Server Dead Time	Maximum period, in minutes, that the controller considers an unresponsive authentication server to be "out of service". This timer is only applicable if there are two or more authentication servers configured on the controller. If there is only one authentication server configured, the server is never considered out of service and all requests are sent to the server. If one or more backup servers are configured and a server is unresponsive, it is marked as out of service for the dead time; subsequent requests are sent to the next server on the priority list for the duration of the dead time. If the server is responsive after the dead time has elapsed, it can take over servicing requests from a lower-priority server; if the server continues to be unresponsive, it is marked as down for the dead time. Range: 0–50 Default: 10 minutes
Logon User Lifetime	Maximum time, in minutes, unauthenticated clients are allowed to remain logged on. Range: 0–255 Default: 5 minutes
User Interim stats frequency	Set the timeout value for user stats reporting in minutes or seconds. The supported range is 300-600 seconds, or 5-10 minutes, and the default value is 600 seconds..

Setting an Authentication Timer

To set an authentication timer, complete one of the following procedures:

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Advanced page.
2. Configure the timers as described above.
3. Click Apply before moving on to another page or closing the browser window. Failure to do this results in loss of configuration and you will have to reconfigure the settings.

In the CLI

```
aaa timers {dead-time <minutes>|idle-timeout <number>|logon-lifetime <minutes>|stats-timeout <seconds>}
```

Chapter 10

802.1x Authentication

802.1x is an Institute of Electrical and Electronics Engineers (IEEE) standard that provides an authentication framework for WLANs. 802.1x uses the Extensible Authentication Protocol (EAP) to exchange messages during the authentication process. The authentication protocols that operate inside the 802.1x framework that are suitable for wireless networks include EAP-Transport Layer Security (EAP-TLS), Protected EAP (PEAP), and EAP-Tunneled TLS (EAP-TTLS). These protocols allow the network to authenticate the client while also allowing the client to authenticate the network.

This chapter describes the following topics:

Other types of authentication not discussed in this chapter can be found in the following sections of this guide:

- Captive portal authentication: "Captive Portal Authentication" on page 364
- VPN authentication: "Planning a VPN Configuration" on page 389
- MAC authentication: "Configuring MAC-Based Authentication" on page 431
- Stateful 802.1x, stateful NTLM, and WISPr authentication: "Stateful and WISPr Authentication" on page 345

Overview of 802.1x Authentication

802.1x authentication consists of three components:

- The *supplicant*, or client, is the device attempting to gain access to the network. You can configure the Dell user-centric network to support 802.1x authentication for wired users as well as wireless users.
- The *authenticator* is the gatekeeper to the network and permits or denies access to the supplicants.
- The *Dell controller* acts as the authenticator, relaying information between the authentication server and supplicant. The EAP type must be consistent between the authentication server and supplicant and is transparent to the controller.

  The authentication server provides a database of information required for authentication and informs the authenticator to deny or permit access to the supplicant.

  The 802.1x authentication server is typically an EAP-compliant Remote Access Dial-In User Service (RADIUS) server which can authenticate either users (through passwords or certificates) or the client computer.

  An example of an 802.1x authentication server is the Internet Authentication Service (IAS) in Windows (see http://technet.microsoft.com/en-us/library/cc759077(WS.10).aspx).

  Dell user-centric networks, you can terminate the 802.1x authentication on the controller. The controller passes user authentication to its internal database or to a "backend" non-802.1x server. This feature, also called "*AAA FastConnect*," is useful for deployments where an 802.1x EAP-compliant RADIUS server is not available or required for authentication.

Supported EAP Types

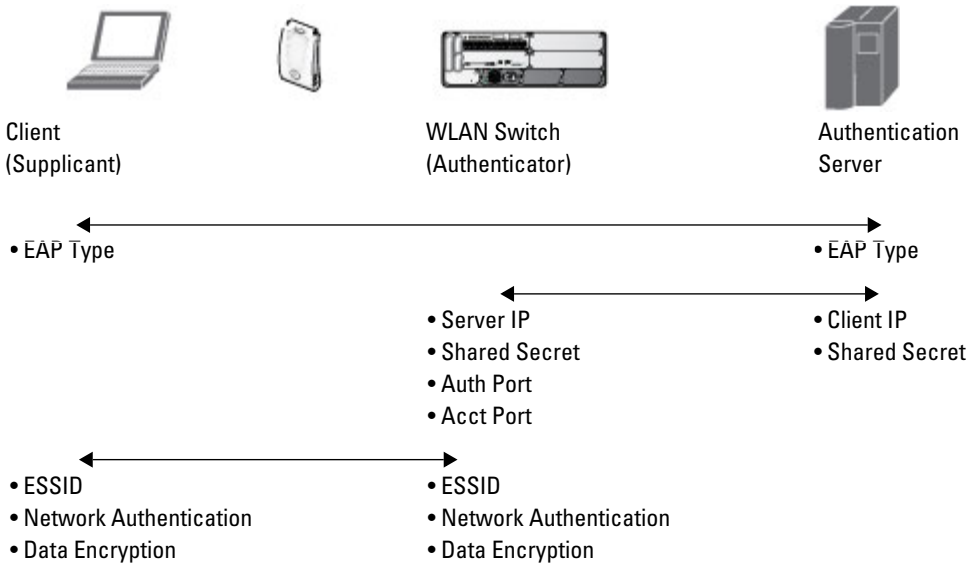
The following is the list of supported EAP types.

- PEAP—Protected EAP (PEAP) is an 802.1x authentication method that uses server-side public key certificates to authenticate clients with server. The PEAP authentication creates an encrypted SSL / TLS tunnel between the client and the authentication server. The exchange of information is encrypted and stored in the tunnel ensuring the user credentials are kept secure.
- EAP-GTC—The EAP-GTC (Generic Token Card) type uses clear text method to exchange authentication controls between client and server. Since the authentication mechanism uses the one-time tokens (generated by the card), this method of credential exchange is considered safe. In addition, EAP-GTC is used in PEAP or TTLS tunnels in wireless environments. The EAP-GTC is described in RFC 2284.
- EAP-AKA—The EAP-AKA (Authentication and Key Agreement) authentication mechanism is typically used in mobile networks that include Universal Mobile Telecommunication Systems (UMTS) and CDMA 2000. This method uses the information stored in the Subscriber Identity Module (SIM) for authentication. The EAP-AKA is described in RFC 4187.
- EAP-FAST—The EAP-FAST (Flexible Authentication via Secure Tunneling) is an alternative authentication method to PEAP. This method uses the Protected Access Credential (PAC) for verifying clients on the network. The EAP-FAST is described in RFC 4851.
- EAP-MD5—The EAP-MD5 method verifies MD5 hash of a user password for authentication. This method is commonly used in a trusted network. The EAP-MD5 is described in RFC 2284.
- EAP-POTP—The EAP type 32 is supported. Complete details are described in RFC 4793.
- EAP-SIM—The EAP-SIM (Subscriber Identity Module) uses Global System for Mobile Communication (GSM) Subscriber Identity Module (SIM) for authentication and session key distribution. This authentication mechanism includes network authentication, user anonymity support, result indication, and fast re-authentication procedure. Complete details about this authentication mechanism is described in RFC 4186.
- EAP-TLS—The EAP-TLS (Transport Layer Security) uses Public key Infrastructure (PKI) to set up authentication with a RADIUS server or any authentication server. This method requires the use of a client-side certificate for communicating with the authentication server. The EAP-TLS is described in RFC 5216.
- EAP-TLV- The EAP-TLV (type-length-value) method allows you to add additional information in an EAP message. Often this method is used to provide more information about a EAP message. For example, status information or authorization data. This method is always used after a typical EAP authentication process.
- EAP-TTLS—The EAP-TTLS (Tunneled Transport Layer Security) method uses server-side certificates to set up authentication between clients and servers. The actually authentication is, however, performed using passwords. Complete details about EAP-TTLS is described in RFC 5281.
- LEAP—Lightweight Extensible Authentication Protocol (LEAP) uses dynamic WEP keys and mutual authentication between client and RADIUS server.
- ZLXEAP—This is Zonelabs EAP. For more information, visit http://tools.ietf.org/html/draft-bersani-eap-synthesis-sharedkeymethods-00#page-30.

Authentication with a RADIUS Server

See Table 55 for an overview of the parameters that you need to configure on authentication components when the authentication server is an 802.1x EAP-compliant RADIUS server.

Figure 47 *802.1x Authentication with RADIUS Server*



The supplicant and authentication server must be configured to use the same EAP type. The controller does not need to know the EAP type used between the supplicant and authentication server.

For the controller to communicate with the authentication server, you must configure the IP address, authentication port, and accounting port of the server on the controller. The authentication server must be configured with the IP address of the RADIUS client, which is the controller in this case. Both the controller and the authentication server must be configured to use the same shared secret.

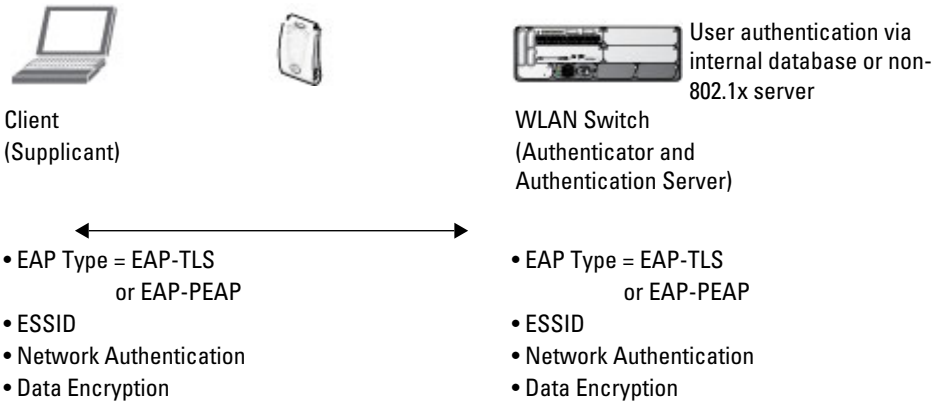
NOTE: Additional information on EAP types supported in a Windows environment, Microsoft supplicants, and authentication server, is available at http://technet.microsoft.com/en-us/library/cc782851(WS.10).aspx.

The client communicates with the controller through a GRE tunnel in order to form an association with an AP and to authenticate to the network. Therefore, the network authentication and encryption configured for an ESSID must be the same on both the client and the controller.

Authentication Terminated on Controller

User authentication is performed either via the controller's internal database or a non-802.1x server. See "802.1x Authentication Profile Basic WebUI Parameters" on page 289 for an overview of the parameters that you need to configure on 802.1x authentication components when 802.1x authentication is terminated on the controller (AAA FastConnect).

Figure 48 *802.1x Authentication with Termination on Controller*



In this scenario, the supplicant is configured for EAP-Transport Layer Security (TLS) or EAP-Protected EAP (PEAP).

- EAP-TLS is used with smart card user authentication. A smart card holds a digital certificate which, with the user-entered personal identification number (PIN), allows the user to be authenticated on the network. EAP-TLS relies on digital certificates to verify the identities of both the client and server.

  EAP-TLS requires that you import server and certification authority (CA) certificates onto the controller (see "Configuring and Using Certificates with AAA FastConnect" on page 294). The client certificate is verified on the controller (the client certificate must be signed by a known CA) before the user name is checked on the authentication server.
- EAP-PEAP uses TLS to create an encrypted tunnel. Within the tunnel, one of the following "inner EAP" methods is used:
  - EAP-Generic Token Card (GTC): Described in RFC 2284, this EAP method permits the transfer of unencrypted usernames and passwords from client to server. The main uses for EAP-GTC are one-time token cards such as SecureID and the use of an LDAP or RADIUS server as the user authentication server. You can also enable caching of user credentials on the controller as a backup to an external authentication server.
  - EAP-Microsoft Challenge Handshake Authentication Protocol version 2 (MS-CHAPv2): Described in RFC 2759, this EAP method is widely supported by Microsoft clients. A RADIUS server must be used as the backend authentication server.

If you are using the controller's internal database for user authentication, you need to add the names and passwords of the users to be authenticated. If you are using an LDAP server for user authentication, you need to configure the LDAP server on the controller, and configure user IDs and passwords. If you are using a RADIUS server for user authentication, you need to configure the RADIUS server on the controller.

Configuring 802.1x Authentication

On the controller, use the following steps to configure a wireless network that uses 802.1x authentication:

1. Configure the VLANs to which the authenticated users will be assigned. See Chapter 2, "Network Parameters" on page 59
2. Configure policies and roles. You can specify a default role for users who are successfully authenticated using 802.1x. You can also configure server derivation rules to assign a user role based on attributes returned by the authentication server; server-derived user roles take precedence over default roles. For more information about policies and roles, see Chapter 12, "Roles and Policies" on page 321.

NOTE: The Policy Enforcement Firewall Virtual Private Network (PEFV) module provides identity-based security for wired and wireless users and must be installed on the controller. The stateful firewall allows user classification based on user identity, device type, location and time of day and provides differentiated access for different classes of users. For information about obtaining and installing licenses, see Chapter 34, "Software Licenses" on page 651.

3. Configure the authentication server(s) and server group. The server can be an 802.1x RADIUS server or, if you are using AAA FastConnect, a non-802.1x server or the controller's internal database. If you are using EAP-GTC within a PEAP tunnel, you can configure an LDAP or RADIUS server as the authentication server (see Chapter 9, "Authentication Servers") If you are using EAP-TLS, you need to import server and CA certificates on the controller (see "Configuring and Using Certificates with AAA FastConnect" on page 294).
4. Configure the AAA profile.
   - Select the 802.1x default user role.
   - Select the server group you previously configured for the 802.1x authentication server group.
5. Configure the 802.1x authentication profile. See "Using the WebUI" on page 307

6. Configure the virtual AP profile for an AP group or for a specific AP:
   - Select the AAA profile you previously configured.
   - In the SSID profile, configure the WLAN for 802.1x authentication.

For details on how to complete the above steps, see "Example Configurations" on page 296

Using the WebUI

This section describes how to create and configure a new instance of an 802.1x authentication profile in the WebUI or the CLI.

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page.
2. In the Profiles list, select 802.1x Authentication Profile.
3. Enter a name for the profile, then click Add.
4. Click Apply.
5. In the Profiles list, select the 802.1x authentication profile you just created.
6. The profile details window includes Basic and Advanced tabs for basic and advanced configuration settings. Click on one or both of these tab to configure the 802.1x Authentication settings. Table 55 describes the parameters you can configure in the high-throughput radio profile.

Table 55 *802.1x Authentication Profile Basic WebUI Parameters*

Parameter	Description
Basic 802.1x Authentication Profile settings	
Max authentication failures	Number of times a user can try to login with wrong credentials after which the user will be blacklisted as a security threat. Set to 0 to disable blacklisting, otherwise enter a non-zero integer to blacklist the user after the specified number of failures. Default: 0
Enforce Machine Authentication	(For Windows environments only) Select this option to enforce machine authentication before user authentication. If selected, either the Machine Authentication Default Role or the User Authentication Default Role is assigned to the user, depending on which authentication is successful. This option is disabled by default. Note: This option may require a PEFNG or PEFV license (see license descriptions at "License Types" on page 652). The Enforce Machine Authentication checkbox is also available on the Advanced settings tab.
Machine Authentication: Default Machine Role	Select the default role to be assigned to the user after completing only machine authentication. Default: guest
Machine Authentication: Default User Role	Select the default role to be assigned to the user after completing 802.1x authentication. Default: guest
Reauthentication	Select this option to force the client to do a 802.1x re-authentication after the expiration of the default timer for re-authentication. The default value of the timer (Reauthentication Interval) is 24 hours. If the user fails to re-authenticate with valid credentials, the state of the user is cleared. If derivation rules are used to classify 802.1x-authenticated users, then the Re-authentication timer per role overrides this setting. Default: disabled
Termination	Select this option to terminate 802.1x authentication on the controller. Default: disabled
Termination EAP-Type	The EAP method, either EAP-PEAP or EAP-TLS. Default: eap-peap

Table 55 *802.1x Authentication Profile Basic WebUI Parameters (Continued)*

Parameter	Description
Termination Inner EAP-Type	Select one of the following: • EAP-Generic Token Card (GTC): Described in RFC 2284, this EAP method permits the transfer of unencrypted usernames and passwords from client to server. The main uses for EAP-GTC are one-time token cards such as SecureID and the use of LDAP or RADIUS as the user authentication server. You can also enable caching of user credentials on the controller as a backup to an external authentication server. • EAP-Microsoft Challenge Authentication Protocol version 2 (MS-CHAPv2): Described in RFC 2759, this EAP method is widely supported by Microsoft clients. Default: eap-mschapv2
Enforce Suite-B 128 bit or more security level Authentication	Configure Suite-B 128 bit or more security level authentication enforcement.
Enforce Suite-B 128 bit or more security level Authentication	Configure Suite-B 192 bit security level authentication enforcement.
Advanced 802.1x Authentication Profile settings	
Max authentication failures	Number of times a user can try to login with wrong credentials after which the user is blacklisted as a security threat. Set to 0 to disable blacklisting, otherwise enter a non-zero integer to blacklist the user after the specified number of failures. The range of allowed values is 0-5 failures, and the default value is 0 failures. Note: This option may require a license (see license descriptions at "License Types" on page 652).
Enforce Machine Authentication	Select the Enforce Machine Authentication option to require machine authentication. This option is also available on the Basic settings tab. Note: This option may require a license (see license descriptions at "License Types" on page 652).
Machine Authentication: Default Machine Role	Default role assigned to the user after completing only machine authentication. The default role for this setting is the "guest" role.
Machine Authentication Cache Timeout	The timeout, in hours, for machine authentication. The allowed range of values is 1-1000 hours, and the default value is 24 hours.
Blacklist on Machine Authentication Failure	Select the Blacklist on Machine Authentication Failure checkbox to blacklist a client if machine authentication fails. This setting is disabled by default
Machine Authentication: Default User Role	Default role assigned to the user after 802.1x authentication. The default role for this setting is the "guest" role.
Interval between Identity Requests	Interval, in seconds, between identity request retries. The allowed range of values is 1-65535 seconds, and the default value is 30 seconds.
Quiet Period after Failed Authentication	The enforced quiet period interval, in seconds, following failed authentication. The allowed range of values is 1-65535 seconds, and the default value is 30 seconds.
Reauthentication Interval	Interval, in seconds, between reauthentication attempts. The allowed range of values for this parameter is 60-864000 seconds, and the default value is 86400 seconds (1day).
Use Server provided Reauthentication Interval	Select this option to override any user-defined reauthentication interval and use the reauthentication period defined by the authentication server.
Multicast Key Rotation Time Interval	Interval, in seconds, between multicast key rotation. The allowed range of values for this parameter is 60-864000 seconds, and the default value is 1800 seconds.
Unicast Key Rotation Time Interval	Interval, in seconds, between unicast key rotation. The allowed range of values for this parameter is 60-864000 seconds, and the default value is 900 seconds.
Authentication Server Retry Interval	Server group retry interval, in seconds. The allowed range of values for this parameter is 5-65535 seconds, and the default value is 30 seconds.

Table 55 *802.1x Authentication Profile Basic WebUI Parameters (Continued)*

Parameter	Description
Authentication Server Retry Count	Maximum number of authentication requests that are sent to server group. The allowed range of values for this parameter is 0-3 requests, and the default value is 2 requests.
Framed MTU	Sets the framed Maximum Transmission Unit (MTU) attribute sent to the authentication server. The allowed range of values for this parameter is 500-1500 bytes, and the default value is 1100 bytes.
Number of times ID-Requests are retried	Maximum number of times ID requests are sent to the client. The allowed range of values for this parameter is 1-10 retries, and the default value is 3 retries.
Maximum Number of Reauthentication Attempts	Number of times a user can try to login with wrong credentials after which the user is blacklisted as a security threat. Set to 0 to disable blacklisting, otherwise enter a value from 0-5 to blacklist the user after the specified number of failures. Note: If changed from its default value, this may require a license This option may require a license (see license descriptions at "License Types" on page 652).
Maximum number of times Held State can be bypassed	Number of consecutive authentication failures which, when reached, causes the controller to not respond to authentication requests from a client while the controller is in a held state after the authentication failure. Before this number is reached, the controller responds to authentication requests from the client even while the controller is in its held state. (This parameter is applicable when 802.1x authentication is terminated on the controller, also known as AAA FastConnect.) The allowed range of values for this parameter is 0-3 failures, and the default value is 0.
Dynamic WEP Key Message Retry Count	Set the Number of times WPA/WPA2 Key Messages are retried. The allowed range of values is 1-5 retries, and the default value is 3 retries.
Dynamic WEP Key Size	The default dynamic WEP key size is 128 bits, If desired, you can change this parameter to either 40 bits.
Interval between WPA/WPA2 Key Messages	Interval, in milliseconds, between each WPA key exchanges. The allowed range of values is 1000-5000ms, and the default value is 3000 ms.
Delay between EAP-Success and WPA2 Unicast Key Exchange	Interval, in milliseconds, between unicast and multicast key exchanges. The allowed range of values is 0-2000ms, and the default value is 0 ms (no delay).
Time interval after which the PMKSA will be deleted	The time interval after which the PMKSA (Pairwise Master Key Security Association) cache is deleted. Time interval in Hours. Range: 1-2000. Default: 8 hrs.
Delay between WPA/WPA2 Unicast Key and Group Key Exchange	Interval, in milliseconds, between unicast and multicast key exchanges. The allowed range of values is 0-2000ms, and the default value is 0 ms (no delay).
WPA/WPA2 Key Message Retry Count	Number of times WPA/WPA2 key messages are retried. The allowed range of values for this parameter is 1-5 retries, and the default value is 3 retries.
Multicast Key Rotation	Select this checkbox to enable multicast key rotation. This feature is disabled by default.
Unicast Key Rotation	Select this checkbox to enable unicast key rotation. This feature is disabled by default.
Reauthentication	Select the Reauthentication checkbox to force the client to do a 802.1x reauthentication after the expiration of the default timer for reauthentication. (The default value of the timer is 24 hours.) If the user fails to reauthenticate with valid credentials, the state of the user is cleared. If derivation rules are used to classify 802.1x-authenticated users, then the reauthentication timer per role overrides this setting. This option is disabled by default.

Table 55 *802.1x Authentication Profile Basic WebUI Parameters (Continued)*

Parameter	Description
Opportunistic Key Caching	By default, the 802.1x authentication profile enables a cached pairwise master key (PMK) derived via a client and an associated AP and used when the client roams to a new AP. This allows clients faster roaming without a full 802.1x authentication. Uncheck this option to disable this feature. Note: Make sure that the wireless client (the 802.1x supplicant) supports this feature. If the client does not support this feature, the client will attempt to renegotiate the key whenever it roams to a new AP. As a result, the key cached on the controller can be out of sync with the key used by the client.
Validate PMKID	This parameter instructs the controller to check the pairwise master key (PMK) ID sent by the client. When this option is enabled, the client must send a PMKID in the associate or reassociate frame to indicate that it supports OKC or PMK caching; otherwise, full 802.1x authentication takes place. Note: This feature is optional, since most clients that support OKC and PMK caching do not send the PMKID in their association request.
Use Session Key	Select the Use Session Key option to use the RADIUS session key as the unicast WEP key. This option is disabled by default.
Use Static Key	Select the Use Static Key option to use a static key as the unicast/multicast WEP key. This option is disabled by default.
xSec MTU	Set the maximum transmission unit (MTU) for frames using the xSec protocol. The range of allowed values is 1024-1500 bytes, and 1300 bytes
Termination	Select the Termination checkbox to allow 802.1x authentication to terminate on the controller. This option is disabled by default.
Termination EAP-Type	If termination is enabled, click either EAP-PEAP or EAP-TLS to select a Extensible Authentication Protocol (EAP) method.
Termination Inner EAP-Type	If you are using EAP-PEAP as the EAP method, specify one of the following inner EAP types: • eap-gtc: Described in RFC 2284, this EAP method permits the transfer of unencrypted • usernames and passwords from client to server. The main uses for EAP-GTC are one-time token cards such as SecureID and the use of LDAP or RADIUS as the user authentication server. You can also enable caching of user credentials on the controller as a backup to an external authentication server. • eap-mschapv2: Described in RFC 2759, this EAP method is widely supported by Microsoft clients.
Enforce Suite-B 128 bit or more security level Authentication	Configure Suite-B 128 bit or more security level authentication enforcement.
Enforce Suite-B 128 bit or more security level Authentication	Configure Suite-B 192 bit security level authentication enforcement.
Token Caching	If you select EAP-GTC as the inner EAP method, you can select the Token Caching checkbox to enable the controller to cache the username and password of each authenticated user. The controller continues to reauthenticate users with the remote authentication server, however, if the authentication server is not available, the controller will inspect its cached credentials to reauthenticate users. This option is disabled by default.
Token Caching Period	If you select EAP-GTC as the inner EAP method, you can specify the timeout period, in hours, for the cached information. The default value is 24 hours.
CA-Certificate	Click the CA-Certificate drop-down list and select a certificate for client authentication. The CA certificate needs to be loaded in the controller before it will appear on this list.
Server-Certificate	Click the Server-Certificate drop-down list and select a server certificate the controller will use to authenticate itself to the client.

Table 55 *802.1x Authentication Profile Basic WebUI Parameters (Continued)*

Parameter	Description
TLS Guest Access	Select TLS Guest Access to enable guest access for EAP-TLS users with valid certificates. This option is disabled by default.
TLS Guest Role	Click the TLS Guest Role drop-down list and select the default user role for EAP-TLS guest users. Note: This option may require a license This option may require a license (see license descriptions at "License Types" on page 652).
Ignore EAPOL-START after authentication	Select Ignore EAPOL-START after authentication to ignore EAPOL-START messages after authentication. This option is disabled by default.
Handle EAPOL-Logoff	Select Handle EAPOL-Logoff to enable handling of EAPOL-LOGOFF messages. This option is disabled by default.
Ignore EAP ID during negotiation	Select Ignore EAP ID during negotiation to ignore EAP IDs during negotiation. This option is disabled by default.
WPA-Fast-Handover	Select this option to enable WPA-fast-handover on phones that support this feature. WAP fast-handover is disabled by default.
Disable rekey and reauthentication for clients on call	This feature disables rekey and reauthentication for VoWLAN clients. It is disabled by default, meaning that rekey and reauthentication is enabled. Note: This option may require a license This option may require a license (see license descriptions at "License Types" on page 652).
Check certificate common name against AAA server	If you use client certificates for user authentication, enable this option to verify that the certificate's common name exists in the server. This parameter is enabled by default in the default-cap and default-rap VPN profiles, and disabled by default on all other VPN profiles.

7. Click Apply.

Using the CLI

The following command configures settings for an 802.1x authentication profiles. Individual parameters are described in Table 55, above.

```
aaa authentication dot1x {<profile>|countermeasures}
   ca-cert <certificate>
   clear
   clone <profile>
   eapol-logoff
   framed-mtu <mtu>
   heldstate-bypass-counter <number>
   ignore-eap-id-match
   ignore-eapolstart-afterauthentication
   machine-authentication blacklist-on-failure|{cache-timeout <hours>}|enable|
   {machine-default-role <role>}|{user-default-role <role>}
   max-authentication-failures <number>
   max-requests <number>
   multicast-keyrotation
   no ...
   opp-key-caching
   reauth-max <number>
   reauthentication
   server {server-retry <number>|server-retry-period <seconds>}
   server-cert <certificate>
   termination {eap-type <type>}|enable|enable-token-caching|{inner-eap-type (eapgtc|
   eap-mschapv2)}|{token-caching-period <hours>}
   timer {idrequest_period <seconds>}|{mkey-rotation-period <seconds>}|{quiet-period
   <seconds>}|{reauth-period <seconds>}|{ukey-rotation-period <seconds>}|{wpagroupkey-
```

```
delay <seconds>}|{wpa-key-period <milliseconds>}
tls-guest-access
tls-guest-role <role>
unicast-keyrotation
use-session-key
use-static-key
validate-pmkid
voice-aware
wep-key-retries <number>
wep-key-size {40|128}
wpa-fast-handover
wpa-key-retries <number>
xSec-mtu <mtu>
```

Configuring and Using Certificates with AAA FastConnect

The controller supports 802.1x authentication using digital certificates for AAA FastConnect.

- Server Certificate—A server certificate installed in the controller verifies the authenticity of the controller for 802.1x authentication. Dell controllers ship with a demonstration digital certificate. Until you install a customer-specific server certificate in the controller, this demonstration certificate is used by default for all secure HTTP connections (such as the WebUI and captive portal) and AAA FastConnect. This certificate is included primarily for the purposes of feature demonstration and convenience and is not intended for long-term use in production networks. Users in a production environment are urged to obtain and install a certificate issued for their site or domain by a well-known certificate authority (CA). You can generate a Certificate Signing Request (CSR) on the controller to submit to a CA. For information on how to generate a CSR and how to import the CA-signed certificate into the controller, see "Managing Certificates" on page 580
- Client Certificates—Client certificates are verified on the controller (the client certificate must be signed by a known CA) before the user name is checked on the authentication server. To use client certificate authentication for AAA FastConnect, you need to import the following certificates into the controller (see "Importing Certificates" on page 583):
  - Controller's server certificate
  - CA certificate for the CA that signed the client certificates

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page.
2. In the Profiles list, select 802.1x Authentication Profile.
3. Select the "default" 802.1x authentication profile from the drop-down menu to display configuration parameters.
4. In the Basic tab, select Termination.
5. Select the Advanced Tab.
6. In the Server-Certificate field, select the server certificate imported into the controller.
7. In the CA-Certificate field, select the CA certificate imported into the controller.
8. Click Save As. Enter a name for the 802.1x authentication profile.
9. Click Apply.

Using the CLI

```
aaa authentication dot1x <profile>
   termination enable
   server-cert <certificate>
   ca-cert <certificate>
```

Configuring User and Machine Authentication

When a Windows device boots, it logs onto the network domain using a machine account. Within the domain, the device is authenticated before computer group policies and software settings can be executed; this process is known as *machine authentication*. Machine authentication ensures that only authorized devices are allowed on the network.

You can configure 802.1x for both user and machine authentication (select the Enforce Machine Authentication option described in Table 55 on page 289). This tightens the authentication process further since both the device and user need to be authenticated.

Role Assignment with Machine Authentication Enabled

When you enable machine authentication, there are two additional roles you can define in the 802.1x authentication profile:

- Machine authentication default machine role
- Machine authentication default user role

While you can select the same role for both options, you should define the roles as per the polices that need to be enforced. Also, these roles can be different from the 802.1x authentication default role configured in the AAA profile.

With machine authentication enabled, the assigned role depends upon the success or failure of the machine and user authentications. In certain cases, the role that is ultimately assigned to a client can also depend upon attributes returned by the authentication server or server derivation rules configured on the controller.

Table 56 describes role assignment based on the results of the machine and user authentications.

Table 56 *Role Assignment for User and Machine Authentication*

Machine Auth Status	User Auth Status	Description	Role Assigned
Failed	Failed	Both machine authentication and user authentication failed. L2 authentication failed.	No role assigned. No access to the network allowed.
Failed	Passed	Machine authentication fails (for example, the machine information is not present on the server) and user authentication succeeds. Server-derived roles do not apply.	Machine authentication default user role configured in the 802.1x authentication profile.
Passed	Failed	Machine authentication succeeds and user authentication has not been initiated. Server-derived roles do not apply.	Machine authentication default machine role configured in the 802.1x authentication profile.
Passed	Passed	Both machine and user are successfully authenticated. If there are server-derived roles, the role assigned via the derivation take precedence. This is the *only* case where server-derived roles are applied.	A role derived from the authentication server takes precedence. Otherwise, the 802.1x authentication default role configured in the AAA profile is assigned.

For example, if the following roles are configured:

- 802.1x authentication default role (in AAA profile): dot1x_user
- Machine authentication default machine role (in 802.1x authentication profile): dot1x_mc
- Machine authentication default user role (in 802.1x authentication profile): guest

Role assignments would be as follows:

- If both machine and user authentication succeed, the role is dot1x_user. If there is a server-derived role, the server-derived role takes precedence.

- If only machine authentication succeeds, the role is dot1x_mc.
- If only user authentication succeeds, the role is guest.
- On failure of both machine and user authentication, the user does not have access to the network.

With machine authentication enabled, the VLAN to which a client is assigned (and from which the client obtains its IP address) depends upon the success or failure of the machine and user authentications. The VLAN that is ultimately assigned to a client can also depend upon attributes returned by the authentication server or server derivation rules configured on the controller (see "About VLAN Assignments" on page 65). If machine authentication is successful, the client is assigned the VLAN configured in the virtual AP profile. However, the client can be assigned a derived VLAN upon successful user authentication.

NOTE: You can optionally assign a VLAN as part of a user role configuration. You should not use VLAN derivation if you configure user roles with VLAN assignments

Table 57 describes VLAN assignment based on the results of the machine and user authentications when VLAN derivation is used.

Table 57 *VLAN Assignment for User and Machine Authentication*

Machine Auth Status	User Auth Status	Description	VLAN Assigned
Failed	Failed	Both machine authentication and user authentication failed. L2 authentication failed.	No VLAN
Failed	Passed	Machine authentication fails (for example, the machine information is not present on the server) and user authentication succeeds.	VLAN configured in the virtual AP profile
Passed	Failed	Machine authentication succeeds and user authentication has not been initiated.	VLAN configured in the virtual AP profile
Passed	Passed	Both machine and user are successfully authenticated.	Derived VLAN. Otherwise, VLAN configured in the virtual AP profile.

NOTE: The administrator can now associate a VLAN Id to a client data based on the authentication credentials in a bridge mode.

Example Configurations

The following examples show basic configurations on the controller for:

- "Authentication with an 802.1x RADIUS Server" on page 297
- "Authentication with the Controller's Internal Database" on page 306

In the following examples:

- Wireless clients associate to the ESSID WLAN-01.
- The following roles allow different networks access capabilities:
  - student
  - faculty
  - guest
  - system administrators

The examples show how to configure using the WebUI and CLI commands.

Authentication with an 802.1x RADIUS Server

- An EAP-compliant RADIUS server provides the 802.1x authentication. The RADIUS server administrator must configure the server to support this authentication. The administrator must also configure the server to all communications with the Dell controller.
- The authentication type is WPA. From the 802.1x authentication exchange, the client and the controller derive dynamic keys to encrypt data transmitted on the wireless network.
- 802.1x authentication based on PEAP with MS-CHAPv2 provides both computer and user authentication. If a user attempts to log in without the computer being authenticated first, the user is placed into a more limited "guest" user role.

  Windows domain credentials are used for computer authentication, and the user's Windows login and password are used for user authentication. A single user sign-on facilitates both authentication to the wireless network and access to the Windows server resources.

NOTE: Appendix D, "" on page 787describes how to configure the Microsoft Internet Authentication Server and Windows XP wireless client to operate with the controller configuration shown in this section.

Configuring Roles and Policies

You can create the following policies and user roles for:

- Student
- Faculty
- Guest
- Sysadming
- Computer

Creating the Student Role and Policy

The student policy prevents students from using telnet, POP3, FTP, SMTP, SNMP, or SSH to the wired portion of the network. The student policy is mapped to the student user role.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page. Select Add to add the student policy.
2. For Policy Name, enter student.
3. For Policy Type, select IPv4 Session.
4. Under Rules, select Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select alias.

NOTE: The following step defines an alias representing all internal network addresses. Once defined, you can use the alias for other rules and policies.

   c. Under the alias selection, click New. For Destination Name, enter "Internal Network". Click Add to add a rule. For Rule Type, select network. For IP Address, enter 10.0.0.0. For Network Mask/Range, enter 255.0.0.0. Click Add to add the network range. Repeat these steps to add the network range 172.16.0.0 255.255.0.0. Click Done. The alias "Internal Network" appears in the Destination menu. This step defines

an alias representing all internal network addresses. Once defined, you can use the alias for other rules and policies.

d. Under Destination, select Internal Network.

e. Under Service, select service. In the Service scrolling list, select svc-telnet.

f. Under Action, select drop.

g. Click Add.

5. Under Rules, click Add.
   a. Under Source, select user.
   b. Under Destination, select alias. Then select Internal Network.
   c. Under Service, select service. In the Service scrolling list, select svc-pop3.
   d. Under Action, select drop.
   e. Click Add.
6. Repeat steps 4A-E to create rules for the following services: svc-ftp, svc-smtp, svc-snmp, and svc-ssh.
7. Click Apply.
8. Click the User Roles tab. Click Add to create the student role.
9. For Role Name, enter student.
10. Under Firewall Policies, click Add. In Choose from Configured Policies, select the student policy you previously created. Click Done.
11. Click Apply.

Using the CLI

```
ip access-list session student
   user alias "Internal Network" svc-telnet deny
   user alias "Internal Network" svc-pop3 deny
   user alias "Internal Network" svc-ftp deny
   user alias "Internal Network" svc-smtp deny
   user alias "Internal Network" svc-snmp deny
   user alias "Internal Network" svc-ssh deny

user-role student
   session-acl student
   session-acl allowall
```

Creating the Faculty Role and Policy

The faculty policy is similar to the student policy, however faculty members are allowed to use POP3 and SMTP for VPN remote access from home. (Students are not permitted to use VPN remote access.) The faculty policy is mapped to the faculty user role.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page. Click Add to add the faculty policy.
2. For Policy Name, enter faculty.
3. For Policy Type, select IPv4 Session.
4. Under Rules, click Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select alias, then select Internal Network.
   c. Under Service, select service. In the Service scrolling list, select svc-telnet.

d. Under Action, select drop.

e. Click Add.

f. Repeat steps A-E to create rules for the following services: svc-ftp, svc-snmp, and svc-ssh.

5. Click Apply.
6. Select the User Roles tab. Click Add to create the faculty role.
7. For Role Name, enter faculty.
8. Under Firewall Policies, click Add. In Choose from Configured Policies, select the faculty policy you previously created. Click Done.

Using the CLI

```
ip access-list session faculty
   user alias "Internal Network" svc-telnet deny
   user alias "Internal Network" svc-ftp deny
   user alias "Internal Network" svc-snmp deny
   user alias "Internal Network" svc-ssh deny

user-role faculty
   session-acl faculty
   session-acl allowall
```

Creating the Guest Role and Policy

The guest policy permits only access to the Internet (via HTTP or HTTPS) and only during daytime working hours. The guest policy is mapped to the guest user role.

Using the WebUI

1. Navigate to the Configuration > Security > Access Control > Time Ranges page to define the time range "working-hours". Click Add.

   a. For Name, enter working-hours.

   b. For Type, select Periodic.

   c. Click Add.

   d. For Start Day, click Weekday.

   e. For Start Time, enter 07:30.

   f. For End Time, enter 17:00.

   g. Click Done.

   h. Click Apply.
2. Click the Policies tab. Click Add to add the guest policy.
3. For Policy Name, enter guest.
4. For Policy Type, select IPv4 Session.
5. Under Rules, click Add to add rules for the policy.

   To create rules to permit access to DHCP and DNS servers during working hours:

   a. Under Source, select user.

   b. Under Destination, select host. In Host IP, enter 10.1.1.25.

   c. Under Service, select service. In the Service scrolling list, select svc-dhcp.

   d. Under Action, select permit.

   e. Under Time Range, select working-hours.

   f. Click Add.

g. Repeat steps A-F to create a rule for svc-dns.

To create a rule to deny access to the internal network:

a. Under Source, select user.

b. Under Destination, select alias. Select Internal Network.

c. Under Service, select any.

d. Under Action, select drop.

e. Click Add.

To create rules to permit HTTP and HTTPS access during working hours:

a. Under Source, select user.

b. Under Destination, select any.

c. Under Service, select service. In the Services scrolling list, select svc-http.

d. Under Action, select permit.

e. Under Time Range, select working-hours.

f. Click Add.

g. Repeat steps A-F for the svc-https service.

To create a rule that denies the user access to all destinations and all services:

a. Under Source, select user.

b. Under Destination, select any.

c. Under Service, select any.

d. Under Action, select drop.

e. Click Add.

6. Click Apply.
7. Click the User Roles tab. Click Add to create the guest role.
8. For Role Name, enter guest.
9. Under Firewall Policies, click Add. In Choose from Configured Policies, select the guest policy you previously created. Click Done.

Using the CLI

```
time-range working-hours periodic
   weekday 07:30 to 17:00

ip access-list session guest
   user host 10.1.1.25 svc-dhcp permit time-range working-hours
   user host 10.1.1.25 svc-dns permit time-range working-hours
   user alias "Internal Network" any deny
   user any svc-http permit time-range working-hours
   user any svc-https permit time-range working-hours
   user any any deny

user-role guest
   session-acl guest
```

Creating Roles and Policies for Sysadmin and Computer

- The allowall policy, a predefined policy, allows unrestricted access to the network. The allowall policy is mapped to both the sysadmin user role and the computer user role.

Using the WebUI to create the Sysadmin Role

1. Navigate to Configuration > Security > Access Control > User Roles page. Click Add to create the sysadmin role.
2. For Role Name, enter sysadmin.
3. Under Firewall Policies, click Add. In Choose from Configured Policies, select the predefined allowall policy. Click Done.
4. Click Apply.

Using the CLI to Create the Sysadmin Role

```
user-role sysadmin
   session-acl allowall
```

Using the WebUI to Create the Computer Role

1. Navigate to Configuration > Security > Access Control > User Roles page. Click Add to create the computer role.
2. For Role Name, enter computer.
3. Under Firewall Policies, click Add. In Choose from Configured Policies, select the predefined allowall policy. Click Done.
4. Click Apply.

Using the CLI to create the computer role

```
user-role computer
   session-acl allowall
```

Creating an Alias for the Internal Network Using CLI

```
netdestination "Internal Network"
   network 10.0.0.0 255.0.0.0
   network 172.16.0.0 255.255.0.0
```

Configuring the RADIUS Authentication Server

Configure the RADIUS server IAS1, with IP address 10.1.1.21 and shared key. The RADIUS server is configured to sent an attribute called Class to the controller; the value of this attribute is set to either "student," "faculty," or "sysadmin" to identify the user's group. The controller uses the literal value of this attribute to determine the role name.

On the controller, you add the configured server (IAS1) into a server group. For the server group, you configure the server rule that allows the Class attribute returned by the server to set the user role.

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. In the Servers list, select Radius Server. In the RADIUS Server Instance list, enter IAS1 and click Add.
   a. Select IAS1 to display configuration parameters for the RADIUS server.
   b. For IP Address, enter 10.1.1.21.
   c. For Key, enter `|*a^t%183923!.` (You must enter the key string twice.)
   d. Click Apply.
3. In the Servers list, select Server Group. In the Server Group Instance list, enter IAS and click Add.
   a. Select the server group IAS to display configuration parameters for the server group.
   b. Under Servers, click New.
   c. From the Server Name drop-down menu, select IAS1. Click Add Server.

4. Under Server Rules, click New.
   a. For Condition, enter Class.
   b. For Attribute, select value-of from the drop-down menu.
   c. For Operand, select set role.
   d. Click Add.
5. Click Apply.

Using the CLI

```
aaa authentication-server radius IAS1
   host 10.1.1.21
   key |*a^t%183923!

aaa server-group IAS
   auth-server IAS1
   set role condition Class value-of
```

Configure 802.1x Authentication

An AAA profile specifies the 802.1x authentication profile and 802.1x server group to be used for authenticating clients for a WLAN. The AAA profile also specifies the default user roles for 802.1x and MAC authentication.

In the 802.1x authentication profile, configure enforcement of machine authentication before user authentication. If a user attempts to log in without machine authentication taking place first, the user is placed in the limited guest role.

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page.
2. Select 802.1x Authentication Profile.
   a. In the list of instances, enter dot1x, then click Add.
   b. Select the profile name you just added.
   c. Select Enforce Machine Authentication.
   d. For the Machine Authentication: Default Machine Role, select computer.
   e. For the Machine Authentication: Default User Role, select guest.
   f. Click Apply.
3. Select the AAA Profiles tab.
   a. In the AAA Profiles Summary, click Add to add a new profile.
   b. Enter aaa_dot1x, then click Add.
   a. Select the profile name you just added.
   b. For MAC Auth Default Role, select computer.
   c. For 802.1x Authentication Default Role, select faculty.
   d. Click Apply.
4. In the Profiles list (under the aaa_dot1x profile), select 802.1x Authentication Profile.
   a. From the drop-down menu, select the dot1x 802.1x authentication profile you configured previously.
   b. Click Apply.
5. In the Profiles list (under the aaa_dot1x profile), select 802.1x Authentication Server Group.
   a. From the drop-down menu, select the IAS server group you created previously.
   b. Click Apply.

Using the CLI

```
aaa authentication dot1x dot1x
   machine-authentication enable
   machine-authentication machine-default-role computer
   machine-authentication user-default-role guest

aaa profile aaa_dot1x
   dot1x-default-role faculty
   mac-default-role computer
   authentication-dot1x dot1x
   dot1x-server-group IAS
```

Configure VLANs

In this example, wireless clients are assigned to either VLAN 60 or 61 while guest users are assigned to VLAN 63. VLANs 60 and 61 split users into smaller IP subnetworks, improving performance by decreasing broadcast traffic. The VLANs are internal to the Dell controller only and do not extend into other parts of the wired network. The clients' default gateway is the Dell controller, which routes traffic out to the 10.1.1.0 subnetwork.

You configure the VLANs, assign IP addresses to each VLAN, and establish the "helper address" to which client DHCP requests are forwarded.

Using the WebUI

1. Navigate to the Configuration > Network > VLANs page. Click Add to add VLAN 60.
   a. For VLAN ID, enter 60.
   b. Click Apply.
   c. Repeat steps A and B to add VLANs 61 and 63.
2. To configure IP parameters for the VLANs, navigate to the Configuration > Network > IP > IP Interfaces page.
   a. Click Edit for VLAN 60.
   b. For IP Address, enter 10.1.60.1.
   c. For Net Mask, enter 255.255.255.0.
   d. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.
   e. Click Apply.
3. In the IP Interfaces page, click Edit for VLAN 61.
   a. For IP Address, enter 10.1.61.1.
   b. For Net Mask, enter 255.255.255.0.
   c. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.
   d. Click Apply.
4. In the IP Interfaces page, click Edit for VLAN 63.
   a. For IP Address, enter 10.1.63.1.
   b. For Net Mask, enter 255.255.255.0.
   c. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.
   d. Click Apply.
5. Select the IP Routes tab.
   a. For Default Gateway, enter 10.1.1.254.
   b. Click Apply.

Using the CLI

```
vlan 60
interface vlan 60
   ip address 10.1.60.1 255.255.255.0
   ip helper-address 10.1.1.25

vlan 61
interface vlan 61
   ip address 10.1.61.1 255.255.255.0
   ip helper-address 10.1.1.25

vlan 63
interface vlan 63
   ip address 10.1.63.1 255.255.255.0
   ip helper-address 10.1.1.25

ip default-gateway 10.1.1.254
```

Configuring the WLANs

In this example, default AP parameters for the entire network are as follows: the default ESSID is WLAN-01 and the encryption mode is TKIP. A second ESSID called "guest" has the encryption mode set to static WEP with a configured WEP key.

In this example, the non-guest clients that associate to an AP are mapped into one of two different user VLANs. The initial AP to which the client associates determines the VLAN: clients that associate to APs in the first floor of the building are mapped to VLAN 60 and clients that associate to APs in the second floor of the building are mapped to VLAN 61. Therefore, the APs in the network are segregated into two AP groups, named "first-floor" and "second-floor". (See "Creating an AP group" on page 109 for information about creating AP groups.) The guest clients are mapped into VLAN 63.

Configuring the Guest WLAN

You create and configure the virtual AP profile "guest" and apply the profile to each AP group. The "guest" virtual AP profile contains the SSID profile "guest" which configures static WEP with a WEP key.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. In the AP Group list, click Edit for first-floor.
3. Under Profiles, select Wireless LAN, then select Virtual AP.
4. To create the guest virtual AP:
   a. Select NEW from the Add a profile drop-down menu. Enter guest, and click Add.
   b. In the Profile Details entry for the guest virtual AP profile, select NEW from the SSID profile drop-down menu. A pop-up window allows you to configure the SSID profile.
   c. For the name for the SSID profile enter guest.
   d. For the Network Name for the SSID, enter guest.
   e. For Network Authentication, select None.
   f. For Encryption, select WEP.
   g. Enter the WEP Key.
   h. Click Apply to apply the SSID profile to the Virtual AP.
   i. Under Profile Details, click Apply.
5. Click on the guest virtual AP name in the Profiles list or in Profile Details to display configuration parameters.

a. Make sure Virtual AP enable is selected.
b. For VLAN, select 63.
c. Click Apply.

6. Navigate to the Configuration > Wireless > AP Configuration page.
7. In the AP Group list, click Edit for the second-floor.
8. In the Profiles list, select Wireless LAN, then select Virtual AP.
9. Select guest from the Add a profile drop-down menu. Click Add.
10. Click Apply.

Using the CLI

```
wlan ssid-profile guest
   essid guest
   wepkey1 aaaaaaaaaa
   opmode static-wep

wlan virtual-ap guest
   vlan 63
   ssid-profile guest

ap-group first-floor
   virtual-ap guest
ap-group second-floor
   virtual-ap guest
```

Configuring the Non-Guest WLANs

You create and configure the SSID profile "WLAN-01" with the ESSID "WLAN-01" and WPA TKIP encryption. You need to create and configure two virtual AP profiles: one with VLAN 60 for the first-floor AP group and the other with VLAN 61 for the second-floor AP group. Each virtual AP profile references the SSID profile "WLAN-01" and the previously-configured AAA profile "aaa_dot1x".

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. In the AP Group list, click Edit for the first-floor.
3. In the Profiles list, select Wireless LAN, then select Virtual AP.
4. To configure the WLAN-01_first-floor virtual AP:
   a. Select NEW from the Add a profile drop-down menu. Enter WLAN-01_first-floor, and click Add.
   b. In the Profile Details entry for the WLAN-01_first-floor virtual AP profile, select the aaa_dot1x AAA profile you previously configured. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   c. From the SSID profile drop-down menu, select NEW. A pop-up window allows you to configure the SSID profile.
   d. Enter WLAN-01 for the name of the SSID profile.
   e. For Network Name, enter WLAN-01.
   f. For Network Authentication, select WPA.
   g. Click Apply in the pop-up window.
   h. At the bottom of the Profile Details page, click Apply.
5. Click on the WLAN-01_first-floor virtual AP name in the Profiles list or in Profile Details to display configuration parameters.

a. Make sure Virtual AP enable is selected.
b. For VLAN, select 60.
c. Click Apply.

6. Navigate to the Configuration > Wireless > AP Configuration page.
7. In the AP Group list, click Edit for the second-floor.
8. In the Profiles list, select Wireless LAN, then select Virtual AP.
9. To configure the WLAN-01_second-floor virtual AP:
   a. Select NEW from the Add a profile drop-down menu. Enter WLAN-second-floor, and click Add.
   b. In the Profile Details entry for the virtual AP profile, select aaa_dot1x from the AAA profile drop-down menu. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   c. From the SSID profile drop-down menu, select WLAN-01. A pop-up window displays the configured SSID profile parameters. Click Apply in the pop-up window.
   d. At the bottom of the Profile Details page, click Apply.
10. Click on the new virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
    a. Make sure Virtual AP enable is selected.
    b. For VLAN, select 61.
    c. Click Apply.

Using the CLI

```
wlan ssid-profile WLAN-01
   essid WLAN-01
   opmode wpa-tkip

wlan virtual-ap WLAN-01_first-floor
   vlan 60
   aaa-profile aaa_dot1x
   ssid-profile WLAN-01

wlan virtual-ap WLAN-01_second-floor
   vlan 61
   aaa-profile aaa_dot1x
   ssid-profile WLAN-01

ap-group first-floor
   virtual-ap WLAN-01_first-floor
ap-group second-floor
   virtual-ap WLAN-01_second-floor
```

Authentication with the Controller's Internal Database

In the following example:

- The controller's internal database provides user authentication.
- The authentication type is WPA. From the 802.1x authentication exchange, the client and the controller derive dynamic keys to encrypt data transmitted on the wireless network.

Configuring the Internal Database

Configure the internal database with the username, password, and role (student, faculty, or sysadmin) for each user. There is a default internal server group that includes the internal database. For the internal server group, configure a server derivation rule that assigns the role to the authenticated client.

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. In the Servers list, select Internal DB.
3. Under Users, click Add User to add users.
4. For each user, enter a username and password.
5. Select the Role for each user (if a role is not specified, the default role is guest).
6. Select the expiration time for the user account in the internal database.
7. Click Apply.

Using the CLI

NOTE: Use the privileged mode in the CLI to configure users in the controller's internal database.

```
local-userdb add username <user> password <password>
```

Configuring a server rule using the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select Server Group to display the Server Group list.
3. Select the internal server group.
4. Under Server Rules, click New to add a server derivation rule.
   a. For Condition, enter Role.
   b. Select value-of from the drop-down menu.
   c. Select Set Role from the drop-down menu.
   d. Click Add.
5. Click Apply.

Configuring a server rule using the CLI

```
aaa server-group internal
   set role condition Role value-of
```

Configure 802.1x Authentication

An AAA profile specifies the 802.1x authentication profile and 802.1x server group to be used for authenticating clients for a WLAN. The AAA profile also specifies the default user role for 802.1x authentication.

For this example, you enable both 802.1x authentication and termination on the controller.

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page. In the profiles list, select 802.1x Authentication Profile.
   a. In the Instance list, enter dot1x, then click Add.
   b. Select the dot1x profile you just created.
   c. Select Termination.

NOTE: The defaults for EAP Method and Inner EAP Method are EAP-PEAP and EAP-MSCHAPv2, respectively.

d. Click Apply.

2. Select the AAA Profiles tab.
   a. In the AAA Profiles Summary, click Add to add a new profile.
   b. Enter aaa_dot1x, then click Add.
   c. Select the aaa_dot1x profile you just created.
   d. For 802.1x Authentication Default Role, select faculty.
   e. Click Apply.
3. In the Profiles list (under the aaa_dot1x profile you just created), select 802.1x Authentication Profile.
   a. Select the dot1x profile from the 802.1x Authentication Profile drop-down menu.
   b. Click Apply.
4. In the Profiles list (under the aaa_dot1x profile you just created), select 802.1x Authentication Server Group.
   a. Select the internal server group.
   b. Click Apply.

Using the CLI

```
aaa authentication dot1x dot1x
   termination enable

aaa profile aaa_dot1x
   dot1x-default-role student
   authentication-dot1x dot1x
   dot1x-server-group internal
```

Configure VLANs

In this example, wireless clients are assigned to either VLAN 60 or 61 while guest users are assigned to VLAN 63. VLANs 60 and 61 split users into smaller IP subnetworks, improving performance by decreasing broadcast traffic. The VLANs are internal to the Dell controller only and do not extend into other parts of the wired network. The clients' default gateway is the Dell controller, which routes traffic out to the 10.1.1.0 subnetwork.

You configure the VLANs, assign IP addresses to each VLAN, and establish the "helper address" to which client DHCP requests are forwarded.

Using the WebUI

1. Navigate to the Configuration > Network > VLAN page. Click Add to add VLAN 60.
   a. For VLAN ID, enter 60.
   b. Click Apply.
   c. Repeat steps A and B to add VLANs 61 and 63.
2. To configure IP parameters for the VLANs, navigate to the Configuration > Network > IP > IP Interfaces page.
   a. Click Edit for VLAN 60.
   b. For IP Address, enter 10.1.60.1.
   c. For Net Mask, enter 255.255.255.0.
   d. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.
   e. Click Apply.
3. In the IP Interfaces page, click Edit for VLAN 61.
   a. For IP Address, enter 10.1.61.1.
   b. For Net Mask, enter 255.255.255.0.

c. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.

d. Click Apply.

4. In the IP Interfaces page, click Edit for VLAN 63.

a. For IP Address, enter 10.1.63.1.

b. For Net Mask, enter 255.255.255.0.

c. Under DHCP Helper Address, click Add. Enter 10.1.1.25 and click Add.

d. Click Apply.

5. Select the IP Routes tab.

a. For Default Gateway, enter 10.1.1.254.

b. Click Apply.

Using the CLI

```
vlan 60
interface vlan 60
   ip address 10.1.60.1 255.255.255.0
   ip helper-address 10.1.1.25

vlan 61
interface vlan 61
   ip address 10.1.61.1 255.255.255.0
   ip helper-address 10.1.1.25

vlan 63
interface vlan 63
   ip address 10.1.63.1 255.255.255.0
   ip helper-address 10.1.1.25

ip default-gateway 10.1.1.254
```

Configuring the WLANs

In this example, default AP parameters for the entire network are as follows: the default ESSID is WLAN-01 and the encryption mode is TKIP. A second ESSID called “guest” has the encryption mode set to static WEP with a configured WEP key.

In this example, the non-guest clients that associate to an AP are mapped into one of two different user VLANs. The initial AP to which the client associates determines the VLAN: clients that associate to APs in the first floor of the building are mapped to VLAN 60 and clients that associate to APs in the second floor of the building are mapped to VLAN 61. Therefore, the APs in the network are segregated into two AP groups, named “first-floor” and “second-floor”. (See “Creating an AP group” on page 109 for information about creating AP groups.) The guest clients are mapped into VLAN 63.

Configuring the Guest WLAN

You create and configure the virtual AP profile “guest” and apply the profile to each AP group. The “guest” virtual AP profile contains the SSID profile “guest” which configures static WEP with a WEP key.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. In the AP Group list, select first-floor.
3. In the Profiles list, select Wireless LAN then select Virtual AP.
4. To configure the guest virtual AP:

a. Select NEW from the Add a profile drop-down menu. Enter guest for the name of the virtual AP profile, and click Add.
b. In the Profile Details entry for the guest virtual AP profile, select NEW from the SSID profile drop-down menu. A pop-up window allows you to configure the SSID profile.
c. Enter guest for the name of the SSID profile.
d. Enter guest for the Network Name.
e. For Network Authentication, select None.
f. For Encryption, select WEP.
g. Enter the WEP key.
h. Click Apply.
i. Under Profile Details, click Apply.

5. Click on the guest virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
   a. Make sure Virtual AP enable is selected.
   b. For VLAN, select 63.
   c. Click Apply.
6. Navigate to the Configuration > Wireless > AP Configuration page.
7. In the AP Group list, select second-floor.
8. In the Profiles list, select Wireless LAN, then select Virtual AP.
9. Select guest from the Add a profile drop-down menu. Click Add.
10. Click Apply.

Using the CLI

```
wlan ssid-profile guest
   essid guest
   wepkey1 aaaaaaaaaa
   opmode static-wep

wlan virtual-ap guest
   vlan 63
   ssid-profile guest

ap-group first-floor
   virtual-ap guest
ap-group second-floor
   virtual-ap guest
```

Configuring the Non-Guest WLANs

You create and configure the SSID profile “WLAN-01” with the ESSID “WLAN-01” and WPA TKIP encryption. You need to create and configure two virtual AP profiles: one with VLAN 60 for the first-floor AP group and the other with VLAN 61 for the second-floor AP group. Each virtual AP profile references the SSID profile “WLAN-01” and the previously-configured AAA profile “aaa_dot1x”.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. In the AP Group list, select first-floor.
3. In the Profiles list, select Wireless LAN, then select Virtual AP.
4. To configure the WLAN-01_first-floor virtual AP:

a. Select NEW from the Add a profile drop-down menu. Enter WLAN-01_first-floor, and click Add.
b. In the Profile Details entry for the WLAN-01_first-floor virtual AP profile, select aaa_dot1x from the AAA Profile drop-down menu. A pop-up window displays the configured AAA parameters. Click Apply in the pop-up window.
c. From the SSID profile drop-down menu, select NEW. A pop-up window allows you to configure the SSID profile.
d. Enter WLAN-01 for the name of the SSID profile.
e. Enter WLAN-01 for the Network Name.
f. Select WPA for Network Authentication.
g. Click Apply in the pop-up window.
h. At the bottom of the Profile Details page, click Apply.

5. Click on the WLAN-01_first-floor virtual AP profile name in the Profiles list or in Profile Details to display configuration parameters.
   a. Make sure Virtual AP enable is selected.
   b. For VLAN, select 60.
   c. Click Apply.
6. Navigate to the Configuration > Wireless > AP Configuration page.
7. In the AP Group list, select second-floor.
8. In the Profiles list, select Wireless LAN then select Virtual AP.
9. To create the WLAN-01_second-floor virtual AP:
   a. Select NEW from the Add a profile drop-down menu. Enter WLAN-01_second-floor, and click Add.
   b. In the Profile Details entry for the virtual AP profile, select aaa_dot1x from the AAA Profile drop-down menu. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   c. From the SSID profile drop-down menu, select WLAN-01. a pop-up window displays the configured SSID profile parameters. Click Apply in the pop-up window.
   d. At the bottom of the Profile Details page, click Apply.
10. Click on the WLAN-01_second-floor virtual AP profile name in the Profiles list or in Profile Details to display configuration parameters.
    a. Make sure Virtual AP enable is selected.
    b. For VLAN, select 61.
    c. Click Apply.

Using the CLI

```
wlan ssid-profile WLAN-01
   essid WLAN-01
   opmode wpa-tkip

wlan virtual-ap WLAN-01_first-floor
   vlan 60
   aaa-profile aaa_dot1x
   ssid-profile WLAN-01

wlan virtual-ap WLAN-01_second-floor
   vlan 61
   aaa-profile aaa_dot1x
   ssid-profile WLAN-01
```

```
ap-group first-floor
   virtual-ap WLAN-01_first-floor
ap-group second-floor
   virtual-ap WLAN-01_second-floor
```

Mixed Authentication Modes

Use `l2-auth-fail-through` command to perform mixed authentication which includes both MAC and 802.1x authentication. When MAC authentication fails, enable the `l2-auth-fail-through` command to perform 802.1x authentication.

NOTE: By default the l2-auth-fail-through command is disabled.

Table 58 describes the different authentication possibilities

Table 58 *Mixed Authentication Modes*

Authentication	1	2	3	4	5	6
MAC authentication	Success	Success	Success	Fail	Fail	Fail
802.1x authentication	Success	Fail	—	Success	Fail	—
Association	dynamic-wep	No Association	static-wep	dynamic-wep	No Association	static-wep
Role Assignment	802.1x	—	MAC	802.1x	—	logon

Using the CLI

```
aaa profile test
  l2-auth-fail-through
```

Advanced Configuration Options for 802.1x

This section describes advanced configuration options for 802.1x authentication.

Configuring reauthentication with Unicast Key Rotation

When enabled, unicast and multicast keys are updated after each reauthorization. It is a best practice to configure the time intervals for reauthentication, multicast key rotation, and unicast key rotation to be at least 15 minutes. Make sure these intervals are mutually prime, and the factor of the unicast key rotation interval and the multicast key rotation interval is less than the reauthentication interval.

NOTE: Unicast key rotation depends upon both the AP/controller and wireless client behavior. It is known that some wireless NICs have issues with unicast key rotation.

The following is an example of the parameters you can configure for reauthentication with unicast and multicast key rotation:

- Reauthentication: Enabled
- Reauthentication Time Interval: 6011 Seconds
- Multicast Key Rotation: Enabled
- Multicast Key Rotation Time Interval:1867 Seconds

- Unicast Key Rotation: Enabled
- Unicast Key Rotation Time Interval: 1021 Seconds

Using the WebUI

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page.
2. Select 802.1x Authentication Profile, then select the name of the profile you want to configure.
3. Select the Advanced tab. Enter the following values:
   - Reauthentication Interval: 6011
   - Multicast Key Rotation Time Interval: 1867
   - Unicast Key Rotation Time Interval: 1021
   - Multicast Key Rotation: (select)
   - Unicast Key Rotation: (select)
   - Reauthentication: (select)
4. Click Apply.

Using the CLI

```
aaa authentication dot1x profile
   reauthentication
   timer reauth-period 6011
   unicast-keyrotation
   timer ukey-rotation-period 1021
   multicast-keyrotation
   timer mkey-rotation-period 1867
```

Chapter 11

Certificate Revocation

The Certificate Revocation feature enables the ArubaOS controller to perform real-time certificate revocation checks using the Online Certificate Status Protocol (OCSP) or traditional certificate validation using the Certificate Revocation List (CRL) client.

About OCSP and CRL

OCSP (RFC 2560) is a standard protocol that consists of an OCSP client and an OCSP responder. This protocol determines revocation status of a given digital public-key certificate without having to download the entire CRL.

CRL is the traditional method of checking certificate validity. A CRL provides a list of certificate serial numbers that have been revoked or are no longer valid. CRLs let the verifier check the revocation status of the presented certificate while verifying it. CRLs are limited to 512 entries.

Controller as OCSP and CRL Clients

The ArubaOS controller can act as an OCSP client and issues OCSP queries to remote OCSP responders located on the intranet or Internet. As many applications in ArubaOS (such as IKE), use digital certificates, a protocol such as OCSP needs to be implemented for revocation.

An entity that relies on the content of a certificate (a relying party) needs to do the checking before accepting the certificate as being valid. One check verifies that the certificate has not been revoked. The OCSP client retrieves certificate revocation status from an OCSP responder. The responder may be the CA (Certificate Authority) that has issued the certificate in question or it may be some other designated entity which provides the service on behalf of the CA. A *revocation checkpoint* is a logical profile that is tied to each CA certificate that the controller has (trusted or intermediate). Also, the user can specify revocation preferences within each profile.

The OCSP request is not signed by the Aruba OCSP client at this time. However, the OCSP response is always signed by the responder.

Both OCSP and CRL configuration and administration is usually performed by the administrator who manages the web access policy for an organization.

In small networks where there are is no Internet connection or connection to an OCSP responder, CRL is better option than OCSP.

Controller as OCSP Responder

The ArubaOS controller can be configured to act as an OCSP responder (server) and respond to OCSP queries from clients that are trying to obtain revocation status of certificates.

The OCSP responder on the controller is accessible over HTTP port 8084. This port is not configurable by the administrator. Although the OCSP responder accepts signed OCSP requests, it does not attempt to verify the signature before processing the request. Therefore, even unsigned OCSP requests are supported.

The controller as an OCSP responder provides revocation status information to ArubaOS applications that are using CRLs. This is useful in small disconnected networks where clients cannot reach outside OCSP server to validate certificates. Typical scenarios include client to client or client to other server communication situations where the certificates of either party need to be validated.

Configuring the Controller as an OCSP Client

When OCSP is used as the revocation method, you need to configure the OCSP responder certificate and the OCSP URL.

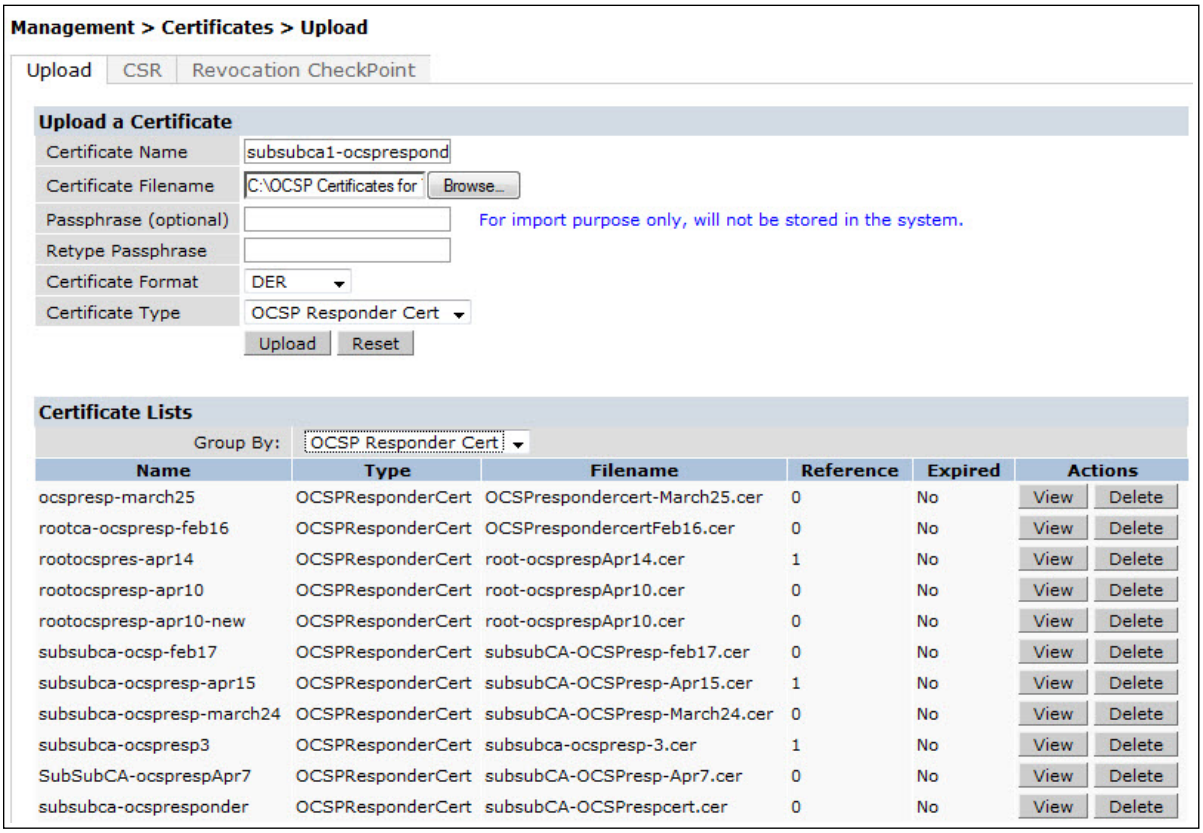
In the WebUI

1. Navigate to the Configuration > Management > Certificates > Upload page.
2. Enter a name in the Certificate Name field. This name identifies the certificate you are uploading.
3. Enter the certificate file name in the Certificate Filename field. Use the Browse button to enter the full pathname.
4. Select the certificate format from the Certificate Format drop-down menu.
5. Select OCSP Responder Cert from the Certificate Type drop-down menu.

NOTE: A revocation check method (OCSP or CRL) can be chosen independently for every revocation checkpoint. In this example, we are only describing the OCSP check method.

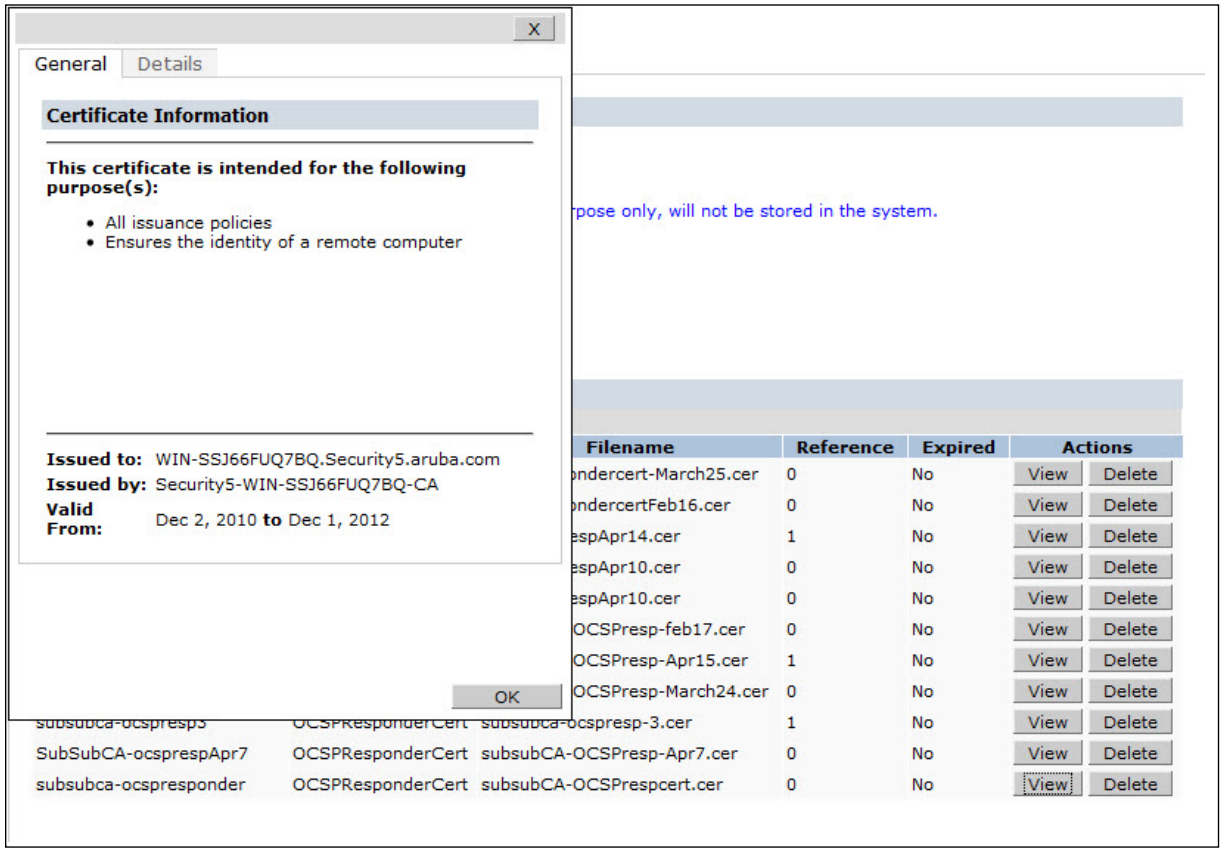
Once this certificate is uploaded it is maintained in the certificate store for OCSP responder certificates. These certificates are used for signature verification.

Figure 49 *Upload a certificate*



6. Click Upload. The certificate appears in the Certificate Lists pane.
7. For detailed information about an uploaded certificate, click View next to the certificate.

Figure 50 *View certificate details*



8. Select the Revocation Checkpoint tab.
9. In the Revocation Checkpoint pane, click Edit next to the revocation checkpoint that you want to configure. The Revocation Checkpoint pane displays.
10. In the Revocation Check field, select ocsp from the Method 1 drop-down list as the primary check method.
11. In the OCSP URL field, enter the URL of the OCSP responder.
12. In the OCSP Responder Cert field, select the OCSP certificate you want to configure from the drop-down menu.
13. Click Apply.

In the CLI

This example configures an OCSP client with the revocation check method as OCSP for revocation check point CAroot.

The OCSP responder certificate is configured as RootCA-Ocsp_responder. The corresponding OCSP responder service is available at http://10.4.46.202/ocsp. The check method is OCSP for revocation check point CARoot.

```
(host) (config) #crypto-local pki rcp CARoot
   (host) (RCP-CARoot) #ocsp-responder-cert RootCA-Ocsp_responder
   (host) (RCP-CARoot) #ocsp-url http://10.4.46.202/ocsp
   (host) (RCP-CARoot) #revocation-check ocsp
```

The *show crypto-local pki OCSPResponderCert* CLI command lists the contents of the OCSP Responder Certificate store.

The *show crypto-local pki revocation checkpoint rcp_name* CLI command shows the entire configuration for a given revocation checkpoint.

Configuring the Controller as a CRL Client

CRL is the traditional method of checking certificate validity. When you want to check certificate validity using a CRL, you need to import the CRL. CRLs can only be imported using the WebUI.

In the WebUI

1. Navigate to the Configuration > Management > Certificates > Upload page.
2. Enter a name in the Certificate Name field. This name identifies the CRL certificate you are uploading.
3. Enter the certificate file name in the Certificate Filename field. Use the Browse button to enter the full pathname.
4. Select the certificate format from the Certificate Format drop-down menu.
5. Select CRL from the Certificate Type drop-down menu.

NOTE: A revocation check method (OCSP or CRL) can be chosen independently for every revocation checkpoint. In this example, we are only describing the CRL check method.

   Once this CRL is uploaded it is maintained in the store for CRLs. These CRLs are used for signature verification.
6. Click Upload. The CRL appears in the Certificate Lists pane. Select CRL from the Group drop-down list if you want to display only CRLs.
7. For detailed information about an uploaded CRL, click View next to the CRL.
8. Select the Revocation Checkpoint tab.
9. In the Revocation Checkpoint pane, click Edit next to the revocation checkpoint that you want to configure. The Revocation Checkpoint pane displays.
10. In the Revocation Check field, select crl from the Method 1 drop-down list.
11. In the CRL Location field, enter the CRL you want used for this revocation checkpoint. The CRLs listed are files that have already been imported onto the controller.
12. Click Apply.

In the CLI

This example configures an OCSP responder with the check method as CRL for revocation check point ROOTCa-ssh-webui.The CRL location is crl1 and the revocation check method is crl.

```
(host) (config) #crypto-local pki rcp ROOTCa-ssh-webui
   (host) (RCP-CARoot) #crl-location file crl1
   (host) (RCP-CARoot) #revocation-check crl
```

Configuring the Controller as a OCSP Responder

When configured as an OCSP responder, the controller provides revocation status information to ArubaOS applications that are using CRLs.

In the WebUI

1. Navigate to the Configuration > Management > Certificates > Upload page.
2. Enter a name in the Certificate Name field. This name identifies the OCSP signer certificate you are uploading.
3. Enter the certificate file name in the Certificate Filename field. Use the Browse button to enter the full pathname.
4. Select the certificate format from the Certificate Format drop-down menu.

5. Select OCSP signer cert from the Certificate Type drop-down menu. Once this certificate is uploaded it is maintained in the certificate store for OCSP signer certificates. These certificates are used for signature verification.

   The OCSP signer cert is used to sign OCSP responses for this revocation check point. The OCSP signer cert can be the same trusted CA as the check point, a designated OCSP signer certificate issued by the same CA as the check point or some other local trusted authority.

   If you do not specify an OCSP signer cert, OCSP responses are signed using the global OCSP signer certificate. If that is not present, than an error message is sent out to clients.

NOTE: The OCSP signer certificate takes precedence over the global OCSP signer certificate as this is check point specific

6. Click Upload. The certificate appears in the Certificate Lists pane. Select OCSP signer cert from the Group drop-down list if you want to display only those certificates which are OCSP signer certificates.
7. For detailed information about an uploaded certificate, click View next to the certificate.
8. Select the Revocation Checkpoint tab.
9. Select Enable next to Enable OCSP Responder.

   Enable OCSP Responder is a global knob that turns the OCSP responder service on or off on the controller. The default is disabled (off). Enabling this knob automatically adds the OCSP responder port (TCP 8084) to the permit list in the CP firewall so this can be accessed from outside the controller.
10. Select the OCSP signer cert from the OCSP Certificates drop-down menu to be used to sign OCSP responses for this revocation check point.
11. In the Revocation Checkpoint pane, click Edit next to the revocation checkpoint that you want to configure. The Revocation Checkpoint pane displays.
12. In the Revocation Check field, optionally select a check method from the Method 1 drop-down list. Optionally, select a backup check method from the Method2 drop-down list.
13. Select Enable next to Enable OCSP Responder.
14. Select the OCSP signer cert from the OCSP Signer Cert drop-down menu.
15. IN the CRL Location field, enter the CRL you want used for this revocation checkpoint. The CRLs listed are files that have already been imported onto the controller.
16. Click Apply.

In the CLI

This example configures the controller as an OCSP responder. The OCSP responder service is enabled, the revocation check point is CAroot, the OCSP signer cert is “oscap_CA1,” the CRL file location is “Sec1-WIN-05PRGNGEKAO-CA-unrevoked.crl.”

```
(host) (config) #crypto-local pki service-ocsp-responder
(host) (config) #crypto-local pki rcp CAroot
   (host) (CAroot) #ocsp-signer-cert oscsp_CA1
   (host) (CAroot) #crl-location file Sec1-WIN-05PRGNGEKAO-CA-unrevoked.crl
   (host) (CAroot) #enable-ocsp-responder
```

Chapter 12

Roles and Policies

Every client in an Dell user-centric network is associated with a *user role*, which determines the client's network privileges, how often it must re-authenticate, and which bandwidth contracts are applicable. A *policy* is a set of rules that applies to traffic that passes through the Dell controller. You specify one or more policies for a user role. Finally, you can assign a user role to clients before or after they authenticate to the system.

This chapter describes assigning and creating roles and policies using the ArubaOS CLI or WebUI. Roles and policies can also be configured for WLANs associated with the "default" ap-group via the WLAN Wizard: Configuration > Wizards > WLAN Wizard. Follow the steps in the workflow pane within the wizard and refer to the help tab for assistance.

This chapter describes the following topics:

NOTE: This chapter describes configuring firewall policies and parameters that relate to IPv4 traffic. See Chapter 35, "IPv6 Support" on page 659 for information about configuring IPv6 firewall policies and parameters.

Policies

A firewall policy identifies specific characteristics about a data packet passing through the Dell controller and takes some action based on that identification. In an Dell controller, that action can be a firewall-type action such as permitting or denying the packet, an administrative action such as logging the packet, or a quality of service (QoS) action such as setting 802.1p bits or placing the packet into a priority queue. You can apply firewall policies to user roles to give differential treatment to different users on the same network, or to physical ports to apply the same policy to all traffic through the port.

Firewall policies differ from access control lists (ACLs) in the following ways:

- Firewall policies are *stateful*, meaning that they recognize flows in a network and keep track of the state of sessions. For example, if a firewall policy permits telnet traffic from a client, the policy also recognizes that inbound traffic associated with that session should be allowed.
- Firewall policies are *bi-directional*, meaning that they keep track of data connections traveling into or out of the network. ACLs are normally applied to either traffic inbound to an interface or outbound from an interface.

- Firewall policies are *dynamic*, meaning that address information in the policy rules can change as the policies are applied to users. For example, the alias *user* in a policy automatically applies to the IP address assigned to a particular user. ACLs typically require static IP addresses in the rule.

NOTE: You can apply IPv4 and IPv6 firewall policies to the same user role. See Chapter 35, "IPv6 Support" on page 659 for information about configuring IPv6 firewall policies.

Access Control Lists (ACLs)

Access control lists (ACLs) are a common way of restricting certain types of traffic on a physical port. ArubaOS provides the following types of ACLs:

- Standard ACLs permit or deny traffic based on the source IP address of the packet. Standard ACLS can be either named or numbered, with valid numbers in the range of 1-99 and 1300-1399. Standard ACLs use a bitwise mask to specify the portion of the source IP address to be matched.
- Extended ACLs permit or deny traffic based on source or destination IP address, source or destination port number, or IP protocol. Extended ACLs can be named or numbered, with valid numbers in the range 100-199 and 2000-2699.
- MAC ACLs are used to filter traffic on a specific source MAC address or range of MAC addresses. Optionally, you can mirror packets to a datapath or remote destination for troubleshooting and debugging purposes. MAC ACLs can be either named or numbered, with valid numbers in the range of 700-799 and 1200-1299.
- Ethertype ACLs are used to filter based on the Ethertype field in the frame header. Optionally, you can mirror packets to a datapath or remote destination for troubleshooting and debugging purposes. Ethertype ACLs can be either named or numbered, with valid numbers in the range of 200-299.These ACLs can be used to permit IP while blocking other non-IP protocols, such as IPX or AppleTalk.

ArubaOS provides both standard and extended ACLs for compatibility with router software from popular vendors, however firewall policies provide equivalent and greater function than standard and extended ACLs and should be used instead.

You can apply MAC and Ethertype ACLs to a user role, however these ACLs only apply to non-IP traffic *from* the user.

Creating a Firewall Policy

This section describes how to configure the rules that constitute a firewall policy. A firewall policy can then be applied to a user role (until the policy is applied to a user role, it does not have any effect).

Table 59 describes required and optional parameters for a rule.

Table 59 *Firewall Policy Rule Parameters*

Field	Description
Source (required)	Source of the traffic, which can be one of the following: • *any*. Acts as a wildcard and applies to any source address. • *user*. This refers to traffic from the wireless client. • *host:* This refers to traffic from a specific host. When this option is chosen, you must configure the IP address of the host. • *network:* This refers to a traffic that has a source IP from a subnet of IP addresses. When this option is chosen, you must configure the IP address and network mask of the subnet. • *alias:* This refers to using an alias for a host or network. You configure the alias by navigating to the Configuration > Advanced Services > Stateful Firewall > Destination page.
Destination (required)	Destination of the traffic, which can be configured in the same manner as Source.

Table 59 *Firewall Policy Rule Parameters (Continued)*

Field	Description
Service (required)	Type of traffic, which can be one of the following: • *any*: This option specifies that this rule applies to any type of traffic. • *tcp*: Using this option, you configure a range of TCP port(s) to match for the rule to be applied. • *udp*: Using this option, you configure a range of UDP port(s) to match for the rule to be applied. • *service:* Using this option, you use one of the pre-defined services (common protocols such as HTTPS, HTTP, and others) as the protocol to match for the rule to be applied. You can also specify a network service that you configure by navigating to the Configuration > Advanced Services > Stateful Firewall > Network Services page. • *protocol*: Using this option, you specify a different layer 4 protocol (other than TCP/UDP) by configuring the IP protocol value.
Action (required)	The action that you want the controller to perform on a packet that matches the specified criteria. This can be one of the following: • *permit:* Permits traffic matching this rule. • *drop:* Drops packets matching this rule without any notification. • *reject:* Drops the packet and sends an ICMP notification to the traffic source. • *src-nat:* Performs network address translation (NAT) on packets matching the rule. When this option is selected, you need to select a NAT pool. (If this pool is not configured, you configure a NAT pool by navigating to the Configuration > Advanced > Security > Advanced > NAT Pools.) • *dst-nat:* This option redirects traffic to the configured IP address and destination port. An example of this option is to redirect all HTTP packets to the captive portal port on the Dell controller as used in the pre-defined policy called *"captiveportal"*. • *dual-nat*: This option performs both source and destination NAT on packets matching the rule. • *redirect to tunnel:* This option redirects traffic into a GRE tunnel. This option is used primarily to redirect all guest traffic into a GRE tunnel to a DMZ router/switch. • *redirect to ESI group*: This option redirects traffic to the specified ESI server group. You also specify the direction of traffic to be redirected: forward, reverse, or both directions.
Log (optional)	Logs a match to this rule. This is recommended when a rule indicates a security breach, such as a data packet on a policy that is meant only to be used for voice calls.
Mirror (optional)	Mirrors session packets to datapath or remote destination.
Queue (optional)	The queue in which a packet matching this rule should be placed. Select High for higher priority data, such as voice, and Low for lower priority traffic.
Time Range (optional)	Time range for which this rule is applicable. Configure time ranges on the Configuration > Security > Access Control > Time Ranges page.
Pause ARM Scanning (optional)	Pause ARM scanning while traffic is present. Note that you must enable "VoIP Aware Scanning" in the ARM profile for this feature to work.
Black List (optional)	Automatically blacklists a client that is the source or destination of traffic matching this rule. This option is recommended for rules that indicate a security breach where the blacklisting option can be used to prevent access to clients that are attempting to breach the security.
White List (optional)	A rule must explicitly permit a traffic session before it is forwarded to the controller. The last rule in the white list denies everything else. Configure white list ACLs on the Configuration > Advanced Services> Stateful Firewall> White List (ACL) page.
TOS (optional)	Value of type of service (TOS) bits to be marked in the IP header of a packet matching this rule when it leaves the controller.
802.1p Priority (optional)	Value of 802.1p priority bits to be marked in the frame of a packet matching this rule when it leaves the controller.

The following example creates a policy 'web-only' that allows web (HTTP and HTTPS) access.

In the WebUI

1. Navigate to the Configuration > Security > Access Control > Policies page on the WebUI.
2. To configure a firewall policy, select the policy type from the Policies title bar. You can select All, IPv4 Session, IPv6 Session, Ethernet, MAC, Standard or Extended.
3. Click Add to create a new policy.
4. If you selected All in Step 2, then select the type of policy you are adding from the Policy Type drop-down menu.
5. Click Add to add a rule that allows HTTP traffic.
   a. Under Service, select service from the drop-down list.
   b. Select svc-http from the scrolling list.
   c. Click Add.
6. Click Add to add a rule that allows HTTPS traffic.
   a. Under Service, select service from the drop-down list.
   b. Select svc-https from the scrolling list.
   c. Click Add.

NOTE: Rules can be re-ordered by using the up and down buttons provided for each rule.

7. Click Apply to apply this configuration. The policy is not created until the configuration is applied.

In the CLI

```
ip access-list session web-only
   any any svc-http permit
   any any svc-https permit
```

Creating a Network Service Alias

A network service alias defines a TCP, UDP or IP protocol and a list or range of ports supported by that service. When you create a network service alias, you can use that alias when specifying the network service for multiple session ACLs.

In the WebUI

1. Navigate to the Configuration > Advanced Services> Stateful Firewall > Network Services page on the WebUI.
2. Click Add to create a new alias.]
3. Enter a name for the alias in the Service Name field.
4. In the Protocol section, select either TCP or UDP, or select Protocol and enter the IP protocol number of the protocol for which you want to create an alias.
5. In the Port Type section, specify whether you want to define the port by a contiguous range of ports, or by a list of non-contiguous port numbers.
   - If you selected Range, enter the starting and ending port numbers in the Starting Port and End Port fields.
   - If you selected list, enter a comma-separated list of port numbers.
6. To limit the service alias to a specific application, click the Application Level Gateway (ALG) drop-down list and select one of the following service types
   - dhcp: Service is DHCP

- dns: Service is DNS
- ftp: Service is FTP
- h323: Service is H323
- noe: Service is Alcatel NOE
- rtsp: Service is RTSP
- sccp: Service is SCCP
- sip: Service is SIP
- sips: Service is Secure SIP
- svp: Service is SVP
- tftp: Service is TFTP
- vocera: Service is VOCERA

7. Click Apply to save your changes.

In the CLI

To define a service alias via the command-line interface, access the CLI in config mode and issue the following command:

```
netservice <name> <protocol>|tcp|udp {list <port>,<port>}|{<port> [<port>]}
[ALG <service>]
```

Creating an ACL White List

The ACL White List consists of rules that explicitly permit or deny session traffic from being forwarded to or blocked from the controller. The white list protects the controller during traffic session processing by prohibiting traffic from being automatically forwarded to the controller if it was not specifically denied in a blacklist. The maximum number of entries allowed in the ACL White List is 64. To create an ACL white list, you must first define a white list bandwidth contract, and then assign it to an ACL.

Configuring a White List Bandwidth Contract in the WebUI

1. Navigate to the Configuration > Advanced Services > Stateful Firewall > White List BW Contracts page.
2. Click Add to create a new contract.
3. In the White list contract name field, enter the name of a bandwidth contract.
4. The Bandwidth Rate field allows you to define a bandwidth rate in either kbps or Mbps. Enter a rate value the Bandwidth rate field, then click the drop-down list and select either kbps or Mbps.
5. Click Done.

Configuring the ACL White List in the WebUI

1. Navigate to the Configuration > Stateful Firewall> ACL White List page.
2. To add an entry, click the Add button at the bottom of the page. The Add New Protocol section displays.
3. Click the Action drop-down list and select Permit or Deny. Permit allows session traffic to be forwarded to the controller while Deny blocks session traffic.
4. In the IP Protocol Number field, enter the number for a protocol used by session traffic.
5. In the Starting Ports field, enter a starting port. This is the first port, in the port range, on which permitted or denied session traffic is running. Port range: 1–65535.
6. In the End Ports field, enter an ending port. This is the last port, in the port range, on which permitted or denied session traffic is running. Port range: 1–65535.

7. (Optional) Click the White list Bandwidth Contract drop-down list and specify the name of a bandwidth contract to apply to the session traffic. For further information on creating Bandwidth Contracts, see "Configuring a Bandwidth Contract in the WebUI" on page 328
8. Click Done. The ACL displays on the white list section.
9. To delete an entry, click Delete next to the entry you want to delete.
10. Click Apply to save changes.

Configuring the White List Bandwidth Contract in the CLI

```
cp-bandwidth-contract <name> {mbits <1..2000>}|{kbits <256..2000000>}
```

Configuring the ACL White List in the CLI

Use the following CLI command to create ACL White Lists.

```
(host) (config) #firewall cp {deny|permit} proto <IP protocol number> ports <start port number> <last port number> [bandwidth-contract <name>]
```

To create a whitelist ACL entry that permits traffic using protocol 6 on ports 5000 through 6000 to be forwarded to the controller:

```
(host) (config-fw-cp) #firewall cp permit proto 6 ports 5000 6000
```

To create a whitelist ACL entry that denies traffic using protocol 2 on port 5000 from being forwarded to the controller:

```
(host) (config-fw-cp) #firewall cp deny proto 2 ports 5000 5000
```

User Roles

This section describes how to create a new user role. When you create a user role, you specify one or more policies for the role.

Table 60 describes the different parameters you can configure for the user role.

Table 60 *User Role Parameters*

Field	Description
Firewall Policies (required)	One or more policies that define the privileges of a wireless client in this role. There are three ways to add a firewall policy to a user role: • Choose from configured policies (see "Creating a Firewall Policy" on page 322): Select a policy from the list of configured policies and click the "Done" button to add the policy to the list of policies in the user role. If this policy is to be applied to this user role only for specific AP groups, you can specify the applicable AP group. • Create a new policy from a configured policy: This option can be used to create a new policy that is derived from an existing policy. • Create a new policy: The rules for the policy can be added as explained in "Creating a Firewall Policy" on page 322.
Re-authentication Interval (optional)	Time, in minutes, after which the client is required to reauthenticate. Enter a value between 0-4096. 0 disables reauthentication. Default: 0 (disabled)
Role VLAN ID (optional)	By default, a client is assigned a VLAN on the basis of the ingress VLAN for the client to the controller. You can override this assignment and configure the VLAN ID that is to be assigned to the user role. You configure a VLAN by navigating to the Configuration > Network > VLANs page.
Bandwidth Contract (optional)	You can assign a bandwidth contract to provide an upper limit to upstream or downstream bandwidth utilized by clients in this role. You can select the Per User option to apply the bandwidth contracts on a per-user basis instead of to all clients in the role. For more information, see "Bandwidth Contracts" on page 328.

Table 60 *User Role Parameters (Continued)*

Field	Description
VPN Dialer (optional)	This assigns a VPN dialer to a user role. For details about VPN dialer, see Chapter 17, "Virtual Private Networks" . Select a dialer from the drop-down list and assign it to the user role. This dialer will be available for download when a client logs in using captive portal and is assigned this role.
L2TP Pool (optional)	This assigns an L2TP pool to the user role. For more details about L2TP pools, see Chapter 17, "Virtual Private Networks" . Select the required L2TP pool from the list to assign to the user role. The inner IP addresses of VPN tunnels using L2TP will be assigned from this pool of IP addresses for clients in this user role.
PPTP Pool (optional)	This assigns a PPTP pool to the user role. For more details about PPTP pools, see Chapter 17, "Virtual Private Networks" . Select the required PPTP pool from the list to assign to the user role. The inner IP addresses of VPN tunnels using PPTP will be assigned from this pool of IP addresses for clients in this user role.
Captive Portal Profile (optional)	This assigns a Captive Portal profile to this role. For more details about Captive Portal profiles, see Chapter 15, "Captive Portal" .
Max Sessions	This configures a maximum number of sessions per user in this role. The default is 65535. You can configure any value between 0-65535.

Creating a User Role

The following example creates the user role 'web-guest' and assigns the previously-configured 'web-only' policy to this user role.

In the WebUI

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click Add to create and configure a new user role.
3. Enter web-guest for Role Name.
4. Under Firewall Policies, click Add. From Choose from Configured Policies, select the 'web-only' session policy from the list. You can click Create to create and configure a new policy.
5. Click Done to add the policy to the user role.

NOTE: If there are multiple policies for this role, policies can be re-ordered by the using the up and down buttons provided for each policy.

6. You can optionally enter configuration values as described in Table 60.
7. Click Apply to apply this configuration. The role is not created until the configuration is applied.

After assigning the user role (see "User Role Assignments" on page 329), you can click the Show Reference button to see the profiles that reference this user role.

To a delete a user role in the WebUI:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click the Delete button against the role you want to delete.

NOTE: You cannot delete a user-role that is referenced to profile or server derived role. Deleting a server referenced role will result in an error. Remove all references to the role and then perform the delete operation.

In the CLI

```
user-role web-guest
```

```
access-list session web-only position 1
```

After assigning the user role (see "User Role Assignments" on page 329), you can use the show reference user-role <*role*> command to see the profiles that reference this user role.

Bandwidth Contracts

You can manage bandwidth utilization by assigning maximum bandwidth rates, or *bandwidth contracts*, to user roles. You can configure bandwidth contracts, in kilobits per second (Kbps) or megabits per second (Mbps), for the following types of traffic:

- from the client to the controller ("upstream" traffic)
- from the controller to the client ("downstream" traffic)

You can assign different bandwidth contracts to upstream and downstream traffic for the same user role. You can also assign a bandwidth contract for only upstream or only downstream traffic for a user role; if there is no bandwidth contract specified for a traffic direction, unlimited bandwidth is allowed.

By default, all users that belong to the same role share a configured bandwidth rate for upstream or downstream traffic. You can optionally apply a bandwidth contract on a *per-user* basis; each user who belongs to the role is allowed the configured bandwidth rate.

For example, if clients are connected to the controller through a DSL line, you may want to restrict the upstream bandwidth rate allowed for *each* user to 128 Kbps. Or, you can limit the *total* downstream bandwidth used by all users in the 'guest' role to 128 Mbps. The following example configures a bandwidth rate of 128 Kbps and applies it to upstream traffic for the previously-configured 'web-guest' user role on a per-user basis.

Configuring a Bandwidth Contract in the WebUI

In the WebUI, you can first configure a bandwidth contract and then assign it to a user role:

1. Navigate to the Configuration > Advanced Services > Stateful Firewall > BW Contracts page.
2. Click Add to create a new contract.
3. In the Contract Name field, enter BC512_up.
4. The Bandwidth field allows you to define a bandwidth rate in either kbps or Mbps. For this example, enter 512 in the Bandwidth field, then click the drop-down list and select kbps.
5. Click Done.

Assigning a Bandwidth Contract to a User Role in the WebUI

Now that you have a defined bandwidth contract, you can assign that contract to a user role.

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Select Edit for the web-guest user role.
3. Under Bandwidth Contract, select BC512_up from the drop-down menu for Upstream.
4. Select Per User.
5. Scroll to the bottom of the page, and click Apply.

You can also can configure the user role and create the bandwidth contract from the User Roles page:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Select Edit for the web-guest user role.
3. In the Bandwidth Contract section, click the Upstream drop-down list and select Add New. The New Bandwidth Contract fields appear.
   a. In the Name field, enter BC512_up.
   b. In the Bandwidth field, enter 512.

c. Click the Bandwidth drop-down list and select kbps.

d. Click Done to add the new contract and assign it to the role. The New Bandwidth Contract section closes.

4. In the Bandwidth Contract section, select the Per User checkbox.
5. Scroll to the bottom of the page, and click Apply.

Configuring and Assigning Bandwidth Contracts in the CLI

```
aaa bandwidth-contract BC512_up kbps 512
user-role web-guest
   bw-contract BC512_up per-user upstream
```

Bandwidth Contract Exceptions

Bandwidth contracts on a VLAN can limit broadcast and multicast traffic. ArubaOS includes an internal exception list to allow broadcast and multicast traffic using the VRRP, LACP, OSPF, PVST and STP protocols. To remove per-vlan bandwidth contract limits on an additional broadcast or multicast protocol, add the MAC address for that broadcast/multicast protocol to the Vlan Bandwidth Contracts MAC Exception List

Viewing the Current Exceptions List

To view the current bandwidth contract exception list, access the command-line interface in enable mode and issue the command show vlan-bwcontract-explist. To view the preconfigured internal bandwidth contract exception list, include the optional internal parameter, as shown in the example below:

```
(host) (config) #show vlan-bwcontract-explist internal
   Vlan Bw Contracts Internal Mac Exception List
   ---------------------------------------------
   Mac address
   -----------
   01:80:C2:00:00:00
   01:00:0C:CC:CC:CD
   01:80:C2:00:00:02
   01:00:5E:00:82:11
```

Configuring Bandwidth Contract Exceptions

To add the MAC address of a protocol to the exception list for bandwidth contracts, access the command-line interface in config mode and issue the command vlan-bwcontract-explist <mac-addr>.

The following example adds the MAC address for CDP (Cisco Discovery Protocol) and VTP (Virtual Trunking Protocol to the list of protocols that are not limited by VLAN bandwidth contracts.

```
(host) (config) #vlan-bwcontract-explist mac 01:00:0C:CC:CC:CC
```

User Role Assignments

A client is assigned a user role by one of several methods. A role assigned by one method may take precedence over one assigned by a different method. The methods of assigning user roles are, from lowest to highest precedence:

1. The initial user role or VLAN for unauthenticated clients is configured in the AAA profile for a virtual AP (see Chapter 4, “Access Points”).
2. The user role can be derived from user attributes upon the client’s association with an AP (this is known as a *user-derived role*). You can configure rules that assign a user role to clients that match a certain set of criteria. For example, you can configure a rule to assign the role “*VoIP-Phone*” to any client that has a MAC address that starts with bytes *xx:yy:zz*. User-derivation rules are executed *before* client authentication.

3. The user role can be the default user role configured for an authentication method, such as 802.1x or VPN. For each authentication method, you can configure a default role for clients who are successfully authenticated using that method.
4. The user role can be derived from attributes returned by the authentication server and certain client attributes (this is known as a *server-derived role*). If the client is authenticated via an authentication server, the user role for the client can be based on one or more attributes returned by the server during authentication, or on client attributes such as SSID (even if the attribute is not returned by the server). Server-derivation rules are executed *after* client authentication.
5. The user role can be derived from Dell Vendor-Specific Attributes (VSA) for RADIUS server authentication. A role derived from an Dell VSA takes precedence over any other user roles.

The following sections describe the methods of assigning user roles.

User Role in AAA Profile

An AAA profile defines the user role for unauthenticated clients (initial role) as well as the default user role for MAC and 802.1x authentication. To configure user roles in the AAA profile:

In the WebUI

1. Navigate to the Configuration > Security > Authentication > AAA Profiles page.
2. Select the "default" profile or a user-defined AAA profile.
3. Click the Initial Role drop-down list, and select the desired user role for unauthenticated users.
4. Click the 802.1x Authentication Default Role drop-down list and select the desired user role for users who have completed 802.1x authentication.
5. Click the MAC Authentication Default Role drop-down list and select the desired user role for clients who have completed MAC authentication.
6. Click Apply.

In the CLI

```
aaa profile <profile>
   initial-role <role>
   dot1x-default-role <role>
   mac-default-role <role>
```

For additional information on creating AAA profiles, see "AAA Profile Parameters" on page 143.

User-Derived Roles or VLANs

Attributes derived from the client's association with an AP can be used to assign the client to a specific role or VLAN, as user-derivation rules are executed before the client is authenticated.

You configure the user role or VLAN to be assigned to the client by specifying condition rules; when a condition is met, the specified user role or VLAN is assigned to the client. You can specify more than one condition rule; the order of rules is important as the first matching condition is applied. You can optionally add a description of the user rule.

Table 61 describes the conditions for which you can specify a user role or VLAN.

Table 61 *Conditions for a User-Derived Role or VLAN*

Rule Type	Condition	Value
BSSID: Assign client to a role or VLAN based upon the BSSID of AP to which client is associating.	One of the following: • contains • ends with • equals • does not equal • starts with	MAC address (xx:xx:xx:xx:xx:xx)
DHCP-Option: Assign client to a role or VLAN based upon the DHCP signature ID.	One of the following: • equals • starts with	DHCP signature ID. NOTE: This string is *not* case sensitive.
DHCP-Option-77: Assign client to a role or VLAN based upon the user class identifier returned by DHCP server.	equals	string
Encryption: Assign client to a role or VLAN based upon the encryption type used by the client.	One of the following: • equals • does not equal	• Open (no encryption) • WPA/WPA2 AES • WPA-TKIP (static or dynamic) • Dynamic WEP • WPA/WPA2 AES PSK • Static WEP • xSec
ESSID: Assign client to a role or VLAN based upon the ESSID to which the client is associated	One of the following: • contains • ends with • equals • does not equal • starts with • value of (does not take *string*; attribute value is used as role)	string
Location: Assign client to a role or VLAN based upon the ESSID to which the client is associated	One of the following: • equals • does not equal	string
MAC address of the client	One of the following: • contains • ends with • equals • does not equal • starts with	MAC address (xx:xx:xx:xx:xx:xx)

Device Identification

The device identification feature allows you to assign a user role or VLAN to a specific device type by identifying a DHCP option and signature for that device. If you create a user rule with the DHCP-Option rule type, the first two characters in the Value field must represent the hexadecimal value of the DHCP option that this rule should match, while the rest of the characters in the Value field indicate the DHCP signature the rule should match. To create a rule that matches DHCP option 12 (host name), the first two characters of the in the Value field must be the hexadecimal value of 12, which is 0C. To create a rule that matches DHCP option 55, the first two characters in the Value field must be the hexadecimal value of 55, which is 37.

The following table describes some of the DHCP options that are useful for assigning a user role or VLAN.

DHCP Option values

DHCP Option	Description	Hexadecimal Equivalent
12	Host name	0C
55	Parameter Request List	37
60	Vendor Class Identifier	3C
81	Client FQDN	51

The device identification features in ArubaOS can also automatically identify different client device types and operating systems by parsing the User-Agent strings in the client's HTTP packets. To enable this feature, select the Device Type Classification option in the AP's AAA profile. For details, see "Device Type Classification" on page 144.

Configuring a User-derived Role or VLAN in the WebUI

1. Navigate to the Configuration > Security > Authentication > User Rules page.
2. Click Add to add a new set of derivation rules. Enter a name for the set of rules, and click Add. The name appears in the User Rules Summary list.
3. In the User Rules Summary list, select the name of the rule set to configure rules.
4. Click Add to add a rule. For Set Type, select Role from the drop-down menu. (You can select VLAN to create a derivation rules for setting the VLAN assigned to a client.)
5. Configure the condition for the rule by setting the Rule Type, Condition, Value parameters and optional description of the rule. See Table 61 for descriptions of these parameters.
6. Select the role assigned to the client when this condition is met.
7. Click Add.
8. You can configure additional rules for this rule set. When you have added rules to the set, use the up or down arrows in the Actions column to modify the order of the rules. (The first matching rule is applied.)
9. Click Apply.
10. (Optional) If the rule uses the DHCP-Option condition, best practices is to enable the Enforce DHCP parameter in the AP group's AAA profile, which requires users to complete a DHCP exchange to obtain an IP address. For details on configuring this parameter in an AAA profile, see "Configuring Authentication" on page 143.

Configure a User-derived Role or VLAN in the CLI

```
aaa derivation-rules user <name>
   set role|vlan
   condition bssid|dhcp-option|dhcp-option-77|encryption-type|essid|location|macaddr
   contains|ends-with|equals|not-equals|starts-with|value-of <string>
   set-value <role>
   position <number>
```

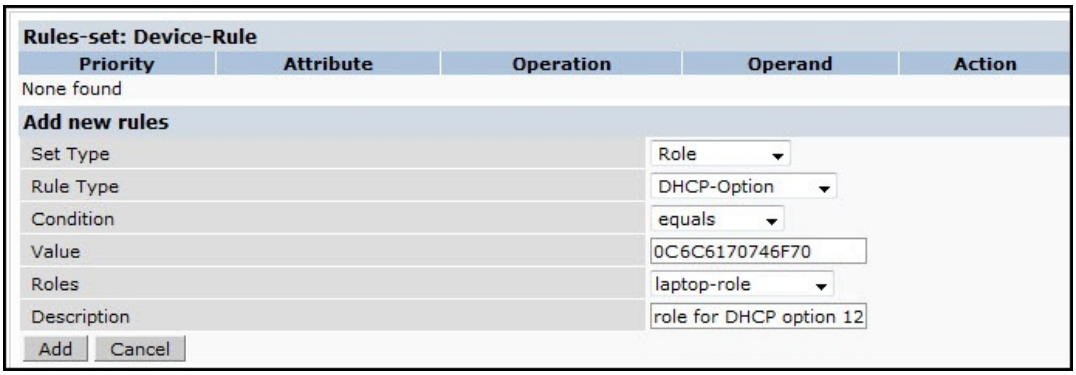
See Table 61 for descriptions of these parameters.

User-Derived Role Example

The example rule shown in Figure 51 below sets a user role for clients whose host name (DHCP option 12) has a value of 6C6170746F70, which is the hexadecimal equivalent of the ASCII string "laptop". The first two digits in the Value field are the hexadecimal value of 12 (which is 0C), followed by the specific signature to be matched.

NOTE: There are many online tools available for converting ASCII text to a hexadecimal string.

Figure 51 *DHCP Option Rule*



To identify DHCP strings used by an individual device, access the command-line interface in config mode and issue the following command to include DHCP option values for DHCP-DISCOVER and DHCP-REQUEST frames in the controller's log files:

```
logging level debugging network process dhcpd
```

Now, connect the device you want to identify to the network, and issue the CLI command show log network. The sample below is an example of the output that may be generated by this command.

```
(host) (config) #show log network all | include DISCOVER
Feb 26 02:50:34 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: DISCOVER 00:19:d2:01:0b:84 Options 74:01
3d:010019d2010b84 0c:736861626172657368612d39393730 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b
Feb 26 02:50:42 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: DISCOVER 00:19:d2:01:0b:84 Options 74:01
3d:010019d2010b84 0c:736861626172657368612d39393730 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b
Feb 26 02:50:42 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan1: DISCOVER 00:19:d2:01:0b:84 Options 74:01
3d:010019d2010b84 0c:736861626172657368612d39393730 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b
Feb 26 02:53:03 :202534:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan10: DISCOVER 00:26:c6:52:6b:7c Options 74:01
3d:010026c6526b7c 0c:41525542412d46416c73653232 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b 2b:dc00
...

(host) #show log network all| include REQUEST
Feb 26 02:53:04 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan10: REQUEST 00:26:c6:52:6b:7c reqIP=10.10.10.254
Options 3d:010026c6526b7c 36:0a0a0a02 0c:41525542412d46416c73653232
51:00000041525542412d46416c736532322e73757279612e636f6d 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b 2b:dc0100
Feb 26 02:53:04 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan10: REQUEST 00:26:c6:52:6b:7c reqIP=10.10.10.254
Options 3d:010026c6526b7c 36:0a0a0a02 0c:41525542412d46416c73653232
51:00000041525542412d46416c736532322e73757279612e636f6d 3c:4d53465420352e30 37:010f03062c2e2f1f21f92b 2b:dc0100
Feb 26 02:56:02 :202536:  <DBUG> |dhcpdwrap| |dhcp| Datapath vlan10: REQUEST 00:26:c6:52:6b:7c reqIP=10.10.10.254
Options 3d:010026c6526b7c 0c:41525542412d46416c73653232 51:00000041525542412d46416c736532322e73757279612e636f6d
```

Be aware that each device type may not have a unique DHCP fingerprint signature. For example, devices from different manufacturers may use vendor class identifiers that begin with similar strings. If you create a DHCP-Option rule that uses the starts-with condition instead of the equals condition, the rule may assign a role or VLAN to more than one device type.

Default Role for Authentication Method

For each authentication method, you can configure a default role for clients who are successfully authenticated using that method. To configure a default role for an authentication method:

In the WebUI

1. Navigate to the Configuration > Security > Authentication page.
2. To configure the default user role for MAC or 802.1x authentication, select the AAA Profiles tab. Select the AAA profile. Enter the user role for MAC Authentication Default Role or 802.1x Authentication Default Role.
3. To configure the default user role for other authentication methods, select the L2 Authentication or L3 Authentication tab. Select the authentication type (Stateful 802.1x or stateful NTLM for L2 Authentication, Captive Portal or VPN for L3 Authentication), and then select the profile. Enter the user role for Default Role.
4. Click Apply.

For additional information on configuring captive portal authentication, see "Captive Portal" on page 351.

In the CLI

To configure the default user role for MAC or 802.1x authentication:

```
aaa profile <profile>
   mac-default-role <role>
   dot1x-default-role <role>
```

To configure the default user role for other authentication methods:

```
aaa authentication captive-portal <profile>
   default-role <role>
aaa authentication stateful-dot1x
   default-role <role>
aaa authentication stateful-ntlm
   default-role <role>
aaa authentication vpn
   default-role <role>
```

Server-Derived Role

If the client is authenticated via an authentication server, the user role for the client can be based on one or more attributes returned by the server during authentication. You configure the user role to be derived by specifying condition rules; when a condition is met, the specified user role is assigned to the client. You can specify more than one condition rule; the order of rules is important as the first matching condition is applied. You can also define server rules based on client attributes such as ESSID, BSSID, or MAC address, even though these attributes are not returned by the server.

For information about configuring a server-derived role, see "Configuring Server-Derivation Rules" on page 277.

VSA-Derived Role

Many Network Address Server (NAS) vendors, including Dell, use VSAs to provide features not supported in standard RADIUS attributes. For Dell systems, VSAs can be employed to provide the user role and VLAN for RADIUS-authenticated clients, however the VSAs must be present on your RADIUS server. This involves defining the vendor (Dell) and/or the vendor-specific code (14823), vendor-assigned attribute number, attribute format (such as string or integer), and attribute value in the RADIUS dictionary file. VSAs supported on controllers conform to the format recommended in RFC 2865, "Remote Authentication Dial In User Service (RADIUS)".

Dictionary files that contain Dell VSAs are available on the Dell support website for various RADIUS servers. Log into the Dell support website to download a dictionary file from the Tools folder.

Global Firewall Parameters

Table 62 describes optional firewall parameters you can set on the controller for IPv4 traffic. To set these options in the WebUI, navigate to the Configuration > Advanced Services > Stateful Firewall > Global Setting page and select or enter values in the IPv4 column. To set these options in the CLI, use the firewall configuration commands.

See Chapter 35, "IPv6 Support" for information about configuring firewall parameters for IPv6 traffic.

Table 62 *IPv4 Firewall Parameters*

Parameter	Description
Monitor Ping Attack	Number of ICMP pings per second, which if exceeded, can indicate a denial of service attack. Valid range is 1-255 pings per second. Recommended value is 4. Default: No default
Monitor TCP SYN Attack rate	Number of TCP SYN messages per second, which if exceeded, can indicate a denial of service attack. Valid range is 1-255 messages per second. Recommended value is 32. Default: No default
Monitor IP Session Attack	Number of TCP or UDP connection requests per second, which if exceeded, can indicate a denial of service attack. Valid range is 1-255 requests per second. Recommended value is 32. Default: No default
Monitor/Police CP Attack rate (per sec)	Rate of misbehaving user's inbound traffic, which if exceeded, can indicate a denial or service attack. Recommended value is 100 frames per second.
Deny Inter User Bridging	Prevents the forwarding of Layer-2 traffic between wired or wireless users. You can configure user role policies that prevent Layer-3 traffic between users or networks but this does not block Layer-2 traffic. This option can be used to prevent traffic, such as Appletalk or IPX, from being forwarded. Default: Disabled
Deny Inter User Traffic	Denies traffic between untrusted users by disallowing layer2 and layer3 traffic. This parameter does not depend on the deny-inter-user-bridging parameter being enabled or disabled. Default: Disabled
Deny All IP Fragments	Drops all IP fragments. NOTE: Do not enable this option unless instructed to do so by an Dell representative. Default: Disabled
Enforce TCP Handshake Before Allowing Data	Prevents data from passing between two clients until the three-way TCP handshake has been performed. This option should be disabled when you have mobile clients on the network as enabling this option will cause mobility to fail. You can enable this option if there are no mobile clients on the network. Default: Disabled
Prohibit IP Spoofing	Enables detection of IP spoofing (where an intruder sends messages using the IP address of a trusted client). When this option is enabled, source and destination IP and MAC addresses are checked for each ARP request/response. Traffic from a second MAC address using a specific IP address is denied, and the entry is not added to the user table. Possible IP spoofing attacks are logged and an SNMP trap is sent. Default: Disabled
Prohibit RST Replay Attack	When enabled, closes a TCP connection in both directions if a TCP RST is received from either direction. You should not enable this option unless instructed to do so by an Dell representative. Default: Disabled

Table 62 *IPv4 Firewall Parameters (Continued)*

Parameter	Description
Log ICMP Errors	Enables logging of received ICMP errors. You should not enable this option unless instructed to do so by an Dell representative. Default: Disabled
Stateful SIP Processing	Disables monitoring of exchanges between a voice over IP or voice over WLAN device and a SIP server. This option should be enabled only when there is no VoIP or VoWLAN traffic on the network. Default: Disabled (stateful SIP processing is enabled)
Allow Tri-session with DNAT	Allows three-way session when performing destination NAT. This option should be enabled when the controller is *not* the default gateway for wireless clients and the default gateway is behind the controller. This option is typically used for captive portal configuration. Default: Disabled.
Session Mirror Destination	Destination (IP address or port) to which mirrored session packets are sent. This option is used only for troubleshooting or debugging. Packets can be mirrored in multiple ACLs, so only a single copy is mirrored if there is a match within more than one ACL. You can configure the following: • Ethertype to be mirrored with the Ethertype ACL mirror option. • IP flows to be mirrored with the session ACL mirror option. • MAC flows to be mirrored with the MAC ACL mirror option. • If you configure both an IP address and a port to receive mirrored packets, the IP address takes precedence. Default: N/A
Session Idle Timeout (sec)	Set the time, in seconds, that a non-TCP session can be idle before it is removed from the session table. Specify a value in the range 16-259 seconds. You should not set this option unless instructed to do so by an Dell representative. Default: 15 seconds
Disable FTP Server	Disables the FTP server on the controller. Enabling this option prevents FTP transfers. You should not enable this option unless instructed to do so by an Dell representative. Default: Disabled (FTP server is enabled)
GRE Call ID Processing	Creates a unique state for each PPTP tunnel. You should not enable this option unless instructed to do so by an Dell representative. Default: Disabled
Per-packet Logging	Enables logging of every packet if logging is enabled for the corresponding session rule. Normally, one event is logged per session. If you enable this option, each packet in the session is logged. You should not enable this option unless instructed to do so by an Dell representative, as doing so may create unnecessary overhead on the controller. Default: Disabled (per-session logging is performed)
Broadcast-filter ARP	Reduces the number of broadcast packets sent to VoIP clients, thereby improving the battery life of voice handsets. You can enable this option for voice handsets in conjunction with increasing the DTIM interval on clients. Default: Disabled
Prohibit ARP Spoofing	Detects and prohibits arp spoofing. When this option is enabled, possible arp spoofing attacks are logged and an SNMP trap is sent. Default: Disabled
Session VOIP Timeout (sec)	Sets the idle session timeout for sessions that are marked as voice sessions. If no voice packet exchange occurs over a voice session for the specified time, the voice session is removed. Range is 16 – 300 seconds. Default: 300 seconds

Table 62 *IPv4 Firewall Parameters (Continued)*

Parameter	Description
Stateful H.323 Processing	Disables stateful H.323 processing. Default: Enabled
Stateful SCCP Processing	Disables stateful SCCP processing. Default: Disabled
Only allow local subnets in user table	Adds only IP addresses, which belong to a local subnet, to the user-table. Default: Disabled
Session mirror IPSEC	Configures session mirroring of all frames that are processed by IPsec. Frames are sent to IP address specified by the session-mirror-destination option. NOTE: Use this option for debugging or troubleshooting only. Default: Disabled
Multicast automatic shaping	Enables multicast optimization and provides excellent streaming quality regardless of the amount of VLANs or IP IGMP groups that are used. Default: Disabled
Stateful VOCERA Processing	Disables stateful VOCERA processing. Default: Disabled
Stateful UA Processing	Disables stateful UA processing. Default: Disabled
Enforce bw contracts for broadcast traffic	Applies bw contracts to local subnet broadcast traffic.
Clear Sessions on Role Update	If enabled, this setting clears all existing user role sessions after a user or client roles is modified.
Enforce TCP Sequence numbers	Enforces the TCP sequence numbers for all packets. Default:Disabled
Enforce WMM Voice Priority Matches Flow Content	If traffic to or from the user is inconsistent with the associated QoS policy for voice, the traffic is reclassified to best effort and data path counters incremented. Default: Disabled
Rate limit CP untrusted ucast traffic (Mbps)	Specifies the untrusted unicast traffic rate limit. Range is 1-200 Mbps. Default: 10 Mbps
Rate limit CP untrusted mcast traffic (Mbps)	Specifies the untrusted multicast traffic rate limit. Range is 1-200 Mbps. Default: 2 Mbps
Rate limit CP trusted ucast traffic (Mbps)	Specifies the trusted unicast traffic rate limit. Range is 1-200 Mbps. Default: 80 Mbps
Rate limit CP trusted mcast traffic (Mbps)	Specifies the trusted multicast traffic rate limit. Range is 1-200 Mbps. Default: 2 Mbps
Rate limit CP route traffic (Mbps)	Specifies the traffic rate limit that needs ARP requests. Range is 1-200 Mbps. Default: 1 Mbps
Rate limit CP session mirror traffic (Mbps)	Specifies the session mirrored traffic forwarded to the controller. Range is 1-200 Mbps. Default: 1 Mbps
Rate limit CP auth process traffic (Mbps)	Specifies the traffic rate limit that is forwarded to the authentication process. Range is 1-200 Mbps. Default: 1 Mbps

Chapter 13

Dashboard Monitoring

The ArubaOS dashboard monitoring functionality provides enhanced visibility into your wireless network performance and usage within a controller. This allows you to easily locate and diagnose WLAN issues in the controller.

The dashboard monitoring is available via the WebUI. To monitor and troubleshoot RF issues in the WLAN, click the Dashboard tab. The following pages in the Dashboard page allows you to view various performance and usage information:

- Performance
- Usage
- Security
- Potential Issues
- WLANs
- Access Points
- Clients

Additionally, you can view the context sensitive help for each field in the Dashboard UI by doing a right click on the field.

Performance

This page displays the performance details of the wireless clients and APs connected to the controller.

Clients

This section displays the total number of wireless clients connected to the controller. You can view the distribution of clients in different SNR ranges, associated data rate ranges, and data transfer speed ranges using the histograms. You can click on the hyperlinked number to view the Clients page. Additionally, you can view the following client performance details:

- Signal to noise ratio (SNR)
- Phy type
- Client connection speed
- Effective data rate of the clients connected to the controller

To understand histogram information, see "Using Dashboard Histograms" on page 340.

APs

This section displays the following performance details of the APs on the controller:

- To client or from client frame rates
- Overall goodput
- Percentage of frames dropped
- Frame rate distribution of the APs

Additionally, you can view the distribution of the APs in different noise floor ranges, channel utilization ranges, and non-Wi-Fi interference ranges using the histograms. To understand histogram information, see "Using Dashboard Histograms" on page 340.

Using Dashboard Histograms

Dashboard histograms are a visual representation of the distribution of the wireless clients, access points, and radios across different performance parameters in the controller. Histograms help you to quickly identify any performance issues in the network from the color of the distribution. For example, critical ranges of the distribution are highlighted in red and the normal ranges are highlighted in green.

You can view the number of clients or APs falling in each range of the distribution with a hyperlink. You can also perform the following tasks on the histograms to get additional information on the clients and APs in the distribution:

- View Client or AP details: Click the hyperlinked number to view the details of the clients or APs in a pop-up window.
- Sort: Click a column header of the clients or APs table to sort the complete list based on the entries on the active column. You can also use the sort icon that appears when you click on a column for sorting.
- Filter: Click the filter icon and select the filter criterion on any column to filter the entries.
- Customize column view: Select or deselect the columns to view or hide by doing a right click on the clients or AP table header.
- Close pop-up window: Click on the close icon to close the client or AP details pop-up window.

Usage

This page displays the usage details of the clients and APs on the controller.

Clients

This section displays the client and WLAN utilization in the controller. You can view the trends of the following client usage details in the last 15 minutes:

- Number of wireless clients connected to the controller
- Number of active wireless clients
- Number of wireless clients that have low usage
- Number of wireless clients associated per WLAN

Additionally, you can click on the hyperlinked number to view the respective client details on the Clients page.

APs

This section displays the AP utilization in the controller. You can view the following AP and radio details:

- Number of APs
- Number of APs that are down
- Radios with low usage
- Overall AP usage

You can click on the hyperlinked number to view the respective AP or radio details on the Access Points or Radios page. Additionally, you can view the trends of the average data bytes transmitted and received by the AP per second and the usage per WLAN in the last 15 minutes.

Security

This page allows you to monitor the detection and protection of wireless intrusions in your network.

The two top tables—Discovered APs & Clients and Events—contain data as links. When these links are selected they arrange, filter, and display the appropriate information in the lower table.

NOTE: The term *events* in this document refers to security threats, vulnerabilities, attacks (intrusion or Denial of Service) and other related events.

Potential Issues

This page displays the total number of radios and wireless clients that may have potential issues in the network. You can right click on the total number to view the trend of the clients and radios with potential issues in the last 15 minutes.You can also view the number of clients or radios that have a specific potential issue in each radio band.

The potential issues that a client may have are:

- Low SNR: Clients that have signal to noise ratio of 30 dBm or lower.
- Low speed: Clients that have a connection speed of 36 Mbps or lower.
- Low goodput: Clients that have an average data rate of 24 Mbps or lower.

The potential issues that a radio may have are:

- High noise floor: Radios that have a noise floor of -85 dB or greater.
- Busy channel: Radios that have a channel utilization of 80% or greater.
- High non-Wi-Fi interference: Radios that have a non-Wi-Fi interference of 20% or greater.
- Low goodput: Radios that have an average data rate of 24 Mbps or lower.
- High client association: Radios that have 15 or more clients connected.

You can click on the hyperlinked number to view the details of the respective clients or radios in the bottom pane of the page. You can perform the following tasks on the details table:

- Sort: Click a column header of the table to sort the complete list based on the entries on the active column. You can also use the sort icon that appears when you click on a column for sorting.
- View or hide columns: Select or deselect the columns to view or hide by doing a right click on the table header.

WLANs

You can view the WLAN details such as the number of associated APs, radios, and wireless clients as well as the WLAN usage in the controller. You can also view the details of the associated APs and clients as tables. You can perform the following tasks on this page:

- Sort: Click a column header of the WLAN table to sort the complete list based on the entries on the active column. You can also use the sort icon that appears when you click on a column for sorting.
- Filter: Click the filter icon and select the filter criterion on any column of the details table to filter the entries.
- Customize column view: Select or deselect the columns to view or hide by doing a right click on the details table header. You can also choose one of the following system defined views that have the appropriate pre-selected columns.
  - Default Columns
  - To/From Client Stats

- View WLAN trends: View the trends of the clients connected in the WLAN and the WLAN usage in the last 15 minutes.
- View client summary: Click on the hyperlinked client name on the client details table to view the Client Summary page. In this page, you can view the client details summary (air quality metrics and from and to clients statistics), bandwidth of the client usage, trend of the client frame loss in the last 15 minutes, and the frame rate distribution of the client.
- View AP or radio summary: Click on the hyperlinked AP name or the radio band on the AP details table to view the Access Points page. In this page you can view the summary of the AP details such as air quality metrics, from and to clients statistics, and the number of clients associated with the AP under different SNR ranges. Additionally, you can view the details of the associated clients and WLANs.

Access Points

You can view the details of all the radios and APs associated with the controller by selecting the respective tab. You can also view the trends of the connected wireless clients and the client usage under the 2.4 Ghz and 5 Ghz radio bands in the last 15 minutes.

You can perform the following tasks on this page:

- Sort: Click a column header of the AP table to sort the complete list based on the entries on the active column. You can also use the sort icon that appears when you click on a column for sorting.
- Filter: Click the filter icon and select the filter criterion on any column of the details table to filter the entries.
- Customize column view: Select or deselect the columns to view or hide by doing a right click on the details table header. You can also choose one of the following system defined views that have the appropriate pre-selected columns.
  - Default Columns
  - Air Quality Metrics
  - To/From Client Stats
- View client details: Click on the number of clients associated with the AP to view the details of the clients on the Clients page.
- View AP or radio summary: Click on the hyperlinked AP name or the radio band on the AP details table to view the summary of the AP details such as air quality metrics, from and to clients statistics, and the number of clients associated with the AP under different SNR ranges. Additionally, you can view the details of the associated clients and WLANs.

Clients

You can view the details of all the wireless clients on the controller. You can also view the trends of the connected clients and the client usage under the 2.4 Ghz and 5 Ghz radio bands in the last 15 minutes.

You can perform the following tasks on this page:

- Sort: Click a column header of the AP table to sort the complete list based on the entries on the active column. You can also use the sort icon that appears when you click on a column for sorting.
- Filter: Click the filter icon and select the filter criterion on any column of the details table to filter the entries.
- Customize column view: Select or deselect the columns to view or hide by doing a right click on the details table header. You can also choose one of the following system defined views that have the appropriate pre-selected columns.
  - Default Columns
  - Air Quality Metrics
  - To/From Client Stats

- View client summary: Click on the hyperlinked client name on the client details table to view the Client Summary page. In this page, you can view the client details summary (air quality metrics and from or to clients statistics), bandwidth of the client usage, trend of the client frame loss in the last 15 minutes, and the frame rate distribution of the client.
- View AP details: Click on the hyperlinked AP name to view the Access Points page.
- View WLAN details: Click on the hyperlinked SSID of the WLAN to view the WLANs page.

Chapter 14

Stateful and WISPr Authentication

ArubaOS supports stateful 802.1x authentication, stateful NTLM authentication and authentication for Wireless Internet Service Provider roaming (WISPr). Stateful authentication differs from 802.1x authentication in that the controller does not manage the authentication process directly, but monitors the authentication messages between a user and an external authentication server, and then assigns a role to that user based upon the information in those authentication messages. WISPr authentication allows clients to roam between hotspots using different ISPs.

This chapter describes the following topics:

Stateful Authentication Overview

ArubaOS supports two different types of stateful authentication, stateful 802.1x and stateful NTLM.

- Stateful 802.1x authentication: This feature allows the controller to learn the identity and role of a user connected to a third-party AP, and is useful for authenticating users to networks with APs from multiple vendors. When an 802.1x-capable access point sends a authentication request to a RADIUS server, the controller inspects this request and the associated response to learn the authentication state of the user. It then applies an identity-based user role through the Policy Enforcement Firewall.
- Stateful NTLM authentication: NT LAN Manager (NTLM) is a suite of Microsoft authentication and session security protocols. You can use stateful NTLM authentication to configure a controller to monitor the NTLM authentication messages between a client and a Windows authentication server. If the client successfully authenticates via an NTLM authentication server, the controller can recognize that the client has been authenticated and assign that client a specified user role.

  The default Windows authentication method changed from the older NTLM protocol to the newer Kerberos protocol, starting with Windows 2000. Therefore, stateful NTLM authentication is most useful for networks with legacy, pre-Windows 2000 clients. Note also that unlike other types of authentication, all users authenticated via stateful NTLM authentication must be assigned to the user role specified in the Stateful NTLM Authentication profile. Dell's stateful NTLM authentication does not support placing users in various roles based upon group membership or other role-derivation attributes.

WISPr Authentication Overview

WISPr authentication allows a "smart client" to authenticate on the network when they roam between Wireless Internet Service Providers, even if the wireless hotspot uses an ISP for which the client may not have an account.

If you are a hotspot operator using WISPr authentication, and a client that has an account with your ISP attempts to access the Internet at your hotspot, then your ISP's WISPr AAA server authenticates that client directly, and allows the client access on the network. If, however, the client only has an account with a *partner* ISP, then your ISP's WISPr AAA server will forward that client's credentials to the partner ISP's WISPr AAA

server for authentication. Once the client has been authenticated on the partner ISP, it will be authenticated on your hotspot's own ISP, as per their service agreements. Once your ISP sends an authentication message to the controller, the controller assigns the default WISPr user role to that client.

ArubaOS supports the following smart clients, which enable client authentication and roaming between hotspots by embedding iPass Generic Interface Specification (GIS) *redirect*, *proxy*, *authentication* and *logoff* messages within HTLM messages to the controller.

- iPass
- Bongo
- Trustive
- weRoam
- AT&T

Important Points to Remember

Before you can configure a stateful authentication feature, you should have defined a user role you want to assign to the authenticated users, and created a server group that includes a RADIUS authentication server for stateful 802.1x authentication or a Windows server for stateful NTLM authentication. For details on performing these tasks, see the following sections of this User Guide:

- "Roles and Policies" on page 321
- "Configuring a RADIUS Server" on page 264
- "Configuring a Windows Server" on page 269
- "Server Groups" on page 273

You can use the default stateful NTLM authentication and WISPr authentication profiles to manage the settings for these features, or you can create additional profiles as desired. Note, however, that unlike most other types of authentication, stateful 802.lx authentication uses only a single Stateful 802.1x profile. This profile can be enabled or disabled, but you can not configure more than one instance of a Stateful 802.1x profile.

Configuring Stateful 802.1x Authentication

When you configure 802.1x authentication for clients on non-Dell APs, you must specify the group of RADIUS servers that will perform the user authentication, and select the role to be assigned to those users who successfully complete authentication. When the user logs off or shuts down the client machine, ArubaOS will note the deauthentication message from the RADIUS server, and will change the user's role from the specified authenticated role back to the logon role. For details on defining a RADIUS server used for stateful 802.1x authentication, see "Configuring a RADIUS Server" on page 264

In the WebUI

To configure the Stateful 802.1x Authentication profile via the WebUI:

1. Navigate to the Configuration > Security > Authentication > L2 Authentication window.
2. In the Profiles list, select Stateful 802.1x Authentication Profile.
3. Click the Default Role drop-down list, and select the role that will be assigned to stateful 802.1x authenticated users.
4. Specify the timeout period for authentication requests, from 1-20 seconds. The default value is 10 seconds.
5. Select the Mode checkbox to enable stateful 802.1x authentication.

In the CLI

Use the following commands to configure stateful 802.1x authentication via the command-line interface. The first set of commands defines the RADIUS server used for 802.1x authentication, and the second set assigns that server to a server group. The third set of commands associates that server group with the stateful 802.1x authentication profile, then sets the authentication role and timeout period.

```
aaa authentication-server radius <server-name>
   acctport <port>
   authport <port>
   clone <server>
   enable
   host <ipaddr>
   key <psk>
   nas-identifier <string>
   nas-ip <ipaddr>
   retransmit <number>
   timeout <seconds>
   use-md5
   !

aaa server-group group <server-group>
   auth-server <server-name>
   !

aaa authentication stateful-dot1x
   server-group <server-group>
   default-role <role>
   enable
   timeout <seconds>
```

Configuring Stateful NTLM Authentication

The Stateful NTLM Authentication profile requires that you specify a server group which includes the servers performing NTLM authentication, and the role to be assigned to users who are successfully authenticated. For details on defining a windows server used for NTLM authentication, see "Configuring a Windows Server" on page 269.

When the user logs off or shuts down the client machine, the user will remain in the authenticated role until the user ages out, that is, until the user has sent no traffic for the amount of time specified in the User Idle Timeout setting in the Configuration > Security > Authentication > Advanced page.

In the WebUI

To create and configure a new instance of a stateful NTLM authentication profile via the WebUI:

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. In the Profiles list, expand the Stateful NTLM Authentication Profile.
3. To define settings for an *existing* profile, click that profile name in the profiles list.

   To create and define settings for a *new* Stateful NTLM Authentication profile, select an existing profile, then click the Save As button in the right window pane. Enter a name for the new profile in the entry field. at the top of the right window pane.
4. Click the Default Role drop-down list, and select the role to be assigned to all users after they complete stateful NTLM authentication.
5. Specify the timeout period for authentication requests, from 1-20 seconds. The default value is 10 seconds.
6. Select the Mode checkbox to enable stateful NTLM authentication.

7. Click Apply.
8. In the Profiles list, select the Server Group entry below the Stateful NTLM Authentication profile.
9. Click the Server Group drop-down list and select the group of Windows servers you want to use for stateful NTLM authentication.
10. Click Apply.

In the CLI

Use the following commands to configure stateful NTLM authentication via the command-line interface. The first set of commands defines the Windows server used for NTLM authentication, the second set adds that server to a server group, and the third set of commands associates that server group with the stateful NTLM authentication profile then defines the profile settings.

```
aaa authentication-server windows <windows_server_name>
   host <ipaddr>
   enable
   !

aaa server-group group <server-group>
   auth-server <windows_server_name>
   !

aaa authentication stateful-ntlm
   default-role <role>
   enable
   server-group <server-group>
   timeout <seconds>
```

Configuring WISPr Authentication

A WISPr authentication profile includes parameters to define RADIUS attributes, the default role for authenticated WISPr users, maximum numbers of authenticated failures and logon wait times. The WISPr-Location-ID sent from the controller to the WISPr RADIUS server will be the concatenation of the ISO Country Code, E.164 Country Code, E.164 Area Code and SSID/Zone parameters configured in this profile

The parameters to define WISPr RADIUS attributes are specific to the RADIUS server your ISP uses for WISPr authentication; contact your ISP to determine these values. You can find a list of ISO and ITU country and area codes at the ISO and ITU websites (www.iso.org and http://www.itu.int.)

In the WebUI

This section describes how to create and configure a new instance of a WISPr authentication profile in the WebUI.

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. In the Profiles list, expand the WISPr Authentication Profile.
3. To define settings for an *existing* profile, click that profile name in the profiles list.

   To create and define settings for a *new* WISPr Authentication profile, select an existing profile, then click the Save As button in the right window pane. Enter a name for the new profile in the entry field. at the top of the right window pane.

4. Define values for the following parameters

Table 63 *WISPr Authentication Profile Parameters*

Parameter	Description
Default Role	Default role assigned to users that complete WISPr authentication.
Logon wait minimum wait	If the controller's CPU utilization has surpassed the Login wait CPU utilization threshold value, the Logon wait minimum wait parameter defines the minimum number of seconds a user will have to wait to retry a login attempt. Range: 1–10 seconds. Default: 5 seconds.
Logon wait maximum wait	If the controller's CPU utilization has surpassed the Login wait CPU utilization threshold value, the Logon wait maximum wait parameter defines the maximum number of seconds a user will have to wait to retry a login attempt. Range: 1–10 seconds. Default: 10 seconds.
Logon wait CPU utilization threshold	Percentage of CPU utilization at which the maximum and minimum login wait times are enforced. Range: 1–100%. Default: 60%.
WISPr Location-ID ISO Country Code	The ISO Country Code section of the WISPr Location ID.
WISPr Location-ID E.164 Country Code	The E.164 Country Code section of the WISPr Location ID.
WISPr Location-ID E.164 Area Code	The E.164 Area Code section of the WISPr Location ID.
WISPr Location-ID SSID/Zone	The SSID/Zone section of the WISPr Location ID.
WISPr Operator Name	A name identifying the hotspot operator.
WISPr Location Name	A name identifying the hotspot location. If no name is defined, the parameter will use the name of the AP to which the user has associated.

5. Click Apply.
6. In the Profiles list, select the Server Group entry below the WISPr Authentication profile.
7. Click the Server Group drop-down list and select the group of RADIUS servers you want to use for WISPr authentication.
8. Click Apply.

NOTE: A Boingo smart client uses a NAS identifier in the format <CarrierID>_<VenueID> for location identification. To support Boingo clients, you must also configure the NAS identifier parameter in the Radius server profile for the WISPr server

In the CLI

Use the following CLI commands to configure WISPr authentication. The first set of commands defines the RADIUS server used for WISPr authentication, the second set adds that server to a server group, and the third set of commands associates that server group with the WISPR authentication profile then defines the profile settings.

```
aaa authentication-server radius <rad_server_name>
   host 172.4.77.214
   key qwERtyuIOp
   enable
   nas-identifier corp_venue1
   !

aaa server-group group <server-group>
   auth-server <radius_server_name>
   !

aaa authentication wispr
```

```
default-role <role>
logon-wait {cpu-threshold|maximum-delay|minimum-delay}
server-group <server-group>
wispr-location-id-ac <wispr-location-id-ac>
wispr-location-id-cc <wispr-location-id-cc>
wispr-location-id-isocc <wispr-location-id-isocc>
wispr-location-id-network <wispr-location-id-network>
wispr-location-name-location <wispr-location-name-location>
wispr-location-name-operator-name <wispr-location-name-location>
```

Chapter 15

Captive Portal

Captive portal is one of the methods of authentication supported by ArubaOS. A captive portal presents a web page which requires user action before network access is granted. The required action can be simply viewing and agreeing to an acceptable use policy, or entering a user ID and password which must be validated against a database of authorized users.

You can also configure captive portal to allow clients to download the Dell VPN dialer for Microsoft VPN clients if the VPN is to be terminated on the Dell controller. For more information about the VPN dialer, see Chapter 17, "Virtual Private Networks" on page 389.

This chapter describes the following topics:

Captive Portal Overview

You can configure captive portal for guest users, where no authentication is required, or for registered users who must be authenticated against an external server or the controller's internal database.

NOTE: While you can use captive portal to authenticate users, it does not provide for encryption of user data and should not be used in networks where data security is required. Captive portal is most often used for guest access, access to open systems (such as public hot spots), or as a way to connect to a VPN.

You can use captive portal for guest and registered users at the same time. The default captive portal web page provided with ArubaOS displays login prompts for both registered users and guests. (You can customize the default captive portal page, as described in "Personalizing the Captive Portal Page" on page 372)

You can also load up to 16 different customized login pages into the controller. The login page displayed is based on the SSID to which the client associates.

Policy Enforcement Firewall Next Generation (PEFNG) License

You can use captive portal with or without the PEFNG license installed in the controller. The PEFNG license provides identity-based security to wired and wireless clients through user roles and firewall rules. You must purchase and install the PEFNG license on the controller to use identity-based security features.

There are differences in how captive portal functions work and how you configure captive portal, depending on whether the license is installed. Later sections in this chapter describe how to configure captive portal in the base operating system (without the PEFNG license) and with the license installed.

Controller Server Certificate

The Dell controller is designed to provide secure services through the use of digital certificates. A server certificate installed in the controller verifies the authenticity of the controller for captive portal.

Dell controllers ship with a demonstration digital certificate. Until you install a customer-specific server certificate in the controller, this demonstration certificate is used by default for all secure HTTP connections such as captive portal. This certificate is included primarily for the purposes of feature demonstration and convenience and is not intended for long-term use in production networks. Users in a production environment are urged to obtain and install a certificate issued for their site or domain by a well-known certificate authority (CA). You can generate a Certificate Signing Request (CSR) on the controller to submit to a CA. For information on how to generate a CSR and how to import the CA-signed certificate into the controller, see "Managing Certificates" on page 580 in Chapter 32, "Management Access" .

Once you have imported a server certificate into the controller, you can select the certificate to be used with captive portal as described in the following sections.

To select a certificate for captive portal using the WebUI:

1. Navigate to the Configuration > Management > General page.
2. Under Captive Portal Certificate, select the name of the imported certificate from the drop-down list.
3. Click Apply.

To select a certificate for captive portal using the command-line interface, access the CLI in config mode and issue the following commands:

```
web-server
   captive-portal-cert <certificate>
```

To specify a different server certificate for captive portal with the CLI, use the no command to revert back to the default certificate *before* you specify the new certificate:

```
web-server
   captive-portal-cert ServerCert1
   no captive-portal-cert
   captive-portal-cert ServerCert2
```

Captive Portal in the Base ArubaOS

The base operating system (ArubaOS without any licenses) allows full network access to all users who connect to an ESSID, both guest and registered users. In the base operating system, you cannot configure or customize user roles; this function is only available by installing the PEFNG license. Captive portal allows you to control or identify who has access to network resources.

When you create a captive portal profile in the base operating system, an implicit user role is automatically created with same name as the captive portal profile. This implicit user role allows only DNS and DHCP traffic between the client and network and directs all HTTP or HTTPS requests to the captive portal. You cannot directly modify the implicit user role or its rules. Upon authentication, captive portal clients are allowed full access to their assigned VLAN.

NOTE: The WLAN Wizard within the ArubaOS WebUI allows for basic captive portal configuration for WLANs associated with the "default" ap-group: Configuration > Wizards > WLAN Wizard. Follow the steps in the workflow pane within the wizard and refer to the help tab for assistance.

What follows are the tasks for configuring captive portal in the base ArubaOS. The example server group and profile names appear inside quotation marks.

- Create the Server Group name. In this example, the server group name is “cp-srv”.

  If you are configuring captive portal for registered users, configure the server(s) and create the server group. For more information about configuring authentication servers and server groups, see Chapter 9, “Authentication Servers” .
- Create Captive Portal Authentication Profile. In this example, the profile name is “c-portal”.

  Create and configure an instance of the captive portal authentication profile. Creating the captive portal profile automatically creates an implicit user role and ACL with the same name. Creating the profile “c-portal” creates an implicit user role called “c-portal”. That user role allows only DNS and DHCP traffic between the client and network and directs all HTTP or HTTPS requests to the captive portal.
- Create an AAA Profile. In this example, the profile name is “aaa_c-portal”.

  Create and configure an instance of the AAA profile. For the initial role, enter the implicit user role that was created in step 1. The initial role in the profile “aaa_c-portal” must be set to “c-portal”.
- Create SSID Profile. In this example, the profile name is “ssid_c-portal”.

  Create and configure an instance of the virtual AP profile which you apply to an AP group or AP name. Specify the AAA profile you created in step 1.
- Create a Virtual AP Profile. In this example, the profile name is “vp_c-portal”.

  Create and configure an instance of the SSID profile for the virtual AP.

The following sections present the procedure for configuring the captive portal authentication profile, the AAA profile, and the virtual AP profile using the WebUI or the command line (CLI). Configuring the VLAN and authentication servers and server groups are described elsewhere in this document.

NOTE: In ArubaOS 2.5.2 and later 2.5.x releases, captive portal users in the base operating system are placed into the predefined *cpbase* initial user role before authentication. The *cpbase* role is not supported in ArubaOS 3.x. You need to create new captive portal profiles in the base operating system, as described in this section, which automatically generates the required policies and roles.

Configuring Captive Portal via the WebUI

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page. Select Captive Portal Authentication Profile.
   a. In the Captive Portal Authentication Profile Instance list, enter the name of the profile (for example, c-portal), then click Add.
   b. Select the captive portal authentication profile you just created.
   c. You can enable user login and/or guest login, and configure other captive portal profile parameters as described in Table 64.
   d. Click Apply.
2. To specify authentication servers, select Server Group under the captive portal authentication profile you just configured.
   a. Select the server group (for example, cp-srv) from the drop-down menu.
   b. Click Apply.
3. Select the AAA Profiles tab.
   a. In the AAA Profiles Summary, click Add to add a new profile. Enter the name of the profile (for example, aaa_c-portal), then click Add.
   b. Select the AAA profile you just created.

c. For Initial Role, select the captive portal authentication profile (for example, c-portal) you created previously.

NOTE: The Initial Role must be exactly the same as the name of the captive portal authentication profile you created.

d. Click Apply.

4. Navigate to the Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the applicable AP group name or AP name.
5. Under Profiles, select Wireless LAN, then select Virtual AP.
6. To create a new virtual AP profile, select NEW from the Add a profile drop-down menu. Enter the name for the virtual AP profile (for example, vp_c-portal), then click Add.
   a. In the Profile Details entry for the new virtual AP profile, select the AAA profile you previously created from the AAA Profile drop-down menu. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   b. From the SSID profile drop-down menu, select NEW. A pop-up window allows to you configure the SSID profile.
   c. Enter the name for the SSID profile (for example, ssid_c-portal).
   d. Enter the Network Name for the SSID (for example, c-portal-ap).
   e. Click Apply in the pop-up window.
   f. At the bottom of the Profile Details page, click Apply.
7. Click on the new virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
   a. Make sure Virtual AP enable is selected.
   b. For VLAN, select the VLAN to which users are assigned (for example, 20).
   c. Click Apply.

Configuring Captive Portal via the CLI

To configure captive portal in the base operating system via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication captive-portal c-portal
   server-group cp-srv
aaa profile aaa_c-portal
   initial-role c-portal
wlan ssid-profile ssid_c-portal
   essid c-portal-ap
wlan virtual-ap vp_c-portal
   aaa-profile aaa_c-portal
   ssid-profile ssid_c-portal
   vlan 20
```

Captive Portal with the PEFNG License

The PEFNG license provides identity-based security for wired and wireless users. There are two user roles that are important for captive portal:

- Default user role, which you specify in the captive portal authentication profile, is the role granted to clients upon captive portal authentication. This can be the predefined guest system role.
- Initial user role, which you specify in the AAA profile, directs clients who associate to the SSID to captive portal whenever the user initiates a Web browser connection. This can be the predefined logon system role.

The captive portal authentication profile specifies the captive portal login page and other configurable parameters. The initial user role configuration must include the applicable captive portal authentication profile instance.

NOTE: MAC-based authentication, if enabled on the controller, takes precedence over captive portal authentication.

The following are the basic tasks for configuring captive portal using role-based access provided by the Policy Enforcement Firewall software module. Note that you must install the PEFNG license before proceeding (see Chapter 34, “Software Licenses”).

- Configure the user role for a default user.

  Create and configure user roles and policies for guest or registered captive portal users. (See Chapter 12, “Roles and Policies” for more information about configuring policies and user roles.)
- Create a server group.

  If you are configuring captive portal for registered users, configure the server(s) and create the server group. (See Chapter 9, “Authentication Servers” for more information about configuring authentication servers and server groups.)

NOTE: If you are using the controller’s internal database for user authentication, use the predefined “Internal” server group. You need to configure entries in the internal database, as described in Chapter 9, “Authentication Servers” .

- Create the captive portal authentication profile.

  Create and configure an instance of the captive portal authentication profile. Specify the default user role for captive portal users.
- Configure the initial user role.

  Create and configure the initial user role for captive portal. You need to include the predefined captiveportal policy, which directs clients to the captive portal, in the initial user role configuration.

  You also need to specify the captive portal authentication profile instance in the initial user role configuration. For example, if you are using the predefined logon system role for the initial role, you need to edit the role to specify the captive portal authentication profile instance.
- Create the AAA Profile .

  Create and configure an instance of the AAA profile. Specify the initial user role.
- Create the SSID Profile “ssid_c-portal”.

  Create and configure an instance of the virtual AP profile that you apply to an AP group or AP name. Specify the AAA profile you just created.
- Create the Virtual AP Profile “vp_c-portal”.

  Create and configure an instance of the SSID profile for the virtual AP.

The following sections present the WebUI and Command Line (CLI) procedures for configuring the captive portal authentication profile, initial user role, the AAA profile, and the virtual AP profile. Other chapters within this document detail the configuration of the user roles and policies, authentication servers, and server groups.

Configuring Captive Portal via the WebUI

To configure captive portal with PEFNG license via the WebUI:

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. Select Captive Portal Authentication Profile.

a. In the Captive Portal Authentication Profile Instance list, enter the name of the profile (for example, c-portal), then click Add.
b. Select the captive portal authentication profile you just created.
c. Select the default role (for example, employee) for captive portal users.
d. Enable guest login and/or user login, as well as other parameters (refer to Table 64).
e. Click Apply.

3. To specify the authentication servers, select Server Group under the captive portal authentication profile you just configured.
   a. Select the server group (for example, cp-srv) from the drop-down menu.
   b. Click Apply.
4. Select the AAA Profiles tab.
   a. In the AAA Profiles Summary, click Add to add a new profile. Enter the name of the profile (for example, aaa_c-portal), then click Add.
   b. Set the Initial role to a role that you will configure with the captive portal authentication profile.
   c. Click Apply.
5. Navigate to the Configuration > Security > Access Control page to configure the initial user role to use captive portal authentication.
   a. To edit the predefined logon role, select the System Roles tab, then click Edit for the logon role.
   b. To configure a new role, first configure policy rules in the Policies tab, then select the User Roles tab to add a new user role and assign policies.
   c. To specify the captive portal authentication profile, scroll down to the bottom of the page. Select the profile from the Captive Portal Profile drop-down menu, and click Change.
   d. Click Apply.
6. Navigate to the Configuration > Wireless > AP Configuration page to configure the virtual AP profile.
7. Select either the AP Group or AP Specific tab. Click Edit for the applicable AP group name or AP name.
8. Under Profiles, select Wireless LAN, then select Virtual AP.
9. Select NEW from the Add a profile drop-down menu to create a new virtual AP profile. Enter the name for the virtual AP profile (for example, vp_c-portal), then click Add.
   a. In the Profile Details entry for the new virtual AP profile, select the AAA profile you previously configured. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   b. From the SSID profile drop-down menu, select NEW. A pop-up window allows you to configure the SSID profile.
   c. Enter the name for the SSID profile (for example, ssid_c-portal).
   d. Enter the Network Name for the SSID (for example, c-portal-ap).
   e. Click Apply in the pop-up window.
   f. At the bottom of the Profile Details page, click Apply.
10. Click on the new virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
    a. Make sure Virtual AP enable is selected.
    b. For VLAN, select the VLAN to which users are assigned (for example, 20).
    c. Click Apply.

Configuring Captive Portal via the CLI

To configure captive portal with the PEFNG license via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication captive-portal c-portal
   default-role employee
   server-group cp-srv
user-role logon
   captive-portal c-portal
aaa profile aaa_c-portal
   initial-role logon
wlan ssid-profile ssid_c-portal
   essid c-portal-ap
   vlan 20
wlan virtual-ap vp_c-portal
   aaa-profile aaa_c-portal
   ssid-profile ssid_c-portal
```

Example Authentication with Captive Portal

In the following example:

- Guest clients associate to the guestnet SSID which is an open wireless LAN. Guest clients are placed into VLAN 900 and assigned IP addresses by the controller's internal DHCP server. The user has no access to network resources beyond DHCP and DNS until they open a web browser and log in with a guest account using captive portal.
- Guest users are given a login and password from guest accounts created in the controller's internal database. The temporary guest accounts are created and administered by the site receptionist.
- Guest users must enter their assigned login and password into the captive portal login before they are given access to use web browsers (HTTP and HTTPS), POP3 email clients, and VPN clients (IPsec, PPTP, and L2TP) on the Internet and only during specified working hours. Guest users are prohibited from accessing internal networks and resources. All traffic to the Internet is source-NATed.

NOTE: This example assumes a Policy Enforcement Firewall Next Generation (PEFNG) license is installed in the controller.

In this example, you create two user roles:

- guest-logon is a user role assigned to any client who associates to the guestnet SSID. Normally, any client that associates to an SSID will be placed into the *logon* system role. The guest-logon user role is more restrictive than the logon role.
- auth-guest is a user role granted to clients who successfully authenticate via the captive portal.

Creating a Guest-logon User Role

The guest-logon user role consists of the following ordered policies:

- captiveportal is a predefined policy that allows captive portal authentication.
- guest-logon-access is a policy that you create with the following rules:
  - Allows DHCP exchanges between the user and the DHCP server during business hours while blocking other users from responding to DHCP requests.
  - Allows ICMP exchanges between the user and the controller during business hours.
- block-internal-access is a policy that you create that denies user access to the internal networks.

NOTE: The guest-logon user role configuration needs to include the name of the captive portal authentication profile instance. You can modify the user role configuration after you create the captive portal authentication profile instance.

Creating an Auth-guest User Role

The auth-guest user role consists of the following ordered policies:

- cplogout is a predefined policy that allows captive portal logout.
- guest-logon-access is a policy that you create with the following rules:
  - Allows DHCP exchanges between the user and the DHCP server during business hours while blocking other users from responding to DHCP requests.
  - Allows DNS exchanges between the user and the public DNS server during business hours. Traffic is source-NATed using the IP interface of the controller for the VLAN.
- block-internal-access is a policy that you create that denies user access to the internal networks.
- auth-guest-access is a policy that you create with the following rules:
  - Allows DHCP exchanges between the user and the DHCP server during business hours while blocking other users from responding to DHCP requests.
  - Allows DNS exchanges between the user and the public DNS server during business hours. Traffic is source-NATed using the IP interface of the controller for the VLAN.
  - Allows HTTP/S traffic from the user during business hours. Traffic is source-NATed using the I interface of the controller for the VLAN.
- drop-and-log is a policy that you create that denies all traffic and logs the attempted network access.

Configuring Policies and Roles in the WebUI

Time Range

To create a time range via the WebUI:

1. Navigate to the Configuration > Security > Access Control > Time Ranges page to define the time range “working-hours”.
2. Click Add.
   a. For Name, enter working-hours.
   b. For Type, select Periodic.
   c. Click Add.
   d. For Start Day, click Weekday.
   e. For Start Time, enter 07:30.
   f. For End Time, enter 17:00.
   g. Click Done.
3. Click Apply.

To create the guest-logon-access policy via the WebUI:

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Select Add to add the guest-logon-access policy.
3. For Policy Name, enter guest-logon-access.
4. For Policy Type, select IPv4 Session.
5. Under Rules, select Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select any.
   c. Under Service, select udp. Enter 68.
   d. Under Action, select drop.

e. Click Add.

6. Under Rules, click Add.
   a. Under Source, select any.
   b. Under Destination, select any.
   c. Under Service, select service. Select svc-dhcp.
   d. Under Action, select permit.
   e. Under Time Range, select working-hours.
   f. Click Add.

Aliases

The following step defines an alias representing the public DNS server addresses. Once defined, you can use the alias for other rules and policies.

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Select Add to add the guest-logon-access policy.
3. For Policy Name, enter guest-logon-access.
4. For Policy Type, select IPv4 Session.
5. Under Rules, click Add.
   a. Under Source, select user.
   b. Under Destination, select alias.
   c. Under the alias selection, click New. For Destination Name, enter “Public DNS”. Click Add to add a rule. For Rule Type, select host. For IP Address, enter 64.151.103.120. Click Add. For Rule Type, select host. For IP Address, enter 216.87.84.209. Click Add. Click Apply. The alias “Public DNS” appears in the Destination menu
   d. Under Destination, select Public DNS.
   e. Under Service, select svc-dns.
   f. Under Action, select src-nat.
   g. Under Time Range, select working-hours.
   h. Click Add.
6. Click Apply.

Auth-Guest-Access Policy

To configure the auth-guest-access policy via the WebUI:

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Select Add to add the guest-logon-access policy.
3. For Policy Name, enter auth-guest-access.
4. For Policy Type, select IPv4 Session.
5. Under Rules, select Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select any.
   c. Under Service, select udp. Enter 68.
   d. Under Action, select drop.
   e. Click Add.
6. Under Rules, click Add.

a. Under Source, select any.
b. Under Destination, select any.
c. Under Service, select service. Select svc-dhcp.
d. Under Action, select permit.
e. Under Time Range, select working-hours.
f. Click Add.

7. Under Rules, click Add.
   a. Under Source, select user.
   b. Under Destination, select alias. Select Public DNS from the drop-down menu.
   c. Under Service, select service. Select svc-dns.
   d. Under Action, select src-nat.
   e. Under Time Range, select working-hours.
   f. Click Add.
8. Under Rules, click Add.
   a. Under Source, select user.
   b. Under Destination, select any.
   c. Under Service, select service. Select svc-http.
   d. Under Action, select src-nat.
   e. Under Time Range, select working-hours.
   f. Click Add.
9. Under Rules, click Add.
   a. Under Source, select user.
   b. Under Destination, select any.
   c. Under Service, select service. Select svc-https.
   d. Under Action, select src-nat.
   e. Under Time Range, select working-hours.
   f. Click Add.
10. Click Apply.

Block-Internal-Access Policy

To create the block-internal-access policy via the WebUI:

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Select Add to add the block-internal-access policy.
3. For Policy Name, enter block-internal-access.
4. For Policy Type, select IPv4 Session.
5. Under Rules, select Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select alias.

NOTE: The following step defines an alias representing all internal network addresses. Once defined, you can use the alias for other rules and policies.

c. Under the alias selection, click New. For Destination Name, enter “Internal Network”. Click Add to add a rule. For Rule Type, select network. For IP Address, enter 10.0.0.0. For Network Mask/Range, enter 255.0.0.0. Click Add to add the network range. Repeat these steps to add the network ranges 172.16.0.0 255.255.0.0 and 192.168.0.0 255.255.0.0. Click Apply. The alias “Internal Network” appears in the Destination menu

d. Under Destination, select Internal Network.

e. Under Service, select any.

f. Under Action, select drop.

g. Click Add.

6. Click Apply.

Drop-and-Log Policy

To create the drop-and-log policy via the WebUI:

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Select Add to add the drop-and-log policy.
3. For Policy Name, enter drop-and-log.
4. For Policy Type, select IPv4 Session.
5. Under Rules, select Add to add rules for the policy.
   a. Under Source, select user.
   b. Under Destination, select any.
   c. Under Service, select any.
   d. Under Action, select drop.
   e. Select Log.
   f. Click Add.
6. Click Apply.

Guest-logon Role

To create the guest-logon role via the WebUI:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click Add.
3. For Role Name, enter guest-logon.
4. Under Firewall Policies, click Add.
5. For Choose from Configured Policies, select captiveportal from the drop-down menu.
6. Click Done.
7. Under Firewall Policies, click Add.
8. For Choose from Configured Policies, select guest-logon-access from the drop-down menu.
9. Click Done.
10. Under Firewall Policies, click Add.
11. For Choose from Configured Policies, select block-internal-access from the drop-down menu.
12. Click Done.
13. Click Apply.

Guest-Logon Role

To create the guest-logon role via the WebUI:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click Add.
3. For Role Name, enter auth-guest.
4. Under Firewall Policies, click Add.
5. For Choose from Configured Policies, select cplogout from the drop-down menu.
6. Click Done.
7. Under Firewall Policies, click Add.
8. For Choose from Configured Policies, select guest-logon-access from the drop-down menu.
9. Click Done.
10. Under Firewall Policies, click Add.
11. For Choose from Configured Policies, select block-internal-access from the drop-down menu.
12. Click Done.
13. Under Firewall Policies, click Add.
14. For Choose from Configured Policies, select auth-guest-access from the drop-down menu.
15. Click Done.
16. Under Firewall Policies, click Add.
17. For Choose from Configured Policies, select drop-and-log from the drop-down menu.
18. Click Done.
19. Click Apply.

Configuring Policies and Roles in the CLI

Time Range

To create a time range via the command-line interface, access the CLI in config mode and issue the following commands:

```
time-range working-hours periodic
   weekday 07:30 to 17:00
```

Aliases

To create aliases via the command-line interface, access the CLI in config mode and issue the following commands:

```
netdestination "Internal Network"
   network 10.0.0.0 255.0.0.0
   network 172.16.0.0 255.255.0.0
   network 192.168.0.0 255.255.0.0
netdestination "Public DNS"
   host 64.151.103.120
   host 216.87.84.209
```

Guest-Logon-Access Policy

To create a guest-logon-access policy via the command-line interface, access the CLI in config mode and issue the following commands:

```
ip access-list session guest-logon-access
   user any udp 68 deny
   any any svc-dhcp permit time-range working-hours
```

```
   user alias "Public DNS" svc-dns src-nat time-range working-hours
```

Auth-Guest-Access Policy

To create an auth-guest-access policy via the command-line interface, access the CLI in config mode and issue the following commands:

```
ip access-list session auth-guest-access
   user any udp 68 deny
   any any svc-dhcp permit time-range working-hours
   user alias "Public DNS" svc-dns src-nat time-range working-hours
   user any svc-http src-nat time-range working-hours
   user any svc-https src-nat time-range working-hours
```

Block-Internal-Access Policy

To create a block-internal-access policy via the command-line interface, access the CLI in config mode and issue the following commands:

```
ip access-list session block-internal-access
   user alias "Internal Network" any deny
```

Drop-and-Log Policy

To create a drop-and-log policy via the command-line interface, access the CLI in config mode and issue the following commands:

```
ip access-list session drop-and-log
   user any any deny log
```

Guest-Logon Role

To create a guest-logon-role via the command-line interface, access the CLI in config mode and issue the following commands:

```
user-role guest-logon
   session-acl captiveportal position 1
   session-acl guest-logon-access position 2
   session-acl block-internal-access position 3
```

Auth-Guest Role

To create an auth-guest role via the command-line interface, access the CLI in config mode and issue the following commands:

```
user-role auth-guest
   session-acl cplogout position 1
   session-acl guest-logon-access position 2
   session-acl block-internal-access position 3
   session-acl auth-guest-access position 4
   session-acl drop-and-log position 5
```

Configuring Guest VLANs

Guests using the WLAN are assigned to VLAN 900 and are given IP addresses via DHCP from the controller.

In the WebUI

1. Navigate to the Configuration > Network > VLANs page.
   a. Click Add.
   b. For VLAN ID, enter 900.
   c. Click Apply.

2. Navigate to the Configuration > Network > IP > IP Interfaces page.
   a. Click Edit for VLAN 900.
   b. For IP Address, enter 192.168.200.20.
   c. For Net Mask, enter 255.255.255.0.
   d. Click Apply.
3. Click the DHCP Server tab.
   a. Select Enable DHCP Server.
   b. Click Add under Pool Configuration.
   c. For Pool Name, enter guestpool.
   d. For Default Router, enter 192.168.200.20.
   e. For DNS Server, enter 64.151.103.120.
   f. For Lease, enter 4 hours.
   g. For Network, enter 192.168.200.0. For Netmask, enter 255.255.255.0.
   h. Click Done.
4. Click Apply.

In the CLI

```
vlan 900
interface vlan 900
ip address 192.168.200.20 255.255.255.0
ip dhcp pool "guestpool"
default-router 192.168.200.20
dns-server 64.151.103.120
lease 0 4 0
network 192.168.200.0 255.255.255.0
```

Captive Portal Authentication

In this section, you create an instance of the captive portal authentication profile and the AAA profile. For the captive portal authentication profile, you specify the previously-created auth-guest user role as the default user role for authenticated captive portal clients and the authentication server group (“Internal”).

To configure captive portal authentication via the WebUI:

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page. In the Profiles list, select Captive Portal Authentication Profile.
   a. In the Captive Portal Authentication Profile Instance list, enter guestnet for the name of the profile, then click Add.
   b. Select the captive portal authentication profile you just created.
   c. For Default Role, select auth-guest.
   d. Select User Login.
   e. Deselect (uncheck) Guest Login.
   f. Click Apply.
2. Select Server Group under the guestnet captive portal authentication profile you just created.
   a. Select internal from the Server Group drop-down menu.
   b. Click Apply.

To configure captive portal authentication via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication captive-portal guestnet
   default-role auth-guest
   user-logon
   no guest-logon
   server-group internal
```

Modifying the Initial User Role

The captive portal authentication profile specifies the captive portal login page and other configurable parameters. The initial user role configuration must include the applicable captive portal authentication profile instance. Therefore, you need to modify the guest-logon user role configuration to include the guestnet captive portal authentication profile.

To modify the guest-logon role via the WebUI:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Select Edit for the guest-logon role.
3. Scroll down to the bottom of the page.
4. Select the captive portal authentication profile you just created from the Captive Portal Profile drop-down menu, and click Change.
5. Click Apply.

To modify the guest-logon role via the command-line interface, access the CLI in config mode and issue the following commands:

```
user-role guest-logon
   captive-portal guestnet
```

Configuring the AAA Profile

In this section, you configure the guestnet AAA profile, which specifies the previously-created guest-logon role as the initial role for clients who associate to the WLAN.

To configure the AAA profile via the WebUI:

1. Navigate to the Configuration > Security > Authentication > AAA Profiles page.
2. In the AAA Profiles Summary, click Add to add a new profile. Enter guestnet for the name of the profile, then click Add.
3. For Initial role, select guest-logon.
4. Click Apply.

To configure the AAA profile via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa profile guestnet
   initial-role guest-logon
```

Configuring the WLAN

In this section, you create the guestnet virtual AP profile for the WLAN. The guestnet virtual AP profile contains the SSID profile guestnet (which configures opensystem for the SSID) and the AAA profile guestnet.

To configure the guest WLAN via the WebUI:

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either AP Group or AP Specific tab. Click Edit for the AP group or AP name.

3. To configure the virtual AP profile, navigate to the Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the applicable AP group name or AP name.
4. Under Profiles, select Wireless LAN, then select Virtual AP.
5. To create a new virtual AP profile, select NEW from the Add a profile drop-down menu. Enter the name for the virtual AP profile (for example, guestnet), and click Add.
   a. In the Profile Details entry for the new virtual AP profile, select the AAA profile you previously configured. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   b. From the SSID profile drop-down menu, select NEW. A pop-up window allows you to configure the SSID profile.
   c. Enter the name for the SSID profile (for example, guestnet).
   d. Enter the Network Name for the SSID (for example, guestnet).
   e. For Network Authentication, select None.
   f. For Encryption, select Open.
   g. Click Apply in the pop-up window.
   h. At the bottom of the Profile Details page, click Apply.
6. Click on the new virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
   a. Make sure Virtual AP enable is selected.
   b. For VLAN, select the ID of the VLAN in which captive portal users are placed (for example, VLAN 900).
   c. Click Apply.

To configure the guest WLAN via the command-line interface, access the CLI in config mode and issue the following commands:

```
wlan ssid-profile guestnet
   essid guestnet
   opmode opensystem

aaa profile guestnet
   initial-role guest-logon

wlan virtual-ap guestnet
   vlan 900
   aaa-profile guestnet
   ssid-profile guestnet
```

User Account Administration

Temporary user accounts are created in the internal database on the controller. You can create a user role which will allow a receptionist to create temporary user accounts. Guests can use the accounts to log into a captive portal login page to gain Internet access.

See "Creating Guest Accounts" on page 595 for more information about configuring guest provisioning users and administering guest accounts.

Captive Portal Configuration Parameters

Table 64 describes configuration parameters on the WebUI Captive Portal Authentication profile page.

NOTE: In the CLI, you configure these options with the aaa authentication captive-portal commands.

Table 64 *Captive Portal Authentication Profile Parameters*

Parameter	Description
Black List	Name of an existing black list on an IPv4 or IPv6 network destination. The black list contains websites (unauthenticated) that a guest cannot access.
Default Guest Role	Role assigned to guest. Default: guest
Default Role	Role assigned to the Captive Portal user upon login. When both user and guest logon are enabled, the default role applies to the user logon; users logging in using the guest interface are assigned the guest role. Default: guest
Show Welcome Page	Displays the configured welcome page before the user is redirected to their original URL. If this option is disabled, redirection to the web URL happens immediately after the user logs in. Default: Enabled
Guest Login	Enables Captive Portal logon without authentication. Default: Disabled
Login Page	URL of the page that appears for the user logon. This can be set to any URL. Default: /auth/index.html
Logon wait maximum wait	Configure parameters for the logon wait interval Default: 10 seconds
Logon wait CPU utilization threshold	CPU utilization percentage above which the Logon wait interval is applied when presenting the user with the logon page. Default: 60%
Logon wait minimum wait	Minimum time, in seconds, the user will have to wait for the logon page to pop up if the CPU load is high. This works in conjunction with the Logon wait CPU utilization threshold parameter. Default: 5 seconds
Logout popout window	Enables a pop-up window with the Logout link for the user to logout after logon. If this is disabled, the user remains logged in until the user timeout period has elapsed or the station reloads. Default: Enabled
Max Authentication failures	Maximum number of authentication failures before the user is blacklisted. Default: 0
Use HTTP for authentication	Use HTTP protocol on redirection to the Captive Portal page. If you use this option, modify the captive portal policy to allow HTTP traffic. Default: disabled (HTTPS is used)
Redirect Pause	Time, in seconds, that the system remains in the initial welcome page before redirecting the user to the final web URL. If set to 0, the welcome page displays until the user clicks on the indicated link. Default: 10 seconds
server group	Name of the group of servers used to authenticate Captive Portal users.
Show FDQN	Allows the user to see and select the fully-qualified domain name (FQDN) on the login page. The FQDNs shown are specified when configuring individual servers for the server group used with captive portal authentication. Default: Disabled
Show Acceptable Use Policy Page	Show the acceptable use policy page before the logon page. Default: Disabled
Allow only one active user session	Allows only one active user session at a time. Default: Disabled

Table 64 *Captive Portal Authentication Profile Parameters (Continued)*

Parameter	Description
Add switch IP address in redirection URL	Sends the controller's IP address in the redirection URL when external captive portal servers are used. An external captive portal server can determine the controller from which a request originated by parsing the 'switchip' variable in the URL. Default: Disabled
Use CHAP (non-standard)	Use CHAP protocol. You should not use this option unless instructed to do so by an Dell representative. Default: Disabled
User Logon	Enables Captive Portal with authentication of user credentials. Default: Enabled
User VLAN Redirection-url	Sends the user's VLAN ID in the redirection URL when external captive portal servers are used.
Welcome Page	URL of the page that appears after logon and before redirection to the web URL. This can be set to any URL. Default: /auth/welcome.html
White List	Name of an existing white list on an IPv4 or IPv6 network destination. The white list contains authenticated websites that a guest can access.

Optional Captive Portal Configurations

The following are optional captive portal configurations:

Per-SSID Captive Portal Page

You can upload custom login pages for captive portal into the controller through the WebUI (refer to Appendix E, "Internal Captive Portal"). The SSID to which the client associates determines the captive portal login page displayed.

You specify the captive portal login page in the captive portal authentication profile, along with other configurable parameters. The initial user role configuration must include the applicable captive portal authentication profile instance. (In the case of captive portal in the base operating system, the initial user role is automatically created when you create the captive portal authentication profile instance.) You then specify the initial user role for captive portal in the AAA profile for the WLAN.

When you have multiple captive portal login pages loaded in the controller, you must configure a unique initial user role and user role, and captive portal authentication profile, AAA profile, SSID profile, and virtual AP profile for each WLAN that will use captive portal. For example, if you want to have different captive portal login pages for the engineering, business and faculty departments, you need to create and configure according to Table 65.

Table 65 *Captive Portal login Pages*

Entity	Engineering	Business	Faculty
Captive portal login page	/auth/eng-login.html	/auth/bus-login.html	/auth/fac-login.html
Captive portal user role	eng-user	bus-user	fac-user

Table 65 *Captive Portal login Pages (Continued)*

Entity	Engineering	Business	Faculty
Captive portal authentication profile	eng-cp (Specify /auth/eng-login.html and eng-user)	bus-cp (Specify /auth/bus-login.html and bus-user)	fac-cp (Specify /auth/bus-login.html and fac-user)
Initial user role	eng-logon (Specify the eng-cp profile)	bus-logon (Specify the bus-cp profile)	fac-logon (Specify the fac-logon profile)
AAA profile	eng-aaa (Specify the eng-logon user role)	bus-aaa (Specify the bus-logon user role)	fac-aaa (Specify the fac-logon user role)
SSID profile	eng-ssid	bus-ssid	fac-ssid
Virtual AP profile	eng-vap	bus-vap	fac-vap

Changing the Protocol to HTTP

By default, the HTTPS protocol is used on redirection to the Captive Portal page. If you need to use HTTP instead, you need to do the following:

- Modify the captive portal authentication profile to enable the HTTP protocol.
- *For captive portal with role-based access only*—Modify the captiveportal policy to permit HTTP traffic instead of HTTPS traffic.

In the base operating system, the implicit ACL captive-portal-profile is automatically modified.

To change the protocol to HTTP via the WebUI:

1. Edit the captive portal authentication profile by navigating to the Configuration > Security > Authentication > L3 Authentication page.
   a. Enable (select) “Use HTTP for authentication”.
   b. Click Apply.
2. (For captive portal with role-based access only) Edit the captiveportal policy by navigating to the Configuration > Security > Access Control > Policies page.
   a. Delete the rule for “user mswitch svc-https dst-nat”.
   b. Add a new rule with the following values and move this rule to the top of the rules list:
      - source is user
      - destination is the mswitch alias
      - service is svc-http
      - action is dst-nat
   c. Click Apply.

To change the protocol to HTTP via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication captive-portal profile
   protocol-http

(For captive portal with role-based access only)
ip access-list session captiveportal
   no user alias mswitch svc-https dst-nat
   user alias mswitch svc-http dst-nat
   user any svc-http dst-nat 8080
   user any svc-https dst-nat 8081
```

Proxy Server Redirect

You can configure captive portal to work with proxy Web servers. When proxy Web servers are used, browser proxy server settings for end users are configured for the proxy server's IP address and TCP port. When the user opens a Web browser, the HTTP/S connection request must be redirected from the proxy server to the captive portal on the controller.

To configure captive portal to work with a proxy server:

- (For captive portal with base operating system) Modify the captive portal authentication profile to specify the proxy server's IP address and TCP port.
- (For captive portal with role-based access) Modify the captiveportal policy to have traffic for the proxy server's port destination NATed to port 8088 on the controller.

The base operating system automatically modifies the implicit ACL *captive-portal-profile*.

The following sections describe how use the WebUI and CLI to configure the captive portal with a proxy server.

NOTE: When HTTPS traffic is redirected from a proxy server to the controller, the user's browser will display a warning that the subject name on the certificate does not match the hostname to which the user is connecting.

To redirect proxy server traffic using the WebUI:

1. For captive portal with Dell base operating system, edit the captive portal authentication profile by navigating to the Configuration > Security > Authentication > L3 Authentication page.
   a. For Proxy Server, enter the IP address and port for the proxy server.
   b. Click Apply.
2. For captive portal with role-based access, edit the captiveportal policy by navigating to the Configuration > Security > Access Control > Policies page.
3. Add a new rule with the following values:
   a. Source is user
   b. Destination is any
   c. Service is TCP
   d. Port is the TCP port on the proxy server
   e. Action is dst-nat
   f. IP address is the IP address of the proxy port
   g. Port is the port on the proxy server
4. Click Add to add the rule. Use the up arrows to move this rule just below the rule that allows HTTP(S) traffic.
5. Click Apply.

To redirect proxy server traffic via the command-line interface, access the CLI in config mode and issue the following commands.

For captive portal with Dell base operating system:

```
aaa authentication captive-portal profile
   proxy host ipaddr port port
```

For captive portal with role-based access:

```
ip access-list session captiveportal
   user alias mswitch svc-https permit
   user any tcp port dst-nat 8088
   user any svc-http dst-nat 8080
```

```
user any svc-https dst-nat 8081
```

Redirecting Clients on Different VLANs

You can redirect wireless clients that are on different VLANs (from the controller's IP address) to the captive portal on the controller. To do this:

1. Specify the redirect address for the captive portal.
2. For captive portal with the PEFNG license only, you need to modify the captiveportal policy that is assigned to the user. To do this:
   a. Create a network destination alias to the controller interface.
   b. Modify the rule set to allow HTTPS to the new alias instead of the mswitch alias.

NOTE: In the base operating system, the implicit ACL *captive-portal-profile* is automatically modified.

This example shows how to use the command-line interface to create a network destination called cp-redirect and use that in the captiveportal policy:

```
ip cp-redirect-address ipaddr
```

For captive portal with PEFNG license:

```
netdestination cp-redirect ipaddr
ip access-list session captiveportal
   user alias cp-redirect svc-https permit
   user any svc-http dst-nat 8080
   user any svc-https dst-nat 8081
```

Web Client Configuration with Proxy Script

If the web client proxy configuration is distributed through a proxy script (a `.pac` file), you need to configure the captiveportal policy to allow the client to download the file. Note that in order modify the captiveportal policy, you must have the PEFNG license installed in the controller.

To allow clients to download proxy script via the WebUI:

1. Edit the captiveportal policy by navigating to the Configuration > Security > Access Control > Policies page.
2. Add a new rule with the following values:
   - Source is user
   - Destination is host
   - Host IP is the IP address of the proxy server
   - Service is svc-https or svc-http
   - Action is permit
3. Click Add to add the rule. Use the up arrows to move this rule above the rules that perform destination NAT.
4. Click Apply.

To allow clients to download proxy script via the command-line interface, access the CLI in config mode and issue the following commands:

```
ip access-list session captiveportal
   user alias mswitch svc-https permit
   user any tcp port dst-nat 8088
   user host ipaddr svc-https permit
   user any svc-http dst-nat 8080
   user any svc-https dst-nat 8081
```

Personalizing the Captive Portal Page

The following can be personalized on the default captive portal page:

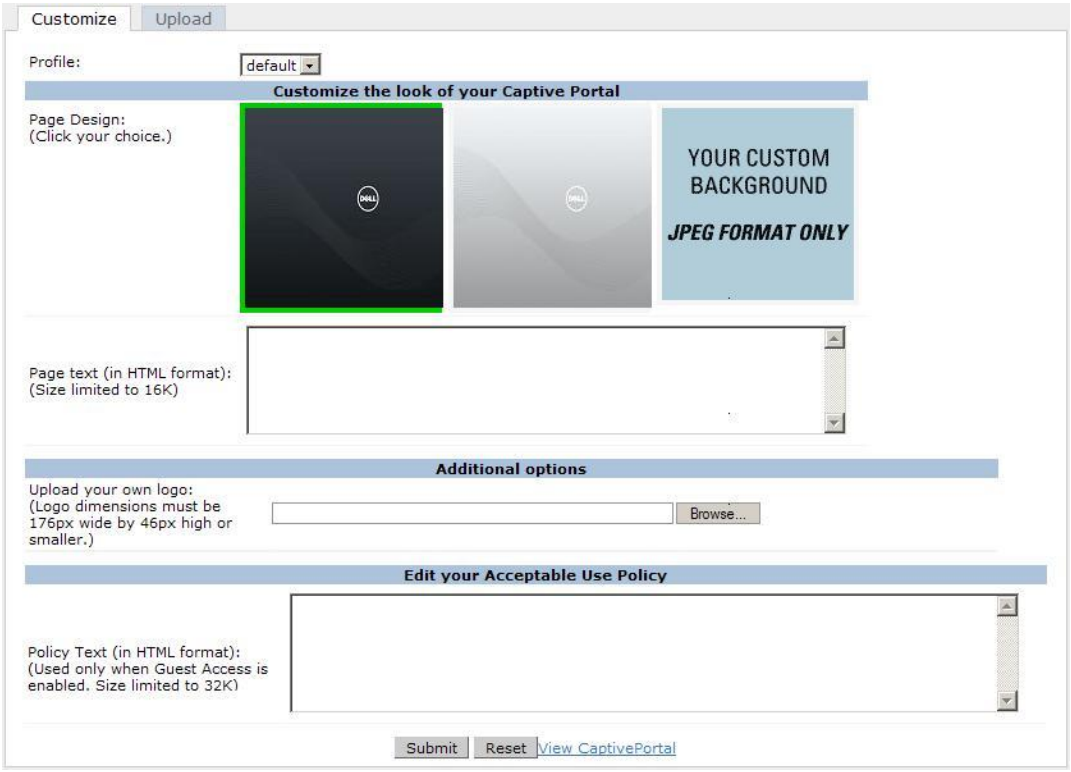
- Captive portal background
- Page text
- Acceptance Use Policy

The background image and text should be visible to users with a browser window on a 1024 by 768 pixel screen. The background should not clash if viewed on a much larger monitor. A good option is to have the background image at 800 by 600 pixels, and set the background color to be compatible. The maximum image size for the background can be around 960 by 720 pixels, as long as the image can be cropped at the bottom and right edges. Leave space on the left side for the login box.

You can create your own web pages and install them in the controller for use with captive portal. See Appendix E, "Internal Captive Portal"

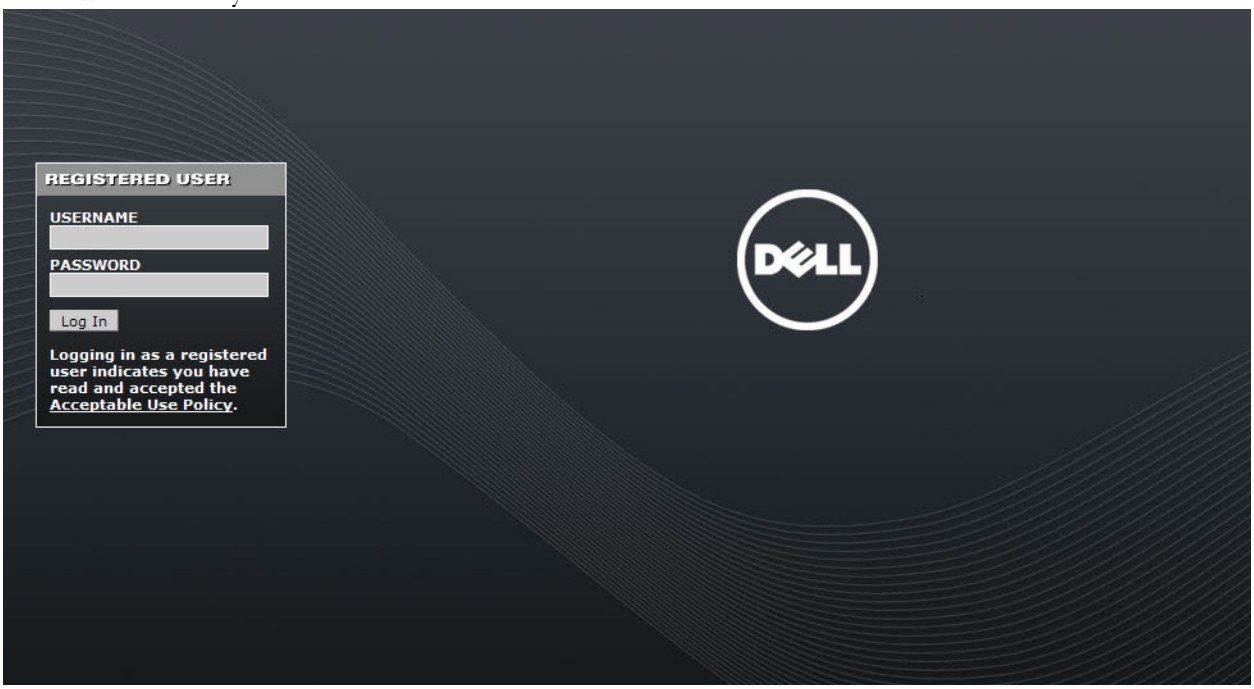
1. Navigate to the Configuration > Management > Captive Portal > Customize Login Page page.

   You can choose one of three page designs. To select an existing design, click the first or the second page design present.



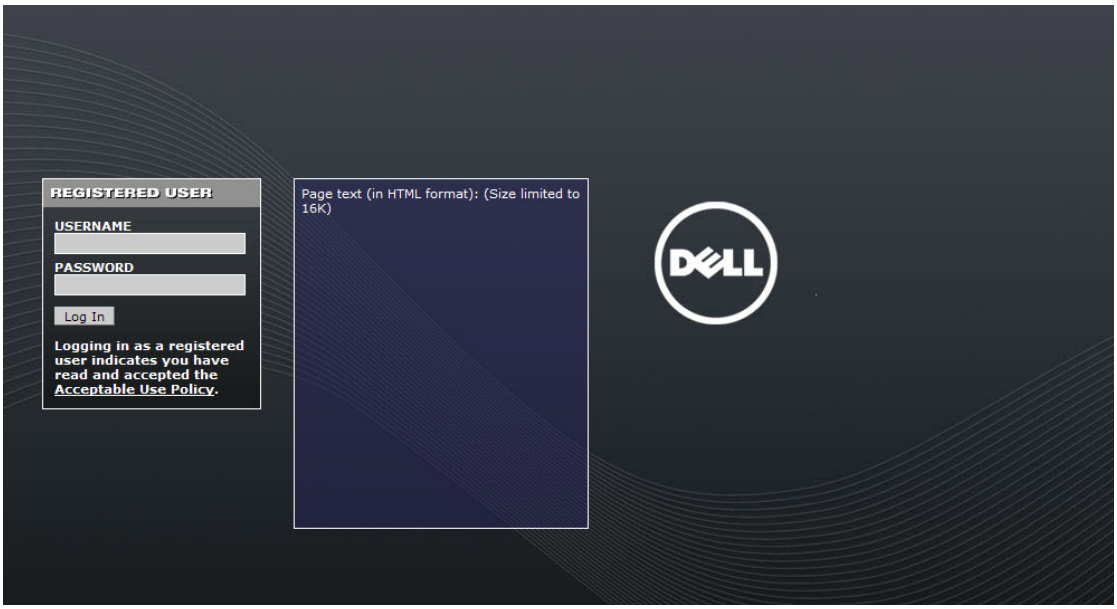
2. To customize the page background:
   a. Select the YOUR CUSTOM BACKGROUND page.
   b. Under Additional options, enter the location of the JPEG image in the Upload your own custom background field.
   c. Set the background color in the Custom page background color field. The color code must a hexadecimal value in the format #hhhhhh.

d. To view the page background changes, click Submit at the bottom on the page and then click the View CaptivePortal link. The User Agreement Policy page appears and displays the Captive Portal page as it will be seen by users.



3. To customize the captive portal background text:
   a. Enter the text that needs to be displayed in the Page Text (in HTML format) message box.
   b. To view the background text changes, click Submit at the bottom on the page and then click the View CaptivePortal link. The User Agreement Policy page appears.
   c. Click Accept. This displays the Captive Portal page as it will be seen by users.
4. To customize the text under the Acceptable Use Policy:
   a. Enter the policy information in the Policy Text text box. Use this only in the case of guest logon.
   b.To view the use policy information changes, click Submit at the bottom on the page and then click the View CaptivePortal link. The User Agreement Policy page appears. The text you entered appears in the Acceptable Use Policy text box.

c.Click Accept. This displays the Captive Portal page as it will be seen by users.



Creating Walled Garden Access

On the Internet, a walled garden typically controls a user's access to web content and services. The walled garden directs the user's navigation within particular areas to allow access to a selection of websites or prevent access to other websites.

NOTE: The Walled Garden feature can be used with the PEFNG or PEFV licenses.

Creating Walled Garden Access

Walled garden access is needed when an external or internal captive portal is used. A common example could be a hotel environment where unauthenticated users are allowed to navigate to a designated login page (for example, a hotel website) and all its contents.

Users who do not sign up for Internet service can view "allowed" websites (typically hotel property websites). The website names must be DNS-based (not IP address based) and support the option to define wildcards. This works for client devices with or without HTTP proxy settings.

When a user attempts to navigate to other websites not configured in the white list walled garden profile, the user is redirected back to the login page. In addition, the black listed walled garden profile is configured to explicitly block navigation to websites from unauthenticated users.

Using the WebUI to create Walled Garden access

1. Navigate to Advanced Services > Stateful Firewall > Destination.
2. Click Add to add a destination name.
3. Select the controller IP version, IPv4 or IPv6, from the IP Version drop-down menu.
4. In the Destination Name field, enter a name and click Add.

5. Select name from the Rule Type drop-down menu and add a hostname or wildcard with domain name to which an unauthenticated user is redirected.
6. Click Apply.
7. Navigate to Configuration > Security > Authentication > L3 Authentication.
8. Select Captive Portal Authentication Profile .
9. To allow users to access a domain, enter the destination name that contains the allowed domain names in the White List field. This stops unauthenticated users from viewing specific domains such as a hotel website.

   A rule in the white list must explicitly permit a traffic session before it is forwarded to the controller. The last rule in the white list denies everything else.
10. To deny users access to a domain, enter the destination name that contains prohibited domain names in the Black List field. This prevents unauthenticated users from viewing specific websites.
11. Click Apply.

Using the CLI to create walled garden access

This example configures a destination named Mywhite-list and adds the domain names, google.com and cnn.com to that destination. It then adds the destination name Mywhite-list (which contains the allowed domain names google.com and cnn.com) to the white list.

```
(host)(config)# netdestination "Mywhite-list"
(host)(config)#name google.com
(host)(config)#name cnn.com

(host) (config) #aaa authentication captive-portal default
(host)(Captive Portal Authentication Profile "default")#white-list Mywhite-list
```

Chapter 16

Advanced Security

Extreme Security (xSec) is a cryptographically secure, Layer-2 tunneling network protocol implemented over the 802.1x protocol. The xSec protocol can be used to secure Layer-2 traffic between the Dell controller and wired and wireless clients, or between Dell controllers.

NOTE: xSec is an optional ArubaOS software module. You must purchase and install the license for the xSec software module on the controller.

This chapter describes the following topics:

xSec encrypts an original Layer-2 data frame inside a Layer-2 xSec frame, the contents of which are defined by the protocol. xSec relies on 256-bit Advanced Encryption Standard (AES) encryption.

Upon 802.1x client authentication, xSec creates a tunnel between the client and the controller. The xSec frame sent over the air or wire between the user and the controller contains user and controller information, as well as original IP and MAC addresses, in encrypted form. All user information is secured using xSec. This concept is also extended to secure management information and data between two controllers on the same VLAN.

For xSec tunneling between a client and controller to work, a version of the Funk Odyssey client software that supports xSec needs to be installed on the client. It is possible to secure clients running Windows 2000 and XP operating systems using xSec and the Odyssey client software..

NOTE: For information about the currently supported release for Funk Odyssey, please contact Juniper Networks.

NOTE: xSec is an optional licensed feature for Dell controllers. xSec is automatically enabled on the controller when you install the license.

xSec provides the following advantages:

- Advanced security as Layer-2 frames are encrypted and tunneled.
- Ease of implementation of advanced encryption in a heterogeneous environment. xSec is designed to support multiple operating systems and a wide range of network interface cards (NICs). All encryption and decryption on the client machine is performed by the Odyssey client while the NICs are configured with NULL encryption. This ensures that even older operating systems that cannot be upgraded to support WPA or WPA2 authentication can be secured using xSec and the Odyssey client.
- Compatible with TLS, TTLS and PEAP.
- Advanced authentication extended to wired clients allowing network managers to secure wired ports.

Securing Client Traffic

You can secure wireless or wired client traffic with xSec. On the client, install the Odyssey Client software. The xSec client must complete 802.1x authentication. to connect to the network. The client indicates the use of the xSec protocol during 802.1x exchanges with the controller. (Dell controllers support 802.1x for both wired and wireless clients.) Upon successful client authentication, an xSec tunnel is established between the controller and the client.

The authenticated client is placed into a configured VLAN, which determines the client's DHCP server, IP address, and Layer-2 connection. For wireless xSec clients, the VLAN is the user VLAN configured for the WLAN. For wired xSec clients and wireless xSec clients that connect to the controller through a non-Dell AP, the VLAN is a designated xSec VLAN. The VLAN can also be derived from configured RADIUS server-derivation rules or from Vendor-Specific Attributes (VSAs). Once an xSec tunnel is established, a DHCP server assigns the xSec client an IP address from the address pool on the VLAN to which the client is assigned. All traffic between the client and the controller is then encrypted.

The following sections describe how to configure xSec on the controller for wireless and wired clients.

Securing Wireless Clients

The following are the basic steps for configuring the controller for xSec wireless clients:

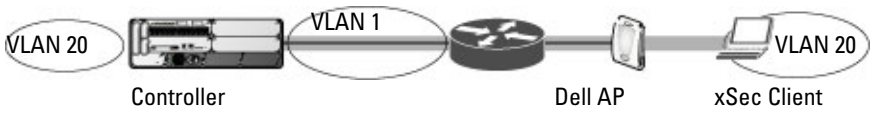
1. Configure the user VLAN to which the authenticated clients will be assigned. See Chapter 2, "Network Parameters" on page 59 for more information.
2. Configure the user role for the authenticated xSec clients. See Chapter 12, "Roles and Policies" for information.
3. Configure the server group that will be used to authenticate clients using 802.1x. See Chapter 9, "Authentication Servers" for more information
4. Configure the AAA profile to specify the 802.1x default user role. Specify the 802.1x authentication server group.

NOTE: You can configure the 802.1x authentication profile if necessary. See Chapter 10, "802.1x Authentication" on page 285 for more information.

5. Configure the virtual AP profile for the WLAN. Specify the previously-configured user VLAN. Only xSec clients will be allowed to connect to the WLAN and non-xSec connections are dropped.
   a. Specify the previously-configured AAA profile.
   b. Configure the SSID profile with xSec as the authentication.
6. Install and set up the Odyssey Client on the wireless client.

Figure 52 is an example network where a wireless xSec client is assigned to the user VLAN 20 and the user role "employee" upon successful 802.1x authentication. VLAN 1 includes the port on the controller that connects to the wired network on which the AP is installed. (APs can connect to the controller across either a Layer-2 or Layer-3 network.)

Figure 52 *Wireless xSec Client Example*



The following sections describe how to use the WebUI or CLI to configure the AAA profile and virtual AP profile for this example. Other chapters in this manual describe the configuration of the user role, VLAN, authentication servers and server group, and 802.1x authentication profile.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > AAA Profiles page.
   a. To create a new AAA profile, click Add in the AAA Profiles Summary.
   b. Enter a name for the profile (for example, xsec-wireless), and click Add.
   c. To configure the AAA profile, click on the newly-created profile name.
   d. For 802.1x Authentication Default Role, select a configured user role (for example, employee).
   e. Click Apply.
   f. In the AAA Profile list, select 802.1x Authentication Profile under the AAA profile you configured. Select the applicable 802.1x authentication profile (for example, xsec-wireless-dot1x). Click Apply.
   g. In the AAA Profile list, select 802.1x Authentication Server Group under the AAA profile you configured. Select the applicable server group (for example, xsec-svrs). Click Apply.
2. Navigate to the Configuration > Wireless > AP Configuration page. Select either the AP Group or AP Specific tab. Click Edit for the applicable AP group name or AP name.
3. Under Profiles, select Wireless LAN, then select Virtual AP.
4. To create a new virtual AP profile, select NEW from the Add a profile drop-down menu. Enter the name for the virtual AP profile (for example, xsec-wireless), and click Add.
   a. In the Profile Details entry for the new virtual AP profile, select the AAA profile you previously configured. A pop-up window displays the configured AAA profile parameters. Click Apply in the pop-up window.
   b. From the SSID profile drop-down menu, select NEW. A pop-up window allows you to configure the SSID profile.
   c. Enter the name for the SSID profile (for example, xsec-wireless).
   d. Enter the Network Name for the SSID (for example, xsec-ap).
   e. For Network Authentication, select xSec.
   f. Click Apply in the pop-up window.
   g. At the bottom of the Profile Details page, click Apply.
5. Click on the new virtual AP name in the Profiles list or in Profile Details to display configuration parameters.
   a. Make sure Virtual AP enable is selected.
   b. For VLAN, enter the ID of the VLAN in which authenticated xSec clients are placed (for example, 20).
   c. Click Apply.

In the CLI

```
aaa profile xsec-wireless
   authentication-dot1x xsec-wireless-dot1x
   dot1x-default-role employee
   dot1x-server-group xsec-svrs
wlan ssid-profile xsec-wireless
   essid xsec-ap
   opmode xSec
wlan virtual-ap xsec-wireless
   vlan 20
   aaa-profile xsec-wireless
   ssid-profile xsec-wireless
```

Securing Wired Clients

The following are the basic steps for configuring the controller for xSec wired clients:

1. Configure the VLAN to which the authenticated clients will be assigned. See Chapter 2, “Network Parameters” on page 59 for information.

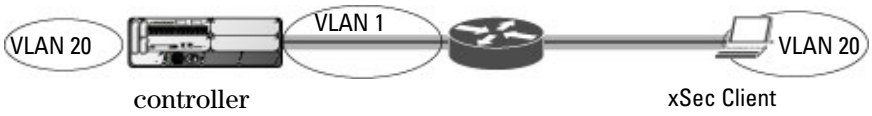
This VLAN must have an IP interface, and is a different VLAN from the port's "native" VLAN that provides connectivity to the network.

2. Configure the user role for the authenticated xSec clients. See Chapter 12, "Roles and Policies" for information.
3. Configure the server group that will be used to authenticate clients using 802.1x. See Chapter 9, "Authentication Servers" for more information.
4. Configure the controller port to which the wired clients) are connected. Specify the VLAN to which the authenticated xSec clients are assigned.

   For firewall rules to be enforced after client authentication, the port must be configured as untrusted.
5. Configure the AAA profile to specify the 802.1x default user role and the 802.1x authentication server group.
6. Configure the wired authentication profile to use the AAA profile.
7. Install and set up the Odyssey Client on the wireless client.

Figure 53 is an example network where a wired xSec client is assigned to the VLAN 20 and the user role "employee" upon successful 802.1x authentication. Traffic between the controller and the xSec client is encrypted.

Figure 53 *Wired xSec Client Example*



The VLAN to which you assign an xSec client must be a different VLAN from the VLAN that contains the controller port to which the wired xSec client or AP is connected.

The following sections describe how to use the WebUI or CLI to configure the controller port to which the wired client is connected, the AAA profile, and the wired authentication profile for this example. Other chapters in this manual describe the configuration of the user role, VLAN, authentication servers and server group, and 802.1x authentication profile.

In the WebUI

1. Navigate to the Configuration > Networks > Ports page to configure the port to which the wired client(s) are connected.
   a. Click the port that you want to configure.
   b. Make sure the Enable Port checkbox is selected.
   c. For Enter VLAN(s), select the native VLAN on the port to ensure Layer-2 connectivity to the network. In Figure 53, this is VLAN 1.
   d. For xSec VLAN, select the VLAN to which authenticated users are assigned from the drop-down menu. In Figure 53, this is VLAN 20.
   e. Click Apply.
2. Navigate to the Configuration > Security > Authentication > AAA Profiles page to configure the AAA profile.
   a. To create a new AAA profile, click Add.
   b. Enter a name for the profile (for example, xsec-wired), and click Add.
   c. To configure the AAA profile, click on the newly-created profile name.
   d. For 802.1x Authentication Default Role, select a configured user role (for example, employee).
   e. Click Apply.

f. In the AAA Profile list, select 802.1x Authentication Profile under the AAA profile you configured. Select the applicable 802.1x authentication profile (for example, xsec-wired-dot1x). Click Apply.

g. In the AAA Profile list, select 802.1x Authentication Server Group under the AAA profile you configured. Select the applicable server group (for example, xsec-svrs). Click Apply.

3. Navigate to the Configuration > Advanced Services > Wired Access page.
   a. Under Wired Access AAA Profile, select the AAA profile you just configured.
   b. Click Apply.

In the CLI

```
interface fastethernet|gigabitethernet slot/port
   switchport access vlan 1
   xsec vlan 20
aaa profile xsec-wired
   authentication-dot1x xsec-wired-dot1x
   dot1x-default-role employee
   dot1x-server-group xsec-svrs
aaa authentication wired
   profile xsec-wired
```

Securing Wireless Clients Through Non-Dell APs

If xSec clients are connecting through a non-Dell AP, you need to configure the controller port to which the AP is connected. The AP must be configured for no (opensystem) authentication.

The following are the basic steps for configuring the controller for xSec wireless clients connecting through a non-Dell AP:

1. Configure the VLAN to which the authenticated clients will be assigned. See Chapter 2, "Network Parameters" on page 59for information.

   This VLAN must have an IP interface, and is a different VLAN from the port's "native" VLAN that provides connectivity to the network.

2. Configure the user role for the authenticated xSec clients. See Chapter 12, "Roles and Policies" for information.
3. Configure the server group that will be used to authenticate clients using 802.1x. See Chapter 9, "Authentication Servers" for more information.
4. Configure the controller port that connects to the wired network on which the non-Dell AP is installed. Specify the VLAN to which the authenticated xSec clients are assigned.

   The ingress and egress ports for xSec client traffic must be different physical ports on the controller.

5. Configure the AAA profile to specify the 802.1x default user role and the 802.1x authentication server group.
6. Configure the wired authentication profile to use the AAA profile.
7. Install and set up the Odyssey Client on the wireless client.

The following sections describe how to use the WebUI or CLI to configure the controller port and AAA and wired authentication profiles for wireless clients connecting with non-Dell APs. Other chapters in this manual describe the configuration of the user role, VLAN, authentication servers and server group, and 802.1x authentication profile.

In the WebUI

1. Navigate to the Configuration > Networks > Ports page to configure the port to which the wireless xSec client(s) are connected.
   a. Click the port that you want to configure.
   b. Make sure the Enable Port checkbox is selected.

c. For Enter VLAN(s), select the native VLAN (for example, VLAN 1) on the port to ensure Layer-2 connectivity to the network.

d. For xSec VLAN, select the VLAN to which authenticated users are assigned from the drop-down menu (for example, VLAN 20)

e. Click Apply.

2. Navigate to the Configuration > Security > Authentication > AAA Profiles page to configure the AAA profile.

a. To create a new AAA profile, click Add.

b. Enter a name for the profile (for example, xsec-3party), and click Add.

c. To configure the AAA profile, click on the newly-created profile name.

d. For 802.1x Authentication Default Role, select a configured user role (for example, employee).

e. Click Apply.

f. In the AAA Profile list, select 802.1x Authentication Profile under the AAA profile you configured. Select the applicable 802.1x authentication profile (for example, xsec-NonDell-dot1x). Click Apply.

g. In the AAA Profile list, select 802.1x Authentication Server Group under the AAA profile you configured. Select the applicable server group (for example, xsec-svrs). Click Apply.

3. Navigate to the Configuration > Advanced Services > Wired Access page.

a. Under Wired Access AAA Profile, select the AAA profile you just configured.

b. Click Apply.

In the CLI

```
interface fastethernet|gigabitethernet slot/port
   switchport access vlan 1
   xsec vlan 20
aaa profile xsec-wired
   authentication-dot1x xsec-NonDell-dot1x
   dot1x-default-role employee
   dot1x-server-group xsec-svrs
aaa authentication wired
   profile xsec-wired
```

Securing Clients on an AP Wired Port

APs with multiple wired Ethernet ports include an wired port profile that can enable or disable the wired port, define an AAA profile for wired port devices, and associate the port with an ethernet link profile that defines its speed and duplex values.

In the WebUI

The procedure to create a new Ethernet port configuration profile depends upon whether or not you want to immediately associate that profile to a specific port on an AP.

1. To configure a new Ethernet port configuration profile without assigning it to a specific port:

a. Navigate to the Configuration > All Profiles page.

b. Expand the AP menu and select AP Wired Port profile.

c. In the Profile Details window, enter a name for the new profile, then click Add.

-or-

To create a new Ethernet port configuration profile for a specific port on an AP or group of APs:

a. Navigate to the Configuration > Wireless > AP Configuration page.

b. Select either the AP Group or AP Specific tab. Click the Edit button by name of the AP group or individual AP you want to configure.

c. In the Profiles list, expand the AP profile menu and select the Ethernet Interface Port Configuration profile for the Ethernet port number you want to configure.

d. In the Profile Details window, click the Ethernet interface port configuration drop-down list and select New.

2. Configure the Ethernet Interface Port/ Wired AP Port Configuration profile parameters described in Table 66.

Table 66 *Ethernet Interface Port/ Wired AP Port Configuration Parameters*

Parameter	Description
`Shut Down`	Disable the wired AP port.
`Remote AP Backup`	Select the Remote AP Backup checkbox to use the wired port on a Remote AP for local connectivity and troubleshooting when the AP cannot reach the controller. If the AP is not connected to the controller, no firewall policies will be applied when this option is enabled. (The AAA profile will only be applied when the AP is connected to controller).
Time to wait for authentication to succeed	Authentication timeout value, in seconds, for devices connecting the AP's wired port. The supported range is 1-65535 seconds, and the default value is 20 seconds.

3. Each Ethernet Interface Port/AP Wired Port Configuration profile is automatically associated to the wired AP profile Default. To assign a new wired AP profile to the AP wired port:

   a. Click the wired AP profile directly under the Ethernet port profile you are editing.

   b. In the Profile Details window, click the Wired AP Profile drop-down list and select a new Wired AP profile.

4. A new AP wired profile is automatically associated to the Ethernet Interface Link profile Default.To assign a new Ethernet Interface Link profile to the AP wired port:

   a. Click the Ethernet Interface Link profile directly under the Ethernet port profile you are editing.

   b. In the Profile Details window, click the Ethernet Interface Link drop-down list and select a new Ethernet Interface Link profile.

5. By default, there is no AAA profile associated with an AP wired port profile. To assign an AAA profile to the AP wired port:

   a. Click the AAA profile directly under the Ethernet port profile you are editing.

   b. In the Profile Details window, click the AAA Profile drop-down list and select an AAA profile.

6. Click Apply to save your settings.

In the CLI

To create a new Ethernet Port/Wired AP Port profile, access the command-line interface in Config mode and issue the following command.

```
ap wired-port-profile <profile>
   aaa-profile <profile>
   authentication-timeout <seconds>
   enet-link-profile <profile>
   rap-backup
   shutdown
   wired-ap-profile <profile>
```

To associate an existing Ethernet Port/Wired AP Port profile to a specific interface on an AP or group of APs, access the command-line interface in Config mode and issue the following command.

```
ap-group <group>
```

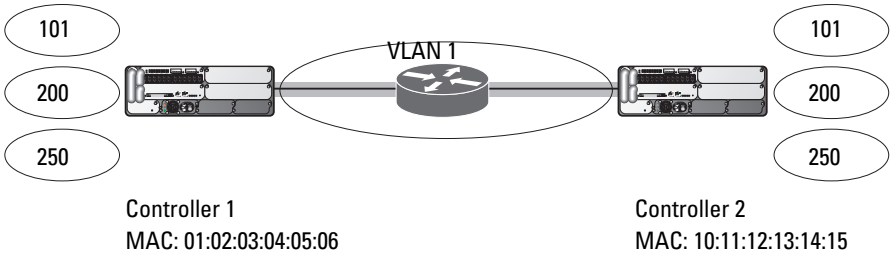
```
enet0-port-profile <profile>
enet1-port-profile <profile>
enet2-port-profile <profile>
enet3-port-profile <profile>
enet4-port-profile <profile>
```

Securing Controller-to-Controller Communication

xSec can be used to secure data and control traffic passed between two controllers. The only requirement is that both controllers be members of the same VLAN. To establish a point-to-point tunnel between the two controllers, you need to configure the following for the connecting ports on each controller:

- The MAC address of the xSec tunnel termination point. This would be the MAC address of the "other" controller.
- A 16-byte shared key used to authenticate the controllers to each other. You must configure the same shared key on both controllers.
- The VLAN IDs for the VLANs that will extend across both the controllers via the xSec. Figure 54 shows an example network where two controllers are connected to the same VLAN, VLAN 1. On controller 1, you configure the MAC address of controller 2 for the xSec tunnel termination point. On controller 2, you configure the MAC address of controller 1 for the xSec tunnel termination point. On both controllers, you configure the same 16-byte shared key and the IDs for the VLANs which are allowed to pass through the xSec tunnel.

Figure 54 *Controller-to-Controller xSec Example*



Configuring Controllers for xSec

The following sections describe how to use the WebUI or CLI to configure the port that connects to the wired network on which the other controller is installed. Other chapters in this manual describe the configuration of VLANs.

In the WebUI

1. On each controller, navigate to the Configuration > Network > Port page.
2. Click on the port to be configured.
3. Select the VLAN from the drop-down list.
4. Configure the xSec point-to-point settings:
   a. Enter the MAC address of the tunnel termination point (the "other" controller's MAC address).
   b. Enter the key (for example, 1234567898765432) used by xSec to establish the tunnel between the controllers.
   c. Select the VLANs that would be allowed across the point-to-point connection from the Allowed VLANs drop-down menu, and click the <-- button.
5. Click Apply.

In the CLI

For Controller 1:

```
interface gigabitethernet|fastethernet slot/port
   vlan 1
   xsec point-to-point 10:11:12:13:14:15 1234567898765432 allowed vlan 101,200,250
```

For Controller 2:

```
interface gigabitethernet|fastethernet slot/port
   vlan 1
   xsec point-to-point 01:02:03:04:05:06 1234567898765432 allowed vlan 101,200,250
```

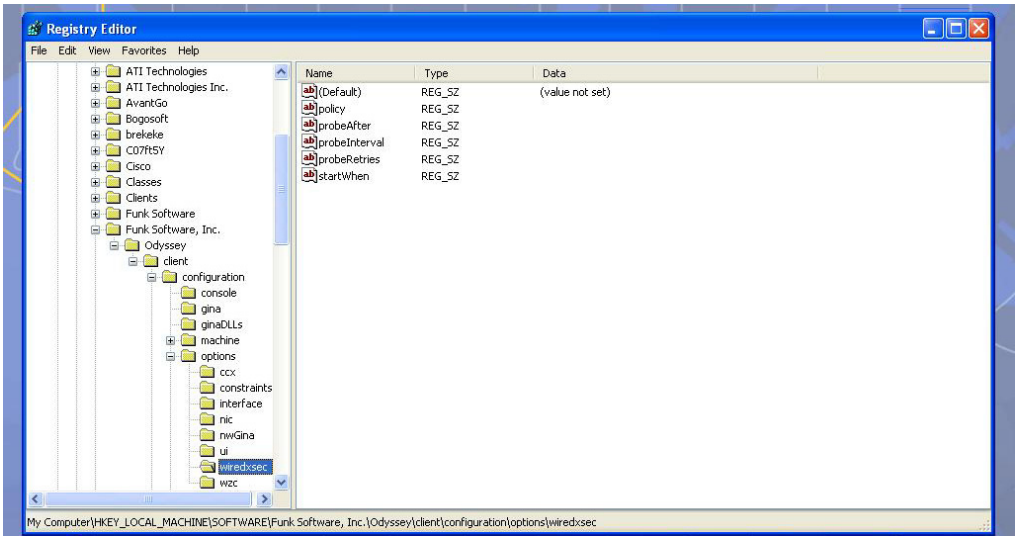
Configuring the Odyssey Client on Client Machines

You can obtain the Odyssey Client from Juniper Networks. For information on Odyssey Client versions, contact Dell or Juniper Networks support.

Installing the Odyssey Client

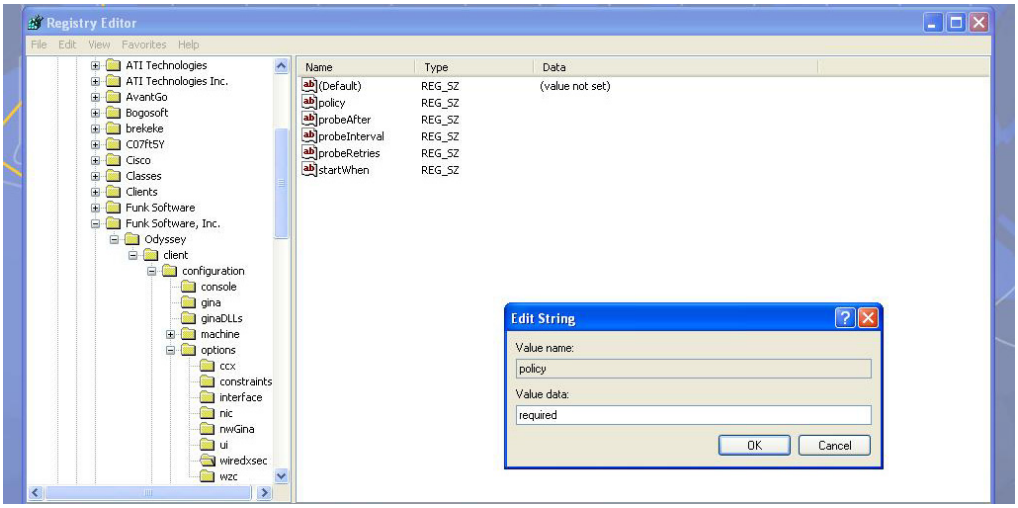
1. Unzip and install the Odyssey client on the client laptop.
2. For wired xSec, to use the Odyssey client to control the wired port, modify the registry:
   a. On the windows machine, click Start and select Run.
   b. Type **`regedit`** in the dialog box and click OK.
   c. Navigate down the tree to `HKEY_LOCAL_MACHINE\SOFTWARE\Funk Software, Inc.\odyssey\client\configuration\options\wiredxsec`.

Figure 55 *The regedit Window*



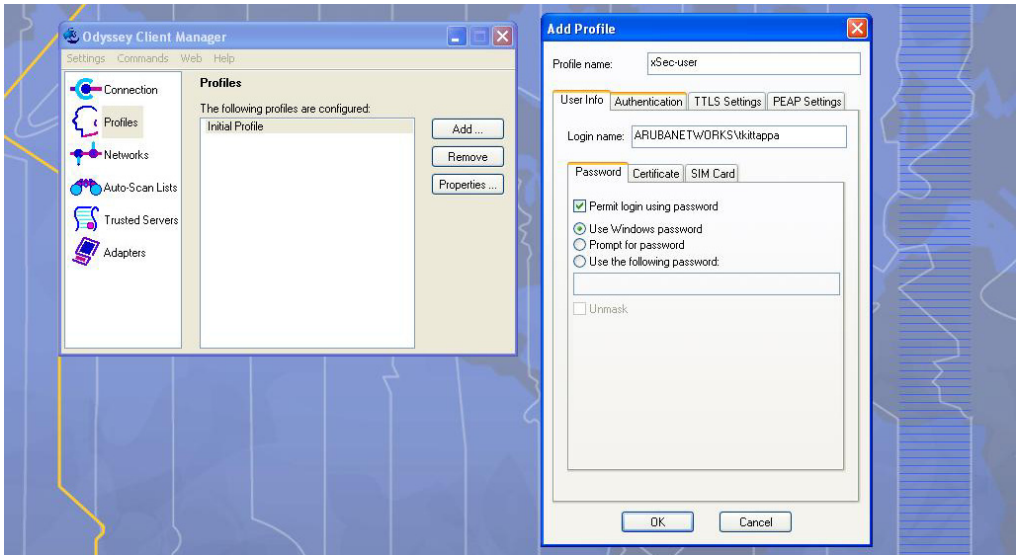
   d. Select “policy” from the registry values and right click on it. Select Modify to modify the contents of policy. Set the value in the resulting window to `required`.

Figure 56 *Modifying a regedit Policy*



3. Open the Funk Odyssey Client. Click the Profile tab in the client window. This allows the user to create the user profile for 802.1x authentication.

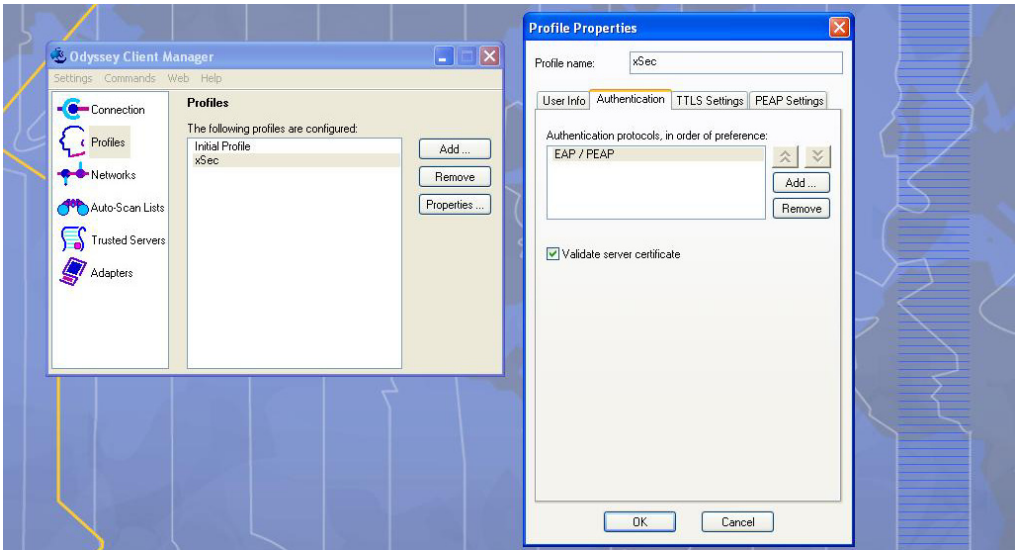
Figure 57 *The Funk Odyssey Client Profile*



a. In the login name dialog box, enter the login name used for 802.1x authentication. For the password, the client could use the WINDOWS password or use the configured password based on the selection made.

b. Click the certificate tab and enter the certificate information required. This example shows the PEAP settings.

Figure 58 *Certificate Information*



c. Click the Authentication tab. In the resultant window, click the Add tab and select EAP/PEAP. Move this option to the top of the list if PEAP is the method chosen. If certification validation not required, uncheck the Validate server certificates setting.

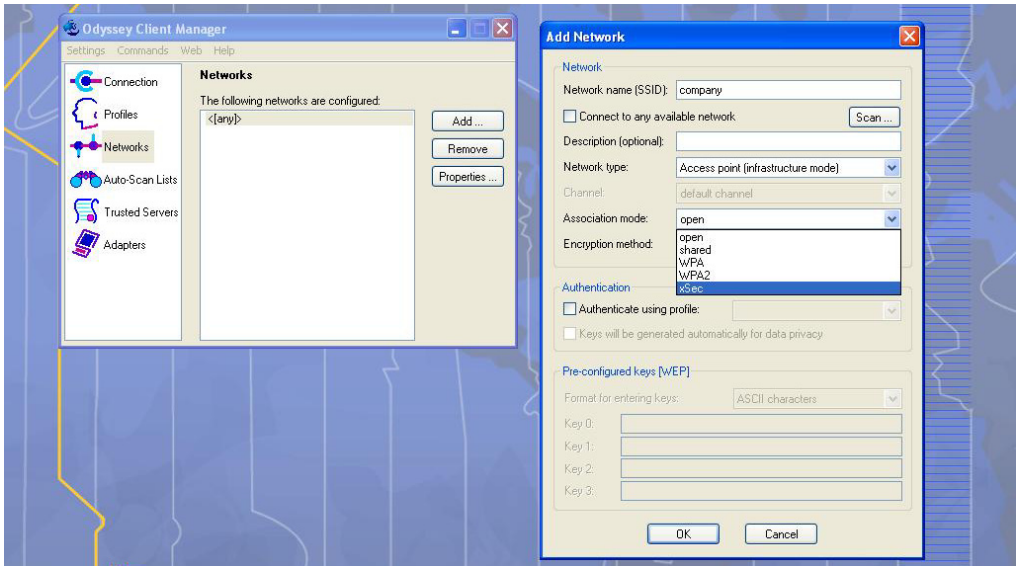
d. Click the PEAP Settings tab and select the EAP protocol supported.

e. Click OK.

f. To modify an existing profile, select the profile and then click the Properties tab.

4. Select the Network tab to configure the network for wireless client. For wired clients, skip this step.

Figure 59 *Network Profile*



a. Click the Add tab. Enter the SSID to which the client connects.

b. Set the Network type to Infrastructure.

c. Set the Association mode to xSec, AES encryption is automatically selected.

d. Under Authentication, select the Authenticate using profile checkbox.

e. From the pull down menu, select the profile used for 802.1x authentication. This would be one of the profiles configured in step 2.

f. Select the keys that will be generated automatically for data privacy.

g. Apply the configuration changes made by clicking on the OK tab.

h. To modify an existing profile, select the profile and then click the Properties tab.

5. Click the Adapters tab if the adapter used is not seen under the list of adapters pull down menu under connections.

   a. When using a wireless client, click the Wireless tab.

   b. Select the Wireless adapters only radio button. From the resulting list, select the adapter required from the list and click OK.

   c. For wired 802.1x clients, select the Wired 802.1x tab and select the Wired adapters only radio button. From the resulting list, select the adapter required from the list and click OK.

6. Establish the connection.

   a. Click the Connection tab.

   b. From the pull down menu, select the adapter required. If the adapter in use is not visible, add the adapter as explained in Step 5.

   c. Select the Connect to network checkbox and select the Network option from the pull down menu. To configure a new network, follow the instructions in Step 4.

   d. This will automatically start the connection process. To reconnect to the network, click Reconnect.

7. Click Scan to display the SSIDs seen by the NIC after a site survey.

Chapter 17

Virtual Private Networks

Wireless networks can use virtual private network (VPN) connections to further secure wireless data from attackers. The Dell controller can be used as a VPN concentrator that terminates all VPN connections from both wired and wireless clients.

This chapter describes the following topics:

Planning a VPN Configuration

You can configure the controller for the following types of VPNs:

- Remote access VPNs allow hosts (for example, telecommuters or traveling employees) to connect to private networks (for example, a corporate network) over the Internet. Each host must run VPN client software which encapsulates and encrypts traffic and sends it to a VPN gateway at the destination network. The controller supports the following remote access VPN protocols:
  - Layer-2 Tunneling Protocol over IPsec (L2TP/IPsec)
  - Point-to-Point Tunneling Protocol (PPTP)
  - XAUTH IKE/IPsec
  - IKEv2 with Certificates
  - IKEv2 with EAP
- Site-to-site VPNs allow networks (for example, a branch office network) to connect to other networks (for example, a corporate network). Unlike a remote access VPN, hosts in a site-to-site VPN do not run VPN client software. All traffic for the other network is sent and received through a VPN gateway which encapsulates and encrypts the traffic.

Before enabling VPN authentication, you must configure the following:

- The default user role for authenticated VPN clients. See Chapter 12, "Roles and Policies" for information about configuring user roles.
- The authentication server group the controller will use to validate the clients. See Chapter 9, "Authentication Servers" for configuration details.

NOTE: A server-derived role, if present, takes precedence over the default user role.

You then specify the default user role and authentication server group in the VPN authentication default profile, as described in the following sections.

Selecting an IKE protocol

Controllers running ArubaOS version 6.1 and later support both IKEv1 and the newer IKEv2 protocol to establish IPsec tunnels. IKEv2 is simpler, faster, and a more reliable protocol than IKEv1, though both IKEv1 and IKEv2 support the same suite-B cryptographic algorithms.

If your IKE policy uses IKEv2, you should be aware of the following caveats when you configure your VPN:

- ArubaOS does not support separate pre-shared keys for both directions of an exchange; the same pre-shared key must be used by both peers. ArubaOS does not support mixed authentication with both pre-shared keys and certificates; each authentication exchange requires a single authentication type. (For example, if a client authenticates with a pre-shared key, the controller must also authenticate with a pre-shared key.)
- ArubaOS does not support IKEv2 mobility (MOBIKE), Authentication Headers (AH) or IP Payload Compression Protocol (IPComp).

Suite-B Encryption Licensing

Dell controllers support Suite-B cryptographic algorithms when the Advanced Cryptography (ACR) license is installed. Table 67 describes the Suite-B algorithms supported by ArubaOS IKE Policies and IPsec tunnels. For further details on configuring a VPN to use Suite-B algorithms, see "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397.

Table 67 *Suite-B Algorithms Supported by the ACR License*

IKE Policies	Suite-B for IPsec tunnels
hash: SHA-256-128, SHA-384-192	Encryption: AES-128-GCM, AES-256-GCM
Diffie-Hellman (DH) Groups : ECP-256, ECP-384	Perfect Forward Secrecy (PFS): ECP-256, ECP-384
Pseudo-Random Function (PRF) : HMAC_SHA_256, HMAC_SHA_384	
Suite-B certificates: ECDSA-256, ECDSA-384	

NOTE: IKE Suite-B AES-128-GCM and AES-256-GCM encryption is supported by the ArubaOS hardware. IKE Suite-B Diffie-Hellman and Certificate-based signature operations and hash, PFS, and PRF algorithm functions are performed by the ArubaOS software.

The following VPN clients support Suite-B algorithms when establishing an L2TP/IPsec VPN.

Table 68 *Client Support for Suite-B*

Client Operating System	Supported Suite-B IKE Authentication	Supported Suite-B IPsec Encryption
• Windows 7 • Windows Vista • Windows XP	• IKEv1 Clients using ECDSA Certificates • IKEv1/IKEv2 Clients using ECDSA Certificates with L2TP/PPP/EAP-TLS certificate user-authentication	• AES-128-GCM • AES-256-GCM

The Suite-B algorithms described in Table 67 are also supported by Site-to-Site VPNs between Dell controllers, or between an Dell controller and a server running Windows 2008 or StrongSwan 4.3.

IKEv2 Clients

Not all clients support the both the IKEv1 and IKEv2 protocols. Only the clients in Table 69 support IKEv2 with the following authentication types:

Table 69 *VPN Clients Supporting IKEv2*

Windows 7 Client	StrongSwan 4.3 Client	VIA Client
• Machine authentication with Certificates • User-name password authentication using EAP-MSCHAPv2 or PEAP-MSCHAPv2 • User smart-card authentication with EAP-TLS / IKEv2 NOTE: Windows 7 clients using IKEv2 do not support pre-shared key authentication.	• Machine authentication with Certificates • User-name password authentication using EAP-MSCHAPv2. • Suite-B cryptographic algorithms	• Machine authentication with Certificates • User-name password authentication using EAP-MSCHAPv2 • EAP-TLS using Microsoft cert repository NOTE: VIA clients using IKEv2 do not support pre-shared key authentication.

Supported VPN AAA Deployments

If you want to simultaneously deploy various combinations of a VPN client, RAP-psk, RAP-certs and CAP on the same controller, see Table 70.

Each row in this table specifies the allowed combinations of AAA servers for simultaneous deployment. Configuration rules include:

- RAP-certs can only use LocalDB-AP
- A RAP-psk and RAP-cert can only terminate on the same controller if the RAP VPN profile's AAA server uses Local-db.
- If a RAP-psk is using an external AAA server, then the RAP-cert cannot be terminated on the same controller.
- Clients can use any type of AAA server, regardless of RAP/CAP authentication configuration server.

Table 70 *Supported VPN AAA Deployments*

VPN Client	RAP psk	RAP certs	CAP
External AAA server 1	LocalDB	LocalDB-AP	CPSEC-whitelist
External AAA server 1	External AAA server 1	Not supported	CPSEC-whitelist
External AAA server 1	External AAA server 2	Not supported	CPSEC-whitelist
LocalDB	LocalDB	LocalDB-AP	CPSEC-whitelist
LocalDB	External AAA server 1	Not supported	CPSEC-whitelist

Certificate Groups

The certificate group feature allows you to access multiple types of certificates on the same controller. To create a certificate group, use the following command:

```
(host) (config) #crypto-local isakmp certificate-group server-certificate
server_certificate ca-certificate ca_certificate
```

You can view existing certificate groups using:

```
show crypto-local isakmp certificate-group
```

VPN Authentication Profiles

VPN Authentication profiles identify a user role for authenticated VPN clients, an authentication server, and the server group to which the authentication server belongs. There are three predefined VPN authentication profiles: default, default-rap and default-cap. These different profiles allow you to use different authentication servers, user roles and IP pools for VPN, remote AP and campus AP clients.

NOTE: The default and default-rap profiles are configurable, but the default-cap profile cannot be edited.

Table 71 *Predefined Authentication Profile settings*

Parameter	default	default-rap	default-cap
Default Role for authenticated users	default-vpn-role	default-vpn-role	sys-ap-role 0
Maximum allowed authentication failures (The number of contiguous authentication failures before the station is blacklisted.)	0 (feature is disabled)	0 (feature is disabled)	0 (feature is disabled)
Check certificate common name against AAA server	disabled	enabled	enabled
Authentication server group	default	default	internal

To edit the default VPN authentication profile:

1. Navigate to the Configuration > Security > Authentication > L3 Authentication page.
2. In the Profiles list in the left window pane, select the default VPN Authentication Profile.
3. Click the Default Role drop-down list and select the default user role for authenticated VPN users. (For detailed information on creating and managing user roles and policies, see "Roles and Policies" on page 321.)
4. (Optional) If you use client certificates for user authentication, select the Check certificate common name against AAA server checkbox to verify that the certificate's common name exists in the server. This parameter is enabled by default in the default-cap and default-rap VPN profiles, and disabled by default on all other VPN profiles.
5. (Optional) Set Max Authentication failures to an integer value (the default value is 0, which disables this feature).
6. Click Apply.
7. In the Default profile menu in the left window pane, select Server Group.
8. From the Server Group drop-down list, select the server group to be used for VPN authentication.
9. Click Apply.

To configure VPN authentication via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication vpn default
   cert-cn-lookup
   clone
   default-role <role>
   max-authentication-failure <number>
   server-group <name>
```

Configuring a Basic VPN for L2TP/IPsec

The combination of Layer-2 Tunneling Protocol and Internet Protocol Security (L2TP/IPsec) is a highly-secure technology that enables VPN connections across public networks such as the Internet. L2TP/IPsec provides both a logical transport mechanism on which to transmit PPP frames as well as tunneling or encapsulation so that the PPP frames can be sent across an IP network. L2TP/IPsec relies on the PPP connection process to perform user authentication and protocol configuration. With L2TP/IPsec, the user authentication process is encrypted using the Data Encryption Standard (DES) or Triple DES (3DES) algorithm.

L2TP/IPsec using IKEv1 requires two levels of authentication:

- Computer-level authentication with a preshared key to create the IPsec security associations (SAs) to protect the L2TP-encapsulated data.
- User-level authentication through a PPP-based authentication protocol using passwords, SecureID, digital certificates, or smart cards after successful creation of the SAs.

NOTE: Only Windows 7 clients, StrongSwan 4.3 clients and VIA clients support IKEv2. For additional information on the authentication types supported by these clients, see "IKEv2 Clients" on page 391.

In the WebUI

Use the following procedures to configure a remote access VPN for L2TP IPsec for clients using pre-shared keys, certificates or EAP for authentication using the WebUI.

Define Authentication Method and Server Addresses

1. First, define the authentication method and server addresses
2. Navigate to Configuration> Advanced Services > VPN Services and click the IPSEC tab.
3. To enable L2TP, select Enable L2TP (this is enabled by default).
4. Select the authentication method for IKEv1 clients. Currently supported methods are:
   - Password Authentication Protocol (PAP)
   - Extensible Authentication Protocol (EAP)
   - Challenge Handshake Authentication Protocol (CHAP)
   - Microsoft Challenge Handshake Authentication Protocol (MSCHAP)
5. Configure the IP addresses of the primary and secondary Domain Name System (DNS) servers and primary and secondary Windows Internet Naming Service (WINS) Server that will be pushed to the VPN client.

Define Address Pools

Next, define the pool from which the clients are assigned addresses.

1. In the Address Pools section of the IPSEC tab, click Add to open the Add Address Pool page.
2. Specify the pool name, the start address, and the end address.

3. Click Done to apply the configuration.

Enable Source NAT

In the Source NAT section of the IPSEC tab, select Enable Source NAT if the IP addresses of clients need to be translated to access the network. If you enabled source NAT, click the NAT pool drop-down list and select an existing NAT pool. If you have not yet created the NAT pool you want to use:

1. Navigate to Configuration > IP > NAT Pools.
2. Click Add.
3. In the Pool Name field, enter a name for the new NAT pool, up to 63 alphanumeric characters.
4. In the Start IP address field, enter the dotted-decimal IP address that defines the beginning of the range of source NAT addresses in the pool.
5. In the End IP address field, enter the dotted-decimal IP address that defines the end of the range of source NAT addresses in the pool.
6. In the Destination NAT IP Address field, enter the destination NAT IP address in dotted-decimal format. If you do not enter an address into this field, the NAT pool uses the destination NAT IP 0.0.0.0.
7. Click Done to close the NAT pools tab
8. Navigate to Configuration > Advanced Services > VPN Services and click the IPsec tab to return to the IPsec window.
9. Click the NAT Pool drop-down list and select the NAT pool you just created.

Select Certificates

If you are configuring a VPN to support machine authentication using certificates, define the IKE Server certificates for VPN clients using IKE. Note that these certificate must be imported into the controller, as described in Chapter 32, “Management Access” on page 571.

1. Select the server certificate for client machines using IKE by clicking the IKE Server Certificate drop-down list and selecting an available certificate name.
2. If you are configuring a VPN to support clients using certificates, you must also assign one or more trusted CA certificates to VPN clients.
   a. Under CA Certificate Assigned for VPN-clients, click Add.
   b. Select a CA certificate from the drop-down list of CA certificates imported in the controller.
   c. Click Done.
   d. Repeat the above steps to add additional CA certificates.

Define IKEv1 Shared Keys

If you are configuring a VPN to support IKEv1 and clients using pre-shared keys, You can configure a global IKE key or configure an IKE key for each subnet. Make sure that this key matches the key on the client.

1. In the IKE Shared Secrets section of the IPSEC tab, click Add to open the Add IKE Secret page.
2. Enter the subnet and subnet mask. To make the IKE key global, specify 0.0.0.0 for both values.
3. Enter the IKE Shared Secret and Verify IKE Shared Secret.
4. Click Done to apply the configurations.

Configure IKE Policies

ArubaOS contains several predefined default IKE policies, as described in Table 72 on page 411. If you do not want to use any of these predefined policies, you can use the procedures below to edit an existing policy or create your own custom IKE policy instead.

NOTE: The IKE policy selections, along with any preshared key, need to be reflected in the VPN client configuration. When using a third-party VPN client, set the VPN configuration on clients to match the choices made above. In case the Dell dialer is used, these configuration need to be made on the dialer prior to downloading the dialer onto the local client

1. Scroll down to the IKE Policies section of the IPSEC tab, then click Edit to edit an existing policy or click Add to create a new policy.
2. Enter a number into the Priority field to set the priority for this policy. Enter a priority to 1 for the configuration to take priority over the Default setting.
3. Select the IKE version. Click the Version drop-down list and select V1 for IKEv1 or V2 for IKEv2.
4. Set the Encryption type. Click the Encryption drop-down list and select one of the following encryption types.
   - DES
   - 3DES
   - AES128
   - AES192
   - AES256
5. Set the HASH function. Click the Hash drop-down list and select one of the following hash types.
   - MD5
   - SHA
   - SHA1-96
   - SHA2-256-128
   - SHA2-384-192
6. ArubaOS VPNs support client authentication using pre-shared keys, RSA digital certificates, or Elliptic Curve Digital Signature Algorithm (ECDSA) certificates. To set the authentication type for the IKE rule, click the Authentication drop-down list and select one of the following types:
   - Pre-Share (for IKEv1 clients using pre-shared keys)
   - RSA (for clients using certificates)
   - ECDSA-256 (for clients using certificates)
   - ECDSA-384 (for clients using certificates)
7. Diffie-Hellman is a key agreement algorithm that allows two parties to agree upon a shared secret, and is used within IKE to securely establish session keys. To set the Diffie Hellman Group for the ISAKMP policy, click the Diffie Hellman Group drop-down list and select one of the following groups:
   - Group 1: 768-bit Diffie Hellman prime modulus group.
   - Group 2: 1024-bit Diffie Hellman prime modulus group.
   - Group 19: 256-bit random Diffie Hellman ECP modulus group.
   - Group 20: 384-bit random Diffie Hellman ECP modulus group.
8. Set the Security Association Lifetime to define the lifetime of the security association, in seconds. The default value is 7200 seconds. To change this value, uncheck the default checkbox and enter a value from 300 to 86400 seconds.
9. Click Done to activate the changes, and return to the previous window

Set the IPsec Dynamic Map

Dynamic maps enable IPsec SA negotiations from dynamically addressed IPsec peers. ArubaOS has a predefined IPsec dynamic map for IKEv1. If you do not want to use this predefined map, you can use the procedures below to edit an existing map or create your own custom IPsec dynamic map instead.

1. Scroll down to the IPsec Dynamic Map section of the IPSEC tab, then click Edit by a map name to edit an existing map or click Add to create a new map.
2. In the Name field, enter a name for the dynamic map
3. In the Priority field, enter a priority number for the map. Negotiation requests for security associations will try to match the highest-priority map first. If that map does not match, the negotiation request will continue down the list to the next-highest priority map until a match is made.
4. Click the Version drop-down list and select V1 to create an IPsec map for remote peers using IKEv1.
5. (Optional) Configure Perfect Forward Secrecy (PFS) settings for the dynamic peer by assigning a Diffie-Hellman prime modulus group. PFS provides an additional level of security by ensuring that the IPsec SA key was not derived from any other key, and therefore can not be compromised if another key is broken. Click the Set PFS drop-down list and select one of the following groups:
   - Group 1: 768-bit Diffie Hellman prime modulus group.
   - Group 2: 1024-bit Diffie Hellman prime modulus group.
   - Group 19: 256-bit random Diffie Hellman ECP modulus group.
   - Group 20: 384-bit random Diffie Hellman ECP modulus group.
6. Select the transform set for the map to define a specific encryption and authentication type used by the dynamic peer. Click the Transform Set drop-down list, and select the transform set for the dynamic peer.

NOTE: To view current configuration settings for an IPsec transform-set, access the command-line interface and issue the command crypto ipsec transform-set tag <transform-set-name>.

7. Set the Security Association Lifetime to define the lifetime of the security association for the dynamic peer, in seconds. The default value is 7200 seconds. To change this value, uncheck the default checkbox and enter a value from 300 to 86400 seconds.
8. Click Done to return to the previous window.

Finalize your WebUI changes

When you have finished configuring your IPsec VPN settings, click Apply to apply the new settings before navigating to other pages.

Configuring a Basic L2TP VPN in the CLI

Use the following procedures to use the command-line interface to configure a remote access VPN for L2TP IPsec.

1. Define the authentication method and server addresses:

```
vpdn group l2tp
   enable
   client configuration {dns|wins} <ipaddr1> [<ipaddr2>]
```

2. Enable authentication methods for IKEv1 clients

```
 vpdn group l2tp ppp authentication {cache-securid|chap|eap|mschap|mschapv2|pap
```

3. Create address pools:

```
ip local pool <pool> <start-ipaddr> <end-ipaddr>
```

4. Configure source NAT

```
ip access-list session srcnat
   user any any src-nat pool <pool> position 1
```

5. If you are configuring a VPN to support machine authentication using certificates, define server certificates for VPN clients using IKEv1.

   For IKEv1*:* `crypto-local isakmp server-certificate <cert>`

6. If you are configuring a VPN to support IKEv1 Clients using pre-shared keys, you can configure a global IKE key by entering 0.0.0.0 for both the address and netmask parameters in the command below, or configure an IKE key for an individual subnet by specifying the IP address and netmask for that subnet.

   ```
   crypto isakmp key <key> address <ipaddr|> netmask <mask>
   ```

7. Define IKE Policies:

   ```
   crypto isakmp policy <priority>
      encryption {3des|aes128|aes192|aes256|des}
      version v1|v2
      authentication {pre-share|rsa-sig|ecdsa-256ecdsa-384}
      group {1|2|19|20}
      hash {md5|sha|sha1-96|sha2-256-128|sha2-384-192}
   lifetime <seconds>
   ```

Configuring a VPN for L2TP/IPsec with IKEv2

Only clients running Windows 7, StrongSwan 4.3 and Dell VIA support IKEv2. For additional information on the authentication types supported by these clients, see "“IKEv2 Clients” on page 391".

In the WebUI

Use the following procedures to use the WebUI configure a remote access VPN for IKEv2 clients using certificates.

Define Authentication Method and Server Addresses

1. First, define the authentication method and server addresses
2. Navigate to Configuration> Advanced Services > VPN Services and click the IPSEC tab.
3. To enable L2TP, select Enable L2TP (this is enabled by default).
4. Select the authentication method for IKEv1 clients. Currently supported methods are:
   - Password Authentication Protocol (PAP)
   - Extensible Authentication Protocol (EAP)
   - Challenge Handshake Authentication Protocol (CHAP)
   - Microsoft Challenge Handshake Authentication Protocol (MSCHAP)
5. Configure the IP addresses of the primary and secondary Domain Name System (DNS) servers and primary and secondary Windows Internet Naming Service (WINS) Server that will be pushed to the VPN client.

Define Address Pools

Next, define the pool from which the clients are assigned addresses.

1. In the Address Pools section of the IPSEC tab, click Add to open the Add Address Pool page.
2. Specify the pool name, the start address, and the end address.
3. Click Done to apply the configuration.

Enable Source NAT

In the Source NAT section of the IPSEC tab, select Enable Source NAT if the IP addresses of clients need to be translated to access the network. If you enabled source NAT, click the NAT pool drop-down list and select an existing NAT pool. If you have not yet created the NAT pool you want to use:

1. Navigate to Configuration > IP > NAT Pools.
2. Click Add.
3. In the Pool Name field, enter a name for the new NAT pool, up to 63 alphanumeric characters.
4. In the Start IP address field, enter the dotted-decimal IP address that defines the beginning of the range of source NAT addresses in the pool.
5. In the End IP address field, enter the dotted-decimal IP address that defines the end of the range of source NAT addresses in the pool.
6. In the Destination NAT IP Address field, enter the destination NAT IP address in dotted-decimal format. If you do not enter an address into this field, the NAT pool will use the destination NAT IP 0.0.0.0.
7. Click Done to close the NAT pools tab
8. Navigate to Configuration > Advanced Services > VPN Services and click the IPsec tab to return to the IPsec window.
9. Click the NAT Pool drop-down list and select the NAT pool you just created.

Select Certificates

To configure the VPN to support machine authentication using certificates, define the IKE Server certificates for VPN clients using IKEv2. Note that these certificate must be imported into the controller, as described in Chapter 32, “Management Access” on page 571.

1. Select the IKEv2 server certificate for client machines using IKEv2 by clicking the IKEv2 Server Certificate drop-down list and selecting an available certificate name.
2. If you are configuring a VPN to support IKEv2 clients using certificates, you must also assign one or more trusted CA certificates to VPN clients.
   a. Under CA Certificate Assigned for VPN-clients, click Add.
   b. Select a CA certificate from the drop-down list of CA certificates imported in the controller.
   c. Click Done.
   d. Repeat the above steps to add additional CA certificates.

Configure IKE Policies

ArubaOS contains several predefined default IKE policies, as described in Table 72. If you do not want to use any of these predefined policies, you can use the procedures below to edit an existing policy or create your own custom IKE policy instead.

NOTE: The IKE policy selections need to be reflected in the VPN client configuration. When using a third-party VPN client, set the VPN configuration on clients to match the choices made above. In case the Dell dialer is used, these configuration need to be made on the dialer prior to downloading the dialer onto the local client

1. Scroll down to the IKE Policies section of the IPSEC tab, then click Edit to edit an existing policy or click Add to create a new policy.

2. Enter a number into the Priority field to set the priority for this policy. Enter a priority to 1 for the configuration to take priority over the Default setting.
3. Select the IKE version. Click the Version drop-down list and select V2 for IKEv2.
4. Set the Encryption type. Click the Encryption drop-down list and select one of the following encryption types.
   - DES
   - 3DES
   - AES128
   - AES192
   - AES256
5. Set the HASH function. Click the Hash drop-down list and select one of the following hash types.
   - MD5
   - SHA
   - SHA1-96
   - SHA2-256-128
   - SHA2-384-192
6. ArubaOS VPNs support IKEv2 client authentication using RSA digital certificates, or Elliptic Curve Digital Signature Algorithm (ECDSA) certificates. To set the authentication type for the IKE rule, click the Authentication drop-down list and select one of the following types:
   - RSA
   - ECDSA-256
   - ECDSA-384
7. Diffie-Hellman is a key agreement algorithm that allows two parties to agree upon a shared secret, and is used within IKE to securely establish session keys. To set the Diffie Hellman Group for the ISAKMP policy, click the Diffie Hellman Group drop-down list and select one of the following groups:
   - Group 1: 768-bit Diffie Hellman prime modulus group.
   - Group 2: 1024-bit Diffie Hellman prime modulus group.
   - Group 19: 256-bit random Diffie Hellman ECP modulus group.
   - Group 20: 384-bit random Diffie Hellman ECP modulus group.
8. Set the Pseudo-Random Function (PRF) value. This algorithm is an HMAC function to used to hash certain values during the key exchange.
   - PRF-HMAC-MD5
   - PRF-HMAC-SHA1
   - PRF-HMAC-SHA256
   - PRF-HMAC-SHA384
9. Set the Security Association Lifetime to define the lifetime of the security association, in seconds. The default value is 7200 seconds. To change this value, uncheck the default checkbox and enter a value from 300 to 86400 seconds.
10. Click Done to activate the changes, and return to the previous window

Set the IPsec Dynamic Map

Dynamic maps enable IPsec SA negotiations from dynamically addressed IPsec peers. ArubaOS has a predefined IPsec dynamic maps for IKEv2. If you do not want to use of these predefined maps, you can use the procedures below to edit an existing map or create your own custom IPsec dynamic map instead.

1. Scroll down to the IPsec Dynamic Map section of the IPSEC tab, then click Edit by a map name to edit an existing map or click Add to create a new map.
2. In the Name field, enter a name for the dynamic map
3. In the Priority field, enter a priority number for the map. Negotiation requests for security associations will try to match the highest-priority map first. If that map does not match, the negotiation request will continue down the list to the next-highest priority map until a match is made.
4. Click the Version drop-down list and select v2 to create a map for remote peers using IKEv2.
5. (Optional) Configure Perfect Forward Secrecy (PFS) settings for the dynamic peer by assigning a Diffie-Hellman prime modulus group. PFS provides an additional level of security by ensuring that the IPsec SA key was not derived from any other key, and therefore can not be compromised if another key is broken. Click the Set PFS drop-down list and select one of the following groups:
   - Group 1: 768-bit Diffie Hellman prime modulus group.
   - Group 2: 1024-bit Diffie Hellman prime modulus group.
   - Group 19: 256-bit random Diffie Hellman ECP modulus group.
   - Group 20: 384-bit random Diffie Hellman ECP modulus group.
6. Select the transform set for the map to define a specific encryption and authentication type used by the dynamic peer. Click the Transform Set drop-down list, and select the transform set for the dynamic peer.

NOTE: To view current configuration settings for an IPsec transform-set, access the command-line interface and issue the command crypto ipsec transform-set tag <transform-set-name>.

7. Set the Security Association Lifetime to define the lifetime of the security association for the dynamic peer, in seconds. The default value is 7200 seconds. To change this value, uncheck the default checkbox and enter a value from 300 to 86400 seconds.
8. Click Done to return to the previous window.

Finalize your WebUI changes

When you have finished configuring your IPsec VPN settings, click Apply to apply the new settings before navigating to other pages.

In the CLI

Use the following procedures to use the command-line interface to configure a remote access VPN for L2TP IPsec using IKEv2.

1. Define the server addresses:

```
vpdn group l2tp
   enable
   client configuration {dns|wins} <ipaddr1> [<ipaddr2>]
```

2. Enable authentication methods for IKEv2 clients:

```
crypto isakmp eap-passthrough {eap-mschapv2|eap-peap|eap-tls}
```

3. Create address pools:

```
ip local pool <pool> <start-ipaddr> <end-ipaddr>
```

4. Configure source NAT

```
ip access-list session srcnat
   user any any src-nat pool <pool> position 1
```

5. If you are configuring a VPN to support machine authentication using certificates, define server certificates for VPN clients using IKEv2.

```
crypto-local isakmp server-certificate <cert>
```

6. Define IKEv2 Policies:

```
crypto isakmp policy <priority>
   encryption {3des|aes128|aes192|aes256|des}
   version v2
   authentication {pre-share|rsa-sig|ecdsa-256ecdsa-384}
   group {1|2|19|20}
   hash {md5|sha|sha1-96|sha2-256-128|sha2-384-192}
   prf PRF-HMAC-MD5|PRF-HMAC-SHA1|PRF-HMAC-SHA256|PRF-HMAC-SHA384
   lifetime <seconds>
```

7. Define IPsec Tunnel parameters

```
crypto ipsec
   mtu <max-mtu>
   transform-set <transform-set-name> esp-3des|esp-aes128|esp-aes128-gcm|esp-
   aes192|esp-aes256|esp-aes256-gcm|esp-des esp-md5-hmac|esp-null-mac|esp-sha-hmac
```

Configuring a VPN for Smart Card Clients

This section describes how to configure a remote access VPN on the controller for Microsoft L2TP/IPsec clients with smart cards. (A smart card contains a digital certificate which allows user-level authentication without the user entering a username and password.) As described previously in this chapter, L2TP/IPsec requires two levels of authentication: first, IKE SA (machine) authentication, and then user-level authentication with an IKEv2 or PPP-based authentication protocol.

Microsoft clients running Windows 7 (or later versions) support both IKEv1 and IKEv2. Microsoft clients using IKEv2 support machine authentication using RSA certificates (but not ECDSA certificates or pre-shared keys) and smart card user-level authentication with EAP-TLS over IKEv2.

NOTE: Windows 7 clients without smart cards also support user password authentication using EAP-MSCHAPv2 or PEAP-MSCHAPv2.

Smart Card clients using IKEv2

To configure a VPN for Windows 7 clients using smart cards and IKEv2, follow the procedure described in "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397, and ensure that the following settings are configured

- L2TP is enabled.
- User Authentication is set to EAP-TLS.
- IKE version is set to V2
- The IKE policy is configured for ECDSA or RSA certificate authentication.

Smart Card Clients using IKEv1

Microsoft clients using IKEv1 (including clients running Windows Vista or earlier versions of Windows) only support machine authentication using a pre-shared key. In this scenario, user-level authentication is performed by an external RADIUS server using PPP EAP-TLS and client and server certificates are mutually authenticated during the EAP-TLS exchange. During the authentication, the controller encapsulates EAP-TLS messages from the client into RADIUS messages and forwards them to the server.

On the controller, you need to configure the L2TP/IPsec VPN with EAP as the PPP authentication and IKE policy for preshared key authentication of the SA.

NOTE: On the RADIUS server, you must configure a remote access policy to allow EAP authentication for smart card users and select a server certificate. The user entry in Microsoft Active Directory must be configured for smart cards.

To configure a L2TP/IPsec VPN for clients using smart cards and IKEv1, ensure that the following settings are configured:

8. On a RADIUS server, you must configure a remote access policy to allow EAP authentication for smart card users and select a server certificate. The user entry in Microsoft Active Directory must be configured for smart cards. (For detailed information on creating and managing user roles and policies, see "Roles and Policies" on page 321.)

- Ensure that RADIUS server is part of the server group used for VPN authentication.
- Configure other VPN settings as described in "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397, while selecting the following options:
  - Select Enable L2TP
  - Select EAP for the Authentication Protocol.
  - Define an IKE Shared Secret to be used for machine authentication. (To make the IKE key global, specify 0.0.0.0 and 0.0.0.0 for both subnet and subnet mask).
  - Configure the IKE policy for Pre-Share authentication.

Configuring a VPN for Clients with User Passwords

This section describes how to configure a remote access VPN on the controller for L2TP/IPsec clients with user passwords. As described previously in this section, L2TP/IPsec requires two levels of authentication: first, IKE SA authentication, and then user-level authentication with the PAP authentication protocol. IKE SA is authenticated with a preshared key, which you must configure as an IKE shared secret on the controller. User-level authentication is performed by the controller's internal database.

On the controller, you need to configure the following:

- AAA database entries for username and passwords
- VPN authentication profile which defines the internal server group and the default role assigned to authenticated clients
- L2TP/IPsec VPN with PAP as the PPP authentication (IKEv1 only).
- (For IKEv1 clients) An IKE policy for preshared key authentication of the SA.
- (For IKEv2 clients) A server certificate to authenticate the controller to clients and a CA certificate to authenticate VPN clients.

In the WebUI

Use the following procedure the configure L2TP/IPsec VPN for username/password clients via the WebUI:

1. Navigate to the Configuration > Security > Authentication > Servers window.
   a. Select Internal DB to display entries for the internal database.
   b. Click Add User.
   c. Enter username and password information for the client.
   d. Click Enabled to activate this entry on creation.
   e. Click Apply.

2. Navigate to the Configuration > Security > Authentication > L3 Authentication window.
   a. Under default VPN Authentication Profile, select Server Group.
   b. Select the internal server group from the drop-down menu.
   c. Click Apply.
3. Navigate to the Configuration > Advanced Services > VPN Services > IPsec window.
   a. Select Enable L2TP (this is enabled by default).
   b. Select PAP for Authentication Protocols.
4. Configure other VPN settings as described in "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397, while ensuring that the following settings are selected:
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable L2TP.
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, select PAP as the authentication protocol.

In the CLI

The following example uses the command-line interface to configure a L2TP/IPsec VPN for username/password clients using IKEv1.

```
vpdn group l2tp
   enable
   ppp authentication pap
   client dns 101.1.1.245

ip local pool pw-clients 10.1.1.1 10.1.1.250

crypto isakmp key <key> address 0.0.0.0 netmask 0.0.00

crypto isakmp policy 1
   authentication pre-share
```

Next, issue the following command in *enable* mode to configure client entries in the internal database:

```
local-userdb add username <name> password <password>
```

Configuring Remote Access VPNs for XAuth

Extended Authentication (XAuth) is an Internet Draft that allows user authentication after IKE Phase 1 authentication. This authentication prompts the user for a username and password, with user credentials authenticated with an external RADIUS or LDAP server or the controller's internal database. Alternatively, the user can start the client authentication with a smart card which contains a digital certificate to verify the client credentials. IKE Phase 1 authentication can be done with either an IKE preshared key or digital certificates.

Configuring VPNs for XAuth Clients using Smart Cards

This section describes how to configure a remote access VPN on the controller for Cisco VPN XAuth clients using smart cards. (A smart card contains a digital certificate which allows user-level authentication without the user entering a username and password.) IKE Phase 1 authentication can be done with either an IKE preshared key or digital certificates; for XAuth clients using smart cards, the smart card digital certificates must be used for IKE authentication. The client is authenticated with the internal database on the controller.

On the controller, you need to configure the following:

1. Add entries for Cisco VPN XAuth clients to the controller's internal database, or to an external RADIUS or LDAP server. For details on configuring an authentication server, see "Authentication Servers" on page 263

NOTE: For each client, you need to create an entry in the internal database with the entire Principal name (SubjectAltname in X.509 certificates) or Common Name as it appears on the certificate.

2. Verify that the server with the client data is part of the server group associated with the VPN authentication profile.
3. In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable L2TP.
4. In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable XAuth to enable prompting for the username and password.
5. The Phase 1 IKE exchange for XAuth clients can be either Main Mode or Aggressive Mode. Aggressive Mode condenses the IKE SA negotiations into three packets (versus six packets for Main Mode). In the Aggressive Mode section of the Configuration>VPN Services>IPsec tab, Enter the authentication group name for aggressive mode to associate this setting to multiple clients. Make sure that the group name matches the aggressive mode group name configured in the VPN client software.
6. Configure other VPN settings as described in "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397, while ensuring that the following settings are selected
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable L2TP.
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable XAuth to enable prompting for the username and password.
   - Define an IKE policy to use RSA or ECDSA authentication.

The following example describes the steps to use the command-line interface to configure a VPN for Cisco Smart Card Clients using certificate authentication and IKEv1, where the client is authenticated against user entries added to the internal database:

```
aaa authentication vpn default
   server-group internal

no crypto-local isakmp xauth

vpdn group l2tp
   enable
   client dns 101.1.1.245

ip local pool sc-clients 10.1.1.1 10.1.1.250

crypto-local isakmp server-certificate MyServerCert
crypto-local isakmp ca-certificate TrustedCA

crypto isakmp policy 1
   authentication rsa-sig
```

Enter the following command in enable mode to configure client entries in the internal database:

```
local-userdb add username <name> password <password>
```

Configuring a VPN for XAuth Clients Using a Username/Password

This section describes how to configure a remote access VPN on the controller for Cisco VPN XAuth clients using passwords. IKE Phase 1 authentication is done with an IKE preshared key; the user is then prompted to enter their username and password which is verified with the internal database on the controller.

On the controller, you need to configure the following:

1. Add entries for Cisco VPN XAuth clients to the controller's internal database, For details on configuring an authentication server, see "Authentication Servers" on page 263

NOTE: For each client, you need to create an entry in the internal database with the entire Principal name (SubjectAltname in X.509 certificates) or Common Name as it appears on the certificate.

2. Verify that the server with the client data is part of the server group associated with the VPN authentication profile.
3. Configure other VPN settings as described in "Configuring a VPN for L2TP/IPsec with IKEv2" on page 397, while ensuring that the following settings are selected:
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable L2TP.
   - In the L2TP and XAUTH Parameters section of the Configuration>VPN Services>IPsec tab, enable XAuth to enable prompting for the username and password.
   - The IKE policy must have pre-shared authentication.

The following example configures a VPN for XAuth IKEv1 clients using a username and passwords. Access the command-line interface and issue the following commands in config mode:

```
aaa authentication vpn default
   server-group internal

crypto-local isakmp xauth

vpdn group l2tp
   enable
   client dns 101.1.1.245

ip local pool pw-clients 10.1.1.1 10.1.1.250

crypto isakmp key 0987654 address 0.0.0.0 netmask 0.0.00

crypto isakmp policy 1
   authentication pre-share
```

Enter the following command in enable mode to configure client entries in the internal database:

```
local-userdb add username <name> password <password>
```

Remote Access VPNs for PPTP

Point-to-Point Tunneling Protocol (PPTP) is an alternative to L2TP/IPsec. Like L2TP/IPsec, PPTP provides a logical transport mechanism to send PPP frames as well as tunneling or encapsulation so that the PPP frames can be sent across an IP network. PPTP relies on the PPP connection process to perform user authentication and protocol configuration.

With PPTP, data encryption begins after PPP authentication and connection process is completed. PPTP connections use Microsoft Point-to-Point Encryption (MPPE), which uses the Rivest-Shamir-Aldeman (RSA) RC-4 encryption algorithm. PPTP connections require user-level authentication through a PPP-based authentication protocol (MSCHAPv2 is the currently-supported method).

In the WebUI

1. Navigate to the Configuration > Advanced Services > VPN Services > PPTP page.

2. To enable PPTP, select Enable PPTP.
3. Select either MSCHAP or MSCHAPv2 as the authentication protocol.
4. Configure IP addresses of the primary and secondary DNS servers.
5. Configure primary and secondary WINS Server IP addresses that will be pushed to the VPN Dialer.
6. Configure the VPN Address Pool.
   a. Click Add. The Add Address Pool window displays.
   b. Specify the pool name, start address, and end address.
   c. Click Done on completion to apply the configuration.
7. Click Apply to apply the changes made before navigating to other pages.

In the CLI

```
vpdn group pptp
   enable
   client configuration {dns|wins} <ipaddr1> [<ipaddr2>]
   ppp authentication {mschapv2}
pptp ip local pool <pool> <start-ipaddr> <end-ipaddr>
```

Site-to-Site VPNs

Site-to-site VPN allows sites at different physical locations to securely communicate with each other over a Layer-3 network such as the Internet. You can use Dell controllers instead of VPN concentrators to connect the sites. Or, you can use a VPN concentrator at one site and a controller at the other site.

The Dell controller supports the following IKE SA authentication methods for site-to-site VPNs:

- Preshared key: Note that the same IKE shared secret must be configured on both the local and remote sites.
- Suite-B cryptographic algorithms
- Digital certificates: You can configure a RSA or ECDSA server certificate and a CA certificate for each site-to-site VPN IPsec map configuration. If you are using certificate-based authentication, the peer must be identified by its certificate subject-name distinguished name (for deployments using IKEv2) or by the peer's IP address (for IKEv1). For more information about importing server and CA certificates into the controller, see Chapter 32, "Management Access" on page 571.

NOTE: Certificate-based authentication is only supported for site-to-site VPN between two controllers with static IP addresses.

Third-Party Devices

Dell controllers can use IKEv1 or IKEv2 to establish a site-to-site VPN between another Dell controller or between that controller and third-party device. Note, however, that only Dell controllers and devices running Windows 2008 Server or Strongswan 4.3 support IKEv2 authentication.

Devices running Windows 2008 server can use Suite-B cryptographic algorithms and IKEv1 to support authentication using RSA or ECDSA. Strongswan 4.3 devices can use IKEv2 to support authentication using RSA or ECDSA certificates, Suite-B cryptographic algorithms, and pre-shared keys.

Site-to-Site VPNs with Dynamic IP Addresses

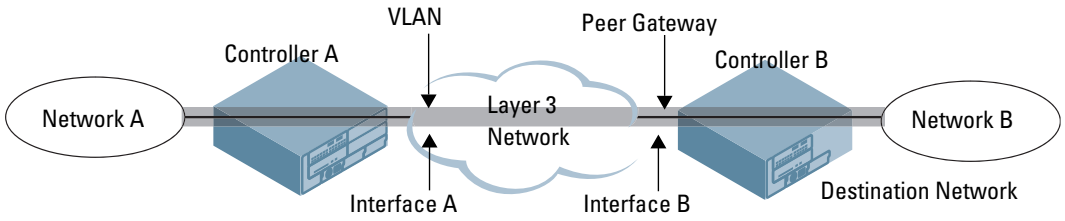
ArubaOS supports site-to-site VPNs with two statically addressed controllers, or with one static and one dynamically addressed controller. By default, site-to-site VPN uses IKE Main-mode with Pre-Shared-Keys to authenticate the IKE SA. This method uses the IP address of the peer, and therefore will not work for dynamically addressed peers.

To support site-site VPN with dynamically addressed devices, you must enable IKE Aggressive-Mode with Authentication based on a Pre-Shared-Key. The Dell controller with a dynamic IP address must be configured to be the *initiator* of IKE Aggressive-mode for Site-Site VPN, while the controller with a static IP address must be configured as the *responder* of IKE Aggressive-mode.

VPN Topologies

You must configure VPN settings on the controllers at both the local and remote sites. In the following figure, a VPN tunnel connects Network A to Network B across the Internet.

Figure 60 *Site-to-Site VPN Configuration Components*



To configure the VPN tunnel on controller A, you need to configure the following:

- The source network (Network A)
- The destination network (Network B)
- The VLAN on which the controller A's interface to the Layer-3 network is located (Interface A in the Figure 60)
- The peer gateway, which is the IP address of controller B's interface to the Layer-3 network (Interface B in the Figure 60)

NOTE: Configure VPN settings on the controllers at both the local and remote sites.

Configuring Site-to-Site VPNs

Use the following procedures to create a site-to-site VPN via the WebUI or command-line interfaces.

In the WebUI

1. Navigate to the Configuration > Advanced Services > VPN Services > Site-to-Site page.
2. In the IPsec Maps section, click Add to open the Add IPsec Map window.
3. Enter a name for this VPN connection in the Name field.
4. Enter a priority level for the IPsec map. Negotiation requests for security associations will try to match the highest-priority map first. If that map does not match, the negotiation request will continue down the list to the next-highest priority map until a match is made.
5. In the Source Network and Source Subnet Mask fields, enter the IP address and netmask for the source (the local network connected to the controller). (See controller A in Figure 60.)
6. In the Destination Network and Destination Subnet Mask fields, enter the IP address and netmask for the destination (the remote network to which the local network will communicate). (See controller B in Figure 60.)
7. If you are using IKEv1 to establish a site-to-site VPN to a statically addressed remote peer, in the Peer Gateway field, enter the IP address of the interface used by remote peer to connect to the L3 network. (See Interface B in Figure 60.) If you are configuring an IPsec map for a dynamically addressed remote peer, you must leave the peer gateway set to its default value of 0.0.0.0.

8. If you are using IKEv2 to establish a site-to-site VPN to a statically addressed remote peer, identify the peer device by entering its certificate subject name in the Peer Certificate Subject Name field.

NOTE: To identify the subject name of a peer certificate, access the command-line interface and issue the command show crypto-local pki servercert <certname> subject

9. The Security Association Lifetime parameter defines the lifetime of the security association, in seconds. The default value is 7200 seconds. To change this value, uncheck the default checkbox and enter a value from 300 to 86400 seconds.
10. Click the Version drop-down list and select V1 to configure the VPN for IKEv1, or V2 for IKEv2.
11. Select the VLAN that contains the interface of the local controller which connects to the Layer-3 network. (See Interface A in Figure 60.)

    This determines the source IP address used to initiate IKE. If you select 0 or None, the default is the VLAN of the controller's IP address (either the VLAN where the loopback IP is configured or VLAN 1 if no loopback IP is configured).
12. If you enable Perfect Forward Secrecy (PFS) mode, new session keys are not derived from previously used session keys. Therefore, if a key is compromised, that compromised key will not affect any previous session keys. PFS mode is disabled by default. To enable this feature, click the PFS drop-down list and select one of the following Perfect Forward Secrecy modes:
    - group1: 768-bit Diffie Hellman prime modulus group.
    - group2: 1024-bit Diffie Hellman prime modulus group.
    - group19: 256-bit random Diffie Hellman ECP modulus group.
    - group20: 384-bit random Diffie Hellman ECP modulus group.
13. Select Pre-Connect to have the VPN connection established even if there is no traffic being sent from the local network. If this is not selected, the VPN connection is only established when traffic is sent from the local network to the remote network.
14. Select Trusted Tunnel if traffic between the networks is trusted. If this is not selected, traffic between the networks is untrusted.
15. Select the Enforce NATT checkbox to always enforce UDP 4500 for IKE and IPSEC. This option is disabled by default.
16. Add one or more transform sets to be used by the IPsec map. Click the Transform Set drop down list, select an existing transform set, then click the arrow button by the drop-down list to add that transform set to the IPsec map.
17. For site-to-site VPNs with dynamically addressed peers, click the Dynamically Addressed Peers checkbox.
    a. Select Initiator if the dynamically addressed switch is the *initiator* of IKE Aggressive-mode for Site-Site VPN, or select Responder if the dynamically addressed switch is the *responder* for IKE Aggressive-mode.
    b. In the FQDN field, enter a fully qualified domain name (FQDN) for the controller. If the controller is defined as a dynamically addressed responder, you can select all peers to make the controller a responder for all VPN peers, or select Per Peer ID and specify the FQDN to make the controller a responder for one specific initiator only.
18. Select an authentication type. For pre-shared key authentication, select Pre-Shared Key, then enter a shared secret in the IKE Shared Secret and Verify IKE Shared Secret fields. This authentication type is required in IPsec maps for a VPN with a dynamically addressed peer.

    -or-

    For certificate authentication, select Certificate, then click the Server Certificate and CA certificate drop-down lists to select certificates previously imported into the controller. See Chapter 32, "Management Access" on page 571 for more information.

19. Click Done to apply the site-to-site VPN configuration.
20. Click Apply.
21. Click the IPSEC tab to configure an IKE policy.
    a. Under IKE Policies, click Add to open the IPSEC Add Policy configuration page.
    b. Set the Priority to 1 for this configuration to take priority over the Default setting.
    c. Set the Version type to match the IKE version you selected in Step 10 above.
    d. Set the Encryption type from the drop-down menu.
    e. Set the HASH Algorithm from the drop-down menu.
    f. Set the Authentication to PRE-SHARE if you are using preshared keys. If you are using certificate-based IKE, select RSA or ECDSA.
    g. Set the Diffie Hellman Group from the drop-down menu.
    h. The IKE policy selections, including any preshared key, need to be reflected in the VPN client configuration. When using a third party VPN client, set the VPN configuration on clients to match the choices made above. If the Dell dialer is used, you must configure the dialer prior to downloading the dialer onto the local client.
    i. Click Done to activate the changes.
    j. Click Apply.

In the CLI

To use the command-line interface to configure a site-to-site VPN with two static IP controllers using IKEv1, issue the following commands:

```
crypto-local ipsec-map <name> <priority>
   src-net <ipaddr> <mask>
   dst-net <ipaddr> <mask>
   peer-ip <ipaddr>
   vlan <id>
   version v1|v2
   peer-cert-dn <peer-dn>
   pre-connect enable|disable
   trusted enable
```

For certificate authentication:

```
   set ca-certificate <cacert-name>
   set server-certificate <cert-name>

   crypto isakmp policy <priority>
      encryption {3des|aes128|aes192|aes256|des}
      version v1|v2
      authentication {rsa-sig|ecdsa-256ecdsa-384}
      group {1|2|19|20}
      hash {md5|sha|sha1-96|sha2-256-128|sha2-384-192}
      lifetime <seconds>
```

For preshared key authentication:

```
crypto-local isakmp key <key> address <ipaddr> netmask <mask>

   crypto isakmp policy <priority>
      encryption {3des|aes128|aes192|aes256|des}
      version v1|v2
      authentication pre-share
```

```
group {1|2|19|20}
hash {md5|sha|sha1-96|sha2-256-128|sha2-384-192}
lifetime <seconds>
```

To configure site-to-site VPN with a static and a dynamically addressed controller that initiates IKE Aggressive-mode for Site-Site VPN:

```
crypto-local ipsec-map <name> <priority>
   src-net <ipaddr> <mask>
   dst-net <ipaddr> <mask>
   peer-ip <ipaddr>
   local-fqdn <local_id_fqdn>
   vlan <id>
   pre-connect enable|disable
   trusted enable
```

For the Pre-shared-key:

```
crypto-local isakmp key <key> address <ipaddr> netmask 255.255.255.255
```

For a static IP controller that responds to IKE Aggressive-mode for Site-Site VPN:

```
crypto-local ipsec-map <name2> <priority>
   src-net <ipaddr> <mask>
   dst-net <ipaddr> <mask>
   peer-ip 0.0.0.0
   peer-fqdn fqdn-id <peer_id_fqdn>
   vlan <id>
   trusted enable
```

For the Pre-shared-key:

```
crypto-local isakmp key <key> fqdn <fqdn-id>
```

For a static IP controller that responds to IKE Aggressive-mode for Site-Site VPN with One PSK for All FQDNs:

```
crypto-local ipsec-map <name2> <priority>
   src-net <ipaddr> <mask>
   peer-ip 0.0.0.0
   peer-fqdn any-fqdn
   vlan <id>
   trusted enable
```

For the Pre-shared-key for All FQDNs:

```
crypto-local isakmp key <key> fqdn-any
```

Dead Peer Detection

Dead Peer Detection (DPD) is enabled by default on the controller for site-to-site VPNs. DPD, as described in RFC 3706, "A Traffic-Based Method of Detecting Dead Internet Key Exchange (IKE) Peers," uses IPsec traffic patterns to minimize the number of IKE messages required to determine the liveliness of an IKE peer.

To configure DPD parameters, issue the following commands via the command-line interface.

```
crypto-local isakmp dpd idle-timeout <idle_seconds> retry-timeout <retry_seconds>
retry-attempts <number>
```

Default IKE policies

ArubaOS includes the following default IKE policies. These policies are predefined and cannot be edited.

Table 72 *Default IKE Policy Settings*

Policy Name	Policy Number	IKE Version	Encryption Algorithm	Hash Algorithm	Authentication Method	PRF Method	Diffie-Hellman Group
Default protection suite	10001	IKEv1	3DES-168	SHA 160	Pre-Shared Key	N/A	2 (1024 bit)
Default RAP Certificate protection suite	10002	IKEv1	AES -256	SHA 160	RSA Signature	N/A	2 (1024 bit)
Default RAP PSK protection suite	10003	IKEv1	AES -256	SHA 160	Pre-Shared Key	N/A	2 (1024 bit)
Default RAP IKEv2 RSA protection suite	1004	IKEv2	AES -256	SSHA160	RSA Signature	hmac-sha1	2 (1024 bit)
Default Cluster PSK protection suite	10005	IKEv1	AES -256	SHA160	Pre-Shared Key	Pre-Shared Key	2 (1024 bit)
Default IKEv2 RSA protection suite	1006	IKEv2	AES - 128	SHA 96	RSA Signature	hmac-sha1	2 (1024 bit)
Default IKEv2 PSK protection suite	10007	IKEv2	AES - 128	SHA 96	Pre-shared key	hmac-sha1	2 (1024 bit)
Default Suite-B 128bit ECDSA protection suite	10008	IKEv2	AES - 128	SHA 256-128	ECDSA-256 Signature	hmac-sha2-256	Random ECP Group (256 bit)
Default Suite-B 256 bit ECDSA protection suite	10009	IKEv2	AES -256	SHA 384-192	ECDSA-384 Signature	hmac-sha2-384	Random ECP Group (384 bit)
Default Suite-B 128bit IKEv1 ECDSA protection suite	10010	IKEv1	AES-GCM-128	SHA 256-128	ECDSA-256 Signature	hmac-sha2-256	Random ECP Group (256 bit)
Default Suite-B 256-bit IKEv1 ECDSA protection suite	10011	IKEv1	AES-GCM-256	SHA 256-128	ECDSA-256 Signature	hmac-sha2-256	Random ECP Group (256 bit)

VPN Dialer

For Windows clients, a dialer can be downloaded from the controller to auto-configure tunnel settings on the client.

Configuring the VPN Dialer

Use the following procedures to configure the VPN dialer via the WebUI or command-line interfaces

In the WebUI

1. Navigate to the Configuration > Advanced Services > VPN Services > Dialers page. Click Add to add a new dialer or click the Edit tab to edit an existing dialer.
2. Enter the Dialer Name that will be used to identify this setting.
3. Configure the dialer to work with PPTP or L2TP by selecting Enable PPTP or Enable L2TP.

4. Select the authentication protocol. This should match the L2TP or PPTP authentication type configured for the VPN in the Configuration > Advanced Services > VPN Services > IPSEC window.
5. (Optional) Select Send Direct Network Traffic In Clear to enable "split tunneling" functionality so that traffic destined for the internal network is tunneled while traffic for the Internet is not. This option is not recommended for security reasons.
6. (Optional) Select Disable Wireless Devices When Client is Wired to allow the dialer to shut down the wireless interface when it detects that a wired network connection is in use.
7. (Optional) Select Enable SecurID New and Next Pin Mode to enable site-to-site VPN support for SecurID new and next pin modes.
8. For L2TP:
   - Set the IKE Hash Algorithm to the value defined in the IKE policy on the Advanced Services > VPN Services > IPSEC window.
   - If a preshared key is configured for an IKE Shared Secret in the VPN Services > IPSEC window, enter the key.
   - The key you enter in the Dialers window must match the preshared key configured on the IPsec page.
   - Select the IPsec Mode Group that matches the Diffie Hellman Group configured for the IPsec policy.
   - Select the IPsec Encryption that matches the Encryption configured for the IPsec policy.
   - Select the IPsec Hash Algorithm that matches the Hash Algorithm configured for the IPsec policy.
9. Click Done to apply the changes made prior to navigating to another page.

In the CLI

Issue the following commands to configure the VPN dialer via the CLI:

```
vpn-dialer <name>
   enable {dnctclear|l2tp|pptp|secureid_newpinmode|wirednowifi}
   ike authentication {pre-share <key>|rsa-sig}
   ike encryption {3des|des}
   ike group {1|2}
   ike hash {md5|sha}
   ipsec encryption {esp-3des|esp-des}
   ipsec hash {esp-md5-hmac|esp-sha-hmac}
   ppp authentication {cache-securid|chap|mschap|mschapv2|pap}
```

Assigning a Dialer to a User Role

The VPN dialer can be downloaded using Captive Portal. For the user role assigned through Captive Portal, configure the dialer by the name used to identify the dialer.

For example, if the captive portal client is assigned the *guest* role after logging on through captive portal and the dialer is called *mydialer,* configure *mydialer* as the dialer to be used in the guest role.

In the WebUI

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click *Edit* for the user role.
3. Under VPN Dialer, select the dialer you configured and click Change.
4. Click Apply.

In the CLI

To configure the captive portal dialer for a user role via the command-line interface, access the CLI in config mode and issue the following commands:

```
user-role <role>
```

```
dialer <name>
```

Chapter 18

Virtual Intranet Access

Virtual Intranet Access (VIA) is part of the Dell remote networks solution targeted for teleworkers and mobile users. VIA detects the users network environment (trusted and un-trusted) and automatically connects the user to their enterprise network. Trusted networks typically refers to a protected office network that allows users to directly access corporate intranet. Un-trusted networks are public Wi-Fi hotspots like airports, cafes, or home network. The VIA solution comes in two parts—VIA connection manager and the controller configuration.

- VIA connection manager—Teleworkers and mobile users can easily install a light weight application on their Microsoft Windows or Apple MacBook computers to connect to their enterprise network from remote locations (see "VIA Connection Manager" on page 415).
- Controller configuration—To set up virtual intranet access for remote users, you must configure your controller to include setting up user roles, authentication, and connection profiles. You can use either WebUI or CLI to configure your controller (see "Configuring the VIA Controller" on page 417).

Topics in this Document

VIA Connection Manager

If a user is connected from a remote location that is outside of the enterprise network, VIA automatically detects the environment as un-trusted and creates a secure IPSec connection between the user and the enterprise network. When the user moves into the trusted network, VIA detects the network type and moves to idle state.

How it Works

VIA provides a seamless connectivity experience to users when accessing an enterprise network resource from an un-trusted or trusted network environment. You can securely connect to your enterprise network from an un-trusted network environment. By default VIA will auto-launch at system start and establish a remote connection. The following table explains the typical behavior:

NOTE: The sequence of events described in Table 73 does not necessarily mean that the events always happen in the order shown in the table.

Table 73 *VIA Connectivity Behavior*

User action / environment	VIA's behavior
The client / user moves from a trusted to un-trusted environment. *Example: From office to a public hot-spot.*	Auto-launches and establishes connection to remote network.

Table 73 *VIA Connectivity Behavior (Continued)*

User action / environment	VIA's behavior
The client moves from an un-trusted to a trusted environment.	Auto-launch and stay idle. VIA does not establish remote connection. You can, however, manually connect to a network by selecting an appropriate connection profile from the *Settings* tab.
While in an un-trusted environment, user disconnects the remote connection.	Disconnects gracefully.
User moves to a trusted environment.	Stays idle and does not connect.
User moves to an un-trusted environment	Stays idle and does not connect. This usually happens, if the user has in a previous occasion disconnected a secure connection by clicking the Disconnect button in VIA. Users can manually connect by one of the following methods: 1. Right click on the VIA icon in the system tray and select the Restore option and then select the Connect option to connect using the default connection profile. 2. Right click on the VIA icon in the system tray and select the Connect option.
User clicks the Reconnect button.	Establishes remote connection.
In an un-trusted environment, user restarts the system.	Auto-launches and establishes remote connection.
In an un-trusted environment, user shuts down the system. Moves to a trusted environment and restarts system.	Auto-launches and stays idle.

Installing the VIA Connection Manager

Users can download VIA from a URL provided to them by their IT department and install it on their computers.

On Microsoft Windows Computers

1. Download the installer (*ansetup.msi or ansetup64.msi*) from the URL provided by the IT department.
2. Double click the installer file and follow the default prompts.
3. After the installation is complete, the user will be prompted to enter the following:
   a. Remote server URL—This should be provided by the IT department. The administrator can also provision the URL on the controller. In such cases, the user is required to specify only the username and password.
   b. Username—The users domain user name.
   c. Password—The users domain password.
4. Click the Connect button to initiate a secure VIA connection. VIA will minimized to system tray after establishing the secure connection.

On Apple MacBooks

1. Download the installer (*ansetup.dmg*) from the URL provided by the IT department.
2. Double click the installer file and follow the default prompts.
3. After the installation is complete, the user will be prompted to enter the following:
   a. Remote server URL—This should be provided by the IT department.
   b. Username—The users domain user name.
   c. Password—The users domain password.
4. Go to System Preferences > Other > select VIA to view VIA connection details.
5. Go to System Preferences > Network, in the list of network connections select VIA to modify login details and remote server address.

Upgrade Workflow

VIA checks for upgrade requirements during the login phase. There are two types of upgrade process: Minimal Upgrade and Complete Upgrade.

Minimal Upgrade

This type of upgrade is initiated for bug fixes and some minor enhancements which requires only some components of the client to be upgraded. When a VPN session is active the upgrade binary is downloaded by VIA from the controller. After the active VIA connection is terminated, the upgrade process is started and the client is upgraded. This type of upgrade does not require a system reboot.

Complete Upgrade

This requires an upgrade to VIA and its underlying network drivers. This type of upgrade requires a system reboot. VIA downloads the upgrade binary from the controller and displays a message about upgrade process after the connection is terminated for that upgrade. The user can choose to proceed or cancel the upgrade process. If the user chooses to upgrade, a system reboot is automatically executed. If the user cancels the upgrade, VIA will prompt the user for an upgrade every time the user terminates a VIA session..

NOTE: See Appendix G, "VIA: End User Instructions" for information about using the desktop application.

VIA Compatibility

The following table shows the compatibility of different versions of VIA with ArubaOS. *(Continued)*

Table 74 *VIA Compatibility Matrix*

ArubaOS Version / Operating System	Microsoft Windows (32-bit) [XP, Vista, Windows 7]	Microsoft Windows (64-bit) [Vista, Windows 7]	Mac OS 10.5, 10.6	Apple iOS 4.2	Android 2.2
ArubaOS 5.0.X	1.0, 1.1, 1.2	—	—	—	—
ArubaOS 6.0.x	1.0, 1.1, 1.2	1.2	—	—	—
ArubaOS 6.1.x	1.1, 1.2, 2.0	1.2	1.0	—	—

Configuring the VIA Controller

VIA configuration requires that you first configure VPN settings and then configure VIA settings. See Chapter 17, "Virtual Private Networks" on page 389 for information on configuring VPN settings on your controller.

Before you Begin

The following ports must be enabled before configuring the VIA controller.

- TCP 443—During the initializing phase, VIA uses HTTPS connections to perform trusted network and captive portal checks against the controller. It is mandatory that you enable port 443 on your network to allow VIA to perform these checks.
- UDP 4500—Required for IPSec transport
- UDP 500—Required for VIA 1.0 on Mac OS

Supported Authentication Mechanisms

VIA 1.x and VIA 2.x support different authentication mechanisms:

Authentication mechanisms supported in VIA 1.x

Authentication is performed using IKEv1 only. Phase 0 authentication, which authenticates the VPN client, can be performed using either a pre-shared key or an X.509 certificate (the X.509 certificate must appear in the operating system's "user" certificate store.). If certificates are used for IKE phase 0 authentication, it must be followed by username/password authentication.

The second authentication phase is performed using xAuth, which requires a username and password. The username and password is authenticated against the controller's internal database, a RADIUS server, or an LDAP server. If a RADIUS server is used, it must support the PAP protocol.

Support for two-factor authentication such as token cards is provided in VIA 1.x. Token product like RSA tokens and other token cards are also supported. This includes support for new-pin and next-pin.

Authentication mechanisms supported in VIA 2.x

In addition to the authentication methods supported by VIA 1.x, VIA 2.x adds support for IKEv2. IKEv2 is an updated version that is faster and supports a wider variety of authentication mechanisms. IKEv2 does not have two phases of authentication, only a single phase. VIA supports the following with IKEv2:

- Username/password
- X.509 certificate. Controllers running ArubaOS 6.1 or greater support OCSP for the purpose of validating that a certificate has not been revoked.
- EAP (Extensible Authentication Protocol) including EAP-TLS and EAP-MSCHAPv2.

Other authentication methods:

- Certificates based authentication.
- Smart cards that support a Smart Card Cryptographic Provider (SCCP) API within the operating system. VIA will look for an X.509 certificate in the operating system's certificate store. A smart card supporting a SCCP will cause the certificate embedded within the smart card to automatically appear in the operating system's certificate store.

Suite B Cryptography Support

Suite B is a new set of cryptographic algorithms that are approved by the US Government for use in classified communication. Suite B provides the highest levels of security available today in public, commercial algorithms. Specifically, VIA provides support for:

- RFC 4869—Suite B Cryptographic Suites for IPsec
- AES-GCM 128/256 for bulk data transfer
- ECDSA for digital signatures, including support for X.509v3 certificates using ECDSA keys with p256/p384 curves
- ECDH for key agreement using p256/p384 curves
- SHA-256 and SHA-384 for message digests

NOTE: Suite B support requires a controller running Dell PowerConnect W-Series ArubaOS 6.1 or greater with the Advanced Cryptography License installed. See Chapter 34, "Software Licenses" for more information on licenses.

Configuring VIA Settings

The following steps are required to configure your controller for VIA. These steps are described in detail in the subsections that follow.

1. Enable VPN Server Module—ArubaOS allows you to connect to the VIA controller using the default user roles. However, to configure and assign specific user roles you must install the Policy Enforcement Firewall Virtual Private Network (PEFV) license.
2. Create VIA User Roles—VIA user roles contain access control policies for users connecting to your network using VIA. You can configure different VIA roles or use the default VIA role—`default-via-role`
3. Create VIA Authentication Profile—A VIA authentication profile contains a server group for authenticating VIA users. The server group contains the list of authentication servers and server rules to derive user roles based on the user authentication. You can configure multiple VIA authentication profiles and / or use the default VIA authentication profile created with *Internal* server group.
4. Create VIA Connection Profile— A VIA connection profile contains settings required by VIA to establish a secure connection to the controller. You can configure multiple VIA connection profiles. A VIA connection profile is always associated to a user role and all users belonging to that role will use the configured settings. If you do not assign a VIA connection profile to a user role, the default connection profile is used.
5. Configure VIA Web Authentication—A VIA web authentication profile contains an ordered list of VIA authentication profiles. The web authentication profile is used by end users to login to the VIA download page (*https://<server-IP-address>/via*) for downloading the VIA client. Only one VIA web authentication profile is available. If more than one VIA authentication profile (step 3 on page 419) is configured, users can view this list and select one during the client login.
6. Associate VIA Connection Profile to User Role—A VIA connection profile has to be associated to a user role. Users will login by authenticating against the server group specified in the VIA authentication profile and are put into that user role. The VIA configuration settings are derived from the VIA connection profile attached to that user role. Default connection profile is used.
7. Configure VIA Client WLAN Profiles—You can push WLAN profiles to end-user computers that use the Microsoft Windows Wireless Zero Config (WZC) service to configure and maintain their wireless networks. After the WLAN profiles are pushed to end-user computers, they are automatically displayed as an ordered list in the preferred networks. The VIA client WLAN profiles provisioned on the client can be selected from the VIA connection profile described in Step 6.
8. Re-branding VIA and Downloading the Installer—You can use a custom logo on the VIA client and on the VIA download web page.
9. Download VIA Installer and Version File

Using WebUI to Configure VIA

The following steps illustrate configuring your controller for VIA using the WebUI.

Enable VPN Server Module

You must install the PEFV license to configure and assign user roles. See Chapter 34, “Software Licenses” for licensing requirements.

To install a license:

1. Navigate to Configuration > Network > Controller and select the Licenses tab on the right hand side.
2. Paste the license key in the Add New License key text box and click the Add button.

Create VIA User Roles

To create VIA users roles:

1. Navigate to Configuration > Security > Access Control > User Roles.
2. Click Add to create new policies. Click Done after creating the user role and apply to save it to the configuration.

Create VIA Authentication Profile

This following steps illustrate the procedure to create an authentication profile to authenticate users against a server group.

1. Navigate to Configuration > Security > Authentication > L3 Authentication.
2. Under the *Profiles* section, expand the VIA Authentication Profile option. You can configure the following parameters for the authentication profile:

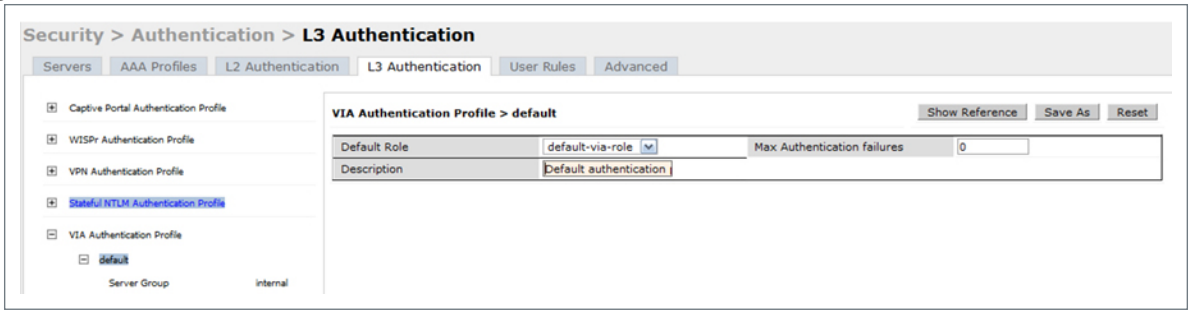
Table 75 *VIA - Authentication Profile Parameters*

Parameter	Description
Default Role	This role that will be assigned to the authenticated users.
Max Authentication Failures	Specifies the maximum authentication failures allowed. The default is 0 (zero).
Description	A user friendly name or description for the authentication profile.

3. To create a new authentication profile:
   a. Enter a name for the new authentication profile under the VIA *Authentication Profiles* section and click the Add button.
   b. Expand the VIA Authentication Profiles option and select the new profile name.
4. To modify an authentication profile, select the profile name to configure the default role

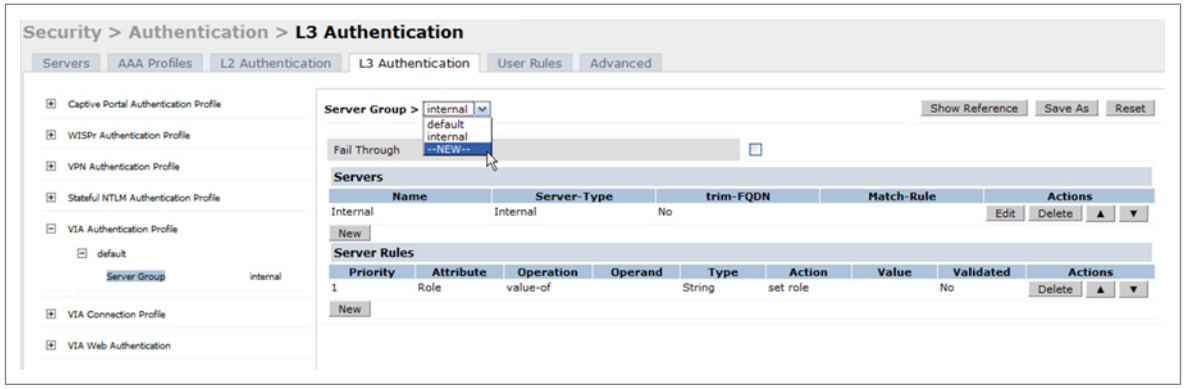
   The following screenshot uses the default authentication profile.

Figure 61 *VIA - Associate User Role to VIA Authentication Profile*



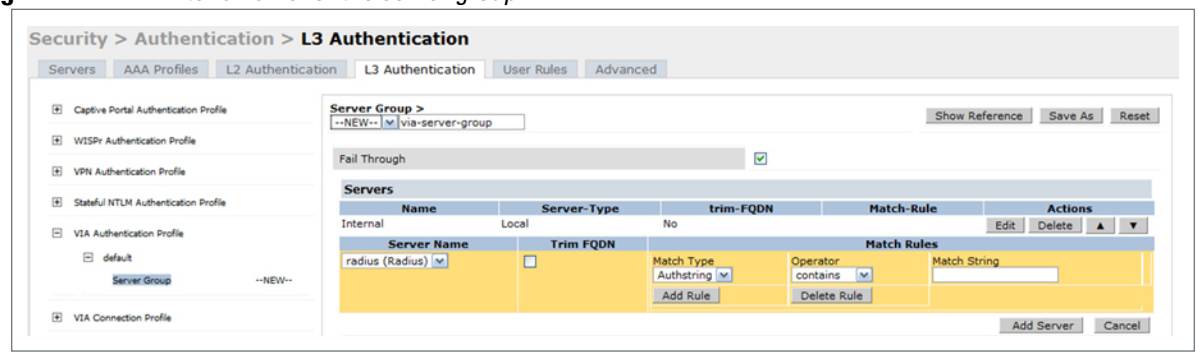
5. To use a different server group, Click *Server Group* under VIA Authentication Profile and select New to create a new server group.

Figure 62 *VIA - Creating a new server group for VIA authentication profile*



6. Enter a name for the server group.

Figure 63 *VIA - Enter a name for the server group*

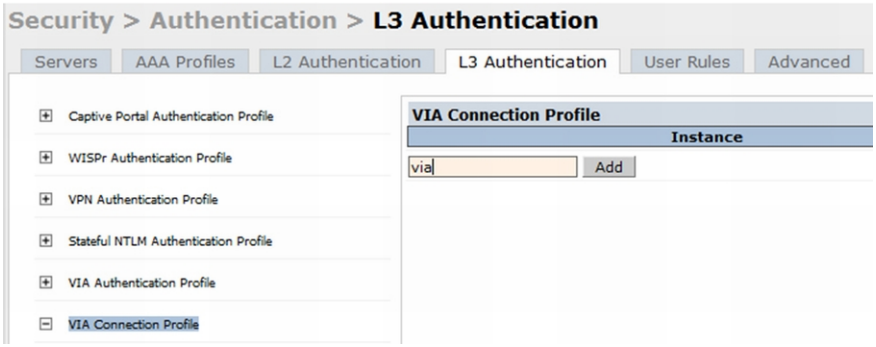


Create VIA Connection Profile

To create VIA connection profile:

1. Navigate to Configuration > Security > Authentication > L3 Authentication tab. Click the VIA *Connection Profile* option and enter a name for the connection profile.

Figure 64 *VIA - Create VIA Connection Profile*



2. Click on the new VIA connection profile to configure the connection settings. You can configure the following options for a VIA connection profile.

Table 76 *VIA - Connection Profile Options*

Configuration Option	Description
VIA Controller	Enter the following information about the VIA controller. • *Controller Hostname/IP Address*: This is the public IP address or the DNS hostname of the VIA controller. Users will connect to remote server using this IP address or the hostname. • Controller Internal IP Address: This is the IP address of any of the VLAN interface IP addresses belongs to this controller. • Controller Description: This is a human-readable description of the controller. Click the Add button after you have entered all the details. If you have more than one VIA controller you order them by clicking the *Up* and *Down* arrows. To delete a controller from your list, select a controller and click the Delete button.
VIA Authentication Profiles to provision	This is the list of VIA authentication profiles that will be displayed to users in the VIA client. See "Create VIA Authentication Profile" on page 420. • Select an authentication profile and click the Add button to add to the authentication profiles list. • You can change the order of the list by clicking the *Up* and *Down* arrows. • To delete an authentication profile, select a profile name and click the Delete button.

Table 76 *VIA - Connection Profile Options (Continued)*

Configuration Option	Description
VIA tunneled networks	A list of network destination (IP address and netmask) that the VIA client will tunnel through the controller. All other network destinations will be reachable directly by the VIA client. • Enter an IP address & network mask and click the Add button to add to the tunneled networks list. • To delete a network entry, select the IP address and click the Delete button.
VIA Client WLAN profiles	A list of VIA client WLAN profiles that needs to be pushed to the client machines that use Windows Zero Config (WZC) to configure or manage their wireless networks. • Select a WLAN profile and click the Add button to add to the client WLAN profiles list. • To delete an entry, select the profile name and click the Delete button. See "Configure VIA Client WLAN Profiles" on page 424 for more information.
VIA IKE V2 Policy	List of available IKEv2 policies.
VIA IKE Policy	List of IKE policies that the VIA Client has to use to connect to the controller. These IKE policies are configured under Configuration > Advanced Services > VPN Services > IPSEC > IKE Policies.
Use Windows Credentials	Enable or disable the use of the Windows credentials to login to VIA. If enabled, the SSO (Single Sign-on) feature can be utilized by remote users to connect to internal resources. Default: Enabled
Enable IKEv2	Select this option to enable or disable the use of IKEv2 policies for VIA.
Use Suite B Cryptography	Select this option to use Suite B cryptography methods. You must install the Advanced Cryptography license to use the Suite B cryptography. See "Licenses" on page 652. for more information.
IKEv2 Authentication method.	List of all IKEv2 authentication methods.
VIA IPSec V2 Crypto Map	List of all IPSec V2 that the VIA client uses to connect to the controller.
VIA IPSec Crypto Map	List of IPSec Crypto Map that the VIA client uses to connect to the controller. These IPSec Crypto Maps are configured in CLI using the `crypto-local ipsec-map <ipsec-map-name>` command.
VIA Client Network Mask	The network mask that has to be set on the client after the VPN connection is established. Default: 255.255.255.255
VIA Client DNS Suffix List	The DNS suffix list (comma separated) that has be set on the client once the VPN connection is established. Default: None.
VIA Support E-mail Address	The support e-mail address to which VIA users will send client logs. Default: None.
VIA external download URL	End users will use this URL to download VIA on their computers.
Content Security Gateway URL	If the split-tunnel is enabled, access to external (non-corporate) web sites will be verified by the specified content security service provider. See Chapter 39, "Content Security Service" on page 767 for details about Dell content security service.
Enable Content Security Services	Select this checkbox to enable content security service. You must install the Content Security Services licenses to use this option. See "Licenses" on page 652. for more information.
Client Auto-Login	Enable or disable VIA client to auto login and establish a secure connection to the controller. Default: Enabled
Allow client to auto-upgrade	Enable or disable VIA client to automatically upgrade when an updated version of the client is available on the controller. Default: Enabled

Table 76 *VIA - Connection Profile Options (Continued)*

Configuration Option	Description
Enable split-tunneling	Enable or disable split tunneling. • If enabled, all traffic to the VIA tunneled networks (Step 3 in this table) will go through the controller and the rest is just bridged directly on the client. • If disabled, all traffic will flow through the controller. Default: off
Allow client-side logging	Enable or disable client side logging. If enabled, VIA client will collect logs that can be sent to the support email-address for troubleshooting. Default: Enabled
Allow user to save passwords	Enable or disable users to save passwords entered in VIA. Default: Enabled
Validate Server Certificate	Enable or disable VIA from validating the server certificate presented by the controller. Default: Enabled
VIA max session timeout	The maximum time (minutes) allowed before the VIA session is disconnected. Default: 1440 min
VIA Logon Script	Specify the name of the logon script that must be executed after VIA establishes a secure connection. The logon script must reside in the client computer.
VIA Logoff Script	Specify the name of the log-off script that must be executed after the VIA connection is disconnected. The logoff script must reside in the client computer.
Maximum reconnection attempts	The maximum number of re-connection attempts by the VIA client due to authentication failures. Default: 3
Allow user to disconnect VIA	Enable or disable users to disconnect their VIA sessions. Default: on
Comma separated list of HTTP ports to be inspected (apart from default port 80)	Traffic from the specified ports will be verified by the content security service provider.
Keep VIA window minimized	Enable this option to minimize the VIA client to system tray during the connection phase. Applicable to VIA client installed in computers running Microsoft Windows operating system.

Configure VIA Web Authentication

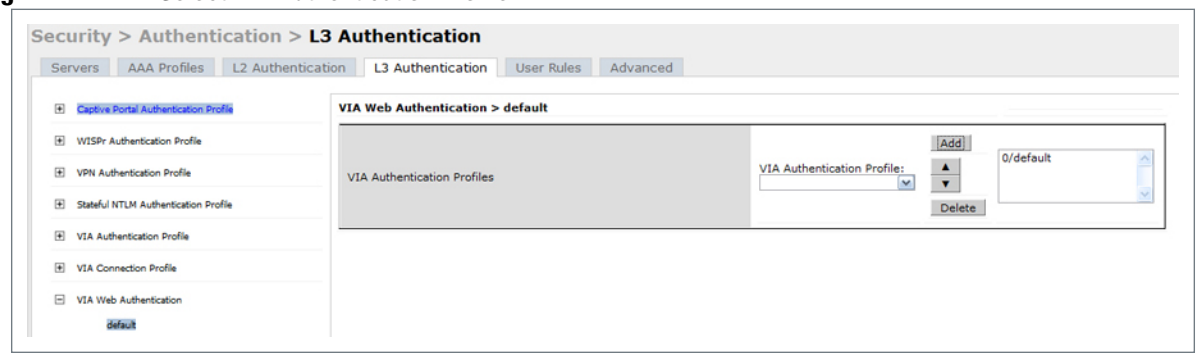
To configure VIA web authentication profile:

1. Navigate to Configuration > Security > Authentication > L3 Authentication tab.
2. Expand VIA Web Authentication and click on *default* profile.

NOTE: You can have only one profile (`default`) for VIA web authentication.

3. Select a profile from VIA Authentication Profile drop-down list box and click the Add button.
   - To re-order profiles, click the *Up* and *Down* button.
   - To delete a profile, select a profile and click the Delete button.
4. If a profile is not selected, the *default* VIA authentication profile is used.

Figure 65 *VIA - Select VIA Authentication Profile*

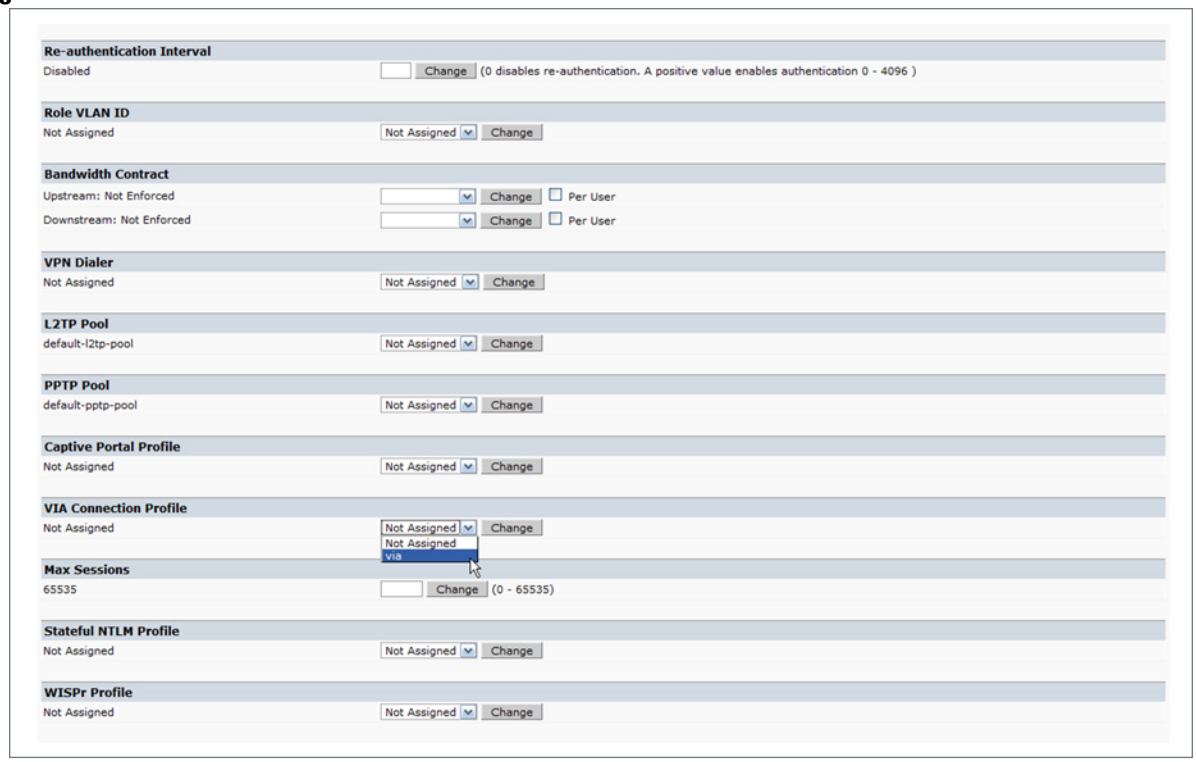


Associate VIA Connection Profile to User Role

To associate a VIA connection profile to a user role:

1. Navigate to Configuration > Security > Access Control > User Roles tab.
2. Select the VIA user role (See "Create VIA User Roles" on page 419) and click the Edit button.
3. In the *Edit Role* page, navigate to VIA Connection Profile and select the connection profile from the drop-down list box and click the Change button.
4. Click the Apply button to save the changes to the configuration.

Figure 66 *VIA - Associate VIA Connection Profile to User Role*

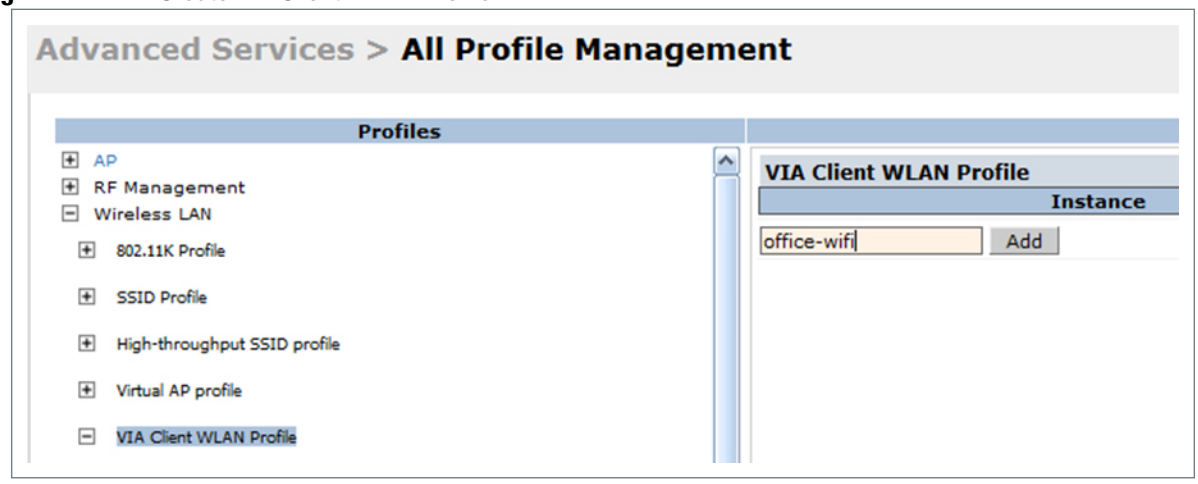


Configure VIA Client WLAN Profiles

To configure a VIA client WLAN profile:

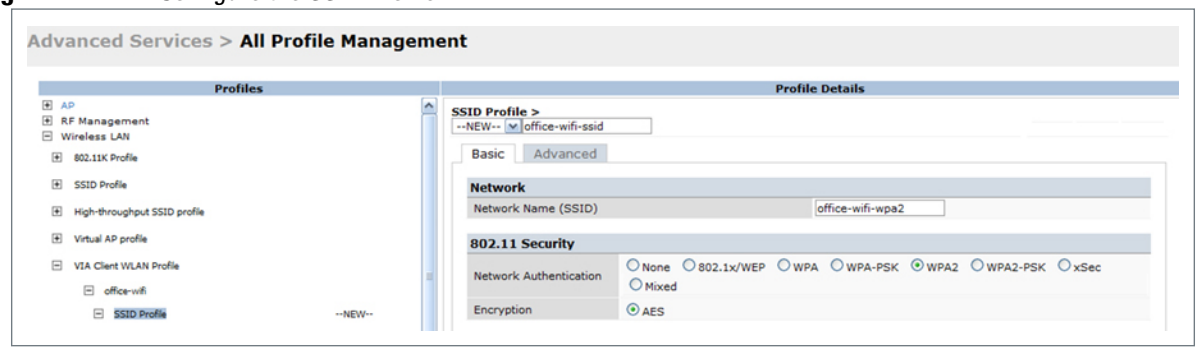
1. Navigate to Configuration > Advanced Services > All Profiles.
2. Expand *Controller Profiles* and select VIA Client WLAN Profile.
3. In the Profile Details, enter a name for the WLAN profile and click the Add button.

Figure 67 *VIA - Create VIA Client WLAN Profile*



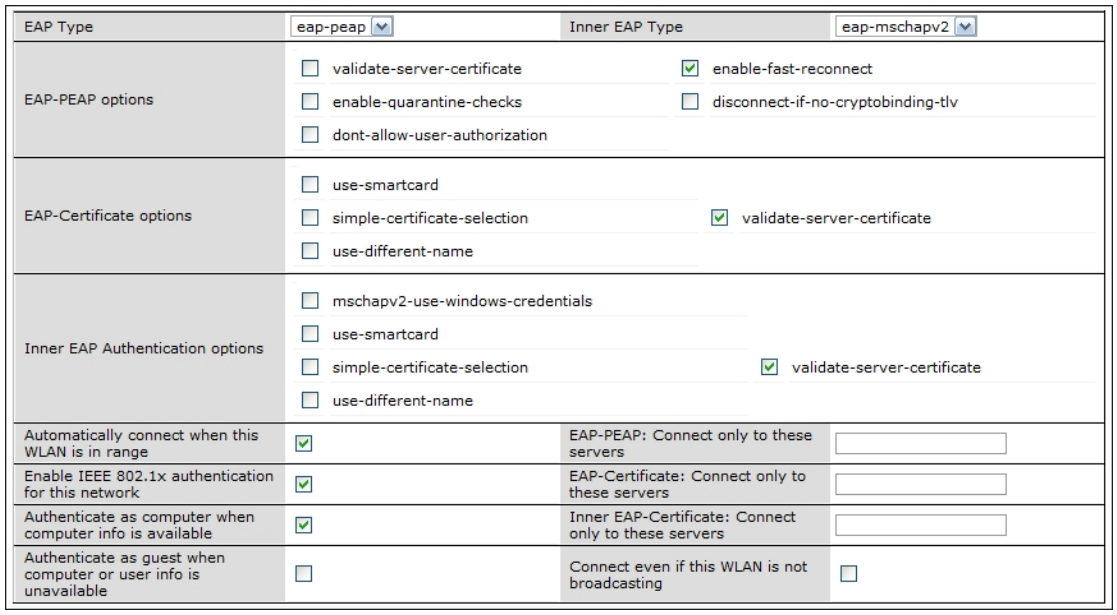
4. Expand the new WLAN profile and click SSID Profile. In the profile details page, select New from the SSDI Profile drop-down box and enter a name for the SSID profile.
5. In the Basic tab, enter the network name (SSID) and select 802.11 security settings. Click the Apply button to continue.

Figure 68 *VIA - Configure the SSID Profile*



6. You can now configure the SSID profile by select the SSID profile under VIA Client WLAN Profile option.

Figure 69 *VIA - Configure VIA Client WLAN Profile*



The VIA client WLAN profile are similar to the authentication settings used to set up a wireless network in Microsoft Windows. The following table shows the Microsoft Windows equivalent settings:

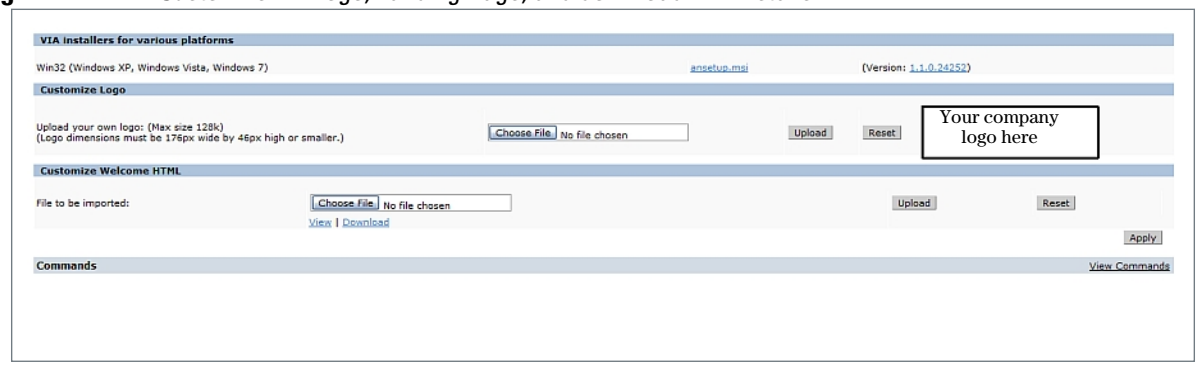
Table 77 *Configure VIA client WLAN profile*

Option	Description
EAP-PEAP options	Select the following options, if the EAP type is PEAP (Protected EAP): • validate-server-certificate: Select this option to validate server certificates. • enable-fast-reconnect: Select this option to allow fast reconnect. • enable-quarantine-checks: Select this option to perform quarantine checks. • disconnect-if-no-cryptobinding-tlv: Select this option to disconnect if server does not present cryptobinding TLV. • dont-allow-user-authorization: Select this to disable prompts to user for authorizing new servers or trusted certification authorities.
EAP Type	Select an EAP type used by client to connect to wireless network. Default: EAP-PEAP
EAP-Certificate Options	If you select EAP type as certificate, you can select one of the following options: • mschapv2-use-windows-credentials • use-smartcard • simple-certificate-selection • use-different-name • validate-server-certificate
Inner EAP Type	Select the inner EAP type. Default: EAP-MSCHAPv2
Inner EAP Authentication options:	• mschapv2-use-windows-credentials: Automatically use the Windows logon name and password (and domain if any) • use-smartcard: Use a smart card • simple-certificate-selection: Use a certificate on the users computer or use a simple certificate selection method (recommended) • validate-server-certificate: Validate the server certificate • use-different-name: Use a different user name for the connection (and not the CN on the certificate)
Automatically connect when this WLAN is in range	Select this option if you want VIA client to connect when this network (SSID) is available.
EAP-PEAP: Connect only to these servers	Comma separated list of servers.
Enable IEEE 802.1x authentication for this network	Select this option to enable 802.1x authentication for this network. Default: Enabled.
EAP-Certificate: Connect only to these certificates	Comma separated list of servers.
Inner EAP-Certificate: Connect only to these servers	Comma separated list of servers.
Connect even if this WLAN is not broadcasting	Default: Disabled

Re-branding VIA and Downloading the Installer

You can re-brand the VIA client and the VIA download page with your custom logo and HTML page.

Figure 70 *VIA - Customize VIA logo, Landing Page, and download VIA Installer*



Download VIA Installer and Version File

To download the VIA installer and version file:

1. Navigate to Configuration > Advanced Services > VPN Services > VIA tab.
2. Under VIA installers for various platforms section, click **`ansetup.msi`** to download the installation file.Using CLI to Configure VIA

Customize VIA Logo

To use a custom logo on the VIA download page and the VIA client:

1. Navigate to Configuration > Advanced Services > VPN Services > VIA tab.
2. Under *Customize Logo* section, browse and select a logo from your computer. Click the Upload button to upload the image to the controller.
   - To use the default Dell logo, click the Reset button.

Customize the Landing Page for Web-based Login

To use a custom landing page for VIA web login:

1. Navigate to Configuration > Advanced Services > VPN Services > VIA tab.
2. Under Customize Welcome HTML section, browse and select the HTML file from your computer. Click the Upload button to upload the image to the controller.
3. The following variables are used in the custom HTML file:

   All variables in the custom HTML file have the following notation

   - `<% user %>`: this will display the username.
   - `<% ip %>`: this will display the IP address of the user.
   - `<% role %>`: this will be display the user role.
   - `<% logo %>`: this is the custom logo (Example: `<img src="<% logo %>">`)
   - `<% logout %>`: the logout link (Example: `<a href="<% logout %>">VIA Web Logout</a>`)
   - `<% download %>`: the installer download link (Example: `<a href="<% download %>">Click here to download VIA</a>`)

   To use the default welcome page, click the Reset button.
4. Click the Apply button to continue.

Using CLI to Configure VIA

The following steps illustrate configuring VIA using CLI. Install your Policy Enforcement Firewall Virtual Private Network (PEFV) license key. For detailed information on the VIA command line options, see the *Dell PowerConnect W-Series ArubaOS 6.1 Command Reference Guide*.

```
(host) (config)# license add <key>
```

Create VIA Roles

```
(host) (config) #user-role example-via-role
(host) (config-role) #access-list session "allowall" position 1
(host) (config-role) #ipv6 session-acl "v6-allowall" position 2
```

Create VIA Authentication Profiles

```
(host) (config) #aaa server-group "via-server-group"
(host) (Server Group "via-server-group") #auth-server "Internal" position 1
(host) (Server Group "via-server-group") #aaa authentication via auth-profile default
(host) (VIA Authentication Profile "default") #default-role example-via-role
(host) (VIA Authentication Profile "default") #desc "Default VIA Authentication
Profile"
(host) (VIA Authentication Profile "default") #server-group "via-server-group"
```

Create VIA Connection Profiles

```
(host) (config) #aaa authentication via connection-profile "via"
(host) (VIA Connection Profile "via") #server addr 202.100.10.100 internal-ip
10.11.12.13 desc "VIA Primary Controller" position 0
(host) (VIA Connection Profile "via") #auth-profile "default" position 0
(host) (VIA Connection Profile "via") #tunnel address 10.0.0.0 netmask 255.255.255.0
(host) (VIA Connection Profile "via") #split-tunneling
(host) (VIA Connection Profile "via") #windows-credentials
(host) (VIA Connection Profile "via") #client-netmask 255.0.0.0
(host) (VIA Connection Profile "via") #dns-suffix-list example.com
(host) (VIA Connection Profile "via") #support-email via-support@example.com
```

Enter the following command after you create the client WLAN profile. See "Configure VIA Client WLAN Profiles" on page 424

```
(host) (VIA Connection Profile "via") #client-wlan-profile "via_corporate_wpa2"
position 0
```

Configure VIA web authentication

```
(host) (config) #aaa authentication via web-auth default
(host) (VIA Web Authentication "default") #auth-profile default position 0
```

NOTE: You can have only one profile (*default*) for VIA web authentication.

Associate VIA connection profile to user role

```
(host) (config) #user-role "example-via-role"
(host) (config-role) #via "via"
```

Configure VIA client WLAN profiles

```
(host) (config) #wlan ssid-profile "via_corporate_wpa2"
(host) (SSID Profile "via_corporate_wpa2") #essid corporate_wpa2
(host) (SSID Profile "via_corporate_wpa2") #opmode wpa2-aes
(host) (SSID Profile "via_corporate_wpa2") #wlan client-wlan-profile
"via_corporate_wpa2"
```

```
(host) (VIA Client WLAN Profile "via_corporate_wpa2") #ssid-profile
"via_corporate_ssid"
```

For detailed configuration parameter information, see "*wlan client-wlan-profile*" command in the *Dell PowerConnect W-Series ArubaOS 6.1 Command Reference Guide*.

Customize VIA logo, landing page and downloading installer

This step can only be performed using the WebUI. See "Re-branding VIA and Downloading the Installer" on page 426..

This chapter describes how to configure MAC-based authentication on the Dell controller using the WebUI.

Use MAC-based authentication to authenticate devices based on their physical media access control (MAC) address. While not the most secure and scalable method, MAC-based authentication implicitly provides an addition layer of security authentication devices. MAC-based authentication is often used to authenticate and allow network access through certain devices while denying access to the rest. For example, if clients are allowed access to the network via station A, then one method of authenticating station A is MAC-based. Clients may be required to authenticate themselves using other methods depending on the network privileges required.

MAC-based authentication can also be used to authenticate Wi-Fi phones as an additional layer of security to prevent other devices from accessing the voice network using what is normally an insecure SSID.

This chapter describes the following topics:

Configuring MAC-Based Authentication

Before configuring MAC-based authentication, you must configure:

- The user role that will be assigned as the default role for the MAC-based authenticated clients. (See Chapter 12, "Roles and Policies" for information on firewall policies to configure roles).

  You configure the default user role for MAC-based authentication in the AAA profile. If derivation rules exist or if the client configuration in the internal database has a role assignment, these values take precedence over the default user role.
- Authentication server group that the controller uses to validate the clients. The internal database can be used to configure the clients for MAC-based authentication. See "Configuring Clients" on page 432 for information on configuring the clients on the local database. For information on configuring authentication servers and server groups, see Chapter 9, "Authentication Servers"

Configuring the MAC Authentication Profile

Table 78 describes the parameters you can configure for MAC-based authentication.

Table 78 *MAC Authentication Profile Configuration Parameters*

Parameter	Description
Delimiter	Delimiter used in the MAC string: • colon specifies the format xx:xx:xx:xx:xx:xx • dash specifies the format xx-xx-xx-xx-xx-xx • none specifies the format xxxxxxxxxxxx Default: none
Case	The case (upper or lower) used in the MAC string. Default: lower
Max Authentication failures	Number of times a station can fail to authenticate before it is blacklisted. A value of 0 disables blacklisting. Default: 0

Using the WebUI to configure a MAC authentication profile

1. Navigate to the Configuration > Security > Authentication > L2 Authentication page.
2. Select MAC Authentication Profile.
3. Enter a profile name and click Add.
4. Select the profile name to display configurable parameters.
5. Configure the parameters, as described in Table 78.
6. Click Apply.

Using the CLI to configure a MAC authentication profile

```
aaa authentication mac <profile>
   case {lower|upper}
   delimiter {colon|dash|none}
   max-authentication-failures <number>
```

Configuring Clients

You can create entries in the controller's internal database that can be used to authenticate client MAC addresses. The internal database contains a list of clients along with the password and default role for each client. To configure entries in the internal database for MAC authentication, you enter the MAC address for both the user name and password for each client.

NOTE: You must enter the MAC address using the delimiter format configured in the MAC authentication profile. The default delimiter is none, which means that MAC addresses should be in the format xxxxxxxxxxxx. If you specify colons for the delimiter, you can enter MAC addresses in the format xx:xx:xx:xx:xx:xx.

Using the WebUI to configure clients in the internal database

1. Navigate to the Configuration > Security > Authentication > Servers > page.
2. Select Internal DB.
3. Click Add User in the Users section. The user configuration page displays.
4. For User Name and Password, enter the MAC address for the client. Use the format specified by the Delimiter parameter in the MAC Authentication profile. For example, if the MAC Authentication profile specifies the default delimiter (none), enter MAC addresses in the format xxxxxxxxxxxx.
5. Click Enabled to activate this entry on creation.
6. Click Apply to apply the configuration.

NOTE: The configuration does not take effect until you perform this step.

Using the CLI to configure clients in the internal database

Enter the following command in enable mode:

```
local-userdb add username <macaddr> password <macaddr>...
```

Chapter 20

Control Plane Security

ArubaOS supports secure IPsec communications between a controller and campus APs using public-key self-signed certificates created by each master controller. The controller certifies its APs by issuing them certificates. If the master controller has any associated local controllers, the master controller sends a certificate to each local controller, which in turn sends certificates to their own associated campus APs. If a local controller is unable to contact the master AP to obtain its own certificate, it will not be able to certify its APs, and those APs will not be able to communicate with their local controller until master-local communication has been reestablished. You will create an initial control plane security configuration when you first configure the controller using the initial setup wizard. The ArubaOS initial setup wizard enables control plane security by default, so it is very important that the local controller is able to communicate with its master controller when it is first provisioned.

Some AP model types have factory-installed digital certificates. These AP models will use their factory-installed certificates for IPsec, and do not need a certificate from the controller. Once a campus AP is certified, either through a factory-installed certificate or a certificate from the controller, the AP can failover between local controllers and still stay connected to the secure network, because each campus AP will have the same master controller as a common trust anchor. The campus AP whitelist contains a list of all APs connected to the network. You can use this whitelist at any time to add new valid APs to the secure network, or revoke network access to any suspected rogue or unauthorized AP.

NOTE: The control plane security feature supports IPv4 campus APs only and is not intended for use with Remote APscontroller that terminates IPv6 APs.

When the controller sends an AP a certificate, that AP must reboot before it can connect to its controller over a secure channel. If you are enabling control plane security for the first time on a large network, you may experience several minutes of interrupted connectivity while each AP receives its certificate and establishes its secure connection.

This chapter describes the following topics:

Control Plane Security Overview

Controllers using control plane security will only send certificates to APs that you have identified as valid APs on the network. If you want closer control over each AP that gets certified, you can manually add individual campus APs to the secure network by adding each AP's information to the campus AP whitelist when you first run the initial setup wizard. If you are confident that all campus APs currently on your network are valid APs, then you can use the initial setup wizard to configure automatic certificate provisioning to send certificates from the controller to each campus AP, or to all campus APs within a specific range of IP addresses.

The default automatic certificate provisioning setting requires that you manually enter each AP's information into the campus AP whitelist. If you change the default automatic certificate provisioning values to let the controller send certificates to all APs on the network, that new setting ensures that all valid APs will receive a certificate, but also increases the chance that a rogue or unwanted AP will also be certified. If you configure the controller to send certificates to only those APs within a range of IP addresses, there is a smaller chance that a rogue AP will get a certificate, but any valid AP with an IP address outside the specified address range will not be given a certificate and will not be able to communicate with the controller (except to obtain a certificate). Consider both options carefully before you complete the control plane security portion of the initial setup wizard. If your controller has a publicly accessible interface, you should identify the campus APs on the network by IP address range. This will prevent the controller from sending certificates to external or rogue campus APs that may attempt to access your controller through that publicly accessible interface.

Configuring Control Plane Security

When you initially deploy the controller, you will create your initial control plane security configuration using the initial setup wizard. These settings can be changed at any time using the WebUI or the command-line interfaces.

NOTE: If you are configuring control plane security for the first time after upgrading from ArubaOS 5.0 or earlier, see "Configuring Control Plane Security after Upgrading" on page 449 for details on enabling this feature using the WebUI or CLI.

In the WebUI

1. Access the WebUI of a standalone or master controller, and navigate to Configuration>Controller.
2. Select the Control Plane Security tab.
3. Configure the following control plane security parameters.

Table 79 *Control Plane Security Parameters*

Parameter	Description
Control Plane Security	Select enable or disable to turn the control plane security feature on or off. This feature is enabled by default.
Auto Cert Provisioning	When the control plane security feature is enabled, you can select this checkbox to turn on automatic certificate provisioning. When this feature is enabled, the controller will attempt to send certificates to all associated campus APs. Auto certificate provisioning is disabled by default. NOTE: If you do not want to enable automatic certificate provisioning the first time you enable control plane security on the controller, you must identify the valid APs on your network by adding those to the campus AP whitelist. For details, see "Viewing and Managing the Master or Local Switch Whitelists" on page 441. After you have enabled automatic certificate provisioning, you must select either Auto Cert Allow all or Addresses Allowed for Auto Cert.
Auto Cert Allow All	If you have enabled both control plane security and auto certificate provisioning, select Auto Cert Allow All to allow all associated campus APs to receive automatic certificate provisioning. This parameter is enabled by default.

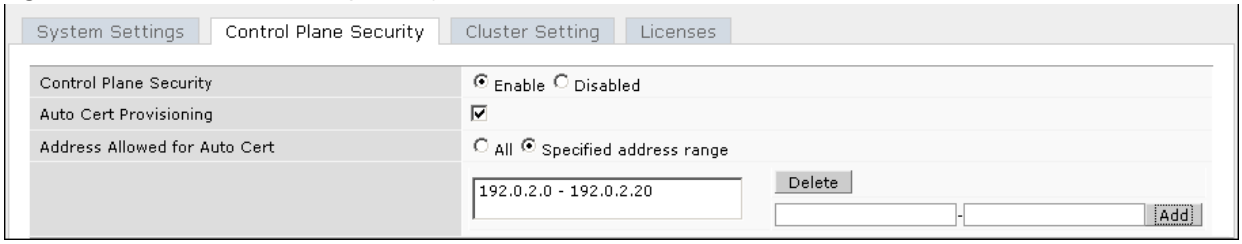
Table 79 *Control Plane Security Parameters (Continued)*

Parameter	Description
Addresses Allowed for Auto Cert	If your controller has a publicly accessible interface, you should identify the campus APs by IP address range. This will prevent the controller from sending certificates to external or rogue campus APs that may attempt to access your controller through that interface. After you have enabled both control plane security and auto certificate provisioning, select Addresses Allowed for Auto Cert to send certificates to a group of campus APs within a range of IP addresses. In the two fields below, enter the start and end IP addresses, then click Add. Repeat this procedure to add additional IP ranges to the list of allowed addresses. If both control plane security and auto certificate provisioning is enabled, all campus APs in the address list will receive automatic certificate provisioning. Remove a range IP addresses from the list of allowed addresses by selecting the IP address range from the list and clicking Delete.

4. Click Apply to save your changes.

The master controller will generate its self-signed certificate and will begin distributing certificates to campus APs and any local controllers on the network over a clear channel. After all APs have received a certificate and have connected to the network using a secure channel, access the Control Plane Security window and turn off auto certificate provisioning if that feature was enabled. This prevents the controller from issuing a certificate to any rogue APs that may appear on your network at a later time.

Figure 71 *Control Plane Security Settings*



In the CLI

Use the following commands to configure control plane security via the command line interface on a standalone or master controller. Descriptions of the individual parameters are listed in Table 79, above.

```
control-plane-security
   auto-cert-allowed-addrs <ipaddress-start> <ipaddress-end>
   auto-cert-allow-all
   auto-cert-prov
   {no cpsec-enable}|cpsec-enable
```

Example:

```
(host)(config) # control-plane-security
   auto-cert-prov
   no auto-cert-allow-all
   auto-cert-allowed-addrs 10.21.18.10 10.21.10.90
```

View the current control plane security settings using the following command:

```
show control-plane-security
```

Managing the Campus AP Whitelist

Campus APs appear as valid APs in the campus AP whitelist when you manually enter their information into the whitelist via the controller's CLI or WebUI, or after the controller sends the AP a certificate via automatic certificate provisioning and the AP connects to its controller via a secure tunnel. Any APs not approved or

certified on the network will also be included in the campus AP whitelist, but these APs will appear in an unapproved state.

Use the campus AP whitelist to grant valid APs secure access to the network, or to revoke access from suspected rogue APs. When you revoke or remove an AP from the campus AP whitelist on a controller that uses control plane security, that AP will not be able to communicate with the controller again, except to obtain a new certificate.

NOTE: If you manually add APs to the campus AP whitelist (rather than automatically adding the APs via the automatic certificate provisioning feature), make sure that the whitelist has been synchronized to all other controllers on the network *before* enabling control plane security.

You can add an AP to the campus AP whitelist via the WebUI or command-line interface. To add an entry via the WebUI, use the following procedure.

1. Access the WebUI, and navigate to Configuration>AP Installation.
2. Click the Campus AP Whitelist tab.
3. To add a new AP to the whitelist, click New.
4. Define the following parameters for each campus AP you want to add to the campus AP whitelist.

Table 80 *Configure Campus AP Whitelist Parameters*

Parameter	Description
AP MAC Address	MAC address of a campus AP that should support secure communications to and from its controller.
Description	(Optional) Use this field to add a brief description of the campus AP.

5. Click Add to add the information to the campus AP whitelist.
6. Click Apply to save your changes.

To add an AP to the Campus AP whitelist via the command-line interface, issue the command

```
whitelist-db cpsec add mac-address <macaddr> description <description>
```

Viewing Entries in the Campus AP Whitelist

Once you have added an entry in the Campus AP whitelist, that entry will be updated with additional information as the status of the AP changes. To view current information for an AP in the campus AP whitelist via the WebUI:

1. Access the WebUI, and navigate to Configuration>AP Installation.
2. Click the Campus AP Whitelist tab. The Campus AP whitelist table includes the following information for each AP entry.

Table 81 *View Campus AP Whitelist Parameters*

Parameter	Description
AP MAC Address	MAC address of the campus AP.
Cert Type	The type of certificate used by the AP. • switch-cert: The campus AP is using a certificate signed by the controller. • factory-cert: the campus AP is using a factory-installed certificate. This option should only be used for AP model typesW-AP105, the W-AP120 Series and the W-AP130 Series.

Table 81 *View Campus AP Whitelist Parameters (Continued)*

Parameter	Description
State	The Campus AP Whitelist reports one of the following states for each campus AP: • unapproved-no-cert: AP has no certificate and is not approved. • unapproved-factory-cert: AP has a preinstalled certificate that was not approved. • approved-ready-for-cert: The AP has been approved as a valid campus AP and is ready to receive a certificate. • certified-factory-cert: The AP is already has a factory certificate. If an AP has the factory-cert certificate type and is in the certified-factory-cert state, then that campus AP will not be re-issued a new certificate if automatic certificate provisioning is enabled. • certified-switch-cert: AP has an approved certificate from the controller. • certified-hold-factory-cert: An AP is put in this state when the controller thinks the AP has been certified with a factory certificate yet the AP requests to be certified again. Since this is not a normal condition, the AP will not be approved as a secure AP until a network administrator manually changes the status of the AP to verify that it is not compromised. NOTE: If an AP is in this state due to connectivity problems, then the AP will recover and will be out of this hold state as soon as connectivity is restored. • certified-hold-switch-cert: An AP is put in this state when the controller thinks the AP has been certified with a controller certificate yet the AP requests to be certified again. Since this is not a normal condition, the AP will not be approved as a secure AP until a network administrator manually changes the status of the AP to verify that it is not compromised. NOTE: If an AP is in this state due to connectivity problems, then the AP will recover and will be out of this hold state as soon as connectivity is restored.
Description	If defined, a brief description of the campus AP.
Revoked	Shows if the AP's secure status has been revoked.
Revoked Text	An optional, brief statement describing why the AP was revoked.

To view information about the campus AP whitelist via the command-line interface, use the commands described in Table 82.

Table 82 *View the Campus AP Whitelist via the CLI*

Command	Description
`show whitelist-db cpsec [mac-address <macaddr>]`	Shows detailed information for each AP in the whitelist, including the AP's MAC address, approved state, certificate type and description. Include the optional mac-address <macaddr> parameters to view data for a single entry.
`show whitelist-db cpsec-status`	The command gives aggregate information for the numbers of APs in each of the following categories: • Total entries • Approved entries • Unapproved entries • Certified entries • Certified hold entries • Revoked entries • Marked for deletion entries

Modifying an AP in the Campus AP Whitelist

Use the following procedure to modify a campus AP entry's certificate type, state, description and revoked status via the WebUI.

1. Access the master controller WebUI, and navigate to Configuration>AP Installation.

2. Click the Campus AP Whitelist tab.
3. Select the checkbox by the entry for the AP you want to edit, then click Modify.

   If your campus AP whitelist is large and you cannot immediately locate the AP entry you want to edit, select the Search link by the upper right corner of the whitelist. The Campus AP Whitelist tab will display several fields that allow you to search for an AP with a specified MAC address, certificate type or state. Specify the values that match the AP you are trying to locate, then click the Search button. The whitelist will display a list of APs that match your search criteria. Select the AP from this list, then click Modify.
4. Update the AP's whitelist entry with the new settings. Some of the configurable parameters were available when you first defined the entry, and are described in Table 80 above. When you modify an existing whitelist entry, you can also configure the following additional parameters that were not configurable when you first created the entry.
   - Cert-type: The type of certificate used by the AP.
     - switch-cert: The campus AP is using a certificate signed by the controller.
     - factory-cert: the campus AP is using a factory-installed certificate. This option should only be used for AP model types W-AP105, the W-AP120 Series and the W-AP130 Series.
   - State: When you click the State drop-down list to modify this parameter, you may choose one of the following options:
     - approved-ready-for-cert: AP has been approved state and is ready to receive a certificate.
     - certified-factory-cert: AP is certified and has a factory-installed certificate.
   - Revoke: Click the Revoke checkbox to revoke an AP's secure status. When you select this checkbox, you will also be allowed to enter a brief comment explaining why the AP is being revoked.
5. Click Update to update the campus AP whitelist entry with its new settings.

To modify an entry in the campus AP whitelist via the command-line interface, issue the following commands:

```
whitelist-db cpsec modify mac-address
   cert-type switch-cert|factory-cert
   description <description>
   mode disable|enable
   revoke-text <revoke-text>
   state approved-ready-for-cert|certified-factory-cert
```

Revoking an AP via the Campus AP Whitelist

You can revoke an invalid or rogue AP either by opening the modify menu and modifying the AP's revoke status (as described in the section above), or by selecting the AP in the campus whitelist and revoking it's secure status directly, without modifying any other parameters or entering a description of why that AP was revoked. When you revoke an AP's secure status in the campus AP whitelist, the whitelist will retain the AP's status information. To revoke an invalid or rogue AP and permanently remove the AP from the whitelist, you must delete that entry.

To revoke an AP via the WebUI:

1. Access the master controller WebUI, and navigate to Configuration>AP Installation.
2. Click the Campus AP Whitelist tab.
3. To revoke one or more secure campus APs, select the checkbox by the entry for each AP whose secure status should be revoked, then click Revoke.

   If your campus AP whitelist is large and you cannot immediately locate the AP entry you want to revoke, select the Search link by the upper right corner of the whitelist. The Campus AP Whitelist tab will display several fields that allow you to search for an AP with a specified MAC address, certificate type or state. Specify the values that match the AP you are trying to locate, then click the Search button. The whitelist will display a list of APs that match your search criteria. Select the AP from this list, then click Revoke.

To revoke an AP via the command-line interface, issue the command:

```
whitelist-db cpsec revoke mac-address <macaddr> revoke-text <"revoke text">
```

Deleting an AP Entry from the Campus AP Whitelist

Before you delete an AP entry from the campus whitelist, verify that auto certificate provisioning is either no longer enabled, or only enabled for IP addresses that do not include the AP being removed. If automatic certificate provisioning is enabled for an AP that it is still connected to the network, you will not be able to permanently delete it from the campus AP whitelist; the controller will immediately re-certify the AP and re-create its whitelist entry.

To delete an AP entry via the WebUI:

1. Access the master controller WebUI, and navigate to Configuration>AP Installation.
2. Click the Campus AP Whitelist tab.
3. Select the checkbox by entry for each AP you want to remove, then click delete.

   If your campus AP whitelist is large and you cannot immediately locate the AP entry you want to delete, select the Search link by the upper right corner of the whitelist. The Campus AP Whitelist tab will display several fields that allow you to search for an AP with a specified MAC address, certificate type or state. Specify the values that match the AP you are trying to locate, then click the Search button. The whitelist will display a list of APs that match your search criteria. Select the AP from this list, then click delete.

To delete an AP entry via the CLI, issue the command:

```
whitelist-db cpsec del mac-address <macaddr>
```

Purging the Campus AP Whitelist

Before you add a new local controller to a network using control plane security, you must purge the campus AP whitelist on the new controller. Any entries in a new controller's campus AP whitelist will be merged into the whitelist for all other master and local controllers as soon as the new controller is added to the hierarchy. If any old or invalid AP entries are added to the campus AP whitelist, all controllers in the hierarchy will begin trusting those APs, creating a potential security risk. For additional information on adding a new local controller using control plane security to your network, see "Replacing a Local Controller" on page 445

To purge a controller's campus AP whitelist via the WebUI:

1. Access the master controller WebUI, and navigate to Configuration>AP Installation.
2. Click the Campus AP Whitelist tab.
3. Click Purge.

To purge a campus AP whitelist via the command-line interface, issue the command

```
whitelist-db cpsec purge
```

Whitelists on Master and Local Controllers

Every controller using the control plane security feature maintains a campus AP whitelist, a local switch whitelist and a master switch whitelist. The contents of these whitelists vary, depending upon the role of the controller, as shown in the figure below.

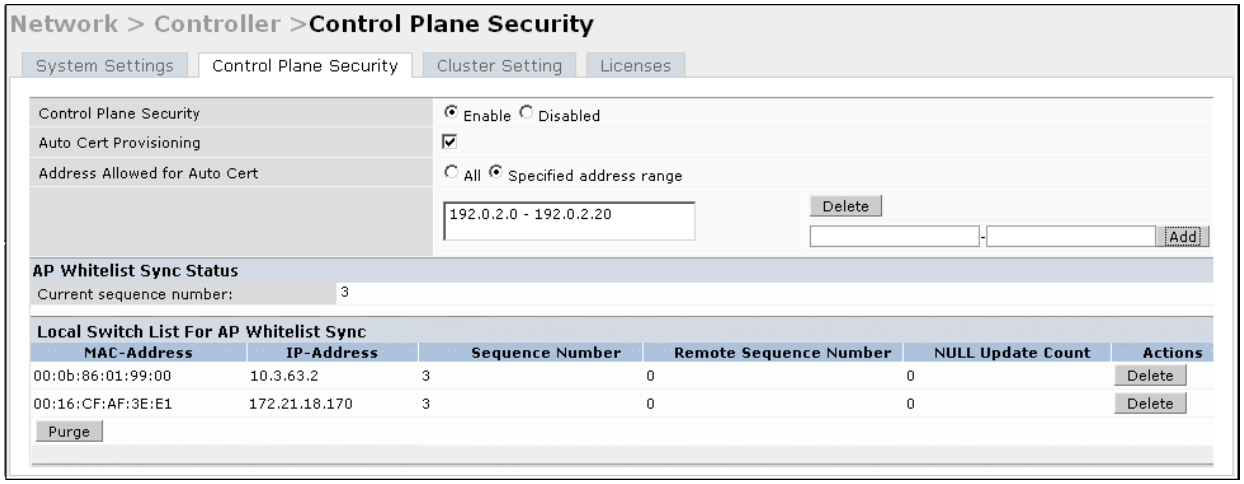
Table 83 *Control Plane Security Whitelists*

Controller Role	Campus AP Whitelist	Master Switch Whitelist	Local Switch Whitelist
On a (standalone) master controller with no local controllers:	The campus AP whitelist contains entries for the secure campus APs associated with that controller.	The master switch whitelist is empty, and does not appear in the WebUI.	The local switch whitelist is empty, and does not appear in the WebUI.

Table 83 *Control Plane Security Whitelists (Continued)*

Controller Role	Campus AP Whitelist	Master Switch Whitelist	Local Switch Whitelist
On a master controller with local controllers:	The campus AP whitelist contains an entry for every secure campus AP on the network, regardless of the controller to which it is connected.	The master switch whitelist is empty, and does not appear in the WebUI.	The local switch whitelist contains an entry for each associated local controller.
On a Local controller:	The campus AP whitelist contains an entry for every secure campus AP on the network, regardless of the controller to which it is connected.	The master switch whitelist contains the MAC and IP address of the master controller.	The local switch whitelist is empty, and does not appear in the WebUI.

Figure 72 *Local Switch Whitelist on a Master Controller*



If your deployment includes both master and local controllers, then the campus AP whitelist on every controller contains an entry for every secure AP on the network, regardless of the controller to which it is connected. The master controller also maintains a whitelist of local controllers using control plane security. When you change a campus AP whitelist on any controller, that controller contacts the other connected controllers to notify them of the change.

The master switch whitelist on each local controller contains the IP and MAC addresses of its master controller. If your network has a redundant master controller, then this whitelist will contain more than one entry. The master switch whitelist rarely needs to be deleted. Although you can delete an entry from the master switch whitelist, you should do so only if you have removed a master controller from the network.

Campus AP Whitelist Synchronization

The current sequence number in the AP Whitelist Sync Status field shows the number of changes to the campus AP whitelist made on that controller. By default, each controller compares its campus AP whitelist against whitelists on other controllers every two minutes. If a controller detects a difference, it will send its changes to the other controllers on the network. If all other controllers on the network have successfully received and acknowledged all whitelist changes made on that controller, every entry in the sequence number column in the local switch or master switch whitelists will have the same value as the sequence number displayed in the AP Whitelist Sync Status field. If a controller in the master or local switch whitelist has a lower sequence number, that controller may still be waiting to complete its update, or its update acknowledgement may not have yet been received. In the example in Figure 72, the master controller has a current sequence number of 3, and each sequence number in its local switch whitelist also shows a value of 3, indicating that both local controllers have received and acknowledged all three campus AP whitelist changes made on the master controller. For additional information on troubleshooting whitelist synchronization, see "Verify Whitelist Synchronization" on page 451.

You can view a controller's current sequence number via the CLI using the command:

```
show whitelist-db cpsec-seq
```

Viewing and Managing the Master or Local Switch Whitelists

The following sections describe the commands to view and delete entries in a master or local switch whitelist.

Viewing the Master or Local Switch Whitelist

To view the master or local switch whitelists via the WebUI, use the procedure below:

1. Access the controller's WebUI, and navigate to Configuration>Controller.
2. Select the Control Plane Security tab.

The master and local controller switch tables each include the following information:

Table 84 *Master and Local Switch Whitelist Information*

Data Column	Description
MAC-Address	On a local switch whitelist: MAC address of the master controller. On a master switch whitelist: MAC address of a local controller.
IP-Address	On a local switch whitelist: IP address of the master controller. On a master switch whitelist: IP address of a local controller.
Sequence Number	The number of times the controller in the whitelist received and acknowledged a campus AP whitelist change from the controller whose WebUI you are currently viewing. For deployments with both master and local controllers: • The sequence number on a master controller should be the same as the remote sequence number on the local controller. • The sequence number on a local controller should be the same as the remote sequence number on the master controller.
Remote Sequence Number	The number of times that the controller whose WebUI you are currently viewing has received and acknowledged a campus AP whitelist change from the controller in the whitelist. For deployments with both master and local controllers: • The remote sequence number on a master controller should be the same as the sequence number on the local controller. • The remote sequence number on a local controller should be the same as the sequence number on the master controller.
Null Update Count	The number of times the controller checked its campus AP whitelist and found nothing to synchronize with the other controller. By default, the controller compares its control plane security whitelist against whitelists on other controllers two minutes. If the null update count reaches 5, the controller will send an "empty sync" heartbeat to the remote controller to ensure the sequence numbers on both controllers are the same, then reset the null update count to zero.

To view the master or local switch whitelists via the command-line interface, issue the following commands:

```
show whitelist-db cpsec-master-switch-list [mac-address <mac-address>]
show whitelist-db cpsec-local-switch-list[mac-address <mac-address>]
```

Deleting an Entry from the Master or Local Switch Whitelist

There is no need to delete a master controller from the master switch whitelist during the course of normal operation. However, if you remove a local controller from the network, you should also remove the local controller from the local switch whitelist on the master controller. If the local switch whitelist contains entries for controllers no longer on the network, then a campus AP whitelist entry can be marked for deletion but will not be physically deleted, as the controller will be waiting for an acknowledgement from another controller no longer on the network. This can increase network traffic and reduce memory resources on the controller.

To delete an entry from the master or local switch whitelist via the WebUI:

1. Access the controller's WebUI, and navigate to Configuration>Controller.
2. Select the Control Plane Security tab.
3. To delete an entry from the Local Switch Whitelist: In the Local Switch List For AP Whitelist Sync section, click the Delete button by each controller entry you want to remove.

   -or-

   To delete an entry from the Master Controller Whitelist: In the Master Switch List For AP Whitelist Sync section, click the Delete button by each controller entry you want to remove.
4. Click Apply to save you settings.

To delete an entry from the master or local switch whitelist via the command-line interface, issue either of the following commands:

```
whitelist-db cpsec-master-switch-list del mac-address <mac-address>
whitelist-db cpsec-local-switch-list del mac-address <mac-address>
```

Purging the Master or Local Switch Whitelist

There is no need to purge a master switch whitelist during the course of normal operation. If, however, you are removing a controller from the network, you can purge its switch whitelist after it has been disconnected from the network. To clear a local switch whitelist entry on a master controller that is still connected to the network, select that individual whitelist entry and delete it using the delete option described on page 441.

To purge a switch whitelist via the WebUI, use the following procedure:

1. Access the controller's WebUI, and navigate to Configuration>Controller.
2. Select the Control Plane Security tab.
3. To clear the Local Switch Whitelist: In the Local Switch List For AP Whitelist Sync section, click Purge.

   -or-
4. To clear the Master Switch Whitelist: In the Master Switch List For AP Whitelist Sync section, click Purge.

To purge a switch whitelist via the command-line interface, issue the following commands:

```
whitelist-db cpsec-master-switch-list purge
whitelist-db cpsec-local-switch-list purge
```

Environments with Multiple Master Controllers

Configuring Networks with a Backup Master Controller

If your network includes a redundant backup master controller, you *must synchronize the database from the primary master to the backup master at least once* after all APs are communicating with their controllers over a secure channel. This ensures that all certificates, IPsec keys and campus AP whitelist entries are synchronized to the backup controller. You should also synchronize the database any time the campus AP whitelist changes (APs are added or removed to ensure that the backup controller has the latest settings.

Master and backup controllers can be synchronized using either of the following methods.

- Manual Synchronization: Issue the database synchronize CLI command in enable mode to manually synchronize databases from your primary controller to the backup controller.

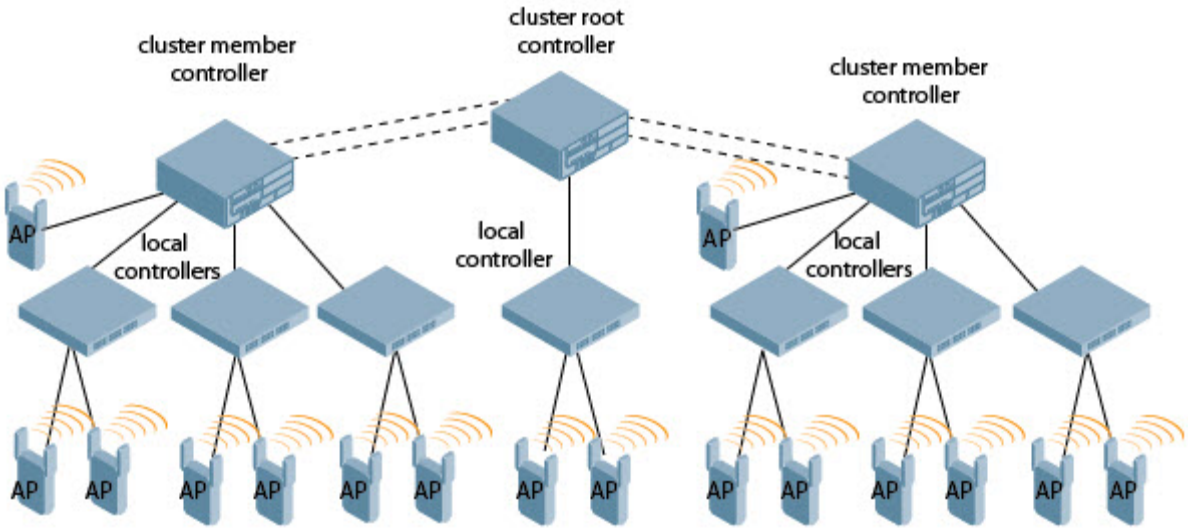
- Automatic Synchronization: Schedule automatic database backups using the database synchronize period CLI command in config mode.

CAUTION: If you add a new backup controller to an existing controller, the backup controller must be added as the lower priority controller. If the backup controller is not added as a lower priority controller, your control plane security keys and certificates may be lost. If you want the new backup controller to become your primary controller, increase the priority of that controller to a primary controller *after* you have synchronized your data.

Configuring Networks with Clusters of Master Controllers

If your network includes multiple master controllers each with their own hierarchy of APs and local controllers, you can allow APs from one hierarchy to failover to any other hierarchy by defining a *cluster* of master controllers. Each cluster will have one master controller as its cluster root, and all other master controllers as cluster members. The master controller operating as the cluster root will create a self-signed certificate, then certify it's own local controllers and APs. Next, the cluster root will send a certificate to each cluster member, which in turn certifies their own local controllers and APs. Since all controllers and APs in the cluster will all have the same trust anchor, the APs can switch to any other controller in the cluster and still remain securely connected to the network.

Figure 73 *A Cluster of Master Controllers using Control Plane Security*



To create a controller cluster, you must first define the root master controller and set an IPsec key or select a certificate for communications between the cluster root and cluster members.

NOTE: You must use the command-line interface to configure certificate authentication for cluster members. The WebUI supports cluster authentication using IPsec keys only. If your master and local controllers use a pre-shared key for authentication, they will create the IPsec tunnel using IKEv1. If your master and local controllers use certificates for authentication, the IPsec tunnel will be created using IKEv2.

Creating a Cluster Root

Use the WebUI to identify a controller as a cluster root and use an IPsec key to secure communication between the cluster root and cluster members. Use the command-line interface to create a cluster root using an IPsec key, factory-installed certificate or custom certificate.

To create a cluster root using the WebUI:

1. Access the WebUI of the controller you want to become the cluster root, and navigate to Configuration>Controller.

2. Click the Cluster Setting tab.
3. For the cluster role, select Root.
4. In the Cluster Member IPsec Keys section, enter the switch IP address of a member controller in the cluster. If you want to use a single key for all member controllers, use the IP address 0.0.0.0.
5. In the IPsec Key and Retype IPsec Key fields, enter the IPsec key for communication between the specified member controller and the cluster root.
6. Click Add.
7. *Optional*: repeat steps 4-6 to add another member controller to the cluster.
8. Click Apply to save your settings

To create a cluster root via the CLI, access the command-line interface of the controller you want to become the root of the controller cluster, then issue one of the following commands.

- To authenticate cluster members using a custom certificate:

  ```
  cluster-member-custom-cert member-mac <mac> ca-cert <ca> server-cert <cert> suite-b
  <gcm-128 | gcm-256>]
  ```

- To authenticate cluster members using a factory-installed certificate.

  ```
  cluster-member-custom-cert member-mac <mac>
  ```

- To authenticate cluster members using an IPsec key:

  ```
  cluster-member-ip <ip-address> ipsec <key>
  ```

  The <ip-address> parameter in this command is the IP address of a member controller in the cluster, and the <key> parameter in each command is the IPsec key for communication between the specified member controller and the cluster root. Use the IP address 0.0.0.0 in this command to set a single IPsec key for all member controllers, or repeat this command as desired to define a different IPsec key for each cluster member.

Creating a Cluster Member

Once you have identified the cluster root, you must then identify the member controllers in the cluster.

Use the WebUI to identify a controller as a cluster member and use an IPsec key to secure communication between the cluster member and the cluster root. Use the command-line interface to create a cluster member and secure communications between that member and the cluster root using an IPsec key, factory-installed certificate or custom certificate.

To create a cluster member using the WebUI:

1. Access the WebUI of the cluster member controller, and navigate to Configuration>Controller.
2. Click the Cluster Setting tab.
3. For the cluster role, select Member.
4. In the Controller IP Address field, enter the IP address of the root controller in the cluster.
5. In the IPsec Key and Retype IPsec Key fields, enter the IPsec key for communication between the specified member controller and the cluster root. This parameter must be have the same value as the key defined for the cluster member in "Creating a Cluster Root" on page 443.
6. Click Add.
7. Click Apply to save your settings.

To create a cluster root via the CLI, access each of the member master controllers and define the IPsec key or certificate for communication between that controller and the cluster root.

```
cluster-root-ip <ip-address>
   ipsec <key>
   factory-cert master-mac <mac>
```

```
ipsec-custom-cert master-mac1 <mac1> [master-mac2 <mac2>] ca-cert <ca> server-cert
<cert> [suite-b <gcm-128 | gcm-256>]
```

In this command the <ip-address> parameter is the IP address of the root master controller in the cluster. If you are using an IPsec key, the <key> parameter in this command must be have the same value as the key defined for the cluster member via the cluster-member-ip command.

Viewing Controller Cluster Settings

To view your current cluster configuration via the WebUI:

1. Navigate to Configuration>Controller.
2. Click the Cluster Setting tab.
   - If you are viewing the WebUI of a cluster root, the output of this command displays the IP address of the VLAN on the cluster member used to connect to the cluster root.
   - If you are viewing the WebUI of a cluster member, the output of this command displays the IP address of the VLAN on the cluster root used to connect to the cluster member.

To view your current cluster configuration via the command-line interface, issue the CLI commands described in Table 85.

Table 85 *CLI Commands to Display Cluster Settings*

Command	Description
`show cluster-switches`	When you issue this command from the cluster *root*, the output of this command displays the IP address of the VLAN used by the cluster member to connect to the cluster root. If you issue this command from a cluster *member*, the output of this command displays the IP address of the VLAN used by the cluster root to connect to the cluster member.
`show cluster-config`	When you issue this command from the cluster *root*, the output of this command shows the cluster role of the controller, and the IP address of each active member controller in the cluster. When you issue this command from a cluster *member*, the output of this command shows the cluster role of the controller, and the IP address of the cluster root.

Replacing a Controller on a Multi-Controller Network

The procedure to replace a controller within a multi-controller network varies, depending upon the role of that controller, whether the network has a single master controller or a cluster of master controllers, and whether or not the controller has a backup.

NOTE: The following sections describe the steps to replace an existing controller. To add a new local controller to a network, or permanently remove a local controller without replacing it, see "Viewing and Managing the Master or Local Switch Whitelists" on page 441.

Replacing Controllers in a Single Master Network

Use the procedures in this section to replace a master or local controller in a network environment with a single master controller.

Replacing a Local Controller

Use the following procedure to replace a local controller in a single-master network.

1. Disconnect the local controller from the network.
2. If you plan on moving the local controller to another location on the network, purge the campus AP whitelist on the controller.

Access the command-line interface on the old local controller and issue the command whitelist-db cpsec purge
-or-
Access the local controller WebUI, navigate to Configuration>AP Installation>Campus AP Whitelist and click Purge.

3. Once the campus AP whitelist has been purged, you must inform the master controller that the local controller will no longer be available. .

NOTE: This step is very important; unused local controller entries in the local switch whitelist can significantly increase network traffic and reduce controller memory resources.

Access the command-line interface on the master controller, and issue the command whitelist-db cpsec-local-switch-list del mac-address <local-controller-mac>
-or -
Access the maser controller WebUI, navigate to the Configuration>Controller>Control Plane Security window, select the entry for the local controller you want to delete from the local switch whitelist, and click Delete.

4. Install the new local controller, but do not connect it to the network yet. If the controller has been previously installed on the network, you must ensure that the new local controller has a clean whitelist.
Access the command-line interface on the new local controller and issue the command whitelist-db cpsec purge
-or-
Access the local controller WebUI, navigate to Configuration>AP Installation>Campus AP Whitelist and click Purge.
5. Now, connect the new local controller to the network. It is very important that the local controller is able to contact the master controller the first time it is connected to the network, because the local controller will try to get its control plane security certificate certified by the master controller the first time the local controller contacts its master.
6. Once the local controller has a valid control plane security certificate and configuration, the local controller will receive the campus AP whitelist from the master controller and will start certifying approved APs.
7. APs associated with the new local controller will reboot and create new IPsec tunnels to their controller using the new certificate keys

Replacing a Master Controller (With No Backup)

Use the following procedure to replace a master controller that does not have a backup controller.

1. Remove the old master controller from the network.
2. Install and configure the new master controller, then connect the new master to the network. The new master controller will generate a new certificate when it first becomes active
3. If the new master controller has a different IP address than the old master controller, change the master IP address on the local controllers to reflect the address of the new master.
4. Reboot each local controller to ensure that the local controllers get their certificate from the new master. Each local controller will begin using a new certificate signed by the master controller.
5. APs will no longer be able to securely communicate with the controller using their current key, and must receive a new certificate. Access the campus AP whitelist on any local controller and change all APs in a “certified” state to an “approved” state. The new master controller will send the approved APs new certificates. The APs will reboot and create new IPsec tunnels to their controller using the new certificate key.

   If the master controller does not have any local controllers, you must recreate the campus AP whitelist by turning on automatic certificate provisioning or manually reentering the campus AP whitelist entries.

Replacing a Redundant Master Controller

The control plane security feature requires you to synchronize databases from the primary master controller to the backup master controller at least once after the network is up at running. This will ensure that all certificates, keys and whitelist entries are synchronized to the backup controller. Since the AP whitelist may change periodically, the network administrator should regularly synchronize these settings to the backup controller. For details, see "Configuring Networks with a Backup Master Controller" on page 442

When you install a new backup master controller, you must add it as a lower priority controller than the existing primary controller. After you install the backup controller on the network, synchronize the database from the existing primary controller to the new backup controller to ensure that all certificates, keys and whitelist entries required for control plane security will be added to the new backup controller configuration. If you want the new controller to act as the primary controller, you can increase that controller's priority *after* the settings have been synchronized.

Replacing Controllers in a Multi-Master Network

Use the following procedures to replace a master or local controller in a network environment with a multiple master controllers.

Replacing a Local Controller in a Multi-Master Network

The procedure to replace a local controller in a network with multiple master controllers is the same as the procedure to replace a local controller is a single-master network. To replace a local controller in a multi-master network, follow the procedure described in "Replacing a Local Controller" on page 445

Replacing a Cluster Member Controller (With no Backup)

The control plane security feature allows APs to fail over from one controller to another within a cluster. Therefore, cluster members or their local controllers may have associated APs that were first certified under some other cluster member (or the cluster root). If you permanently remove a cluster member whose APs were all originally certified under the cluster member being removed, its associated APs will not need to reboot in order to connect to a different controller. If, however, you remove a cluster member whose associated APs were originally certified under a *different* cluster member, those APs will need to reboot and get recertified before they can connect to a different controller. If the cluster member you are removing has local controllers, the local controllers will also reboot so they can update themselves with new certificates, then pass the trust update to their terminating APs.

To replace a cluster member that does not have a backup controller:

1. On the cluster master to be removed, clear the cluster root IP address by accessing the command-line interface and issuing the command no cluster-root-ip <cluster-root-ip> ipsec <clusterkey>.
2. Remove the cluster member from the network.
3. If the cluster master you removed has any associated APs, you must reboot those APs so they will get an updated certificate.
4. If the cluster member you removed has any associated local controllers, reboot those local controllers so they can get a new certificate and then pass that trust update to their APs.
5. Remove the cluster master from the cluster root's master controller list by accessing the command-line interface on the cluster root and issuing the command whitelist-db cpsec-master-switch-list del mac-address <cluster-master-mac>.

NOTE: This step is very important; unused local controller entries in the local switch whitelist can significantly increase network traffic and reduce controller memory resources.

6. Remove the old cluster member from the network. Remember, that controller will still have campus AP whitelist entries from the entire cluster. You may want to delete or revoke unwanted entries from the campus AP whitelist.

Now, you must install the new cluster member controller according to the procedure described in "Creating a Cluster Member" on page 444. The new cluster member obtains a certificate from the cluster root when it first becomes active.

7. If the new cluster member has any associated APs, reboot those APs to allow them to get a trust update.
8. If the new cluster member has any local controllers, reboot the local controllers associated with the new cluster member. The local controllers will obtain a new certificate signed by the cluster member, and will then pass that trust update to their associated APs.

Replacing a Redundant Cluster Member Controller

The control plane security feature requires you to synchronize databases from the primary controller to the backup controller at least once after the network is up at running. This will ensure that all certificates, keys and whitelist entries are synchronized to the backup controller. Since the AP whitelist may change periodically, the network administrator should regularly synchronize these settings to the backup controller. For details, see "Configuring Networks with a Backup Master Controller" on page 442.

When you install a new backup cluster member, you must add it as a lower priority controller than the existing primary controller. After you install the backup cluster member on the network, resynchronize the database from the existing primary controller to the new backup controller to ensure that all certificates, keys and whitelist entries required for control plane security will be added to the new backup controller configuration. If you want the new controller to act as the primary controller, you can increase that controller's priority *after* the settings have been resynchronized.

Replacing a Cluster Root Controller with no Backup Controller

If you replace a cluster root controller that does not have a backup controller, the new cluster root controller will create its own self-signed certificate. You will then need to reboot each controller in the hierarchy in a specific order to certify all APs with that new certificate.

1. Remove the old cluster root from the network.
2. Install and configure the new cluster root.
3. Connect the new cluster root to the network so it can access cluster masters and local controllers.
4. If necessary, reconfigure the cluster masters and local controllers with their new cluster root IP and master IP addresses.
5. Reboot every cluster member controller. The cluster member will begin using a new certificate signed by the cluster root.
6. Reboot every local controller. Each local controller will begin using a new certificate signed by the cluster member.
7. Because the cluster root is new, it will not have a configured campus AP whitelist. Access the campus AP whitelist on any local controller or cluster master and change all APs in a "certified" state to an "approved" state. The APs will get recertified, reboot and create new IPsec tunnels to their controller using the new certificate key.

   If a cluster root controller does not have any cluster master or local controllers, you must recreate the campus AP whitelist on the cluster root by turning on automatic certificate provisioning or manually reentering the campus AP whitelist entries.

Replacing a Redundant Cluster Root Controller

Dell recommends using a backup controller with your cluster root controller. If your cluster root has a backup controller, you can replace the backup cluster root without having to reboot all cluster master and local controllers, minimizing network disruptions.

The control plane security feature requires you to synchronize databases from the primary controller to the backup controller at least once after the network is up at running. This will ensure that all certificates, keys and whitelist entries are synchronized to the backup controller. Since the AP whitelist may change periodically, the network administrator should regularly synchronize these settings to the backup controller. For details, see "Configuring Networks with a Backup Master Controller" on page 442.

When you install a new backup cluster root, you must add it as a lower priority controller than the existing primary controller. After you install the backup cluster root on the network, resynchronize the database from the existing primary controller to the new backup controller to ensure that all certificates, keys and whitelist entries required for control plane security will be added to the new backup controller configuration. If you want the new controller to act as the primary controller, you can increase that controller's priority *after* the settings have been resynchronized.

Configuring Control Plane Security after Upgrading

When you initially deploy a controller running ArubaOS 6.0 or later, you will create your initial control plane security configuration using the initial setup wizard. However, if you are upgrading to ArubaOS 6.0 from ArubaOS 5.0 *but did not yet have control plane security enabled before the upgrade*, then you can use the strategies described in Table 86 to enable and configure control plane security feature. For complete details on performing each of these individual steps, see "Configuring Control Plane Security" on page 434 and ""Whitelists on Master and Local Controllers" on page 439.

NOTE: If you upgrade a controller running ArubaOS 5.0.x to ArubaOS 6.0 or later, then the controller's control plane security settings will not change after the upgrade. If control plane security was already enabled, then it will remain enabled after the upgrade. If it was not enabled previously, but you wish to use the feature after upgrading, then it must be manually enabled.

Table 86 *Control Plane Security Upgrade Strategies*

Automatically send Certificates to Campus APs	Manually Certify Campus APs
1. Access the control plane security window and enable both the control plane security feature and the auto certificate provisioning option. Next, specify whether you want all associated campus APs to automatically receive a certificate, or if you want to certify only those APs within a defined range of IP addresses.	1. Identify the campus APs that should receive certificates by entering the campus APs' MAC addresses in the campus AP whitelist.
2. Once all APs have received their certificates, disable auto certificate provisioning to prevent certificates from being issued to any rogue APs that may appear on your network at a later time.	2. If your network includes both master and local controllers, wait a few minutes, then verify that the campus AP whitelist has been propagated to all other controllers on the network. Access the WebUI of the master controller, navigate to Configuration>Controller>Control Plane Security, then verify that the Current Sequence Number field has the same value as the Sequence Number entry for each local controller in the local switch whitelist. (For details, see "Verify Whitelist Synchronization" on page 451.)
3. If a valid AP did not receive a certificate during the initial certificate distribution, you can manually certify the AP by adding that AP's MAC address to the campus AP whitelist. You can also use this whitelist to revoke certificates from APs that should not be allowed access to the secure network.	3. Enable the control plane security feature.

CAUTION: If you upgraded your controller from ArubaOS 5.0 or earlier and you want to use this feature for the first time, you must either add all valid APs to the campus AP whitelist or enable automatic certificate provisioning *before you enable the feature*. If you do not enable automatic certificate provisioning, only the APs currently approved in the campus AP whitelist will be allowed to communicate with the controller over a secure channel. Any APs that do not receive a certificate will not be able to communicate with the controller except to request a certificate.

Troubleshooting Control Plane Security

Certificate Problems

If an AP has a problem with its certificate, check the state of the AP in the campus AP whitelist. If the AP is in either the certified-hold-factory-cert or certified-hold-switch-cert states, you may need to manually change the status of that AP before it can be certified.

- certified-hold-factory-cert: An AP is put in this state when the controller thinks the AP has been certified with a factory certificate yet the AP requests to be certified again. Since this is not a normal condition, the AP will not be approved as a secure AP until a network administrator manually changes the status of the AP to verify that it is not compromised. If an AP is in this state due to connectivity problems, then the AP will recover and will be out of this hold state as soon as connectivity is restored.
- certified-hold-switch-cert: An AP is put in this state when the controller thinks the AP has been certified with a controller certificate yet the AP requests to be certified again. Since this is not a normal condition, the AP will not be approved as a secure AP until a network administrator manually changes the status of the AP to verify that it is not compromised. If an AP is in this state due to connectivity problems, then the AP will recover and will be out of this hold state as soon as connectivity is restored.

Verifying Certificates

If you are unable to configure the control plane security feature on W-6000M3, W-600 Series or W-3000 Series controllers, verify that its Trusted Platform Module (TPM) and factory-installed certificates are present and valid

by accessing the controller's command-line interface and issuing the command show tpm cert-info. If the controller has a valid certificate, the output of the command should appear similar to the output in the example below.

```
(host) # show tpm cert-info
subject= /CN=AC1234567::00:0b:86:11:22:33
issuer= /DC=com/DC=companyname/DC=ca3/CN=DEVICE-CA3
serial=5147D5BC00000000000C
notBefore=Aug 29 22:16:12 2009 GMT
notAfter=Aug 18 22:16:12 2029 GMT
```

If the controller displays the following output, it may have a corrupted or missing TPM and factory certificates. Contact Dell technical support.

```
(host) # show tpm cert-info
Cannot get TPM and Factory Certificate Info.
TPM and/or Factory Certificates might be missing.
```

Disabling Control Plane Security

If you disable control plane security on a standalone or local controller, all APs connected to that controller will reboot then reconnect to the controller over a clear channel.

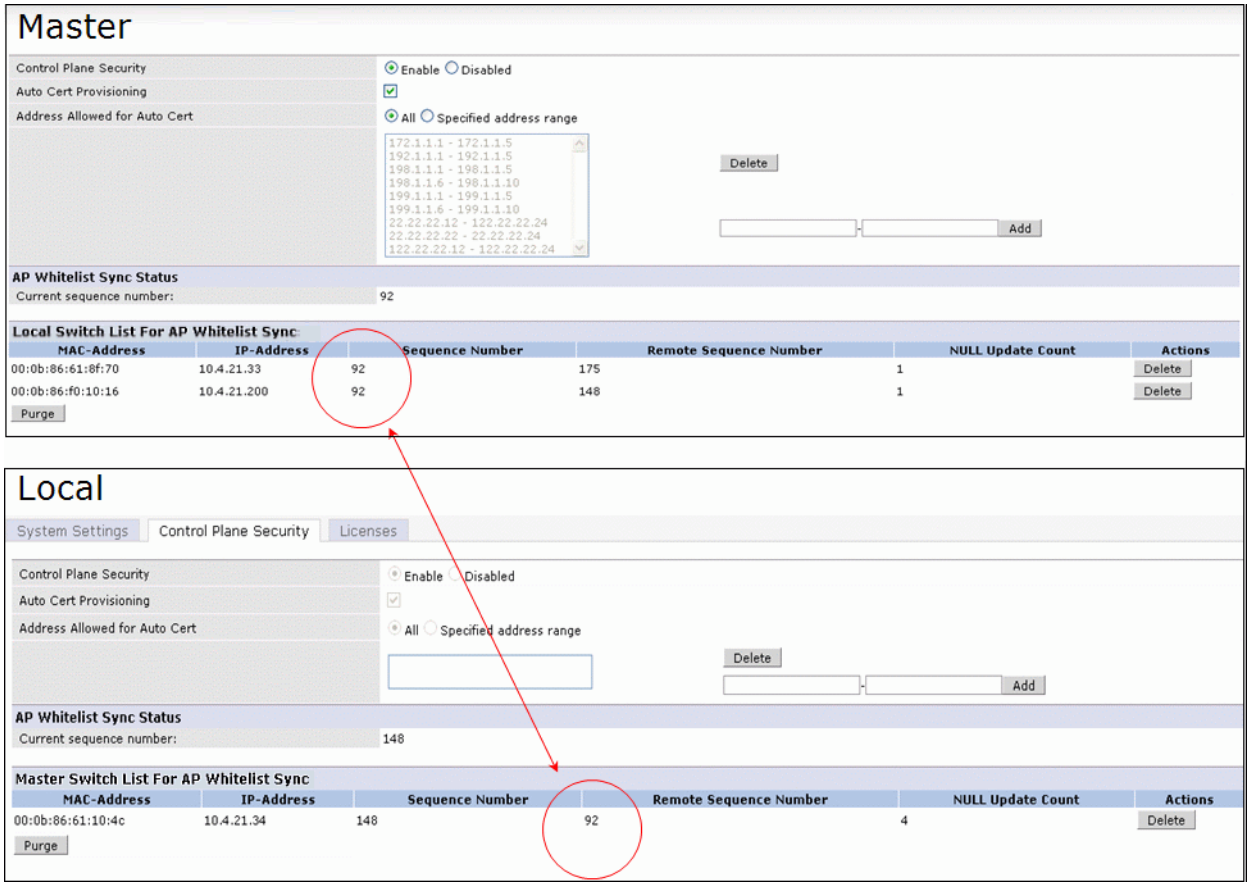
If your disable control plane security on a *master* controller, APs directly connected to the master controller will reboot then reconnect to the master controller over a clear channel. However, its local controllers will continue to communicate with their APs over a secure channel until you save your configuration on the master controller. Once you save the configuration, the changes are pushed down to the local controllers. At that point, any APs connected to the local controllers will also reboot and reconnect over a secure channel.

Verify Whitelist Synchronization

To verify that a network of master and local controllers are correctly sharing their campus AP whitelists, check the sequence numbers on the master and local switch whitelists.

- The sequence number value on a master controller should be the same as the remote sequence number on the local controller.
- The sequence number value on a local controller should be the same as the remote sequence number on the master controller.

Figure 74 *Sequence numbers on Master and Local Controllers*



Supported APs

The control plane security feature is supported on AP modelsW-AP105 andW-AP120 Series, W-AP130 Series, and W-AP175. APs that do not support control plane security will not be able to connect to a controller enabled with this feature.

Rogue APs

If you enable auto certificate provisioning enabled with the Auto Cert Allow All option, any AP that appears on the network will receive a certificate. If you notice unwanted or rogue APs connecting to your controller via an IPsec tunnel, verify that automatic certificate provisioning has been disabled, then manually remove the unwanted APs by deleting their entries from the campus AP whitelist.

Chapter 21

Adding Local Controllers

This chapter explains how to expand your network by adding a local controller to a master controller configuration. Typically, this is the first expansion of a network with just one controller (which is a master controller). This chapter is a basic discussion of creating master-local controller configurations. More complicated multi-controller configurations are discussed in other chapters.

This chapter describes the following topics:

Moving to a Multi-Controller Environment

For a single WLAN configuration, the master controller is the controller which controls the RF and security settings of the WLAN. Additional controllers to the same WLAN serve as local switches to the master controller. The local controller operates independently of the master controller and depends on the master controller only for its security and RF settings. You configure the layer-2 and layer-3 settings on the local controller independent of the master controller. The local controller needs to have connectivity to the master controller at all times to ensure that any changes on the master are propagated to the local controller.

Some of the common reasons to move from a single to a multi-controller-environment include:

- Scaling to include a larger coverage area
- Setting up remote Access Points (APs)
- Network setup requires APs to be redistributed from a single controller to multiple controllers

You can use a preshared key (PSK) or a certificate to create IPSec tunnels between a master and backup master controllers and between master and local controllers. These inter-controller IPSec tunnels carry management traffic such as mobility, configuration, and master-local information.

NOTE: An inter-controller IPSec tunnel can be used to route data between networks attached to the controllers if you have installed PEFV licenses in the controllers. To route traffic, configure a static route on each controller specifying the destination network and the name of the IPSec tunnel.

There is a default PSK to allow inter-controller communications, however, for security you need to configure a a unique PSK for each controller pair. You can use either the WebUI or CLI to configure a 6-64 character PSK on master and local controllers. To configure a unique PSK for each controller pair, you must configure the master controller with the IP address of the local and the PSK, and configure the local controller with the IP address of the master and the PSK.

You can configure a global PSK for all master-local communications, although this is not recommended for networks with more than two controllers. On the master controller, use 0.0.0.0 for the IP address of the local. On the local controller, configure the IP address of the master and the PSK.

The local controller can be located behind a NAT device or over the Internet. On the local controller, when you specify the IP address of the master controller, use the public IP address for the master.

If your master and local controllers use a pre-shared key for authentication, the IPsec tunnel will be created using IKEv1. If they use a factory-installed or custom certificate, they will use IKEv2 to create the IPsec tunnel. Controllers using IKEv2 and custom-installed certificates can optionally use Suite-B encryption for IPsec

encryption. For details and requirements for Suite-B encryption, see "Configuring an SSID for Suite-B cryptography" on page 152.

Configuring a Preshared Key

Leaving the PSK set to the default value exposes the IPSec channel to serious risk, therefore you should always configure a unique PSK for each controller pair.

Sharing the same PSK between more than two controllers increases the likelihood of compromise. If one controller is compromised, all controllers are compromised. Therefore, best security practices include configuring a unique PSK for each controller pair

CAUTION: Do not use the default global PSK on a master or stand-alone controller. If you have a multi-controller network then configure the local controllers to match the new IPSec PSK key on the master controller.

Weak keys are susceptible to offline dictionary attacks, meaning that a hostile eavesdropper can capture a few packets during connection setup and derive the PSK, thus compromising the connection. Therefore the PSK selection process should be the same process as selecting a strong passphrase:

- the PSK should be at least ten characters in length
- the PSK should not be a dictionary word
- the PSK should combine characters from at least three of the following four groups:
  - lowercase characters
  - uppercase characters
  - numbers
  - punctuation or special characters, such as ~‘@#$%^&*()_-+=\|//.[]{}

The following sections describe how to configure a PSK using the WebUI or CLI.

Using the WebUI to configure a Local Controller PSK

1. Navigate to the Configuration > Network > Controller > System Settings page.
2. The procedure to configure a local PSK varies, depending upon whether it is configured using a local controller or a master controller.
   - On a local controller, enter the IPSec key in the IPSec Key (IKE PSK) and Retype IPSec Key (IKE PSK) fields.
   - On a master controller, click New under Local Controller IPSec Keys. then enter the local controller IP address and then enter and retype the IPSec key. Click Add.
3. Click Apply.

Using the WebUI to configure a Master Controller PSK

Use the procedure below to configures the IP address and preshared key for the master controller.

1. Navigate to the Configuration > Network > Controller > System Settings page.
2. In the IPSEC Key (IKE PSK) field, enter the IPSec key. Reenter this key in the Retype IPSEC Key (IKE PSK) field.
3. (Optional) In the FQDN field, enter a fully qualified domain name used in IKE.
4. (Optional) Click the Source IP address field and select the VLAN ID of Vlan interface to initiate IKE. The controller IP address will be used if the VLAN is not specified.
5. Click Apply.

Using the CLI to configure a PSK

Master Controller

On the master controller you can configure a specific IPSec PSK for a local controller and use the localip 0.0.0.0 ipsec command:

NOTE: You need to change the secret key to a non-default PSK key value even if you use a per-local controller PSK key configuration.

```
localip 0.0.0.0 ipsec <secret_key>
localip <ipaddr> ipsec <secret_key>
```

Local Controller

On the local controller the secret key (PSK) must match the master controller's PSK.

```
masterip <ipaddr> ipsec <secret_key> [fqdn <fqdn>][uplink][vlan <id>]
```

Configuring a Controller Certificate

The following sections describe how to use the command-line interface to select a factory-installed or custom certificate for secure inter-controller communication.

Using the CLI to configure a Local Controller Certificate

- Issue the following command on a master controller to configure the factory-installed certificate for secure communication between that master and a local controller.

  ```
  local-factory-cert local-mac <lmac>
  ```

  In this command, <lmac> is the MAC address of the local controller's factory-installed certificate.
- Issue the following command on a master controller to configure a custom certificate for secure communication between that master and a local controller.

  ```
  local-custom-cert local-mac <lmac> ca-cert <ca> server-cert <cert>
  suite-b <gcm-128 | gcm-256>
  ```

  In this command, <lmac> is the MAC address of the local controller's custom certificate.

Using the CLI to configure the Master Controller Certificate

Issue the following command on a local controller to configure the preshared key or certificate for the master controller.

```
masterip <ipaddr>
   ipsec <key> [interface uplink|{vlan <id>}] [fqdn <fqdn>]
   ipsec-custom-cert master-mac1 <mac1> [master-mac2 <mac2>] ca-cert <ca> server-cert
   <cert> [interface uplink|{vlan <id>}] [fqdn <fqdn>] [suite-b gcm-128|gcm-256]
   ipsec-factory-cert master-mac1 <mac1> [master-mac2 <mac2>] [interface uplink|{vlan
   <id>}] [fqdn <fqdn>]
```

Configuring Local Controllers

This section highlights the difference in configuration for both of these scenarios.

The steps involved in migrating from a single to a multi-controller environment are:

1. Configure the role of the local controller to local and specify the IP address of the master.
2. Configure the layer-2 / layer-3 settings on the local controller (VLANs, IP subnets, IP routes).
3. Configure as trusted ports the ports the master and local controller use to communicate with each other.

4. For those APs that need to boot off the local controller, configure the LMS IP address to point to the new local controller.
5. Reboot the APs that are already on the network, so that they now connect to the local controller.

These steps are explained below.

Configuring the Local Controller

You configure the role of a controller by running the initial setup on an unconfigured controller, or by using the WebUI, Controller Wizard, or CLI on a previously-configured controller.

Using the Initial Setup

Initial setup can be done using the browser-based Setup Wizard or by accessing the initial setup dialog via a serial port connection. Both methods are described in the *Dell PowerConnect W-Series ArubaOS Quick Start Guide* and are referred to throughout this chapter as "initial setup."

The initial setup allows you to configure the IP address of the controller and its role, in addition to other operating parameters. You perform the initial setup the first time you connect to and log into the controller or whenever the controller is reset to its factory default configuration (after executing a write erase, reload sequence).

When prompted to enter the controller role in the initial setup, select or enter local to set the controller operational mode to be a local controller. You are then prompted for the master controller IP address. Enter the IP address of the master controller for the WLAN network. Enter the preshared key (PSK) that is used to authenticate communications between controllers.

NOTE: You need to enter the same PSK on the master controller and on the local controllers that are managed by the master.

Using the Web UI

For a controller that is up and operating with layer-3 connectivity, configure the following to set the controller as local:

1. Navigate to the Configuration > Network > Controller > System Settings page.
2. Set the Controller Role to Local.
3. Enter the IP address of the master controller. If master redundancy is enabled on the master, this address should be the VRRP address for the VLAN instance corresponding to the IP address of the controller.
4. Enter the preshared key (PSK) that is used to authenticate communications between controllers.

NOTE: You need to enter the same PSK on the master controller and on the local controllers that are managed by the master.

Using the CLI

For a controller that is up and operating with layer-3 connectivity, configure the following to set the controller as local:

```
masterip <ipaddr> ipsec <key>
```

Configuring Layer-2/Layer-3 Settings

Configure the VLANs, subnets, and IP address on the local controller for IP connectivity.

Verify connectivity to the master controller by pinging the master controller from the local controller.

Ensure that the master controller recognizes the new controller as its local controller. The local controller should be listed with type local in the Monitoring > Network > All WLAN Controllers page on the master. It takes about 4 – 5 minutes for the master and local controllers to synchronize configurations.

Configuring Trusted Ports

On the local controller, navigate to the Configuration > Network > Ports page and make sure that the port on the local controller connecting to the master is trusted. On the master controller, check this for the port on the master controller that connects to the local controller.

Configuring Local Controller Settings

Many controller settings are unique to that device and therefore are not replicated from a master controller to a local controller. The following settings must be manually configured on a local controller that synchronizes with the master controller.

- Time zone and daylight savings time settings
- VPN pools for remote APs and other VPN clients.
- Controller and IP interfaces. (Note that these values may need to be set *before* synchronization with the master so the synchronization can properly complete.)
- IP routing and spanning-tree configurations
- Remote AP whitelist and local-user database values

NOTE: By default, the local controllers forward the authentication requests for the RAP whitelist and the local user database to the master controller. Therefore, this data does not have to be manually replicated *unless* the default behavior has been altered. The user table is NOT synchronized, so if an AP fails over to a master from a local or vice versa, that AP will have to re-authenticate.

- DHCP pools and reservations
- NAT pools
- SNMP, NTP, and syslog settings
- Hostnames, DNS and SMTP servers
- ACLs applied to ports
- Certificates
- RADIUS client details and RADIUS source interfaces
- Stateful firewall settings
- Customized captive portal pages and images, and the captive portal redirect address.

Configuring APs

APs download their configurations from a master controller. However, an AP or AP group can tunnel client traffic to a local controller. To specify the controller to which an AP or AP group tunnels client traffic, you configure the LMS IP in the AP system profile on the master controller.

Configuration changes take effect only after you reboot the affected APs; this allows them to reassociate with the local controller. After rebooting, these APs appear to the new local controller as local APs.

Using the WebUI to configure the LMS IP

1. Navigate to the Configuration > Wireless > AP Configuration page.
   - If you select AP Group, click Edit for the AP group name for which you want to configure the LMS IP.
   - If you select AP Specific, select the name of the AP for which you want to configure the LMS IP.
2. Under the Profiles section, select AP to display the AP profiles.

3. Select the AP system profile you want to modify.
4. Enter the controller IP address in the LMS IP field.
5. Click Apply.

Using the CLI to configure the LMS IP

```
ap system-profile <profile>
   lms-ip <ipaddr>

ap-group <group>
   ap-system-profile <profile>

ap-name <name>
   ap-system-profile <profile>
```

Chapter 22

Remote Nodes

A remote node (RN) is an easy-to-provision controller that can get its local and global configuration and license limits from a central controller called a remote node controller (RNC). You define configuration settings for each RN via an remote-node profile on the RNC, which can be either a local controller or a master controller. Each RN configuration profile defines values for VLANs, VLAN interfaces, GRE tunnels, and management users for one or more RNs.

RNs offer the following advantages over a standard local controller:

- Centralized management: RN configuration settings, licenses and debugging tasks can all be managed from a single RNC.
- Low-Touch Provisioning: Similar to a remote AP, an RN requires just an uplink IP address and pre-shared key or certificate to boot up and connect to the RNC.
- Ease of expansion: Additional RNs can be added to the network at any time and become active with an existing RN profile. No additional profile changes are required.
- Single Sign-On: You can manage all RNs attached to a RNC from the RNC WebUI.

The VLANs and IP Addresses for RNs are managed by the master RNC using DHCP pool assignments. Dynamic DHCP pools are allocated to each VLAN or Tunnel type on the master RNC, and then are pushed to each RN when it comes up. The IP address of the RN acting as the DNS proxy server will be pushed along with the DHCP pool settings.

When you first install an RN at a remote site, you will use the initial setup wizard to define that controller as a RN, and specify the IP address of the RNC and the IPsec key or certificate the RN will use to contact the RNC over a secure IPsec tunnel. Once the initial setup is complete, the RN will connect to its RNC via an IPsec tunnel. The RNC checks a whitelist to verify that the RN is valid. Once the RN has been validated, it will request its local and global configuration from the RNC. The RNC then sends the RN the configuration settings in its RN configuration profile. Licenses for each RN are also installed on and maintained by its RNC, which acts as a licensing server and disseminates licenses to all RNs assigned to that RNC.

After the RN is provisioned and active on the network, management users can edit the RN's configuration via the RN configuration profile on the RNC.

NOTE: Only W-3000 Series and W-600 Series controllers can be configured as remote nodes.

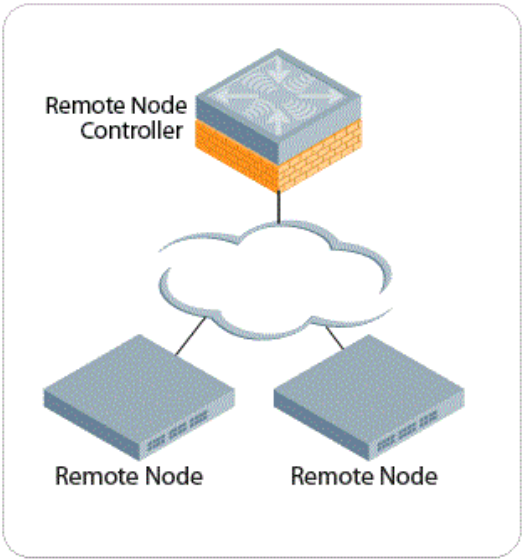
This chapter describes the following procedures in the recommended order in which they should be performed:

Creating Remote Node Profiles

Before you begin to configure settings for individual RNs, you must select a master or local controller to serve as a RNC on the network. A controller can act either as a RN or as a RNC, but not both. The following topology shows

a master controller with two local controllers configured as RNCs. Each RNC in this example manages two individual RNs.

Figure 75 *Remote Nodes in a Network*



Once you have decided which controller you want to configure as a RN, follow the steps below to create a new remote-node profile and activate that profile by validating that it has been correctly configured. Note that you can only create a remote note profile via the command-line interface; there is no WebUI support for this feature.

Adding a New Remote Node Profile

To create a new RN configuration profile, access the command-line interface on the RNC, enter config mode, then issue the command

```
remote-node-profile <profile-name>
```

Once in remote-node profile configuration mode, you can issue any of the following commands to define the values you want to assign to that profile. Required parameters are in bold.

After you have defined configuration settings for an RN profile, you must activate that profile by issuing the command remote-node-profile <profile-name> validate to validate that the configuration has a correctly defined defined uplink, model type, and an interface type supported by the RN model.

NOTE: You cannot assign an RN configuration profile to an RN until that profile has been activated.

Use the commands listed in the table below to configure a Remote Node profile. For complete details on each command refer to the ArubaOS Command-Line Interface Reference Guide.

Table 87 *Configuration Commands Available in Remote-Node Profile Mode*

Command	Description
`aaa`	Configure an authentication server.
`remote-node-dhcp-pool`	Define an RN IP address pool. For details on using this command, see "Defining Remote Node Address Pools" on page 461.
`cellular profile <name>`	Cellular interface profile associated with this RN profile.
`clone <profile-name>`	Use this command to make a copy of another RN profile.

Table 87 *Configuration Commands Available in Remote-Node Profile Mode (Continued)*

Command	Description
`controller-ip loopback vlan <id>`	Configure the controller IP. For details on using this command, see "controller-ip" on page 175.
`dialer group <name>`	Dialer group profile associated with this RN profile.
`instance`	Configure the RN MAC address.
`interface`	Configure the RN interface • cellular—Configure the cellular Interface. • fastethernet—Configure the FastEthernet (IEEE 802.3) interface. • gigabitethernet—Configure the GigabitEthernet Interface. • loopback—Configure the Loopback Interface. • port-channel—Configure the Ethernet channel of interfaces. • tunnel—Configure the Tunnel interface. • vlan —Configure the Switch VLAN Virtual Interface. NOTE: The VLAN ID mapped using the "interface vlan <id> ip address" command can use the following parameters to define how the controller-ip is derived: ▪ **dhcp-client**: The RN will use DHCP to obtain IP address ▪ **internal**: Then RN IP will be derived from the RN DHCP pool. ▪ **pppoe:** Use PPPoE to obtain IP address
`ip`	Interface Internet Protocol config commands
`logging`	Set the logging level up to which messages are logged. • alerts • critical • debugging • emergencies • errors • informational • notifications • warnings
`mgmt-user`	Configure a management user
`model`	Controller model associated to the RN profile, where <model-type> is one of the following controller model types: • W-3200 • W-3400 • W-3600 • W-620 • W-650 • W-651
`priority-map`	Priority Map specification, used to prioritize the incoming packets on an interface.
`spanning-tree`	Create a Spanning Tree Subsystem
`uplink`	Define an uplink manager configuration
`vlan`	Create an RN VLAN Virtual Interface
`vrrp`	Define a Virtual Router Redundancy Protocol (VRRP) configuration.

Defining Remote Node Address Pools

Each RN must have a pool of addresses it can dynamically assign to APs or Users on each of its VLANs, and a separate IP address that RN will use to create a GRE tunnel to the RNC. RN VLAN pools and the tunnel pool are

defined on the RNC. Remote Node address pools are pushed out to each RN when it comes up on the network. If a RN is removed from the RNC, the IP addresses allocated to that RN can be reused and reassigned to a new RN.

An RNC must have a separate VLAN pool defined for each VLAN used by its RNs. A VLAN pool allocates a static, continuous block of multiple IP addresses to each RN. The RN will act as a DNS proxy server and dynamically assign IP addresses from its allocated pool to each AP or client on the VLAN.

The tunnel pool on an RNC defines a range of IP addresses that the RNs will use to create a GRE tunnel within the IPsec tunnel back to the RNC. Unlike VLAN pools, which allocates multiple addresses to each RN VLAN, the tunnel DHCP pool assigns a single tunnel IP address to each RN.

NOTE: Any change to an active RN's DHCP pool configuration will cause the RN to reboot.

To define an RN DHCP pool, access config mode on the RNC's command-line interface, and issue the following command:

```
remote-node-profile <profile-name> remote-node-dhcp-pool <pool-name>
   pool-type {vlan <id>}|tunnel
   range startip <start-ip> endip <end-ip> num_hosts
```

This command includes the following parameters:

Table 88 *Remote Node DHCP Address Pool Parameters*

Parameter	Description
`<pool-name>`	The name of the new DHCP pool.
`pool-type {vlan <id>}|tunnel`	Specify whether you are creating a pool of IP addresses for RN VLANs or RN tunnels.
`<id>`	The ID number of the VLAN associated with the RN.
`<start-ip>`	IP addresses at the start and end of the RN's address range, in dotted-decimal format.
`end-ip>`	IP address at the end of the RN's address range, in dotted-decimal format.
`num_hosts`	Maximum number of hosts supported by an RN using this pool.

OSPF and Static Routes

The remote node profile must be configured with static route that allows the RN to get to the RNC. This static profile will get pushed to from the RNC to the RN with the rest of the remote node profile settings.

You cannot configure a static route on the RNC itself because the RNC will not know which RN will be terminating on which tunnel. Therefore, the RNC handles the route from the RNC to each RN in one of two different ways.

- Static Routes: This routes are automatically generated automatically when the tunnel comes up.
- OSPF Routes: This routes are redistributed from the RN to the RNC once the OSPF is established over the tunnel.

Configuration Examples

The following set of commands configures an remote-node profile named Location_1. This example defines settings for a VLAN and VLAN interfaces, management users, and an RN dhcp pool for a W-3200 model controller.

Create a remote node profile

```
remote-node-profile remote-node-pilot-620
  model 620
  controller-ip vlan 10
```

Define VLANs for a remote node profile and assign a wired aaa profile to each VLAN

```
  vlan 10
  vlan 20
  vlan 10 wired aaa-profile "corp-captive-portal"
  vlan 20 wired aaa-profile "guest-captive-portal"
  interface fastethernet "1/4"
    switchport access vlan 20
    trusted
    ip access-group "wired-source-nat" session
  !
```

Identify the RN interfaces to be used as access ports for each VLAN

The following commands make those ports trusted ports and assign an AP access group to each interface to apply an access control list (ACL) to the interface.

```
  interface fastethernet "1/6"
    switchport access vlan 20
    trusted
    ip access-group "wired-source-nat" session
  !
  interface fastethernet "1/0"
    switchport access vlan 10
    trusted
  !
  interface fastethernet "1/5"
    switchport access vlan 20
    trusted
    ip access-group "wired-source-nat" session
  !
  interface fastethernet "1/7"
    switchport access vlan 20
    trusted
    ip access-group "wired-source-nat" session
  !
  interface fastethernet "1/2"
    switchport access vlan 10
    trusted
    ip access-group "wired-source-nat" session
  !
  interface fastethernet "1/3"
    switchport access vlan 10
  !
  interface fastethernet "1/1"
    switchport access vlan 10
    trusted
  !
```

Configure each VLAN interface with an internal IP address

Internal IP addresses are allocated from the RN address pool:

```
  interface vlan 20
    ip address internal
```

```
  operstate up
!
interface vlan 10
  ip address internal
!
```

Manage and configure the uplink network connection

```
uplink wired vlan 2
interface tunnel 1
  tunnel source controller-ip
  tunnel destination remote-node-master-ip
  ip address internal
  ip ospf area 1.1.1.1
  trusted
!
```

Configure the uplink network connection and define a static IPsec route map

```
no spanning-tree
ip route 10.100.0.0 255.255.0.0 ipsec "default-boc-bm-ipsecmap"
ip route 10.1.0.0 255.255.0.0 ipsec "default-boc-bm-ipsecmap"
ip route 10.0.0.0 255.0.0.0 ipsec "default-boc-bm-ipsecmap"
```

Configure user roles and passwords for administrative users

```
  mgmt-user "admin" "root" "1be34780250627e4881460a6e332ea5d"
  mgmt-user "guest-master" "guest-provisioning"
"894936fc71d7a1c0677e5d5542c51b16c801e6ab72be4793"
```

Define the server used for name and address resolution

```
ip name-server 10.1.1.50
```

Define the OSPF settings for the upstream router

```
router ospf area 1.1.1.1 stub
router ospf redistribute vlan "10"
router ospf
```

(Optional) Define SNMP settings

```
snmp-server enable trap
```

Specify that the RN use its internal database to authenticate clients

```
aaa authentication-server internal use-local-switch
```

Define NAT settings and identify the interface for outgoing RADIUS packets

The IP address of the specified interface is included in the IP header of RADIUS packets:

```
ip radius source-interface vlan "10"
ip nat pool "dynamic-srcnat" "0.0.0.0" "0.0.0.0"
```

Define DHCP pools for a RN tunnel

```
remote-node-dhcp-pool tunnel1
    pool-type tunnel 1
    domain-name arubanetworks.com
    range startip 1.1.1.0 endip 1.1.2.0 hosts 1
  !
```

Define RN DHCP pools for each VLAN

```
  remote-node-dhcp-pool vlan10
    pool-type vlan 10
    domain-name arubanetworks.com
    range startip 10.71.10.0 endip 10.71.11.0 hosts 16
  !
  remote-node-dhcp-pool vlan20
    pool-type vlan 20
    domain-name arubanetworks.com
    range startip 10.71.20.0 endip 10.71.21.0 hosts 16
  !
!
```

Once the profile has been sent from the RNC to the RN at the remote site, that profile will create the following configuration on the RN.

```
controller-ip vlan 10
vlan 10
vlan 20
vlan 10 wired aaa-profile "corp-captive-portal"
vlan 20 wired aaa-profile "guest-captive-portal"
interface fastethernet "1/4"
  interface fastethernet "1/4" switchport access vlan 20
  interface fastethernet "1/4" trusted
  interface fastethernet "1/4" ip access-group "wired-source-nat" session
interface fastethernet "1/6"
  interface fastethernet "1/6" switchport access vlan 20
  interface fastethernet "1/6" trusted
  interface fastethernet "1/6" ip access-group "wired-source-nat" session
interface fastethernet "1/0"
  interface fastethernet "1/0" switchport access vlan 10
  interface fastethernet "1/0" trusted
interface fastethernet "1/5"
  interface fastethernet "1/5" switchport access vlan 20
  interface fastethernet "1/5" trusted
  interface fastethernet "1/5" ip access-group "wired-source-nat" session
interface fastethernet "1/7"
  interface fastethernet "1/7" switchport access vlan 20
  interface fastethernet "1/7" trusted
  interface fastethernet "1/7" ip access-group "wired-source-nat" session
interface fastethernet "1/2"
  interface fastethernet "1/2" switchport access vlan 10
  interface fastethernet "1/2" trusted
  interface fastethernet "1/2" ip access-group "wired-source-nat" session
interface fastethernet "1/3"
  interface fastethernet "1/3" switchport access vlan 10
interface fastethernet "1/1"
  interface fastethernet "1/1" switchport access vlan 10
  interface fastethernet "1/1" trusted
interface vlan 20
```

```
  interface vlan 20 ip address 10.71.20.241 255.255.255.240
  interface vlan 20 operstate up
interface vlan 10
  interface vlan 10 ip address 10.71.10.241 255.255.255.240
uplink wired vlan 2
interface tunnel 1
  interface tunnel 1 tunnel source controller-ip
  interface tunnel 1 tunnel destination remote-node-master-ip
  interface tunnel 1 ip address 1.1.1.61 255.255.255.252
  interface tunnel 1 ip ospf area 1.1.1.1
  interface tunnel 1 trusted
no spanning-tree
ip route 10.100.0.0 255.255.0.0 ipsec "default-boc-bm-ipsecmap"
ip route 10.1.0.0 255.255.0.0 ipsec "default-boc-bm-ipsecmap"
ip route 10.0.0.0 255.0.0.0 ipsec "default-boc-bm-ipsecmap"
mgmt-user "admin" "root" "1be34780250627e4881460a6e332ea5d"
mgmt-user "guest-master" "guest-provisioning"
"894936fc71d7a1c0677e5d5542c51b16c801e6ab72be4793"
ip name-server 10.1.1.50
router ospf area 1.1.1.1 stub
router ospf redistribute vlan "10"
router ospf
snmp-server enable trap
aaa authentication-server internal use-local-switch
ip radius source-interface vlan "10"
ip nat pool "dynamic-srcnat" "0.0.0.0" "0.0.0.0"
service dhcp
ip dhcp pool vlan10 domain-name arubanetworks.com
ip dhcp pool vlan10
ip dhcp pool vlan10 default-router 10.71.10.241
ip dhcp pool vlan10 dns-server 10.71.10.241
ip dhcp pool vlan10 network 10.71.10.240 255.255.255.240
ip dhcp pool vlan20 domain-name arubanetworks.com
ip dhcp pool vlan20
ip dhcp pool vlan20 default-router 10.71.20.241
ip dhcp pool vlan20 dns-server 10.71.20.241
ip dhcp pool vlan20 network 10.71.20.240 255.255.255.240
ip dhcp pool vlan10 domain-name arubanetworks.com
ip dhcp pool vlan10
ip dhcp pool vlan10 default-router 10.71.10.241
ip dhcp pool vlan10 dns-server 10.71.10.241
ip dhcp pool vlan10 network 10.71.10.240 255.255.255.240
ip dhcp pool vlan20 domain-name arubanetworks.com
ip dhcp pool vlan20
ip dhcp pool vlan20 default-router 10.71.20.241
ip dhcp pool vlan20 dns-server 10.71.20.241
ip dhcp pool vlan20 network 10.71.20.240 255.255.255.240
remote-node config-id 155
```

Configuring the Remote Node Whitelist

The Whitelist database links the MAC address of the RN to the RN profile. Validating is done to the RN profile and not per RN.

Adding an RN to the whitelist

To add an RN to the RN whitelist, access the command-line interface of the RNC, enter enable mode, then issue the command

```
local-userdb-remote-node add mac-address <mac-address> remote-node-profile <profile-name>
```

where <mac-address> is the MAC address of the RN in colon-separated six-octet format, and <profile-name> is the name of the RN configuration profile you want to assign to that RN.

Example:

```
(remote-node-master) #local-userdb-remote-node add mac-address 00:16:CF:AF:3E:E1 remote-node-profile Location_1
```

Note that you cannot change the profile assigned to the RN in the whitelist entry. To assign a different configuration to an unprovisioned RN, you must delete the whitelist entry and create a new RN whitelist entry with the correct RN configuration profile.

Removing an RN from the Whitelist

When you remove an entry for an active RN from the RN whitelist on the RNC, that RN will no longer receive configuration or license updates from the RNC, but will continue to operate as previously configured. As the license server is the RNC, any operation related to the licensing will not work after it is detached.If you remove an individual RN entry from the RN whitelist before that RN is connected to the network, that RN will not be automatically provisioned as a RN, and will remain inactive on the network until manually provisioned.

To remove an RN from the RN whitelist, access the command-line interface of the RNC, access enable mode, then enter the command

```
local-userdb-remote-node del mac-address <mac-address>
```

where <mac-address> is the MAC address of the RN, in colon-separated six-octet format.

Example:

```
(remote-node-master)(config) #local-userdb-remote-node del mac-address 00:16:CF:AF:3E:E1
```

Viewing Remote Node Whitelist Settings

To view the RN whitelist, access the command-line interface of a RNC and issue the following command from enable mode:

```
show local-userdb-remote-node
   mac-address <mac-addr>
   start <offset>
```

If your network incudes multiple RNCs under a single master controller (like the topology shown in on page 460) the output of this command will show all RNs and RNCs on the network. By default, this command displays all entries in the whitelist. To display only part of the RN whitelist, include the start <offset> parameters to start displaying the RN whitelist at the specified entry value. You can also include the optional mac-address <mac-addr> parameters to display values for a single RN entry.

Installing the Remote Node at the Remote Site

To install and provision an RN at a remote site you will need to supply the information described in the checklist below. Before you install the RN on your network, fill in the third column of this initial setup checklist with your settings. Use the procedure in the Quick Start guide to launch the initial setup wizard for RN, and enter the values in Table 89. You may need to consult your system administrator or network administrator

Table 89 *RN Provisioning Checklist*

Parameter	Description	Your Setting
Name	Name of the RN	
Date/Time and Country Code	Current date and time at the RN's location and the country code. If you want the RN to take its date and time settings from a NTP server, specify the IP address of that server.	
IP address of the RNC	IP address of the RNC, in dotted-decimal format.	
Shared key	Shared key to communicate with the RNC controller. If secure communication between the RNC and the RN is based upon a certificate rather than a shared key, this parameter is not necessary.	
Uplink Type	Specify whether the RN uplink will connect through a wired port or a cellular modem. You must also specify if the uplink is defined as a Static IP address, PPPoE (Point-to-Point Protocol over Ethernet), or an address assigned via a DHCP server.	
Static IP address	If Uplink type is Wired Static: Uplink port, name and IP address of a VLAN.	
PPPoE	If Uplink type is Wired PPoE: Uplink port, VLAN name and username.	
DHCP server	If Uplink type is Wired DHCP: Uplink port and name of VLAN.	

Monitoring and Managing Remote Nodes

After you have created and validated your RN configuration profiles and added an entry for each RN to the RN whitelist on the RNC, you can start installing individual RNs. When you first connect a RN to your network, that RN contacts its RNC as soon as it powers up. If the RN has an entry in the RN whitelist, the RNC validates the RN on the network and sends it its configuration over a secure IPsec tunnel. Once the RN has received its configuration from the RNC, the RN will reboot then become active and able to serve hosts on the network.

Editing a Remote Node Configuration

If you want to change RN configuration settings, you must do so by editing the RN configuration profile on the RNC, rather than through the CLI or WebUI of the RN itself.

1. Access the CLI of the RNC for the RN you want to edit.
2. From config mode, enter the command remote-node-profile <profile-name>, where <profile-name> is the name of the RN-profile assigned to the RN you want to edit.

Once in remote-node profile configuration mode, you can issue any of the commands shown in Table 87 to define the values you want to assign to that profile.

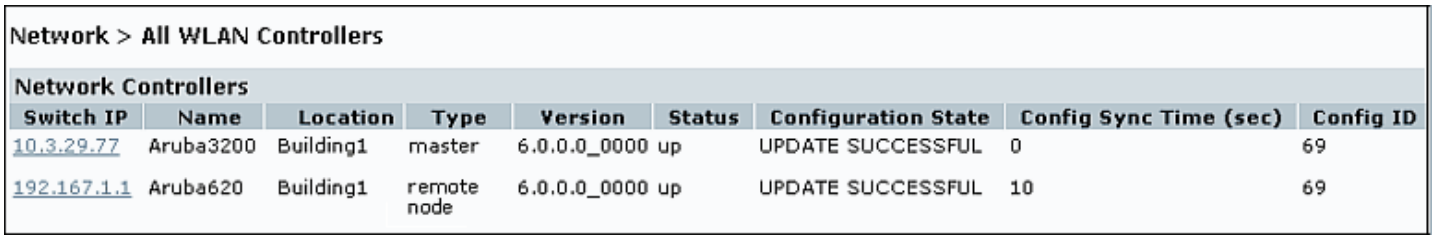
Monitoring a Remote Node

You can monitor an RN from its RNC WebUI. Although a management user can access the RN monitoring page via the RN WebUI, the WebUI is disabled on the RN itself. To access the RN directly, you must use the RN command-line interface. Note, however, that users logging directly into the RN CLI will not be able to save any configuration changes locally

In the WebUI

The Monitoring window on the RNC WebUI includes a link that lets you view a network summary for each RN, including WLAN Network Status and the WLAN Performance Summary.

Figure 76 *Selecting an RN via the WLAN Controllers*



To view a detailed network summary for an individual RN:

1. Access the WebUI of the RNC and navigate to Monitor>Network>All WLAN Controllers. You can identify the RNs on your network using Type column in the Network Controllers table; entries for RNs have the Remote Node type.
2. From the WLAN Controllers table, click the entry for the RN you want to monitor. The Network Summary window for that RN appears in the RNC WebUI.

   The tables in the Network Summary window contain links that allow you to drill down and view additional information about the RN, such as access points or air monitors associated to that RN. To return to the *All WLAN Controllers* window, click the All WLAN Controllers link in the left navigation bar.

In the CLI

The RN command-line interface allows you to view the RN's configuration profile parameters and controller settings. You can also view remote-node profile settings via the command-line interface of the RNC.

Access enable mode on the RN command-line interface to issue show commands for the RN controller. Note, however that the following show commands used to display RN information are not available on the RN, and can be issued only on the RNC CLI. The following commands may be especially useful for managing and troubleshooting the RN controller via the RNC CLI.

Table 90 *Useful RN Show Commands*

Command	Description
show remote-node running-config	Display the configuration settings for all remote-node profiles on the RNC.
show remote-node dhcp-instance <mac-address>	This command will show the RN DHCP address pools used by the specified RN.
show switches remote-node	Lists all the RNs and local controllers associated to the RNC controller. Give more information for debugging purposes per RN.
show local-userdb-remote-node	The output of this command lists the MAC address and assigned RN-profile for of each RN associated with that RNC.

RN Troubleshooting

The All WLAN controllers table in the RNC WebUI and the output of the show switches command in the RNC CLI include the Config ID for each RN. Each time the RNC sends a configuration update to any associated RN or local controller, the RNC increases its Config ID by one. When an RN or local controller acknowledges that the configuration change has been sent, the RNC increases the Config ID for that RN or local controller by one also. Therefore, if the Config ID of an RN or local controller is *lower* than the Config ID of the RNC, that controller may still be waiting to receive a configuration update. If an RN does not seem to be running as expected, verify that the RN can reach its RNC, and that it has successfully downloaded the most recent version of its remote-node profile.

Chapter 23

IP Mobility

A *mobility domain* is a group of Dell controllers among which a wireless user can roam without losing their IP address. Mobility domains are not tied with the master controller, thus it is possible for a user to roam between controllers managed by different master controllers as long as all of the controllers belong to the same mobility domain.

You enable and configure mobility domains only on Dell controllers. No additional software or configuration is required on wireless clients to allow roaming within the domain.

This chapter describes the following topics:

Dell Mobility Architecture

Dell's layer-3 mobility solution is based on the Mobile IP protocol standard, as described in RFC 3344, "IP Mobility Support for IPv4". This standard addresses users who need both network connectivity and mobility within the work environment.

Unlike other layer-3 mobility solutions, an Dell mobility solution does not require that you install mobility software or perform additional configuration on wireless clients. The Dell controllers perform all functions that enable clients to roam within the mobility domain.

In a mobility domain, a *mobile client* is a wireless client that can change its point of attachment from one network to another within the domain. A mobile client receives an IP address (a *home address*) on a *home network*.

A mobile client can detach at any time from its home network and reconnect to a *foreign network* (any network other than the mobile client's home network) within the mobility domain. When a mobile client is connected to a foreign network, it is bound to a *care-of address* that reflects its current point of attachment. A care-of address is the IP address of the Dell controller in the foreign network with which the mobile client is associated.

The *home agent* for the client is the controller where the client appears for the first time when it joins the mobility domain. The home agent is the single point of contact for the client when the client roams. The *foreign agent* for the client is the controller which handles all Mobile IP communication with the home agent on behalf of the client. Traffic sent to a client's home address is intercepted by the home agent and tunneled for delivery to the client on the foreign network. On the foreign network, the foreign agent delivers the tunneled data to the mobile client.

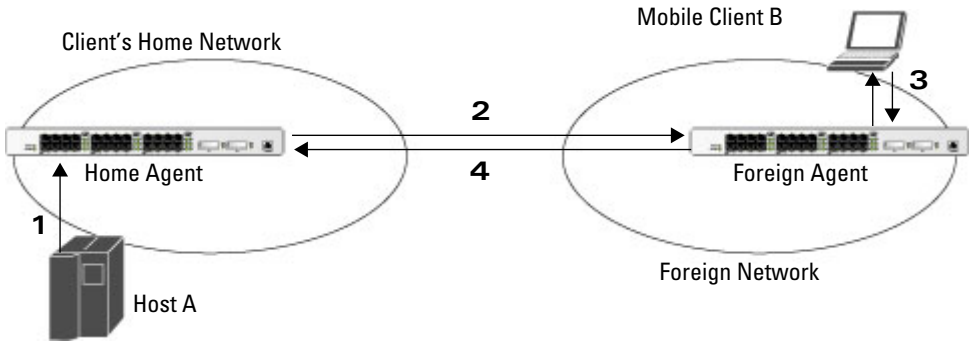
Figure 77 shows the routing of traffic from Host A to Mobile Client B when the client is away from its home network. The client's care-of address is the IP address of the Dell controller in the foreign network.

The numbers in the Figure 77 correspond to the following descriptions:

1. Traffic to Mobile Client B arrives at the client's home network via standard IP routing mechanisms.
2. The traffic is intercepted by the home agent in the client's home network and tunneled to the care-of address in the foreign network.

3. The foreign agent delivers traffic to the mobile client.
4. Traffic sent by Mobile Client B is also tunneled back to the home agent.

Figure 77 *Routing of Traffic to Mobile Client within Mobility Domain*



Configuring Mobility Domains

Before configuring a mobility domain, you should determine the user VLAN(s) for which mobility is required. For example, you may want to allow employees to be able to roam from one subnetwork to another. All controllers that support the VLANs into which employee users can be placed should be part of the same mobility domain.

NOTE: Dell mobility domains are supported only on Dell controllers.

A controller can be part of multiple mobility domains, although Dell recommends that a controller belong to only one domain. The controllers in a mobility domain do not need to be managed by the same master controller.

You configure a mobility domain on a master controller; the mobility domain information is pushed to all local controllers that are managed by the same master controller. On each controller, you must specify the *active* domain (the domain to which the controller belongs). If you do not specify the active domain, the controller will be assigned to a predefined "default" domain.

Although you configure a mobility domain on a master controller, the master controller does not need to be a member of the mobility domain. For example, you could set up a mobility domain that contains only local controllers; you still need to configure the mobility domain on the master controller that manages the local controllers. You can also configure a mobility domain that contains multiple master controllers; you need to configure the mobility domain on each master controller.

The basic tasks you need to perform to configure a mobility domain are listed below. The sections following describe each task in further detail. A sample mobility domain configuration is provided in "Example Configuration" on page 474.

On a master controller:	On all controllers in the mobility domain:
• Configure the mobility domain, including the entries in the home agent table (HAT)	• Enable mobility (disabled by default) • Join a specified mobility domain (not required for "default" mobility domain)

You can enable or disable IP mobility in a virtual AP profile (IP mobility is enabled by default). When IP mobility is enabled in a virtual AP profile, the ESSID that is configured for the virtual AP supports layer-3 mobility. If you disable IP mobility for a virtual AP, any clients that associate to the virtual AP will not have mobility service.

Configuring a Mobility Domain

You configure mobility domains on master controllers. All local controllers managed by the master controller share the list of mobility domains configured on the master. Mobility is disabled by default and must be explicitly enabled on all controllers that will support client mobility. Disabling mobility does not delete any mobility-related configuration.

The home agent table (HAT) maps a user VLAN IP subnet to potential home agent addresses. The mobility feature uses the HAT table to locate a potential home agent for each mobile client, and then uses this information to perform home agent discovery. To configure a mobility domain, you must assign a home agent address to at least one controller with direct access to the user VLAN IP subnet. (Some network topologies may require multiple home agents.)

Dell recommends you configure the switch IP address to match the AP's local controller *or* define the Virtual Router Redundancy Protocol (VRRP) IP address to match the VRRP IP used for controller redundancy. Do not configure both a switch IP address and a VRRP IP address as a home agent address, or multiple home agent discoveries may be sent to the controller.

NOTE: All user VLANs that are part of a mobility domain must have an IP address that can correctly forward layer-3 broadcast multicast traffic to clients when they are away from home network.

Configure the HAT with a list of every subnetwork, mask, VLAN ID, VRRP IP, and home agent IP address in the mobility domain. Include an entry for every home agent and user VLAN to which an IP subnetwork maps. If there is more than one controller in the mobility domain providing service for the same user VLAN, you must configure an entry for the VLAN for each controller. Dell recommends using the same VRRP IP used by the AP.

The mobility domain named "default" is the default active domain for all controllers. If you need only one mobility domain, you can use this default domain. However, you also have the flexibility to create one or more user-defined domains to meet the unique needs of your network topology. Once you assign a controller to a user-defined domain, it automatically leaves the "default" mobility domain. If you want a controller to belong to both the "default" and a user-defined mobility domain at the same time, you must explicitly configure the "default" domain as an active domain for the controller.

Using the WebUI

The following procedure illustrates configuring mobility domain on a master controller.

1. Navigate to the Configuration > Advanced Services > IP Mobility page. Select the Enable IP Mobility checkbox.
2. To configure the default mobility domain, select the "default" domain in the Mobility Domain list.

   To create a new mobility domain, enter the name of the domain in Mobility Domain Name and click Add; the new domain name appears in the Mobility Domain list.
3. Select the newly-created domain name. Click Add under the Subnet column. Enter the subnetwork, mask, VLAN ID, VRIP, and home agent IP address and click Add. Repeat this step for each HAT entry.
4. Click Apply.

Using the CLI

The following command configures mobility domain on a master controller.

```
router mobile
ip mobile domain <name>
      hat <subnetwork> <netmask> <vlan-id> <home-agent-address> description <desc>
```

The VLAN ID must be the VLAN number on the home agent controller.

To view currently-configured mobility domains in the CLI, use the show ip mobile domain command.

Make sure that the ESSID to which the mobile client will connect supports IP mobility. You can disable IP mobility for an ESSID in the virtual AP profile (IP mobility is enabled by default). If you disable IP mobility for a virtual AP, any client that associates to the virtual AP will not have mobility service.

Joining a Mobility Domain

Assigning a controller to a specific mobility domain is the key to defining the roaming area for mobile clients. You should take extra care in planning your mobility domains, including surveying the user VLANs and controllers to which clients can roam, to ensure that there are no roaming holes.

All controllers are initially part of the "default" mobility domain. If you are using the default mobility domain, you do not need to specify this domain as the active domain on a controller. However, once you assign a controller to a user-defined domain, the "default" mobility domain is no longer an active domain on the controller.

In the WebUI

1. Navigate to the Configuration > Advanced Services > IP Mobility page.
2. In the Mobility Domain list, select the mobility domain.
3. Select the Active checkbox for the domain.
4. Click Apply.

In the CLI

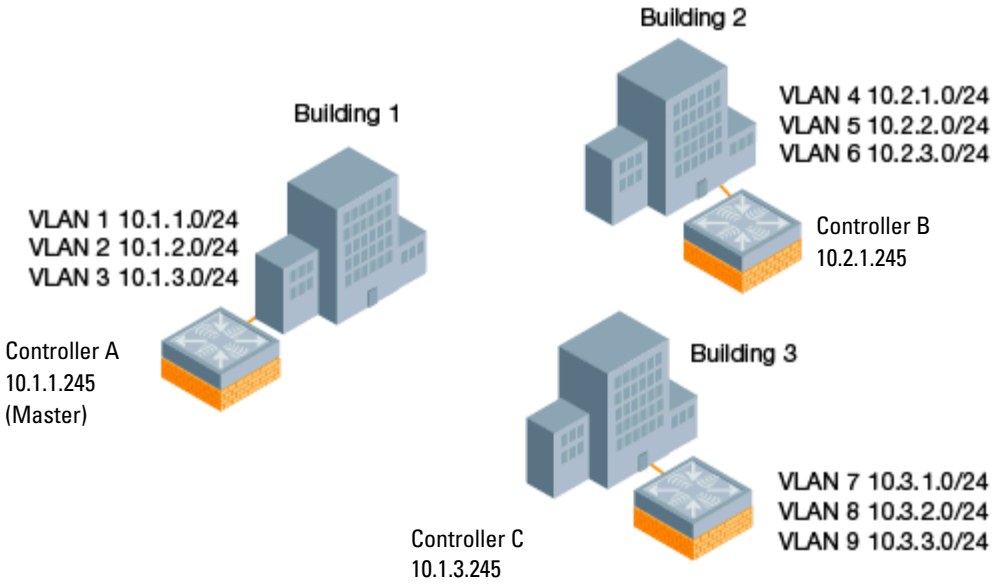
```
ip mobile active-domain <name>
```

To view the active domains in the CLI, use the show ip mobile active-domains command on the controller.

Example Configuration

The following example (Figure 78) configures a network in a campus with three buildings. An Dell controller in each building provides network connections for wireless users on several different user VLANs. To allow wireless users to roam from building to building without interrupting ongoing sessions, you configure a mobility domain that includes all user VLANs on the three controllers. You configure the HAT on the master controller only (controller A in this example). On the local controllers (controllers B and C), you only need to enable mobility.

Figure 78 *Example Configuration: Campus-Wide*



This example uses the "default" mobility domain for the campus-wide roaming area. Since all controllers are initially included in the default mobility domain, you do not need to explicitly configure "default" as the active domain on each controller.

Configuring Mobility using the WebUI

On controller A (the master controller):

1. Navigate to the Configuration > Advanced Services > IP Mobility page.
2. Select the Enable IP Mobility checkbox.
3. Select the "default" domain in the Mobility Domain list.
4. Click Add under the Subnet column. Enter the subnetwork, mask, VLAN ID, home agent IP address, and a description for the first entry shown below and click Add. Repeat this step for each HAT entry.

Table 91 *Example entries*

Subnetwork	Mask	VLAN ID	Home Agent Address or VRIP
10.1.1.0	255.255.255.0	1	10.1.1.245
10.1.1.0	255.255.255.0	1	10.2.1.245
10.1.2.0	255.255.255.0	2	10.1.1.245
10.1.3.0	255.255.255.0	3	10.1.1.245
10.2.1.0	255.255.255.0	4	10.2.1.245
10.2.2.0	255.255.255.0	5	10.2.1.245
10.2.3.0	255.255.255.0	6	10.2.1.245
10.3.1.0	255.255.255.0	7	10.3.1.245
10.3.2.0	255.255.255.0	8	10.3.1.245
10.3.3.0	255.255.255.0	9	10.3.1.245

5. Click Apply.

On controllers B and C:

1. Navigate to the Configuration > Advanced Services > IP Mobility page.
2. Select the Enable IP Mobility checkbox.
3. Click Apply.

Configuring Mobility using the CLI

On controller A (the master controller):

```
ip mobile domain default
   hat 10.1.1.0 255.255.255.0 1 10.1.1.245 description "corporate mobility entry"
   hat 10.1.1.0 255.255.255.0 1 10.2.1.245 description "local entry"
   hat 10.1.2.0 255.255.255.0 2 10.1.1.245 description "reserved rentry"
   hat 10.1.3.0 255.255.255.0 3 10.1.1.245 description "sales team"
   hat 10.2.1.0 255.255.255.0 4 10.2.1.245 description "marketing team"
   hat 10.2.2.0 255.255.255.0 5 10.2.1.245 description "test environment"
   hat 10.2.3.0 255.255.255.0 6 10.2.1.245 description "guess access"
   hat 10.3.1.0 255.255.255.0 7 10.3.1.245 description "backup"
   hat 10.3.2.0 255.255.255.0 8 10.3.1.245 description "reserved"
   hat 10.3.3.0 255.255.255.0 9 10.3.1.245 description "reserved"
router mobile
```

On controllers B and C:

```
router mobile
```

Tracking Mobile Users

This section describes the ways in which you can view information about the status of mobile clients in the mobility domain.

Location-related information for users, such as roaming status, AP name, ESSID, BSSID, and physical type are consistent in both the home agent and foreign agent. The user name, role, and authentication can be different on the home agent and foreign agent, as explained by the following: Whenever a client connects to a controller in a mobility domain, layer-2 authentication is performed and the station obtains the layer-2 (logon) role. When the client roams to other networks, layer-2 authentication is performed and the client obtains the layer-2 role. If layer-3 authentication is required, this authentication is performed on the client's home agent only. The home agent obtains a new role for the client after layer-3 authentication; this new role appears in the user status on the home agent only. Even if re-authentication occurs after the station moves to a foreign agent, the display on the foreign agent still shows the layer-2 role for the user.

Mobile Client Roaming Status

You can view the list of mobile clients and their roaming status on any controller in the mobility domain:

Viewing mobile client status using the WebUI

Navigate to the Monitoring > controller > Clients page.

Viewing mobile client status using the CLI

```
show ip mobile host
```

Roaming status can be one of the following:

Table 92 *Client Roaming Status*

Roaming Status Type	Description
Home Switch/Home VLAN	This controller is the home agent for a station and the client is on the VLAN on which it has an IP address.
Mobile IP Visitor	This controller is not the home agent for a client.
Mobile IP Binding (away)	This controller is the home agent for a client that is currently away.
Home Switch/Foreign VLAN	This controller is the home agent for a client but the client is currently on a different VLAN than its home VLAN (the VLAN from which it acquired its IP address).
Stale	The client does not have connectivity in the mobility domain. Either the controller has received a disassociation message for a client but has not received an association or registration request for the client from another controller, or a home agent binding for the station has expired before being refreshed by a foreign agent.
No Mobility Service	The controller cannot provide mobility service to this client. The mobile client may lose its IP address if it obtains the address via DHCP and has limited connectivity. The mobile client may be using an IP address that cannot be served, or there may be a roaming hole due to improper configuration.

You can view the roaming status of users on any controller in the mobility domain:

Viewing user roaming status using the CLI

```
show user
```

Roaming status can be one of the following:

Table 93 *User Roaming status*

Status Type	Description
Associated	This client is on its home agent controller and the client is on the VLAN on which it has an IP address.
Visitor	This client is visiting this controller and the controller is not its home agent.
Away	This client is currently away from its home agent controller.
Foreign VLAN	This client is on its home agent controller but the client is currently on a different VLAN than the one on which it has an IP address.
Stale	This should be a temporary state as the client will either recover connectivity or the client's entry is deleted when the stale timer expires.

You can use the following CLI command to view the home agent, foreign agent, and roaming status for a specific mobile client.

Viewing specific client information using the CLI

```
show ip mobile trace <ip-address>|<mac-address>
```

Mobile Client Roaming Locations

You can view information about where a mobile user has been in the mobility domain. This information can only be viewed on the client's home agent.

In the WebUI

1. Navigate to the Monitoring > controller > Clients page.
2. Click Status. The mobility state section contains information about the user locations.

In the CLI

```
show ip mobile trail <ip-address>|<mac-address>
```

HA Discovery on Association

In normal circumstances a controller performs an HA discovery only when it is aware of the client's IP address which it learns through the ARP or any L3 packet from the client. This limitation of learning the client's IP and then performing the HA discovery is not effective when the client performs an inter switch move silently (does not send any data packet when in power save mode). This behavior is commonly seen with various handheld devices, Wi-Fi phones, etc. This delays HA discovery and eventually resulting in loss of downstream traffic if any meant for the mobile client.

With HA discovery on association, a controller can perform a HA discovery as soon as the client is associated. This feature can be enabled using the `ha-disc-onassoc` parameter in the `wlan virtual <ap-profile>` command. By default, this feature is disabled. You can enable this on virtual APs with devices in power-save mode and requiring mobility. This option will also poll for all potential HAs.

Setting up Mobility Association Using CLI

```
wlan virtual-ap default ha-disc-onassoc
```

Advanced Mobility Functions

You can configure various parameters that pertain to mobility functions on a controller in a mobility domain using either the WebUI or the CLI.

Configuring Advanced Mobility Functions Using the WebUI

1. Navigate to the Configuration > Advanced Services > IP Mobility page.
2. Select the Global Parameters tab.
3. Configure your desired IP mobility settings. Table 94 describes the parameters you can configure on the Global Parameters tab.

Table 94 *IP Mobility Configuration Parameters*

Parameter	Description
General	
Encapsulation Supported	This parameter shows the type of encapsulation currently supported on the controller.
Clear Trail Entries	Clear the station location trail table. You can view entries in this table using the show ip mobile trail command.
Clear Mobility Counters	Clear counters for IP mobility statistics.

Table 94 *IP Mobility Configuration Parameters (Continued)*

Parameter	Description
Foreign Agent	
lifetime	Requested lifetime, in seconds, as per RFC 3344, "IP Mobility Support for IPv4". The range of allowed values is 10-65534 seconds. The default setting is 180 seconds.
Max. Visitors Allowed	Set a maximum allowed number of active visitors. The range of allowed values for this option is 0-5000 visitors. The default setting is 5000 visitors.
Registration Requests Retransmits	Maximum number of times the foreign agent attempts mobile IP registration message exchanges before giving up. The range of allowed values for this option is 0-5 attempts. The default setting is 3 attempts.
Registration Requests Interval	Retransmission interval, in milliseconds. The range of allowed values for this option is 100-10000 milliseconds, inclusive. The default setting is 1000 milliseconds.
Home Agent	
Replay	Time difference, in seconds, for timestamp-based replay protection, as described by RFC 3344, "IP Mobility Support for IPv4". 0 disables replay. The range of allowed values is 0-5000 seconds. The default setting is 5000 seconds.
Max. Binding Allowed	Maximum number of mobile IP bindings. Note that there is a license-based limit on the number of users and a one user per binding limit in addition to unrelated users. This option is an additional limitation to control the maximum number of roaming users. When the limit is reached, registration requests from the foreign agent fail which causes a mobile client to set a new session on the visited controller, which will become its home controller. The range of allowed values is 0-300 seconds. The default setting is 7 seconds.
Proxy Mobile IP	
Trigger Mobility on Station Association	If enabled, mobility move detection is performed when the client associates with the controller instead of when the client sends packets. This option is enabled by default. Mobility on association can speed up roaming and improve connectivity for devices that do not send many uplink packets out that can trigger mobility. The downside to this option is lowered security; an association is all it takes to trigger mobility, however, this is irrelevant unless layer-2 security is enforced.
Stand Alone AP Support	Enables support for third party or standalone APs. When this is enabled, broadcast packets are not used to trigger mobility and packets from untrusted interfaces are accepted. If mobility is enabled, you must also enable standalone AP for the client to connect to the controller's untrusted port. If the controller learns wired users via the following methods, enable standalone AP: • Third party AP connected to the controller through the untrusted port. • Clients connected to ENET1 on the AP-70???. • Wired user connected directly to the controller's untrusted port. When IP mobility is enabled, you must also enable the Stand Alone AP Support option so that a tunneled node server can perform properly and display all wired users who are connected to a tunneled node port.
Mobility Trail Logging	Enables logging at the notification level for mobile client moves.
Roaming for Authenticated Stations Only	Allows a client to roam only if has been authenticated. If a client has not been authenticated, no mobility service is offered if it roams to a different VLAN or controller.
Blocking DHCP Release from stations	Determines whether DHCP release packets generated from the client should be dropped or forwarded to the DHCP server. Blocking the packets prevents the DHCP server from assigning the same IP address to another client until the lease has expired.
Re-Homing for Voice Capable Client	Allows on-hook phones to be assigned a new home agent. This is to load balance voice client home agents across controllers in a mobility domain. This parameter requires that you install the Policy Enforcement Firewall Next Generation (PEFNG) license in the controller, and is disabled by default.

Table 94 *IP Mobility Configuration Parameters (Continued)*

Parameter	Description
Max. Station Mobility Events per Second	Maximum number of mobility events (events that can trigger mobility) handled per second. Mobility events above this threshold are ignored. This helps to control frequent mobility state changes when the client bounces back and forth on APs before settling down. The allowed range of values is 1-65535 events, and the default value is 25 events.
Station Trail Timeout	Specifies the maximum interval, in seconds, an inactive mobility trail is held. The allowed range of values is 120-86400 seconds, and the default value is 3600 seconds.
Station Trail Max. Entries	Specifies the maximum number of entries (client moves) stored in the user mobility trail. The allowed range of values is 1-100 entries, and the default value is 30 entries.
Mobility Host Entry Hold Time	Number of seconds the mobility state is retained after the loss of connectivity. This allows authentication state and mobility information to be preserved on the home agent controller. The default is 60 seconds but can be safely increased. Note that in many case a station state is deleted without waiting for the stale timeout; user delete from management, foreign agent to foreign agent handoff, etc. (This is different from the no-service-timeout; no-service-timeout occurs up front while the stale-timeout begins when mobility service is provided but the connection is disrupted for some reason.)
Mobility Host Entry Lifetime	Time, in seconds, after which mobility service expires. If nothing has changed from the previous state, the client is given another bridge entry but it will have limited connectivity.
Proxy DHCP	
Max. BOOTP Messages per Transaction	Maximum number of BOOTP packets that are allowed to be handled during one DHCP session. The allowed range of values for tis parameter is 0-65534 packets. The default value is 25.
Max. Time Allowed per DHCP Transaction	Maximum time allowed for a proxy DHCP session to complete. The allowed range of values for this parameter is 1-600 seconds. The default value is 60 seconds.
Time to hold DHCP state after transaction completion	Hold time, in seconds, on proxy DHCP state after completion of DHCP transaction (DHCP ACK) was forwarded to the client. This option ensures that late BOOTP replies reach the station and that a retransmitted BOOTP request does not trigger a new proxy DHCP session. The allowed range of values for this parameter is 1-600 seconds. The default value is 5 seconds.
Revocation	
Retransmits	Maximum number of times the home agent or foreign agent attempts mobile IP registration/ revocation message exchanges before giving up. The allowed range of values for this parameter is 0-5 retransmissions. The default value is 3 retransmissions.
Interval	Retransmission interval, in milliseconds. The allowed range of values for this parameter is 100-10000 milliseconds. The default value is 1000 milliseconds.

4. Click Apply after setting the parameter.

Configuring Mobility Functions Using CLI

To configure foreign agent functionality, use the following command:

```
ip mobile foreign-agent {lifetime <seconds> | max-visitors <number> |
   registrations {interval <msecs> | retransmits <number>}}
```

To configure home agent functionality, use the following command:

```
ip mobile home-agent {max-bindings <number>|replay <seconds>}
```

To configure proxy mobile IP and DHCP functionality, use the following command:

```
ip mobile proxy
   auth-sta-roam-only | block-dhcp-release | dhcp {aggressive-transaction|ignore-
   options|max-requests <number>|transaction-hold <seconds>|transaction-timeout
```

```
<seconds>}| event-threshold <number> | log-trail | no-service-timeout <seconds> | on-
association |re-home | stale-timeout <seconds> | stand-alone-AP | trail-length
<number> |trail-timeout <seconds>
```

To configure revocation functionality, use the following command:

```
ip mobile revocation {interval <msec>|retransmits <number>
```

To enable packet trace for a given MAC address, use the following command:

```
ip mobile packet-trace <host MAC address>
```

Proxy Mobile IP

The *proxy mobile IP module* in a mobility-enabled controller detects when a mobile client has moved to a foreign network and determines the home agent for a roaming client. The proxy mobile IP module performs the following functions:

- Derives the address of the home agent for a mobile client from the HAT using the mobile client's IP address. If there is more than one possible home agent for a mobile client in the HAT, the proxy mobile IP module uses a discovery mechanism to find the current home agent for the client.
- Detects when a mobile client has moved. Client moves are detected based on ingress port and VLAN changes and mobility is triggered accordingly. For faster roaming convergence between AP(s) on the same controller, it is recommended that you keep the "on-association" option enabled. This helps trigger mobility as soon as 802.11 association packets are received from the mobile client.

Proxy DHCP

When a mobile client first associates with a controller, it sends a DHCP discover request with no requested IP. The controller allows DHCP packets for the client onto the configured VLAN where, presumably, it will receive an IP address. The incoming VLAN becomes the client's home VLAN.

If a mobile client moves to another AP on the same controller that places the client on a different VLAN than its initial (home) VLAN, the *proxy DHCP module* redirects packets from the client's current/visited VLAN to the home VLAN. The proxy DHCP module also redirects DHCP packets for the client from the home VLAN to the visited VLAN.

If the mobile client moves to another controller, the proxy DHCP module attempts to discover if the client has an ongoing session on a different controller. When a remote controller is identified, all DHCP packets from the client are sent to the home agent where they are replayed on the home VLAN. The proxy DHCP module also redirects DHCP packets for the client from the home VLAN to the visited network. In either situation, operations of the proxy DHCP module do not replace DHCP relay functions which can still operate on the client's home VLAN, either in the controller or in another device.

Revocations

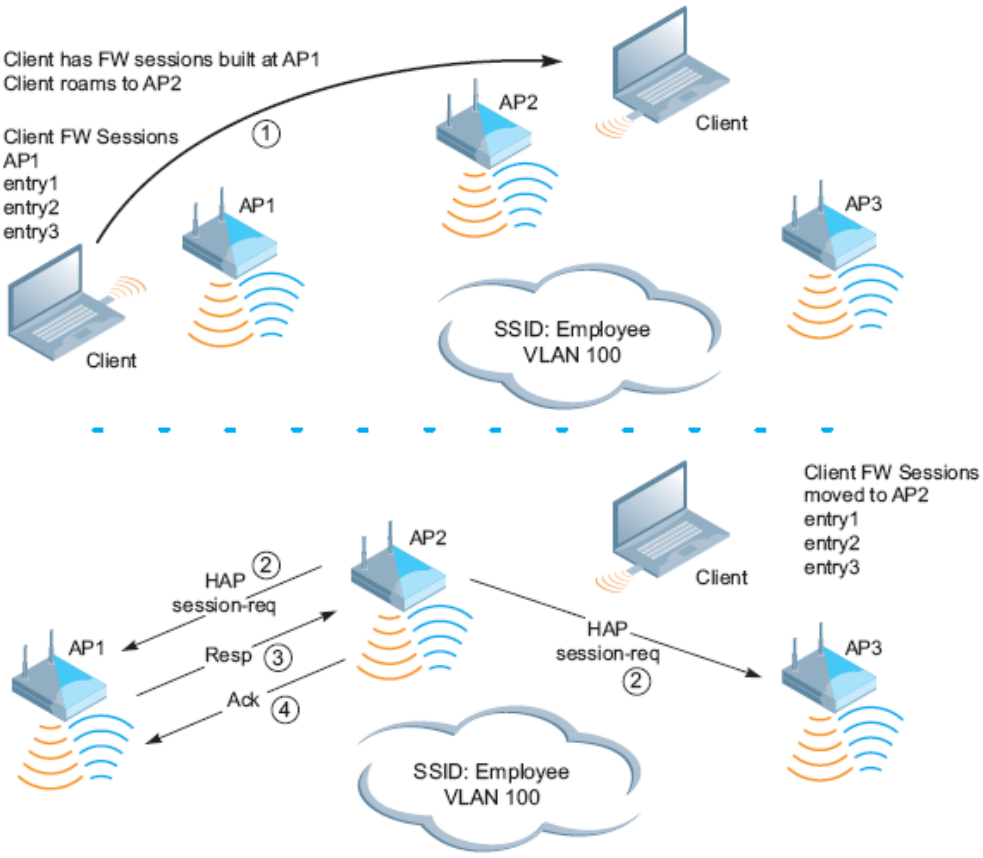
A home agent or foreign agent can send a registration revocation message, which revokes registration service for the mobile client. For example, when a mobile client roams from one foreign agent to another, the home agent can send a registration revocation message to the first foreign agent so that the foreign agent can free any resources held for the client.

Bridge Mode Mobility

In bridge mode deployments, it is possible that more than one AP could be deployed in a single location. Therefore, APs in bridge forwarding mode support firewall session synchronization, which allows clients to retain their current session and IP address as they roam between different bridge mode APs on the same layer-2 network.

The bridge mode mobility feature facilitates client mobility on up to 32 layer-2 connected APs by allowing the APs to communicate and share user state as the user roams from AP to AP. This mechanism is always enabled when an AP is set to bridge mode, and it requires that all of the APs where roaming will occur be on the same Layer 2 segment.

Figure 79 *Bridge Mode Mobility*



The roaming process occurs as follows:

1. A client begins to roam from AP1 and starts an association with AP2.
2. AP2 sends a broadcast message to all APs on the local layer-2 network asking if any other AP has a current session state for the roaming client.
3. Only AP1 responds to the broadcast, and sends the current session table of the client.
4. AP2 acknowledges the receipt of the session table.
5. AP1 deletes the session state of the client.
6. Roaming is complete.

Mobility Multicast

Internet Protocol (IP) multicast is a network addressing method used to simultaneously deliver a single stream of information from one sender to multiple clients on a network. Unlike broadcast traffic, which is meant for all hosts in a single domain, multicast traffic is sent only to those specific hosts who are configured to receive such traffic. Clients who want to receive multicast traffic can join a multicast group via IGMP messages. Upstream routers use IGMP message information to compute multicast routing tables and determine the outgoing interfaces for each multicast group stream.

In ArubaOS 3.3.x and earlier, when a mobile client moved away from its local network and associated with a VLAN on a foreign controller (or a foreign VLAN on its own controller) the client's multicast membership information would not be available at its new destination, and multicast traffic from the client could be interrupted. ArubaOS 3.4 and later supports mobility multicast enhancements that provide uninterrupted streaming of multicast traffic, regardless of a client's location.

Proxy IGMP and Proxy Remote Subscription

The mobility controller is always aware of the client's location, so the controller can join multicast group(s) on behalf of that mobile client. This feature, called Proxy IGMP, allows the controller to join a multicast group and suppresses the client's IGMP control messages to the upstream multicast router. (The client's IGMP control messages will, however, still be used by controller to maintain a multicast forwarding table.) The multicast IGMP traffic originating from the client will instead be sent from the controller's incoming VLAN interface IP.

The IGMP proxy feature includes both a host implementation and a router implementation. An upstream router sees a Dell controller running IGMP proxy as a host; a client attached to the controller would see the controller as router. When Proxy IGMP is enabled, all multicast clients associated with the controller are hidden from the upstream multicast device or router.

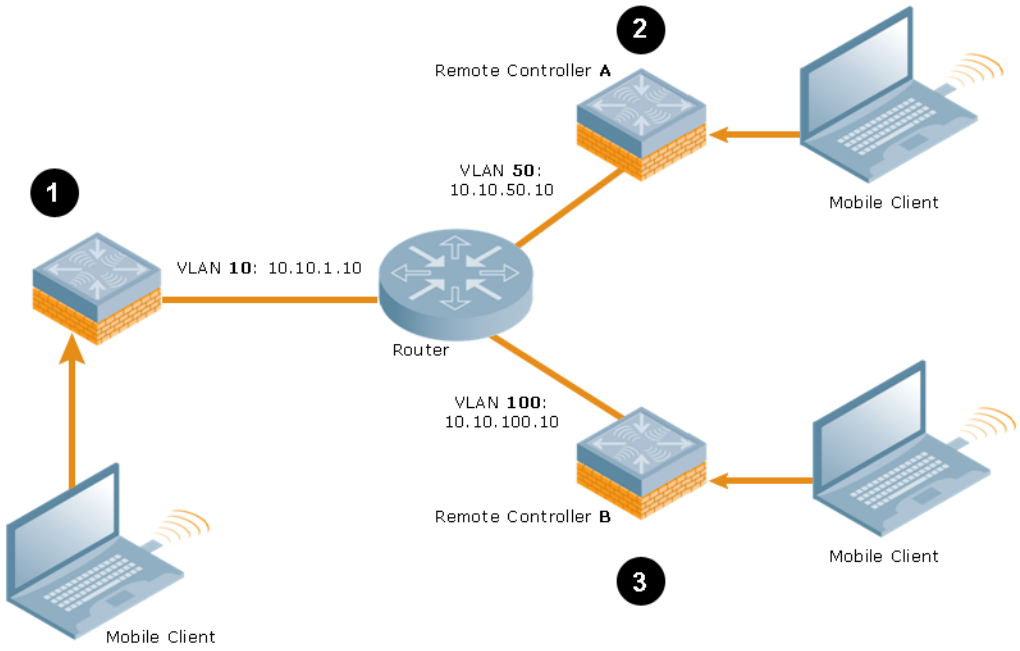
NOTE: The newer IGMP proxy feature and the older IGMP snooping feature cannot be enabled at the same time, as both features add membership information to multicast group table. For most multicast deployments, you should enable the IGMP Proxy feature on all VLAN interfaces to manage all the multicast membership requirements on the controller. If IGMP snooping is configured on some of the interfaces, there is a greater chance that multicast information transfers may be interrupted.

IGMP proxy must be enabled or disabled on each individual interface. To use the IGMP proxy ensure that the VLANs on the controllers are extended to the upstream router. Enabling IGMP proxy enables IGMP on the interface and sets the querier to the controller itself. You must identify the controller port from which the controller sends proxy join information to the upstream router, and identify the upstream router by upstream port so the controller can dynamically update the upstream multicast router information.

Inter-controller Mobility

When a client moves from one controller to another, multicast traffic migrates as follows:

Figure 80 *Inter-controller Mobility*



1. The local controller uses its VLAN 10 IP address to join multicast group1 on behalf of a mobile client.
2. The mobile client leaves its local controller and roams to VLAN 50 remote controller A.

   Remote controller A locates the mobile client's local controller and learns about the client's multicast groups. Remote controller A then joins group1 on behalf the mobile client, using its VLAN 50 source IP. Upstream multicast traffic from the roaming client is sent to the local controller over an IPIP tunnel. The remote controller will receive downstream multicast traffic and send it to the mobile client.

   Meanwhile, the local controller checks to see if other local clients require group1 traffic. If no other clients are interested in group1, then the local controller will leave that group. If there are other clients using that group, the controller it will continue its group1 membership.
3. Now the mobile client leaves remote controller A and roams to VLAN 100 on remote controller B. Remote controller B locates he mobile client's local controller and learns about the client's multicast groups. Remote controller B then joins group1 on behalf the roaming mobile client 1, using its VLAN 100 IP address.

   Both the local controller and remote controller A will check to see if any of their other clients require group1 traffic. If none of their other clients are interested in group1, then that controller will leave the group. (If the local controller leaves the group, it will also notify remote controller A.) If either controller has other clients using that group, that controller it will continue its group1 membership.

Configuring Mobility Multicast Using the WebUI

To configure the mobility multicast feature using the controller WebUI:

1. Navigate to the Configuration > Network > IP window.
2. Click the Edit button by the VLAN interface for which you want to configure mobility multicast. The Edit VLAN window opens.
3. Select Enable IGMP to enable the router to discover the presence of multicast listeners on directly-attached links. When
4. Select Snooping to save bandwidth and limit the sending of multicast frames to only those nodes that need to receive them.
5. Select the Interface checkbox, then click the Proxy drop-down list and select the controller interface, port and slot for which you want to enable proxy IGMP.

6. Click Apply to apply your changes.
7. (Optional) Repeat steps 1-6 above to configure mobility multicast for another VLAN interface.

Configuring Mobility Multicast Using the CLI

The following command enables IGMP and/or IGMP snooping on this interface, or configures a VLAN interface for uninterrupted streaming of multicast traffic.

```
interface vlan <vlan>
   ip igmp proxy [{fastethernet|gigabitethernet} <slot>/<port>]|[snooping]
```

Table 95 *Command Syntax*

Parameter	Description
`fastethernet`	Enable IGMP proxy on the FastEthernet (IEEE 802.3) interface
`gigabitethernet`	Enable IGMP proxy on the GigabitEthernet (IEEE 802.3) interface
`<slot>/<port>`	Any command that references a Fast Ethernet or Gigabit Ethernet interface requires that you specify the corresponding port on the controller in the format <slot>/<port>. The <slot> parameter is always 1 except when referring to any of the four interfaces on the W-6000 controller (slots 0-3). The <port> parameter refers to the network interfaces that are embedded in the front panel of the W-3000 Series controller, or a line card installed in the W-6000 controller. Port numbers start at 0 from the left-most position.
`snooping`	Enable IGMP snooping. The IGMP protocol enables an router to discover the presence of multicast listeners on directly-attached links. Enable IGMP snooping to limit the sending of multicast frames to only those nodes that need to receive them.

Example

The following example configures IGMP proxy for VLAN 2. IGMP reports from the controller would be sent to the upstream router on fastethernet port 1/3.

```
(host) (config)# interface vlan 2
   conf-subif# ip igmp proxy fastethernet 1/3
```

Chapter 24

VRRP

The underlying mechanism for the Dell redundancy solution is the Virtual Router Redundancy Protocol (VRRP). VRRP is used to create various redundancy solutions, including:

- Pairs of local Dell controllers acting in an active-active mode or a hot-standby mode
- A master controller backing up a set of local controllers
- A pair of controllers acting as a redundant pair of master controllers in a hot-standby mode

VRRP eliminates a single point of failure by providing an election mechanism, among the controllers, to elect a VRRP "master" controller. The master controller election is:

- If VRRP preemption is disabled (the default setting) and all controllers share the same priority, the first controller that comes up becomes the master.

  or

- If VRRP preemption is enabled and all controllers share the same priority, the controller with the highest IP address becomes the master.

The master controller owns the configured virtual IP address for the VRRP instance. When the master controller becomes unavailable, a backup controller steps in as the master and takes ownership of the virtual IP address. All network elements (APs and other controllers) can be configured to access the virtual IP address, thereby providing a transparent redundant solution to your network.

Redundancy Parameters

Depending on your redundancy solution, you configure the VRRP parameters listed in Table 96 on your master and local controllers.

Table 96 *VRRP Parameters*

Parameter	Description
Virtual Router ID	This uniquely identifies this VRRP instance. For ease in administration, you should configure this with the same value as the VLAN ID.
Advertisement Interval	This is the interval, in seconds, between successive VRRP advertisements sent by the current *master*. The default interval time is recommended. Default: 1 second
Authentication Password	This is an optional password, of up to eight characters, that can be used to authenticate VRRP peers in their advertisements. If this is not configured, there is no authentication password set.
Description	This is an optional text description to describe the VRRP instance.
IP Address	This is the virtual IP address that will be owned by the elected VRRP *master.*
Enable Router Pre-emption	Selecting this option means that a controller can take over the role of *master* if it detects a lower priority controller currently acting as *master.*

Table 96 *VRRP Parameters (Continued)*

Parameter	Description
Delay	Specifying a value enables the delay timer. The timer is triggered when the VRRP state moves out of backup or init state to become a master. This is applicable only if router pre-emption is enabled. When the timer is triggered, it forces VRRP to wait for a specified period of time, so that all the applications are ready before coming up. This prevents the APs from connecting to the controller before it can receive them. In the mean time, if there is an advertisement from another VRRP, the VRRP stops the timer and does not transition to master.
Priority	Priority level of the VRRP instance for the controller. This value is used in the election mechanism for the *master.*
Tracking	Configures a tracking mechanism that modifies a specified *value* to the priority after a controller has been the master for the VRRP instance. This mechanism is used to avoid failing over to a backup Master for transient failures. Tracking can be based on one of the following: • Master Up Time: how long the controller has been the master. The value of *duration* is the length of time that the administrator expects will be long enough that the database gathered in the time is too important to be lost. This will obviously vary from instance to instance. • VRRP Master State Priority: the master state of another VRRP. Tracking can also be based on the interface states of the controller: • VLAN and Interface: prevents asymmetric routing by tracking multiple VRRP instances. The priority of the VRRP interface determined by the *sub* value can increase or decrease based on the operational and transitional states of the specified VLAN or Fast Ethernet/ Gigabit Ethernet port. When the VLAN or interface comes up again, the value is restored to the previous priority level. You can track a combined maximum of 16 interfaces and VLANs. For example, you can track an interface that connects to a default gateway. In this situation, configure the VRRP priority to decrease and trigger a VRRP master re-election if the interface goes down. This not only prevents network traffic from being forwarded, but reduces VRRP processing.
Admin State	Administrative state of the VRRP instance. To start the VRRP instance, change the admin state to UP in the WebUI.
VLAN	VLAN on which the VRRP protocol will run.

Configuring the Local Controller for Redundancy

In an Dell network, the APs are controlled by a controller. The APs tunnel all data to the controller which processes the data, including encryption/decryption, bridging/forwarding, etc.

Local controller redundancy refers to providing redundancy for a controller such that the APs "fail over" to a *backup* controller if a controller becomes unavailable. Local controller redundancy is provided by running VRRP between a pair of controllers.

NOTE: The two controllers need to be connected on the same broadcast domain (or Layer-2 connected) for VRRP operation. The two controllers should be of the same class (for example, and both controllers should be running the same version of ArubaOS.

The APs are then configured to connect to the "virtual-IP" configured for the VRRP instance.

Collect the following information needed to configure local controller redundancy:

- VLAN ID on the two local controllers that are on the same Layer-2 network and is used to configure VRRP.
- Virtual IP address to be used for the VRRP instance.

You can use either the WebUI or CLI to configure VRRP on the local controllers. For this topology, it is recommended to use the default priority value.

In the WebUI

1. Navigate to the Configuration > Advanced Services > Redundancy page on the WebUI for each of the local controllers.
2. Under Virtual Router Table, click Add to create a VRRP instance.
3. Enter the IP Address for the virtual router. Select the VLAN on which VRRP will run. Set the Admin State to Up.
4. Click Done to apply the configuration and add the VRRP instance.

In the CLI

```
vrrp <id>
   ip address <ipaddr>
   vlan <vlan>
   no shutdown
```

Configuring the LMS IP

Configure the APs to terminate their tunnels on the virtual-IP address. To specify the controller to which an AP or AP group tunnels client traffic, you configure the LMS IP in the AP system profile on the master controller. For information on how to configure the LMS IP in the AP system profile, see "Configuring APs" on page 457.

NOTE: This configuration needs to be executed on the master controller; the APs obtain their configuration from the master controller.

In the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page on the master controller.
   - If you select AP Group, click Edit for the AP group name for which you want to configure the LMS IP.
   - If you select AP Specific, select the name of the AP for which you want to configure the LMS IP.
2. Under the Profiles section, select AP to display the AP profiles.
3. Select the AP system profile you want to modify.
4. Enter the controller IP address in the LMS IP field.
5. Click Apply.

In the CLI

On the master controller:

```
ap system-profile <profile>
   lms-ip <ipaddr>

ap-group <group>
   ap-system-profile <profile>

ap-name <name>
   ap-system-profile <profile>
```

Configuring the Master Controller for Redundancy

The master controller in the Dell user-centric network acts as a single point of configuration for global policies such as firewall policies, authentication parameters, RF configuration to ease the configuration and maintenance of a wireless network. It also maintains a database related to the wireless network that is used to make any adjustments (automated as well as manual) in reaction to events that cause a change in the environment (such as an AP becoming unavailable).

The master controller is also responsible for providing the configuration for any AP to complete its boot process. If the master controller becomes unavailable, the network continues to run without any interruption. However, any change in the network topology or configuration will require the availability of the master controller.

To maintain a highly redundant network, the administrator can use a controller to act as a hot standby for the master controller. The underlying protocol used is the same as in local redundancy, that is, VRRP.

- Collect the following data before configuring master controller redundancy.
  - VLAN ID on the two controllers that are on the same layer 2 network and will be used to configure VRRP.
  - Virtual IP address that has been reserved to be used for the VRRP instance
- You can use either the WebUI or CLI to configure VRRP on the master controllers (see Table 96). For this topology, the following are recommended values:
  - For priority: Set the master to 110; set the backup to 100 (the default value)
  - Enable preemption
  - Configure master up time or master state tracking with an add value of 20.

The following is a configuration example for the "*initially-preferred master*".

```
vrrp 22
   vlan 22
   ip address 10.200.22.254
   priority 110
   preempt
   authentication password
   description Preferred-Master
   tracking master-up-time 30 add 20
   no shutdown
```

The following configuration is the corresponding VRRP configuration for the peer controller.

```
vrrp 22
   vlan 22
   ip address 10.200.22.254
   priority 100
   preempt
   authentication password
   description Backup-Master
   tracking master-up-time 30 add 20
   no shutdown
```

Use the following commands to associate the VRRP instance with master controller redundancy.

Table 97 *VRRP Commands*

Command	Explanation
`master-redundancy`	Enter the master-redundancy context.
`master-vrrp <id>`	Associates a VRRP instance with master redundancy. Enter the virtual router ID of the VRRP instance.
`peer-ip-address <ipaddr> ipsec <key>`	Loopback IP address of the peer controller for master redundancy. The pre-shared key secures communication between the master controllers. Specify a key of up to 64 characters.
`masterip <ipaddr> ipsec <key>`	Configures the master IP address and pre-shared key on a local controller for communication with the master controller. Configure this to be the virtual IP address of the VRRP instance used for master redundancy.

NOTE: All the APs and local controllers in the network should be configured with the virtual IP address as the master IP address. The master IP address can be configured for local controllers during the Initial Setup. The controller will require a reboot after changing the master IP on the controller.

If DNS resolution is the chosen mechanism for the APs to discover their master controller, ensure that the name "*aruba-master*" resolves to the same virtual IP address configured as a part of the master redundancy.

Configuring Database Synchronization

In a redundant master controller scenario, you can configure a redundant pair to synchronize their WMS and local user databases. In addition, you can also synchronize RF Plan data between the pair of controllers. You can either manually or automatically synchronize the databases.

NOTE: When synchronizing the databases, Dell recommends that you also synchronize RF plan data.

When manually synchronizing the database, the active VRRP master synchronizes its database with the standby. The command takes effect immediately.

When configuring automatic synchronization, you set how often the two controllers synchronize their databases. To ensure successful synchronization of database events, you should set periodic synchronization to a minimum period of 20 minutes.

In the WebUI

1. On each controller, navigate to the Configuration > Advanced Services > Redundancy page.
2. Under Database Synchronization Parameters, do the following:
   a. Select the Enable periodic database synchronization check box. This enables database synchronization.
   b. Enter the frequency of synchronizing the databases. Dell recommends a minimum value of 20 minutes.
   c. By default, RF Plan data is also synchronized. Dell recommends that you always enable this option.
3. Click Apply.

In the CLI

Use the following commands to configure database synchronization.

Table 98 *Database Synchronization Command*

Command	Description
`database synchronize`	This enable mode command manually synchronizes the databases and takes effect immediately.
`database synchronize rf-plan-data`	This config mode command includes RF plan data when synchronizing databases. This data is included by default.
`database synchronize period <minutes>`	This config mode command defines the scheduled interval for synchronizing the databases.

To view the database synchronization settings on the controller, use the following command:

```
show database synchronize
```

Incremental Configuration Synchronization

Typically when the master and the local is synchronized, the complete configuration is sent to the local. You can, now send only the incremental updates to the local by using the following CLI commands

In the CLI

Use the following commands for incremental configuration synchronization:

Table 99 *Incremental Configuration Synchronization Commands*

Command	Description
`cfgm set sync-type <complete>`	The master sends full configuration file to the local.
`cfgm set sync-type <snapshot>`	The master sends only the incremental configuration to the local. NOTE: By default, this configuration is enabled.
`cfgm set sync-command-block <number>`	To configure the number of command-list blocks. Each block contains a list of global configuration commands for each write-mem operation. By default, the number is 3.
`show master-configpending`	To show a list of global commands, which are not saved but are sent to the local.
`clear master-local-session <A.B.C.D>`	To manually push the full configuration to the local.

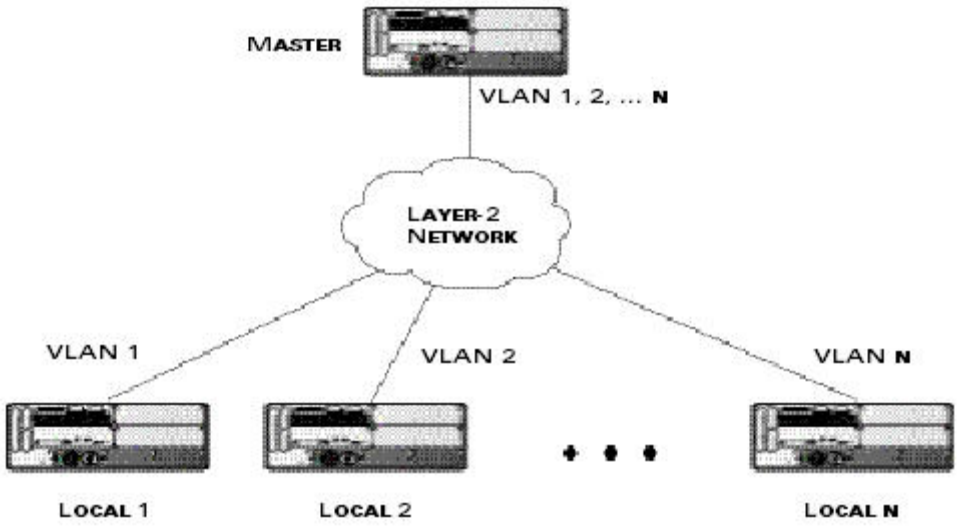
Configuring Master-Local Controller Redundancy

This section outlines the concepts behind a redundancy solution where a master can act as a backup for one or more local controllers and shows how to configure the Dell controllers for such a redundant solution. In this solution, the local controllers act as the controller for the APs. When any one of the local controllers becomes unavailable, the master takes over the APs controlled by that local controller for the time that the local controller remains unavailable. It is configured such that when the local controller comes back again, it can take control over the APs once more.

This type of redundant solution is illustrated by the following topology diagram.

NOTE: This solution requires that the master controller have Layer-2 connectivity to all the local controllers.

Figure 81 *Redundant Topology: Master-Local Redundancy*



The network in Figure 81, the master controller is connected to the local controllers on VLANs 1 through *n* through a Layer-2 network. To configure redundancy as described in the conceptual overview for master-local redundancy, configure VRRP instances on each of the VLANs between the master and the respective local controller. The VRRP instance on the local controller is configured with a higher priority to ensure that when available, the APs always choose the local controller to terminate their tunnels.

- Configure the interface on the master controller to be a trunk port with 1, 2… *n* being member VLANs.
- Collect the following data before configuring master controller redundancy.
  - VLAN IDs on the controllers corresponding to the VLANs 1, 2…*n* shown in the topology above.
  - Virtual IP addresses that has been reserved to be used for the VRRP instances.
- You can use either the WebUI or CLI to configure VRRP on the master controllers (see Table 96). For this topology, the following are recommended values:
  - For priority: Set the local to 110; set the master to 100 (the default value)
  - Enable preemption

NOTE: The master controller is configured for a number of VRRP instances (equal to the number of local controllers the master is backing up).

The following example configuration of the master controller in such a topology for one of the VLANs (in this case VLAN 22).

```
vrrp 22
   vlan 22
   ip address 10.200.22.254
   priority 100
   preempt
   authentication password
   description Master-acting-as-backup-to-local
   tracking master-up-time 30 add 20
   no shutdown
```

The following example configuration on the corresponding local controller.

```
vrrp 22
   vlan 22
   ip address 10.200.22.254
   priority 110
```

```
preempt
authentication password
description local-backed-by-master
no shutdown
```

To configure APs, configure the appropriate virtual IP address (depending on which controller is expected to control the APs) for the LMS IP address parameter in the AP system profile for an AP group or specified AP.

As an example, the administrator can configure APs in the AP group “floor1” to be controlled by local controller 1, APs in the AP group “floor2” to be controlled by local controller 2 and so on. All the local controllers are backed up by the master controller. In the AP system profile for the AP group “floor1”, enter the virtual IP address (10.200.22.154 in the example configuration) for the LMS IP address on the master controller.

NOTE: You configure APs on the master controller.

Configuration changes take effect only after you reboot the affected APs; this allows them to reassociate with the local controller. After rebooting, these APs appear to the new local controller as local APs.

Chapter 25

RSTP

Dell's implementation of Rapid Spanning Tree Protocol (RSTP) is as specified in 802.1w with backward compatibility to legacy Spanning Tree (STP) 802.1D. RSTP takes advantage of point-to-point links and provides rapid convergence of the spanning tree. RSTP is enabled by default on all Dell controllers.

Migration and Interoperability

Dell's RSTP implementation interoperates with PVST (Per VLAN Spanning Tree 802.1D) and Rapid-PVST (802.1w) implementation on industry-standard router/switches. Dell supports global instances of STP and RSTP only. Therefore, the ports on industry-standard routers/switches must be on the default or untagged VLAN for interoperability with Dell controllers.

ArubaOS supports RSTP on the following interfaces:

- FastEthernet IEEE 802.3—fastethernet
- Gigabitethernet IEEE 802.3—gigabitethernet
- Port Channel ID—port-channel

Rapid Convergence

Since RSTP is backward compatible with STP, it is possible to configure bridges RSTP (and STP) in the same network. However, such mixed networks may not always provide rapid convergence. RSTP provides rapid convergence when interfaces are configured as either:

- Edge ports—These are the interfaces/ports connected to hosts. These interfaces are immediately moved to the forwarding state. In this mode an interface forwards frames by default until it receives a BPDU (Bridge Protocol Data Units) indicating that it should behave otherwise; it does not go through the Listening and Learning states.
- Point-to-Point links—These are the interfaces/ports connected directly to neighboring bridges over a point-to-point link. RSTP negotiates with the neighbor bridge for rapid convergence/transition only when the link is point-to-point.

Table 100 compares the port states between STP and RSTP.

Table 100 *Port State Comparison*

STP (802.1d) Port State	RSTP (802.1w) Port State
Disabled	Discarding
Blocking	Discarding
Listening	Discarding
Learning	Learning
Forwarding	Forwarding

In addition to port state changes, RSTP introduces port roles for all the interfaces (see Table 101).

Table 101 *Port Role Descriptions*

RSTP (802.1w) Port Role	Description
Root	The port that receives the best BPDU on a bridge.
Designated	The port can send the best BPDU on the segment to which it is connected.
Alternate	The port offers an alternate path, in the direction of root bridge, to that provided by bridge's root port.
Backup	The port acts as a backup for the path provided by a designated port in the direction of the spanning tree.

The show spantree command (configuration mode) output reveals the state and port role.

```
(host) (config) #show spantree

Designated Root MAC       00:0b:86:50:3c:20
Designated Root Priority  32768
Root Max Age 20 sec   Hello Time 2 sec   Forward Delay 15 sec

Bridge MAC                00:0b:86:50:3c:20
Bridge Priority           32768
Configured Max Age 20 sec   Hello Time 2 sec   Forward Delay 15 sec

Rapid Spanning-Tree port configuration
--------------------------------
Port    State       Cost  Prio  PortFast  P-to-P  Role
----    -----       ----  ----  --------  ------  ----
FE 1/0  Discarding  0     128   Disable   Enable  Disabled
FE 1/1  Forwarding  0     128   Disable   Enable  Designated
FE 1/2  Forwarding  0     128   Disable   Enable  Root
FE 1/3  Discarding  0     128   Disable   Disable Disabled
FE 1/4  Discarding  0     128   Disable   Enable  Alternate
```

Also, the show spanning-tree interface command indicates the state and roles; see the partial output below.

```
(host) #show spanning-tree interface fastethernet 1/1

Interface FE 1/7 (port 8) in Spanning tree is FORWARDING
Port path cost 19, Port priority 128 Role DESIGNATED
...
```

Edge Port and Point-to-Point

At the interface level, the portfast command specifies an interface as an edge port and the point-to-point command specifies an interface as a point-to-point link. Since RSTP is enabled by default, all the interfaces are, by default, point-to-point links.

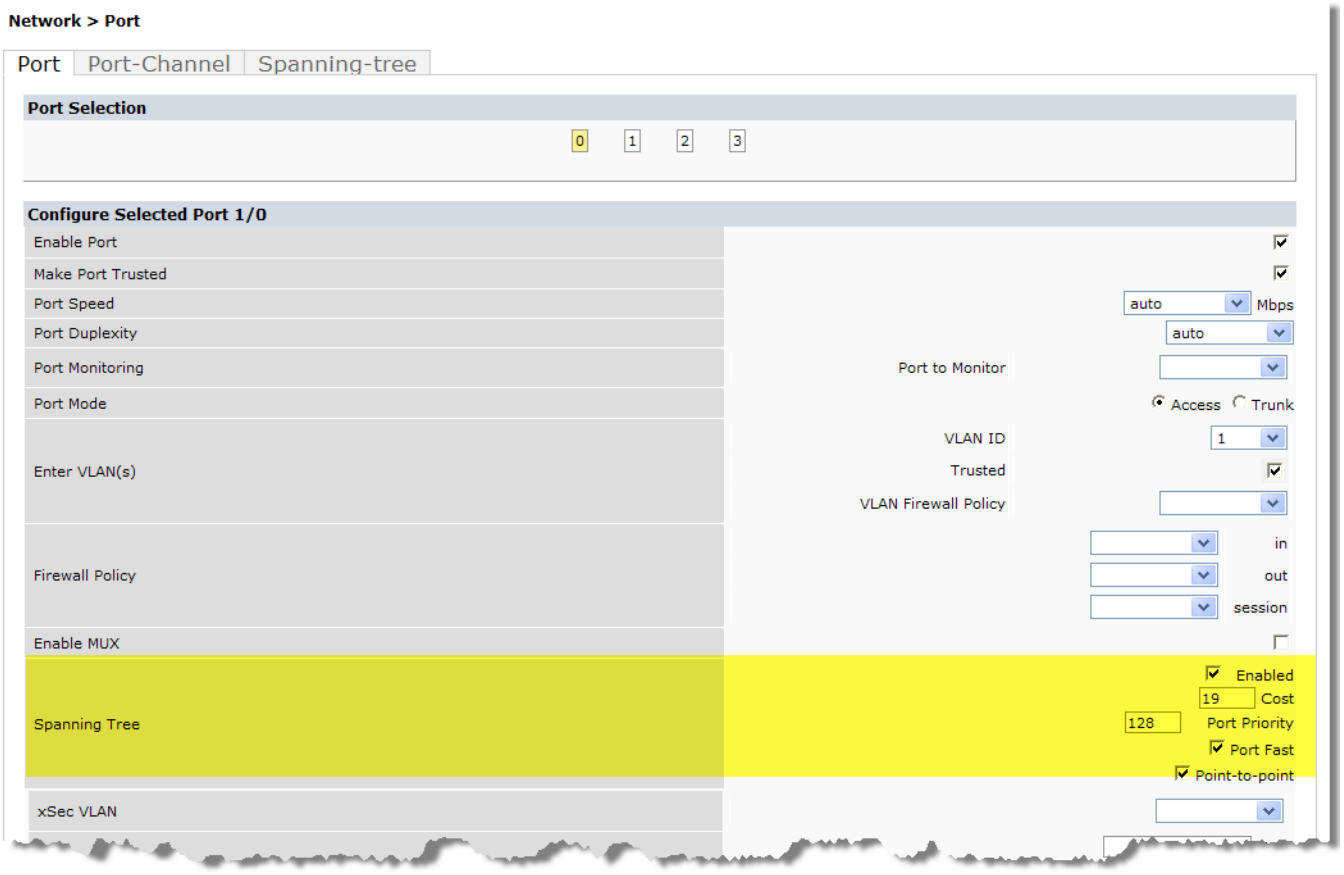
Configuring RSTP

Use either the command line reference or the WebUI to configuring RSTP.

In the WebUI

The RSTP port interface is designated as point-to-point, by default, in the existing port configuration screen (Figure 82).

Figure 82 *Configuring RSTP*



Since RSTP is enabled by default, the default values appear in the WebUI. Table 102 list the RSTP defaults and ranges (when applicable) in the configuration interface mode (config-if).

Table 102 *RSTP Default Values*

Feature	Default Value/Range
Port Cost	The RSTP interface path cost. Range: 1 - 65536 Default: Based on Interface type: Fast Ethernet 10Mbs—100 Fast Ethernet 100Mbs—19 1 Gigabit Ethernet—4 10 Gigabit Ethernet—2
Priority	Change the interface's RSTP priority Range: 0 - 255 Default: 128
Port Fast	Change from blocking to forwarding Default: disabled
Point-to-Point	Enabled—Set the interface as a point-to-point link

In the CLI

Change the default configurations via the command line.

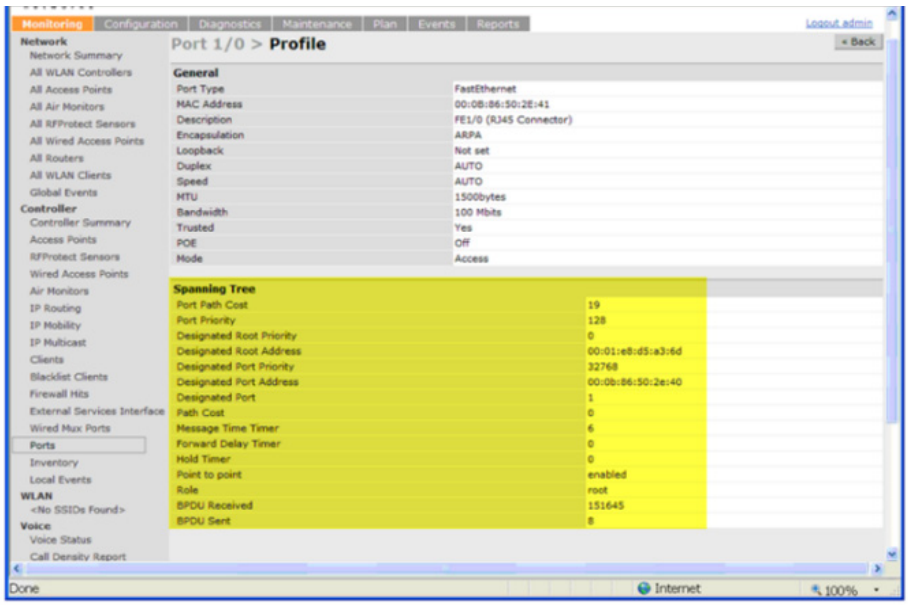
```
(host) (config-if)#spanning-tree ?
cost                    Change an interface's spanning tree path cost
```

```
point-to-point          Set interface as point-to-point link
port-priority           Change an interface's spanning tree priority
portfast                Allow a change from blocking to forwarding
```

Monitoring RSTP

Statistical information for point-to-point, role, BPDU etc. can be viewed from the WebUI (see Figure 83).

Figure 83 *Monitoring RSTP*



Troubleshooting

The following points give some troubleshooting tips.

- The show spantree command displays the root and the bridge information; verify that they are correct. Also displayed is the port/interface information (for example state, role, etc.); make sure that the state and role information correspond to each other.

```
(host) (config) #show spantree
Designated Root MAC       00:0b:86:50:3c:20
Designated Root Priority  32768
Root Max Age 20 sec   Hello Time 2 sec   Forward Delay 15 sec

Bridge MAC                00:0b:86:50:3c:20
Bridge Priority           32768
Configured Max Age 20 sec   Hello Time 2 sec   Forward Delay 15 sec

Rapid Spanning-Tree port configuration
--------------------------------
Port     State       Cost   Prio   PortFast   P-to-P   Role
----     -----       ----   ----   --------   ------   ----
FE 1/0   Discarding  0      128    Disable    Enable   Disabled
FE 1/1   Forwarding  0      128    Disable    Enable   Designated
FE 1/2   Forwarding  0      128    Disable    Enable   Root
FE 1/3   Discarding  0      128    Disable    Disable  Disabled
FE 1/4   Discarding  0      128    Disable    Enable   Alternate
```

- The show spanning-tree interface command (config-if mode) displays Tx/Rx BPDU counters. Validate those values. For example, if a port's role is "designated", it only transmit BPDUs and does not receive any. In this

case, Tx counter will keep incrementing while Rx counter will remain the same. It is quite opposite for a port with role as "root/alternate/backup".

```
(host) (config-if)#show spanning-tree interface fastethernet 1/1

Interface FE 1/1 (port 2) in Spanning tree is FORWARDING
Port path cost 19, Port priority 128 Role DISNIGNATED
PortFast DISABLED P-to-P ENABLED
Designated root has priority 0 address 00:01:e8:d5:a3:6d
Designated bridge has priority 32768 address 00:0b:86:50:58:30
Designated port is 2, path cost 0
Timers:  message age 0, forward delay 20, hold 0
Counts:  BPDUs received 0, sent 0

(host) (config-if)#
```

Chapter 26

PVST+

PVST+ (Per-VLAN Spanning Tree Plus) provides for load balancing of VLANs across multiple ports resulting in optimal usage of network resources. PVST+ also ensures interoperability with industry accepted PVST+ protocols.

NOTE: By default, PVST+ is disable.

Interoperability and Best Practices

The interoperability between RSTP and PVST+ are:

- When the access port on the controller and the trunk port terminate on one Layer 2 switch running PVST+, PVST+ will send untagged STP BPDUs on the access port; it also transmits untagged STP BPDUs (in addition to the other PVST+ BPDUs) on the native VLAN trunk port. If the Dell controller is the root, it will detect a loop on the native VLAN.

NOTE: If PVST+ is not on the controller, best practices recommends disabling RSTP on the Dell controller to avoid a looping issue.

- For VLAN load balancing when controllers are connected to armed mode, the VLAN priorities on two ports and bridge priorities must be configured so that one set of VLANs are active on one link and the other set of VLANs are active on the other link.
- Supported instances are 64 on the W-6000M3 and W-3000 Series; 32 on the W-600 Series

Configure using the CLI

PVST+ is disabled by default. Enable PVST+, ensure a VLAN instance is configured, and then configure PVST+.

1. Enable PVST+:

   ```
   spanning-tree mode rapid-pvst
   ```

2. Configure PVST+ forward time; the following command sets the time VLAN 2 spends in the listening and learning state (3 seconds).

   ```
   spanning-tree vlan 2 forward-time 3
   ```

3. Configure PVST+ hello time; the following command sets the time VLAN 2 waits to transmit BPDUs to four seconds:

   ```
   spanning-tree vlan 2 hello-time 4
   ```

4. Configure PVST+ max age; the following command sets the time VLAN 2 waits to receive a hello packet to 30 seconds:

   ```
   spanning-tree vlan 2 max-age 30
   ```

5. Configure PVST+ priority: the following command sets the VLAN 2 priority to 10, making it more likely to become the root bridge:

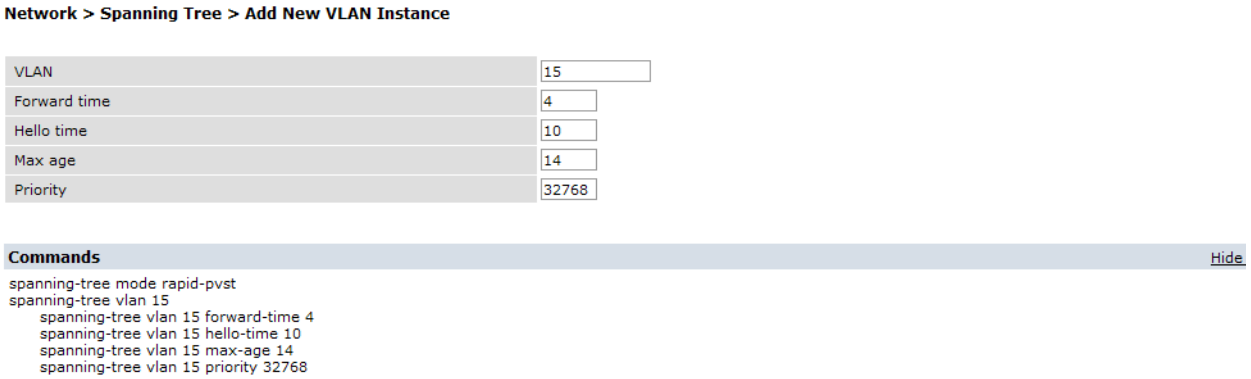
   ```
   spanning-tree vlan 2 priority 10
   ```

6. Configure PVST+ on a range of VLANs using the VLAN IDs (coma separated or hyphen separated)

```
spanning-tree vlan range 2-6,11
```

Configure using the WebUI

From the WebUI, add a VLAN instance and enable PVST+



Chapter 27

W-600 Series Controller

The W-600 Controller Series is designed for compact, cost-effective "all-in-one" networking solutions. The W-600 Series includes a firewall, wireless LAN controller, 9-port (8-port for the W-650 and W-651) Ethernet switch with PoE+, IP router, site-to-site VPN edge device, file server, and print server. Additionally, the W-651 controller includes an integrated single radio dual-band (802.11 a/n or 802.11 b/g/n) wireless internal Access Point (AP).

The W-600 Series is an enterprise-class, wireless LAN controller that connects, controls, and integrates wireless APs and Air Monitors (AMs) into a wired LAN system. Table 103 list some of the hardware features by the numbers.

Table 103 *W-600 Controller Series by the Numbers*

Controller	USB Ports	Maximum External APs	Internal AP	Remote APs
W-620	1	8	None	32
W-650	4	16	None	64
W-651	4	16	1	64

The sections in this chapter are:

NOTE: The NAS and Print Server features are scheduled for deprecation in ArubaOS version 6.2

Important Points to Remember

- The internal AP, in the W-651, does not support the Spectrum Analysis feature.
- Only FAT16, FAT32, ext2 and ext3 partitions are supported.
- For shared folders in an ext2/ext3 partition, the owner of the folder must be "nobody". Otherwise clients will not be able to access the shared folder.
- Unsupported partitions may exist on the NAS device; only supported partitions are mounted.
- User authentication for file access is not supported. The same permissions are applicable to all users.

- Sharing disks that contain errors may cause unpredictable behavior. Scan the disk for errors before mounting the disks to a W-600 Series.
- Un-mount all partitions before disconnecting the disk from the controller.
- Detection of devices connected to an external USB hub may be unpredictable.
- A USB hard disk connected to the controller via an USB ExpressCard adapter is not supported.

Internal Access Point (AP)

The W-651 controller includes an internal AP. The internal AP is provisioned in the same way as any other external AP. The provisioning data is stored in the NVRAM. The internal AP identifies itself to a Master controller as the W-651. The internal AP can operate as an AP, Mesh Portal, or an Air Monitor. However, the W-651 internal AP can not operate as a remote AP, a mesh point, or an RF Protect sensor.

NOTE: The W-651 internal AP does not support the Spectrum Analysis feature.

USB Cellular Modems

USB Cellular Modems are supported via a USB port. ArubaOS supports several EVDO (Evolution Data Optimized, up to 3.1 Mbps, CDMA) and 3G HSPA (High-Speed Packet Access, 3G data service) modems. The 3G HSPA is provided by AT&T in the United States and numerous other 3G providers worldwide.

Functional Description

Plug the USB Cellular Modem into the USB port of the W-600 Series controller. The USB Cellular Modem is automatically detected and negotiates a PPP IP address. If the modem fails to obtain a PPP IP address within 45 seconds, the controller ignores the modem's presence, and boots as if the modem is not present.

Mode-Switching

Many of the newer modems contain multiple USB devices; creating a very elegant plug-n-play solution. When your USB Cellular Modem is first powered on, a storage device is registered. This storage device contains the software driver/executable necessary to install and operate the modem.

Once the software installation is complete, the modem must *mode-switch* from a storage device to a registered modem device. Mode-switching varies by manufacturer. For example, The Novatel modem mode-switches via a SCSI eject command; the Huawei modem mode-switches via a SCSI rezero command, while the Sierra modem mode-switches via a specific USB command. Once the mode-switching is complete, the modem automatically registers itself.

The controller can dial (via the modem) your Service Provider to initiate a PPP session. During the boot sequence, the controller issues your device's mode-switching command, every few seconds, until the PPP link connects.

USB Modems Commands

To support the USB cellular modems on the W-600 Series, cellular specific commands are available at the command line (see Figure 84 and Figure 85). For detailed information on these commands, refer to the Command Line Reference Guide.

Figure 84 *Cellular Profile Commands*

```
(host) (config) # cellular profile profile_name
(host) (config-cellular profile_name)# ?
dialer                  Dialer group settings
driver                  Cellular modem driver
import                  Import USB device parameters
modeswitch              USB device modeswitch settings
no                      Delete Command
priority                Override default priority
serial                  USB device serial
tty                     Modem TTY port
user                    User name authentication
vendor                  USB Vendor ID

(host) (config-cellular profile_name)#
```

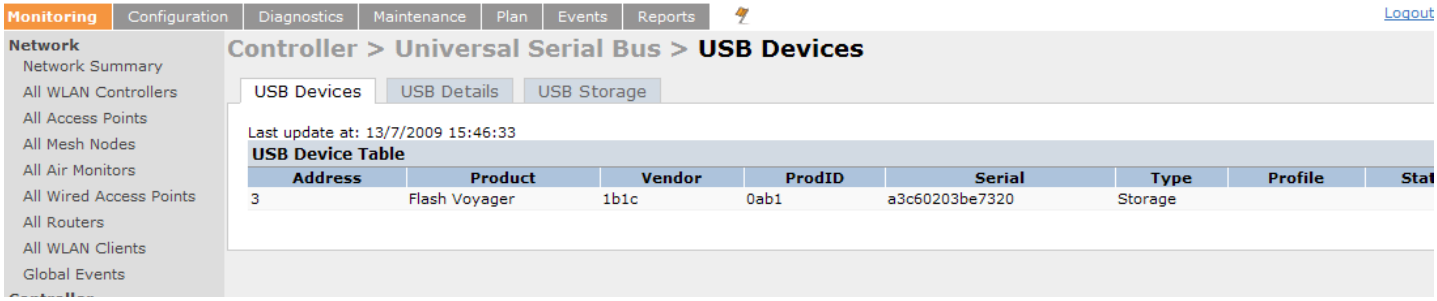
Figure 85 list the Uplink commands.

Figure 85 *Uplink Commands*

```
(host) (config) # uplink ?
cellular                Cellular uplink configuration
disable                 Disable uplink manager
enable                  Enable uplink manager
wired                   Wired uplink configuration

(host) (config) # uplink
```

You can view connected USB cellular devices via the Controller > Universal Serial Bus > USB Devices in the Web UI (see Figure 86). Navigating to this page is the equivalent of executing the show usb command at the command prompt.

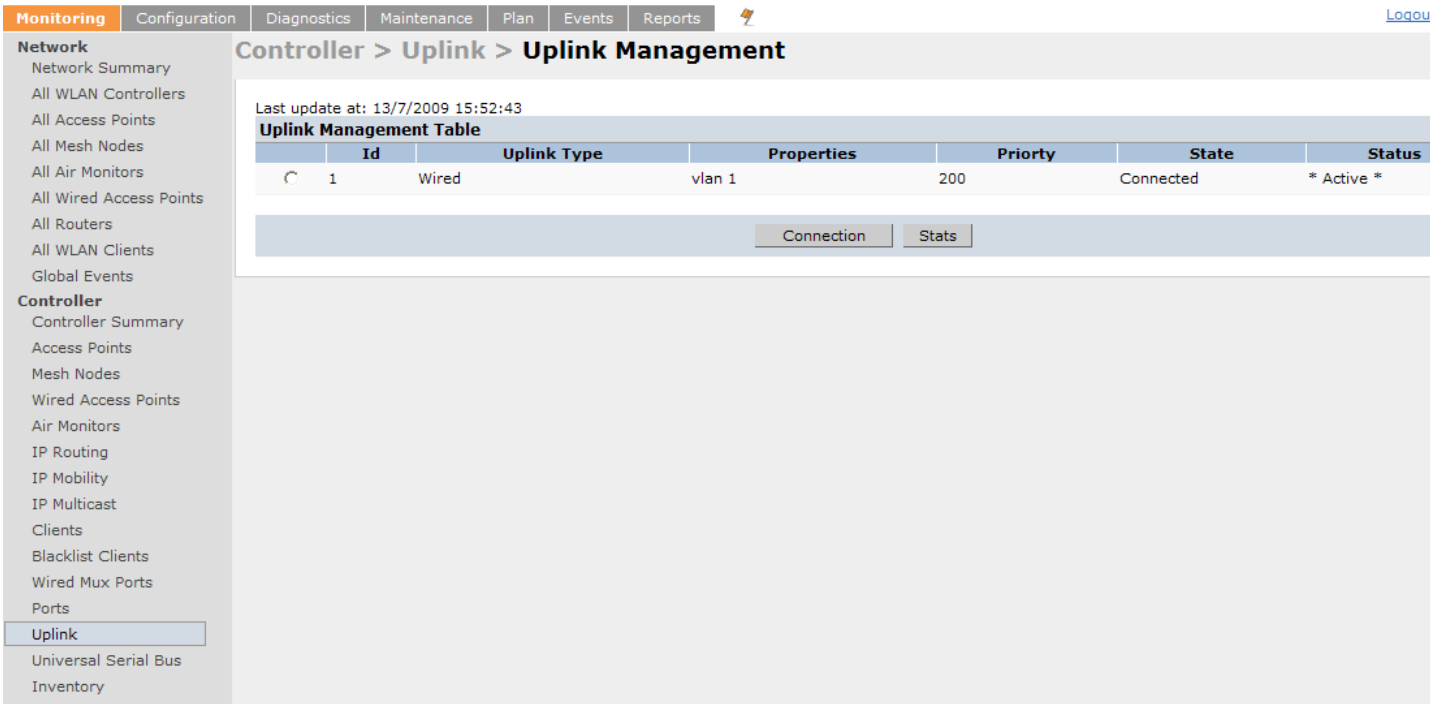
Figure 86 *Connected Cellular Devices*



Uplink Manager

Access the Uplink Manager feature from the WebUI Configuration tab. Navigate to this feature via Uplink > Uplink Manager (Figure 87).

Figure 87 *WebUI Uplink Manager*



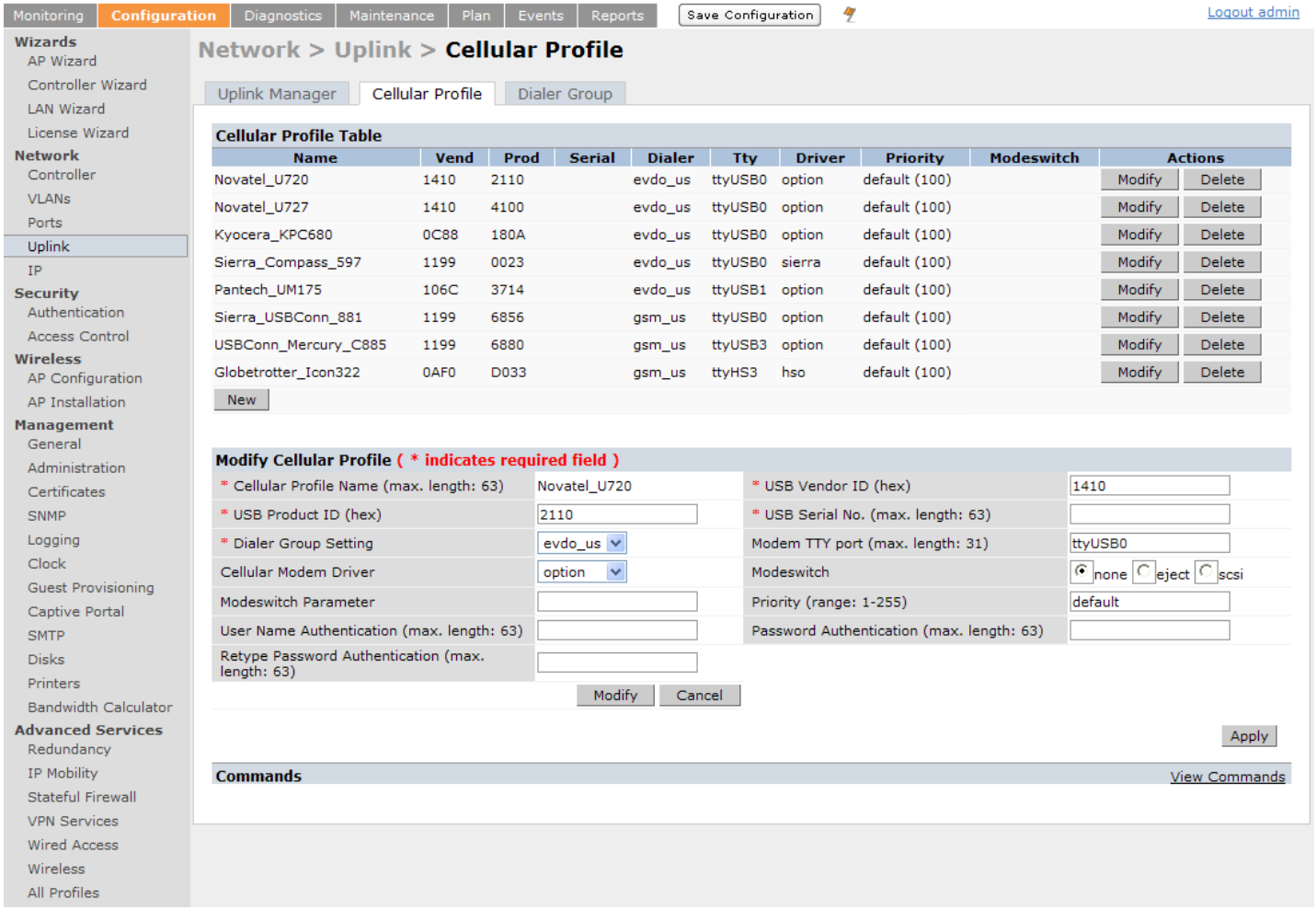
You can enable/disable the uplink to overwrite cellular and wired uplink priority. The corresponding commands are:

```
(host) (config)# uplink [enable | disable]
(host) (config)# uplink [cellular | wired] priority [x]
```

Cellular Profile

The Cellular Profile tab allows you to add/modify/delete one or more cellular profiles. The WebUI screen for Cellular Profile is divided into the Cellular Profile Table (the top portion) and the Modify Cellular Profile (the bottom portion). When a cellular profile is selected for modification (see Figure 88) the bottom modify portion is revealed. All changes are entered into the buffer until the Apply button is executed.

Figure 88 *Cellular Profile from the WebUI*

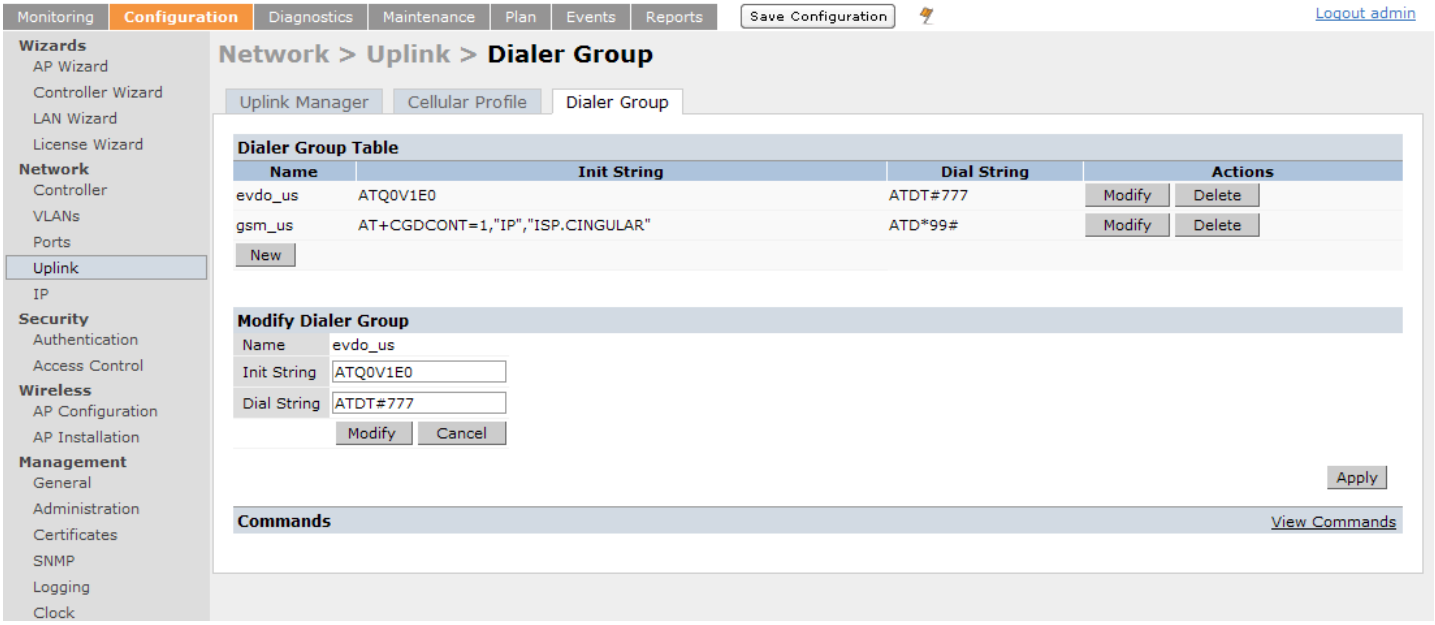


Dialer Group

Use the Dialer Group command to configure EVDO devices that require specific input for the initial string (init-string) and dial string. When adding or modifying an existing dialer group (see Figure 89), the WebUI executes the following commands:

```
(host) (config-cellular profile_name)# dialer group <name> init-string <string>
(host) (config-cellular profile_name)# dialer group <name> dial-string <string>
```

Figure 89 *Configuring Dialer Group*



Configuring a Supported USB Modem

If your USB Modem is a validated modem, then no configuration is needed. Just follow the "plug and play" steps below.

1. Insert the USB Modem into an open USB port.
2. Verify that the modem is detected (show usb command)

Figure 90 *Display supported USB modems*

```
(host) #show usb
Address  Product                Vendor  ProdID  Serial           Type      Profile       State
-------  -------                ------  ------  ------           ----      -------       -----
3        Novatel Wireless CDMA  1410    4100    091087843891000  Cellular  Novatel_U727  Device ready

(host) #
```

If your modem is not recognized (such as "type is unknown", "no matching profile", or "device not ready"), use the show usb verbose command to verify your modem is listed.

Figure 91 *show usb verbose example (partial)*

```
(host) #show usb verbose
...
T:  Bus=01 Lev=02 Prnt=02 Port=00 Cnt=01 Dev#=  3 Spd=12  MxCh= 0
D:  Ver= 1.10 Cls=00(>ifc ) Sub=00 Prot=00 MxPS=64 #Cfgs=  1
P:  Vendor=1410 ProdID=4100 Rev= 0.00
S:  Manufacturer=Novatel Wireless Inc.
S:  Product=Novatel Wireless CDMA
S:  SerialNumber=091087843891000
C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=500mA
...
(host) #
```

3. Verify the modem is registered with the Uplink Manager.

Figure 92 *show uplink*

```
(host) #show uplink
Id  Uplink Type  Properties    Priority  State      Status
--  -----------  ----------    --------  -----      ------
1   Wired        vlan 1        200       Connected  * Active *
2   Cellular     Novatel_U727  100       Standby    Ready
(host) #
```

Cellular uplinks have a lower priority than wired links by default. You can change the default by changing the profile-specific priority or by changing the default cell priority.

Figure 93 *uplink cellular priority*

```
(host) (config) #uplink cellular priority 201
(host) (config) #
```

4. Check the modem dialing status. The connection may take up to a 45 seconds to establish. To see the connection progress, execute the show uplink connection *uplink id* command.
5. Verify the connection is established and IP addressed is programed.
   - Once the cellular link state is *Connected*, you can find the PPP dynamic entries by executing the command show uplink connection *id*
   - The IP address can be found using the command show ip interface brief
   - The Gateway can be found using the command show ip route
   - The DNS entries can be found using the command show ip domain-name

Configuring a New USB Modem

Cellular modems must be activated before they can "talk" on the cellular network. Typically, the activation is done by the carrier. Some carriers use a proprietary PC client. In all cases, make sure that your modem works on your PC before using it on the Dell W-600 Series.

NOTE: Verify your modem is activated and works with your Microsoft Windows or Apple Mac computers.

Each time a USB device is inserted, Linux assigns it a new USB address. This is true even if the same device is re-inserted. Modem ports are organized under their individual addresses. For example, ttyUSB0 at address 3 is separate than ttyUSB0 at address 7. The address is displayed when you execute the commands, show usb and show usb verbose (the Dev# field).

Configuring the Profile and Modem Driver

1. Insert the USB Modem into an open USB port.
2. Verify that the modem is detected (the show usb command see Figure 94)

Figure 94 *show usb command*

```
(host) #show usb
Address  Product                Vendor  ProdID  Serial           Type      Profile       State
-------  -------                ------  ------  ------           ----      -------       -----
3        Novatel Wireless CDMA  1410    4100    091087843891000  Cellular  Novatel_U727  Device ready

(host) #
```

If your modem is not recognized (such as “type is unknown”, “no matching profile”, or “device not ready”), use the show usb verbose (Figure 95) command to verify your modem is listed.

Figure 95 *show usb verbose for profile and driver*

```
(host) #show usb verbose
...
T:  Bus=01 Lev=02 Prnt=02 Port=00 Cnt=01 Dev#=  3 Spd=12  MxCh= 0
D:  Ver= 1.10 Cls=00(>ifc ) Sub=00 Prot=00 MxPS=64 #Cfgs=  1
P:  Vendor=1410 ProdID=4100 Rev= 0.00
S:  Manufacturer=Novatel Wireless Inc.
S:  Product=Novatel Wireless CDMA
S:  SerialNumber=091087843891000
C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=500mA
...
(host) #
```

3. Create a cellular profile and import the identifiers. The Dialer, Tty, and Driver fields are the new profile defaults.

Figure 96 *cellular profile new_card command*

```
(host) (config) #cellular profile new_card
(host) (config-cellular new_card)# import 10
(host) (config-cellular new_card)# show cellular profile

Cellular Profile Table
----------------------
Name                  Vend  Prod  Serial           Dialer   Tty      Driver  Priority  Modeswitch
----                  ----  ----  ------           ------   ---      ------  --------  ----------
new_card              1410  5010  091087843890000  evdo_us  ttyUSB0  option  default

(host) (config) #
```

4. Configure the modem driver.

   The default “option” driver is a catch-all for cellular modems. Nearly all cards use this driver and support for new modems are added here. Once option driver is configured to work with this device, it recognizes the modem and expose its ports. The following example has four serial TTY ports (option driver) and one flash device (usb-storage driver).

Figure 97 *Driver options*

```
(host) #show usb verbose
...
P:  Vendor=1410 ProdID=4100 Rev= 0.00
S:  Manufacturer=Novatel Wireless Inc.
S:  Product=Novatel Wireless CDMA
S:  SerialNumber=091087843891000
C:* #Ifs= 5 Cfg#= 1 Atr=a0 MxPwr=500mA
I:  If#= 0 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=ff Prot=ff Driver=option
I:  If#= 1 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=option
I:  If#= 2 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=option
I:  If#= 3 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=option
I:  If#= 4 Alt= 0 #EPs= 2 Cls=08(stor.) Sub=06 Prot=50 Driver=usb-storage
...
```

If you get entries similar to the example below:

Figure 98 *Driver=(none)*

```
(host) #show usb verbose
...
I:  If#= 0 Alt= 0 #EPs= 3 Cls=ff(vend.) Sub=ff Prot=ff Driver=(none)
I:  If#= 1 Alt= 0 #EPs= 2 Cls=ff(vend.) Sub=ff Prot=ff Driver=(none)

...
```

This means the driver does not work with these ports. Try the other drivers and see if they pick up the device. Airprime is the reliable *catch-all* driver, Sierra is for certain Sierra cards, and cdc-acm is a legacy abstract control modem driver. Your goal is to assign a driver for the unclaimed (none) interfaces (If#).

If no option driver appears or only storage interfaces appear, then the modem must be switched to data mode (see "Mode-Switching" on page 504).

Configuring the TTY Port

1. View the exposed TTY ports by executing the show usb ports 13 command.

Figure 99 *show usb ports 13 command*

```
(host) (config-cellular new_card)# show usb ports 13
ttyUSB0
ttyUSB1
ttyUSB2
ttyUSB3
(host) (config-cellular new_card)#
```

In the example above, the command reveals four exposed TTY ports. One is the modem port, while the other ports are for GPS, real-time statistics, or diagnostics. If the command does not reveal any ports or if only storage devices (such as 'sr0') appear, then the device must be switched to data mode before proceeding. See "Mode-Switching" on page 504 for instruction.

2. Send a test AT command to determine the correct modem port.

Figure 100 *show usb test command*

```
(host) (support)#show usb test 16 ttyUSB0
AT
OK
TTY port responded to modem AT commands
(host) (support)#
```

In the example above, the TTY port responds with an 'OK'. This indicates that ttyUSB0 is a valid modem port.

There may be more than one modem port; you can continue to send AT commands to determine which ports are modem ports. If the port is not a valid modem port, a time out error is generated as shown in the example below

Figure 101 *Time out error example.*

```
(host) (support)#show usb test 16 ttyUSB1
Error: Timed out while waiting for modem to respond to AT commands
(host) (support)#
```

In the example below, the TTY port does not exist, or is busy with a previous PPP session.

Figure 102 *Port I/O error*

```
(host) (support)#show usb test 16 ttyUSB4
Error: Port I/O error. TTY port usb/16/ttyUSB4 inaccessible
(host) (support)#
```

Once you find one (or more) modem TTY port, configure it in the cellular profile and test the port.

Testing the TTY Port

After your TTY port is correctly configured, the port is in the 'Device Ready' state.

Figure 103 *Device Ready State*

```
(host) (config-cellular new_modem)# show usb
USB Device Table
----------------
Address  Product                Vendor  ProdID  Serial           Type      Profile    State
-------  -------                ------  ------  ------           ----      -------    -----
18       Novatel Wireless CDMA  1410    4100    091087843891000  Cellular  new_modem  Device ready
(host) (config-cellular new_modem)#
```

The 'Device Ready' state indicates the port has passed the diagnostic test and is ready.

You can also run extended diagnostics to displays more information about the modem.

NOTE: Not all modems support the extended AT command set. If the modem hangs after sending an extended AT command; removing the device and then re-inserting it usually fixes the problem

The AT+CSQ command queries is the modem's current signal strength. The first number represents the signal ranging from 1 (poor) to 33 (excellent). In the example below, the strength is in the excellent range (31).

Figure 104 *usb test extended.*

```
(host) #show usb test 18 ttyUSB0 extended
OK
ATI0
Manufacturer: NOVATEL WIRELESS INCORPORATED
Model: U727 SPRINT
Revision: m6800B-RAPTOR65_S-114 [Dec 07 2007 18:00:00]
ESN: 0x5B860A05
+GCAP: +CIS707-A, CIS-856-A, +MS, +ES, +DS
OK
AT+CSQ
31, 99
OK
TTY port responded to modem AT commands
(host) #
```

Selecting the Dialer Profile

The phone number, user name, and password (if any) are set in the dialer setting. In the United States, AT&T and T-Mobile use the 'gsm_us' profile, while Sprint and Verizon use the 'evdo_us' profile. User names and passwords are not typically used by U.S. carriers, but they may be required by International carriers.

Choose the dialer group that matches your carrier. If one doesn't exist, create a new dialer group with information from your carrier (Figure 105)

Figure 105 *show dialer group example*

```
(host)# show dialer group
Dialer Group Table
------------------
Name         Init String                       Dial String
----         -----------                       -----------
evdo_us      ATQ0V1E0                          ATDT#777
gsm_us       AT+CGDCONT=1,"IP","ISP.CINGULAR"  ATD*99#
(host)#
```

The ATD, in the Dial String column in Figure 105, specifies the number to dial, and is typically the same among respective CDMA/GSM carriers. The information under the Init String column typically just resets the modem to the factory default state, but may contain carrier specific options. You can often find these settings in online forums or from your ISP.

Linux Support

The Internet is a great place to research Linux support for your modem. Chances are someone already got it working on their system and their configuration can be leveraged. The following sites provide useful information:

http://www.evdoforums.com/

http://ubuntuforums.org

http://www.linux.com/forums

http://kenkinder.com/

NAS (Network-Attached Storage)

NOTE: The NAS and Print Server features are scheduled for deprecation in ArubaOS version 6.2 In preparation for the deprecation, NAS configuration commands are hidden at the command line.

The W-600 Series controller allows you to connect a pre-formatted NAS device that can be made available to all connected clients. The W-600 Series supports NAS devices with partitions in filesystem formats:

- ext2
- ext3
- FAT16
- FAT32

The W-600 Series supports a maximum of four devices. To ensure higher reliability, only connect one USB powered device. The other three devices should use an external power source.

NAS Device Setup

Setting up a NAS device involves the following step:

- Connecting the physical device to the USB port in the controller
- Mounting the device on the controller
- Creating a share—To use the mounted NAS device, you must create a share on the NAS device.
- Associating the share with a filesystem path

Power on the NAS device after you connect the NAS device to the W-600 Series controller's USB port. Verify that the usb disk is detected (show usb command).

```
(host) #show usb
```

```
USB Device Table

----------------

Address  Product            Vendor  ProdID  Serial        Type     Profile  State

-------  -------            ------  ------  ------        ----     -------  -----

5        OneTouch           0d49    7350    2HAS49ZZ      Storage

3                           0424    2502                  Hub

4        HP LaserJet P3005  03f0    7317    CNH1D00105    Printer
```

Configuring in the CLI

1. Login as admin and switch to config mode.
2. Enter the command below to enable NAS service:

   ```
   (host)(config)# service network-storage
   ```

3. Enter the show usb-storage command to view a list of mounted and unmounted devices:

   ```
   (host)(config) #show usb-storage
   USB Disk Table
   --------------
   Device Name                          Device Alias  Num of Partitions  Size      Mounted partitions
   -----------                          ------------  -----------------  ----      ------------------
   Maxtor-Basics_Desktop-2HBADMJ4       Maxtor1TB     1                  1000 GB   No
   WD-2500BEV_External-WD-WXE508ET3777  WD250GB       1                  250 GB    No
   ```

4. Enter the show usb-storage partitions command to view disk partitions:

```
(host) (config) #show usb-storage partitions

USB Disk Partition Table
------------------------
Partition Name                          Partition Alias  Filesystem  Size  Used    Mount Name
--------------                          ---------------  ----------  ----  ----    ----------
Maxtor-Basics_Desktop-2HBADMJ4_p1        MxDocs           EXT3/EXT2   1000  204.2M  Maxtor-Basics_Desktop-2HBADMJ4_p1
WD-2500BEV_External-WD-WXE508ET3777_p1   WdImages         EXT3/EXT2    250  223.1M  WD-2500BEV_External-WD-WXE508ET3777_p1
```

5. Enter the command below to create a share:

   ```
   (host) (config)# network-storage share <sharename>
   ```

6. Associating the share to a filesystem path—To access the share, you must create a filesystem path to the share. enter:

   ```
   (host) (config-network-storage share)# share usb: disk <disk name> <filesystem path> mode
   ```

   Where,

   disk name is the name of the disk. You can also specify the disk alias instead of the disk name.

   filesystem path is the path to access the share. This path contains the partition name and the shared folder name.

   mode is the permission settings. You can either specify `read-only` or `read-write` modes.

   Example: `share usb: disk WD250GB WdImages/desktop mode Read-Write`

7. Display the status of a connected NAS device, enter the command:

   ```
   (host) (config)# show network-storage status
   ```

Users can now access the connected storage device from the filesystem path.

For example: `\\<controller-ip>\<sharename>\<directory>\`

Managing NAS Devices

The following commands are available for managing a NAS devices after they are mounted and configured in the controller. For more details on these command, see the *Command Line Reference Guide*.

- Creating an alias for a disk

  ```
  usb-storage disk WD-2500BEV_External-WD-WXE508ET3777 alias WD250GB
  ```
- View list of shares in a disk

  ```
  show network-storage shares
  ```

  Displays the disk name, partition name, folder and share name, share path, permission settings and status.
- View list of files opened by clients

  ```
  show network-storage files opened
  ```

  Displays the client machine IP address, path to opened file in controller, permission settings and time-stamp details.
- View list of connected users

  ```
  show network-storage users
  ```

  Displays the list of users by IP address, connected share name and connection time.
- View list of directories in a disk

  ```
  show dir usb: disk <disk-name> <filesystem-path>
  ```

  Displays the list of directories in the specified disk and the filesystem path.
- View mounted and unmounted storage device status

  ```
  show usb-storage
  ```

  Displays device name, device alias (if any), number of partitions in the device, size and mounted partition status of all disks connected to the controller.
- View mounted storage device status (see

  ```
  show usb-storage mounted
  ```
- View unmounted storage device status

  ```
  show usb-storage unmounted
  ```

  Displays if the parti tons in the connected disks are unmounted.
- View details of both mounted and unmounted disk partitions

  ```
  show usb-storage partitions
  ```
- View details of unmounted disk partitions

  ```
  show usb-storage unmounted partitions
  ```
- View details of mounted disk partitions

  ```
  show usb-storage mounted partitions
  ```

Mounting and Unmounting Devices

Users who don't have access to the CLI can unmount/mount all the disks using the media eject button. This multi-function button means that pressing and holding the button for shorter or longer periods of time will result in entirely different functions. Table 104 list the functions and related status LED for the multi-function eject button.

Table 104 *Multi-function Media Eject Button*

Initial State	LED State	Action	Status LED	Function	LED Action Completed
NAS Media Operational	Green-solid	Press and hold media eject button for 1 to 5 seconds only	Amber-flashing	Un-mount all NAS media	Amber-solid
NAS Media Unmounted	Amber-solid	Press and hold media eject button for 1 to 5 seconds only	Amber-flashing	Mount all attached NAS devices, and return to fully functional operation	Green-solid
Operational	Green-solid	Press and hold media eject button for more than 5 seconds only	Red-flashing	Controller goes into Standby	Red-solid
Operating with NAS Media un-mounted	Amber-solid	Press and hold media eject button for more than 5 seconds only	Red-flashing	Controller goes into Standby	Red-solid
Standby	Red-solid	Press media eject button	Amber-flashing	Controller wake-up	Green-solid

Print Server

NOTE: The NAS and Print Server features are scheduled for deprecation in ArubaOS version 6.2 In preparation for the deprecation, NAS configuration commands are hidden at the command line.

The W-600 Series Controller allows you to connect a printer so that it is available to all connected clients.

Printer Setup Using the CLI

Connect the printer to the controller's USB port and power on the printer. Then you can configure the printer using the CLI.

1. Login to the W-600 Series controller as an admin and switch to config mode.
2. Enable the printer service by entering the command:

   ```
   (host)(config)# service print-server
   ```
3. To view a list of printers mounted on the controller, type:

   ```
   (host)# show network-printer status
   ```
4. You can create a printer alias name so that it is identified easily in the network. To create an alias, switch to *config mode* and enter the command:

   ```
   ((host) # usb-printer <printer-name> alias <new-printer-name>
   ```
5. Defining client association
   a. Maximum clients—You can define the maximum number of clients that can use the printer. Enter the command:

      ```
      (host) (config)# network-printer max-clients <2-20>
      ```

      Currently, the W-600 Series supports a maximum of 20 concurrent clients.

      Maximum number of clients per host—To define the maximum number of concurrent clients for a single host, enter the command:

      ```
      (host) (config)# network-printer max-clients-per-host <1-20>
      ```

      The W-600 Series supports a maximum of 20 concurrent clients.

6. Defining printer job storage—To view the maximum number of jobs that can be saved in the memory, type:

   ```
   (host) (config)# network-printer max-jobs <1-50>
   ```

   The W-600 Series controller will support a storage of 50 jobs.

You can now access the printer from their clients.

For example: \\<controller-ip>\<printername>

Additional Commands for Managing Printers

The following commands are available for managing a printer after they are configured in the controller.

- View printer configuration

  ```
  show network-printer config
  ```

  Displays configuration parameter and its assigned value.
- View list of jobs in printer memory

  ```
  show network-printer job <printer-name>
  ```
- Delete print jobs

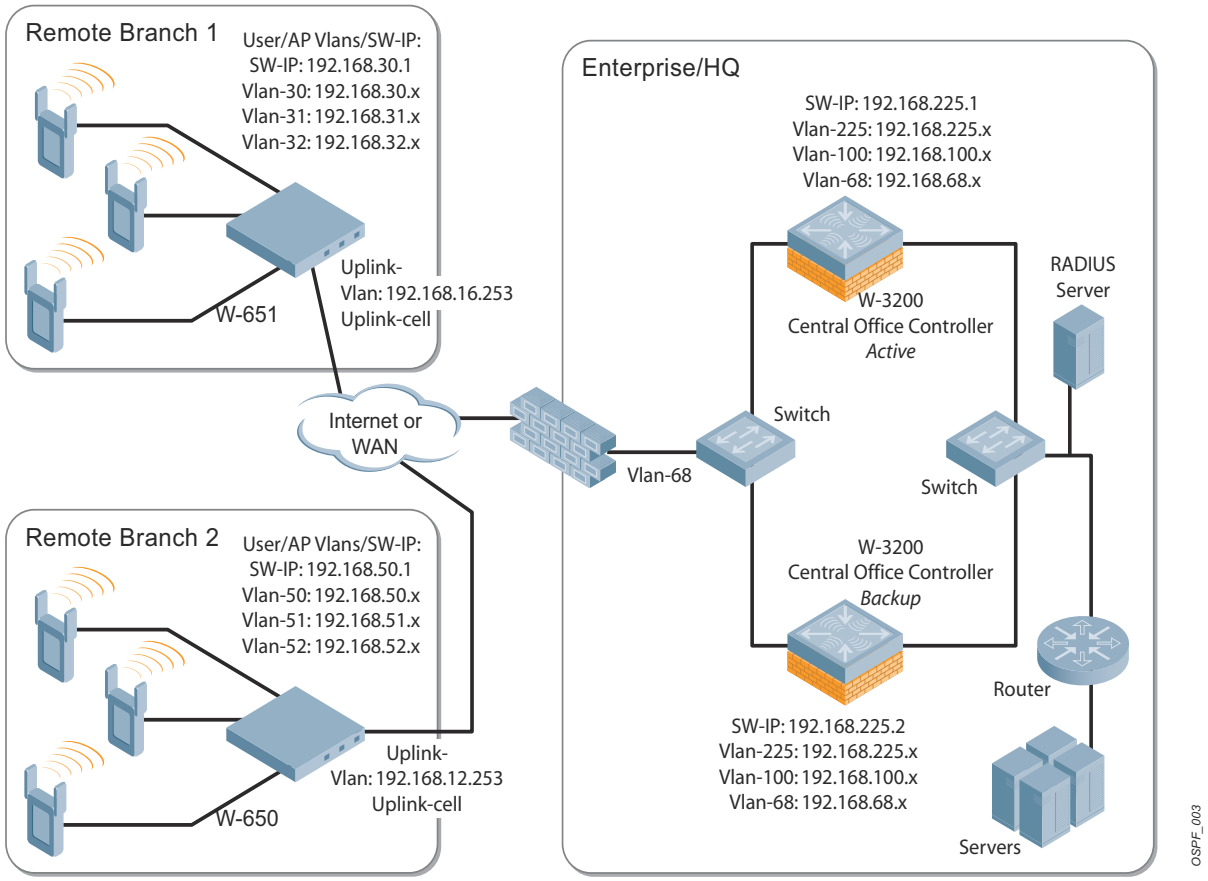
  ```
  network-printer delete <printer-name> job <job-id>
  ```
- View printer status. The command below displays the printer name, alias, status and status comment.

  ```
  show network-printer status
  ```

Sample Topology and Configuration

Figure 106 uses both the W-650 and W-651 controller to illustrate this example topology. Where the W-650 is used, a W-620 could be used just as effectively.

Figure 106 *W-600 Series Topology*



Remote Branch 1—W-651 Controller

```
masterip 192.168.68.217 ipsec ****** uplink
controller-ip vlan 30
vlan 16
vlan 30
vlan 31
vlan 32
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 16
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 30
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 31
```

```
!
interface gigabitethernet  1/3
        description "GE1/3"
        trusted
        switchport access vlan 32
!
interface vlan 16
        ip address 192.168.16.251 255.255.255.0
!
interface vlan 30
        ip address 192.168.30.1 255.255.255.0
!
interface vlan 31
        ip address 192.168.31.1 255.255.255.0
!
interface vlan 32
        ip address 192.168.32.1 255.255.255.0
!
uplink wired priority 202
uplink cellular priority 201
uplink wired vlan  16
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.0.0.3 255.0.0.0
        tunnel source 192.168.30.1
        tunnel destination 192.168.68.217
        trusted
        ip ospf area 10.10.10.10
!
ip default-gateway 192.168.16.254
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.30.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 30-32
```

Remote Branch 2—W-650 Controller

```
masterip 192.168.68.217 ipsec ****** uplink
controller-ip vlan 50
!
vlan 20
vlan 50
vlan 51
vlan 52
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 20
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 50
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
```

```
        switchport access vlan 51
!
interface gigabitethernet  1/3
        description "GE1/3"
        trusted
        switchport access vlan 52
!
interface vlan 20
        ip address 192.168.20.1 255.255.255.0
!
interface vlan 50
        ip address 192.168.50.1 255.255.255.0
!
interface vlan 51
        ip address 192.168.51.1 255.255.255.0
!
interface vlan 52
        ip address 192.168.52.1 255.255.255.0
!
uplink wired priority 206
uplink cellular priority 205
uplink wired vlan  20
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.0.0.5 255.0.0.0
        tunnel source 192.168.50.1
        tunnel destination 192.168.68.217
        trusted
        ip ospf area 10.10.10.10
!
ip default-gateway 192.168.20.254
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.50.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 50-52
```

W-3200 Central Office Controller—Active

```
localip 0.0.0.0 ipsec db947e8d1b383813a4070ab0799fa6246b80fc5cfcc3268f
controller-ip vlan 225
vlan 68
vlan 100
vlan 225
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 225
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 100
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
```

```
        switchport access vlan 68
!
interface vlan 68
        ip address 192.168.68.220 255.255.255.0
!
interface vlan 100
        ip address 192.168.100.1 255.255.255.0
!
interface vlan 225
        ip address 192.168.225.2 255.255.255.0
!
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.1.0.3 255.0.0.0
        tunnel source 192.168.225.2
        tunnel destination 192.168.30.1
        trusted
        ip ospf area 10.10.10.10
!
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.1.0.5 255.0.0.0
        tunnel source 192.168.225.2
        tunnel destination 192.168.50.1
        trusted
        ip ospf area 10.10.10.10
!
master-redundancy
  master-vrrp 2
  peer-ip-address 192.168.68.221 ipsec password123
!
vrrp 1
  priority 120
  authentication password123
  ip address 192.168.68.217
  vlan 68
  preempt
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
vrrp 2
  priority 120
  ip address 192.168.225.9
  vlan 225
  preempt
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
ip default-gateway 192.168.68.1
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.225.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 100,225
```

```
!
```

W-3200 Central Office Controller—Backup

```
localip 0.0.0.0 ipsec db947e8d1b383813a4070ab0799fa6246b80fc5cfcc3268f
controller-ip vlan 225
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 225
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 100
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 68
!
interface vlan 68
        ip address 192.168.68.221 255.255.255.224
!
interface vlan 100
        ip address 192.168.100.5 255.255.255.0
!
interface vlan 225
        ip address 192.168.225.1 255.255.255.0
!
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.1.0.3 255.0.0.0
        tunnel source 192.168.225.1
        tunnel destination 192.168.30.1
        trusted
        ip ospf area 10.10.10.10
!
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.1.0.5 255.0.0.0
        tunnel source 192.168.225.1
        tunnel destination 192.168.50.1
        trusted
        ip ospf area 10.10.10.10
!
master-redundancy
  master-vrrp 2
  peer-ip-address 192.168.68.220 ipsec password123
!
vrrp 1
  priority 99
  authentication password123
  ip address 192.168.68.217
  vlan 68
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
```

```
  no shutdown
!
vrrp 2
  priority 99
  ip address 192.168.225.9
  vlan 225
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
ip default-gateway 192.168.68.1
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.225.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 100,225
!
```

Upgrading and Migrating

The W-600 Series Controllers require ArubaOS 3.4 or later. ArubaOS releases prior to ArubaOS version 3.4. do not support the W-600 Series Controllers.

- **you are a new customer—upgrade your controller from its factory installed software with ArubaOS 3.4**
- **you are a current customer—upgrade the ArubaOS on your master and local controller to ArubaOS 3.4 or higher before installing the Dell W-600 Series Controller into your existing network.**

NOTE: The master controller, its redundant master controller, and all of its local controllers must run on the same version of ArubaOS. Once you upgrade your network and install an Dell W-600 Series Controller into your network, verify that the ArubaOS 3.4, or higher, is on your controller and on the rest of your network.

Chapter 28

OSPFv2

OSPFv2 (Open Shortest Path First) is a dynamic Interior Gateway routing Protocol (IGP) based on IETF RFC 2328. The premise of OSPF is that the shortest or fastest routing path is used. Dell's implementation of OSPFv2 allows Dell controllers to deploy effectively in a Layer 3 topology. Dell controllers can act as default gateway for all clients and forward user packets to the upstream router. The information in this chapter is in the following sections:

Important Points to Remember

- OSPF is disabled by default.
- Dell controllers support only one OSPF instance.
- Maximum OSPF routes is 1K.
- Convergence takes between 5 and 15 seconds.
- All area types are supported.
- Multiple configured areas are supported.
- An Dell controller can act as ABR (Area border router).
- OSPF supports VLAN and GRE tunnel interfaces.
- To run OSPF over IPSec tunnels, a Layer 3 GRE tunnel is configured between two routers with GRE destination addresses as the inner address of the IPsec tunnel. OSPF is enabled on the Layer 3 GRE tunnel interface and all of the OSPF control packets undergo GRE encapsulation before entering the IPsec tunnels.

  The default MTU value for a Layer 3 GRE tunnel in an Dell controller is 1100. When running OSPF over a GRE tunnel between an Dell controller and another vendor's router, the MTU values must be the same on both sides of the GRE tunnel.

OSPF is a robust routing protocol addressing various link types and deployment scenarios, the Dell implementation applies to two main use cases; WLAN Scenario and Branch Office Scenario.

WLAN Scenario

In the WLAN scenario, the Dell controller acts as a default gateway for all the clients and talks to one or two (for redundancy) upstream routers. The controller advertises all the user subnet addresses as stub addresses via LSAs to the routers..

NOTE: Totally stub areas *see* only a default route and routes local to the areas themselves.

WLAN Topology

The controller (Figure 107) is configured with VLAN 10 and VLAN 12 as user VLANs. These VLANs have clients on the subnets and the controller is the default router for those clients. VLAN 4 and VLAN 5 both have OSPF enabled. These interfaces are connected to a upstream routers (Router 1 and Router 2). The OSPF interface cost on VLAN 4 is configured lower than VLAN 5. The IDs are:

- Dell controller—40.1.1.1
- Router 1—50.1.1.1
- Router 2—60.1.1.1

Based on the cost of the uplink interface, default route from one of the upstream routers is installed in the forwarding information base (FIB) by the routing information base/route table manager (RIB/RTM) module.

WLAN Routing Table

View the controller routing table using the show ip route command:

```
(host) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default

Gateway of last resort is 4.1.1.2 to network 0.0.0.0

O*    0.0.0.0/0  [1/0] via 4.1.1.2*
C    4.1.1.0 is directly connected, VLAN4
C    5.1.1.0 is directly connected, VLAN5
C    10.1.1.0 is directly connected, VLAN10
C    12.1.1.0 is directly connected, VLAN12
```

Below is the routing table for Router 1:

```
(router1) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default


O    10.1.1.0/24  [1/0] via 4.1.1.1
O    12.1.1.0/24  [1/0] via 4.1.1.1
C    4.1.1.0 is directly connected, VLAN4
```

Below is the routing table for Router 2:

```
(router2) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default


O    10.1.1.0/24  [2/0] via 5.1.1.1
O    12.1.1.0/24  [2/0] via 5.1.1.1
C    5.1.1.0 is directly connected, VLAN5
```

Branch Office Scenario

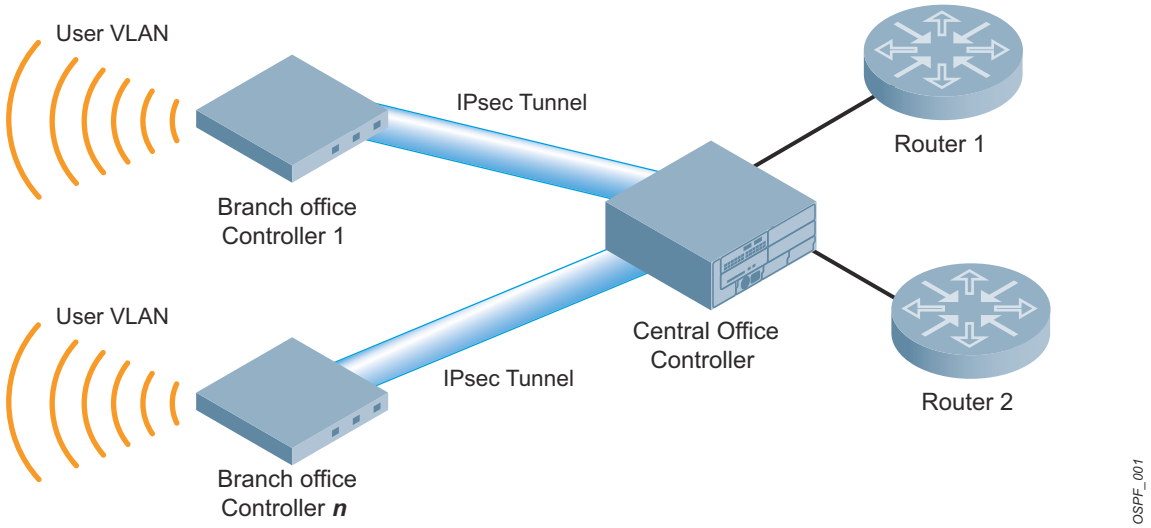
The branch office scenario has a number of remote branch offices with controllers talking to a central office via an Dell concentrator/controller using site-to-site VPN tunnels or master-local IPsec tunnels. The central office controller is in turn talking to upstream routers (see Figure 107).

In this scenario the default route is normally pointed to the uplink router; in many cases the ISP. Configure the area as stub so that inter-area routes are also advertised enabling the branch office controller to reach the corporate subnets.

Branch Office Topology

All the OSPF control packets exchanged between the Branch office and the Central office controllers undergo GRE encapsulation before entering the IPsec tunnels. The controllers in the branch offices advertise all the user subnet addresses to the Central office controller as stub addresses in router LSA. The Central office controller in turn forwards those router LSAs to the upstream routers.

Figure 107 *Branch Office OSPF Topology*



All the branch office controllers, the Central office controller, and the upstream routers are part of a stub area. Since the OSPF packets follow GRE encapsulation over IPsec tunnels, the Central office controller can be a controller or any vendor's VPN concentrator. Regardless, the controller in the branch office will interoperate with other vendors seamlessly.

In Figure 107, the branch office controller is configured using VLAN 14 and VLAN 15. Layer 3 GRE tunnel is configured with IP address 20.1.1.1/24 and OSPF is enabled on the tunnel interface.

In the Central office controller, OSPF is enabled on VLAN interfaces 4, 5, and, the Layer 3 GRE tunnel interface (configured with IP address 20.1.1.2/24). OSPF interface cost on VLAN 4 is configured lower than VLAN 5.

Branch Office Routing Table

View the branch office controller routing table using the show ip route command:

```
(host) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default

Gateway of last resort is 20.1.1.2 to network 0.0.0.0

O*    30.0.0.0/0  [1/0] via 20.1.1.2*
C    14.1.1.0 is directly connected, VLAN14
C    15.1.1.0 is directly connected, VLAN15
C    20.1.1.0 is directly connected, Tunnel 1
```

The routing table of the Central office controller is below:

```
(host) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default

Gateway of last resort is 4.1.1.2 to network 0.0.0.0

O*    0.0.0.0/0  [1/0] via 4.1.1.2*
O    14.1.1.0/24  [1/0] via 30.1.1.1*
O    15.1.1.0/24  [1/0] via 30.1.1.1*
C    4.1.1.0 is directly connected, VLAN4
C    5.1.1.0 is directly connected, VLAN5
C    20.1.1.0 is directly connected, Tunnel 1
```

The routing table for Router 1 is below:

```
(router1) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default


O    14.1.1.0/24  [1/0] via 4.1.1.1
O    15.1.1.0/24  [1/0] via 4.1.1.1
C    4.1.1.0 is directly connected, VLAN4
```

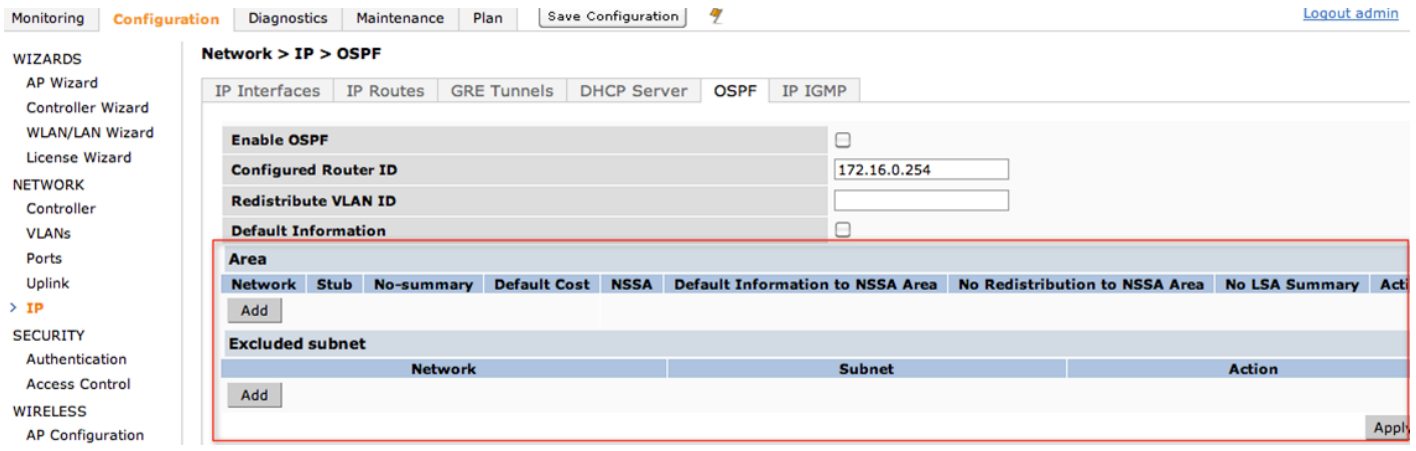
The routing table Router 2 is below:

```
(router2) #show ip route

Codes: C - connected, O - OSPF, R - RIP, S - static
       M - mgmt, U - route usable, * - candidate default


O    14.1.1.0/24  [1/0] via 5.1.1.1
O    15.1.1.0/24  [1/0] via 5.1.1.1
C    5.1.1.0 is directly connected, VLAN5
```

Configuring OSPF

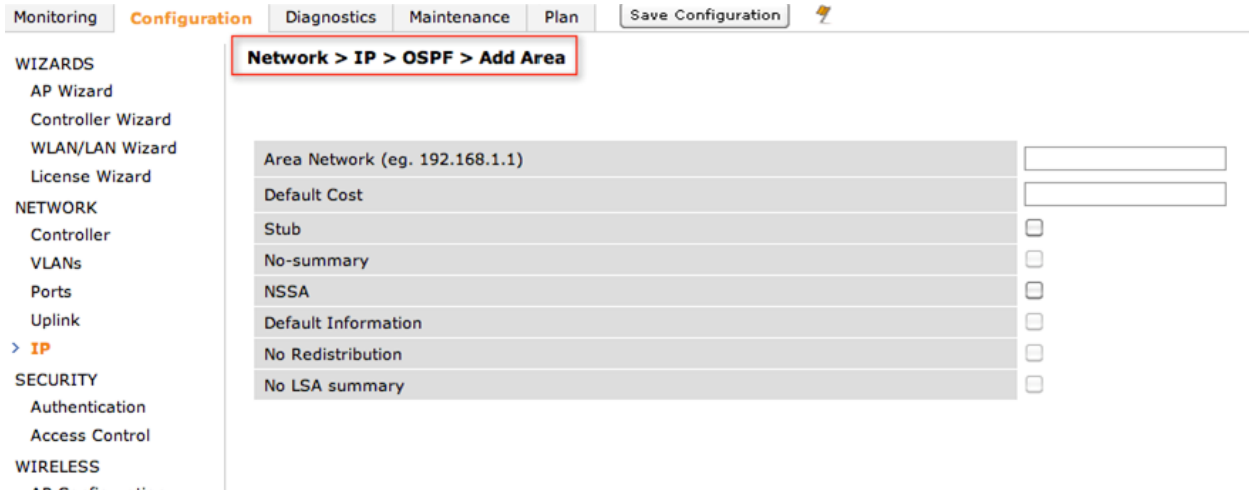
Configure general OSPF settings from the OSPF tab on the Configuration >IP page (see Figure 108). The Area and Excluded subnets are displayed in table format. If not explicitly specified for OSPF, the router ID defaults to the switch IP.

Figure 108 *General OSPF Configuration*



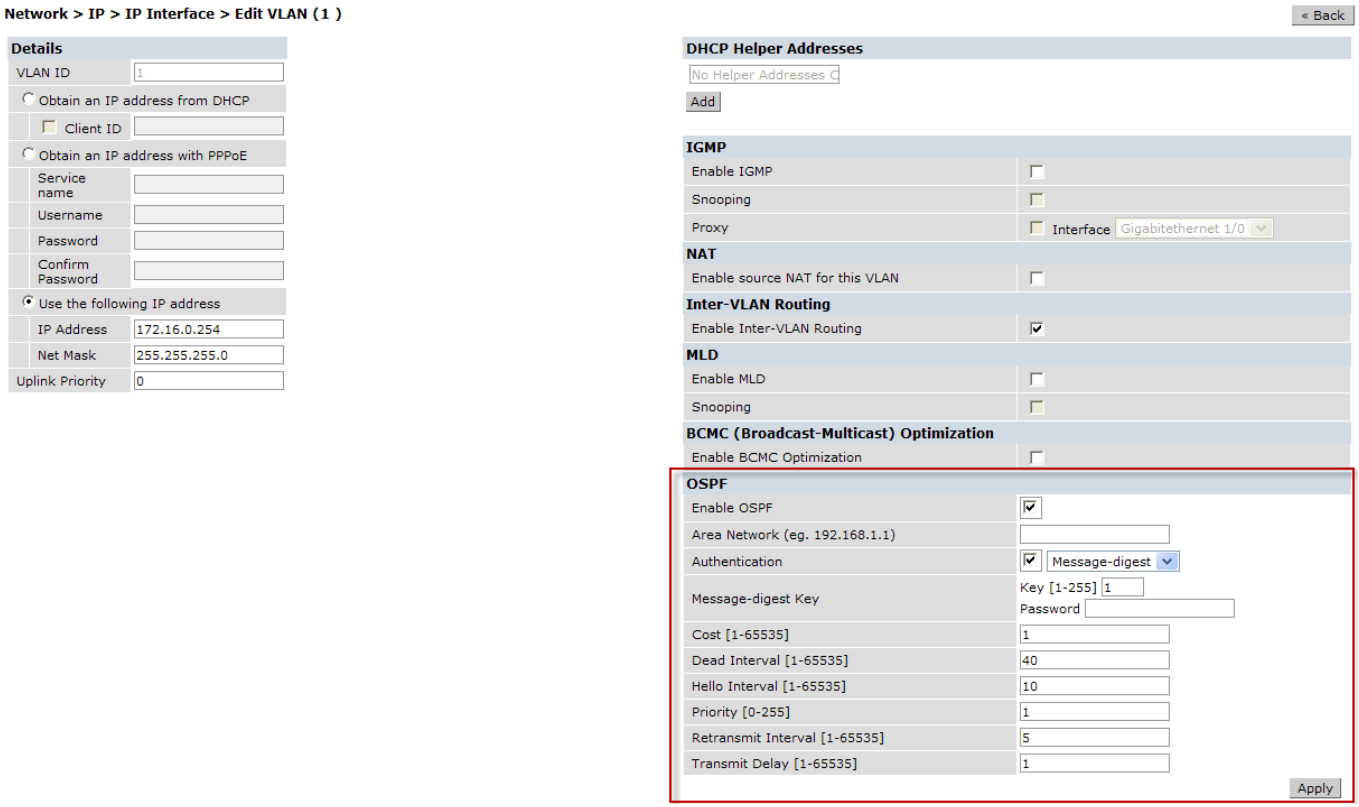
Select the Add button to add an area (see Figure 109).

Figure 109 *Add an OSPF Area*



Configure the OSPF interface settings in the Configuration screen (Figure 110). If OSPF is enable, the parameters contain the correct default values. The OSPF values are editable only when OSPF is enabled on the interface.

Figure 110 *Edit OSPF VLAN Settings*



OSPF monitoring is available from an IP Routing sub-section (Controller > IP Routing > Routing). Both Static and OSPF routes are available in table format.

OSPF Interfaces and Neighboring information is available from the OSPF tab. The Interface information includes transmit (TX) and receive (RX) statistics.

Deployment Best Practices

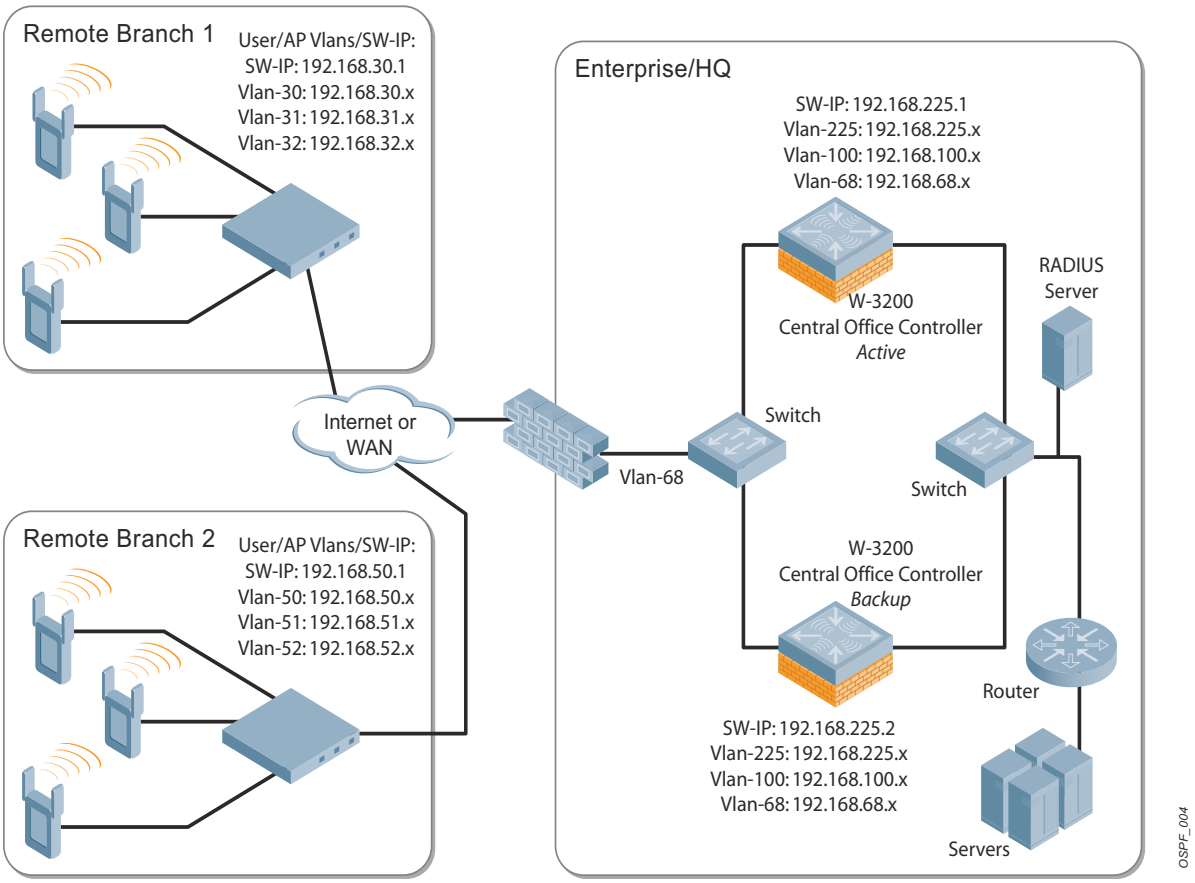
Below are some guidelines regarding deployment and topology for this release of OSPFv2.

- In WLAN scenario, configure the Dell controller and all upstream routers in totally stub area; in Branch Office scenario, configure as stub area so that the Branch Office controller can receive corporate subnets.
- In the WLAN scenario upstream router, only configure the interface connected to the controller in the same area as the controller. This will minimize the number of local subnet addresses advertised by the upstream router to the controller.
- Use the upstream router as the designated router (DR) for the link/interface between the controller and the upstream router.
- The default MTU value for a Layer 3 GRE tunnel in an Dell controller is 1100. When running OSPF over a GRE tunnel between an Dell controller and another vendor's router, the MTU values must be the same on both sides of the GRE tunnel.
- Do not enable OSPF on any uplink/WAN interfaces on the Branch Office Controller. Enable OSPF only on the Layer 3 GRE tunnel connecting the master controller.
- Use only one physical port in the uplink VLAN interface that is connecting to the upstream router. This will prevent broadcasting the protocol PDUs to other ports and hence limit the number of adjacencies on the uplink interface to only one.

Sample Topology and Configuration

Figure 111 displays a sample OSPF topology followed by sample configurations of the Remote Branch 1, Remote Branch 2, and the W-3200 Central Office Controller (Active and Backup).

Figure 111 *Sample OSPF Topology*



Remote Branch 1

```
controller-ip vlan 30
vlan 16
vlan 30
vlan 31
vlan 32
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 16
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 30
!

interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 31
!
```

```
interface gigabitethernet  1/3
        description "GE1/3"
        trusted
        switchport access vlan 32
!
interface vlan 16
        ip address 192.168.16.251 255.255.255.0
!
interface vlan 30
        ip address 192.168.30.1 255.255.255.0
!
interface vlan 31
        ip address 192.168.31.1 255.255.255.0
!
interface vlan 32
        ip address 192.168.32.1 255.255.255.0
!
uplink wired priority 202
uplink cellular priority 201
uplink wired vlan  16
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.0.0.3 255.0.0.0
        tunnel source 192.168.30.1
        tunnel destination 192.168.68.217
        trusted
        ip ospf area 10.10.10.10
!
ip default-gateway 192.168.16.254
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.30.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 30-32
```

Remote Branch 2

```
controller-ip vlan 50
!
vlan 20
vlan 50
vlan 51
vlan 52
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 20
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 50
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 51
```

```
!
interface gigabitethernet  1/3
        description "GE1/3"
        trusted
        switchport access vlan 52
!
interface vlan 20
        ip address 192.168.20.1 255.255.255.0
!
interface vlan 50
        ip address 192.168.50.1 255.255.255.0
!
interface vlan 51
        ip address 192.168.51.1 255.255.255.0
!
interface vlan 52
        ip address 192.168.52.1 255.255.255.0
!
uplink wired priority 206
uplink cellular priority 205
uplink wired vlan  20
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.0.0.5 255.0.0.0
        tunnel source 192.168.50.1
        tunnel destination 192.168.68.217
        trusted
        ip ospf area 10.10.10.10
!
ip default-gateway 192.168.20.254
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.50.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 50-52
```

W-3200 Central Office Controller—Active

```
localip 0.0.0.0 ipsec db947e8d1b383813a4070ab0799fa6246b80fc5cfcc3268f
controller-ip vlan 225
vlan 68
vlan 100
vlan 225
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 225
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 100
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 68
!
```

```
interface vlan 68
        ip address 192.168.68.220 255.255.255.0
!
interface vlan 100
        ip address 192.168.100.1 255.255.255.0
!
interface vlan 225
        ip address 192.168.225.2 255.255.255.0
!
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.1.0.3 255.0.0.0
        tunnel source 192.168.225.2
        tunnel destination 192.168.30.1
        trusted
        ip ospf area 10.10.10.10
!
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.1.0.5 255.0.0.0
        tunnel source 192.168.225.2
        tunnel destination 192.168.50.1
        trusted
        ip ospf area 10.10.10.10
!
master-redundancy
  master-vrrp 2
  peer-ip-address 192.168.68.221 ipsec password123
!
vrrp 1
  priority 120
  authentication password123
  ip address 192.168.68.217
  vlan 68
  preempt
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
vrrp 2
  priority 120
  ip address 192.168.225.9
  vlan 225
  preempt
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
ip default-gateway 192.168.68.1
ip route 192.168.0.0 255.255.0.0 null 0

router ospf
router ospf router-id 192.168.225.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 100,225
!
```

W-3200 Central Office Controller—Backup

```
localip 0.0.0.0 ipsec db947e8d1b383813a4070ab0799fa6246b80fc5cfcc3268f
controller-ip vlan 225
!
interface gigabitethernet  1/0
        description "GE1/0"
        trusted
        switchport access vlan 225
!
interface gigabitethernet  1/1
        description "GE1/1"
        trusted
        switchport access vlan 100
!
interface gigabitethernet  1/2
        description "GE1/2"
        trusted
        switchport access vlan 68
!
interface vlan 68
        ip address 192.168.68.221 255.255.255.224
!
interface vlan 100
        ip address 192.168.100.5 255.255.255.0
!
interface vlan 225
        ip address 192.168.225.1 255.255.255.0
!
interface tunnel 2003
        description "Tunnel Interface"
        ip address 2.1.0.3 255.0.0.0
        tunnel source 192.168.225.1
        tunnel destination 192.168.30.1
        trusted
        ip ospf area 10.10.10.10
!
interface tunnel 2005
        description "Tunnel Interface"
        ip address 2.1.0.5 255.0.0.0
        tunnel source 192.168.225.1
        tunnel destination 192.168.50.1
        trusted
        ip ospf area 10.10.10.10
!
master-redundancy
  master-vrrp 2
  peer-ip-address 192.168.68.220 ipsec password123
!
vrrp 1
  priority 99
  authentication password123
  ip address 192.168.68.217
  vlan 68
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
vrrp 2
```

```
  priority 99
  ip address 192.168.225.9
  vlan 225
  tracking vlan 68 sub 40
  tracking vlan 100 sub 40
  tracking vlan 225 sub 40
  no shutdown
!
ip default-gateway 192.168.68.1
ip route 192.168.0.0 255.255.0.0 null 0
!
router ospf
router ospf router-id 192.168.225.1
router ospf area 10.10.10.10 stub
router ospf redistribute vlan 100,225
!
```

Chapter 29

Wireless Intrusion Prevention

The ArubaOS Wireless Intrusion Prevention (WIP) features and configurations are discussed in this chapter. WIP offers a wide selection of intrusion detection and protection features to protect the network against wireless threats. Like most other security-related features of the Dell network, the WIP configuration is done on the master controller in the network.

To use most of the features described in this chapter, you must install a Wireless Intrusion Protection (RFprotect) license on all controllers in your network. If you install a RFprotect license on a master controller only, an AP or AM terminated on a local controller will not provide the WIP features.

These features do not require an RFprotect license:

- Rogue AP classification techniques other than AP classification rules
- Rogue containment
- Wired containment
- Wireless containment without Tarpit

For details on commands see the *ArubaOS Command Line Interface Reference* document.

This chapter contains the following sections:

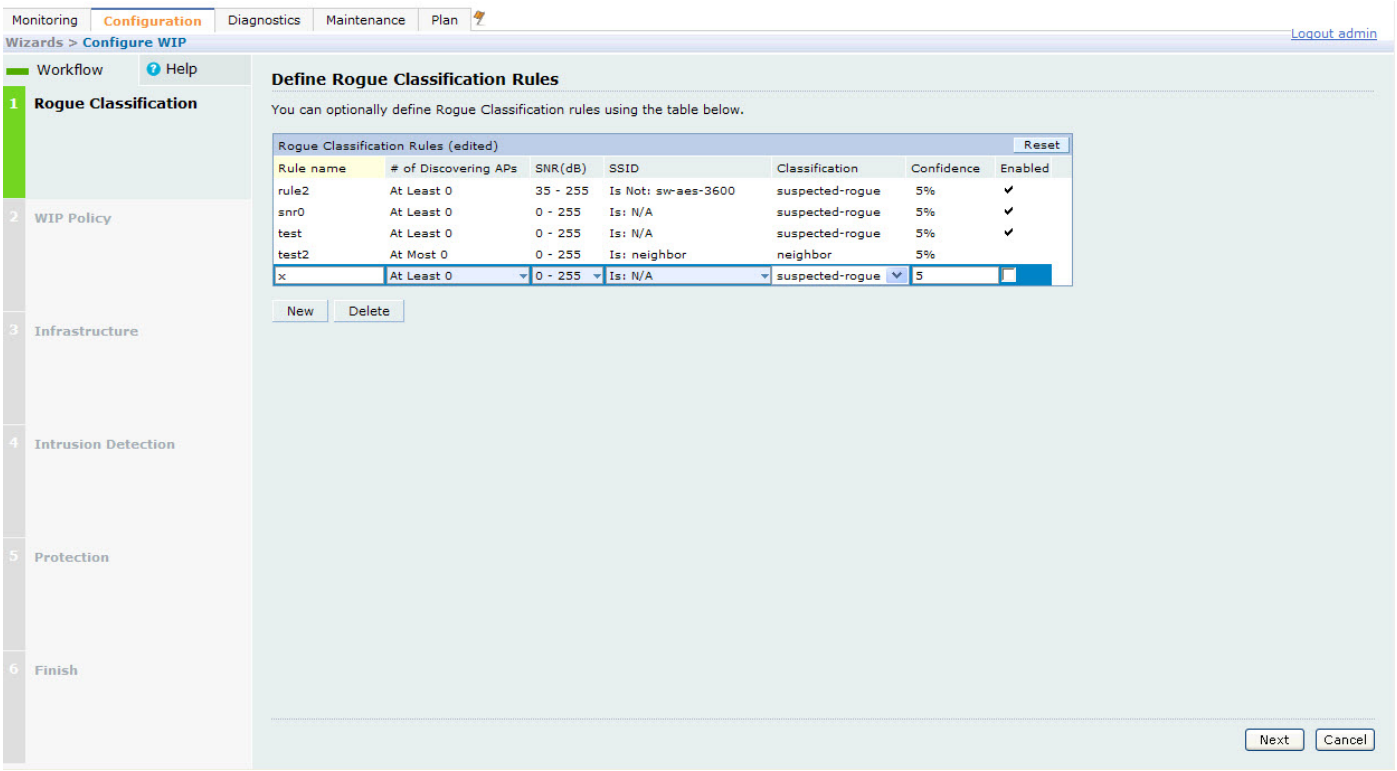
Reusable Wizard

The WebUI's reusable, intuitive, user-friendly Wizard provides steps to enable, define, or change:

- Integrated vs Overlay WLAN/WIP options
- Rules-based rogue classification
- Detection features for attacks against infrastructure
- Detection features for attacks against WLAN clients
- Protection features for attacks against infrastructure
- Protection features for WLAN clients

Figure 112 displays the WIP Wizard layout. Highlighting one of the previously configured rules reveals drop down menus for changing values. Note that the reusable wizard includes robust online Help.

Figure 112 *WIP Wizard*



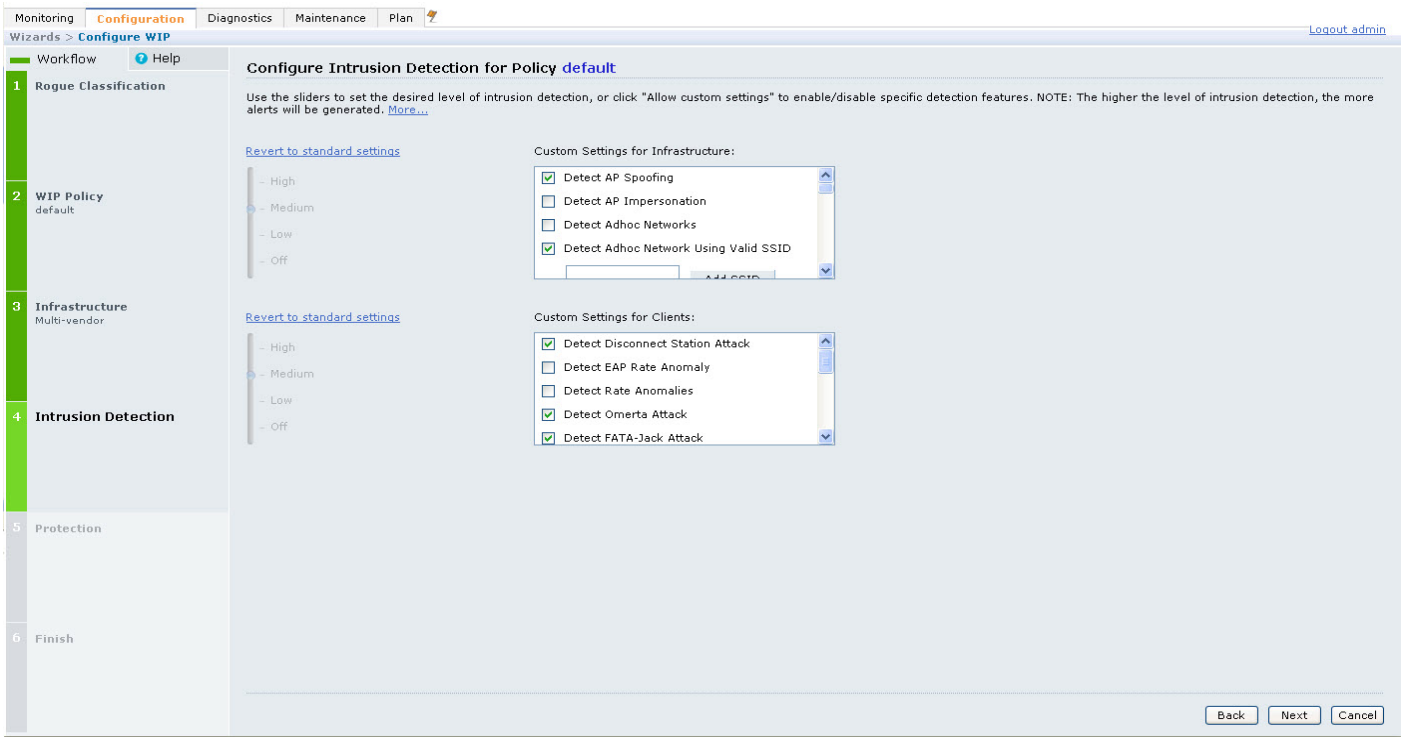
Wizard Intrusion Detection

Apply the intrusion detection mechanisms for detecting attacks against your infrastructure and clients (see Figure 113). You can either set the detection level to automatically enable the appropriate detection mechanisms or customize the settings for infrastructure and client attacks. Use the slider to select one of the detection levels for the infrastructure and clients:

- High—Enables all the detection mechanisms applicable to your infrastructure including all the options of low and medium level settings.
- Medium (Default)—Enables some important detection mechanisms for your infrastructure. This includes all the options of the low level settings.
- Low—Enables only the most critical detection mechanisms for your infrastructure.
- Off—Disables all the detection mechanisms.

To enable custom settings, click the *Allow custom settings* link to manually enable or disable the detection mechanisms for your clients. To revert to the standard settings from the custom settings mode, click the *Revert to standard settings* link.

Figure 113 *WIP Wizard's Intrusion Detection*



Wizard Intrusion Protection

Apply the intrusion protection mechanisms for your infrastructure and clients (see Figure 114). You can set the protection level to automatically enable the appropriate protection mechanisms or customize the settings for your infrastructure and clients.

Protection for Infrastructure

Use the slider to select one of the protection levels for the infrastructure:

- High—Enables all the protection mechanisms applicable to your infrastructure including all the options of low and medium level settings.
- Medium—Enables some important protection mechanisms for your infrastructure including all the options of the low level settings.
- Low—Enables only the most critical protection mechanisms for your infrastructure.
- Off (Default)—Disables all the protection mechanisms.

To enable custom settings, click the *Allow custom settings* link. You can manually enable or disable the protection mechanisms for your infrastructure. To revert to the standard settings from custom settings mode, click the *Revert to standard settings* link.

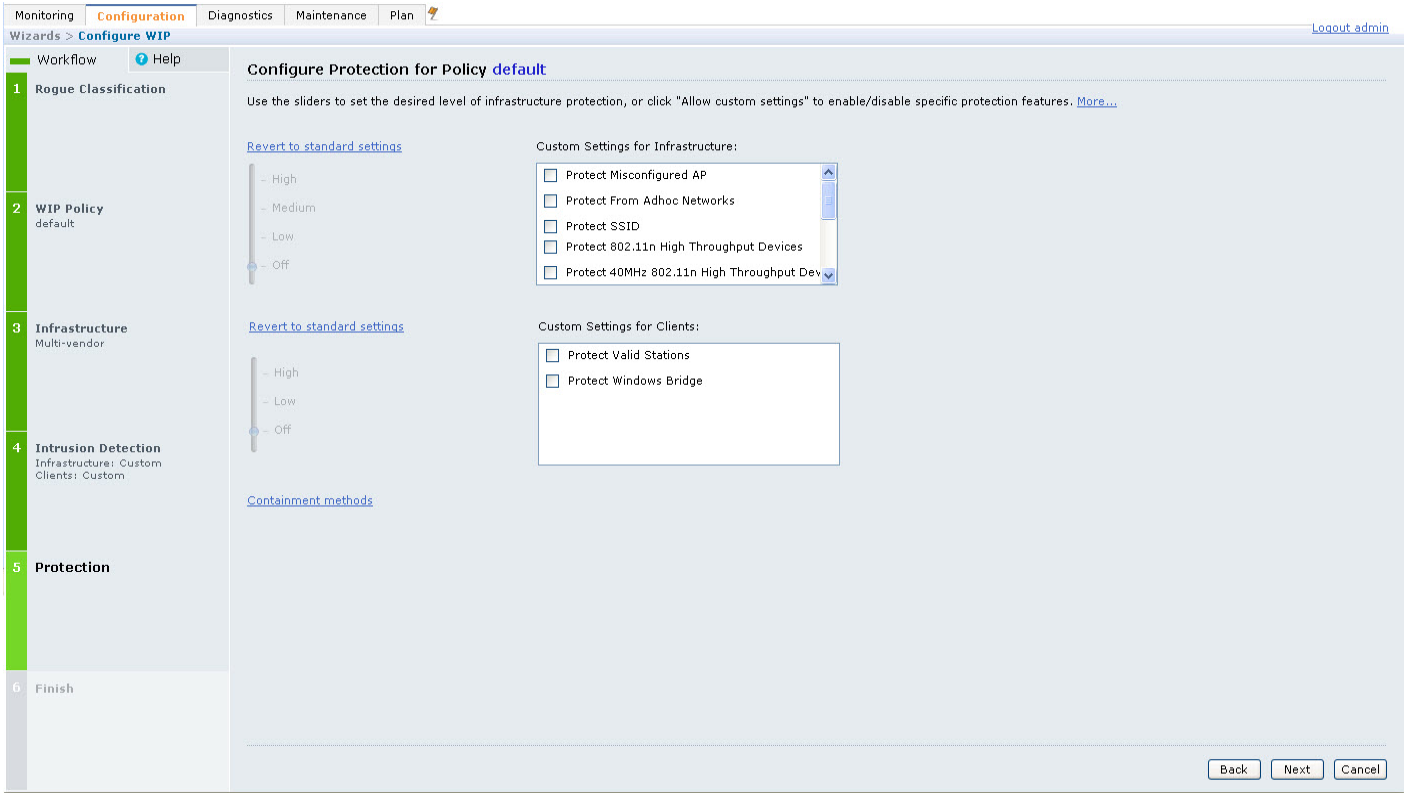
Protection for Clients

Use the slider (see Figure 114) to select one of the following preset protection levels for your clients:

- High—Enables all the protection mechanisms applicable to your clients including all the options of the low level settings.
- Low—Enables only the most critical protection mechanisms for your clients.
- Off (Default)—Disables all the protection mechanisms.

To enable custom settings, click the *Allow custom settings* link to manually enable or disable the protection mechanisms for your clients. To revert to the standard settings from custom settings mode, click the *Revert to standard settings* link.

Figure 114 *WIP Wizard Intrusion Protection*



Monitoring Dashboard

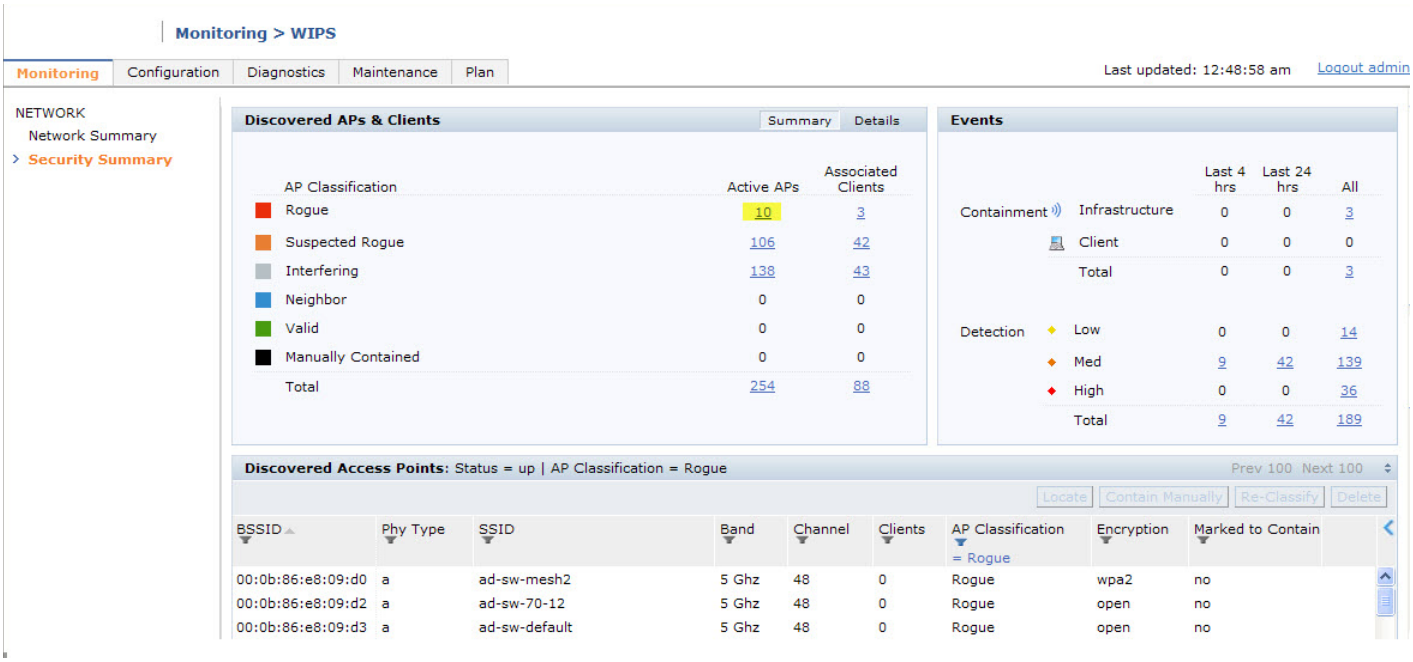
The Security Summary dashboard, in the Monitoring section of the WebUI, allows you to monitor the detection and protection of wireless intrusions in your network.

The dashboard's two top tables—Discovered APs & Clients and Events—contain data as links. When these links are selected they arrange, filter, and display the appropriate information in the lower table. For example, if you select the number 10 under the Active APs column (highlighted in yellow in Figure 115) then the bottom table will filter and arrange information about the ten classified Rogue APs. Use the scroll bar at the right to view all ten Rogue APs.

NOTE: The term *events* in this document is meant to include security threats, vulnerabilities, attacks (intrusion or Denial of Service) and other similarly related events.

The Event table contains data links. Selecting these data links will display information, in the bottom table, related to the Event you selected. Again, remember to use the scroll bar at the right to view all the Events.

Figure 115 *WIP Monitoring Dashboard*



Rogue AP Detection

The most important WIP functionality is the ability to classify an AP as a potential security threat. An AP is considered to be a rogue AP if it is both unauthorized and plugged into the wired side of the network. An AP is considered to be an interfering AP if it is seen in the RF environment but is not connected to the wired network.

While the interfering AP can potentially cause RF interference, it is not considered a direct security threat since it is not connected to the wired network. However, an interfering AP may be reclassified as a rogue AP.

Classification Terminology

APs and clients are discovered during scanning of the wireless medium, and they are classified into various groups. The AP and client classification definitions are in Table 105 and Table 106.

Table 105 *AP Classification Definition*

Classification	Description
Valid AP	An AP that is part of the enterprise providing WLAN service.
Interfering AP	An AP that is seen in the RF environment but is not connected to the wired network. An interfering AP is not considered a direct security threat since it is not connected to the wired network. For example, an interfering AP can be an AP that belongs to a neighboring office's WLAN but is not part of your WLAN network.
Neighbor AP	A neighboring AP is when the BSSIDs are known. Once classified, a neighboring AP does not change its state.
Rogue AP	An unauthorized AP that is plugged into the wired side of the network.
Suspected-Rogue AP	A suspected rogue AP is an unauthorized AP that may be plugged into the wired side of the network.
Manually-contained AP	An AP for which DoS is enabled manually.

Table 106 *Client Classification Definitions*

Classification	Description
Valid Client	Any client that successfully authenticates with a valid AP and passes encrypted traffic is classified as a valid client.
Manually-contained Client	Any clients for which DoS is enabled manually.
Interfering Client	A client associated to any AP and is not valid.

Classification Methodology

A discovered AP is classified as a rogue or a suspected rogue by the following methods:

- Internal heuristics
- AP classification rules
- Manually by the user

The internal heuristics works by checking if the discovered AP is communicating with a wired device on the customer network. This is done by matching the MAC address of devices that are on the discovered AP's network with that of the user's wired network. The MAC of the device on the discovered AP's network is known as the *Match MAC*. The ways in which the matching of wired MACs occurs is detailed in the sections Match Methods and Match Types.

Match Methods

The match methods are:

- Plus One—The match MAC matches a device whose MAC address' last bit was one more than that of the Match MAC.
- Minus One—The match MAC matches a device whose MAC address' last bit was one less than that of the Match MAC.
- Equal—The match was against the same MAC address.
- OUI—The match was against the manufacturer's OUI of the wired device.

The classification details are available in the 'Discovered AP table' section of the 'Security Summary' page of the WebUI. The information can be obtained by clicking on the details icon for a selected discovered AP. The information is also available in the command show wms rogue-ap.

Match Types

- Eth-Wired-MAC—The MAC addresses of wired devices learned by an AP on its Ethernet interface.
- GW-Wired-MAC—The collection of Gateway MACs of all APs across the master and local controllers.
- AP-Wired-MAC—The MAC addresses of wired devices learned by monitoring traffic out of other valid and rogue APs.
- Config-Wired-MAC—The MAC addresses that are configured by the user typically that of well known servers in the network.
- Manual—User triggered classification.
- External-Wired-MAC—The MAC address matched a set of known wired devices that are maintained in an external database.
- Mobility-Manager—The classification was determined by the mobility manager, AMP.
- Classification-off—AP is classified as rogue because classification has been disabled causing all non-authorized APs to be classified as a rogue.

- Propagated-Wired-MAC—The MAC addresses of wired devices learned by a different AP than the one that uses it for classifying a rogue.
- Base-BSSID-Override—The classification was derived from another BSSID which belongs to the same AP that supports multiple BSSIDs on the radio interface.
- AP-Rule—A user defined AP classification rule has matched.
- System-Wired-MAC—The MAC addresses of wired devices learned at the controller.
- System-Gateway-MAC—The Gateway MAC addresses learned at the controller.

Suspected Rogue Confidence Level

A suspected rogue AP is an AP that is potentially a threat to the WLAN infrastructure. A suspected rogue AP has a confidence level associated with it. An AP can be marked as a suspected rogue if it is determined to be a potentially threat on the wired network, or if it matches a user defined classification rule.

The suspected-rogue classification mechanism are:

- Each mechanism that causes a suspected-rogue classification is assigned a confidence level increment of 20%.
- AP classification rules have a configured confidence level.
- When a mechanism matches a previously unmatched mechanism, the confidence level increment associated with that mechanism is added to the current confidence level (the confident level starts at zero).
- The confidence level is capped at 100%.
- If your controller reboots, your suspected-rogue APs are not checked against any new rules that were configured after the reboot. Without this restriction, all the mechanisms that classified your APs as suspected-rogue may trigger again causing the confidence level to surpass their cap of 100%. You can explicitly mark an AP as “interfering” to trigger all new rules to match against it.

AP Classification Rules

AP classification rule configuration is performed only on a master controller. If AMP is enabled via the mobility-manager command, then processing of the AP classification rules is disabled on the master controller. A rule is identified by its ASCII character string name (32 characters maximum). The AP classification rules have one of the following specifications:

- SSID of the AP
- SNR of the AP
- Discovered-AP-Count or the number of APs that can see the AP

SSID specification

Each rule can have up to 6 SSID parameters. If one or more SSIDs are specified in a rule, an option of whether to match any of the SSIDs, or to not match all of the SSIDs can be specified. The default is to check for a match operation.

SNR specification

Each rule can have only one specification of the SNR. A minimum and/or maximum can be specified in each rule and the specification is in SNR (db).

Discovered-AP-Count specification

Each rule can have only one specification of the Discovered-AP-Count. Each rule can specify a minimum or maximum of the Discovered-AP-count. The minimum or maximum operation must be specified if the Discovered-AP-count is specified. The default setting is to check for the minimum discovered-AP-count.

Example Rules

If SSID equals xyz AND SNR > 40 then classify AP as suspected-rogue with conf-level-increment of 20

If SNR > 60 and DISCOVERING_APS > 2, then classify AP as suspected-rogue with conf-level increment of 35

If SSID equals 'XYZ', then classify AP as known-neighbor

Rule Matching

A rule must be enabled before it is matched. A maximum of 32 rules can be created with a maximum of 16 rules active simultaneously. If a rule matches, an AP is classified to:

- Suspected-Rogue—an associated confidence-level is provided (minimum is 5%)
- Neighbor

The following mechanism is used for rule matching.

- When *all* the conditions specified in the rule evaluate to true, the rule matches.
- If multiple rules match causing the AP to be classified as a Suspected-Rogue, the confidence level of each rule is aggregated to determine the confidence level of the classification.
- When multiple rules match and any one of those matching rules cause the AP to be classified as a Neighbor, then the AP is classified as Neighbor.
- APs classified as either Neighbor or Suspected-Rogue will attempted to match any configured AP rule.
- Once a rule matches an AP, the same rule will not be checked for the AP.
- When the controller reboots, no attempt to match a previously matched AP is made.
- If a rule is disabled or modified, all APs that were previously classified based on that rule will continue to be in the newly classified state.

Intrusion Detection

This section covers Infrastructure and Client Intrusion Detections.

Infrastructure Intrusion Detection

Detecting attacks against the infrastructure is critical in avoiding attacks that may lead to a large-scale Denial of Service (DOS) attack or a security breach. This group of features detects attacks against the WLAN infrastructure, which consists of authorized APs, the RF medium, and the wired network. An authorized or valid-AP is defined as an AP that belongs to the WLAN infrastructure. The AP is either an Dell AP or a third party AP. ArubaOS automatically learns authorized Dell APs.

Table 107 presents a summary of the Intrusion infrastructure detection features with their related commands, traps, and syslog identification. Feature details follow the table.

Table 107 *Infrastructure Detection Summary*

Feature	Command	Trap	Syslog ID
Detect 802.11n 40MHz Intolerance Setting	`ids dos-profile detect-ht-40mhz-intolerance client-ht-40mhz-intol-quiet-time`	wlsxHT40MHzIntoleranceAP wlsxHT40MHzIntoleranceSta	126052, 126053, 127052, 127053
Detect Active 802.11n Greenfield Mode	`ids unauthorized-device-profile detect-ht-greenfield`	wlsxHtGreenfieldSupported	126054, 127054

Table 107 *Infrastructure Detection Summary (Continued)*

Feature	Command	Trap	Syslog ID
Detect Ad hoc Networks	`ids unauthorized-device-profile detect-adhoc-network`	wlsxNAdhocNetwork	126033, 127033
Detect Ad hoc Network Using Valid SSID	`ids unauthorized-device-profile detect-adhoc-using-valid-ssid adhoc-using-valid-ssid-quiet-time`	wlsxAdhocUsingValidSSID	126068, 127068
Detect AP Flood Attack	`ids dos-profile detect-ap-flood ap-flood-threshold ap-flood-inc-time ap-flood-quiet-time`	wlsxApFloodAttack	126034, 127034
Detect AP Impersonation	`ids impersonation-profile detect-ap-impersonation beacon-diff-threshold beacon-inc-wait-time`	wlsxAPImpersonation	126006, 127006
Detect AP Spoofing	`ids impersonation-profile detect-ap-spoofing ap-spoofing-quiet-time`	wlsxAPSpoofingDetected wlsxClientAssociatingOn WrongChannel	126069, 126070, 127069, 127070
Detect Bad WEP	`ids unauthorized-device-profile detect-bad-wep`	wlsxRepeatWEPIVViolation wlsxStaRepeatWEPIVViolation wlsxWeakWEPIVViolation wlsxStaWeakWEPIVViolation	126014, 126015, 126016, 126017, 127014, 127015, 127016, 127017
Detect Beacon Wrong Channel	`ids impersonation-profile detect-beacon-wrong-channel beacon-wrong-channel-quiet-time`	wlsxMalformedFrameWrongChannel Detected	126086, 127086
Detect Client Flood Attack	`ids dos-profile detect-client-flood client-flood-threshold client-flood-inc-time client-flood-quiet-time`	wlsxClientFloodAttack	126064, 127064
Detect CTS Rate Anomaly	`ids dos-profile detect-cts-rate-anomaly cts-rate-threshold cts-rate-time-interval cts-rate-quiet-time`	wlsxCtsRateAnomaly	126073, 127073
Detect Devices with an Invalid MAC OUI	`ids unauthorized-device-profile detect-invalid-mac-oui mac-oui-quiet-time`	wlsxInvalidMacOUIAP wlsxInvalidMacOUISta	126029, 126030, 127029, 127030
Detect Invalid Address Combination	`ids dos-profile detect-invalid-address-combination invalid-address-combination-quiet-time`	wlsxInvalidAddressCombination	126079, 127079
Detect Overflow EAPOL Key	`ids dos-profile detect-overflow-eapol-key overflow-eapol-key-quiet-time`	wlsxMalformedOverflowEAPOLKey Detected	126082, 127082

Table 107 *Infrastructure Detection Summary (Continued)*

Feature	Command	Trap	Syslog ID
Detect Overflow IE	`ids dos-profile detect-overflow-ie overflow-ie-quiet-time`	wlsxOverflowIEDetected	126084, 127084
Detect Malformed Frame-Assoc Request	`ids dos-profile detect-malformed-assoc-req malformed-assoc-req-quiet-time`	wlsxMalformedAssocReqDetected	126080, 127080
Detect Malformed Frame-Auth	`ids dos-profile detect-malformed-frame-auth malformed-auth-frame-quiet-time`	wlsxMalformedAuthFrameDetected	126083, 127083
Detect Malformed Frame-HT IE	`ids dos-profile detect-malformed-htie malformed-htie-quiet-time`	wlsxMalformedHTIEDetected	126081, 127081
Detect Malformed Frame-Large Duration	`ids-dos-profile detect-malformed-large-duration malformed-large-duration-quiet-time`	wlsxMalformedFrameLargeDuration Detected	126085, 127085
Detect Misconfigured AP (WEP, WPA, SSID, Channel, OUI)	`ids unauthorized-device-profile detect-misconfigured-ap privacy require-wpa valid-and-protected-ssid cfg-valid-11g-channel cfg-valid-11a-channel valid-oui`	wlsxWEPMisconfiguration wlsxWPAMisconfiguration wlsxSSIDMisconfiguration wlsxChannelMisconfiguration wlsxOUIMisconfiguration	126011, 126028, 126010, 126008, 126009, 127011, 127028, 127010, 127008, 127009
Detect RTS Rate Anomaly	`ids dos-profile detect-rts-rate-anomaly rts-rate-threshold rts-rate-time-interval rts-rate-quiet-time`	wlsxRtsRateAnomaly	126074, 127074
Detect Windows Bridge	`ids unauthorized-device-profile detect-windows-bridge`	wlsxWindowsBridgeDetectedAP wlsxWindowsBridgeDetectedSta wlsxNAdhocNetworkBridgeDetected AP wlsxNAdhocNetworkBridgeDetected Sta	126039, 126040, 126041, 126042, 127039, 127040, 127041, 127042
Detect Wireless Bridge	`ids unauthorized-device-profile detect-wireless-bridge wireless-bridge-quiet-time`	wlsxWirelessBridge	126036, 127036

Detect Broadcast Deauthenticationt	`ids signature-matching-profile signature deauth-Broadcast`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchDeauthBcast	126047, 127047

Detect Broadcast Disassociation	`ids signature-matching-profile signature disassoc-Broadcast`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchDisassocBcast	126066, 127066

Table 107 *Infrastructure Detection Summary (Continued)*

Feature	Command	Trap	Syslog ID

Detect Netstumbler	`ids signature-matching-profile signature 'Netstumbler Generic' signature 'Netstumbler Version 3.3.0.x'`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchNetstumbler	126043, 127043

Detect Valid SSID Misuse	`ids-unauthorized-device-profile detect-valid-ssid-misuse valid-and-protected-ssid`	wlsxValidSSIDViolation	126007, 127007

Detect Wellenreiter	`ids signature-matching-profile signature Wellenreiter`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchWellenreiter	126067, 127067

Detect 802.11n 40MHz Intolerance Setting

When a client sets the HT capability "intolerant bit" to indicate that it is unable to participate in a 40MHz BSS, the AP must use lower data rates with all of its clients. Network administrators often want to know if there are devices that are advertising 40MHz intolerance, as this can impact the performance of the network.

Detect Active 802.11n Greenfield Mode

When 802.11 devices use the HT operating mode, they can not share the same channel as 802.11a/b/g stations. Not only can they not communicate with legacy devices, the way they use the transmission medium is different, which would cause collisions, errors and retransmissions.

Detect Ad hoc Networks

An ad hoc network is a collection of wireless clients that form a network amongst themselves without the use of an AP. As far as network administrators are concerned, ad hoc wireless networks are uncontrolled. If they do not use encryption, they may expose sensitive data to outside eavesdroppers. If a device is connected to a wired network and has bridging enabled, an ad-hoc network may also function like a rogue AP. Additionally, ad-hoc networks can expose client devices to viruses and other security vulnerabilities. For these reasons, many administrators choose to prohibit ad-hoc networks.

Detect Ad hoc Network Using Valid SSID

If an unauthorized ad hoc network is using the same SSID as an authorized network, a valid client may be tricked into connecting to the wrong network. If a client connects to a malicious ad hoc network, security breaches or attacks can occur.

Detect AP Flood Attack

Fake AP is a tool that was originally created to thwart wardrivers by flooding beacon frames containing hundreds of different addresses. This would appear to a wardriver as though there were hundreds of APs in the area, thus concealing the real AP. An attacker can use this tool to flood an enterprise or public hotspots with fake AP beacons to confuse legitimate users and to increase the amount of processing need on client operating systems.

Detect AP Impersonation

In AP impersonation attacks, the attacker sets up an AP that assumes the BSSID and ESSID of a valid AP. AP impersonation attacks can be done for man-in-the-middle attacks, a rogue AP attempting to bypass detection, or a honeypot attack.

Detect AP Spoofing

An AP Spoofing attack involves an intruder sending forged frames that are made to look like they are from a legitimate AP. It is trivial for an attacker to do this, since tools are readily available to inject wireless frames with any MAC address that the user desires. Spoofing frames from a legitimate AP is the foundation of many wireless attacks.

Detect Bad WEP

This is the detection of WEP initialization vectors that are known to be weak. A primary means of cracking WEP keys is to capture 802.11 frames over an extended period of time and searching for such weak implementations that are still used by many legacy devices.

Detect Beacon Wrong Channel

In this type of attack, an intruder spoofs a beacon packet on a channel that is different from that advertised in the beacon frame of the AP.

Detect Client Flood Attack

There are fake AP tools that can be used to attack wireless intrusion detection itself by generating a large number of fake clients that fill internal tables with fake information. If successful, it overwhelms the wireless intrusion system, resulting in a DoS.

Detect CTS Rate Anomaly

and

Detect RTS Rate Anomaly

The RF medium can be reserved via Virtual Carrier Sensing using an CTS/RTS transaction. The transmitter station sends a Request To Send (RTS) frame to the receiver station. The receiver station responds with a Clear To Send (CTS) frame. All other stations that receive these RTS and/or CTS frames will refrain from transmitting over the wireless medium for an amount of time specified in the *duration* fields of these frames.

Attackers can exploit the Virtual Carrier Sensing mechanism to launch a DoS attack on the WLAN by transmitting numerous RTS and/or CTS frames. This causes other stations in the WLAN to defer transmission to the wireless medium. The attacker can essentially block the authorized stations in the WLAN with this attack.

Detect Devices with an Invalid MAC OUI

The first three bytes of a MAC address, known as the MAC organizationally unique identifier (OUI), is assigned by the IEEE to known manufacturers. Often clients using a spoofed MAC address do not use a valid OUI and instead use a randomly generated MAC address.

Detect Invalid Address Combination

In this attack, an intruder can cause an AP to transmit deauthentication and disassociation frames to all of its clients. Triggers that can cause this condition include the use of broadcast or multicast MAC address in the source address field.

Detect Overflow EAPOL Key

Some wireless drivers used in access points do not correctly validate the EAPOL key fields. A malicious EAPOL-Key packet with an invalid advertised length can trigger a DoS or possible code execution. This can only be achieved after a successful 802.11 association exchange.

Detect Overflow IE

Some wireless drivers used in access points do not correctly parse the vendor-specific IE tags. A malicious association request sent to the AP containing an IE with an inappropriate length (too long) can cause a DoS and potentially lead to code execution. The association request must be sent after a successful 802.11 authentication exchange.

Detect Malformed Frame-Assoc Request

Some wireless drivers used in access points do not correctly parse the SSID information element tag contained in association request frames. A malicious association request with a null SSID (that is, zero length SSID) can trigger a DoS or potential code execution condition on the targeted device.

Detect Malformed Frame-Auth

Malformed 802.11 authentication frames that do not conform to the specification can expose vulnerabilities in some drivers that have not implemented proper error checking. This feature checks for unexpected values in a Authentication frame.

Detect Malformed Frame-HT IE

The IEEE 802.11n HT (High Throughput) IE is used to convey information about the 802.11n network. A 802.11 management frame containing a malformed HT IE can crash some client implementations; potentially representing an exploitable condition when transmitted by a malicious attacker.

Detect Malformed Frame-Large Duration

The virtual carrier-sense attack is implemented by modifying the 802.11 MAC layer implementation to allow random duration values to be sent periodically. This attack can be carried out on the ACK, data, RTS, and CTS frame types by using large duration values. This attack can prevent channel access to legitimate users.

Detect Misconfigured AP

A list of parameters can be configured that defines the characteristics of a valid AP. This feature is primarily used when non-Dell APs are used in the network since the Dell controller cannot configure the third-party APs. These parameters include WEP, WPA, OUI of valid MAC addresses, valid channels, and valid SSIDs.

Detect Windows Bridge

A Windows Bridge occurs when a client that is associated to an AP is also connected to the wired network, and has enabled bridging between these two interfaces.

Detect Wireless Bridge

Wireless bridges are normally used to connect multiple buildings together. However, an attacker could place (or have an authorized person place) a wireless bridge inside the network that would extend the corporate network somewhere outside the building. Wireless bridges are somewhat different from rogue APs in that they do not use beacons and have no concept of association. Most networks do not use bridges – in these networks, the presence of a bridge is a signal that a security problem exists.

Detect Broadcast Deauthentication

A deauthentication broadcast attempts to disconnect all stations in range. Rather than sending a spoofed deauth to a specific MAC address, this attack sends the frame to a broadcast address.

Detect Broadcast Disassociation

By sending disassociation frames to the broadcast address (FF:FF:FF:FF:FF:FF), an attacker can disconnect all stations on a network for a widespread DoS.

Detect Netstumbler

NetStumbler is a popular wardriving application used to locate 802.11 networks. When used with certain NICs, NetStumbler generates a characteristic frame that can be detected. Version 3.3.0 of NetStumbler changed the characteristic frame slightly.

Detect Valid SSID Misuse

If an unauthorized AP (neighbor or interfering) is using the same SSID as an authorized network, a valid client may be tricked into connecting to the wrong network. If a client connects to a malicious network, security breaches or attacks can occur.

Detect Wellenreiter

Wellenreiter is a passive wireless network discovery tool that is used to compile a list of APs along with their MAC address, SSID, channel, security setting in the vicinity. It passively sniffs wireless traffic and with certain version (versions 1.4, 1.5, and 1.6) sends active probes that target known default SSIDs.

Client Intrusion Detection

Generally, clients are more vulnerable to attacks than APs. Clients are more apt to associate with a malignant AP due to the client's driver behavior or to a mis-configured client. It is important to monitor authorized clients to track their associations and to track any attacks raised against the client.

Client attack detection is categorized as:

- Detecting attacks against Dell APs clients—An attacker can perform an active DOS attack against an associated client, or perform a replay attack to obtain the keys of transmission which could lead to more serious attacks.
- Monitoring Authorized clients—Since clients are easily tricked into associating with unauthorized APs, tracking all mis-associations of authorized clients is very important.

An authorized client is a client authorized to use the WLAN network. In ArubaOS, an authorized client is called a *valid-client*. ArubaOS automatically learns a valid client. A client is determined to be valid if it is associated to an authorized or valid AP using encryption; either Layer 2 or IPSEC.

NOTE: Detection of attacks is limited to valid clients and clients associated to valid APs. Clients that are associated as guests using unencrypted association are included in the attack detection. However, clients on neighboring (interfering) APs are not tracked for attack detection unless they are specified as valid.

Table 108 presents a summary of the client intrusion detection features with their related commands, traps, and syslog identification. Details of each feature follow the table.

Table 108 *Client Detection Summary*

Feature	Command	Trap	Syslog ID
Detect Block ACK DoS	`ids-dos-profile detect-block-ack-attack block-ack-quiet-time`	wlsxBlockAckAttackDetected	126087, 127087
Detect ChopChop Attack	`ids-dos-profile detect-chopchop-attack chopchop-quiet-time`	wlsxChopChopAttackDetected	126078, 127078

Table 108 *Client Detection Summary (Continued)*

Feature	Command	Trap	Syslog ID

Detect Disconnect Station Attack	`ids dos-profile <name>`
	`detect-disconnect-sta`
	`disconnect-sta-quiet-time`
	`disconnect-sta-assoc-resp-threshold`
	`disconnect-deauth-disassoc-threshold`
		wlsxNDisconnectStationAttack	126035, 127035

Detect EAP Rate Anomaly	`ids-dos-profile`
	`detect-eap-rate-anomaly`
	`eap-rate-threshold`
	`eap-rate-time-interval`
	`eap-rate-quiet-time`
		wlsxEAPRateAnomaly	126032, 127032

Detect FATA-Jack Attack Structure	`ids dos-profile`
	`detect-fatajack-attack`
	`fatajack-attack-quiet-time`
		wlsxFataJackAttackDetected	126072, 127072

Detect Hotspotter Attack	`ids impersonation-profile`
	`detect-hotspotter-attack`
	`hotspotter-quiet-time`
		wlsxHotspotterAttackDetected	126088, 127088

Detect Meiners Power Save DoS Attack	`ids dos-profile`
	`detect-power-save-dos-attack`
	`power-save-dos-min-frames`
	`power-save-dos-quiet-time`
	`power-save-dos-threshold`
		wlsxPowerSaveDoSAttack	126109, 127109

Detect Omerta Attack	`ids dos-profile`
	`detect-omerta-attack`
	`omerta-attack-threshold`
	`omerta-attack-quiet-time`
		wlsxOmertaAttack	126071, 127071

Detect Rate Anomalies	`ids dos-profile`
	`detect-rate-anomalies`
	
	`assoc-rate-thresholds`
	`disassoc-rate-thresholds`
	`deauth-rate-thresholds`
	`probe-request-rate-thresholds`
	`probe-response-rate-thresholds`
	`auth-rate-thresholds`
		wlsxChannelRateAnomaly
		wlsxNodeRateAnomalyAP
		wlsxNodeRateAnomalySta
			126061, 126062, 126063, 127061, 127062, 127063

Detect TKIP Replay Attack	`ids dos-profile`
	`detect-tkip-replay-attack`
	`tkip-replay-quiet-time`
		wlsxTkipReplayAttackDetected	126077, 127077

Detect Unencrypted Valid Clients	`ids unauthorized-device-profile`
	`detect-unencrypted-valid-client`
	`unencrypted-valid-client-quiet-time`
		wlsxValidClientNotUsingEncryption	126065, 127065

Detect Valid Client Misassociation	`ids unauthorized-device-profile` `detect-valid-client-misassociation`	wlsxValidClientMisassociation	126075, 127075

Table 108 *Client Detection Summary (Continued)*

Feature	Command	Trap	Syslog ID

Detect AirJack	`ids signature-matching-profile signature AirJack`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchAirjack	126046, 127046

Detect ASLEAP	`ids signature-matching-profile signature ASLEAP`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchAsleap	126044, 127044

Detect Null Probe Response	`ids signature-matching-profile signature Null Probe Response`
	
	`ids general-profile signature-quiet-time`
		wlsxNSignatureMatchNullProbeResp	126045, 127045

Detect Block ACK DoS

The Block ACK mechanism that was introduced in 802.11e, and enhanced in 802.11nD3.0, has a built-in DoS vulnerability. The Bock ACK mechanism allows for a sender to use the ADDBA request frame to specify the sequence number window that the receiver should expect. The receiver will only accept frames in this window.

An attacker can spoof the ADDBA request frame causing the receiver to reset its sequence number window and thereby drop frames that do not fall in that range.

Detect ChopChop Attack

ChopChop is a plaintext recovery attack against WEP encrypted networks. It works by forcing the plaintext, one byte at a time, by truncating a captured frame and then trying all 256 possible values for the last byte with a corrected CRC. The correct guess causes the AP to retransmit the frame. When that happens, the frame is truncated again.

Detect Disconnect Station Attack

A disconnect attack can be launched in many ways; the end result is that the client is effectively and repeatedly disconnected from the AP.

Detect EAP Rate Anomaly

To authenticate wireless clients, WLANs may use 802.1x, which is based on a framework called Extensible Authentication Protocol (EAP). After an EAP packet exchange and the user is successfully authenticated, the EAP-Success is sent from the AP to the client. If the user fails to authenticate, an EAP-Failure is sent. In this attack, EAP-Failure or EAP-Success frames are spoofed from the access point to the client to disrupting the authentication state on the client. This confuses the client's state causing it to drop the AP connection. By continuously sending EAP Success or Failure messages, an attacker can effectively prevent the client from authenticating with the APs in the WLAN.

Detect FATA-Jack Attack Structure

FATA-Jack is an 802.11 client DoS tool that tries to disconnect targeted stations using spoofed authentication frames that contain an invalid authentication algorithm number.

Detect Hotspotter Attack

The Hotspotter attack is an evil-twin attack which attempts to lure a client to a malicious AP. Many enterprise employees use their laptop in Wi-Fi area hotspots at airports, cafes, malls etc. They have SSIDs of their hotspot service providers configured on their laptops. The SSIDs used by different hotspot service providers are well known. This enables the attackers to set up APs with hotspot SSIDs in close proximity of the enterprise premises. When the enterprise laptop Client probes for hotspot SSID, these malicious APs respond and invite the client to connect to them. When the client connects to a malicious AP, a number of security attacks can be launched on the client. A popular hacking tool used to launch these attacks is Airsnarf.

Detect Meiners Power Save DoS Attack

To save on power, wireless clients will "sleep" periodically, during which they cannot transmit or receive. A client indicates its intention to sleep by sending frames to the AP with the Power Management bit ON. The AP then begins buffering traffic bound for that client until it indicates that it is awake. An intruder could exploit this mechanism by sending (spoofed) frames to the AP on behalf of the client to trick the AP into believing the client is asleep. This will cause the AP to buffer most, if not all, frames destined for the client.

Detect Omerta Attack

Omerta is an 802.11 DoS tool that sends disassociation frames to all stations on a channel in response to data frames. The Omerta attack is characterized by disassociation frames with a reason code of 0x01. This reason code is “unspecified” and is not be used under normal circumstances.

Detect Rate Anomalies

Many DoS attacks flood an AP or multiple APs with 802.11 management frames. These can include authenticate/associate frames which are designed to fill up the association table of an AP. Other management frame floods, such as probe request floods, can consume excess processing power on the AP.

Detect TKIP Replay Attack

TKIP is vulnerable to replay (via WMM/QoS) and plaintext discovery (via ChopChop). This affects all WPA-TKIP usage. By replaying a captured TKIP data frame on other QoS queues, an attacker can manipulate the RC4 data and checksum to derive the plaintext at a rate of one byte per minute.

By targeting an ARP frame and guessing the known payload, an attacker can extract the complete plaintext and MIC checksum. With the extracted MIC checksum, an attacker can reverse the MIC AP to Station key and sign future messages as MIC compliant, opening the door for more advanced attacks.

Detect Unencrypted Valid Clients

An authorized (valid) client that is passing traffic in unencrypted mode is a security risk. An intruder can sniff unencrypted traffic (also known as *packet capture*) with software tools known as sniffers. These packets are then reassembled to produce the original message.

Detect Valid Client Misassociation

This feature does not detect attacks, but rather it monitors authorized (valid) wireless clients and their association within the network. Valid client misassociation is potentially dangerous to network security. The four types of misassociation that we monitor are:

- Authorized Client associated to Rogue—A valid client that is associated to a rogue AP
- Authorized Client associated to External AP—An external AP, in this context, is any AP that is not valid and not a rogue

- Authorized Client associated to Honeypot AP—A honeypot is an AP that is not *valid* but is using an SSID that has been designated as valid/protected
- Authorized Client in ad hoc connection mode—A valid client that has joined an ad hoc network

Detect AirJack

AirJack is a suite of device drivers for 802.11(a/b/g) raw frame injection and reception. It was intended to be used as a development tool for all 802.11 applications that need to access the raw protocol, however one of the tools included allowed users to force off all users on an AP.

Detect ASLEAP

ASLEAP is a tool created for Linux systems which is used to attack Cisco LEAP authentication protocol.

Detect Null Probe Response

A null probe response attack has the potential to crash or lock up the firmware of many 802.11 NICs. In this attack, a client probe-request frame will be answered by a probe response containing a null SSID. A number of popular NIC cards will lock up upon receiving such a probe response.

Intrusion Protection

Intrusion protection features support containment of an AP or a client. In the case of an AP, we will attempt to disconnect all client that are connected or attempting to connect to the AP. In the case of a client, the client's association to an AP is targeted. The following containment mechanisms are supported:

- Deauthentication containment: An AP or client is contained by disrupting its association on the wireless interface.
- Tarpit containment: An AP is contained by luring clients that are attempting to associate with it to a tarpit. The tarpit can be on the same channel as the AP being contained, or on a different channel (see "Tarpit Shielding" on page 565).
- Wired containment: An AP or client is contained by disrupting its connection on the wired interface.

The WIP feature supports separate enforcement policies that use the underlying containment mechanisms to contain an AP or a client that do not conform to the policy. These policies are discussed in the sections that follow.

Infrastructure Intrusion Protection

Table 109 presents a summary of the infrastructure intrusion protection features with their related commands, traps, and syslog identifications. Details of each feature follow the table.

Table 109 *Infrastructure Protection Summary*

Feature	Command	Trap	Syslog ID
Protect 40MHz 802.11 High Throughput Devices	`ids unauthorized-device-profile protect-ht-40mhz`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Protect 802.11n High Throughput Devices	`ids unauthorized-device-profile protect-high-throughput`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Protect from Adhoc Networks	`ids unauthorized-device-profile protect-adhoc-network`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126012, 126102, 126103, 126108, 127102, 127103, 127108

Table 109 *Infrastructure Protection Summary (Continued)*

Feature	Command	Trap	Syslog ID
Protect From AP Impersonation	`ids impersonation-profile protect-ap-impersonation`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Protect Misconfigured AP	`ids unauthorized-device-profile protect-misconfigured-ap`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Protect SSID	`ids unauthorized-device-profile protect-ssid`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Rogue Containment	`ids unauthorized-device-profile rogue-containment`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Suspected Rogue Containment	`ids unauthorized-device-profile suspect-rogue-containment suspect-rogue-conf-level`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 106010, 126102, 126103, 126108, 127102, 127103, 127108

Protect 40MHz 802.11 High Throughput Devices

Protection from AP(s) that support 40MHz HT involves containing the AP such that clients can not connect.

Protect 802.11n High Throughput Devices

Protection from AP(s) that support HT involves containing the AP such that clients can not connect.

Protect from Adhoc Networks

Protection from an Ad hoc Network involves containing the ad hoc network so that clients can not connect to it.

Protect From AP Impersonation

Protection from AP impersonation involves containing both the legitimate and impersonating AP so that clients can not connect to either AP.

Protect Misconfigured AP

Protect Misconfigured AP enforces that valid APs are configured properly. An offending AP is contained by preventing clients from associating to it.

Protect SSID

Protect SSID enforces that valid/protected SSIDs are used only by valid APs. An offending AP is contained by preventing clients from associating to it.

Rogue Containment

By default, rogue APs are not automatically disabled. Rogue containment automatically disables a rogue AP by preventing clients from associating to it.

Suspected Rogue Containment

By default, suspected rogue APs are not automatically contained. In combination with the suspected rogue containment confidence level, suspected rogue containment automatically disables a suspect rogue by preventing clients from associating to it.

Client Intrusion Protection

Table 110 list the client intrusion protection features with their related commands, traps, and syslog identifications. Details of each feature follow the table.

Table 110 *Client Protection Summary*

Feature	Command	Trap	Syslog ID
Protect Valid Stations	`ids unauthorized-device-profile protect-valid-sta`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108
Protect Windows Bridge	`ids unauthorized-device-profile protect-windows-bridge`	wlsxAPDeauthContainment wlsxClientDeauthContainment wlsxTarpitContainment	106005, 106006, 126102, 126103, 126108, 127102, 127103, 127108

Protect Valid Stations

Protecting a valid client involves disconnecting that client if it is associated to a non-valid AP.

Protect Windows Bridge

Protecting from a Windows Bridge involves containing the client that is forming the bridge so that it can not connect to the AP.

WLAN Management System

The WLAN management system (WMS) on the controller monitors wireless traffic to detect any new AP or wireless client station that tries to connect to the network. When an AP or wireless client is detected, it is classified and its classification is used to determine the security policies which should be enforced on the AP or client.

Configuring WMS via the WebUI

1. Navigate to the Configuration > Advanced Services > Wireless page.
2. Configure the parameters, as described in Table 111. Then click Apply.

Table 111 *WMS Configuration Parameters*

Parameter	Description
Adhoc AP Ageout	The amount of time, in minutes, that an adhoc (IBSS) AP unseen by any probes before it is deleted from the database. Enter 0 to disable ageout. Default: 30 minutes
AP Ageout Interval	The amount of time, in minutes, that an AP is unseen by any probes before it is deleted from the database. Enter 0 to disable ageout. Default: 30 minutes
AM Poll Interval	Interval, in milliseconds, for communication between the controller and Dell AMs. The controller contacts the AM at this interval to download AP to STA associations, update policy configuration changes, and download AP and STA statistics. Default: 60000 milliseconds (1 minute)
Number of AM Poll Retries	Maximum number of failed polling attempts before the polled AM is considered to be down. Default: 3

Table 111 *WMS Configuration Parameters (Continued)*

Parameter	Description
Station Ageout Interval	The amount of time, in minutes, that a client is unseen by any probes before it is deleted from the database. Enter 0 to disable ageout. Default: 30 minutes
Enable Statistics Update in DB	Enables or disables statistics update in the database. Default: enabled
Collect Stat	Enables collection of statistics (up to 25,000 entries) on the master controller for monitored APs and clients. This only applies when Mobility Manager??? is not configured. Default: disabled
Learn System Wired Mac	Enable or disable "learning" of wired MACs at the controller. Default: disabled
Propogate Wired Mac	Enables the propagation of the gateway wired MAC information. Default: enabled
Mark Neighbor APs as Persistent Neighbor APs	Enables or disables APs that are marked as neighbor from being aged out. Default: enabled
Learn APs	Enables or disables AP learning. Learning affects the way APs are classified. Default: disabled

Configuring WMS via the CLI

Use the following commands to configure WMS via the CLI. The parameters in this command are described in detail in Table 111.

```
wms general
   adhoc-ap-ageout-interval <minutes> | ap-ageout-interval <minutes> | collect-stats
   {disable|enable} | learn-ap {enable|disable} | learn-system-wired-macs |
   persistent-neighbor {enable|disable} | poll-interval <milliseconds> |
   poll-retries <number> | propagate-wired-macs {enable|disable} | sta-ageout-interval
   <minutes> | stat-update {enable|disable}
```

Configuring Local WMS Settings

You can also use the CLI to define local WMS system settings for the maximum number of APs and client stations.

NOTE: Use this command with caution. Increasing the limit will cause an increase in usage in the memory by WMS. In general, each entry will consume about 500 bytes of memory. If the setting is bumped up by 2000, then it will cause an increase in WMS memory usage by 1MB

```
(host) (config) #wms-local system max-threshold <max-threshold>
```

Managing the WMS Database

The WMS process interacts with all the air monitor (AM) processes in the network. When WMS receives an event message from an AM, the WMS process will save the event information along with the BSSID of the AP that generated the event in the WMS database. Use the following commands in Enable mode to manage the WMS database.

The wms export-db command exports the specified file as an ASCII text file into the WMS database.

```
(host) #wms export-db database <file>
```

The wms import-db command imports the specified file into the WMS database:

```
(host) #wms import-db database <file>
```

The wms reint-db command reinitializes the WMS database. Note that this command does not make an automatic backup of the current database.

```
(host) #wms renit-db
```

Client Blacklisting

When a client is blacklisted in the Dell system, the client is not allowed to associate with any AP in the network for a specified amount of time. If a client is connected to the network when it is blacklisted, a deauthentication message is sent to force the client to disconnect. While blacklisted, the client cannot associate with another SSID in the network.

The controller retains the client blacklist in the user database, so the information is not lost if the controller reboots. When you import or export the controller's user database, the client blacklist will be exported or imported as well.

Methods of Blacklisting

There are several ways in which a client can be blacklisted in the Dell system:

- You can manually blacklist a specific client. See "Manual Blacklisting" on page 558 for more information.
- A client fails to successfully authenticate for a configured number of times for a specified authentication method. The client is automatically blacklisted. See "Authentication Failure Blacklisting" on page 559 for more information.
- A DoS or man in the middle (MITM) attack has been launched in the network. Detection of these attacks can cause the immediate blacklisting of a client. See "Attack Blacklisting" on page 559 for more information.
- An external application or appliance that provides network services, such as virus protection or intrusion detection, can blacklist a client and send the blacklisting information to the controller via an XML API server. When the controller receives the client blacklist request from the server, it blacklists the client, logs an event, and sends an SNMP trap.

  See Chapter 37, "External Services Interface" for more information.

NOTE: The External Services Interface feature require the Policy Enforcement Firewall Next Generation (PEFNG) license installed in the controller.

Manual Blacklisting

There are several reasons why you may choose to blacklist a client. For example, you can enable different Dell intrusion detection system (IDS) features that detect suspicious activities, such as MAC address spoofing or DoS attacks. When these activities are detected, an event is logged and an SNMP trap is sent with the client information. To blacklist a client, you need to know its MAC address.

To manually blacklist a client via the WebUI:

1. Navigate to the Monitoring > Controller > Clients page.
2. Select the client to be blacklisted and click the Blacklist button.

To clear the entire client blacklist using the WebUI:

1. Navigate to the Monitoring > Controller > Clients page.
2. Click Remove All from Blacklist.

To manually blacklist a client via the command-line interface, access the CLI in config mode and issue the following command:

```
stm add-blacklist-client <macaddr>
```

To clear the entire client blacklist using the command-line interface, access the CLI in config mode and issue the following command:

```
stm purge-blacklist-client
```

Authentication Failure Blacklisting

You can configure a maximum authentication failure threshold for each of the following authentication methods:

- 802.1x
- MAC
- Captive portal
- VPN

When a client exceeds the configured threshold for one of the above methods, the client is automatically blacklisted by the controller, an event is logged, and an SNMP trap is sent. By default, the maximum authentication failure threshold is set to 0 for the above authentication methods, which means that there is no limit to the number of times a client can attempt to authenticate.

With 802.1x authentication, you can also configure blacklisting of clients who fail machine authentication.

NOTE: When clients are blacklisted because they exceed the authentication failure threshold, they are blacklisted indefinitely by default. You can configure the duration of the blacklisting; see "Blacklist Duration" on page 560.

To set the authentication failure threshold via the WebUI:

1. Navigate to the Configuration > Security > Authentication > Profiles page.
2. In the Profiles list, select the appropriate authentication profile, then select the profile instance.
3. Enter a value in the Max Authentication failures field.
4. Click Apply.

To set the authentication failure threshold via the command-line interface, access the CLI in config mode and issue the following commands:

```
aaa authentication {captive-portal|dot1x|mac|vpn} <profile>
   max-authentication-failures <number>
```

Attack Blacklisting

There are two type of automatic client blacklisting that can be enabled: blacklisting due to spoofed deauthentication, or blacklisting due to other types of DoS attacks.

Automatic blacklisting for DoS attacks other than spoofed deauthentication is enabled by default. You can disable this blacklisting on a per-SSID basis in the virtual AP profile.

Man in the middle (MITM) attacks begin with an intruder impersonating a valid enterprise AP. If an AP needs to reboot, it sends deauthentication packets to connected clients to enable them to disconnect and reassociate with another AP. An intruder or attacker can spoof deauthentication packets, forcing clients to disconnect from the network and reassociate with the attacker's AP. A valid enterprise client associates to the intruder's AP, while the intruder then associates to the enterprise AP. Communication between the network and the client flows through the intruder (the man in the middle), thus allowing the intruder the ability to add, delete, or modify data. When this type of attack is identified by the Dell system, the client can be blacklisted, blocking the MITM attack. Enable this blacklisting ability in the IDS DoS profile (this is disabled by default).

To enable spoofed deauth detection and blacklisting via the WebUI:

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either AP Group or AP Specific tab. Click Edit for the AP group or AP name.

3. In the Profiles list, expand the IDS menu, then select IDS profile.
4. Select the IDS DOS profile.
5. Select (check) Spoofed Deauth Blacklist.
6. Click Apply.

To enabled spoofed deauth detection and blacklisting via the command-line interface, access the CLI in config mode, and issue the following commands:

```
ids dos-profile <profile>
   spoofed-deauth-blacklist
```

Blacklist Duration

You can configure the duration that clients are blacklisted on a per-SSID basis via the virtual AP profile. There are two different blacklist duration settings:

- For clients that are blacklisted due to authentication failure. By default, this is set to 0 (the client is blacklisted indefinitely).
- For clients that are blacklisted due to other reasons, including manual blacklisting. By default, this is set to 3600 seconds (one hour). You can set this to 0 to blacklist clients indefinitely.

To configure the blacklist duration via the WebUI:

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. In the Profiles list, select Wireless LAN, then Virtual AP. Select the virtual AP instance.
   - To set a blacklist duration for authentication failure, enter a value for Authentication Failure Blacklist Time.
   - To set a blacklist duration for other reasons, enter a value for Blacklist Time.
4. Click Apply.

To configure the blacklist duration via the command-line interface, access the CLI in config mode and issue the following commands:

```
wlan virtual-ap <profile>
   auth-failure-blacklist-time <seconds>
   blacklist-time <seconds>
```

Removing a Client from Blacklisting

You can manually remove a client from blacklisting using either the WebUI or CLI:

To remove a client from blacklisting via the WebUI:

1. Navigate to the Monitoring > Controller > Blacklist Clients page.
2. Select the client that you want to remove from the blacklist, then click Remove from Blacklist.

To remove a client from blacklisting via the command-line interface, access the CLI in enable mode and issue the following command:

```
stm remove-blacklist-client <macaddr>
```

Chapter 30

WIP Advanced Features

Device Classification is the first step in securing the corporate environment from unauthorized wireless access. Adequate measures to quickly shut down intrusions are critical to protect sensitive information and network resources. APs and stations must be accurately classified to determine whether they are valid, rogue or neighboring APs, and an automated response can be implemented to prevent possible intrusion attempts.

TotalWatch™ allows for detecting devices that are running on typical operational channels. Tarpit Shielding provides a better way of containing devices that are deemed unauthorized. Both of these features are discussed in the sections that follow.

TotalWatch

Aruba 802.11n APs and non-11n APs in AM-mode support for TotalWatch is the ability to scan all channels of the RF spectrum, including 2.4-and 5-GHz bands as well as the 4.9-GHz public safety band. TotalWatch also provides 5-MHz granular channel scanning of bands for rogue devices, and dynamic scanning dwell times to focus on those channels with traffic. TotalWatch provides an advanced set of features to detect unauthorized wireless devices and a set of customized rules are used to highlight devices that truly pose a threat to the network.

NOTE: TotalWatch is supported on APs deployed in the AM-mode only.

TotalWatch provides monitoring support for the entire WLAN spectrum. Dell APs in the AM-mode can *monitor* the following frequencies:

- 2412MHz to 2472MHz in the 2.5GHz band
- 5100Mhz to 5895MHz in the 5GHz band.

Dell APs in AM-mode can *scan* the following additional frequencies:

- 2484 MHz and 4900Mhz to 5000MHz (J-channels)
- 5000 to 5100Mhz

If the AP is HT-capable (High Throughput), then these frequencies are scanned in the 40MHz mode.

Channel Types and Qualifiers

Based on the regulatory characteristics, channels are categorized into the following types:

Reg-domain Channels—A channel that belongs to the regulatory domain of the country in which the AP is deployed. The set of channels that belong to this group is a subset of the channels in all-reg-domain channel group.

All-reg-domain Channels—A valid non-overlapping channel that is in the regulatory domain of at least one country. The channels in this category belong to the frequency range of:

- 2412MHz to 2472MHz in the g-band
- 5100Mhz to 5895MHz in the a-band.

Rare Channel—Channels that fall into a frequency range outside of the regulatory domain; 2484 MHz and 4900MHz-4995MHz (J-channels), and 5000-5100Mhz. The channels in this group do not belong to any other group.

Each of these channel types can have an associated qualifier:

Active Channel—This qualifier indicates that wireless activity is detected on this channel by the presence of an AP or other 802.11 activity; a probe requests for example.

DOS Channel—A channel where wireless containment is active. This channel should belong to the country-code channel (regulatory domain).

Monitoring

TotalWatch enables monitoring of all channels including regulatory domain and rare channels. You can select one of the following scanning modes for each radio AP.

- scan only the channels that belong to the AP's regulatory domain
- scan channels that belong to all regulatory domains
- scan all channels

Scanning Spectrum

TotalWatch scans the following frequencies.

- G-band—2412MHz to 2472MHz
- J band—2484 MHz
- A-band—5000-5100Mhz to 5895MHz
- J-band—4900-4995MHz

Table 112 list the frequency-to-channel mapping used by TotalWatch.

Table 112 *Frequency to Channel Mapping*

Frequency	Channel
2412 – 2472MHz (in increments of 5MHz)	1 - 13
2484MHz	14
5100 – 5895MHz (in increments of 5MHz)	20 - 179
4900 – 4995MHz (in increments of 5MHz)	180 - 199
5000 – 5100MHz	200 - 219

Channel Dwell Time

When an AP (in am-mode) visits a channel, the amount of time the AP *stays* on that channel is known as the *dwell time*. The channel dwell time is a variable value based on the following channel types.

dwell-time-active-channel—For channels where there is wireless activity. Default is setting is 500 ms.

dwell-time-reg-domain channel—For channels that belong to the AP's regulatory domain group (reg-domain) with *no* wireless activity. The default setting is 250 ms.

dwell-time-other-reg-domain-channel—For channels that belong to the *all* regulatory domain group (all-reg-domain) with *no* wireless activity The default setting is 250 ms.

dwell-time-rare-channel—For channels in the rare group where *no* wireless activity is detected. The default value is 100 ms.

Use the rf am-scan-profile command to set the dwell time and scan mode.

Channel Visiting

The Active and DOS channels are visited more frequently than the other channels. The order of preference in selecting the next channel is:

1. DOS
2. Active
3. reg-domain
4. All-reg-domain
5. Rare

Once a channel is selected, the dwell time for that channel is determined based on the channel type. At the end of the dwell time, a new channel is picked.

Age out of Devices

ArubaOS uses a combination of inactivity time and unseen time to age out a device. This ensures that the channel is scanned a sufficient number of times before a device ages out. AM module maintains the following parameters:

Discovered Time—The absolute time, is seconds, since the device was discovered.

Monitored Time—The number of times the channel was scanned since discovery.

Inactivity Time—The number of times the device was not "seen" when the channel is scanned.

Unseen Time—The absolute time, in seconds, since the device was last "seen."

TotalWatch Administration

The AM module will initialize the channel list for each of the AP's radios based on the scan mode setting for the radio. For example, if scan mode is set to rare, then the channel list will contain all possible channels. You can view these channels by using the show ap arm scan-times command.

Configuring Per Radio Settings

For each radio, you can configure the following settings (for detailed information on commands, refer to the *Command Line Reference Guide*):

- the dwell times for the various channel types
- the channel list that should be used for scanning

These settings are configured via the command rf am-scan-profile, which can be attached to the two profiles, dot11a-radio-profile and dot11g-radio-profile.

The am-scan-profile includes the following parameters that can be configured:

```
rf am-scan-profile <name>
scan-mode [reg-domain | all-reg-domain | rare]
```

The default setting is the all-reg-domain. This is consistent with the default functioning of the AM scanning where the radio scans channels belonging to all regulatory domains.

Configuring Per AP Setting

If the AP is a dual-band single radio AP, an option is available to specify which band should be used for scanning in AM-mode. This setting is available in the "ap system-profile", via the am-scan-rf-band command.

```
ap system-profile <name>
am-scan-rf-band [a | g | all]
```

The default value is "all", which is consistent with the prior behavior. This setting is ignored in the case of a dual radio AP.

There are four parameters that will control the age out of devices in the AM module.

```
ids general-profile <name>
ap-inactivity-timeout
sta-inactivity-timeout
ap-max-unseen-timeout
sta-max-unseen-timeout
```

The inactivity timeout is the number of times the device was not "seen" when the channel was scanned. The unseen timeout is the time, in seconds, since the device was last "seen."

The show ap monitor scan-info/channel commands provide details of the channel types, dwell times, and the channel visit sequence.

```
(host) # show ap monitor scan-info ap-name rb-121

WIF Scanning State: wifi0
--------------------------
Parameter                     Value
---------                     -----
Scan Mode                     all-reg-domain
Scan Channel                  yes
Disable Scanning              no
Current Channel               36-
Current Scan Channel          36-
Current Channel Index         1
Current Scan Start Milli Tick 351757100
Current Dwell Time            600
Current Scan Type             active

Scan-Type-Info
---------------
Info-Type          Active  Reg-domain  All-reg-domain  Rare  DOS
---------          ------  ----------  --------------  ----  ---
Dwell Times        600     250         100             100   600
Last Scan Channel  36-     116-        0               0     0

(host) #show ap monitor channel ap-name rb-121 36

Aggregate Stats
---------------
retry  low-speed  non-unicast  frag  bwidth  phy-err  mac-err  noise
-----  ---------  -----------  ----  ------  -------  -------  -----
0      0          0            0     1       0        9        90

Scanning Stats
---------------
scans-attempted  assign-time(ms)  last-visit-time  monitored-time  reside-time(ms)
dos-scans  flags
---------------  ---------------  ---------------  --------------  ---------------  ---
------  -----
```

```
42702            25620500         402424           56245           0
    0          DVACLU
Channel Flags: D: Default, V: Valid, A: AP Present, C: Reg Domain Channel,
               O: DOS Channel, Z: Rare Channel
               T: Valid 20MHZ Channel, F: Valid 40MHz Channel,
               L: Scan 40MHz Channel (lower), U: Scan 40MHz channel (upper)
               R: Radar detected in last 30 min, X: DFS required
```

Licensing

The ability to perform rare scanning is available only with the RFprotect license. However, the AP can scan 'reg-domain' or 'all-reg-domain' channels without the RFprotect license.

Tarpit Shielding

The Tarpit Shielding feature is a type of wireless containment. Detected devices that are classified as rogues are contained by forcing client association to a fake channel or BSSID. This method of tarpitting is more efficient than rogue containment via repeated de-authorization requests. Tarpit Shielding works by spoofing frames from an AP to *confuse* a client about its association. The *confused* client assumes it is associated to the AP on a different (fake) channel than the channel that the AP is actually operating on, and will attempt to communicate with the AP in the fake channel.

Tarpit Shielding works in conjunction with the *deauth* wireless containment mechanism. The deauth mechanism triggers the client to generate probe request and subsequent association request frames. The AP then responds with probe response and association response frames. Once the monitoring AP sees these frames, it will spoof the probe-response and association response frames, and manipulates the content of the frames to confuse the client.

A station is determined to be in the Tarpit when we *see* it sending data frames in the fake channel. With some clients, the station remains in tarpit state until the user manually disables and re-enables the wireless interface.

Tarpit Shielding Administration

Tarpit shielding is configured on an AP using one of two methods:

Disable all clients—In this method, any client that attempts to associate with an AP marked for containment is sent spoofed frames.

Disable non-valid clients—In this method, only non-authorized clients that attempt to associate with an AP is sent to the tarpit.

The choices for disabling Tarpit Shielding on an AP are:

- Deauth-wireless-containment
- Deauth-wireless-containment with tarpit-shielding (excluding-valid-clients)
- Deauth-wireless-containment with tarpit-shielding

Configuring Tarpit Shielding

Use the ids-general-profile command to configure Tarpit Shielding (for detailed information on commands refer to the *Command Line Reference Guide*).

```
ids general-profile default
   wireless-containment [deauth-only | none | tarpit-all-sta | tarpit-non-valid-sta]
```

Use the following show commands to view updated Tarpit Shielding status and the spoofed frames generated for an AP:

```
show ap monitor stats …
show ap monitor containment-info
```

Licensing

In the ids general-profile default wireless-containment command, the 'tarpit-non-valid-sta' and 'tarpit-all-sta' options are available only with a RFprotect license. The 'deauth-only' and 'none' options are available with the Base OS license.

Chapter 31

Link Aggregation Control Protocol

Dell PowerConnect implementation of Link Aggregation Control Protocol (LACP) is based on the standards specified in 802.3ad. LACP provides a standardized means for exchanging information, with partner systems, to form a link aggregation group (LAG). LACP avoids port channel misconfiguration.

Two devices (actor and partner) exchange LACP data units (DUs) in the process of forming a LAG. Once multiple ports in the system have the same actor system ID, actor key, partner system ID, and partner key, they belong to the same LAG.

The maximum number of supported port-channels is 8. With the introduction of LACP, this number remains the same. In essence, a port-channel group (LAG) is created either statically or dynamically via LACP. This chapter contains:

Important Points to Remember

- LACP is disabled by default
- LACP depends on periodical Tx/Rx of LACP data units (LACPDU). Any failures are noticed immediately and that port is removed from the LAG
- The maximum LAG supported per system is 8 groups; each group can be created statically or via LACP
- Each LAG can have up to 8 member ports
- The LAG group identification (ID) range is 0 to 7 for both static (port-channel) and LACP groups
- When a port is added to a LACP LAG, it inherits the port-channel's properties (i.e. VLAN membership, trunk status etc)
- When a port is added to LACP LAG, the port's property (i.e. speed) is compared to the existing port properties. If there is a mismatch, the command is rejected.

Configuring LACP

Two LACP configured devices exchange LACPDUs to form a LAG. A device is configurable as an active or passive participant. In active mode, the device initiates DUs irrespective of the partner state; passive mode devices respond only to the incoming DUs sent by the partner device. Hence, to form a LAG group between two devices, one device must be an active participant. For detailed information on the LACP commands, see the ArubaOS Command Line Reference Guide.

In the CLI

LACPDUs exchange their corresponding system identifier/priority along with their port's key/priority. This information determines the LAG of a given port. The LAG for a port is selected based on it's keys; the port is placed in that LAG only when it's system ID/key and partner's system ID/key matches the other ports in the LAG (if the group has ports).

1. Enable LACP and configure the per-port specific LACP. The group number range is 0 to 7.

   ```
   lacp group <group_number> mode {active | passive}
   ```

   - Active mode—the interface is in active negotiating state. LACP runs on any link that is configured to be in the active state. The port in an active mode also automatically initiates negotiations with other ports by initiating LACP packets.
   - Passive mode—the interface is *not* in an active negotiating state. LACP runs on any link that is configured in a passive state. The port in a passive mode responds to negotiations requests from other ports that are in an active state. Ports in passive state respond to LACP packets.

NOTE: A port in a passive state cannot set up a port channel (LAG group) with another port in a passive state.

2. Set the timeout for the LACP session. The timeout value is the amount of time that a port-channel interface waits for a LACPDU from the remote system before terminating the LACP session. The default time out value is long (90 seconds); short is 3 seconds

   ```
   lacp timeout {long | short}
   ```

3. Set the port priority.

   ```
   lacp port-priority <priority_value>
   ```

   The higher the priority value the lower the priority. Range is 1 to 65535 and default is 255.

4. View your LACP configuration.

   The port uses the group number +1 as the "actor admin key". By default, all the ports use the long timeout value (90 seconds).

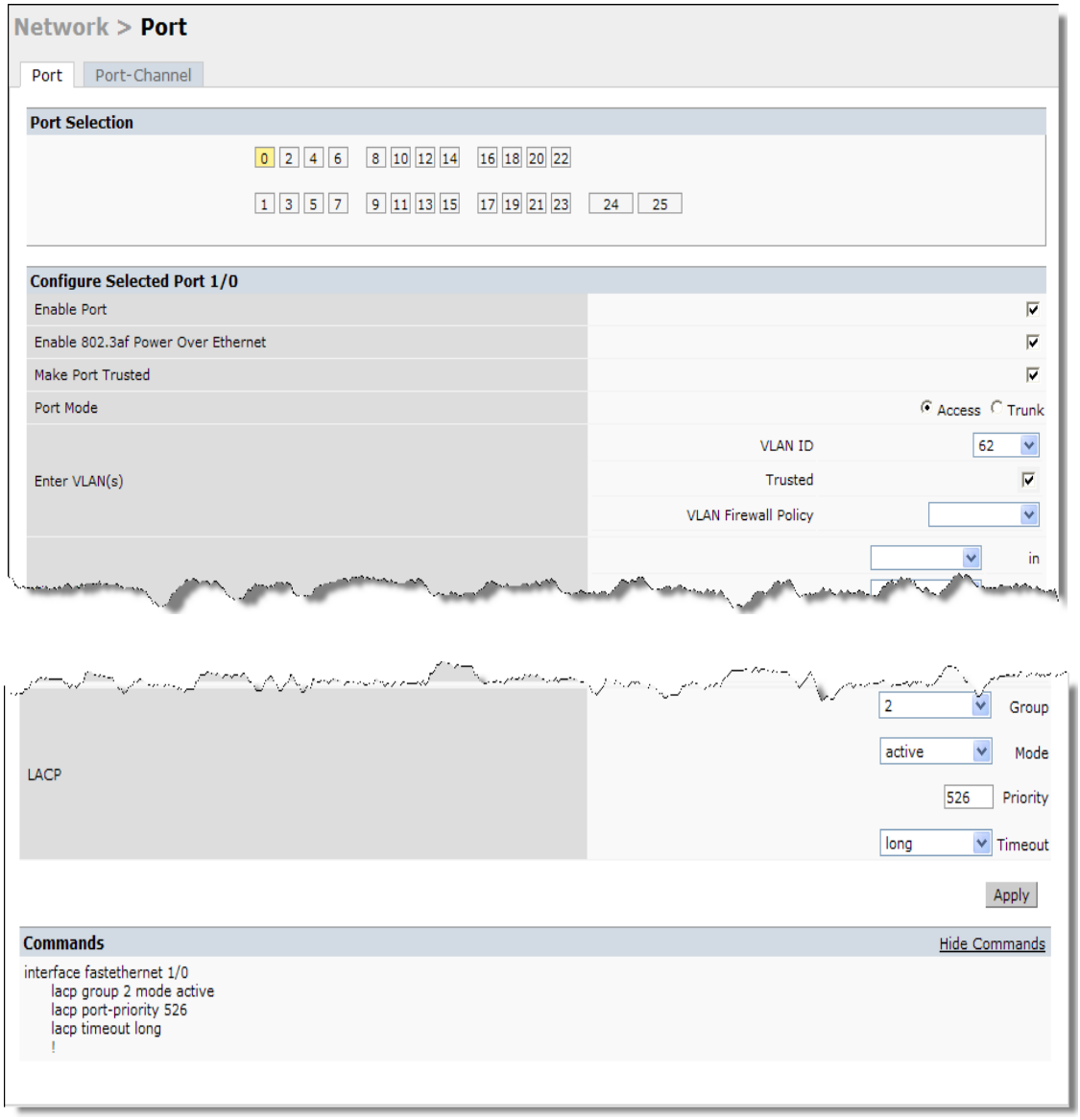
   ```
   (TechPubs)#show lacp 0 neighbor
   Flags: S - Device is requesting Slow LACPDUs
              F - Device is requesting fast LACPDUs
              A - Device is in active mode P - Device is in passive mode
   Partner's information
   ---------------------
   Port    Flags  Pri  OperKey  State Num  Dev Id
   ----    -----  ---- -------  ----- ---- ----------------
   FE 1/1  SA     1    0x10     0x45  0x5  00:0b:86:51:1e:70
   FE 1/2  SA     1    0x10     0x45  0x6  00:0b:86:51:1e:70
   ```

   When a port in a LAG, is misconfigured (that is, the partner device is different than the other ports) or the neighbor timesout or can not exchange LACPDUs with the partner, the port status is displayed as "DOWN" (see the following example).

   ```
   (TechPubs)#show lacp 0 internal
   Flags: S - Device is requesting Slow LACPDUs
   F - Device is requesting fast LACPDUs
    A - Device is in active mode P - Device is in passive mode

   Port    Flags  Pri  AdminKey  OperKey  State Num  Status
   ----    -----  ---- --------  -------- ----- ---- -------
   FE 1/1  SA     1    0x1       0x1      0x45  0x2  DOWN
   FE 1/2  SA     1    0x1       0x1      0x45  0x3  UP
   ```

In the WebUI

Access LACP from the Configuration->Network->Port tabs. Use the drop down menus to enter the LACP values.



- LACP Group—The link aggregation group (LAG) number; range is 0 to 7
- Mode—Active negotiation state or not in an active negotiation state indicated by the *passive* option.
- Priority—The port priority value; range is 1 to 65535 Default 255
- Timeout—Time out value for the LACP session; Long, the default, is 90 seconds; short is 3 seconds

Best Practices

- The LACP commands can not be configured on a port that is already a member of a static port-channel. Similarly, if the group assigned in the command lacp group <number> already contains static port members, the command is rejected.
- The port uses the group number as it's actor admin key.
- By default, all ports use long timeout values (90 seconds)

- The output of the command show interface port-channel now indicates if the LAG is created by LACP (dynamic) or static configuration. If the LAG is created via LACP, you can not add/delete any ports under that port channel. All other commands are allowed.

Sample Configuration

The following sample configuration is for FastEthernet (FE) port/slot 1/0, 1/1, and 1/2

```
interface fastethernet 1/0
        description "FE1/0"
        trusted vlan 1-4094
        lacp group 0 mode active
!
interface fastethernet 1/1
        description "FE1/1"
        trusted vlan 1-4094
        lacp timeout short
        lacp group 0 mode active
!
interface fastethernet 1/2
        description "FE1/2"
        trusted vlan 1-4094
        lacp group 0 mode passive
!
```

Chapter 32

Management Access

This chapter describes management access and tasks for a user-centric network and includes the following topics:

Certificate Authentication for WebUI Access

The controller supports client certificate authentication for users accessing the controller using the WebUI. (The default is for username/password authentication.) You can use client certificate authentication only, or client certificate authentication with username/password (if certificate authentication fails, the user can log in with a configured username and password).

NOTE: Each controller can support a maximum of ten management users.

Configuring Certificate Authentication for WebUI Access

To use client certificate authentication, you must do the following:

1. Obtain a client certificate and import the certificate into the controller. Obtaining and importing a client certificate is described in "Managing Certificates" on page 580.
2. Configure certificate authentication for WebUI management. You can optionally also select username/password authentication.
3. Configure a user with a management role. Specify the client certificate for authentication of the user.

In the WebUI

1. Navigate to the Configuration > Management > General page.
2. Under WebUI Management Authentication Method, select Client Certificate. You can select Username and Password as well; in this case, the user is prompted to manually enter the username and password only if the client certificate is invalid.
3. Select the server certificate to be used for this service.
4. Click Apply.

5. To configure the management user, navigate to the Configuration > Management > Administration page.
   a. Under Management Users, click Add.
   b. Select Certificate Management.
   c. Select WebUI Certificate.
   d. Enter the username.
   e. Select the user role assigned to the user upon validation of the client certificate
   f. Enter the serial number for the client certificate.
   g. Select the name of the CA that issued the client certificate.
   h. Click Apply.

In the CLI

```
web-server
   mgmt-auth certificate
   switch-cert <certificate>
mgmt-user webui-cacert <ca> serial <number> <username> < role>
```

Public Key Authentication for SSH Access

The controller allows public key authentication of users accessing the controller using SSH. (The default is for username/password authentication.) When you import an X.509 client certificate into the controller, the certificate is converted to SSH-RSA keys. When you enable public key authentication for SSH, the controller validates the client's credentials with the imported public keys. You can specify public key authentication only, or public key authentication with username/password (if the public key authentication fails, the user can login with a configured username and password).

To use public key authentication, you must do the following:

1. Import the X.509 client certificate into the controller using the WebUI, as described in "Importing Certificates" on page 583.
2. Configure SSH for client public key authentication. You can optionally also select username/password authentication.
3. Configure the username, role and client certificate.

In the WebUI

1. Navigate to the Configuration > Management > General page.
2. Under SSH (Secure Shell) Authentication Method, select Client Public Key. You can optionally select Username/Password to use both username/password and public key authentication for SSH access.
3. Click Apply.
4. To configure the user, navigate to the Configuration > Management > Administration page.
   a. Under Management Users, click Add.
   b. Select Certificate Management.
   c. Select SSH Public Key.

NOTE: ArubaOS recommends that the username and role for SSH be the same as for the WebUI Certificate. You can optionally use the checkbox to copy the username and role from the Web Certificate section to the SSH Public Key section.

d. Enter the username.

e. Select the management role assigned to the user upon validation of the client certificate.

f. Select the client certificate.

g. Click Apply.

In the CLI

```
ssh mgmt-auth public-key [username/password]
mgmt-user ssh-pubkey client-cert <certificate> <username> <role>
```

Radius Server Authentication

Radius Server Username/Password Authentication

In this example, an external RADIUS server is used to authenticate management users. Upon authentication, users are assigned the default role root.

In the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select RADIUS Server to display the Radius Server List.
   a. To configure a RADIUS server, enter the name for the server (for example, rad1) and click Add.
   b. Select the name to configure server parameters, such as IP address. Select the Mode checkbox to activate the server.
   c. Click Apply.
3. Select Server Group to display the Server Group list.
   a. Enter the name of the new server group (for example, corp_rad) and click Add.
   b. Select the name to configure the server group.
   c. Under Servers, click New to add a server to the group.
   d. Select a server from the drop-down menu and click Add Server.
   e. Click Apply.
4. Navigate to the Configuration > Management > Administration page.
   a. Under Management Authentication Servers, select a management role (for example, root) for the Default Role.
   b. Select (check) Mode.
   c. For Server Group, select the server group that you just configured.
   d. Click Apply.

In the CLI

```
aaa authentication-server radius rad1
  host <ipaddr>
  enable

aaa server-group corp_rad
  auth-server rad1

aaa authentication mgmt
  default-role root
  enable
```

```
server-group corp_rad
```

RADIUS Server Authentication with VSA

In this scenario, an external RADIUS server authenticates management users and returns to the controller the Dell vendor-specific attribute (VSA) called Dell-Admin-Role that contains the name of the management role for the user. The authenticated user is placed into the management role specified by the VSA.

The controller configuration is identical to the "Radius Server Username/Password Authentication" on page 573. The only difference is the configuration of the VSA on the RADIUS server. Ensure that the value of the VSA returned by the RADIUS server is one of the predefined management roles. Otherwise, the user will have *no* access to the controller.

RADIUS Server Authentication with Server-Derivation Rule

NOTE: Dell controllers do not make use of any returned attributes from a TACACS+ server.

A RADIUS server can return to the controller a standard RADIUS attribute that contains one of the following values:

- The name of the management role for the user
- A value from which a management role can be derived

For either situation, configure a server-derivation rule for the server group.

In the following example, the RADIUS server returns the attribute Class to the controller. The value of the attribute can be either "root" or "network-operations" depending upon the user; the returned value is the role granted to the user.

NOTE: Ensure that the value of the attribute returned by the RADIUS server is one of the predefined management roles. Otherwise, the management user will not be granted access to the controller.

Configuring a Value-of Server-derivation Rule in the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select RADIUS Server to display the Radius Server List.
   a. To configure a RADIUS server, enter the name for the server (for example, rad1) and click Add.
   b. Select the name to configure server parameters, such as IP address. Select the Mode checkbox to activate the server.
   c. Click Apply.
3. Select Server Group to display the Server Group list.
   a. Enter the name of the new server group (for example, corp_rad) and click Add.
   b. Select the name to configure the server group.
   c. Under Servers, click New to add a server to the group.
   d. Select a server from the drop-down menu and click Add Server.
   e. Under Server Rules, click New to add a server rule.
   f. For Condition, select Class from the scrolling list. Select value-of from the drop-down menu. Select Set Role from the drop-down menu.
   g. Click Add.
   h. Click Apply.

4. Navigate to the Configuration > Management > Administration page.
   a. Under Management Authentication Servers, select a management role (for example, read-only) for the Default Role.
   b. Select (check) Mode.
   c. For Server Group, select the server group that you just configured.
   d. Click Apply.

In the CLI

```
aaa authentication-server radius rad1
  host <ipaddr>
  enable

aaa server-group corp_rad
  auth-server rad1
  set role condition Class value-of

aaa authentication mgmt
  default-role read-only
  enable
  server-group corp_rad
```

In the following example, the RADIUS server returns the attribute Class to the controller; the value of this attribute can be "it", in which case, the user is granted the root role. If the value of the Class attribute is anything else, the user is granted the default read-only role.

Configuring a set-value server-derivation rule in the WebUI

1. Navigate to the Configuration > Security > Authentication > Servers page.
2. Select RADIUS Server to display the Radius Server List.
   a. To configure a RADIUS server, enter the name for the server (for example, rad1) and click Add.
   b. Select the name to configure server parameters, such as IP address. Select the Mode checkbox to activate the server.
   c. Click Apply.
3. Select Server Group to display the Server Group list.
   a. Enter the name of the new server group (for example, corp_rad) and click Add.
   b. Select the name to configure the server group.
   c. Under Servers, click New to add a server to the group.
   d. Select a server from the drop-down menu and click Add Server.
   e. Under Server Rules, click New to add a server rule.
   f. For Condition, select Class from the scrolling list. Select equals from the drop-down menu. Enter it. Select Set Role from the drop-down menu. For Value, select root from the drop-down menu.
   g. Click Add.
   h. Click Apply.
4. Navigate to the Configuration > Management > Administration page.
   a. Under Management Authentication Servers, select a management role (for example, read-only) for the Default Role.
   b. Select (check) Mode.
   c. For Server Group, select the server group that you just configured.
   d. Click Apply.

In the CLI

```
aaa authentication-server radius rad1
  host <ipaddr>
  enable

aaa server-group corp_rad
  auth-server rad1
  set role condition Class equals it set-value root

aaa authentication mgmt
  default-role read-only
  enable
  server-group corp_rad
```

For more information about configuring server-derivation rules, see "Configuring Server-Derivation Rules" on page 277.

Disabling Authentication of Local Management User Accounts

You can disable authentication of management user accounts in local switches if the configured authentication server(s) (RADIUS or TACACS+) are not available.

You can disable authentication of management users based on the results returned by the authentication server. When configured, locally-defined management accounts (for example, admin) are not allowed to log in if the server(s) are reachable and the user entry is not found in the authentication server. In this situation, if the RADIUS or TACACS+ server is unreachable, meaning it does not receive a response during authentication, or fails to authenticate a user because of a timeout, local authentication is used and you can log in with a locally-defined management account.

In the WebUI

1. Navigate to the Configuration > Management > Administration page.
2. Under Management Authentication Servers, uncheck the Local Authentication Mode checkbox.
3. Click Apply.

In the CLI

```
mgmt-user localauth-disable
```

Verifying the configuration

To verify if authentication of local management user accounts is enabled or disabled, use the following command:

```
show mgmt-user local-authentication-mode
```

Resetting the Admin or Enable Password

This section describes how to reset the password for the default administrator user account (admin) on the controller. Use this procedure if the administrator user account password is lost or forgotten.

1. Connect a local console to the serial port on the controller.
2. From the console, login in the controller using the username password and the password forgetme!.
3. Enter enable mode by typing in enable, followed by the password enable.
4. Enter configuration mode by typing in configure terminal.
5. To configure the administrator user account, enter mgmt-user admin root. Enter a new password for this account. Retype the same password to confirm.
6. Exit from the configuration mode, enable mode, and user mode.

This procedure also resets the enable mode password to enable. If you have defined a management user password policy, make sure that the new password conforms to this policy. For details, see "Management Password Policy" on page 578.

Figure 116 is an example of how to reset the password. The commands in bold type are what you enter.

Figure 116 *Resetting the Password*

```
(host)
User: password
Password: forgetme!
(host) >enable
Password: enable
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(host) (config) #mgmt-user admin root
Password: ******
Re-Type password: ******
(host) (config) #exit
(host) #exit
(host) >exit
```

After you reset the administrator user account and password, you can login to the controller and reconfigure the enable mode password. To do this, enter configuration mode and type the enable secret command. You are prompted to enter a new password and retype it to confirm. Save the configuration by entering write memory.

Figure 117 details an example reconfigure the enable mode password. Again, the command you enter displays in bold type.

Figure 117 *Reconfigure the enable mode password*

```
User: admin
Password: ******
(host) >enable
Password: ******
(host) #configure terminal
Enter Configuration commands, one per line. End with CNTL/Z

(host) (config) #enable secret
Password: ******
Re-Type password: ******
(host) (config) #write memory
```

Bypassing the Enable Password Prompt

The bypass enable feature lets you bypass the enable password prompt and go directly to the privileged commands (config mode) after logging on to the controller. This is useful if you want to avoid changing the enable password due to company policy.

Use the `enable bypass` CLI command to bypass the enable prompt an go directly to the privileged commands (config mode). Use the `no enable bypass` CLI command to restore the enable password prompt.

Setting an Administrator Session Timeout

You can configure the number of seconds after which an Administrator's WebUI or CLI session times out.

Setting a CLI Session Timeout

To define a timeout interval for a CLI session, use the command:

```
loginsession timeout <value>
```

In the above command, <val> can be any number of minutes from 5 to 60 or seconds from 1 to 3600, inclusive. You can also specify a timeout value of 0 to disable CLI session timeouts.

Setting a WebUI Session Timeout

To define a timeout interval for a WebUI session, use the command:

```
web-server sessiontimeout <session-timeout>
```

In the above command, <session-timeout> can be any number of seconds from 30 to 3600, inclusive.

Management Password Policy

By default, the password for a new management user has no requirements other than a minimum length of 6 alphanumeric or special characters. However, if your company enforces a best practices password policy for management users with root access to network equipment, you may want to configure a password policy that sets requirements for management user passwords.

Defining a Management Password Policy

To define specific management password policy settings through the WebUI or the CLI, complete the following steps:

In the WebUI

1. Navigate to Configuration>All Profiles.
2. Expand Other Profiles.
3. Select Mgmt Password Policy.
4. Configure the settings described in Table 113.

Table 113 *Management Password Policy Settings*

Parameter	Description
Enable Password Policy	Select this checkbox to enable the password management policy. The password policy will not be enforced until this checkbox is selected.
Minimum password length required	The minimum number of characters required for a management user password Range: 6-64 characters. Default: 6.
Minimum number of Upper Case characters	The minimum number of uppercase characters required in a management user password. Range: 0-10 characters. By default, there is no requirement for uppercase letters in a password, and the parameter has a default value of 0.
Minimum number of Lower Case characters	The minimum number of lowercase characters required in a management user password. Range: 0-10 characters. By default, there is no requirement for lowercase letters in a password, and the parameter has a default value of 0.
Minimum number of Digits	The minimum number of numeric digits required in a management user password. Range: 0-10 digits. By default, there is no requirement for numerical digits in a password, and the parameter has a default value of 0.
Username or Reverse of username NOT in Password	When you select this checkbox, the password cannot be the management users' current username or the username spelled backwards.

Table 113 *Management Password Policy Settings (Continued)*

Parameter	Description
Maximum Number of failed attempts in 3 minute window to lockout user	The number of failed attempts within a 3 minute window that causes the user to be locked out for the period of time specified by the Time duration to lockout the user upon crossing the "lock-out" threshold parameter. Range: 0-10 attempts. By default, the password lockout feature is disabled, and the default value of this parameter is 0 attempts.
Maximum consecutive character repeats	The maximum number of consecutive repeating characters allowed in a management user password. Range: 0-10 characters. By default, there is no limitation on the numbers of character that can repeat within a password, and the parameter has a default value of 0 characters.

5. Click Apply to save your settings.

The table below describes the characters allowed in a management user password. The disallowed characters cannot be used by any management user password, even if the password policy is disabled.

Table 114 *Allowed Characters in a Management User Password*

Allowed Characters	Disallowed Characters
exclamation point: !	Parenthesis: ( )
underscore: _	apostrophe: '
at symbol: @	semi-colon: ;
pound sign: #	dash: -
dollar sign: $	equals sign: =
percent sign: %	slash: /
caret: ^	question mark: ?
ampersand: &	
star: *	
greater and less than symbols: < >	
curled braces: { }	
straight braces: [ ]	
colon :	
period: .	
pipe: |	
plus sign: +	
tilde: ~	
comma: ,	
accent mark: `	

In the CLI

```
aaa password-policy mgmt
   enable
   no
```

```
password-lock-out
password-lock-out-time
password-max-character-repeat.
password-min-digit
password-min-length
password-min-lowercase-characters
password-min-special-character
password-min-uppercase-characters
password-not-username
```

Management Authentication Profile Parameters

Table 115 describes configuration parameters on the Management Authentication profile page.

NOTE: In the CLI, you configure these options with the aaa authentication mgmt and aaa-server-group commands.

Table 115 *Management Authentication Profile Parameters*

Parameter	Description
Enable	Enables authentication for administrative users.
Default Role	Select a predefined management role to assign to authenticated administrative users:
Root	Default superuser role
guest-provisioning	Guest provisioning role
location-api-mgmt	Location API role
network-operations	Network operations role
no-access	No commands are accessible for this role
read-only	Read-only role
no access	Negates any configured parameter.
Server Group	Name of the group of servers used to authenticate administrative users. See the CLI command aaa-server-group, in the *CLI Command Reference Guide* for more information..

Managing Certificates

The Dell controller is designed to provide secure services through the use of digital certificates. Certificates provide security when authenticating users and computers and eliminate the need for less secure password-based authentication.

There is a *default* server certificate installed in the controller to demonstrate the authentication of the controller for captive portal and WebUI management access. However, this certificate does not guarantee security in production networks. Dell *strongly* recommends that you replace the default certificate with a custom certificate issued for your site or domain by a trusted Certificate Authority (CA). This section describes how to generate a Certificate Signing Request (CSR) to submit to a CA and how to import the signed certificate received from the CA into the controller.

The controller supports client authentication using digital certificates for specific user-centric network services, such as AAA FastConnect (see), VPN (see Chapter 17, "Virtual Private Networks"), and WebUI and SSH management access. Each service can employ different sets of client and server certificates.

During certificate-based authentication, the controller provides its server certificate to the client for authentication. After validating the controller's server certificate, the client presents its own certificate to the controller for authentication. To validate the client certificate, the controller checks the certificate revocation list (CRL) maintained by the CA that issued the client certificate. After validating the client's certificate, the controller can check the user name in the certificate with the configured authentication server (this action is optional and configurable).

About Digital Certificates

Clients and the servers to which they connect may hold authentication certificates that validate their identities. When a client connects to a server for the first time, or the first time since its previous certificate has expired or been revoked, the server requests that the client transmit its authentication certificate. The client's certificate is then verified against the CA which issued it. Clients can also request and verify the server's authentication certificate. For some applications, such as 802.1x authentication, clients do not need to validate the server certificate for the authentication to function.

Digital certificates are issued by a CA which can be either a commercial, third-party company or a private CA controlled by your organization. The CA is trusted to authenticate the owner of the certificate before issuing a certificate. A CA-signed certificate guarantees the identity of the certificate holder. This is done by comparing the digital signature on a client or server certificate to the signature on the certificate for the CA. When CA-signed certificates are used to authenticate clients, the controller checks the validity of client certificates using certificate revocation lists (CRLs) maintained by the CA that issued the certificate.

Digital certificates employ public key infrastructure (PKI), which requires a private-public key pair. A digital certificate is associated with a private key, known only to the certificate owner, and a public key. A certificate encrypted with a private key is decrypted with its public key. For example, party A encrypts its certificate with its private key and sends it to party B. Party B decrypts the certificate with party A's public key.

Obtaining a Server Certificate

Dell strongly recommends that you replace the default server certificate in the controller with a custom certificate issued for your site or domain by a trusted CA. To obtain a security certificate for the controller from a CA:

1. Generate a Certificate Signing Request (CSR) on the controller using either the WebUI or CLI.
2. Submit the CSR to a CA. Copy and paste the output of the CSR into an email and send it to the CA of your choice.
3. The CA returns a signed server certificate and the CA's certificate and public key.
4. Install the server certificate, as described in "Importing Certificates" on page 583.

NOTE: There can be only one outstanding CSR at a time in the controller. Once you generate a CSR, you need to import the CA-signed certificate into the controller before you can generate another CSR.

In the WebUI

1. Navigate to the Configuration > Management > Certificates > CSR page.
2. Enter the following information:

Table 116 *CSR Parameters*

Parameter	Description	Range
CSR Type	Type of the CSR. You can generate a certificate signing request either with an Elliptic curve (EC) key, or with a Rivest-Shamir-Aldeman (RSA) key.	ec/rsa
Curve name	Length of the private/public key for ECDSA. This is applicable only if CSR Type is `ec`.	secp256r1/secp384r1
Key Length	Length of the private/public key for RSA. This is applicable only if CSR Type is `rsa`.	1024/2048/4096
Common Name	Typically, this is the host and domain name, as in www.yourcompany.com.	—
Country	Two-letter ISO country code for the country in which your organization is located.	
State/Province	State, province, region, or territory in which your organization is located.	
City	City in which your organization is located.	
Organization	Name of your organization.	
Unit	Optional field to distinguish a department or other unit within your organization.	
Email Address	Email address referenced in the CSR.	

3. Click Generate New.
4. Click View Current to display the generated CSR. Select and copy the CSR output between the BEGIN CERTIFICATE REQUEST and END CERTIFICATE REQUEST lines, paste it into an email and send it to the CA of your choice.

In the CLI

1. Run the following command:

```
crypto pki csr {rsa key_len <key_val> |{ec curve-name <key_val>} common_name
<common_val> country <country_val> state_or_province <state> city <city_val>
organization <organization_val> unit <unit_val> email <email_val>
```

2. Display the CSR output with the following command:

```
show crypto pki csr
```

3. Copy the CSR output between the BEGIN CERTIFICATE REQUEST and END CERTIFICATE REQUEST lines, paste it into an email and send it to the CA of your choice.

Obtaining a Client Certificate

You can use the CSR generated on the controller to obtain a certificate for a client. However, since there may be a large number of clients in a network, you typically obtain client certificates from a corporate CA server. For example, in a browser window, enter http://<ipaddr>/crtserv, where <ipaddr> is the IP address of the CA server.

Importing Certificates

Use the WebUI or the CLI to import certificates into the controller.

NOTE: You cannot export certificates from the controller.

You can import the following types of certificates into the controller:

- Server certificate signed by a trusted CA. This includes a public and private key pair.
- CA certificate used to validate other server or client certificates. This includes only the public key for the certificate.
- Client certificate and client's public key. (The public key is used for applications such as SSH which does not support X509 certificates and requires the public key to verify an allowed certificate.)

Certificates can be in the following formats:

- X509 PEM unencrypted
- X509 PEM encrypted with a key
- DER
- PKCS7 encrypted
- PKCS12 encrypted

In the WebUI

1. Navigate to the Configuration > Management > Certificates > Upload page.
2. For Certificate Name, enter a user-defined name.
3. For Certificate Filename, click Browse to navigate to the appropriate file on your computer.
4. If the certificate is encrypted, enter the passphrase.
5. Select the Certificate Format from the drop-down menu.
6. Select the Certificate Type from the drop-down menu.
7. Click Upload to install the certificate in the controller.

In the CLI

Use the following command to import CSR certificates:

```
crypto pki-import {der|pem|pfx|pkcs12|pkcs7} {PublicCert|ServerCert|TrustedCA} <name>
```

The following example imports a server certificate named cert_20 in DER format:

```
crypto pki-import der ServerCert cert_20
```

Viewing Certificate Information

In the WebUI, the Certificate Lists section of the page lists the certificates that are currently installed in the controller. Click View to display the contents of a certificate.

To view the contents of a certificate with the CLI, use the following commands:

Table 117 *Certificate Show Commands*

Command	Description
show crypto-local pki trustedCAs [<name>]<[attribute>]	Displays the contents of a trusted CA certificate. If a name is not specified, all CA certificates imported into the controller are displayed. If name and attribute are specified, then only the attribute in the certificate are displayed. Attributes can be CN, validity, serial-number, issuer, subject, public-key.
show crypto-local pki serverCerts [<name>][<attribute>]	Displays the contents of a server certificate. If a name is not specified, all server certificates imported into the controller are displayed.
show crypto-local pki publiccert [<name>][<attribute>]	Displays the contents of a public certificate. If a name is not specified, all public certificates imported into the controller are displayed.

Imported Certificate Locations

Imported certificates and keys are stored in the following locations in flash on the controller:

Table 118 *Imported Certificate Locations*

Location	Description
/flash/certmgr/trustedCAs	Trusted CA certificates, either for root or intermediate CAs. Dell recommends that if you import the certificate for an intermediate CA, you also import the certificate for the signing CA.
/flash/certmgr/serverCerts	Server certificates. These certificates must contain both a public and private key (the public and private key must match). You can import certificates in PKCS12 and X509 PEM formats, but they are stored in X509 PEM DES encrypted format.
/flash/certmgr/CSR	Temporary certificate signing requests (CSRs) that have been generated on the controller and are awaiting a CA to sign them.
/flash/certmgr/publiccert	Public key of certificates. This allows a service on the controller to identify a certificate as an allowed certificate.

Checking CRLs

A CA maintains a CRL that contains a list of certificates that have been revoked before their expiration date. Expired client certificates are not accepted for any user-centric network service. Certificates may be revoked because certificate key has been compromised or the user specified in the certificate is no longer authorized to use the key.

When a client certificate is being authenticated for a user-centric network service, the controller checks with the appropriate CA to make sure that the certificate has not been revoked.

NOTE: The controller does not support download of CRLs.

Configuring SNMP

Dell controllers support versions 1, 2c, and 3 of Simple Network Management Protocol (SNMP) for reporting purposes only. In other words, SNMP cannot be used for setting values in an Dell system in the current ArubaOS version.

NOTE: Dell-specific management information bases (MIBs) describe the objects that can be managed using SNMP. See the *Dell PowerConnect W-Series ArubaOS MIB Reference Guide* for information about the Dell MIBs and SNMP traps.

SNMP Parameters for the Controller

You can configure the following SNMP parameters for the controller.

Table 119 *SNMP Parameters for the Controller*

Field	Description
Host Name	Host name of the controller.
System Contact	Name of the person who acts as the System Contact or administrator for the controller.
System Location	String to describe the location of the controller.
Read Community Strings	Community strings used to authenticate requests for SNMP versions before version 3. NOTE: This is needed only if using SNMP v2c and is not needed if using version 3.
Enable Trap Generation	Enables generation of SNMP traps to configured SNMP trap receivers. Refer to the list of traps in the "SNMP traps" section below for a list of traps that are generated by the Dell controller.
Trap receivers	Host information about a trap receiver. This host needs to be running a trap receiver to receive and interpret the traps sent by the Dell controller. Configure the following for each host/trap receiver: • IP address • SNMP version: can be 1 or 2c • Type: Trap or Inform (SNMP 2c only) • Retry Count (SNMP 2c only) • Timout Interval (SNMP 2c only) • Security string • UDP port on which the trap receiver is listening for traps. The default is the UDP port number 162. This is optional, and will use the default port number if not modified by the user.
If you are using SNMPv3 to obtain values from the Dell controller, you can configure the following parameters:	
User name	A string representing the name of the user.
Authentication protocol	An indication of whether messages sent on behalf of this user can be authenticated, and if so, the type of authentication protocol used. This can take one of the two values: • MD5: HMAC-MD5-96 Digest Authentication Protocol • SHA: HMAC-SHA-96 Digest Authentication Protocol
Authentication protocol password	If messages sent on behalf of this user can be authenticated, the (private) authentication key for use with the authentication protocol. This is a string password for MD5 or SHA depending on the choice above.
Privacy protocol	An indication of whether messages sent on behalf of this user can be protected from disclosure, and if so, the type of privacy protocol which is used. This takes the value DES (CBC-DES Symmetric Encryption Protocol).
Privacy protocol password	If messages sent on behalf of this user can be encrypted/decrypted with DES, the (private) privacy key for use with the privacy protocol.

Follow the steps below to configure a controller's basic SNMP parameters.

In the WebUI

1. Navigate to the Configuration > Management > SNMP page.
2. If the controller will be sending SNMP traps, click Add in the Trap Receivers section to add a trap receiver.
3. If you are using SNMPv3 to obtain values from the Dell controller, click Add in the SNMPv3 Users section to add a new SNMPv3 user.
4. Click Apply.

In the CLI

```
hostname name
syscontact name
syslocation string
snmp-server community string
snmp-server enable trap
snmp-server engine-id engine-id
snmp-server host ipaddr version {1|2c|3} string [udp-port number]
snmp-server trap source ipaddr
snmp-server user name [auth-prot {md5|sha} password priv-prot DES password
```

NOTE: Earlier versions of ArubaOS supported SNMP on individual APs. This feature is not supported by this version of ArubaOS.

Configuring Logging

This section outlines the steps required to configure logging on an Dell controller. For each category or subcategory of message, you can set the logging level or severity level of the messages to be logged. Table 120 summarizes these categories:

Table 120 *Software Modules*

Category/Subcategory	Description
Network	Network messages
all	All network messages
packet-dump	Protocol packet dump messages
mobility	Mobility messages
dhcp	DHCP messages
System	System messages
all	All system messages
configuration	Configuration messages
messages	Messages
snmp	SNMP messages
webserver	Web server messages
Security	Security messages
all	All security messages
aaa	AAA messages

Table 120 *Software Modules (Continued)*

Category/Subcategory	Description
firewall	Firewall messages
packet-trace	Packet trace messages
mobility	Mobility messages
vpn	VPN messages
dot1x	802.1x messages
ike	IKE messages
webserver	Web server messages
Wireless	Wireless messages
all	All wireless messages
User	User messages
all	All user messages
captive-portal	Captive portal user messages
vpn	VPN messages
dot1x	802.1x messages
radius	RADIUS user messages

For each category or subcategory, you can configure a logging level. Table 121 describes the logging levels in order of severity, from most to least severe.

Table 121 *Logging Levels*

Logging Level	Description
Emergency	Panic conditions that occur when the system becomes unusable.
Alert	Any condition requiring immediate attention and correction.
Critical	Any critical conditions such as a hard drive error.
Errors	Error conditions.
Warning	Warning messages.
Notice	Significant events of a non-critical and normal nature.
Informational	Messages of general interest to system users.
Debug	Messages containing information useful for debugging.

The default logging level for all categories is Warning. You can also configure IP address of a syslog server to which the controller can direct these logs.

In the WebUI

1. Navigate to the Configuration > Management > Logging > Servers page.
2. To add a logging server, click New in the Logging Servers section.
3. Click Add to add the logging server to the list of logging servers. Ensure that the syslog server is enabled and configured on this host. Click Apply.
4. To select the types of messages you want to log, select the Levels tab.
5. Select the category or subcategory to be logged.
6. To select the severity level for the category or subcategory, scroll to the bottom of the page. Select the level from the Logging Level drop-down menu. Click Done.
7. Click Apply to apply the configuration.

In the CLI

```
logging <ipaddr>
logging level <level> <category> [subcat <subcategory>]
```

Guest Provisioning

The Guest Provisioning feature lets you manage guests who need access to your company's Dell wireless network. This section describes how to:

- Design and configure the Guest Provisioning page – Using the WebUI, the network administrator designs and configures the Guest Provisioning page that is used to create a guest account.
- Configure a guest provisioning user – The network administrator configures one or more guest provisioning users. A guest provisioning user, such as a front desk receptionist, signs in guests at your company.
- Using the Guest Provisioning page – The Guest Provisioning page is used by the guest provisioning user to create guest accounts for people who are visiting your company.

Configuring the Guest Provisioning Page

Use the Guest Provisioning Configuration page to create the Guest Provisioning page. This configuration page consists of three tabs: Guest Fields, Page Design and Email. You configure the information on all three tabs to create a Guest Provisioning page.

- Guest Fields tab—lets you select the fields that appear on the Guest Provisioning page.
- Page Design tab—lets you specify the company banner, heading, and text and background colors that appear on the Guest Provisioning page.
- Email tab—lets you specify an email to be sent to the guest or sponsor (or both). Email messages can be sent automatically at account creation time and also may be sent manually by the administrator from the Guest Provisioning page.

In the WebUI

NOTE: You can only create and design the Guest Provisioning page in the WebUI.

This section describes how to design a Guest Provisioning page using all three tabs.

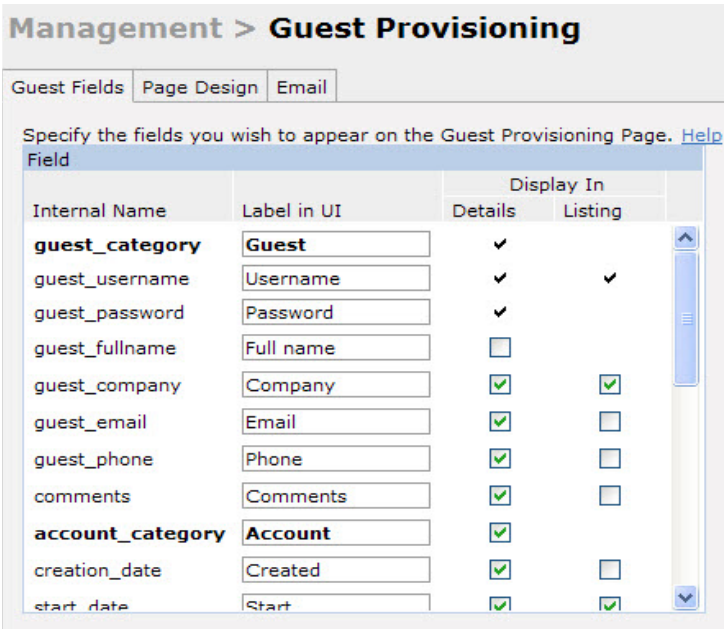
Configuring the Guest Fields

1. Navigate to the Configuration > Management > Guest Provisioning page. The Guest Provisioning configuration page displays with the Guest Fields tab on top. This tab contains the following columns:
   - Internal Name—The unique identifier that is mapped to the label in the UI.
   - Label in UI—A customizable string that displays in both the main listing pane and details sheet on the Guest Provisioning page.
   - Display in Details—Fields with selected checkboxes appear in the Show Details popup-window.

NOTE: If the guest_category, account_category, sponsor_category and optional_category fields are not checked, their respective sections do not appear on the Guest Provisioning page.

   - Display in Listing—Fields with selected checkboxes appear as columns in the management user summary page.

Figure 118 *Guest Provisioning Configuration Page—Guest Fields Tab*



2. Select the checkbox next to each field, described in Table 122, that you want to appear on the Guest Provisioning page. Optionally, you can customize the label that displays in the UI.
3. Click Preview Current Settings to view what the Guest Provisioning page looks like while you are designing it.
4. To save changes, click Apply.

NOTE: Dell recommends to check the Display in Listing field for only the most essential fields, so that the Guest Provisioning user does not have to scroll the guest listing horizontally to see all the columns.

Table 122 *Guest Provisioning—Guest Field Descriptions*

Guest Field	Description
guest_category	A guest is the person who needs guest access to the company's Dell wireless network. This is the label on the Guest Provisioning page for the guest information.

Table 122 *Guest Provisioning—Guest Field Descriptions (Continued)*

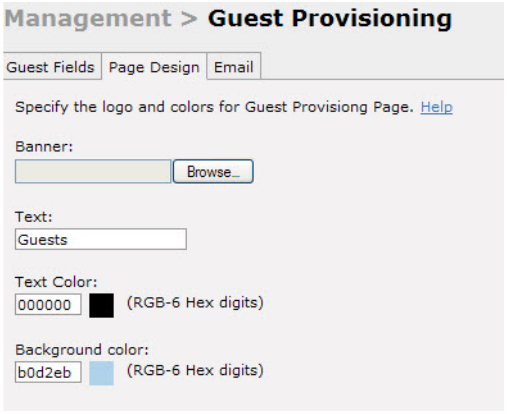
Guest Field	Description (Continued)
guest_username	Username for the guest.
guest_password	Password for the guest. (Must contain at least 1-6 characters and at least one digit.)
guest_fullname	Full name of the guest.
guest_company	Name of the guest's company.
guest_email	Guest's Email address.
guest_phone	Guest's phone number
comments	Optional comments about the guest's account status, meeting schedule and so on.
account_category	This is the label on the Guest Provisioning page for the account information.
creation-date	Date the account is created.
start_date	Date the guest account begins.
end_date	Date the guest account ends.
grantor	The username of the person of who created the guest account.
grantor_role	The authentication role of the grantor.
sponsor_category	A sponsor is the guest's primary contact for the visit. This is the label in the Guest Provisioning page for the sponsor information.
sponsor_username	Username of the sponsor.
sponsor_dept	Sponsor's work department
sponsor_email	Sponsor's Email address.
optional_category	This is the label in the Guest Provisioning page for the information in the optional fields that follow. NOTE: The optional_category field can be used for another person, for example a “Supervisor.” You can enter username, full name, department and Email information into the optional fields. Or, you can use this category for some other purpose.
optional_field_1	optional_field_1 description
optional_field_2	optional_field_2 description
optional_field_3	optional_field_2 description
optional_field_4	optional_field_2 description

Configuring the Page Design

The Page Design tab lets you specify the company banner, heading, and text and background colors that appear on the Guest Provisioning page.

1. Navigate to the Configuration > Management > Guest Provisioning page and select the Page Design tab.

Figure 119 *Guest Provisioning Configuration Page—Page Design Tab*



2. Enter the filename which contains the company banner in the Banner field. Or, click Browse to search for the filename

NOTE: Dell recommends using a logo or banner image that is 600 x 100 pixels (width x height). The WebUI does not apply the size restrictions when you upload an image file, but the image is resized to 600 x 100 pixels when it displays or is printed.

3. Enter the label for the guest listing (the one you used in the Guest Fields tab) in the Text field.
4. Enter the hex value for the color of the text in the Text Color field. The text in the header of the guest listing displays in this color.
5. Enter the hex value for the color of the background in the Background color field. This determines the color of the header of the guest listing.
6. Click Preview Current Settings to preview the Guest Provisioning page while you are designing it.
7. To save changes, click Apply.

Configuring Email Messages

You can specify an email to be sent to the guest or sponsor (or both). Email messages can be sent automatically at account creation time or sent manually by the network administrator or guest provisioning user from the Guest Provisioning page at any time.

1. Specify the SMTP server and port that processes the guest provisioning (also known as guest access) email. You can complete this step using the WebUI or CLI commands:
   - "Configuring the SMTP Server and Port in the WebUI" on page 591
   - "Configuring an SMTP server and port in the CLI" on page 592
2. Create the email messages. Complete this step using the WebUI:

   "Creating Email Messages in the WebUI" on page 592

Configuring the SMTP Server and Port in the WebUI

1. Navigate to the Configuration > Management > SMTP page.
2. Enter the IP address of the SMTP server to which the controller sends the guest provisioning email in the IP Address of SMTP server field.

3. Enter the number of the port through which the guest provisioning email passes in the Port field.
4. Click Apply and then Save Configuration.

Configuring an SMTP server and port in the CLI

The following command creates a guest-access email and sends guest user email through SMTP server IP address 1.1.1.1 on port 25.

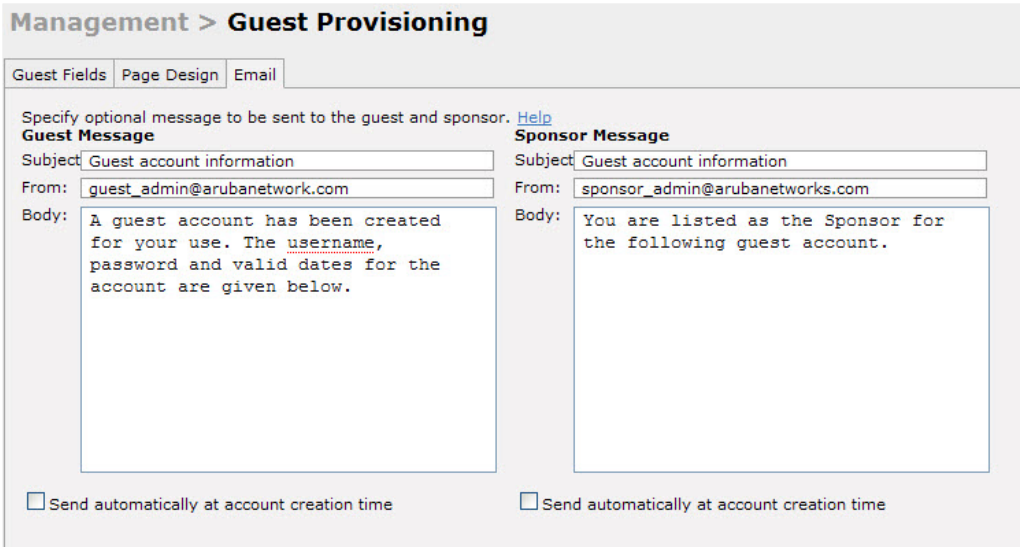
```
(host) (config) #guest-access-email
(host) (Guest-access Email ) #
(host) (Guest-access Email ) #smtp-port 25
(host) (Guest-access Email ) #smtp-server 1.1.1.1
```

Creating Email Messages in the WebUI

After you configured the SMTP server and port, follow these steps:

1. Navigate to the Configuration > Management > Guest Provisioning page and select the Email tab.

Figure 120 *Guest Provisioning Configuration Page—Email Tab*



2. To create a message for a guest or sponsor, customize the text in the Subject, From and Body fields as needed for both the Guest message and Sponsor message.
3. Optionally, select the Send automatically at account creation time checkbox when you want an email message to be sent to the guest and/or sponsor alerting them that a guest account has just been created.

NOTE: Regardless of whether you select this option, the person responsible for managing the Guest Provisioning page may choose to send this email message manually at any time.

Figure 121 shows a sample email message that is sent to the guest after the guest account is created.

Figure 121 *Sample Guest Account Email – Sent to Sponsor*

```
Sent: Monday, February 09, 2009 12:59 PM
To: John Smith
Subject: Guest account information

A guest account has been created for your use. The username, password and
valid dates for the account are given below.
================================================
Username:  guest3518444
Password:  hqtehjc1936850
Guest Name:
Guest Company:  MyCompany
Guest Email:  JSmith@MyCompany.com
Guest Phone:
Sponsor Email:  DJones@AcmeCompany.com
Start Date:  Mon Feb  9 18:46:00 2009
Expiration Date:  Mon Feb  9 19:46:00 2009
```

4. To save changes, click Apply.

Configuring a Guest Provisioning User

The guest provisioning user has access to the Guest Provisioning Page (GPP) to create guest accounts within your company. The guest provisioning user is usually a person at the front desk who greets guests and creates guest accounts. Depending upon your needs, there are three ways to configure and authenticate a guest provisioning user:

- Username and Password authentication — Allows you to configure a user in a guest provisioning role.
- Smart Card authentication
  - Static authentication —Uses a configured certificate name and serial number to derive the user role. This authentication process uses a previously configured certificate name and serial number to derive the user role. This method does not use and external authentication server.
  - Authentication server — Uses an external authentication server to derive the management role. This is helpful if there is a large number of users who need to be deployed as guest provisioning users.

You can use the WebUI or CLI to create a Guest Provisioning user.

In the WebUI

This section describes how to configure a guest provisioning user. All three methods are described.

Username and Password Authentication Method

1. Navigate to the Configuration > Management > Administration page.
2. In the Management Users section, click Add.
3. In the Add User page select Conventional User Accounts.
4. In the User Name field, enter the name of the user who you want to configure as a guest provisioning user.
5. In the Password and Confirm Password fields, enter the user's password and reconfirm it.
6. From the Role drop-down menu, select guest-provisioning.
7. Click Apply.

Static Authentication Method

NOTE: Before using this method, make sure that the correct CA certificate is uploaded to the controller.

1. Navigate to the Configuration > Management > Administration page.
2. In the Management Users section, click Add.
3. In the Add User page, select Certificate Management.
4. Make sure that the Use external authentication server to authenticate check box is unchecked.
5. In the Username field, enter the name of the user who you want to configure as a guest provisioning user.
6. In the Role field, select guest-provisioning from the drop-down list.
7. Enter client certificate serial number in the Client Certificate Serial No. field.
8. Select the CA certificate you want to use from the Trusted CA Certificate Name drop-down menu.
9. Click Apply.

Smart Card Authentication Method

1. Navigate to the Configuration > Management > General page.
2. In the WebUI Management Authentication Method section, select Client Certificate.
3. Click Apply.
4. Navigate to the Configuration > Management > Administration page.
5. In the Management Authentication Servers section, select guest-provisioning from the Default Role drop-down menu.
6. Select the Mode checkbox.
7. Select the server group from the Server Group drop-down menu.
8. Click Apply.
9. In the Management Users section, click Add to display the Configuration > Management > Add User page.
10. Select Certificate Management, WebUI Certificate and Use external authentication server to authenticate.
11. Select the trusted CA certificate you want to use from the Trusted CA Certificated Name drop-down menu.
12. Click Apply and Save Configuration.

In the CLI

Username and Password Method

This example creates a user named Paula and assigns her the role of guest provisioning.

```
(host) (config)# mgmt-user Paula guest-provisioning
```

Static Authentication Method

This example uses the CA certificate mycertificate with the serial number 1234 to authenticate user Laura in the guest provisioning role.

```
(host) (config)# mgmt-user webui-cacert mycertificate serial 1234 Laura guest-provisioning
```

Smart Card Authentication Method

This example shows that using previously configured certificate (1234), authentication and authorization are automatically configured using an authentication server.

```
(host) (config) #web-server mgmt-auth username/password certificate
(host) (config)#mgmt-user webui-cacert <certificate_name>
(host) (config) #aaa authentication mgmt
(host) (config) # server-group "internal"
(host) (config) #mgmt-user webui-cacert default
(host) (config) #mgmt-user webui-cacert 1234
```

Customizing the Guest Access Pass

In the WebUI, you can customize the pop-up window that displays the guest account information. You may want to do this before the Guest Provisioning user creates guest accounts.

1. Navigate to the Configuration > Security > Access Control > Guest Access page.
2. Click Browse to insert a logo or other banner information on the window.

NOTE: Dell recommends using a logo or banner image that is 600 x 100 pixels (width x height). The WebUI does not apply the size restrictions when you upload an image file, but the image is resized to 600 x 100 pixels when it displays or is printed.

3. You can enter text for the Terms and Conditions portion of the window.
4. Click Submit to save your changes. Click Preview Pass to preview the window. (See Figure 122.)

Figure 122 *Customized Guest Account Information Window*

Creating Guest Accounts

After the Guest Provisioning user is created, that person can log in to the controller using the preconfigured username and password. The Guest Provisioning page displays. (See Figure 124.) This is a sample page as the fields may differ based on how the network administrator designed the page.

NOTE: Starting with ArubaOS 3.4 release, a guest user account that is created by a guest provisioning user can only be viewed, modified or deleted by the guest provisioning user who created the account or the network administrator. A guest user account that is created by the network administrator can only be viewed, modified or deleted by the network administrator.

Figure 123 *Creating a Guest Account—Guest Provisioning Page*

NOTE: If you do not want multiple guest users to share the same guest account concurrently, navigate to the Captive Portal Authentication and select the “Allow only one active user session” option. If a guest user authenticates successfully but the controller detects there is already a guest session with the same guest username, the second login is rejected.

Guest Provisioning User Tasks

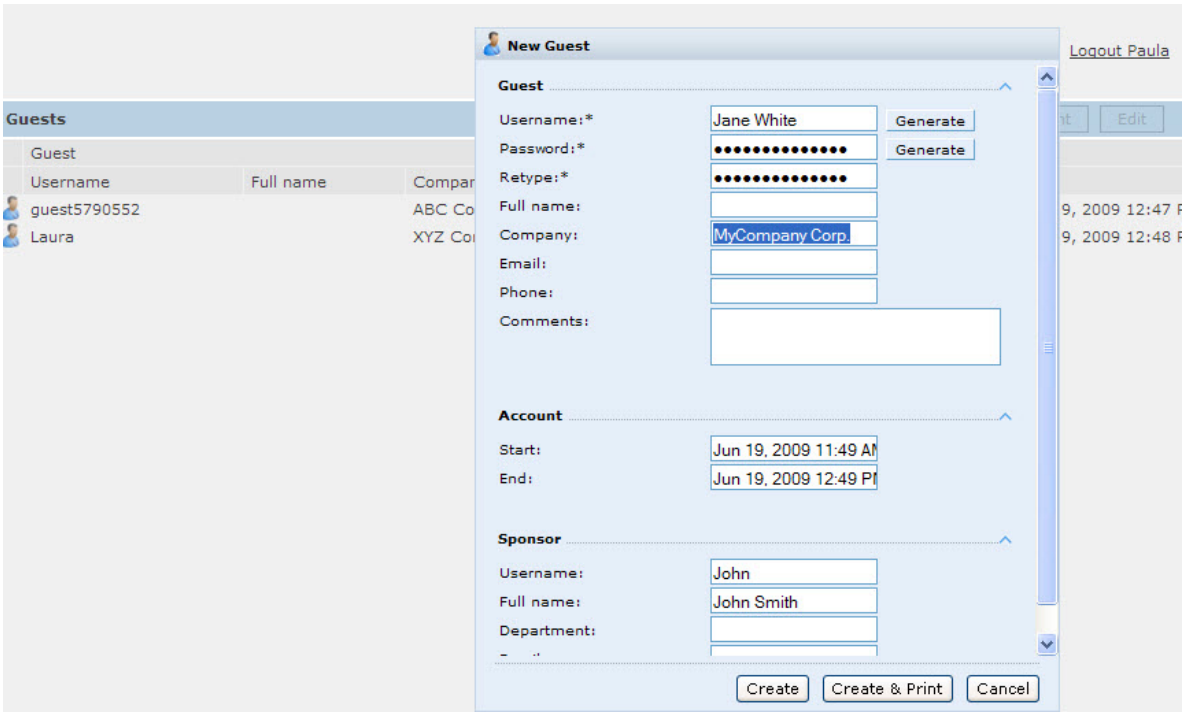
The Guest Provisioning user creates guest accounts by filling in information on the Guest Provisioning page. Tasks include creating, editing, manually sending email, enabling, printing, disabling and deleting guest accounts. The Guest Provisioning user can also manually send emails to either the guest or sponsor.

To create a new guest account, the Guest Provisioning user clicks New to display the New Guest window. (See Figure 124.) After filling in information into the fields, click Create. The guest account now displays on the Guest Provisioning page.

If you manually configure the user name and password, note the following:

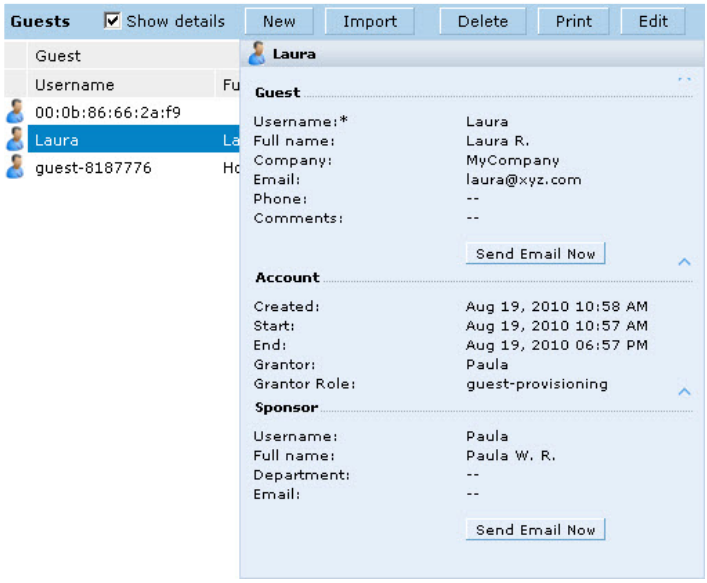
- User name entries support alphanumeric characters, however the percent sign (%) and trailing the back slash are not allowed.
- Passwords must have a minimum of six characters. You can use special characters for the password.
- Click on the Account Start and End fields to change the account start and end times. The default account start to end time setting is eight hours.

Figure 124 *Creating a Guest Account—New Guest Window*



To see details about an existing user account, highlight an existing account and select the Show Details checkbox. The Show Details popup-window displays. (See Figure 125.) The Guest Provisioning user can send out Email from this window to either the guest or the sponsor. When you send an email from the Details pop-up window, a pop-up message confirming that the email was successfully processed displays.

Figure 125 *Creating a Guest Account—Show Details Pop-up Window*



Importing Multiple Guest Entries

The Guest Provisioning user can manually create individual guest entries, as previously described, or import multiple guest entries into the database from a CSV file. This is useful and more efficient if you want to enter multiple guest entries at once. To import multiple guest entries, you need to:

1. Create a CSV file that contains the guest entries
2. Import the CSV file into the database

Creating Multiple Guest Entries in a CSV File

Create a CSV file that contains multiple guest entries. Each field in an entry needs to be separated by a comma and each entry needs to end with a carriage return. The order of the fields is:

- Guest's first name (required)
- Guest's last name (required)
- Guest's email address (optional)
- Guest's phone number (optional)
- Guest's user ID (optional)
- Guest's password (optional)
- Sponsor's first name (optional)
- Sponsor's last name (optional)
- Sponsor's email address (optional)

See Figure 126 for an example of how guest entries need to be formatted in a CSV file.

Figure 126 *CVS File Format—Guest Entries Information*

```
Gene,Phineas,gphineas@arubanetworks.com,(415)555-1212,guest-
gwang,abcdefg,Jane,Smith,jsmith@arubanetworks.com¶
Caulfield,Holden¶
John,Galt,,,guestlll0¶
```

Note the following limitations when creating guest entries in a CVS file:

- None of the field values can have a comma

- There is no format checking on field. Only the local-userdb-guest CLI command will validate proper format.
- Any extra columns, beyond the 9th column, are discarded.
- The WebUI only supports characters that the CLI supports.
- If a guest's user ID is not provided, then it is automatically generated based on the numeric suffix in the Import Guest List window. See Figure 127.
- We recommend a maximum of 250 entries per CSV file.

Importing the CSV File into the Database

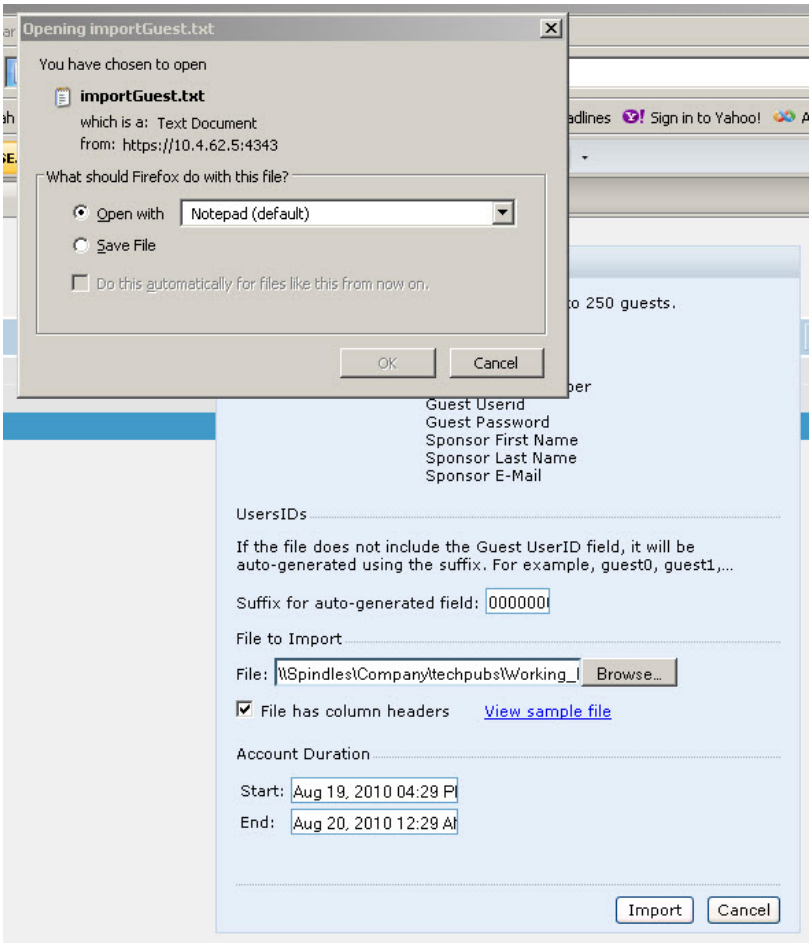
To import a CSV file that contains multiple guest entries, the Guest Provisioning user must follow these steps:

1. Log in to the WebUI using the username and password assigned to the Guest Provisioning user.
2. Click on Import. The Import Guest List pop-up window displays. See Figure 127.

Figure 127 *Importing a CSV file that contains Guest Entries*

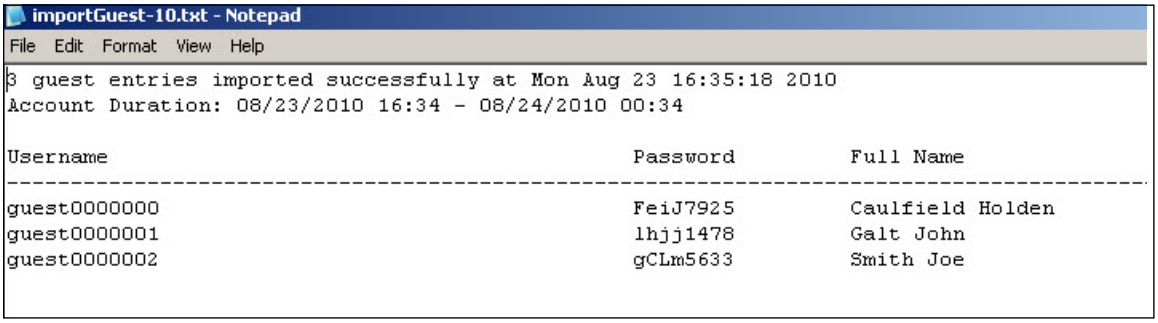
3. Click Browse to locate for the CSV file you want to import.
4. Click Import. A window displays that lets you open CSV file in text format. (See Figure 128.) Open the text file to see a summary of the number of users and error messages if users are not imported.

Figure 128 *Displaying the Guest Entries Log File*



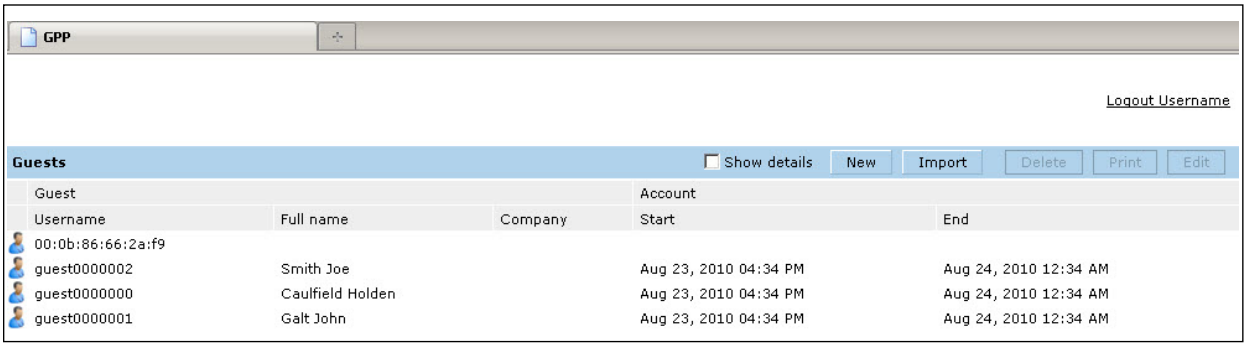
5. Click Import. A window displays that lets you open CSV file in text format. (See Figure 128.)
6. Open the text file. (See Figure 129.) Note that because no user ID is entered in the CSV file, a guest ID (username) is automatically generated based on the default value in the Suffix for auto-generated field. Make changes or corrections to the guest entry information in text file. A user can also change the start time and end time from this window. Save and exit the file.

Figure 129 *Viewing and Editing Guest Entries in the Log File*



7. Click Cancel to close the Import Guest List window. Guest entries are now displayed in the Guest Provisioning page.

Figure 130 *Viewing Multiple Imported Guest Entries—Guest Provisioning Page*

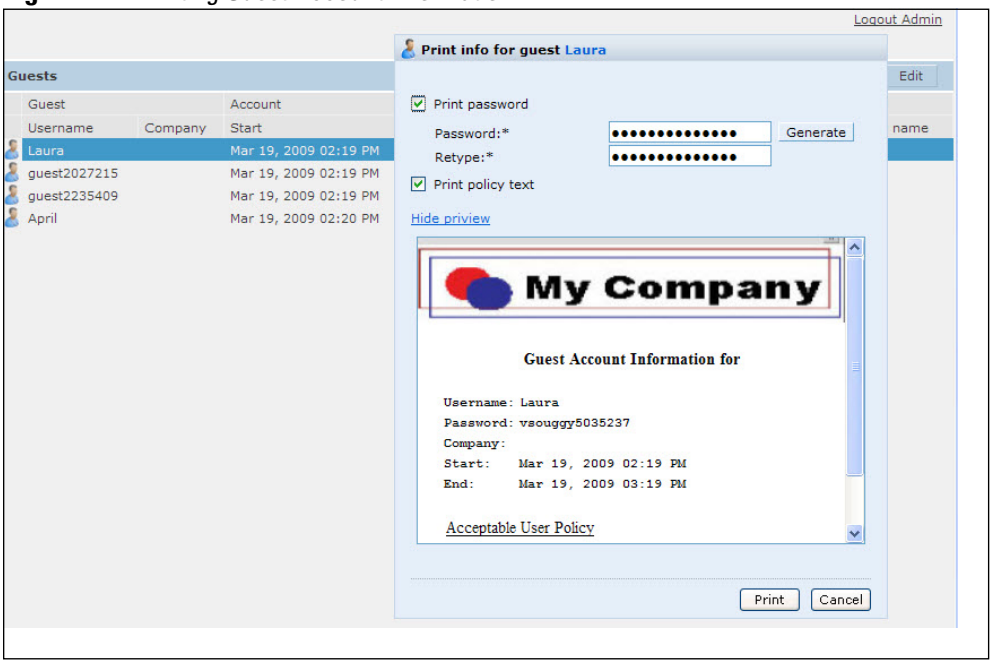


Printing Guest Account Information

To print guest account information:

1. Highlight the guest account you want to print and click Print. The Print info for guest window displays.
2. Click Print password if you want to print the guest password on the badge. Then enter or generate a new password for the guest. This modifies the existing guest password. (See Figure 131.)
3. Optionally, click Print policy text if you want your company policy text to appear on the print out.
4. Click Show preview to view the information before it is printed.
5. Click Print to print the guest account information.

Figure 131 *Printing Guest Account Information*



Optional Configurations

This section describes guest provisioning options that the administrator can configure.

NOTE: These options are not configurable by the guest provisioning user.

Restricting one Captive Portal Session for each Guest

You can restrict one captive portal session for each guest. When a new captive portal request is received and passes authentication, all users are checked and compared with user names. If a user with the same name already exists and this option is enabled, the second login is denied.

NOTE: If a guest logs in from one system (and does not log out) and tries to log in again from another system, that guest has to wait for the initial session to expire.

1. Navigate to the Configuration > Advanced Services> All s page.
2. Select Wireless Lan.
3. Under Wireless Lan, select and open Captive Portal Authentication.
4. Add a new or select and existing
5. Select the Allow only one active user session check box.
6. Click Apply.

Using the CLI to restrict one Captive Portal session for each guest

```
(host)(config)# aaa authentication captive-portal <> single-session
```

Setting the Maximum Time for Guest Accounts

You can set the maximum expiration time (in minutes) for guest accounts. If the guest-provisioning user attempt to add a guest account that expires beyond this time period, an error message is displayed and the guest account is created with the maximum time you configured.

NOTE: If you set the maximum expiration time, it applies to all users in the internal database whether they are guests or not.

Using the WebUI to set the maximum time for guest accounts

1. Navigate to the Configuration > Security > Authentication page.
2. Select Internal DB.
3. Under Internal DB Maintenance, enter a value in Maximum Expiration.
4. Click Apply.

Using the CLI to set the maximum time for guest accounts

```
(host)# local-userdb maximum-expiration <minutes>
```

Managing Files on the Controller

You can transfer the following types of files between the controller and an external server or host:

- ArubaOS image file
- A specified file in the controller's flash file system, or a compressed archive file that contains the entire content of the flash file system

NOTE: You back up the entire content of the flash file system to a compressed archive file, which you can then copy from the flash system to another destination.

- Configuration file, either the active running configuration or a startup configuration
- Log files

You can use the following protocols to copy files to or from a controller:

- File Transfer Protocol (FTP): Standard TCP/IP protocol for exchanging files between computers.
- Trivial File Transfer Protocol (TFTP): Software protocol that does not require user authentication and is simpler to implement and use than FTP.
- Secure Copy (SCP): Protocol for secure transfer of files between computers that relies on the underlying Secure Shell (SSH) protocol to provide authentication and security.

NOTE: You can use SCP only for transferring image files to or from the controller, or transferring files between the flash file system on the controller and a remote host. The SCP server or remote host must support SSH version 2 protocol.

Table 123 lists the parameters that you configure to copy files to or from a controller.

Table 123 *File Transfer Configuration Parameters*

Server Type	Configuration
Trivial File Transfer Protocol (TFTP)	• IP address of the server • filename
File Transfer Protocol (FTP)	• IP address of the server • username and password to log into server • filename
Secure Copy (SCP) You must use the CLI to transfer files with SCP.	• IP address of the server or remote host • username to log into server • absolute path of filename (otherwise, SCP searches for the file relative to the user's home directory)

For example, you can copy an ArubaOS image file from an SCP server to a system partition on a controller or copy the startup configuration on a controller to a file on a TFTP server, You can also store the contents of a controller's flash file system to an archive file which you can then copy to an FTP server. You can use SCP to securely download system image files from a remote host to the controller or securely transfer a configuration file from flash to a remote host.

Transferring ArubaOS Image Files

You can download an ArubaOS image file onto a controller from a TFTP, FTP, or SCP server. In addition, the WebUI allows you to upload an ArubaOS image file from the local PC on which you are running the browser.

When you transfer an ArubaOS image file to a controller, you must specify the system partition to which the file is copied. The WebUI shows the current content of the system partitions on the controller. You have the option of rebooting the controller with the transferred image file.

In the WebUI

1. Navigate to the Maintenance > Controller > Image Management page.
2. Select TFTP, FTP, SCP, or Upload Local File.
3. Enter or select the appropriate values for the file transfer method.
4. Select the system partition to which the image file is copied.
5. Specify whether the controller is to be rebooted after the image file is transferred, and whether the current configuration is saved before the controller is rebooted.
6. Click Upgrade.

In the CLI

```
copy tftp: <tftphost> <filename> system: partition [0|1]}
copy ftp: <ftphost> <user> <filename> system: partition {0|1}
copy scp: <scphost> <username> <filename> system: partition [0|1]
```

Backing Up and Restoring the Flash File System

You can store the entire content of the flash file system on a controller to a compressed archive file. You can then copy the archive file to an external server for backup purposes. If necessary, you can restore the backup file from the server to the flash file system.

Backup the Flash File System in the WebUI

1. Navigate to the Maintenance > File > Backup Flash page.
2. Click Create Backup to back up the contents of the flash system to the flashbackup.tar.gz file.
3. Click Copy Backup to enter the Copy Files page where you can select the destination server for the file.
4. Click Apply.

Backup the Flash File Systemin the CLI

```
backup flash
copy flash: flashbackup.tar.gz tftp: <tftphost> <destfilename>
copy flash: flashbackup.tar.gz scp: <scphost> <username> <destfilename>
```

Restore the Flash File System in the WebUI

1. Navigate to the Maintenance > File > Copy Files page.
   a. For Source Selection, specify the server to which the flashbackup.tar.gz file was previously copied.
   b. For Destination Selection, select Flash File System.
   c. Click Apply.
2. Navigate to the Maintenance > File > Restore Flash page.
3. Click Restore to restore the flashbackup.tar.gz file to the flash file system.
4. Navigate to the Maintenance > Switch > Reboot Switch page.
5. Click Continue to reboot the controller.

Restore the Flash File System Using CLI

```
copy tftp: <tftphost> <srcfilename> flash: flashbackup.tar.gz
copy scp: <scphost> <username> <srcfilename> flash: flashbackup.tar.gz
restore flash
```

Copying Log Files

You can store log files into a compressed archive file which you can then copy to an external TFTP or SCP server. The WebUI allows you to copy the log files to a WinZip folder which you can display or save on your local PC.

In the WebUI

1. Navigate to the Maintenance > File > Copy Logs page.
2. For Destination, specify the TFTP or FTP server to which log files are copied.
3. Select Download Logs to download the log files into a WinZip file on your local PC,
4. Click Apply.

In the CLI

```
tar logs
```

```
copy flash: logs.tar tftp: <tftphost> <destfilename>
copy flash: logs.tar scp: <scphost> <username> <destfilename>
```

Copying Other Files

The flash file system contains the following configuration files:

- startup-config: Contains the configuration options that are used the next time the controller is rebooted. It contains all options saved by clicking the Save Configuration button in the WebUI or by entering the write memory CLI command. You can copy this file to a different file in the flash file system or to a TFTP server.
- running-config: Contains the current configuration, including changes which have yet to be saved. You can copy this file to a different file in the flash file system, to the startup-config file, or to a TFTP or FTP server.

You can copy a file in the flash file system or a configuration file between the controller and an external server.

In the WebUI

1. Navigate to the Maintenance > File > Copy Files page.
2. Select the source where the file or image exists.
3. Select the destination to where the file or image is to be copied.
4. Click Apply.

In the CLI

```
copy startup-config flash: <filename>
copy startup-config tftp: <tftphost> <filename>

copy running-config flash: <filename>
copy running-config ftp: <ftphost> <user> <password> <filename> [<remote-dir>]
copy running-config startup-config
copy running-config tftp: <tftphost> <filename>
```

Setting the System Clock

You can set the clock on a controller manually or by configuring the controller to use a Network Time Protocol (NTP) server to synchronize its system clock with a central time source.

Manually Setting the Clock

You can use either the WebUI or CLI to manually set the time on the controller's clock.

In the WebUI

1. Navigate to the Configuration > Management > Clock page.
2. Under Controller Date/Time, set the date and time for the clock.
3. Under Time Zone, enter the name of the time zone and the offset from Greenwich Mean Time (GMT).
4. To adjust the clock for daylight savings time, click Enabled under Summer Time. Additional fields appear that allow you to set the offset from UTC, and the start and end recurrences.
5. Click Apply.

In the CLI

To set the date and time, enter the following command in privileged mode:

```
clock set <year> <month> <date> <hour> <minutes> <seconds>
```

To set the time zone and daylight savings time adjustment, enter the following commands in configure mode:

```
clock timezone <WORD> <-23 - 23>
```

```
clock summer-time <zone> [recurring]
   <1-4> <start day> <start month> <hh:mm>
   first <start day> <start month> <hh:mm>
   last <start day> <start month> <hh:mm>
   <1-4> <end day> <end month> <hh:mm>
   first <end day> <end month> <hh:mm>
   last <end day> <end month> <hh:mm>
   [<-23 - 23>]
```

Clock Synchronization

You can use NTP to synchronize the controller to a central time source. Configure the controller to set its system clock using NTP by configuring one or more NTP servers.

For each NTP server, you can optionally specify the NTP iburst mode for faster clock synchronization. The iburst mode sends up ten queries within the first minute to the NTP server. (When iburst mode is not enabled, only one query is sent within the first minute to the NTP server.) After the first minute, the iburst mode typically synchronizes the clock so that queries need to be sent at intervals of 64 seconds or more.

NOTE: The iburst mode is a configurable option and not the default behavior for the controller, as this option is considered "aggressive" by some public NTP servers. If an NTP server is unresponsive, the iburst mode continues to send frequent queries until the server responds and time synchronization starts.

In the WebUI

1. Navigate to the Configuration > Management > Clock page.
2. Under NTP Servers, click Add.
3. Enter the IP address of the NTP server.
4. Select (check) the iburst mode, if desired.
5. Click Add.

In the CLI

```
ntp server ipaddr [iburst]
```

Configuring NTP Authentication

The Network Time Protocol adds security to an NTP client by authenticating the server before synchronizing the local clock. NTP authentication works by using a symmetric key which is configured by the user. The secret key is shared by both the Dell controller and an external NTP server. This helps identify secure servers from fraudulent servers.

In the WebUI

1. Navigate to the Configuration > Management > Clock page.
2. Under NTP Authentication, make sure Enable is selected. Enable is the default.
3. Under NTP Servers, enter the NTP server IP address in the NTP Server Address field.
4. Under NTP Identification Keys, enter an identification key in the Identification Key field. Then add a secret string in the Md5 Secret field. The secret string must be numeric characters between 1 to 65535.
5. Click Add.
6. The identification key along with its corresponding Md5 secret string display in the NTP Identification Keys section.

7. Under NTP Trusted Keys, enter a string in the Trusted Key field. This is a subset of key which are trusted. The trusted key value must be numeric characters between 1 to 65535.
8. Click Apply.

In the CLI

This example enables NTP authentication, add authentication secret keys into the database, and specifies a subset of keys which are trusted. It also enables the iburst option.

```
(host) (config) #ntp authenticate
(host) (config) #ntp authentication-key <key-id> md5 <key-secret>
(host) (config) #ntp trusted-key <key-id>
(host) (config) #ntp <server IP> iburst key <key-id>
```

Chapter 33

Spectrum Analysis

Wireless networks operate in environments with electrical and radio frequency devices that can interfere with network communications. Microwave ovens, cordless phones, and even adjacent Wi-Fi networks are all potential sources of continuous or intermittent interference. The spectrum analysis software modules on APs that support this feature are able to examine the radio frequency (RF) environment in which the Wi-Fi network is operating, identify interference and classify its sources. An analysis of the results can then be used to quickly isolate issues with packet transmission, channel quality, and traffic congestion caused by contention with other devices operating in the same band or channel.

AP radios that gather spectrum data but do not service clients are called spectrum monitors, or *SMs*. Each SM will scan and analyze the spectrum band used by the SM's radio (2.4Ghz or 5Ghz). An AP radio in *hybrid AP* mode will continue to serve clients as an access point while it analyzes spectrum analysis data for the channel the radio uses to serve clients. You can record data for both types of spectrum analysis devices, save that data, and then play it back for later analysis.

This chapter describes the following topics:

Overview

The table below lists the AP models that support the spectrum analysis feature. Note that only radios on the W-AP130 Series and can be configured as hybrid APs.

Table 124 *Device support for spectrum analysis*

Device	Configurable as a Spectrum Monitor?	Configurable as a Hybrid AP?
W-AP105	Yes	No
W-AP92	Yes	No
W-AP93	Yes	No
W-AP120 Series	Yes	No
W-AP130 Series	Yes	Yes
W-AP175	Yes	No

The radios on groups of APs can be converted to dedicated spectrum monitors or hybrid APs via the AP group's dot11a and dot11g radio profiles. Individual APs can also be converted to spectrum monitors through the AP's spectrum override profile.

The radios on groups of APs can be converted to dedicated spectrum monitors or hybrid APs via the AP group's dot11a and dot11g radio profiles. Individual APs can also be converted to spectrum monitors through the AP's spectrum override profile.

NOTE: The spectrum analysis feature requires the RF Protect license. In order to convert an AP to a spectrum monitor or hybrid AP, you must have an AP license *and* an RF protect license for each AP on that controller.

The Spectrum Analysis section of the WebUI includes the Spectrum Monitors, Spectrum Session Log, and Spectrum Dashboards windows.

- Spectrum Monitors: A spectrum analysis client is any laptop or desktop computer that can access the controller WebUI and receive streaming data from individual spectrum monitors or APs in hybrid mode. The Spectrum Monitors window displays a list of active spectrum monitors and hybrid APs streaming data to your client, the radio band the device is monitoring, and the date and time the SM or hybrid AP was connected to your spectrum analysis client. This window allows you to select the spectrum monitors or hybrid APs for which you want to view information, and release the connection between your client and any device you no longer want to view.
- Spectrum Session Log: This tab displays activity for spectrum monitors and hybrid APs during the current browser session, including timestamps showing when the devices were connected to and disconnected from the client, and any changes to a hybrid APs monitored channel.
- Spectrum Dashboards: The Spectrum Dashboards window shows different user-customizable data charts for 2.4Ghz and 5 GHz spectrum monitor or hybrid AP radios. Table 125 below gives a basic description of each of the spectrum analysis graphs that can appear on the spectrum dashboard.

NOTE: For more detailed information on these graphs, see "Customizing Spectrum Analysis Graphs" on page 621

Table 125 *Spectrum Analysis Graphs*

Graph Title	Description
Active Devices	A pie chart showing the percentages and total numbers of each device type for all active devices.
Active Devices Table	This table lets you view and sort for details on each device detected on the spectrum monitor's radio band, including the device's BSSID, SSID, the channels affected by that device, and its occupied bandwidth. The active devices table for a hybrid AP only shows active device details for devices using the hybrid AP's monitored channel.
Active Devices Trend	A line chart showing the numbers of up to five different types of Wi-Fi and non-Wi-Fi devices seen on selected channels during a specified time interval. This chart can show devices on multiple channels for a spectrum monitor, or the single monitored channel for a hybrid AP.
Channel Metrics	This stacked bar chart shows the current relative quality, availability or utilization of selected channels in the 2.4 GHz or 5 GHz radio bands. This chart can show multiple channels for a spectrum monitor, or the single monitored channel for a hybrid AP.
Channel Metrics Trend	A line chart showing the relative quality of selected channels in the 2.4 GHz or 5 GHz radio bands over a specified time interval. Spectrum monitors can show channel data for multiple channels, while a hybrid AP will show information only for its one monitored channel.
Channel Summary Table	The Channel Summary table displays the number of devices found on each channel in the spectrum monitor's radio band, the percentage of channel utilization, and AP power and interference levels. Spectrum monitors can show data for multiple channels, while a hybrid AP will show a channel summary only for its one monitored channel.

Table 125 *Spectrum Analysis Graphs (Continued)*

Graph Title	Description
Channel Utilization Trend	A line chart that shows the channel utilization for one or more radio channels, as measured over a defined time interval. Spectrum monitors can show data for multiple channels, while a hybrid AP will show utilization levels for its one monitored channel only.
Device Duty Cycle	A stacked bar chart showing the percent of each channel in the spectrum monitor radio's frequency band utilized by a Wi-Fi AP or any other device type detected by the spectrum monitor. The Device Duty Cycle chart for a hybrid AP will only show data for the one channel monitored by the hybrid AP. This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.
Devices vs Channel	A stacked bar chart showing the total numbers of each device type detected on each channel in the spectrum monitor radio's frequency band. The Devices vs Channel chart for a hybrid AP will only show data for the one channel monitored by the hybrid AP.
FFT Duty Cycle	Fast Fourier Transform, or FFT, is an algorithm for computing the frequency spectrum of a time-varying input signal. This line chart shows the FFT duty cycle, which represents the percent of time a signal is broadcast on the specified channel or frequency. Spectrum monitors can show data for multiple channels, while a hybrid AP will show information only for its one monitored channel. This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.
Interference Power	This chart shows information about Wi-Fi interference, including the Wi-Fi noise floor, and the amount of adjacent channel interference from cordless phones, bluetooth devices and microwaves. Spectrum monitors can show interference power data for multiple channels, while a hybrid AP will show information only for its one monitored channel.
Quality Spectrogram	This plot shows quality statistics for selected range of channels or frequencies as determined by the current noise floor, non-Wi-Fi (interferer) utilization and duty-cycles and certain types of retries. This chart can also be configured to show channel availability, the percentage of each channel that is unused and available for additional traffic. Spectrum monitors can show data for multiple channels, while a hybrid AP will show information only for its one monitored channel.
Real-Time FFT	Fast Fourier Transform, or FFT, is an algorithm for computing the frequency spectrum of a time-varying input signal. This line chart shows the power level of a signal on the channels or frequencies monitored by a spectrum monitor radio. Spectrum monitors can show data for multiple channels, while a hybrid AP will show information only for its one monitored channel. This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.
Swept Spectrogram	This plot displays FFT power levels or the FFT duty cycle for a selected channel or frequency, as measured during each time tick. Spectrum monitors can show data for multiple channels, while a hybrid AP will show information only for its one monitored channel. This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.

Spectrum Analysis Clients

The maximum number of spectrum monitor radios and hybrid AP radios on a controller is limited only by the number of APs on that controller. If desired, you can configure every radio on an AP that supports the Spectrum Analysis feature as a spectrum device. A dual-radio AP can operate as two spectrum devices, since each radio can be individually configured as a spectrum monitor (SM) or hybrid AP.

A spectrum analysis client can simultaneously access data from up to four individual spectrum device radios. Each spectrum device radio, however, can only be connected to a single client WebUI.

When you select a specific spectrum monitor or hybrid AP radio to stream data to your client, the controller first checks the availability the device, to verify that it is not subscribed to some other client. Once the SM or hybrid AP radio has been verified as available, the SM or hybrid AP establishes a connection to the client and begins sending spectrum analysis data either every second or every five seconds, depending on the type of data being

requested. Each client may select up to eight different spectrum analysis charts and graphs to appear in the spectrum dashboard.

A controller can support up to 22 active WebUI connections. If spectrum analysis clients are simultaneously viewing WebUI data for than 22 spectrum analysis devices, any additional WebUI requests will be refused until some clients close their WebUI browser sessions.

When you finish reviewing data from an SM or hybrid AP, you should disconnect the device from your spectrum client. Do not forget this important step—no other user will be able to access data from that spectrum monitor or hybrid AP until you release your subscription. Note, however, that when you disconnect a spectrum monitor from your client, the AP will continue to operate as a spectrum monitor until you return it to AP mode by removing the local spectrum override, or by changing the mode parameter in the AP's 802.11a or 802.11g radio profile from spectrum-mode back to AP-mode.

NOTE: A spectrum monitor or hybrid AP automatically disconnects from a client when you close the browser window you used to connect the spectrum monitor to your client. However, if you are using Internet Explorer and have multiple instances of an Internet Explorer browser open, the data-streaming connection to the spectrum monitor or hybrid AP will not be released until 60 seconds after you close the spectrum client browser window. During this 60-second period, the user will see the spectrum monitor is still being connected to the client.

When a spectrum monitor or hybrid AP is not subscribed to any client, it will still perform all classification tasks and collect all necessary channel lists and device information. You can view classification, device and channel information for any active spectrum monitor or hybrid AP via the controller's command-line interface, regardless of whether or not that device is sending real-time spectrum data to another client WebUI.

Individual spectrum analysis graphs and charts are explained in detail in "Customizing Spectrum Analysis Graphs" on page 621.

Hybrid AP Channel Changes

By default, a hybrid AP only monitors the channel specified in its 802.11a or 802.11g radio profile for spectrum interference. If you want to change the channel monitored by a hybrid AP, you must edit the channel setting in those profiles. There are, however, other ArubaOS features that may automatically change the channels on hybrid APs. APs using Dynamic Frequency Selection (DFS) perform off-channel scanning to detect the presence of satellite and radar transmissions, and switch to a different channel if it detects that satellite or radar transmissions are present. APs using the Adaptive Radio Response (ARM) feature constantly monitor the network and automatically select the best channel and transmission power settings for that AP. If you manually change a channel monitored by a hybrid AP, best practices are to temporarily disable the ARM feature, as ARM may automatically return the channel to its previous setting.

If a hybrid AP is using ARM or DFS, that hybrid AP may automatically move to a different channel in response to changes in the network environment. If a hybrid AP changes channels while it is connected to a spectrum analysis client, the hybrid AP will update the graphs in the spectrum dashboard to start displaying spectrum data for the new channel, and will send a log message to the a spectrum analysis log. For details on changing the channel monitored by a hybrid AP, see "802.11a/802.11g RF Management Configuration Parameters" on page 233.

Hybrid APs Using Mode-Aware ARM

If a radio is configured as a hybrid AP and that AP is enabled with mode-aware ARM, the hybrid AP can change to an Air Monitor (or *AM*) if too many APs are detected in the area. If the ARM feature changes a hybrid AP to an Air Monitor, that AM will not provide spectrum data after the mode change. The AM will unsubscribe from any connected spectrum analysis client, send a log message warning about the change. If mode-aware ARM changes the AM back to an AP, the hybrid AP will not automatically resubscribe back to the spectrum analysis client. The hybrid AP must manually resubscribed before it can appear in the client's spectrum monitors page.

Creating Spectrum Monitors and Hybrid APs

Each controller can support up to 22 active WebUI connections to spectrum monitor or hybrid AP radios. If you plan on using spectrum monitors or hybrid APs as a permanent overlay to constantly monitor your network, you should create a separate AP group for these devices. If you plan on temporarily converting campus APs to spectrum monitors, best practices are to use the spectrum local override profile to convert an AP to a spectrum monitor.

This section describes the following tasks for converting regular APs into hybrid APs or spectrum monitors.

Converting APs to Hybrid APs

You can convert a group of regular APs into a hybrid APs by selecting the spectrum monitor option in the AP group's 802.11a and 802.11g radio profiles. Once you have enabled the spectrum monitor option, all APs in the group that support the spectrum monitoring feature will function as hybrid APs. If any AP in the group does *not* support the spectrum monitoring feature, that AP will continue to function as a standard AP, rather than a hybrid AP.

NOTE: The spectrum monitor option in the 802.11a and 802.11g radio profiles only affects APs in ap-mode. Devices in am-mode (Air Monitors) or sm-mode (Spectrum Monitors) will not be affected by enabling or disabling this option.

If you want to convert a individual AP (and not an entire AP group) to a hybrid AP, you must create a new 802.11a or 802.11g radio profile, enable the spectrum monitor option, then reassign that AP to the new profile. For additional information see "RF Management (802.11a and 802.11g) Profiles" on page 232 for details on how to create a new 802.11a/g radio profile, then assign an individual AP to that profile.

NOTE: If the spectrum local-override profile on the controller that terminates the AP contains an entry for a hybrid AP radio, that entry will override the mode selection in the 802.11a or 802.11g radio profile, and the AP will operate as a spectrum monitor, *not* as a hybrid AP. You must remove any spectrum local override for an AP to allow the device to operate as a hybrid AP. For further details on editing a spectrum local override, see "Converting an Individual AP to a Spectrum Monitor" on page 612

In the WebUI

Follow the procedure below to convert a group of APs to hybrid mode via the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select the AP Group tab.
2. Click the Edit button by the name of the AP group you want to convert to hybrid APs.
3. Under the Profiles list, expand the RF Management menu.
4. To enable a spectrum monitor on the 802.11a radio band, select the 802.11a radio profile menu.

   -or-

   To enable a spectrum monitor on the 802.11g radio band, select the 802.11g radio profile menu.
5. The Profile Details pane appears. Select the Spectrum Monitor checkbox.
6. Click Apply to save your settings.
7. You must now configure the spectrum profile for your AP group. For details, see "Configuring the Spectrum Profile" on page 613.

In the CLI

To convert a group of APs via the command-line interface, access the CLI in config mode and issue the following commands, where <profile> is the name of the 802.11a or 802.11g radio profile used by the group of APs you want to convert to hybrid APs.

```
rf dot11a-radio-profile <profile> spectrum-monitoring
rf dot11g-radio-profile <profile> spectrum-monitoring
```

Converting an Individual AP to a Spectrum Monitor

There are two ways to change a radio on an individual AP or AM into a spectrum monitor. You can assign that AP to a different 802.11a and 802.11g radio profile that is already set to spectrum mode, or you can temporarily change the AP into a spectrum monitor using a local spectrum override profile. When you use a local spectrum override profile to override an AP's mode setting, that AP will begin to operate as a spectrum monitor, but will remain associated with its previous 802.11a and 802.11g radio profiles. If you change any parameter (other than the overridden *mode* parameter) in the spectrum monitor's 802.11a or 802.11 radio profiles, the spectrum monitor will immediately update with the change. When you remove the local spectrum override, the spectrum monitor will revert back to its previous mode, and remain assigned to the same 802.11a and 802.11 radio profiles as before.

The spectrum local override profile overrides the mode parameter in the 802.11a or 802.11g radio profile, changing it from ap-mode or am-mode to spectrum-mode while allowing the spectrum monitor to continue to inherit all other settings from its 802.11a/802.11g radio profiles. When the spectrum local override is removed, the AP automatically reverts to its previous mode as defined it its 802.11a or 802.11g radio profile settings. If you use the local override profile to change an AP radio to a spectrum monitor, you must do so by accessing the WebUI or CLI of the controller that terminates the AP. This is usually a local controller, and not a master controller.

When you convert an AP to a spectrum monitor using the spectrum local override profile, the spectrum local override profile can allow a 802.11a or (dual-band) 802.11a/g AP to monitor a different part of the spectrum than currently specified by that radio's spectrum profile. For additional information about spectrum profile parameters, see "Configuring the Spectrum Profile" on page 613.

In the WebUI

To convert an individual AP using the local spectrum override profile in the WebUI:

1. Select Configuration > All Profiles. The All Profile Management window opens.
2. Select AP to expand the AP profiles section.
3. Select Spectrum Local Override Profile. The Profile Details pane displays the current Override Entry settings.
4. In the AP name entry blank, enter the name of an AP whose radio you want to configure as a spectrum monitor. Note that AP names are case-sensitive.
5. If your AP has multiple radios or a single dual-band radio, click the band drop-down list and select the spectrum band you want that radio to monitor: 2-ghz, 5-ghz-lower, 5-ghz-middle or 5-ghz-upper. Click Add to add that radio to the Override Entry list.
6. (Optional) Repeat steps 4-6 to convert other AP radios to spectrum monitors, as desired. To remove a spectrum monitor from the override entry list, select that radio name in the override entry list, then click Delete.
7. Click Apply to save your changes.
8. You must now configure the spectrum profile for your AP group. For details, see "Configuring the Spectrum Profile" on page 613.

In the CLI

To convert an individual AP spectrum monitor using the spectrum local override profile in the command-line interface, access the CLI in config mode and issue the following command:

```
ap spectrum local-override override ap-name <ap-name> spectrum-band 2ghz|5ghz-
lower|5ghz-middle|5ghz-upper
```

Converting a Group of APs to Spectrum Monitors

When you convert a group of APs to spectrum monitors using their 802.11a/802.11g radio profiles, all APs in the group will stop serving clients and will act as spectrum monitors only. Therefore, before you convert an entire group of APs to spectrum monitors, be sure that none of the APs are currently serving clients, as that may temporarily interrupt service to those clients.

NOTE: If you use an 802.11a or 802.11g radio profile to create a group of spectrum monitors, all APs in any AP group referencing that radio profile will be set to spectrum mode. Therefore, best practices are to create a new 802.11a or 802.11g radio profile just for spectrum monitors using the following CLI commands:

```
ap-name <ap name> dot11a-radio-profile <profile-name>
ap-name <ap name> dot11g-radio-profile <profile-name>
```

If you want to set an existing 802.11a or 802.11g radio profile to spectrum mode, verify that no other AP group references that radio profile using the following CLI commands:

```
show references rf dot11a-radio-profile <profile-name>
show references rf dot11g-radio-profile <profile-name>
```

In the WebUI

Follow the procedure below to convert a group of APs to Spectrum mode via the WebUI.

1. Navigate to the Configuration > Wireless > AP Configuration window. Select the AP Group tab.
2. Click the Edit button by the name of the AP group you want to convert to spectrum monitors.
3. Under the Profiles list, expand the RF Management menu.
4. To enable a spectrum monitor on the 802.11a radio band, select the 802.11a radio profile menu.

   -or-

   To enable a spectrum monitor on the 802.11g radio band, select the 802.11g radio profile menu.
5. The Profile Details pane appears. Click the Mode drop-down list, and select spectrum-mode.
6. Click Apply to save your settings.

In the CLI

To convert a group of APs via the command-line interface, access the CLI in config mode and issue the commands

```
rf dot11a-radio-profile <profile> mode spectrum-mode
rf dot11g-radio-profile <profile> mode spectrum-mode
```

where <profile> is the 80211a or 80211g radio profile used by the AP group.

Configuring the Spectrum Profile

Each 802.11a and 802.11g radio profile references a spectrum profile, which identifies the spectrum band the spectrum monitor or hybrid AP will monitor and analyze, and defines the default ageout times for each monitored device type. By default, an 802.11a radio profile references a spectrum profile named default-a (which configures the 802.11a spectrum monitor to monitor the upper channels of the 5 GHz radio band), and an 802.11g radio profile references a spectrum profile named default-g (which configures the spectrum monitor to monitor all channels the 2.4 GHz radio band). If you want to configure an entire AP group to use non-default

ageout times or to monitor a different part of the radio band, you can create a new spectrum profile, and assign that new profile to the AP group's 802.11a or 802.11g radio profile.

NOTE: If you want an individual spectrum monitor to analyze a non-default frequency band, best practices are to define the frequency band using the spectrum monitor's spectrum local override profile. This allows the spectrum monitor to analyze a different frequency band without changing the spectrum profile for any other spectrum monitors in its AP group.

In the WebUI

To create a new spectrum profile:

1. Navigate to the Configuration > Wireless > AP Configuration window. Select either the AP Group or AP Specific tab.
   - If you selected AP Group, click the Edit button by the name of the AP group you want to configure.
   - If you selected AP Specific, click the Edit button by the AP you want to configure.
2. Under the Profiles list, expand the RF Management menu.
3. To create a new spectrum profile for the 802.11a radio band, expand the 802.11a radio profile menu.

   -or-

   To create a new spectrum profile for the 802.11g radio band, expand the 802.11g radio profile menu.
4. Expand the menu for the 802.11a or 802.11g radio profile whose spectrum profile you want to change.
5. In the profile list, select the Spectrum Profile assigned to the 802.11a or 802.11g radio profile. Details for that Spectrum profile appear in the Profile Details window.
6. Configure the spectrum profile options as described in Table 126.

NOTE: For additional details about non-Wi-Fi device types described in Table 126, see "Non-Wi-Fi Interferers" on page 646.

Table 126 *Spectrum Profile Parameters*

Parameter	Description
Spectrum Band	Select the spectrum band you want the radio to monitor. • 2GHz (channels 1-14) • 5GHz-lower (channels 36-64) • 5GHz-middle (channels 100-140) • 5GHz-upper (channels 149-165). This is the default setting for the 5Ghz spectrum.
Age Out: WIFI	Define the ageout time for Wi-Fi devices. The default time is 600 seconds.
Age Out: Generic Interferer	Define the ageout time for generic devices. The default time is 600 seconds.
Age Out: Microwave	Define the ageout time for microwave ovens. The default time is 15 seconds.
Age Out: Microwave (Inverter type)	Define the ageout time for inverter microwave ovens. The default time is 15 seconds.
Age Out: Video Device	Define the ageout time for video devices. The default time is 10 seconds.
Age Out: Audio Device	Define the ageout time for audio devices. The default time is 10 seconds.
Age Out: Cordless Phone Fixed Frequency	Define the ageout time for fixed frequency cordless phones. The default time is 10 seconds.
Age Out: Generic Fixed Frequency	Define the ageout time for generic fixed-frequency devices. The default time is 10 seconds.
Age Out: Bluetooth	Define the ageout time for Bluetooth devices. The default time is 25 seconds.

Table 126 *Spectrum Profile Parameters (Continued)*

Parameter	Description
Age Out: Xbox	Define the ageout time for Xbox consoles. The default time is 25 seconds.
Age Out: Cordless Network Frequency Hopper	Define the ageout time for cordless network frequency hopping devices. The default time is 25 seconds.
Age Out: Cordless Base Frequency Hopper	Define the ageout time for cordless base frequency hopping devices. The default time is 25 seconds.
Age Out: Generic Frequency Hopper	Define the ageout time for Generic Frequency Hopper devices. The default time is 25 seconds.

7. Click Apply to save the changes to the existing spectrum profile, or, to create a new spectrum profile with the updating settings, click Save As, and enter a name for the new spectrum profile, then click Apply.

In the CLI

To create new spectrum profile via the command-line interface, access the CLI in config mode and issue the following commands:

```
rf spectrum-profile <profile>
   age-out {audio <secs>}|{bluetooth <secs>}|{cordless-base-freq-hopper
   <secs>}|{cordless-network-freq-hopper <secs>}|{cordless-phone-fixed-frequency
   <secs>}|{generic-fixed-frequency <secs>}|{generic-freq-hopper <secs>|generic-
   interferer <secs>}|{microwave <secs>}|{microwave-inverter <secs>}|{video
   <secs>}|{wifi <secs>}|{xbox <secs>
   channel <channel>
   clone <profile>
   no
   spectrum-band 2ghz|5ghz-lower|5ghz-middle|5ghz-upper
```

By default, the 802.11a radio profile references the spectrum profile default-a and the 802.11g radio profile references the spectrum profile default-g. To assign a different Spectrum profile to a 802.11a or 802.11g radio profile, issue the following command:

```
rf dot11a-radio-profile <profile> spectrum-profile <profile>
```

Connecting Spectrum Devices to the Spectrum Analysis Client

A spectrum analysis client is any laptop or desktop computer that can access the controller WebUI and receive streaming data from individual spectrum monitors or hybrid APs. Once you have configured one or more APs to operate a a spectrum monitor or hybrid AP, use the Spectrum Monitors window to identify the spectrum devices you want to actively connect the spectrum analysis client. To connect one or more spectrum devices to your client:

1. Navigate to Monitoring>Spectrum Analysis.
2. Click the Spectrum Monitors tab.

3. Click the Add button. A table appears, displaying a list of spectrum analysis devices, sorted by name. Single-radio spectrum devices will have a single entry in this table, and dual-radio spectrum devices will have two entries; one for each radio. This table displays the following data for each radio.

Table 127 *Spectrum Device Selection Information*

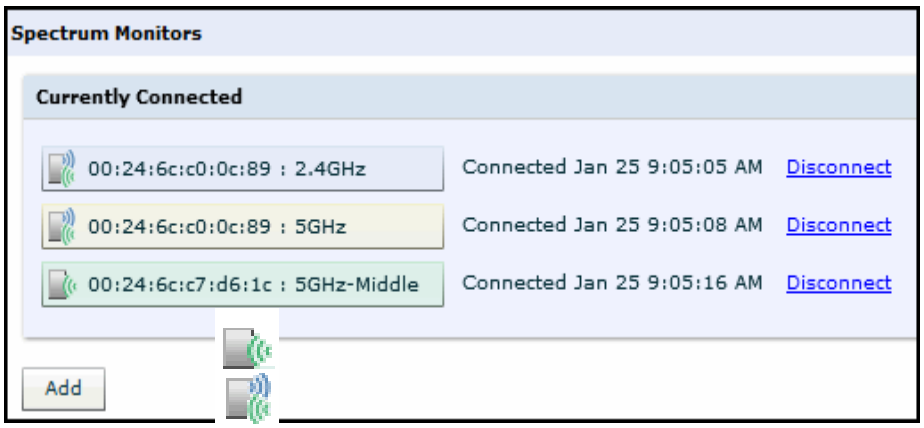
Table Column	Description
AP	Name of the AP whose radio you want to convert to a spectrum monitor. AP names are case sensitive. This column includes the following icons: Radio is operating as a spectrum monitor. Radio is operating as a hybrid AP with spectrum enabled.
Band	The frequency band currently used by the radio. This value can be either 2.4 GHz or 5 GHz.
Status	Indicates if the spectrum monitor is currently up or down.
Model	AP model type.
AP Group	Name of the AP group to which the spectrum monitor is currently associated.
Mode	This column indicates the type of spectrum analysis device: • Spectrum Monitor: AP is in spectrum monitor mode. • Access Point: AP is configured as an access point but with spectrum monitoring enabled (Hybrid AP).
Availability for Connection	Indicates if the AP is available to send spectrum analysis data to the client. Possible options are as follows: • Available, 2.4GHz: The radio is available to send spectrum analysis data on the 2.4GHz frequency band. • Available, 5GHz: The radio is available to send spectrum analysis data on the 5GHz frequency band. • Available, Dual Band: The radio is available and is capable of sending spectrum analysis data on either the 2.4 GHz or the 5 GHz frequency bands. • Available, current channel - <channel>: The AP radio is in hybrid mode and can display spectrum analysis data for the single specified channel only. • Not available: An AP may not be available because it is currently sending spectrum analysis data to another client.

4. Click the table entry for a spectrum monitor radio, then click Connect.
   - If the radio you are connecting to the Spectrum Analysis client is a 5 GHz radio, an additional window requires that you specify which part of the band that radio should use. Select either 5 GHz Lower, 5 GHz Middle, or 5GHZ Upper, then click Connect.
   - If the radio you are connecting to the Spectrum Analysis client is a dual-band radio, an additional window requires that you specify which band or part of the band that radio should use. Select either 2 Ghz, 5 GHz Lower, 5 GHz Middle, or 5GHZ Upper, then click Connect.
5. Repeat steps 3-4 to connect additional devices, if desired.

View Connected Spectrum Analysis Devices

Once you have connected one or more spectrum monitors or hybrid APs to your Spectrum Analysis client, the Monitoring>Spectrum Analysis>Spectrum Monitors window displays a table of currently connected spectrum devices. This table includes the name of each spectrum monitor or hybrid AP, its current radio band (2GHz or 5GHz), and, for spectrum monitors with a radio in the 5GHz radio band, whether the Spectrum monitor will display data for the upper, middle, or lower end of the 5GHz band.

Figure 132 *Viewing a list of Connected Spectrum Monitors*



To view a list of connected spectrum devices via the command-line interface, issue the command show ap spectrum monitors.

```
(host)# show ap spectrum monitors
List of Sensors
---------------
AP name  Group    AP Type  Phy  Band       Channel  Mode             Client IP  Subscribe
Time
-------  -----    -------  ---  ----       -------  ----             ---------  ----------
----
AP12     default  105      G    2GHz       -        Spectrum Monitor 10.4.165.227  2011-04-
25 02:53:52 AM
AP16     default  135      A    5GHz       149      Access Point     10.4.165.227  2011-04-
25 02:53:55 AM
AP44     default  105      G    2GHz       -        Spectrum Monitor 10.4.165.227  2011-04-
25 02:54:03 AM

Num Sensors:3
Current Time: 2011-04-25 03:03:25 AM
```

Disconnecting a Spectrum Device

A spectrum monitor or hybrid AP can send spectrum analysis data to only one client at a time. When you are done viewing data for a spectrum device, you should release your client's subscription to that spectrum device and allow other clients to view data from that device. A spectrum monitor or hybrid AP will automatically disconnect from your client when you close the browser window you used to connect the spectrum device your client.

To disconnect a spectrum monitor:

1. Navigate to the Monitoring>Spectrum Analysis window.
2. Click the Spectrum Monitors tab.
3. Each table entry in the Currently Connected table includes a Disconnect link to release the client's connection to that spectrum monitor. Identify the table entry for the spectrum monitor you want to release then click Disconnect.
4. A popup window asks you to confirm that you want to disconnect the spectrum monitor from the spectrum analysis client. Click OK. The spectrum monitor will disconnect from the client and the device's entry will be removed from the Currently Connected table.

When you disconnect a spectrum monitor from your client, the AP will continue to operate as a spectrum monitor until you return it to AP mode by removing the local spectrum override, or by changing the mode parameter in the AP's 802.11a or 802.11g radio profile from spectrum-mode to AP-mode

NOTE: If you are using Internet Explorer and have multiple instances of an Internet Explorer browser open, the data streaming connection to spectrum monitor will not be released until 60 seconds after you close the spectrum client browser window. During this 60-second period, the user will see the spectrum monitor is still being connected to the client.

Configuring the Spectrum Analysis Dashboards

Once you have connected spectrum monitors to your spectrum analysis client, you can begin to monitor spectrum data in the spectrum analysis dashboards. There are two predefined sets of dashboard views, *View1*, and *View 2*. By default, View1 displays the Real-Time FFT, FFT Duty-Cycle and Swept Spectrogram graphs, and View 2 displays the Swept Spectrogram and Quality Spectrogram charts, and the Channel Summary and Active Devices tables.

Each chart in the dashboard can be replaced with other chart types, or reconfigured to show data for a different spectrum monitor. Once you have configured a dashboard view with different settings, you can rename that dashboard view to better reflect its new content.

The following sections explain how to customize your Spectrum Analysis Dashboard to best suit the needs of your individual network.

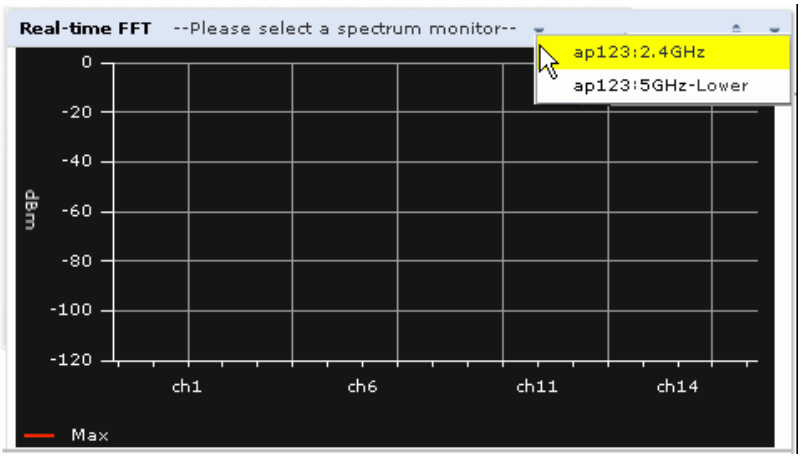
Selecting a Spectrum Monitor

When you first log into the Spectrum Analysis dashboard, it will display blank charts. You must identify the spectrum monitor whose information you want to view before the graphs will be able to display any data.

To identify the spectrum monitor radio whose data you want to appear in the Spectrum Analysis dashboard:

1. Access the Monitoring>Spectrum Analysis window in the WebUI.
2. Click the Spectrum Dashboards tab.
3. In the graph title bar, click the down arrow by the Please select a spectrum monitor heading, as shown in Figure 133. A drop-down list appears with the name of all spectrum monitor and hybrid AP radios currently connected to the client.

Figure 133 *Selecting a Spectrum Monitor*



4. Select a spectrum monitor from the list. The spectrum monitor or hybrid AP name will appear in the chart titlebar and the chart will start displaying data for that spectrum monitor.

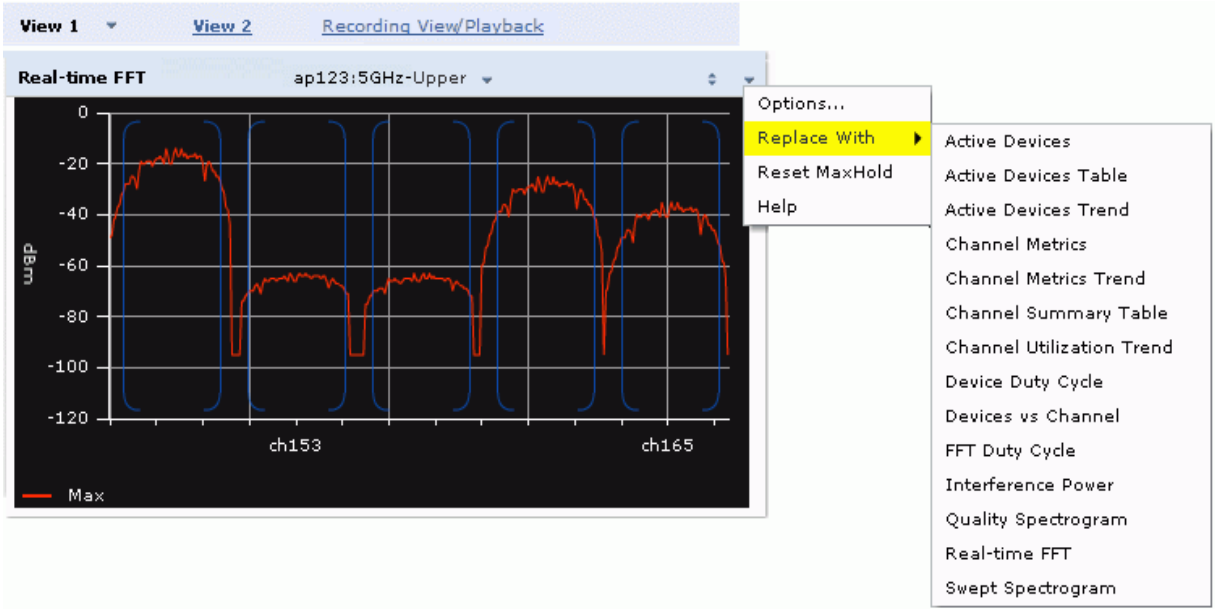
After you have selected the initial spectrum monitor or hybrid AP for a graph, you can display data for a different spectrum device at any time by clicking the down arrow by the device name in the chart titlebar and selecting a different connected spectrum monitor or hybrid AP.

Changing Graphs within a Spectrum View

To replace an existing graph with any other type of graph or chart:

1. From the Monitoring>Spectrum Analysis>Spectrum Dashboards window, click one of the dashboard names at the top of the window to select the dashboard layout with the graph you want to change.
2. Click the down arrow at the far right end of the graph title bar to display a drop-down menu of chart options.
3. Click Replace With to display a list of available graphs.
4. Click the name of the new graph you want to display.

Figure 134 *Replacing a Graph in the Spectrum Analysis Dashboard*



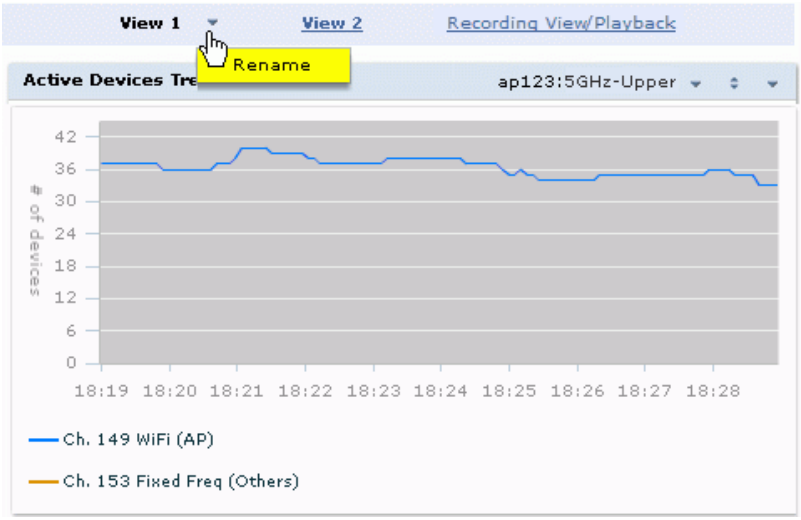
Renaming a Spectrum Analysis Dashboard View

You can rename either of the two spectrum analysis dashboard views at any time. Note, however, that simply renaming a view does not save its settings. (For details on saving a spectrum dashboard view, see "Saving a Dashboard View" on page 620.)

To rename a Spectrum Analysis Dashboard view:

1. From the Monitoring>Spectrum Analysis>Spectrum Dashboards window, click the down arrow to the right of the dashboard view you want to rename.
2. Select Rename.

Figure 135 *Renaming a Spectrum Dashboard View*



3. The Dashboard Name popup window appears. Enter a new name for the dashboard view, then click OK.

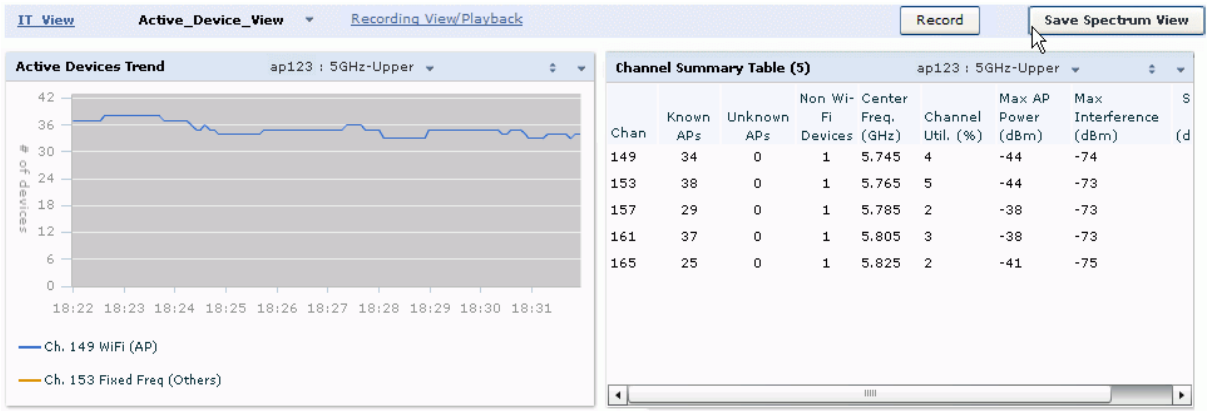
Saving a Dashboard View

You can select different graphs to display in a dashboard view, but these changes will not be saved unless you save that view. Dashboard views, (like the spectrum analysis profile and spectrum local-override profile) are all local configurations that must be configured on each controller. None of these settings are synchronized between controllers.

To save a dashboard view:

1. After selecting the graphs you want to appear in the view, click the Save Spectrum View button at the top of the window.

Figure 136 *Save a Spectrum Analysis Dashboard Layout*



2. The Spectrum View Saved confirmation window appears when the spectrum view has been saved. The graphs will now appear by default whenever you log in to view the spectrum dashboard.

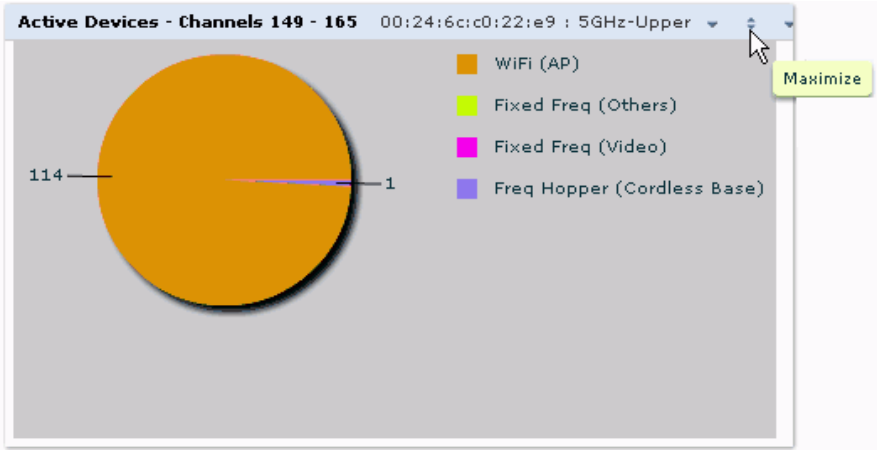
NOTE: If you change graphs in a spectrum view but do not save your settings, you will be prompted to save or cancel your changes when you close the spectrum dashboard browser window

Resizing an Individual Graph

The left side of the title bar for each graph includes a resizing button on that allows you to expand a graph for easier viewing. Click this button as shown in Figure 137 to expand the selected graph to the size of the full window and display the Options pane, which allows you to change the current display options for that graph.

(Configuration options are described in "Spectrum Analysis Graph Configuration Options" on page 621). To close the options pane if you have not made any changes to the graph, click Close at the bottom of the Options pane *or* click the resize button again to return the graph to its original size. To save any changes to the graph, click OK to save your settings and close the Options pane.

Figure 137 *Resizing a Spectrum Analysis Graph*

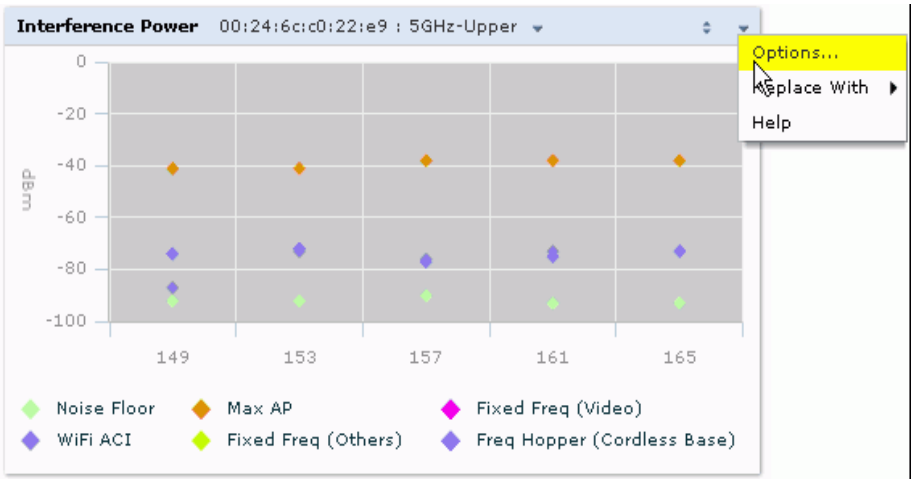


Customizing Spectrum Analysis Graphs

Each Spectrum Analysis graph can be customized to display or hide selected data types. To view the available options for a graph type:

1. From the Monitoring>Spectrum Analysis>Spectrum Dashboards window, click the down arrow at the end of the title bar for the graph you want to configure.
2. Select Options. The Options window appears to the right of the graph.

Figure 138 *Viewing Spectrum Analysis Graph Options*



3. From the Options window, configure graph settings described in "Spectrum Analysis Graph Configuration Options" on page 621.
4. When you are done, click OK at the bottom of the Options window to hide the options window.
5. (Optional) Click Save Spectrum View at the top of the window to save your new settings.

Spectrum Analysis Graph Configuration Options

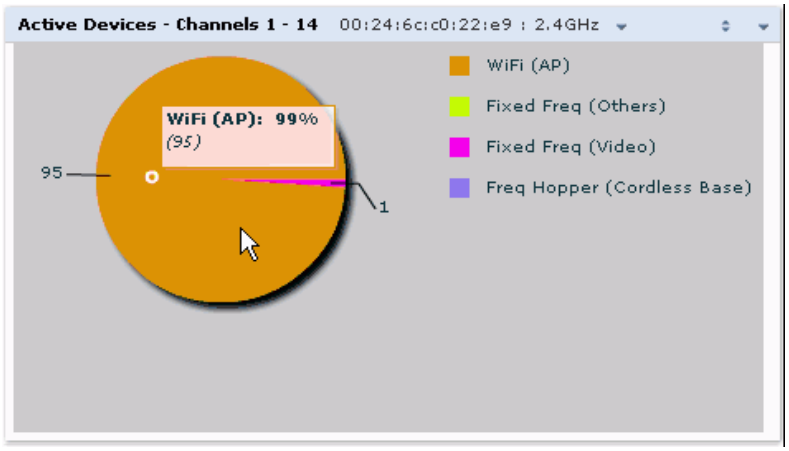
The following sections describe the customizable parameters and the default settings for each spectrum analysis graph.

Active Devices

This graph appears as a pie chart showing the percentages and total numbers of each device type for all active devices seen by the spectrum monitor or hybrid AP radio. This chart is useful for determining which types of devices are sending signals on the specified radio band or channel. The Active Devices graphs for spectrum monitors can be configured to show data for several different device types on a single radio channel or range of channels. Active Devices graphs for hybrid APs can show data for the single monitored channel only.

The data in this chart updates every five seconds. When you hover your mouse over any section of the pie chart, a tooltip will display the percentage and number of active devices classified into that device type. The example in Figure 139 shows that 99% of the active devices a spectrum monitor radio sees in the 2.4 GHz band are Wi-Fi APs.

Figure 139 *Active Devices Graph*



Click the down arrow in the upper right corner of this chart then click the Options menu to access the configuration settings for the Active Devices graph. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 128 *Active Devices Graph Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Channel Range	For graphs created by spectrum monitors, specify a channel range to determine which channels will appear in this graph. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the graph. By default, this graph will display all channels within the spectrum monitor's radio band. NOTE: This parameter is not configurable for graphs created by hybrid APs.

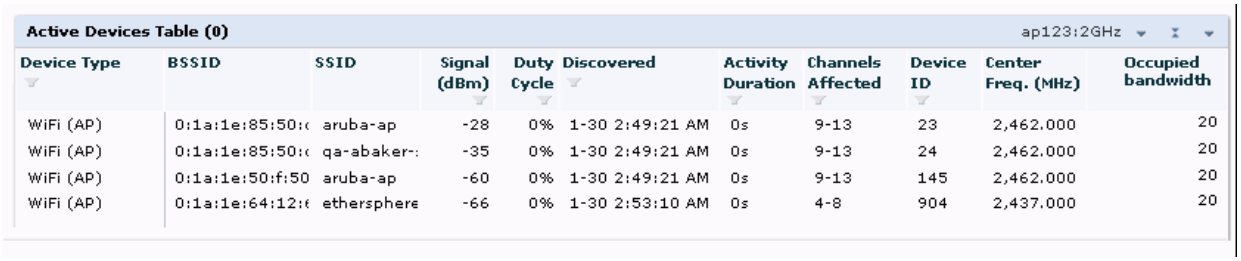
Table 128 *Active Devices Graph Options (Continued)*

Parameter	Description
Show	Click the checkbox by any of these device categories to include that device type in the graph. • WiFi (AP) • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer NOTE: For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646.

Active Devices Table

This table lets you view, sort, and search for data about the devices that are sending signals on the specified radio band or channel. The Active Devices table for a spectrum monitor displays data for all channels on the selected band. The Active Devices table for a hybrid monitor displays data for the single monitored channel only. Click any of the column headings to sort the information in the table by that column criteria. Make a column wider or narrower by clicking the border of a column heading and dragging the border to a new position.

Figure 140 *Active Devices Table*



The data in this chart updates every five seconds. You can save the data in the Active Devices table for later analysis by exporting it as data file in .csv format, which can be viewed by spreadsheet and database management applications like Microsoft Excel. To export this table, click the down arrow in the upper right corner of this chart and select Export. A window will open and let you browse to the location to which you want to save the file. Once you have identified the location where you want to save the file, click Save.

You can also filter table entries by signal strength, duty cycle, discovery time, activity duration, channels affected and device ID number by clicking the icon below any column heading and specifying the values or value ranges that should appear in the table. Table 129 describes each of the columns in the table and the filters that can be applied to the table output.

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Table 129 *Active Devices Table Options*

Parameter	Description
Device Type	This column shows the type of active device detected by the spectrum monitor or hybrid AP. This column may display any of the following values: • WiFi (AP) • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer NOTE: For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646.
BSSID	The Basic Service Set Identifier of the device. An AP's BSSID is usually its MAC address.
SSID	The service set identifier of the device's 802.11 wireless LAN.
Signal (dBm)	The current transmission power for this device, in dBm. To filter the output of this table to show only specific device types, click the icon in the column heading then select one of the following options: • Select Any to display entries for all signal strength levels. • To display entries within a specific range of power strength levels, enter the minimum signal strength level in the Min field and enter the maximum signal strength level in the Max field. Click OK to save your settings and return to the Active Devices table.
Duty Cycle	The device's duty cycle; the percentage of time that the device is actively sending a signal on the radio band or channel. To filter the output of this table to show only specific duty cycle values or a range of values types, click the icon in the column heading then select one of the following options: • Select Any to display all entries, regardless of duty cycle value. • To display entries within a specific range of duty cycles, enter the minimum duty cycle percentage in the Min field and enter the maximum duty cycle percentage in the Max field. Click OK to save your settings and return to the Active Devices table.
Discovered	The time at which the device was first discovered by the spectrum monitor or hybrid AP. To filter the output of this table to show devices discovered within a specific time, click the icon in the column heading. Select Any to display all entries, regardless of when the device was discovered. To display entries for devices discovered within a specific time range: 1. Select the button by the Less than drop down list. 2. Click the Less than drop-down list and select either Less than or More than to limit the output of this table to devices discovered earlier or after a specified number of hours or minutes. 3. Enter the number of hours or minutes in the time range you want apply to this filter. 4. Click the min. drop down list and select either min. or hrs. to define the time range in minutes or hours. 5. Click OK to save your settings and return to the Active Devices Table.

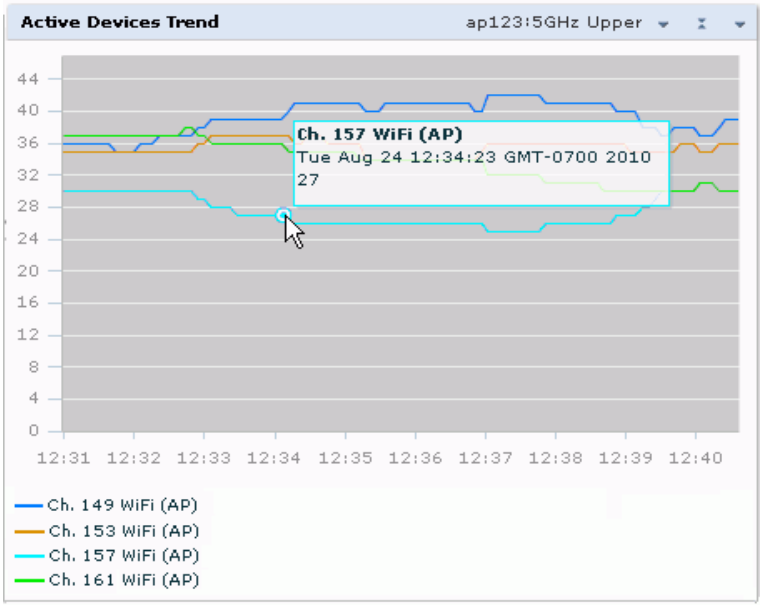
Table 129 *Active Devices Table Options (Continued)*

Parameter	Description
Activity Duration	Amount of time that the device has been active. To filter the output of this table to show devices that have been active within a specific time range, click the icon in the column heading. Select Any to display all entries, regardless of how long the device has been active. To display entries for devices active for a specific time range: 1. Select the button by the > symbol. 2. Click drop-down list with the > symbol and select either > (Greater than), < (Less than), <= (less than or equal to), or >= (more than or equal to) to limit the output of this table to devices that have been active for a specified time range. 3. Enter the number of hours or minutes in the time range you want apply to this filter. 4. Click the min. drop-down list and select either min. or hrs. to define the time range in minutes or hours. 5. Click OK to save your settings and return to the Active Devices table.
Channels Affected	Radio channels affected by the device's transmission. By default, the Active Devices table for a spectrum monitor shows entries for all devices, regardless of the channels their transmissions may affect. To filter the output of this table to show devices that affect a specific channel or range of channels, click the icon in the column heading. • Select Any to display all entries, regardless of the channels that device may affect. • Select Single Channel then enter the channel value to only display devices that affect the specified channel. • Select Range of Channels then enter the lower and upper channels in the channel range to filter the output to show only those devices whose transmissions affect the specified channel range. This option is only available for tables created by spectrum monitors, not hybrid APs. • Select Specified Channels to show only those devices whose transmissions affect selected channels. If you choose this option, you can click the none checkbox to show only those devices whose transmissions do not affect any other channels, select all to show devices whose transmissions affect any channel, or click the checkboxes by individual channel numbers to show only those devices whose output affect those selected channels. This option is only available for tables created by spectrum monitors, not hybrid APs. Click OK to save your settings and return to the Active Devices table. NOTE: This option is not available for Active Devices tables created by a hybrid AP, because each hybrid AP monitors a single channel only.
Device ID	The spectrum monitor or hybrid AP applies a unique device ID per device type to each device it detects on the radio channel. To display the entry for a device that matches a single device ID, click the icon in the column heading and enter the device ID. Click OK to save your settings and return to the Active Devices table.
Center Frequency (MHz)	Signals from a wireless device can spread beyond the boundaries of an individual 802.11 channel. This table column shows the center frequency for the device's transmission, in megahertz.
Occupied Bandwidth	Channel bandwidth used by the device, in megahertz.

Active Devices Trend

The Active Devices Trend chart is a line chart that shows the numbers of Wi-Fi and non-Wi-Fi devices seen on each radio channel during the displayed time interval. The data in this chart updates every five seconds. When you hover your mouse over any line in the chart, a tooltip displays the number of active devices for the selected device type. The example in Figure 141 shows that there are 27 active Wi-Fi APs on channel 157 of the upper 5 GHz radio band.

Figure 141 *Active Devices Trend Graph*



An Active Devices Trend chart created by a hybrid AP displays data for the single channel monitored by that device. For spectrum monitors, the Active Devices Trend chart can display values for up to five different channels and device types. These graphs show the following data by default:

- For SMs on the 2.4 GHz radio band, Wi-Fi APs on channel 1, and fixed-frequency devices on channel 6.
- For SMs on the lower 5 GHz band, Wi-Fi APs on channel 36, and fixed-frequency devices on channel 40.
- For SMs on the middle 5 GHz band, Wi-Fi APs on channel 100 and fixed-frequency devices on channel 104.
- For SMs on the upper 5 GHz band Wi-Fi APs on channel 149 and fixed-frequency devices on channel 153.

Table 130 describes the other values that can be displayed in the Active Devices Trend chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access the Active Devices Trend configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 130 *Active Devices Trend Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Show Trend for Last	Amount of elapsed time for which this chart should display data.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.

Table 130 *Active Devices Trend Options (Continued)*

Parameter	Description
Show lines for these channels	The Active Devices Trend chart can display values for up to five different device types on different channels for a spectrum monitor, or a single device type for a hybrid AP. To choose which type of data each line should represent, click the channel number drop-down list and select a channel within the radio band, then click the device type drop-down list and select one of the following device types. • WiFi (AP) • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer Select the checkbox beside each channel and device entry to show that information on the chart, or unselect the checkbox to hide that information. For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646.

Channel Metrics

This stacked bar chart can show one of three different types of channel metrics; *channel utilization*, *channel availability*, or *channel quality*.

By default, this chart displays channel utilization data, showing both the percentage of each monitored channel that is currently being used by Wi-Fi devices, and the percentage of each channel being used by non-Wi-Fi devices and 802.11 adjacent channel interference (ACI).

NOTE: ACI refers to the interference on a channel created by a transmitter operating in an adjacent channel. A transmitter on a nonadjacent or partially overlapping channel may also cause interference, depending on the transmit power of the interfering transmitter and/or the distance between the devices. In general, ACI may be caused by a Wi-Fi transmitter or a non-Wi-Fi interferer. However, whenever the term ACI appears in Spectrum Analysis graphs, it refers to the ACI caused by Wi-Fi transmitters. The channel utilization option in the Channel Metrics Chart shows the percentage of the channel utilization due to both ACI and non-Wi-Fi interfering devices. Unlike the ACI shown in the Interference Power chart, the ACI shown in this graph indicates the percentage of channel time that is occupied by ACI or unavailable for Wi-Fi communication due to ACI.

The Channel Metrics graph can also show channel availability, the percentage of each channel that is available for use, or display the current relative quality of selected channels in the 2.4 GHz or 5 GHz radio bands. Spectrum monitors can display data for all channels in their selected band. Hybrid APs display data for their one monitored channel only.

In the spectrum analysis feature, channel quality is a relative measure that indicates the ability of the channel to support reliable Wi-Fi communication. Channel quality, which is represented as a percentage in this chart, is a weighted metric derived from key parameters that can affect the communication quality of a wireless channel, including noise, non-Wi-Fi (interferer) utilization and duty-cycles, and certain types of retries. Note that channel quality is not directly related to Wi-Fi channel utilization, as a higher quality channel may or may not be highly utilized.

When you hover your mouse over any bar in the chart, a tooltip displays the metric value for that individual channel. The example below shows that 61% of channel 3 is being consumed by non-Wi-Fi devices and 802.11 adjacent channel interference.

Figure 142 *Channel Metrics Graph*

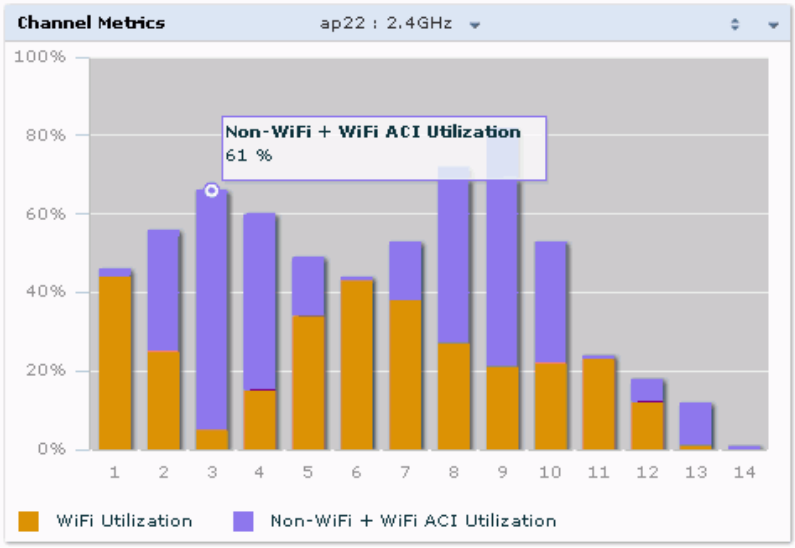


Table 131 describes the parameters that can be displayed in the Channel Metrics graph. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 131 *Channel Metrics Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Channel Range	For graphs created by spectrum monitors, specify a channel range to determine which channels will appear in this graph. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the graph. By default, this graph will display all channels within the spectrum monitor's radio band. NOTE: This parameter is not configurable for graphs created by hybrid APs.
Display Mode	Select Channel Quality to show the relative quality of the channel. Channel Quality is a weighted metric derived from key parameters which include noise, non-Wi-Fi (interferer) utilization and duty-cycles, and certain types of retries. Select Channel Availability to show the percentage of the channel that is unused and available for additional Wi-Fi traffic. Select Channel Utilization to show both the percentage of the channel that is currently utilized by Wi-Fi devices, and the percentage of each channel that is being utilized by non-802.11 devices or 802.11 adjacent channel interference (ACI).

Channel Metrics Trend

By default, this line chart shows the current relative quality of selected channels in the 2.4 GHz or 5 GHz radio bands over a period of time. The Channel Metrics Trend chart can also be configured to display trends for the current availability of selected channels within the selected channel range, or the percentage of utilization for

those channels. Spectrum monitors can display data for up to five different channels in their selected band. Hybrid APs display data for their one monitored channel only.

NOTE: For more information on how the spectrum analysis feature determines the quality of a channel, see "Channel Metrics" on page 627.

When you hover your mouse over any line in the chart, a tooltip displays channel quality or availability data for that individual channel at the selected time.

Figure 143 *Channel Metrics Trend Chart*

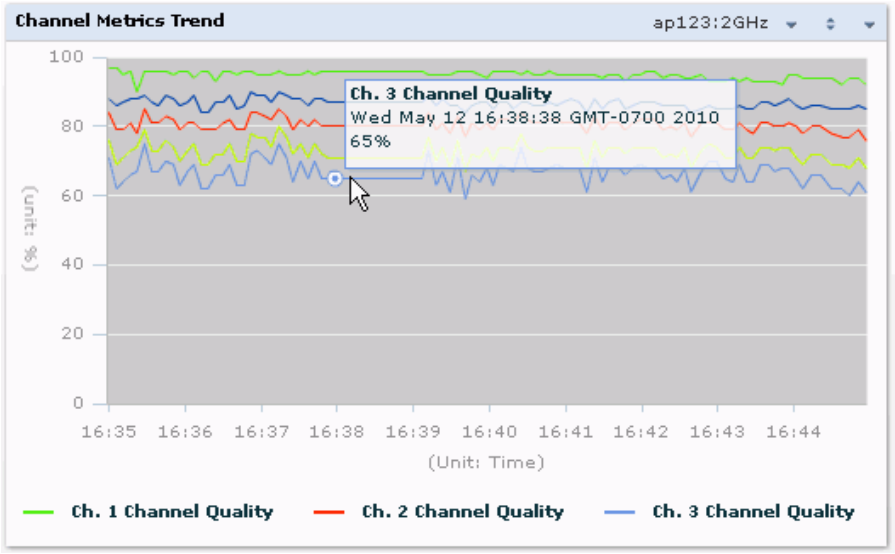


Table 132 describes the other parameters that can be displayed in the Channel Metrics Trend output. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboard.

Table 132 *Channel Metrics Trend Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Show Trend for Last	By default, the Channel Quality Trend chart shows channel quality or channel availability for the past 10 minutes. To view data for a different time range, click the Show Trend for Last drop-down list and select one of the following options: • 10 minutes • 30 minutes • 1 hour
Channel numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.

Table 132 *Channel Metrics Trend Options (Continued)*

Parameter	Description
Show Lines for These Channels	The Channel Quality Trend chart for a spectrum monitor can display channel quality, channel availability or channel utilization values for up to five different channels on the selected radio band. Charts for hybrid APs can display data for the one channel monitored by that hybrid AP radio. To choose which type of data each line should represent on a chart for a spectrum monitor, click the channel number drop-down list and select a channel within the radio band, then click the second drop-down list and select either Channel Quality, or Channel Availability. Select the checkbox beside each channel entry to show that information on the chart, or unselect the checkbox to hide that information.

Channel Summary Table

The channel summary table provides a summarized or aggregated view of key statistics. Spectrum monitors display spectrum analysis data seen on all channels in the selected band, and hybrid APs display data from the one channel they are monitoring. The example in Figure 144 below shows that a spectrum monitor sees 49 known APs and 12% channel utilization on channel 149 in the upper 5GHz radio band.

Figure 144 *Channel Summary Table*

Channel Summary Table (8) a889:5GHz-Upper

Chan	Known APs	Unknown APs	Non Wi-Fi Devices	Center Freq. (GHz)	Channel Util. (%)	Max AP Power (dBm)	Max Interference (dBm)	SNIR (dB)
149	49	0	1	5.745	12	-38	-67	29
153	36	0	1	5.765	8	-41	-66	25
157	48	0	1	5.785	7	-51	-66	15
161	46	0	1	5.805	5	-39	-67	28
165	27	0	1	5.825	4	-28	-70	42

Spectrum monitor radios using the 5 GHz radio band can display channels using either 20 MHz or 40 MHz channel numbering. To toggle between these two channel numbering modes, click the down arrow in the upper right corner of the graph titlebar then click either Show 20 MHz Channels or Show 40 MHz Channels.

Click any of the column headings to sort the information in the table by that column criteria. Make a column wider or narrower by clicking the border of a column heading and dragging the border to a new position.

Table 133 describes the output of the Channel Summary table.

Table 133 *Channel Summary Table Parameters*

Parameter	Description
Channel	Radio channel being monitored by the spectrum monitor or hybrid AP
Known APs	Number of known APs seen on the network.
Unknown APs	Number of unknown or invalid APs seen on the network.
Non Wi-Fi Devices	Number of Non-Wi-Fi (interfering) devices detected/classified by the spectrum monitor
Center Freq. (GHz)	Center frequency of the Wi-Fi signals sent on that radio channel.
Channel Util. (%)	Percentage of the channel currently being used by devices on the network
Max AP Power (dBm)	Signal strength of the AP that has the maximum signal strength on a channel.
Max Interference (dBm)	Signal strength of the non-Wi-Fi device that has the highest signal strength.

Table 133 *Channel Summary Table Parameters (Continued)*

Parameter	Description
SNIR (dB)	The Signal-to-Noise-and-Interference Ratio (SNIR) is the ratio of signal strength to the combined levels of interference and noise on that channel. This value is calculated by determining the maximum noise-floor and interference-signal levels, and then calculating how strong the desired signal is above this maximum.

Device Duty Cycle

The Device Duty Cycle Chart is a stacked bar chart that shows the duty cycle of each device type on a channel. The duty cycle is the percentage of time each device type operates or transmits on that channel. Though Wi-Fi devices not transmit if there is another Wi-Fi or non-Wi-Fi device active at that time, most non-Wi-Fi devices do not follow such a protocol for transmissions. Since these devices operate independently without regard to any other devices operating on the same channel, the total duty cycle of all device types may add up to more than 100% on a channel. For example, one or more video bridges may be active on a channel, each with 100% duty cycle. The same channel may have a cordless transmitter with 10% duty cycle and a microwave oven with 50% duty cycle. In this example, the Device Duty Cycle chart will show all three device types with their respective duty cycle percentages.

NOTE: This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.

Spectrum monitors display spectrum analysis data seen on all channels in the selected band, and hybrid APs display data from the one channel they are monitoring. The example below shows data from a spectrum monitor monitoring all channels in the 2.4 Ghz band.

Figure 145 *Device Duty Cycle*

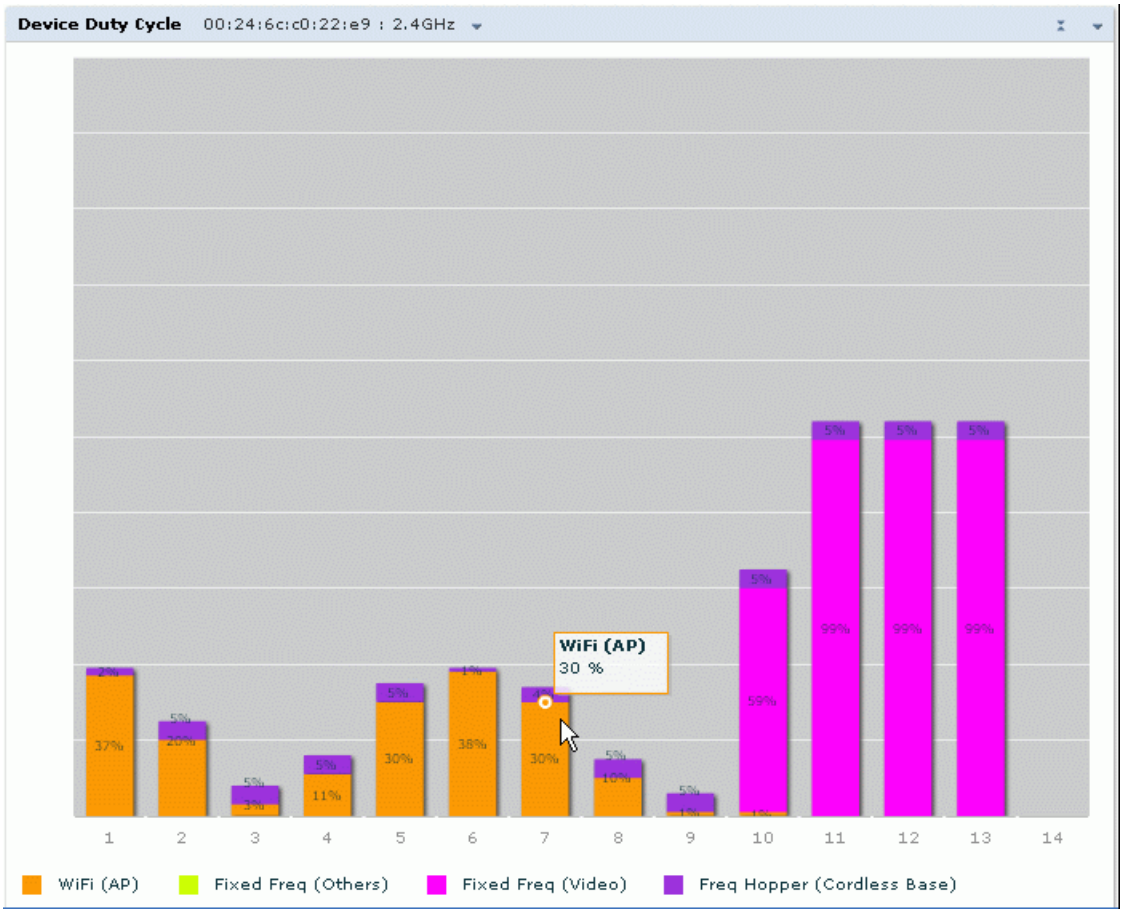


Table 134 describes the parameters you can use to customize the Device Duty Cycle chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 134 *Device Duty Cycle Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Channel Range	For graphs created by spectrum monitors, specify a channel range to determine which channels will appear in this graph. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the graph. By default, this graph will display all channels within the spectrum monitor's radio band. NOTE: This parameter is not configurable for graphs created by hybrid APs.

Table 134 *Device Duty Cycle Options (Continued)*

Parameter	Description
Show	This graph can display values for up to five different device types on different channels for a spectrum monitor, or a single device type for a hybrid AP monitoring a single channel. To choose which type of data each line should represent, click the channel number drop-down list and select a channel within the radio band, then click the device type drop-down list and select one of the following device types • WiFi (AP) • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer NOTE: For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646.

Channel Utilization Trend

The Channel Utilization Trend chart is a line chart that shows the percentage of total utilization on each channel over a time interval. The channel utilization includes the utilization due to Wi-Fi as well as utilization due to non-Wi-Fi interferers and Adjacent Channel Interference (ACI).

NOTE: For additional information on how the spectrum analysis feature measures ACI, see "Channel Metrics" on page 627.

This graph can show data recorded for the last ten, thirty, or sixty minutes. Spectrum monitors display spectrum analysis data seen on all channels in the selected band, and hybrid APs display data from the one channel they are monitoring. When you hover your mouse over any line in the chart, a tooltip will show the percentage of the channel being utilized at the specified time. The example in Figure 146 shows that channel 1 was 70% utilized at the selected time in the chart.

Figure 146 *Channel Utilization Trend*

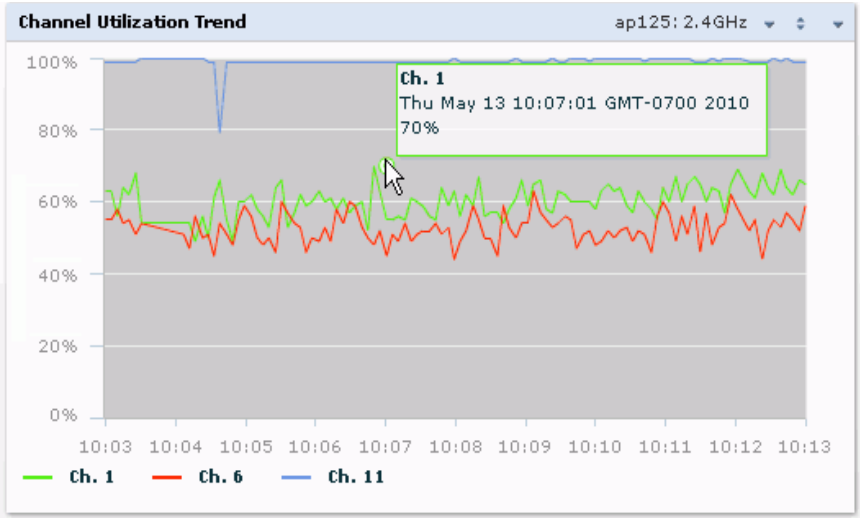


Table 135 describes the parameters you can use to customize the Channel Utilization Trend chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 135 *Channel Utilization Trend Options*

Parameter	Description
Intervals	By default, the Channel Utilization Trend chart shows channel quality or channel availability for the past 10 minutes. To view data for a different time range, click the Intervals drop-down list and select one of the following options: • 10 minutes • 30 minutes • 1 hour
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Show	To select individual channels you want to display on this chart, click the checkbox by a channel entry, then click the channel drop-down list to select the channel to display. To hide a channel, uncheck the checkbox by that channel number.

Devices vs Channel

This stacked bar chart shows the current number of devices using each channel in the radio's frequency band. This chart can show separate per-channel statistics for the numbers of Wi-Fi devices, cordless phones, bluetooth devices, microwaves, and other non-Wi-Fi devices.

If a device affects more than one channel, it will be recorded as a device on all channels it affects. For example, if a 20Mhz Wi-Fi AP has a center frequency of 2637 Ghz (channel 6) it will be counted as a device on channels 3-9 because it affects all those channels. Similarly, if a channel-hopping device uses all channels within a frequency band, it will be counted as a device on all channels in that band.

When you hover the mouse over any part of the chart, a tooltip will show the numbers of the device type currently using that channel. The example in Figure 147 shows that the spectrum monitor can detect 42 APs on channel 5.

Figure 147 *Devices vs Channel*

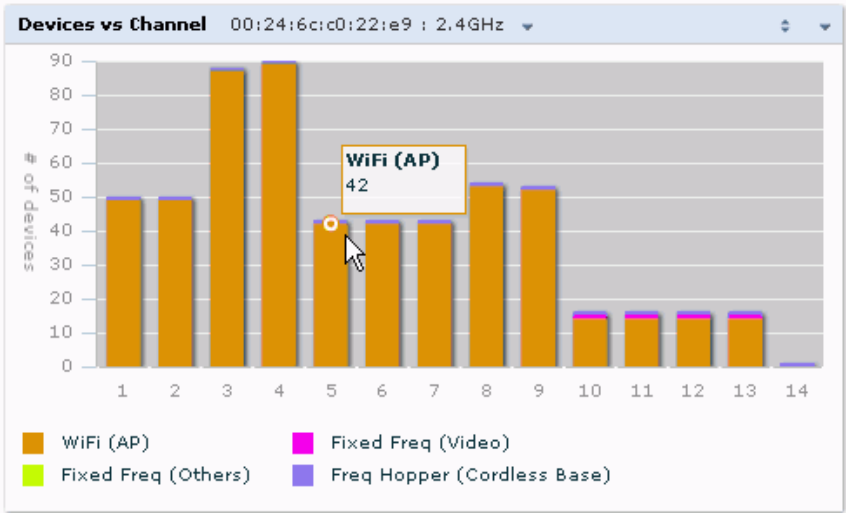


Table 136 describes the parameters you can use to customize the Devices vs Channel chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 136 *Devices vs Channel Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Channel Range	For graphs created by spectrum monitors, specify a channel range to determine which channels will appear in this graph. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the graph. By default, this graph will display all channels within the spectrum monitor's radio band. NOTE: This parameter is not configurable for graphs created by hybrid APs.
Show	This graph can show data for up to five different device types. To show how many devices of a specific type are sending a signal on the selected channel range, click the show checkbox by that device, then click the device drop-down list and select one of the following device types. • WiFi (AP) • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer NOTE: For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646

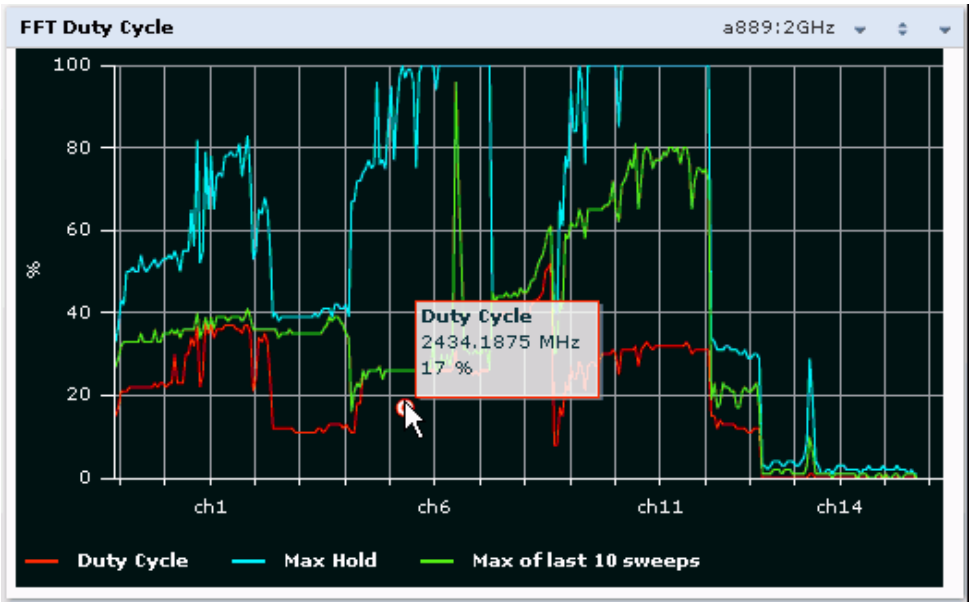
FFT Duty Cycle

The FFT Duty Cycle chart is a line chart that shows the duty cycle for each frequency bin. The width of the each frequency bin depends on the resolution bandwidth of the spectrum monitor. The spectrum analysis feature considers a frequency bin to be utilized if the detected power in that bin is at least 20 dB higher than the nominal noise floor on that channel. The FFT Duty Cycle provides a more granular view of the duty cycle per bin as opposed to the aggregated channel utilization reported in the Channel Metrics chart.

NOTE: This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.

This chart can show the duty cycle over the last second, the maximum FFT duty cycle measured for all samples taken over the last N sweeps, and the greatest FFT duty cycle recorded since the chart was last reset.

Figure 148 *FFT Duty Cycle*



By default, this chart shows the current duty cycle for devices on all channels being monitored by the spectrum monitor radio. Table 137 describes the other optional parameters you can use to customize the FFT Duty Cycle table. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 137 *FFT Duty Cycle Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
X-Axis	Select either Channel or Frequency to show the duty cycle for a range of channels or frequencies.
Channel Range	If you selected Channel in the X-Axis parameter, you must also specify a channel range to determine which channels will appear in the x-axis of this chart. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the chart. NOTE: This parameter is not configurable for graphs created by hybrid APs.
Center Frequency	If you selected Frequency in the X-Axis parameter, enter the frequency, in MHz, that you want to appear in the center of the x-axis of this chart.
Span	If you selected Frequency in the X-Axis parameter, specify the size of the range of frequencies around the selected center frequency. If you set a frequency span of 100 MHz, for example, the chart will show the FFT duty cycle for a range of frequencies from 50MHz lower to 50 MHz higher than the selected center.

Table 137 *FFT Duty Cycle Options (Continued)*

Parameter	Description
Show	Select a checkbox to display that information on the FFT Duty Cycle chart. • Duty Cycle: The percentage of duty cycle the channel or frequency was actively utilized. • Max Hold: The maximum recorded percentage of active duty cycles for the channel frequency since the chart was last reset. To clear this setting, click the down arrow at the end of the title bar for this graph and select Reset MaxHold. • Max of last sweeps: By default, this chart shows the maximum percentage of active duty cycles for the channel of frequency recorded during the last 10 sweeps. To change the number of sweeps used to determine this value, enter a number from 2 to 20, inclusive. To clear this setting, click the down arrow at the end of the title bar for this graph and select Reset MaxNSweep.

Interference Power

The Interference Power chart displays various power levels of interest, including the Wi-Fi AP with maximum signal strength, noise, and interferer types with maximum signal strength. The ACI displayed in the Interference Power Chart is the ACI power level based on the signal strength(s) of the Wi-Fi APs on adjacent channels. A higher ACI value in Interference Power Chart does not necessarily mean higher interference since the AP that is contributing to the maximum ACI may or may not be very actively transmitting data to other clients at all times. The ACI power levels are derived from the signal strength of the beacons.

This chart displays the noise floor of each selected channel in dBm. The noise floor of a channel depends on the noise figure of the RF components used in the radio, temperature, presence of certain types of interferers or noise, and the width of the channel. For example, in a clean RF environment, a 20 MHz channel have a noise floor around -95 dBm and a 40 MHz channel will have a noise floor around -92 dBm. Certain types of fixed-frequency continuous transmitters such as video bridges, fixed-frequency phones, and wireless cameras typically elevate the noise floor seen by the spectrum monitor. Other interferers such as frequency-hopping phones, Bluetooth and Xbox may not affect the noise floor of the radio. A Wi-Fi radio can only reliably decode Wi-Fi signals that are a certain dB above the noise floor and therefore estimating and understanding the actual noise floor of the radio is critical to understanding the reliability of the RF environment.

The chart also includes information about the AP on each channel with the highest power level. You can hover your mouse over an AP on the chart to view the AP's name, SSID and current power level. The example below shows that the AP with the maximum power on channel 157 has the SSID qa-ss, and a power level of -55dBm.

Figure 149 *Interference Power*

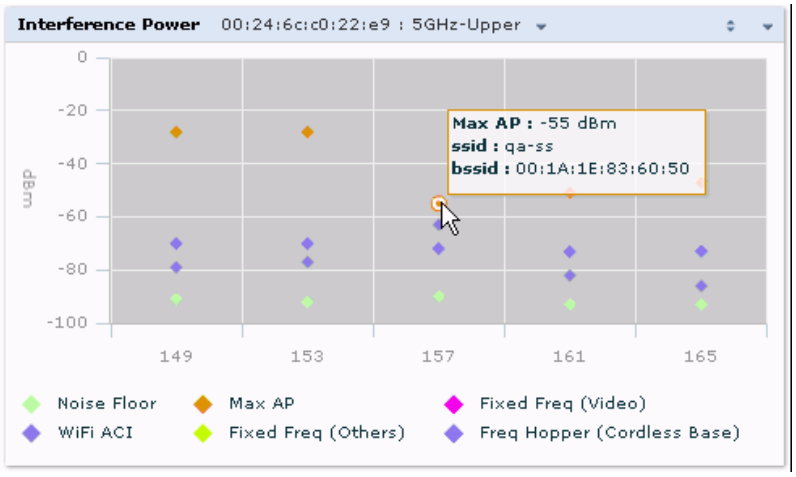


Table 138 describes the other optional parameters you can use to customize the interference power chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration

settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 138 *Interference Power Options*

Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Show	By default, this chart displays data for the current noise floor, adjacent channel interference (ACI), and the maximum AP power level for each channel. To display interference power levels form other devices, click the show checkbox then click the show drop-down list and select one of the following device types. • Microwave *(This option is only available for 2.4 GHz radios)* • Bluetooth *(This option is only available for 2.4 GHz radios)* • Fixed Freq (Others) • Fixed Freq (Cordless Phones) • Fixed Freq (Video) • Fixed Freq (Audio) • Freq Hopper (Others) • Freq Hopper (Cordless Network) • Freq Hopper (Cordless Base) • Freq Hopper Xbox *(This option is only available for 2.4 GHz radios)* • Microwave (Inverter) *(This option is only available for 2.4 GHz radios)* • Generic Interferer For more information on non-Wi-Fi device types detected by a spectrum monitor, see "Non-Wi-Fi Interferers" on page 646.
Channel Range	For graphs created by spectrum monitors, specify a channel range to determine which channels will appear in this graph. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the graph. By default, this graph will display all channels within the spectrum monitor's radio band. NOTE: This parameter is not configurable for graphs created by hybrid APs.

Quality Spectrogram

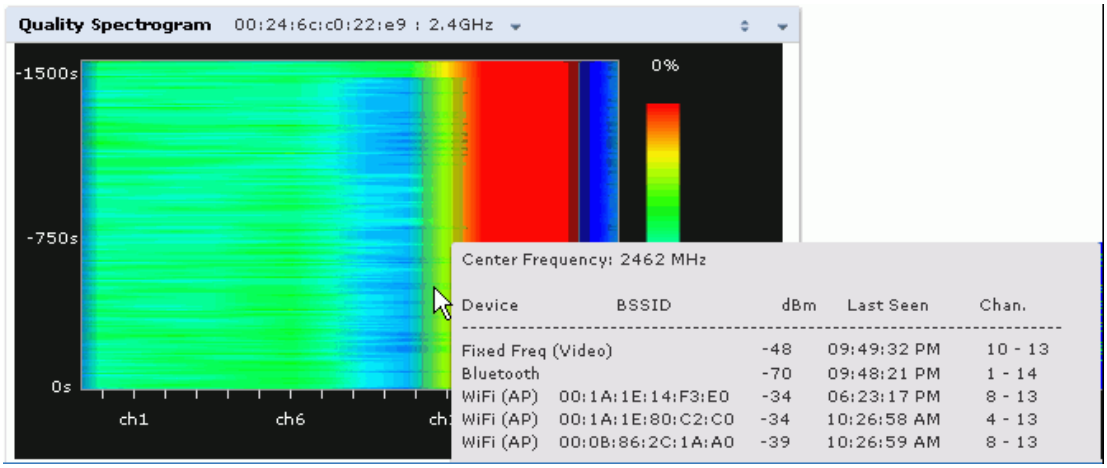
This plot shows the channel quality statistics for selected range of channels or frequencies. This chart can also be configured to show channel availability, the percentage of each channel that is unused and available for additional traffic.

Channel Quality is a weighted metric derived from key parameters which include noise, non-Wi-Fi (interferer) utilization and duty-cycles and certain types of retries. Quality levels are indicated by a range of colors between dark blue, which represents a higher channel quality, and red, which represents a lower channel quality. Channel availability is indicated by a range of colors between dark blue, which represents 100% channel availability, and red, which represents 0% availability.

NOTE: For additional information on interpreting an Dell Spectrogram plot, see "Swept Spectrogram" on page 641.

The Spectrum Analysis Quality Spectrogram chart measures channel data each second, so after every 5-second sweep, the newest data appears as a thin colored line on the bottom of the chart. Older data is pushed up higher on the chart until it reaches the top of the spectrogram and ages out. The example below shows the Dell Quality Spectrogram chart after it has recorded over 1500 seconds of FFT data.

Figure 150 *Quality Spectrogram*



When you hover your mouse over any part of the spectrogram, a tooltip will show the devices the spectrum monitor detected on that frequency, the BSSID of the device (if applicable), the power level of the device in dBm, the time the device was last seen by the spectrum monitor, and the channels affected by the device.

describes the other optional parameters you can use to customize the Quality Spectrogram. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards

Table 139 *Quality Spectrogram Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
Channel Range	Specify a channel range to determine which channels will appear in the x-axis of this chart. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the chart. NOTE: This parameter is not configurable for graphs created by hybrid APs.

Real-Time FFT

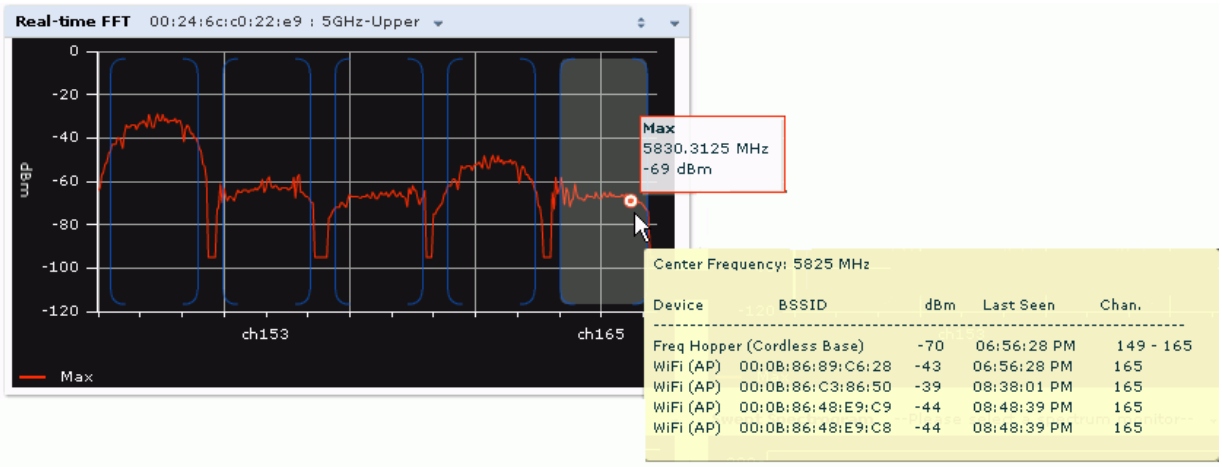
The Real-time FFT chart displays the instantaneous Fast Fourier Transform (FFT) signature of the RF signal seen by the radio. The Fast Fourier Transform (FFT) converts a RF signal from time domain to frequency domain. The frequency domain representation divides RF signals into discrete frequency bins; small frequency ranges whose width depends on the resolution bandwidth of the spectrum monitor (i.e., how many Hz are represented by a single signal strength value). Each frequency bin has a corresponding signal strength value. Since

there may be a large number of FFT signatures received by the radio every second, an algorithm selects one FFT sample to display in the Real-time FFT chart every second.

NOTE: This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.

This chart can show an average for all samples taken over the last second, the maximum FFT power measured for all samples taken over ten channel sweeps, and the greatest FFT power recorded since the chart was last reset. When you hover your mouse over any line, a tooltip will show the power level and channel or frequency level represented by that point in the graph. When you hover your mouse over a frequency level (within the blue brackets on the graph), a tooltip will show the types of devices seen on that frequency, as well as each device's BSSID, power level, channels affected and the time the device was last seen by the spectrum monitor.

Figure 151 *Real-TIme FFT*



By default, this chart shows the maximum power level recorded for any device on all channels or frequencies monitored by the spectrum monitor radio.

Table 140 describes the other parameters you can use to customize the Real-time FFT chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 140 *Real-Time FFT Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
X-Axis	Select either Channel or Frequency to show FFT power for a range of channels or frequencies. If you select Frequency, you must select the radio frequency on which this chart should center, and determine the span of frequencies for the graph.
Channel Range	If you selected Channel in the X-Axis parameter, you must also specify a channel range to determine which channels will appear in the X-axis of this chart. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the chart. NOTE: This parameter is not configurable for graphs created by hybrid APs.

Table 140 *Real-Time FFT Options (Continued)*

Parameter	Description
Center Frequency	If you selected Frequency in the X-Axis parameter, enter the frequency, in MHz, that you want to appear in the center of the x-axis of this chart.
Span	If you selected Frequency in the X-Axis parameter, specify the size of the range of frequencies around the selected center frequency. If you set a frequency span of 100 MHz, for example, the chart will show the FFT duty cycle for a range of frequencies from 50MHz lower to 50 MHz higher than the selected center.
Y-axis	Select the range of power levels, in -dBm, to appear in the y-axis of this chart. Enter the lower value in the right field, and the higher value in the left field.
Show	Select the checkbox by the following items to display that information on the FFT Power chart. • Average: The average power level of all samples recorded during the last 10 sweeps. • Max: The highest power recorded during the last 10 channel sweeps. • Max Hold: The highest maximum power level recorded since the chart data was reset. To clear this setting, click the down arrow at the end of the title bar for this graph and select Clear Max Hold.

Swept Spectrogram

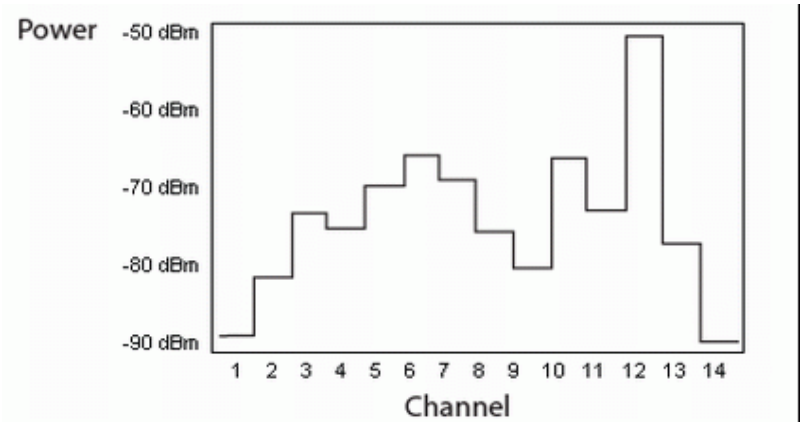
A spectrogram is a chart that shows how the density of the quantity being plotted varies with time. The spectrum analysis Swept Spectrogram chart plots real-time FFT Maximums, real-time FFT Averages or the FFT Duty Cycle. In this swept spectrogram, the x-axis represents frequency or channel and the y-axis represents time. Each line in the swept spectrogram corresponds to the data displayed in the Real-Time FFT or FFT Duty Cycle chart.

NOTE: This chart is only available for AP models W-AP105, W-AP92, W-AP93, W-AP175and the W-AP130 Series.

The power or duty cycle values recorded in each sweep are mapped to a range of colors. In the average or maximum FFT power Swept Spectrogram charts, the signal strength levels are indicated by a range of colors between dark blue, which represents -90 dBm, and red, which represents a higher -50 dBm. The duty cycle Swept Spectrogram chart shows the percentage of the time tick interval that the selected channel or frequency was broadcasting a signal. These percentages are indicated by a range of colors between dark blue, which represents a duty cycle of 0% percent, and red, which represents a duty cycle of 100%.
A spectrogram plot is a complex chart that can display a lot of information. If you are not familiar with these types of charts, they may be difficult to interpret. The following illustrations can help explain how FFT power data is rendered in a spectrogram format.

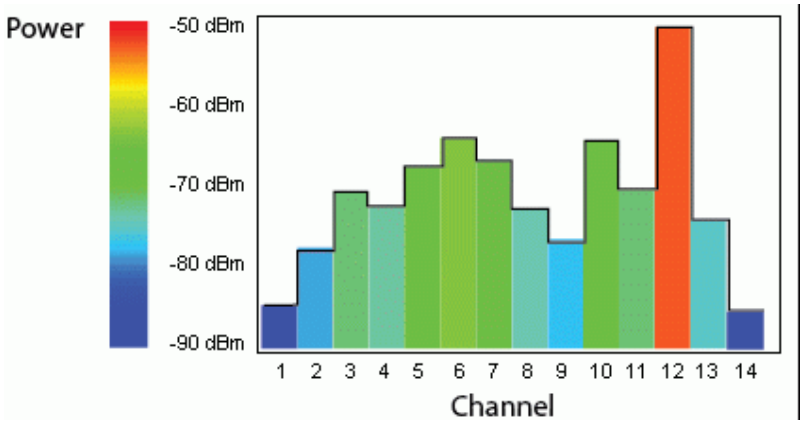
The example in Figure 152 shows how an FFT Power chart could appear if a single data measurement was plotted as a simple line graph.

Figure 152 *Simple Line Graph of FFT Power Data*



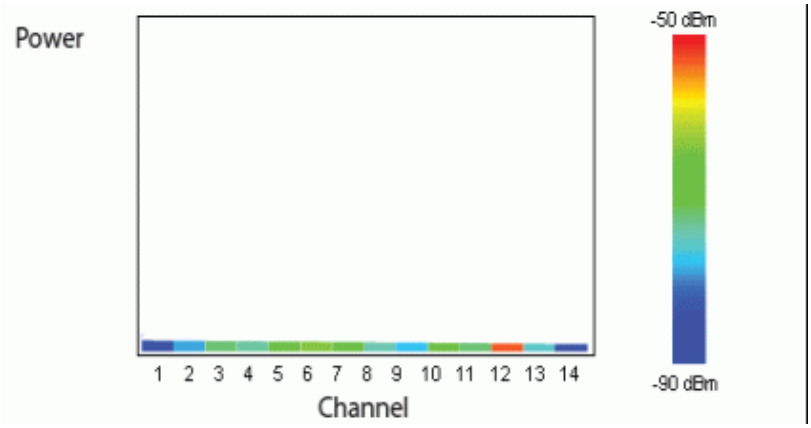
Now, suppose that each channel's FFT power level was also represented by a color that corresponded to that specific FFT power level. In the example below, channel 12 has a FFT power level of -50 dBm, so it is represented by the color red. Channel 1 has a FFT power level of -85 dBm, so it is represented by dark blue.

Figure 153 *FFT Power Line Graph with Color*



If the graph was then flattened so each channel's FFT power for that single1-second sweep was represented only by a color (and not by a value on the y-axis), the graph could then appear as follows:

Figure 154 *FFT Power Spectrogram Sample*



The spectrum analysis Swept Spectrogram measures FFT power levels or duty cycle data each second, so after every 1-second sweep, the newest data appears as a thin colored line on the bottom of the chart. Older data is

pushed up higher on the chart until it reaches the top of the spectrogram and ages out. The example below shows the Swept Spectrogram chart after it has recorded over 300 seconds of FFT data.

Figure 155 *Swept Spectrogram*

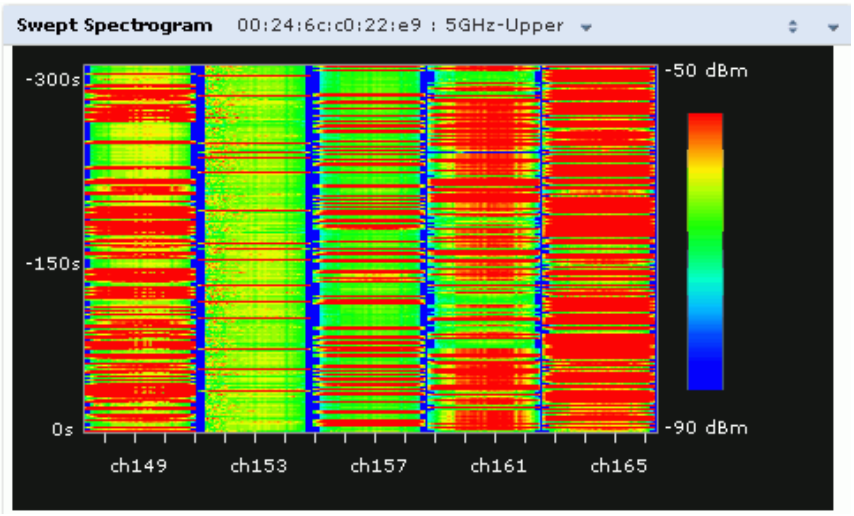


Table 141 describes the parameters you can use to customize the Swept Spectrogram chart. Click the down arrow in the upper right corner of this chart then click the Options menu to access these configuration settings. Once you have configured the desired parameters, click OK at the bottom of the Options menu to save your settings and return to the spectrum dashboards.

Table 141 *Swept Spectrogram Options*

Parameter	Description
Band	This field shows the radio band used by the spectrum monitor or hybrid AP radio (2.4 GHz or 5GHz). It is not selectable and cannot be changed via the Options window.
Channel Numbering	For spectrum monitors using the 5 GHz radio band, select either 20 MHz or 40 MHz channel numbering to identify a channel numbering scheme for the graph. NOTE: This parameter is not configurable for graphs created by hybrid APs or spectrum monitor radios that use the 2.4 GHz radio band.
X-Axis	Select either Channel or Frequency. to show FFT power or duty cycles for a range of channels or frequencies. If you select Frequency, you must select the radio frequency on which this chart should center, and determine the span of frequencies for the graph.
Channel Range	If you selected Channel in the X-Axis parameter, you must also specify a channel range to determine which channels will appear in the x-axis of this chart. Click the first drop-down list to select the lowest channel in the range, then click the second drop-down list to select the highest channel to appear in the chart. NOTE: This parameter is not configurable for graphs created by hybrid APs.
Center Frequency	If you selected Frequency in the X-Axis parameter, enter the frequency, in MHz, that you want to appear in the center of the x-axis of this chart.
Span	If you selected Frequency in the X-Axis parameter, specify the size of the range of frequencies around the selected center frequency. If you set a frequency span of 100 MHz, for example, the chart will show the swept spectrogram for a range of frequencies from 50MHz lower to 50 MHz higher than the selected center.

Table 141 *Swept Spectrogram Options (Continued)*

Parameter	Description
Color-Map Range	*If this chart is configured to show average or maximum FFT values,* the default color range on this chart represents values from -50dBm (red) to -90dBm (blue). If you would like the color range on this chart to represent a different range of FFT power levels, enter this range in the from and to entry blanks. For example, if you defined a color-map range from -60 to -80, then any FFT power level at or above -60 dBm would appear as red, and any FFT power level at or below -80 would appear blue. Only the channel or frequency qualities between -60 dBm and -80 dBm would be represented by gradiated colors within color range. *If this chart is configured to show the FFT duty cycle,* the default color range on this chart represents duty cycles from 0% (red) to 100% (blue). If you would like the color range on this chart to represent a different range of FFT duty cycle percentages, enter this range in the from and to entry blanks. For example, if you defined a color-map range from 25 to 75, then any FFT duty cycle at or below 25% would appear as red, and any FFT duty cycle at or below 75% would appear blue. Only the duty cycle levels between 25% and 75% would be represented by gradiated colors within color range. NOTE: If your swept spectrogram is showing a single color only, you may need to increase the color map range to display a greater range of values.
Show	Select FFT Avg, FFT Max or FFT Duty Cycle to select the type of data you want to appear in this chart.

Recording Spectrum Analysis Data

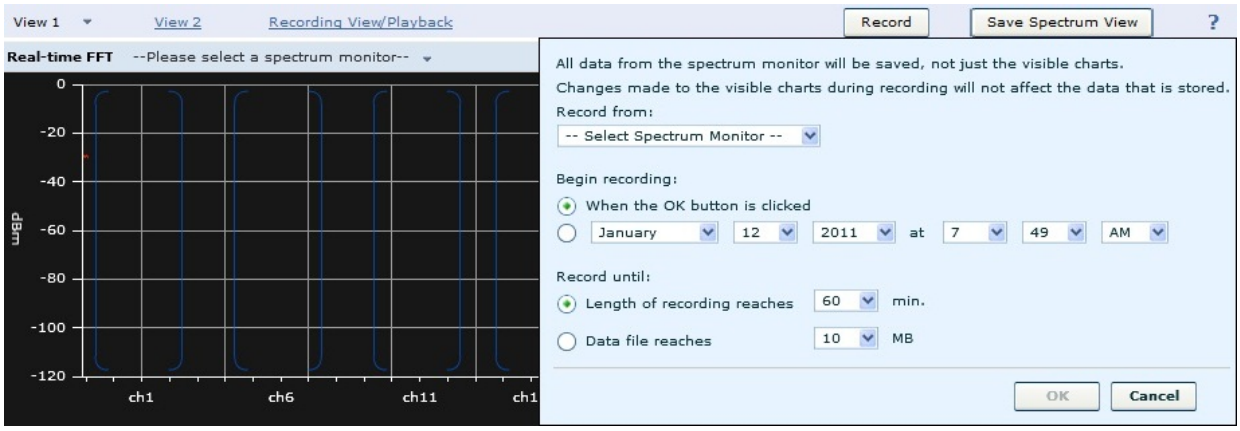
The spectrum analysis tool allows you to record up to 60 continuous minutes (or up to 10 Mb) of spectrum analysis data. By default, each spectrum analysis recording displays data for the Real-Time FFT, FFT Duty Cycle, and Swept Spectrogram charts, however, you can view device data for any the spectrum analysis charts supported by that spectrum monitor radio. Configurable recording settings allow you to start a recording session immediately, or schedule a recording time to begin at a later date and time. Each recording can be scheduled to end after a selected amount of time has passed, or continue on until recorded data file reaches a specified size. You can save the file your spectrum monitor client, then play back that data at a later time.

Creating a Spectrum Analysis Record

To record spectrum analysis data for later analysis:

1. Navigate to the Monitoring>Spectrum Analysis>Spectrum Dashboards window.
2. Click the Record button at the top of the window. The New Recording popup window appears.
3. Click the Record From link, and select the spectrum monitor whose data you want to record.
4. Next, decide whether you want the recording to start immediately, or at a later scheduled time. If you want the recording to start immediately, select When the OK button is clicked. To schedule a different starting time for the recording, click the date and time drop-down lists to select a starting month, day, year and time.
5. The recording will continue until either the specified amount of time has passed, or until the recording files reaches a selected size. Click the Length of recording reaches drop down list and select the amount of time the recording should last, or click the Data file reaches drop down list and select the maximum file size for the recording.
6. Click OK to save your settings. If you selected the When the OK button is clicked option in step 5, the recording will begin.

Figure 156 *Recording Spectrum Analysis Data*



While the recording is in progress, a round, red recording icon and recording status information appears at the top of the spectrum dashboard. You will be allowed to view data for other spectrum monitors and charts while the recording is in progress. If you want to stop the recording before recording period has finished, click the Stop button by the recording status information. When you click the stop button, a popup window appears and allows you to stop and delete the current recording, stop and save the recording in its current state (before it has completed), or continue recording again.

Saving the Recording

After the recording has ended, either because the recording period has elapsed, the recording maximum file size has been reached, the Spectrum Monitor Recording Complete window appears and displays information for the current recording.

Figure 157 *Saving Spectrum Analysis Data*

To save the recording file:

1. From the Spectrum Monitor Recording Complete window, click Continue.
2. A Save As window appears and prompts you to select a file name for the recording and a location to save the file.
3. Click Save.

Playing a Spectrum Analysis Recording

The spectrum monitor does not have to be subscribed to your spectrum analysis client in order to play back a recording in the spectrum dashboard. Note, however, that you cannot play back an existing recording in the spectrum dashboard while another recording session is currently in progress.

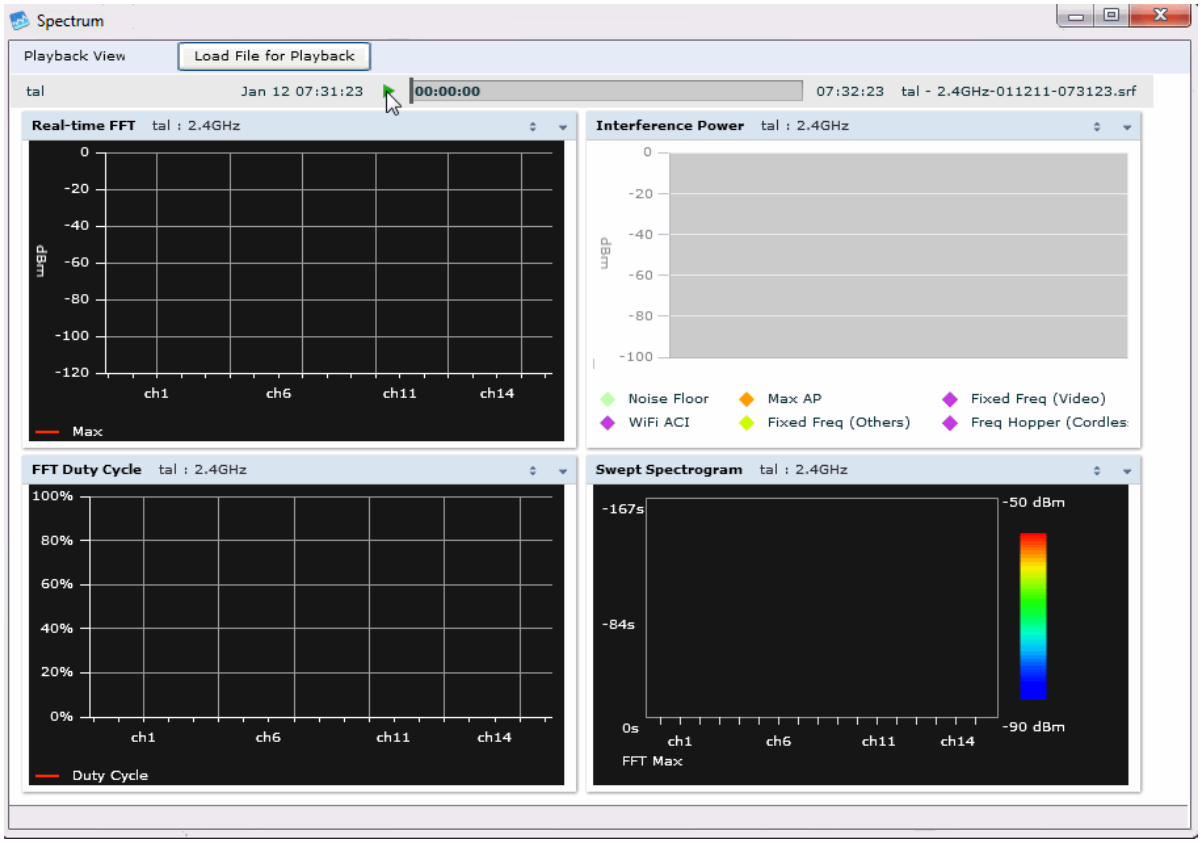
To play a spectrum analysis recording in the spectrum dashboard:

1. Navigate to Monitoring>Spectrum Analysis>Spectrum Dashboards window.
2. Click the Recording View/Play link at the top of the window.
3. Click Load File For Playback.

4. An Open dialog box appears and prompts you to browse to and select the file you want to open.
5. Click Open.
6. Click the triangular *play* icon at the top of the window to start playing back the recording.

Recorded data for the selected spectrum monitor and dashboard view appears in the spectrum analysis dashboard. A playback progress bar at the top of the window shows what part of the recording currently appears on the dashboard. You can also replace any of the graphs in the dashboard with a different graph type while replaying the recording.

Figure 158 *Playing a Recording with the Spectrum Playback Tool*



Non-Wi-Fi Interferers

The following table describes each type of non-Wi-Fi interferer detected by the spectrum analysis feature. These devices appear in the following charts:

- Active Devices
- Active Devices Table
- Active Devices Trend
- Device Duty Cycle
- Device vs Channel
- Interference Power

Table 142 *Non-Wi-Fi Interferer Types*

Non-Wi-Fi Interferer	Description
Bluetooth	Any device that uses the Bluetooth protocol to communicate in the 2.4 GHz band is classified as a *Bluetooth* device. Bluetooth uses a frequency hopping protocol.
Fixed Frequency (Audio)	Some audio devices such as wireless speakers and microphones also use fixed frequency to continuously transmit audio. These devices are classified as *Fixed Frequency (Audio)*.
Fixed Frequency (Cordless Phones)	Some cordless phones use a fixed frequency to transmit data (much like the fixed frequency video devices). These devices are classified as *Fixed Frequency (Cordless Phones)*.
Fixed Frequency (Video)	Video transmitters that continuously transmit video on a single frequency are classified as *Fixed Frequency (Video*). These devices typically have close to a 100% duty cycle. These types of devices may be used for video surveillance, TV or other video distribution, and similar applications.
Fixed Frequency (Other)	All other fixed frequency devices that do not fall into one of the above categories are classified as *Fixed Frequency (Other*). Note that the RF signatures of the fixed frequency audio, video and cordless phone devices are very similar and that some of these devices may be occasionally classified as Fixed Frequency (Other).
Frequency Hopper (Cordless Base)	Frequency hopping cordless phone base units transmit periodic beacon-like frames at all times. When the handsets are not transmitting (i.e., no active phone calls), the cordless base is classified as *Frequency Hopper (Cordless Base*).
Frequency Hopper (Cordless Network)	When there is an active phone call and one or more handsets are part of the phone conversation, the device is classified as *Frequency Hopper (Cordless Network*). Cordless phones may operate in 2.4 GHz or 5 GHz bands. Some phones use both 2.4 GHz and 5 GHz bands (for example, 5 GHz for Base-to-handset and 2.4 GHz for Handset-to-base). These phones may be classified as unique Frequency Hopper devices on both bands.
Frequency Hopper (Xbox)	The Microsoft Xbox device uses a frequency hopping protocol in the 2.4 GHz band. These devices are classified as *Frequency Hopper (Xbox*).
Frequency Hopper (Other)	When the classifier detects a frequency hopper that does not fall into one of the above categories, it is classified as Frequency Hopper (Other). Some examples include IEEE 802.11 FHSS devices, game consoles and cordless/hands-free devices that do not use one of the known cordless phone protocols.
Microwave	Common residential microwave ovens with a single magnetron are classified as a *Microwave*. These types of microwave ovens may be used in cafeterias, break rooms, dormitories and similar environments. Some industrial, healthcare or manufacturing environments may also have other equipment that behave like a microwave and may also be classified as a Microwave device.
Microwave (Inverter)	Some newer-model microwave ovens have the inverter technology to control the power output and these microwave ovens may have a duty cycle close to 100%. These microwave ovens are classified as *Microwave (Inverter)*. Dual-magnetron industrial microwave ovens with higher duty cycle may also be classified as Microwave (Inverter). As in the Microwave category described above, there may be other equipment that behave like inverter microwaves in some industrial, healthcare or manufacturing environments. Those devices may also be classified as Microwave (Inverter).
Generic Interferer	Any non-frequency hopping device that does not fall into one of the other categories described in this table is classified as a *Generic Interferer*. For example a Microwave-like device that does not operate in the known operating frequencies used by the Microwave ovens may be classified as a Generic Interferer. Similarly wide-band interfering devices may be classified as Generic Interferers.

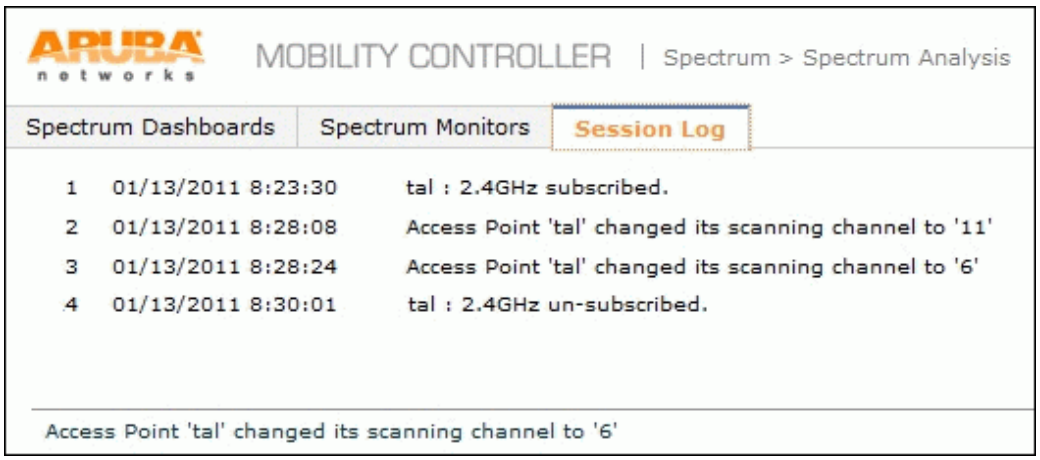
Spectrum Analysis Session Log

The spectrum analysis Session Log tab displays times the spectrum monitors and hybrid APs connected to or disconnected from the spectrum client during the current browser session. This tab also shows changes in a hybrid AP's scanning channel caused by changes to the hybrid AP's 802.11a or 802.11g radio profile or automatic channel changes by the DFS or ARM features. The latest entry in the session log is also displayed in a footer at

the bottom of the Spectrum Monitors and Spectrum Dashboard window. When you close the browser and end your spectrum analysis session, the session log will be cleared.

The example in Figure 159 shows that a 2.4 GHz radio on hybrid AP was connected to the spectrum analysis client, its channel changed twice, then was disconnected from the spectrum client.

Figure 159 *Spectrum Analysis Session Logs*



Viewing Spectrum Analysis Data via the CLI

You can use the command-line interface to view spectrum analysis data from any spectrum monitor, even if that spectrum monitor is currently sending data to another spectrum monitor client's WebUI. Table 143 shows the commands that display spectrum analysis data in the CLI interface.

Table 143 *Spectrum Analysis CLI Commands*

Command	Description
`show ap spectrum ap-list`	This command shows spectrum data seen by an access point that has been converted to a spectrum monitor.
`show ap spectrum channel-metrics`	This command shows channel utilization information for a 802.11a or 802.11g radio band, as seen by a spectrum monitor
`show ap spectrum channel-summary`	This command displays a summary of the 802.11a or 802.11g channels seen by a spectrum monitor.
`show ap spectrum client-list`	This command shows details for Wi-Fi clients seen by a specified spectrum monitor.
`show ap spectrum debug`	Sub-commands under this command save spectrum analysis channel information to a file on the controller.
`show ap spectrum device-duty-cycle`	Shows the current duty cycle for devices on all channels being monitored by the spectrum monitor radio.
`show ap spectrum device-history`	This command displays spectrum analysis history for non-interfering devices.
`show ap spectrum device-list`	Show a device summary table and channel information for non-Wi-Fi devices currently seen by the spectrum monitor.
`show ap spectrum device-log`	This command shows a time log of add and delete events for non-Wi-Fi devices.
`show ap spectrum device-summary`	This command shows the numbers of Wi-Fi and non-Wi-Fi device types on each channel monitored by a spectrum monitor.

Table 143 *Spectrum Analysis CLI Commands (Continued)*

Command	Description
`show ap spectrum interference-power`	This command shows the interference power detected by a 802.11a or 80211g radio on a spectrum monitor.
`show ap spectrum monitors`	This command shows a list of APs currently configured as spectrum monitors.
`show ap spectrum technical-support`	Save spectrum data for later analysis by your Dell technical support representative.

Spectrum Analysis Troubleshooting Tips

Spectrum Monitors support One Client per Radio

Each spectrum monitor radio can only send information to one client at a time. If you log into a controller and the spectrum monitor dashboard does not display any data for the selected radio, another user may be logged in to the controller at that time. Note that dual-radio spectrum monitors may be accessed by two clients; one client for each radio.

Converting a Spectrum Monitor back to an AP or Air Monitor

If you are trying to convert a spectrum monitor radio to back to AP or AM mode but the radio still comes up as a spectrum monitor, access the command-line interface and see if that spectrum monitor appears in the output of the show ap spectrum local-override command. If the spectrum monitor does appear in the local override profile table, issue the command ap spectrum local-override no override ap-name <ap-name> spectrum-band <spectrum-band>" to remove the local override for that spectrum monitor and return the radio to AP or AM mode.

Browser Issues

If you access the spectrum analysis dashboard using the Safari 5.0 browser, clicking the backspace button may return you to the previous browser screen. Avoid using the backspace button when changing dashboard view names or chart options.

If you are recording spectrum analysis data or playing back a spectrum analysis recording using a Mac client, do not minimize the browser window while the recording is in progress, as that may cause the Adobe Flash player to pause.

Loading a Spectrum View

If your client is unable to load a saved spectrum view in the spectrum dashboard, access the CLI in enable mode and issue the command ap spectrum clear-webui-view-settings to delete the saved spectrum view.

Issues with Adobe Flash Player 10.1

Removing focus from the browser window displaying the spectrum analysis dashboard may cause Adobe Flash 10.1 to stop updating the spectrum charts in order to reduce CPU usage. When you restore focus to the spectrum analysis dashboard, you may see the spectrum charts update rapidly as the display catches up. Recorded data may be inaccurate if you navigate away from the spectrum window during a recording. Flash 10.0 does not have this issue.

Spectrum Analysis Syslog Messages

The spectrum analysis feature can send four different types of syslog messages: wifi add, wifi delete, non-wifi add, and non-wifi delete. All messages are in the wireless category at the syslog severity level NOTICE.

The four syslog message types appear in the following formats:

- AM: Spectrum: new wifi device found = [addr:%s] SSID = [ssid:%s] BSSID [bssid_str:%s] DEVICE ID [did:%d]
- AM: Spectrum: deleting wifi device = [addr:%s] SSID = [ssid:%s] BSSID [bssid_str:%s] DEVICE ID [did:%d]
- AM: Spectrum: new non-wifi device found = DEVICE ID [did:%u] Type [dytpe:%s] Signal [sig:%u] Freq [freq:%u]KHz Bandwidth [bw:%u]KHz
- AM: Spectrum: deleting non-wifi device = DEVICE ID [did:%d] Type [dtype:%s]

Chapter 34

Software Licenses

ArubaOS base features include sophisticated authentication and encryption, protection against rogue wireless APs, seamless mobility with fast roaming, the origination and termination of IPsec/L2TP/PPTP tunnels between controllers, clients, and other VPN gateways, adaptive RF management and analysis tools, centralized configuration, and location tracking.

Optional add-on licenses provide advanced feature such as Wireless Intrusion Protection and Policy Enforcement Firewall. Evaluation licenses are available for some of these advanced features.

ArubaOS licenses are detailed in the following sections:

Terminology

For clarity, the following terminology is used throughout this chapter.

- Bundle—a cost effective way to purchase functionality that supports a controller and *x*-number of APs.
- Certificate ID—the identification number attached to the Software License Certificate. The Certificate ID is used in conjunction with the controller's (chassis or W-6000M3) serial number to create the License Key.
- Evaluation License—a license that allows you to evaluate a feature set (or module) for a maximum of 90 days. The evaluation licenses are uploaded in 30 day increments. Only modules that offer new and unique functionality support Evaluation Licenses.
- License Certificate—a certificate (soft copy) that contains license information including:
  - License Description
  - Quantity
  - Part Number/Order Number
  - Certificate ID
- License Database—the licenses installed on your controller
- License Key—generated from the controller serial number
- Permanent License—the opposite of an evaluation license. This license permanently installs the specific features represented by the license.
- Upgrade License—a license that adds AP capacity to your controller. Note that Upgrade Licenses do not support an evaluation license.

Licenses

Each license refers to specific functionality (or module) that supports unique features. The licenses are:

- Base OS—base operating functions including VPN and VIA clients.
- AP Capacity —capacity license for RAP indoor and outdoor Mesh APs. Campus, Remote, or Mesh APs can terminate on the controller without the need for a separate license.
- Advanced Cryptography (ACR)—this is required for the Suite B Cryptography in IPsec and 802.11 modes. License enforcement behavior controls the total number of concurrent connections (IPsec or 802.11) using Suite B Cryptography. Bundled with this license are the xSec license features.
- Policy Enforcement Firewall Virtual Private Network (PEFV)—enables Policy Enforcement Firewall for VIA clients. This is a controller license.
- Policy Enforcement Firewall Next Generation (PEFNG)—Wired, WLAN Licensed per AP numbers including user roles, access rights, Layers 4 through 7 traffic control, per-service prioritization/QoS, authentication/accounting APIs, External Service Interfaces (ESI), Voice and Video. This is an AP count license.
- Public Access—reserved for future use.
- RFprotect—Wireless Intrusion Protection (WIPS) and Spectrum Analysis. This is an AP count license.
- xSec (Extreme Security) for Federal—Layer 2 VPN for wired or wireless using FIPS-approved algorithms.
- Internal Test Functions—for internal use only.

License Types

These are the license categories available:

- Permanent license—This type of license permanently enables the desired software module on a specific Dell controller. You obtain permanent licenses through the sales order process only. Permanent software license keys are sent to you via email.
- Evaluation license—This type of license allows you to evaluate the unrestricted functionality of a software module on a specific controller for 90 days (in three 30-day increments).

  An expired evaluation license will remain in the license database until the controller is reset using the command write erase all where all license keys are removed. An expired evaluation license has no impact on the normal operation of the controller. It is kept in the license database to prevent abuse.

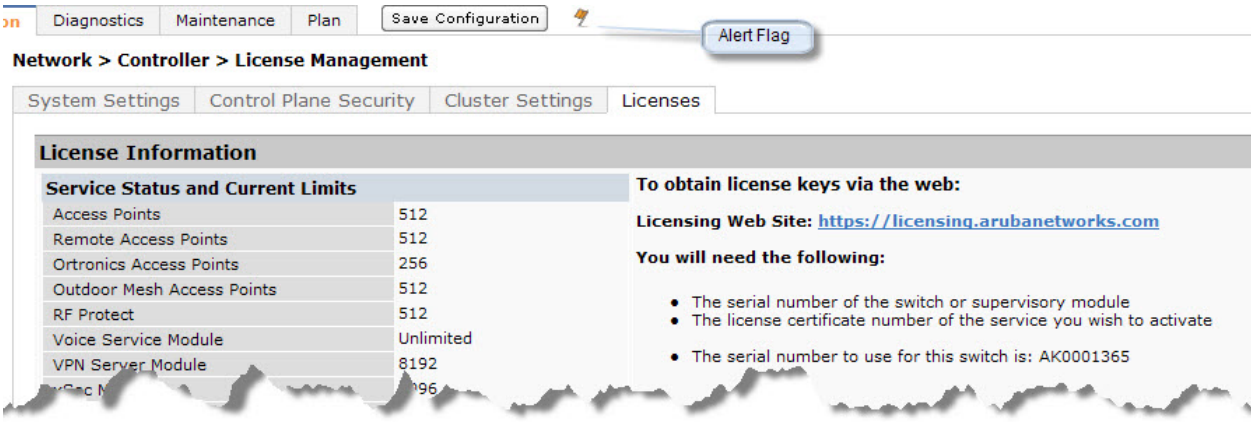
CAUTION: When license keys are applied on a controller, abnormal tampering of the device's system clock (setting the system clock back) results in the disabling of software licensed modules and their supported features. This can affect network services.

To determine your time remaining on an evaluation license, a banner is displayed when you log in through the command line:

```
NOTICE
NOTICE -- This switch has active licenses that will expire in 29 days
NOTICE
NOTICE -- See 'show license' for details.
NOTICE
```

From the WebUI, an "Alert" appears with information regarding the evaluation license status (see Figure 160).

Figure 160 *Alert Flag*



At the end of the 90-day period, you must apply for a permanent license to re-enable the features permanently on the controller. Evaluation software license keys are only available in electronic form and are emailed to you.

When an evaluation period expires:

- The controller automatically backs up the startup configuration and reboots itself at midnight (according to the system clock).
- All permanent licenses are unaffected. The expired evaluation licensed feature is no longer available and is displayed as Expired in the WebUI.

- Upgrade license—This license expands AP capacity. There are no Evaluation licenses available for Upgrade licenses.

Multi-Controller Network

In order to configure each feature on the local controller, the master controller(s) must be licensed for each feature configured on the local controllers. If present, a backup master must be licensed with the same features as the Master. Backup controllers are “hot-standby”, that is, the backup controller processes AP, traffic, etc. while standing by in backup mode.

Dell PowerConnect best practices is to install the same set of feature licenses on every controller in your network.

License Usage

Licenses are platform independent and can be installed on any Dell controller. Installation of the feature license unlocks that feature’s functionality for the maximum capacity of the controller.

NOTE: The license limits are enforced until you reach the controller limit (see Table 145)

The controllers are: Controller categories are based on architecture:

- MIPS Controllers—W-6000M3, W-3000 Series, W-600 Series

Table 144 list how licenses are consumed on the MIPS Controllers.

Table 144 *Usage per License*

License	Basis	What Consumes One License
PEFNG	AP	One operational AP
xSec	Session	One active client termination

Table 144 *Usage per License (Continued)*

License	Basis	What Consumes One License
RFprotect	AP	One operational AP
AP	AP	One operational LAN-connected or mesh AP that is advertising at least one BSSID (virtual-AP) or RAP
ACR	Session	One active client termination

The MIPS controller licenses are variable-capacity (see Table 145).

NOTE: In Table 145, the Remote AP count is equal to the total AP count for all the controllers. The Campus AP count is 1/4 of the total AP count *except* for the M3 which is 1/2 the AP count.

Table 145 *MIPS Controller AP Capacity*

Controller	Total AP Count	Campus APs	Remote APs
W-6000M3	1024	512	1024
W-3200	128	32	128
W-3400	256	64	256
W-3600	512	128	512
W-620	32	8	32
W-650	64	16	64
W-651	64	16	64

Interaction

The various licenses do require some equality and other important interactions.

- AP/PEFNG and RFprotect must be equal
  - All active APs run AP/PEFNG and RFprotect services (if enabled). If they are not equal, the number of active APs are restricted to the minimum of the AP/PEFNG and RFprotect license count.

NOTE: It is not possible to designate specific APs for RFprotect/non-RFprotect operations.

  - Mesh portals/mesh points, with no virtual-APs, do not consume a RFprotect license
- If a Mesh node is also configured for client service (advertises a BSSID for example), it consumes one AP license
- RAPs consume only AP licenses
- ACR Interaction
  - On a platform that supports 2048 IPsec tunnels, the maximum number of Suite B IPsec tunnels supported is 2048, even if a larger capacity license is installed.
  - The ACR license is cumulative. If you want to support 2048 Suite B connections, install two ACR licenses (LIC-ACR-1024).

- An evaluation ACR license is available (EVL-ACR-1024). You can install the ACR evaluation license with a higher capacity than the platform maximum.
- On a platform that supports 2048 IPsec tunnels, with a LIC-ACR-512 installed, only 512 IPsec tunnels can be terminated using Suite B encryption. An additional 1536 IPsec tunnels, using non-Suite B modes (e.g. AES-CBC), can still be supported.
- On a platform with LIC-ACR-512 installed, a mixture of IPsec and 802.11i Suite B connections can be supported. The combined number of these sessions may not exceed 512.
- A single client using both 802.11i Suite B and IPsec Suite B simultaneously will consume two ACR licenses.

Best Practices

- Back up the controller's configuration (backup flash command) and back up the License database (license export *filename*) before making any changes.

```
(host) #backup flash
Please wait while we tar relevant files from flash...
Please wait while we compress the tar file...
Checking for free space on flash...
Copying file to flash...
File flashbackup.tar.gz created successfully on flash.
Please copy it out of the switch and delete it when done.
(host) #license export licensebackup.db
Successfully exported 1 licenses from the License Database to licensebackup.db
```

- Allow for the maximum quantity required at any given time
- When calculating AP licenses, determine the normal AP load of your controller and add backup load for failure scenarios
- Use 20 users per AP as a reasonable estimate when calculating user licenses. Do not forget to consider occasional large assemblies or gatherings.

Installing a License

The Dell licensing system is controller-based. A license key is a unique alphanumerical string generated using the controller's serial number and is valid only for that controller only. Licenses can be pre-installed at the factory so that all licensed features are available upon initial setup. Or you can install licenses features yourself.

NOTE: Dell recommends that you obtain a user account on the Dell Software License Management website even if software license keys are pre-installed on your controller.

Enabling a new license on your controller

The basic steps to installing and enabling a new license feature are listed below along with a reference to a section in this document with more detailed information.

1. Obtain a valid Dell software license from your sales account manager or authorized reseller (see "Software License Email" on page 656).
2. Locate the system serial number of your controller or W-6000M3 (see "Locating the System Serial Number" on page 656).
3. Use your system's serial number to obtain a software license key from the Dell Software License Management website at (see "Obtaining a Software License Key" on page 656).

4. Enter the software license key via the controller's WebUI; navigate to Configuration > Network > Controller > System Settings page and select the License tab. Enter the software license key and click Apply (see "Applying the Software License Key in the WebUI" on page 657).

   Or

   Launch the License Wizard from the Configuration tab and click the New button. Enter the software license key in the space provided (see "Applying the Software License Key in the License Wizard" on page 657).
5. Reboot your controller to enable your new license and features.

Software License Email

To obtain either a permanent or evaluation software license, contact your sales account manager or authorized reseller. The license details are provided via email with an attached text file. Use the text file to cut and paste the licensing information into the WebUI or at the command line.

NOTE: Ensure that you have provided your sales person with a valid email address.

The email also includes:

- The orderable part number for the license
- A description of the software module type and Dell controller for which it is valid
- A unique, 32-character alphanumerical string used to access the license management website and which, in conjunction with the serial number of your controller, generates a unique software license key

Locating the System Serial Number

Each controller and W-6000M3 have unique serial numbers located at the rear of the controller or on the W-6000M3 itself. The location of the serial number is:

- at the rear of an Dell controller chassis
- on the W-6000M3 itself

You can also find the serial numbers by navigating to the Controller > Inventory page on the WebUI or by executing the show inventory command from the CLI.

NOTE: To physically inspect the system serial number on a W-6000M3, you need to remove the card from the controller chassis, which may result in network down time.

Obtaining a Software License Key

To obtain a software license key, you must log in to the Dell License Management website.

If you are a first time user of the licensing site, you can use the software license certificate ID number to log in initially and request a user account. If you already have a user account, log in to the site.

Once logged in, you are presented with several options:

- Activate a certificate: Activate a new certificate and create the software license key that you will apply to your controller.
- Transfer a certificate: Transfer a software license certificate ID from one controller to another (for example, transferring licenses to a spare system).
- Import preloaded certificates: For controllers on which licenses are pre-installed at the factory. transfer all software license certificate IDs used on the sales order to this user account.
- List your certificates: View all currently available and active software license certificates for your account.

Creating a software license key

1. Select Activate a Certificate.
2. Enter the certificate ID number and the system serial number of your controller.
3. Review the license agreement and select Yes to accept the agreement.
4. Click Activate it. A copy of the transaction and the software license key is emailed to you at the email address you entered for your user account

NOTE: The software license key is *only* valid for the system serial number for which you activated the certificate.

Applying the Software License Key in the WebUI

To enable the software module and functionality, you must apply the software license key to your controller: Log in to your controller's WebUI.

1. Navigate to the Configuration > Network > Controller > System Settings page and select the License tab.
2. Copy the software license key, from your email, and paste it into the Add New License Key field. Click Add.
3. Reboot your controller to enable the new license feature.

Applying the Software License Key in the License Wizard

Log in to your controller's WebUI.

1. Launch the License Wizard from the Configuration tab and click the New button.
2. The License Wizard will step you through the activation process. Click on the Help tab within the License Wizard for additional assistance.
3. Reboot your controller to enable the new license feature.

Deleting a License

To remove a license from a system:

1. Navigate to the Configuration > Network > Controller > System Settings page and select the License tab.
2. Scroll down to the License Table and locate the license you want to delete.
3. Click the Delete button at the far right hand side of the license to delete the license.

   If a license feature is under an evaluation license, no key is generated when the feature is deleted.

Moving Licenses

It may become necessary to move licenses from one controller to another or simply delete the license for future use. To move licenses, delete the license from the chassis as described in"Deleting a License" on page 657. Then install the license key on the new controller as described in "Applying the Software License Key in the WebUI" on page 657.

CAUTION: The ability to move a license from one controller to another is provided for maximum flexibility in managing an organization's network and to minimize an RMA impact. License fraud detection is monitored and enforced by Dell. Abnormally high volumes of license transfers for the same license certificate to multiple controllers can indicate breach of the Dell end user software license agreement and will be investigated.

Resetting the Controller

Rebooting or resetting a controller has no effect on either permanent or evaluation licenses.

Issuing the write erase command on a controller running software licenses does *not* affect the license key management database on the controller.

Issuing the write erase all command resets the controller to factory defaults, and deletes all databases on the controller including the license key management database. You must reinstall all previously-installed license keys.

Chapter 35

IPv6 Support

This chapter describes ArubaOS support for IPv6 clients.

About IPv6

The IPv6 protocol enables the next generation of large-scale IP networks by supporting addresses that are 128 bits long. This allows 2^{128} possible addresses (versus 2^{32} possible IPv4 addresses).

Typically, the IP address assigned on an IPv6 host consists of a 64-bit subnet identifier and a 64-bit interface identifier. IPv6 addresses are represented as eight colon-separated fields of up to four hexadecimal digits each. The following are examples of IPv6 addresses:

```
FEDC:BA98:7654:3210:FEDC:BA98:7654:3210
1080:0:0:0:0:800:200C:417A
```

The use of the "::" symbol is a special syntax that you can use to compress one or more 16-bit groups of zeros or to compress leading or trailing zeros in an address. The "::" can appear only once in an address. For example, the address, `1080:0:0:0:0:800:200C:417A` can also be represented as `1080::800:200C:417A`.

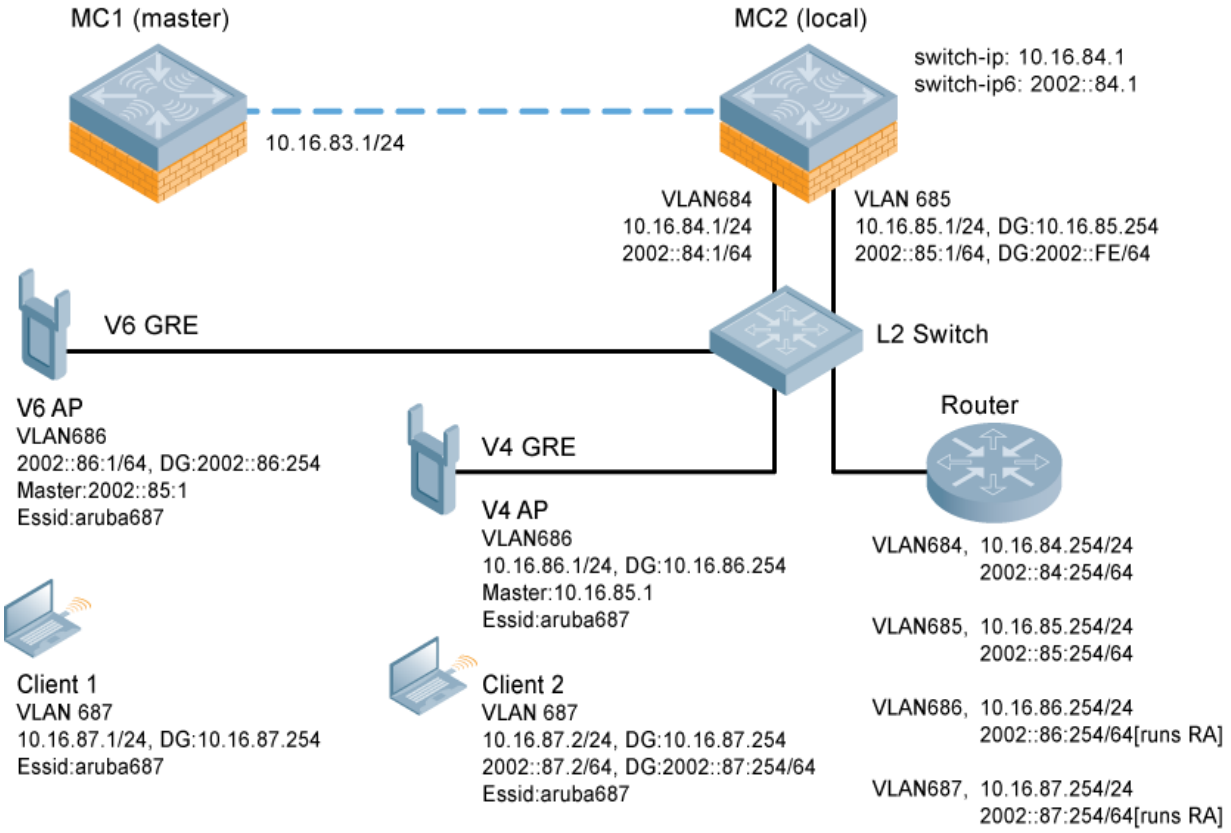
IPv6 uses subnet identifiers to identify subnetworks to which nodes are attached. In ArubaOS, when you refer IPv6 subnetworks in firewall policies, you must specify a subnet mask in addition to the IPv6 address. The subnet mask is a bitmask that specifies the prefix length. For example, `1080::800:200C:417A ffff:ffff:ffff:ffff::` represents all IPv6 addresses with the subnet identifier `1080:0:0:0`.

IPv6 Topology

IPv6 APs connect to the IPv6 controller over an IPv6 L3 network. The IPv6 controller can terminate both IPv4 and IPv6 APs. IPv4 and IPv6 clients can terminate to either IPv4 or IPv6 APs. An external IPv6 router is required in the subnet to generate router advertisements (RA), if the IPv6 APs and clients depend on stateless autoconfiguration to obtain IPv6 address. The external IPv6 router is the default gateway in most deployments. However, the controller can be the default gateway by using static routes.The master-local communication always happens in IPv4.

The following image illustrates how IPv6 clients, APs, and controller communicate with each other in an IPv6 network.

Figure 161 *IPv6 Topology*



- The IPv6 controller (MC2) terminates both V4 AP (IPv4 AP) and V6 AP (IPv6 AP).
- Client 1 (IPv4 client) terminates to V6 AP and Client 2 (IPv6 client) terminates to V4 AP.
- Router is an external IPv6 router in the subnet to generate RAs and acts as the default gateway in this illustration.
- MC1 (master) and MC2 (local) communicates in IPv4.

IPv6 Support for Controller and AP

This release of ArubaOS provides IPv6 support for controller and access points. You can now configure the master controller with an IPv6 address to manage the controllers and APs. Both IPv4 and IPv6 APs can terminate on the IPv6 controller. You can provision an IPv6 AP in the network only if the controller interface is configured with an IPv6 address. An IPv6 AP can serve both IPv4 and IPv6 clients.

NOTE: You must manually configure an IPv6 address on the controller interface to enable IPv6 support.

You can perform the following IPv6 operations on the controller:

- “Configure IPv6 Interface Address” on page 662
- “Configure IPv6 Static Neighbor” on page 663
- “Configure IPv6 Default Gateway and Static IPv6 Routes” on page 663
- “Manage Controller IP Address” on page 664

- “Configure Multicast Listener Discovery (MLD)” on page 664
- “Debug IPv6 Controller” on page 665
- “Provision IPv6 AP” on page 666

You can also view the IPv6 statistics on the controller using the following commands:

- `show datapath ip-reassembly ipv6`: View the IPv6 contents of the IP Reassembly statistics table.
- `show datapath route ipv6`: View datapath IPv6 routing table.
- `show datapath route-cache ipv6`: View datapath IPv6 route cache.
- `show datapath tunnel ipv6`: View the tcp tunnel table filtered on IPv6 entries.
- `show datapath user ipv6`: View datapath IPv6 user statistics such as current entries, pending deletes, high water mark, maximum entries, total entries, allocation failures, invalid users, and maximum link length.
- `show datapath session ipv6`: View datapath IPv6 session entries and statistics such as current entries, pending deletes, high water mark, maximum entries, total entries, allocation failures, invalid users, and maximum link length.

Additionally, you can view the IPv6 AP information on the controller using the following show commands:

- `show ap database`
- `show ap active`
- `show user`
- `show ap details ip6-addr`
- `show ap debug`

The following table gives the list of features that are supported and not supported on IPv6 APs:

Table 146 *IPv6 APs Support Matrix*

Features	Supported on IPv6 APs?
Forward Mode - Tunnel	Yes
Forward Mode - Decrypt Tunnel	No
Forward Mode - Bridge	No
Forward Mode - Split Tunnel	No
AP Type - CAP	Yes
AP Type - RAP	No
AP Type - Mesh Node	No
IPSEC	No
CPSec	No
Wired-AP/Secure-Jack	No
Fragmentation/Reassembly	Yes
MTU Discovery	Yes
Provisioning through Static IPv6 Addresses	Yes
Provisioning through IPv6 FQDN Master Name	Yes
Provisioning from WebUI	Yes
AP boot by Flash	Yes

Table 146 *IPv6 APs Support Matrix (Continued)*

Features	Supported on IPv6 APs?
AP boot by TFTP	No
WMM QoS	No
AP Debug and Syslog	Yes
ARM & AM	Yes
WIDS	Yes (Limited)
CLI support for users & datapath	Yes

Configure IPv6 Interface Address

You can configure IPv6 addresses for the management interface, VLAN interface, and the loopback interface of the controller. The controller can have up to three IPv6 addresses for each VLAN interface. The IPv6 address configured on the loopback interface or the first VLAN interface of the controller becomes the default IPv6 address of the controller.

NOTE: If only one IPv6 address is configured on the controller, it becomes the default IPv6 address of the controller. You cannot delete the IPv6 address unless there is an IPv6 address configured for the loopback interface or a VLAN interface of the controller.

You can configure IPv6 interface address using the WebUI or CLI.

Using WebUI

To Configure Link Local Address

1. Navigate to the Configuration > Network > IP page and select the IP Interfaces tab.
2. Edit a VLAN # and select IP version as IPv6.
3. Enter the link local address in the Link Local Address field.
4. Click the Apply button to apply the configuration.

To Configure Global Unicast Address

1. Navigate to the Configuration > Network > IP page and select the IP Interfaces tab.
2. Edit a VLAN # and select IP version as IPv6.
3. Enter the global unicast address and the prefix-length in the IP Address/Prefix-length field.
4. (Optional) Select the EUI64 Format check box, if applicable.
5. Click the Add button add the address to the global address list.
6. Click the Apply button to apply the configuration.

To Configure Loopback Interface Address

1. Navigate to the Configuration > Network > Controller page and select the System Settings tab.
2. Under Loopback Interface enter the loopback address in the IPv6 Address field.
3. Click the Apply button to apply the configuration.

NOTE: You cannot configure the management interface address using the WebUI.

Using CLI

To configure link local address

```
(host)(config)#interface vlan <vlan#>
(host)(config-subif)#ipv6 address <ipv6-address> link-local
```

To configure global unicast address

```
(host)(config)#interface vlan <vlan#>
(host)(config-subif)#ipv6 address <ipv6-prefix>/<prefix-length>
```

To configure global unicast address (EUI 64 format)

```
(host)(config)#interface vlan <vlan#>
(host)(config-subif)#ipv6 address <ipv6-prefix/prefix-length> eui-64
```

To configure management interface address

```
(host)(config)#interface mgmt
(host)(config-subif)#ipv6 address <ipv6-prefix/prefix-length>
```

To configure loopback interface address

```
(host)(config)#interface loopback
(host)(config-subif)#ipv6 address <ipv6-prefix>
```

Configure IPv6 Static Neighbor

You can configure a static neighbor on a VLAN interface either using the WebUI or the CLI.

Using WebUI

1. Navigate to the Configuration > Network > IP page and select the IPv6 Neighbors tab.
2. Click the Add button and enter the following details of the IPv6 neighbor:
   - IPv6 Address
   - Link-layer Addr
   - VLAN Interface
3. Click the Done button to apply the configuration.

Using CLI

To configure a static neighbor on a VLAN interface

```
(host)(config)#ipv6 neighbor <ipv6addr> vlan <vlan#> <mac>
```

Configure IPv6 Default Gateway and Static IPv6 Routes

You can configure IPv6 default gateway and static IPv6 routes using the WebUI or CLI.

Using WebUI

To Configure IPv6 Default Gateway

1. Navigate to the Configuration > Network > IP page and select the IP Routes tab.
2. Under the Default Gateway section, click the Add button.
3. Select IPv6 as IP Version, and enter the IPv6 address in the IP Address field.
4. Click the Add button to add the address to the IPv6 default gateway table.
5. Click the Apply button to apply the configuration.

To Configure Static IPv6 Routes

1. Under the IP Routes section, click the Add button and select IPv6 as IP Version.

2. Enter the destination IP address and the forwarding settings in the respective fields.
3. Click the Done button to add the static route to the IPv6 routes table.
4. Click the Apply button to apply the configuration.

Using CLI

To configure IPv6 default gateway

```
(host)(config)#ipv6 default-gateway <ipv6-address> <cost>
```

To configure static IPv6 routes

```
(host)(config)#ipv6 route <ipv6-prefix/prefix-length> <ipv6-next-hop> <cost>
<ipv6-next-hop>  = X:X:X:X::X
```

Manage Controller IP Address

You can change the default controller IP address by assigning a different VLAN interface address or the loop back interface address. You can also turn on Syslog messaging for IPv6 (similar to IPv4 logging) using the `logging <ipv6 address>` command. For more information on logging, see "Configuring Logging" on page 586.You can use the WebUI or CLI to change the default controller IP address.

Using WebUI

1. Navigate to the Configuration > Network > Controller page and select the System Settings tab.
2. Under the Controller IP Details section, select the VLAN Id or the loopback interface Id in the IPv6 Address drop down.
3. Click the Apply button to apply the configuration.

Using CLI

To configure an IPv6 address to the controller

```
(host)(config)#controller-ipv6 loopback
(host)(config)#controller-ipv6 vlan <vlanId>
```

To enable logging over IPv6

```
(host)(config)#logging <ipv6 address>
```

Configure Multicast Listener Discovery (MLD)

You can enable the IPv6 multicast snooping on the controller using the WebUI or CLI. You can also modify the default values of the MLD parameters such as query interval, query response interval, and robustness variable.

Using WebUI

To Enable IPv6 MLD Snooping

1. Navigate to the Configuration > Network > IP page and select the IP Interfaces tab.
2. Edit the required VLAN interface.
3. Check the Enable MLD Snooping check box to enable IPv6 MLD snooping.
4. Click the Apply button to apply the configuration.

To Modify IPv6 MLD Parameters

1. Navigate to the Configuration > Network > IP page and select the Multicast Routing tab.
2. Under the MLD section, enter the required values in the following fields:
   - Robustness Variable: default value is 2
   - Query Interval: default value is 125 seconds

- Query Response Interval: default value is 100 (1/10 seconds).

3. Click the Apply button to apply the configuration.

Using CLI

To enable IPv6 MLD snooping:

```
(host) (config) #interface vlan 1
(host) (config-subif)#ipv6 mld snooping
```

To view if IPv6 MLD snooping is enabled:

```
(host) (config-subif)#show ipv6 mld interface
MLD Interface Table
-------------------
VLAN  Snooping  Querier
----  --------  -------
1     enabled   ::
3     disabled  ::
60    disabled  ::
```

To modify IPv6 MLD parameters:

```
(host) (config) #ipv6 mld
(host) (config-mld) # query-interval <time in seconds (1-65535)>|query-response-
interval <time in 1/10th of seconds (1-65535)|robustness-variable <value (2-10)>
```

To view MLD configuration:

```
(host) (config-subif)#show ipv6 mld config
MLD Config
----------
Name                     Value
----                     -----
robustness-variable      2
query-interval           125
query-response-interval  100
```

Debug IPv6 Controller

You can now use the debug options such as ping and tracepath for IPv6 hosts. You can either use the WebUI or the CLI to use the ping and tracepath options.

Using WebUI

1. To ping an IPv6 host, navigate to the Diagnostics > Network > Ping page, enter an IPv6 address, and click the Ping button.
2. To trace the path of an IPv6 host, navigate to the Diagnostics > Network > Tracepath page, enter an IPv6 address, and click the Trace button.

Using CLI

To ping an IPv6 host

```
(host) #ping ipv6 <global-ipv6-address>
(host) #ping ipv6 interface vlan <vlan-id> <linklocal-address>
```

To trace the path of an IPv6 host

```
(host) #tracepath ipv6 <global-ipv6-address>
```

Provision IPv6 AP

You can provision an IPv6 AP on an IPv6 controller. You can either configure a static IP address or obtain a dynamic IPv6 address via stateless-autoconfig. The controller can act as the default gateway for the IPv6 clients, if static IPv6 routes are set on the controller.

NOTE: In this release of ArubaOS, the IPv6 controller cannot generate router advertisements (RA). It can, however, pass on the RAs generated by the external routers to the clients.

You can provision an IPv6 AP using the WebUI or CLI.

Using WebUI

1. Navigate to the Configuration > AP Installation> Provision page and select the Provisioning tab.
2. Select an AP and click the Provision button.
3. Under the Master Discovery section, enter the host controller IP address and the IPv6 address of the master controller.
4. To provision a static IP, select the Use the following IP address check box under the IP Settings section, and enter the following details:
   - IPv6 Address/Prefix-lengths
   - Gateway IPv6 Address
   - DNS IPv6 Address

NOTE: Ensure that CPSEC is disabled before rebooting the AP.

5. Click the Apply and Reboot button to bring the IPv6 AP up.

Using CLI

To provision a static IPv6 address

```
(host) (config)#provision-ap
(host) (AP provisioning)# master <IPv6 address of the master controller>
(host) (AP provisioning)# dns-server-ip6 <IPv6 address of the AP's DNS server>
(host) (AP provisioning)# ip6addr <the static IPv6 address of the AP>
(host) (AP provisioning)# ip6prefix <the prefix of the AP's static IPv6 address>
(host) (AP provisioning)# gateway6 <the default gateway IPv6 address for the AP>
```

IPv6 Extension Header (EH) Filtering

ArubaOS firewall is enhanced to process the IPv6 Extension Header (EH) to enable IPv6 packet filtering. You can now filter the incoming IPv6 packets based on the EH type. You can edit the packet filter options in the default EH, using the CLI. By default, the default EH alias permits all EH types.

Using CLI

Execute the following commands to permit or deny the IPv6 packets matching an EH type:

```
(host) (config) #netexthdr default
```

```
(host) (config-exthdr) #eh <eh-type> permit | deny
```

To view the EH types denied:

```
(host) (config-exthdr) #show netexthdr default

Extended Header type(s) Denied
------------------------------
51,  234,
```

Captive Portal over IPv6

IPv6 is now enabled on the captive portal for user authentication on the Dell controller. For user authentication use the internal captive portal that is initiated from the controller. A new parameter `captive` has been added to the IPv6 captive portal session ACL.

```
ipv6 user alias controller6 svc-https captive
```

NOTE: This release does not support external captive portal for IPv6. The captive portal authentication, customization of pages, and other attributes are same as IPv4.

Configuring Captive Portal over IPv6

You can configure captive portal over IPv6 (similar to IPv4) using the WebUI or CLI. For more information on configuration, see "Captive Portal in the Base ArubaOS" on page 352.

ArubaOS Support for IPv6 Clients

ArubaOS provides wired or wireless clients using IPv6 addressing with services such as firewall functionality, layer-2 authentication, and, with the installation of the Policy Enforcement Firewall Next Generation (PEFNG), identity-based security. The Dell controller does not provide routing or Network Address Translation to IPv6 clients (see "Important Points to Remember" on page 674).

Enabling IPv6

You must enable the IPv6 option on the controller before using any of the IPv6 functions. You can use the `ipv6 enable` command to enable the IPv6 processing on the controller. By default, the IPv6 option is disabled.

You can also use the WebUI to enable the IPv6 option as follows:

1. Navigate to the Configuration > Advanced Services > Stateful Firewall page.
2. Select the Global Settings tab.
3. Select the IPv6 Enable check box to enable the IPv6 option.
4. Click the Apply button to apply the configuration.

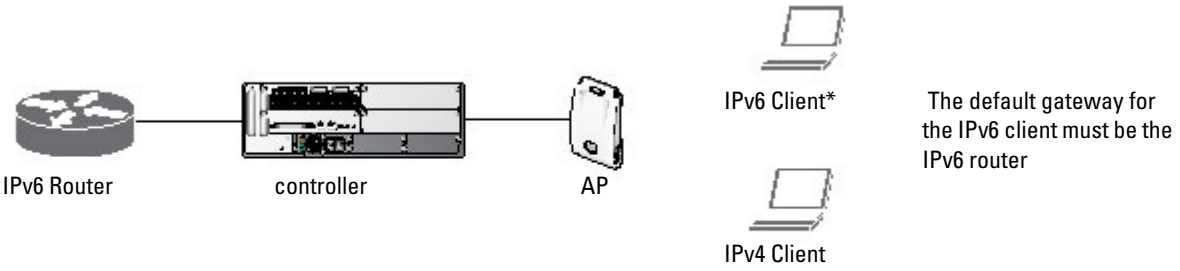
Supported Network Configuration

Clients can be wired or wireless and use IPv4 and/or IPv6 addressing. ArubaOS requires that the default gateway for the IPv6 clients be an external router that supports IPv6. The Dell controller itself has an IPv4 address, and can offer limited routing services to IPv6 clients. It is highly recommended to use an external IPv6 router for a complete routing experience (dynamic routing and router advertisements). You can use the WebUI or CLI to display IPv6 client information.

IPv6 clients must be mapped to a VLAN that is bridged to an external router which provides IPv6 services to those clients. On the controller, you can configure IPv4 and IPv6 clients on the same VLAN.

NOTE: IPv6 clients and the IPv6 router must be on the same VLAN.

Figure 162 *Supported Network Configuration*



Network Connection for Windows IPv6 Clients

This section describes the network connection sequence for Windows Vista/XP clients that use IPv6 addresses, and the actions performed by the AP and controller.

1. The IPv6 client sends a Router Solicit message through the AP. The AP passes the Router Solicit message from the IPv6 client through the GRE tunnel to the controller.
2. The controller removes the 802.11 frame and creates an 802.3 frame for the Router Solicit message.
   a. The controller authenticates the user, applies firewall policies and bridges the 802.3 frame to the IPv6 router.
   b. Entries are created in the user and session tables.
3. IPv6 router responds with a Router Advertisement message.
4. The controller applies firewall policies, then creates an 802.11 frame for the Router Advertisement message. The controller sends the Router Advertisement through the GRE tunnel to the AP.
5. IPv6 client sends a Neighbor Solicitation message.
6. IPv6 router responds with a Neighbor Advertisement message.
7. If DHCP is required to provide IPv6 addresses, the DHCPv6 process is started.
8. IPv6 client sends data.
9. The controller removes the 802.11 frame and creates an 802.3 frame for the data.

   The controller authenticates the user, applies firewall policies and bridges the 802.3 frame to the IPv6 router. Entries are created in the user and session tables.

ArubaOS Features that Support IPv6

This section describes ArubaOS features that support IPv6 clients.

Authentication

This release of ArubaOS only supports 802.1x authentication for IPv6 clients. You cannot configure layer-3 authentications to authenticate IPv6 clients.

Table 147 *IPv6 Client Authentication*

Authentication Method	Supported for IPv6 Clients?
802.1x	Yes
Stateful 802.1x (with non-Dell APs)	Yes
Local database	Yes
Captive Portal	Yes
VPN	No
xSec	No (not tested)
MAC-based	Yes

You configure 802.1x authentication for IPv6 clients in the same way as for IPv4 client configuration. For more information about configuring 802.1x authentication on the controller, see Chapter 10, "802.1x Authentication" on page 285.

NOTE: This release does not support authentication of management users on IPv6 clients.

Firewall Functions

If you installed a Policy Enforcement Firewall Next Generation (PEFNG) license in the controller, you can configure firewall functions for IPv6 client traffic. While these firewall functions are identical to firewall functions for IPv4 clients, you need to explicitly configure them for IPv6 traffic. For more information about firewall policies, see "Global Firewall Parameters" on page 335.

NOTE: Voice-related and NAT firewall functions are not supported for IPv6 traffic.

Table 148 *IPv6 Firewall Parameters*

Authentication Method	Description
Monitor Ping Attack	Number of ICMP pings per second, which if exceeded, can indicate a denial of service attack. Valid range is 1–255 pings per second. Recommended value is 4. Default: No default
Monitor TCP SYN Attack rate	Number of TCP SYN messages per second, which if exceeded, can indicate a denial of service attack. Valid range is 1–255 messages per second. Recommended value is 32. Default: No default
Monitor IP Session Attack	Number of TCP or UDP connection requests per second, which if exceeded, can indicate a denial of service attack. Valid range is 1–255 requests per second. Recommended value is 32. Default: No default

Table 148 *IPv6 Firewall Parameters (Continued)*

Authentication Method	Description
Deny Inter User Bridging	Prevents the forwarding of Layer-2 traffic between wired or wireless users. You can configure user role policies that prevent Layer-3 traffic between users or networks but this does not block Layer-2 traffic. This option can be used to prevent traffic, such as Appletalk or IPX, from being forwarded. Default: Disabled
Deny All IP Fragments	Drops all IP fragments. NOTE: Do not enable this option unless instructed to do so by an Dell representative. Default: Disabled
Enforce TCP Handshake Before Allowing Data	Prevents data from passing between two clients until the three-way TCP handshake has been performed. This option should be disabled when you have mobile clients on the network as enabling this option will cause mobility to fail. You can enable this option if there are no mobile clients on the network. Default: Disabled
Prohibit IP Spoofing	Enables detection of IP spoofing (where an intruder sends messages using the IP address of a trusted client). When this option is enabled, IP and MAC addresses are checked for each ARP request/response. Traffic from a second MAC address using a specific IP address is denied, and the entry is not added to the user table. Possible IP spoofing attacks are logged and an SNMP trap is sent. Default: Disabled NOTE: An IPv6 client can have multiple IP addresses. Enabling IP spoofing on the controller can cause IPv6 clients to lose network access.
Prohibit RST Replay Attack	When enabled, closes a TCP connection in both directions if a TCP RST is received from either direction. You should not enable this option unless instructed to do so by an Dell representative. Default: Disabled
Session Mirror Destination	Destination (IPv4 address or controller port) to which mirrored session packets are sent. You can configure IPv6 flows to be mirrored with the session ACL “mirror” option.This option is used only for troubleshooting or debugging. Default: N/A
Session Idle Timeout	Set the time, in seconds, that a non-TCP session can be idle before it is removed from the session table. Specify a value in the range 16–259 seconds. You should not set this option unless instructed to do so by an Dell representative. Default: 30 seconds
Per-packet Logging	Enables logging of every packet if logging is enabled for the corresponding session rule. Normally, one event is logged per session. If you enable this option, each packet in the session is logged. You should not enable this option unless instructed to do so by an Dell representative, as doing so may create unnecessary overhead on the controller. Default: Disabled (per-session logging is performed)

The following examples configure attack rates and the session timeout for IPv6 traffic.

To configure the firewall function via the WebUI:

1. Navigate to the Configuration > Advanced Services > Stateful Firewall > Global Setting page.
2. Under the IPv6 column, enter the following:
   - For Monitor Ping Attack, enter 15
   - For Monitor IP Session Attack, enter 25
   - For Session Idle Timeout, enter 60
3. Click Apply.

To configure firewall functions using the command line interface, issue the following commands in config mode:

```
ipv6 firewall attack-rate ping 15
ipv6 firewall attack-rate session 25
```

```
ipv6 firewall session-idle-timeout 60
```

Firewall Policies

A user role, which determines a client's network privileges, is defined by one or more firewall policies. A firewall policy consists of one or more rules that define the source, destination, and service type for specific traffic and whether you want the controller to permit or deny traffic that matches the rule.

You can configure firewall policies for IPv4 traffic or for IPv6 traffic and apply IPv4 and IPv6 firewall policies to the same user role. For example, if you have employees that are using both IPv4 and IPv6 clients you can configure both IPv4 and IPv6 firewall policies and apply them both to the "employee" user role.

The procedure to configure an IPv6 firewall policy rule is similar to configuring a firewall policy rule for IPv4 traffic, but with some differences. Table 149 describes required and optional parameters for an IPv6 firewall policy rule.

Table 149 *IPv6 Firewall Policy Rule Parameters*

Field	Description
Source (required)	Source of the traffic, which can be one of the following: • *any*: Acts as a wildcard and applies to any source address. • *user*: This refers to traffic from the wireless client. • *host:* This refers to traffic from a specific host. When this option is chosen, you must configure the IPv6 address of the host. For example, 2002:d81f:f9f0:1000:c7e:5d61:585c:3ab. • *network:* This refers to a traffic that has a source IP from a subnet of IP addresses. When this option is chosen, you must configure the IPv6 address and network mask of the subnet. For example, 2002:ac10:fe:: ffff:ffff:ffff::. • *alias:* This refers to using an alias for a host or network. NOTE: This release does not support IPv6 aliases. You cannot configure an alias for an IPv6 host or network.
Destination (required)	Destination of the traffic, which can be configured in the same manner as Source.
Service (required)	NOTE: Voice over IP services are not available for IPv6 policies. Type of traffic, which can be one of the following: • *any*: This option specifies that this rule applies to any type of traffic. • *tcp*: Using this option, you configure a range of TCP port(s) to match for the rule to be applied. • *udp*: Using this option, you configure a range of UDP port(s) to match for the rule to be applied. • *service:* Using this option, you use one of the pre-defined services (common protocols such as HTTPS, HTTP, and others) as the protocol to match for the rule to be applied. You can also specify a network service that you configure by navigating to the Configuration > Advanced Services > Stateful Firewall > Network Services page. • *protocol*: Using this option, you specify a different layer 4 protocol (other than TCP/UDP) by configuring the IP protocol value.
Action (required)	The action that you want the controller to perform on a packet that matches the specified criteria. This can be one of the following: NOTE: The only actions for IPv6 policy rules are permit or deny; in this release, the controller cannot perform network address translation (NAT) or redirection on IPv6 packets. You can specify options such as logging, mirroring, or blacklisting (described below). • *permit:* Permits traffic matching this rule. • *drop:* Drops packets matching this rule without any notification.
Log (optional)	Logs a match to this rule. This is recommended when a rule indicates a security breach, such as a data packet on a policy that is meant only to be used for voice calls.
Mirror (optional)	Mirrors session packets to datapath or remote destination specified in the IPv6 firewall function (see "Session Mirror Destination" in Table 148 on page 669). If the destination is an IP address, it must be an IPv4 IP address.
Queue (optional)	The queue in which a packet matching this rule should be placed. Select High for higher priority data, such as voice, and Low for lower priority traffic.

Table 149 *IPv6 Firewall Policy Rule Parameters (Continued)*

Field	Description
Time Range (optional)	Time range for which this rule is applicable. You configure time ranges in the Configuration > Security > Access Control > Time Ranges page.
Black List (optional)	Automatically blacklists a client that is the source or destination of traffic matching this rule. This option is recommended for rules that indicate a security breach where the blacklisting option can be used to prevent access to clients that are attempting to breach the security.
TOS (optional)	Value of type of service (TOS) bits to be marked in the IP header of a packet matching this rule when it leaves the controller.
802.1p Priority (optional)	Value of 802.1p priority bits to be marked in the frame of a packet matching this rule when it leaves the controller.

The following example creates a policy 'ipv6-web-only' that allows only web (HTTP and HTTPS) access for IPv6 clients and assigns the policy to the user role "web-guest".

NOTE: The user role "web-guest" can include both IPv6 and IPv4 policies, although this example only shows configuration of an IPv6 policy.

Creating an IPv6 firewall policy

Following the procedure below to create an IPv6 firewall policy via the WebUI.

1. Navigate to the Configuration > Security > Access Control > Policies page.
2. Click Add to create a new policy.
3. Enter ipv6-web-only for the Policy Name.
4. To configure a firewall policy, select Session for Policy Type.
5. Click Add to add a rule that allows HTTP traffic.
   a. Under IP Version column, select IPv6.
   b. Under Source, select network from the drop-down list.
   c. For Host IP, enter 2002:d81f:f9f0:1000::.
   d. For Mask, enter ffff:ffff:ffff:ffff::.
   e. Under Service, select service from the drop-down list.
   f. Select svc-http from the scrolling list.
   g. Click Add.
6. Click Add to add a rule that allows HTTPS traffic.
   a. Under IP Version column, select IPv6.
   b. Under Source, select network from the drop-down list.
   c. For Host IP, enter 2002:d81f:f9f0:1000::.
   d. For Mask, enter ffff:ffff:ffff:ffff::.
   e. Under Service, select service from the drop-down list.
   f. Select svc-https from the scrolling list.
   g. Click Add

NOTE: Rules can be reordered using the up and down arrow buttons provided for each rule.

7. Click Apply to apply the configuration. The policy is not created until the configuration is applied.

To create an IPv6 firewall policy using the command-line interface, issue the following commands in config mode:

```
ip access-list session ipv6-web-only
  ipv6 network 2002:d81f:f9f0:1000::/64 any svc-http permit
  ipv6 network 2002:d81f:f9f0:1000::/64 any svc-https permit
```

Assigning an IPv6 Policy to a User Role

To assign an IPv6 policy using the WebUI:

1. Navigate to the Configuration > Security > Access Control > User Roles page.
2. Click Add to create a new user role.
3. Enter web-guest for Role Name.
4. Under Firewall Policies, click Add. From Choose from Configured Policies, select the "ipv6-web-only" IPv6 session policy from the list.
5. Click Done to add the policy to the user role.
6. Click Apply to apply this configuration.

To assign an IPv6 policy to a user role via the command-line interface, issue the following command in config mode:

```
user-role web-guest
  access-list session ipv6-web-only position 1
```

DHCPv6 Passthrough/Relay

The controller forwards DHCPv6 requests from IPv6 clients to the external IPv6 router. On the external IPv6 router, you must configure the controller's IP address as the DHCP relay. You do *not* need to configure an IP helper address on the controller to forward DHCPv6 requests.

IPv6 User Addresses

Viewing or Deleting User Entries

To view or delete IPv6 user entries via the WebUI:

1. Navigate to the Monitoring > Controller > Clients page.
2. Click the IPv6 tab to display IPv6 clients.
3. To delete an entry in the IPv6 client display, click the radio button to the left of the client and then click Disconnect.

To view user entries for IPv6 clients using the command line interface, use the show user-table command in enable mode. To delete a user entry for an IPv6 client, access the CLI in config mode and use the aaa ipv6 user delete command. For example:

```
aaa ipv6 user delete 2002:d81f:f9f0:1000:e409:9331:1d27:ef44
```

User Roles

An IPv6 user or a client can inherit the corresponding IPv4 roles. A user or client entry on the user table will contain the user or client's IPv4 and IPv6 entries. After captive-portal authentication, a IPv4 client can acquire a different role. This role is also updated on the client's IPv6 entry in the user table.

Viewing Datapath Statistics for IPv6 Sessions

To view datapath session statistics for individual IPv6 sessions, access the command-line interface in enable mode and issue the command show datapath session ipv6. To display the user entries in the datapath, access the command-line interface in enable mode, and issue the command show datapath user ipv6. For details on each of these commands and the output they display, see the ArubaOS CLI Reference Guide.

Important Points to Remember

This ArubaOS release does not support the following functions for IPv6 clients:

- Do not use VLAN pooling if you enable IPv6 forwarding on the controller, as VLAN pooling will flood IPv6 multicast packets for all VLANs that are part of the VLAN pool. This can cause autoconfigured clients to acquire multiple IPv6 addresses (one for each vlan in the pool) making those clients behave unpredictably. If you need to work around this limitation, you can unicast BC/MC traffic to every station. To enable this workaround, you must enable the wlan ssid-profile battery-boost option, and install a Policy Enforcement Firewall Next Generation (PEFNG) license.
- The controller offers limited routing services to IPv6 clients. It is highly recommended to use an external IPv6 router for a complete routing experience (dynamic routing and router advertisements).
- The controller does not perform network address translation on IPv6 addresses.
- The controller does not generate any IPv6 ICMP messages.
- Voice over IP is not supported for IPv6 clients.
- Remote AP supports IPv6 clients in tunnel forwarding mode only. The Remote AP bridge and split-tunnel forwarding modes do not support IPv6 clients. Secure Thin Remote Access Point (STRAP) cannot support IPv6 clients.
- The controller cannot terminate VPNs for IPv6 clients.
- VPN authentication cannot be performed for IPv6 clients.
- ArubaOS does not support RADIUS over IPv6 as an authentication protocol.
- Authentication of management users on IPv6 clients is not supported.
- The controller does not access the flow information field in IPv6 packet headers. (This field can be used by IPv6 routers to identify the sequence of packets and to facilitate routing decisions.)
- A client can have an both IPv4 address and an IPv6 address, but the controller does not relate the states of the IPv4 and IPv6 addresses on the same client. For example, if an IPv6 user session is active on a client, an IPv4 user session on the same client will be deleted if the idle timeout for the IPv4 session is reached.

Chapter 36

Voice and Video

This chapter outlines the steps required to configure voice and video services on the Dell controller for Voice over IP (VoIP) devices, including Session Initiation Protocol (SIP), Spectralink Voice Priority (SVP), H323, SCCP, Vocera, and Alcatel NOE phones, clients running Microsoft Office Communicator Server (OCS), and Apple devices running the Facetime application. Since video and voice applications are more vulnerable to delay and jitter, the network infrastructure must be able to prioritize video and voice traffic over data traffic.

This chapter describes the following topics:

Voice and Video License Requirements

The voice and video services require PEFNG licenses on the controller. For complete details on the required licenses, see Chapter 34, "Software Licenses" on page 651.

Configuring Voice and Video

This section describes the steps required to set up and configure voice features on an Dell controller. To configure voice features you must do the following:

1. Set up net services
2. Configure roles
3. Configure firewall settings for voice and video ALGs
4. Configure other parameters depending on the need and environment

NOTE: Assigning voice traffic to the high priority queue is recommended when deploying voice over WLAN networks.

Setting up Net Services

You can either use the default net services and ports or you can create or modify net services.

Using Default Net Services

The following table lists the default net services and their ports:

Table 150 *Default Voice Net Services and Ports*

Net Service Name	Protocol	Port	ALG
svc-sccp	TCP	2000	SCCP
svc-sip-tcp	TCP	5060	SIP
svc-sip-udp	UDP	5060	SIP
svc-sips	TCP	5061	SIP
svc-noe	UDP	32512	NOE
svc-h323-udp	UDP	1718, 1719	H.323
svc-h323-tcp	TCP	1720	H.323
svc-vocera	UDP	5002	VOCERA
svc-svp	SVP	None	SVP

Creating Custom Net Services

You can use CLI to create or modify net services. In the config mode on the controller enter:

```
(host) (config)# netservice [service name] [protocol] [port] [alg]
```

To create an *svc-noe* service on UDP port 32522, enter:

```
(host) (config)# netservice svc-noe udp 32522 alg noe
```

Configuring User Roles

In the user-centric network, the user role of a wireless client determines its privileges and the type of traffic that it can send or receive in the wireless network. You can configure roles for clients that use mostly data traffic, such as laptops, and roles for clients that use mostly voice traffic, such as VoIP phones. Although there are different ways for a client to derive a user role, in most cases the clients using data traffic are assigned a role after they are authenticated through a method such as 802.1x, VPN, or captive portal. The user role for VoIP phones is derived from the OUI of their MAC addresses or the SSID to which they associate. See Chapter 12, "Roles and Policies," for details on how to create and configure a user role.

This section describes how to configure voice user roles with the required privileges and priorities. Dell controller provides default user roles for all voice services. You can do one of the following:

- Use default user roles
- Create or modify user roles
- Use user-derivation roles

Using the Default User Role

The controller is configured with the default voice role. This role has the following settings:

- No limit on upload or download bandwidth
- Default L2TP and PPTP pool
- Maximum sessions: 65535

The following ACLs are associated with the default voice role:

- SIP-ACL
- NOE-ACL
- SVP-ACL
- VOCERA-ACL
- SKINNY-ACL
- H323-ACL
- DHCP-ACL
- TFTP-ACL
- DNS-ACL
- ICMP-ACL

For more details on the default voice role, enter the following command in the config mode on your controller:

```
(host) (config) #show rights voice
```

Creating or Modifying Voice User Roles

You can create roles for NOE, SIP, SVP, Vocera, SCCP, and H.323 ALGs. Use the WebUI or CLI to configure user roles for any of the ALGs.

Using the WebUI to configure user roles

1. Navigate to the Configuration > Security > Access Control page.
2. Select the Policies tab. Click Add to create a new policy.
3. For Policy Name, enter a name here.
4. For Policy Type, select Session.
5. Under Rules, click Add.
   a. For IP Version, select IPv4.
   a. For Source, select any.
   b. For Destination, select any.
   c. For Service, select service, then select the correct voice or video ALG service. See Table 151 on page 677 and Table 152 on page 678 for service names for all ALGs.:

Table 151 *Services for ALGs*

ALG	Service Name
NOE	svc-noe sip-noe-oxo
SIP	• svc-sips • svc-sip-tcp • svc-sip-udp
SVP	svc-svp

Table 151 *Services for ALGs (Continued)*

ALG	Service Name
VOCERA	svc-vocera
SCCP	svc-sccp
H.323	• svc-h323-tcp • svc-h323-udp
DHCP	svc-dhcp
TFTP	svc-tftp
ICMP	svc-icmp
DNS	svc-dns

Table 152 *Other Mandatory Services for the ALGs*

ACL	Service Name
DHCP	svc-dhcp
TFTP	svc-tftp
ICMP	svc-icmp
DNS	svc-dns

d. For Action, select permit.

e. For Queue, select High.

f. Click Add. Repeat steps 1 to 5e to add more ALG services.

6. Click Apply.
7. Select the User Roles tab. Click Add to add a user role.
   a. For Role Name, enter a name for the user role.
   b. Under Firewall Policies, click Add.
   c. Select the previously-configured policy name from the Choose from Configured Policies drop-down menu.
   d. Click Done.
   e. Under Firewall Policies, click Add.
   f. Select *control* from the Choose from Configured Policies drop-down menu.
   g. Click Done.
8. Click Apply

Using the CLI to configure a user role

```
ip access-list session <policy-name>
   any any <service-name> permit queue high
   any any dhcp-acl permit queue high
   any any tftp-acl permit queue high
   any any dns-acl permit queue high
   any any icmp-acl permit queue high

user-role <role-name>
```

```
session-acl <policy-name>
```

Replace the following strings:

- *policy-name* with a string that you want to identify the roles policy
- *role-name* with the name you want to identify the voice user role.
- service-name with any of the service names from Table 150 on page 676.

Using the User-Derivation Roles

The user role can be derived from attributes from the client's association with an AP. For VoIP phones, you can configure the devices to be placed in their user role based on the SSID or the Organizational Unit Identifier (OUI) of the client's MAC address.

NOTE: User-derivation rules are executed *before* the client is authenticated.

Using the WebUI to derive the role based on SSID

1. Navigate to the Configuration > Security > Authentication > User Rules page.
2. Click Add to add a new set of derivation rules. Enter a name for the set of rules, and click Add. The name appears in the User Rules Summary list.
3. In the User Rules Summary list, select the name of the rule set to configure rules.
4. Click Add to add a rule. For Set Type, select Role from the drop-down menu.
5. For Rule Type, select ESSID.
6. For Condition, select equals.
7. For Value, enter the SSID used for the phones.
8. For Roles, select the user role you previously created.
9. Click Add.
10. Click Apply.

Using the CLI to derive the role based on SSID

```
aaa derivation-rules user name
   set role condition essid equals ssid set-value role
```

Using the WebUI to derive the role based on MAC OUI

1. Navigate to the Configuration > Security > Authentication > User Rules page.
2. Click Add to add a new set of derivation rules. Enter a name for the set of rules, and click Add. The name appears in the User Rules Summary list.
3. In the User Rules Summary list, select the name of the rule set to configure rules.
4. Click Add to add a rule. For Set Type, select Role from the drop-down menu.
5. For Rule Type, select MAC Address.
6. For Condition, select contains.
7. For Value, enter the first three octets (the OUI) of the MAC address of the phones (for example, the Spectralink OUI is 00:09:7a).
8. For Roles, select the user role you previously created.
9. Click Add.
10. Click Apply.

Using the CLI to derive the role based on MAC OUI

```
aaa derivation-rules user name
   set role condition macaddr contains xx:xx:xx set-value role
```

Configuring Firewall Settings for Voice and Video ALGs

After configuring the user roles, you must configure the firewall settings for the voice and video Application-Level Gateways (ALGs) to pass the traffic securely through the Dell devices.

You can use the WebUI or CLI to configure the firewall settings for the ALGs.

Using WebUI

1. Navigate to the Configuration > Advanced Services > Stateful Firewall page.
2. Enable the firewall settings for the ALGs:
   a. Select the Stateful SIP Processing check box for the SIP ALG.
   b. Select the Stateful H.323 Processing check box for the H.323 ALG.
   c. Select the Stateful SCCP Processing check box for the SCCP ALG.
   d. Select the Stateful Vocera Processing check box for the Vocera ALG.
   e. Select the Stateful UA Processing check box for the NOE ALG.

Using CLI

To enable the firewall settings for the SIP ALG:

```
(host) #configure terminal
(host) (config) #no firewall disable-stateful-sip-processing
```

To enable the firewall settings for the H.323 ALG:

```
(host) (config) #no firewall disable-stateful-h323-processing
```

To enable the firewall settings for the SCCP ALG:

```
(host) (config) #no firewall disable-stateful-sccp-processing
```

To enable the firewall settings for the Vocera ALG:

```
(host) (config) #no firewall disable-stateful-vocera-processing
```

To enable the firewall settings for the NOE ALG:

```
(host) (config) #no firewall disable-stateful-ua-processing
```

Additional Video Configurations

You can configure ArubaOS to reliably and efficiently stream video traffic over wireless LAN (WLAN). This new method allows you to stream video traffic reliably without much loss. To ensure that video data is transmitted reliably dynamic multicast optimization techniques are used.

Although the dynamic multicast optimization conversion generates more traffic, that traffic is buffered by the AP and delivered to the client when the client emerges from power-save mode.

Configuring Video over WLAN enhancements

To configure video over WLAN enhancements, do the following:

- Enable WMM on the SSID profile.
- Enable IGMP proxy or IGMP snooping.
- Configure an ACL to set a DSCP value same as the `wmm-vi-dscp` value in the SSID profile for prioritizing the multicast video traffic.
- Enable dynamic multicast optimization under VAP profile.

- Configure the dynamic multicast optimization threshold—The maximum number of high throughput stations in a multicast group. The optimization will stop if the number exceeds the threshold value.
- Enable multicast rate optimization to support higher data rate for multicast traffic in the absence of dynamic multicast optimization. Dynamic multicast optimization takes precedence over multicast rate optimization up to the configured threshold value.
- Enable video aware scan on ARM profile—This ensures that AP does not scan when a video stream is active.
- Optionally you can configure and apply WMM bandwidth management profile—The total bandwidth share should not exceed 100 percent.
- Enable multicast shaping to shape the bursty traffic from the source.

You can either use CLI or WebUI to configure the video over WLAN enhancements.

Pre-requisites

- You will need the Policy Enforcement Firewall Next Generation (PEFNG) license to enable dynamic multicast optimization.
- This feature is available only on W-3000 Series and W-600 Series controller platforms.

Using CLI

1. Enable IGMP proxy or IGMP snooping on the controller.

   To enable IGMP proxy:

   ```
   (host) (config) #interface vlan 1
   (host) (config-subif)#ip igmp proxy gigabitethernet 1/3
   ```

   To enable IGMP snooping

   ```
   (host) (config) #interface vlan 1
   (host) (config-subif)#ip igmp snooping
   ```

2. Enable wireless multimedia and set a DSCP value for video traffic.

   ```
   (host) (config)#wlan ssid-profile default
   (host) (ssid-profile "default")#wmm
   (host) (ssid-profile "default")#wmm-vi-dscp <value>
   ```

   Example: `(host) (ssid-profile "default")#wmm-vi-dscp 40`

   ```
   (host) (SSID Profile "default") #show wlan ssid-profile default

   SSID Profile "default"
   ----------------------
   Parameter                                          Value
   ---------                                          -----
   SSID enable                                        Enabled
   ESSID                                              building1-ap
   ...
   ...
   ...
   Wireless Multimedia (WMM)                          Enabled
   Wireless Multimedia U-APSD (WMM-UAPSD) Powersave   Enabled
   WMM TSPEC Min Inactivity Interval                  0 msec
   Override DSCP mappings for WMM clients             Disabled
   DSCP mapping for WMM voice AC                      56
   DSCP mapping for WMM video AC                      40
   ...
   ...
   ...
   ```

   Setting the DSCP value, tags the content as video stream that the APs can recognize. By default, the DSCP value is set to 40.

3. Create an ACL on the controller with the values equivalent to the DSCP mappings to prioritize the video traffic.

   Example: The following ACL prioritizes the multicast traffic from the specified multicast group on the controller. You can also add this ACL to any user role or port.

   ```
   (host) (config-sess-mcast_video_acl)#any network 224.0.0.0 255.0.0.0 any permit tos
   40 queue high 802.1p 5
   ```

   a. To add the ACL to a user role:

   ```
   (host) (config) #user-role authenticated access-list session mcast_video_acl
   ```

   This example uses the user role, *authenticated*.

   b. To add the ACL to a port:

   ```
   (host) (config) #interface gigabitethernet 1/3
   (host) (config-if)#ip access-group mcast_video_acl session
   ```

4. Configure dynamic multicast optimization for video traffic on a virtual AP profile.

   ```
   (host) (config)#wlan virtual-ap default
   (host) (Virtual AP Profile "default")#dynamic-mcast-optimization
   (host) #show wlan virtual-ap default
   Virtual AP profile "default"
   ----------------------------
   Parameter                                 Value
   ---------                                 -----
   Virtual AP enable                         Enabled
   ...
   ...
   Blacklist Time                            3600 sec
   Dynamic Multicast Optimization for Video  Enabled
   Dynamic Multicast Optimization Threshold  6
   ...
   ...
   ```

5. Configure the dynamic multicast optimization threshold value.

   ```
   (host) (config) #dynamic-mcast-optimization-thresh 6
   (host) #(host} #show wlan virtual-ap default
   Virtual AP profile "default"
   ----------------------------
   Parameter                                 Value
   ---------                                 -----
   Virtual AP enable                         Enabled
   Allowed band                              all
   ...
   ...
   ...
   Blacklist Time                            3600 sec
   Dynamic Multicast Optimization for Video  Enabled
   Dynamic Multicast Optimization Threshold  6
   Authentication Failure Blacklist Time     3600 sec
   ...
   ...
   ...
   ```

6. **Configure multicast rate optimization for video traffic.**

```
(host) (config) #wlan ssid-profile default
(host) (SSID Profile "default") #mcast-rate-opt
(host) (SSID Profile "default") #show wlan ssid-profile default
SSID Profile "default"
----------------------
Parameter                                       Value
---------                                       -----
SSID enable                                     Enabled
ESSID                                           building1-ap
Encryption                                      opensystem
DTIM Interval                                   1 beacon periods
802.11a Basic Rates                             6 12 24
...
...
...
EDCA Parameters Station profile                 N/A
EDCA Parameters AP profile                      N/A
BC/MC Rate Optimization                         Enabled
Strict Spectralink Voice Protocol (SVP)         Disabled
...
...
...
```

7. **Configure ARM scanning for video traffic.**

   In the default RF ARM profile, enable the video aware scan option. This prevents APs from scanning when a video traffic is active.

```
(host) (config) #rf arm-profile default
(host) (Adaptive Radio Management (ARM) profile "default") #video-aware-scan
(host) (Adaptive Radio Management (ARM) profile "default") #end
(host) #show rf arm-profile default

Adaptive Radio Management (ARM) profile "default"
-------------------------------------------------
Parameter                         Value
---------                         -----
Assignment                        single-band
Allowed bands for 40MHz channels  a-only
Client Aware                      Enabled
...
...
...
Scanning                          Enabled
Scan Time                         110 msec
VoIP Aware Scan                   Disabled
Power Save Aware Scan             Enabled
Video Aware Scan                  Enabled
...
...
...
Load aware Scan Threshold         1250000 Bps
Mode Aware Arm                    Disabled
```

8. Configure and apply a bandwidth management profile.

```
(host) (config)# wlan wmm-traffic-management-profile default
```

NOTE: Ensure that you configure the WMM traffic management profile to the virtual AP profile if you have configured the virtual AP traffic management profile.

a. Enable a bandwidth shaping policy so that the allocated bandwidth share is appropriately used.

```
(host) (WMM Traffic management profile "default") # enable-shaping
```

b. Set a bandwidth percentage for the following categories:

```
(host) (WMM Traffic management profile "default") # background 10
(host) (WMM Traffic management profile "default") # best-effort 20
(host) (WMM Traffic management profile "default") # video 50
(host) (WMM Traffic management profile "default") # voice 20
(host) (WMM Traffic management profile "default") # show wlan wmm-traffic-management-
profile default

WMM Traffic management profile "default"
----------------------------------------
Parameter              Value
---------              -----
Enable Shaping Policy  true
Voice Share            20 %
Video Share            50 %
Best-effort Share      20 %
Background Share       10 %
```

After you configure the WMM bandwidth management profile, apply it to the virtual AP profile.

```
(config) #wlan virtual-ap default
(Virtual AP profile "default") #wmm-traffic-management-profile default
```

9. Enable multicast shaping on the firewall.

```
(host) (config) #firewall shape-mcast
(host) (config) #show firewall

Global firewall policies
------------------------
Policy                                        Action    Rate      Slot/Port
------                                        ------    ----      ---------
Enforce TCP handshake before allowing data    Disabled
Prohibit RST replay attack                    Disabled
...
...
Multicast automatic shaping                   Enabled
Clear Sessions on Role Update                 Disabled
Session mirror IPSEC                          Disabled
```

Using the WebUI

1. Enable IGMP proxy or IGMP snooping on the controller.

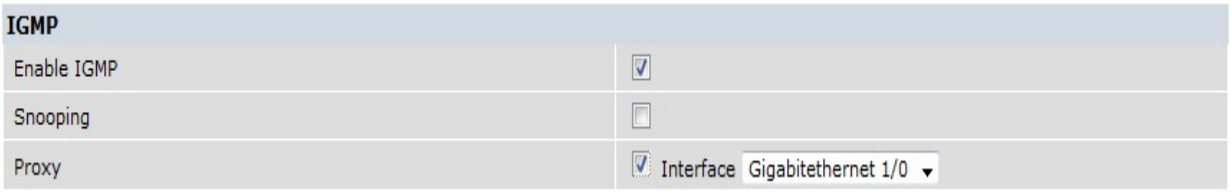
   To enable IGMP proxy:

   a. Navigate to the Configuration > Network > IP page. Under the IGMP settings, select the Enable IGMP checkbox.

   b. Select the Proxy checkbox and select the appropriate value from the Interface drop down menu.

c. Click the Apply button to apply the settings and save the configurations.

Figure 163 *Enable IGMP Proxy*



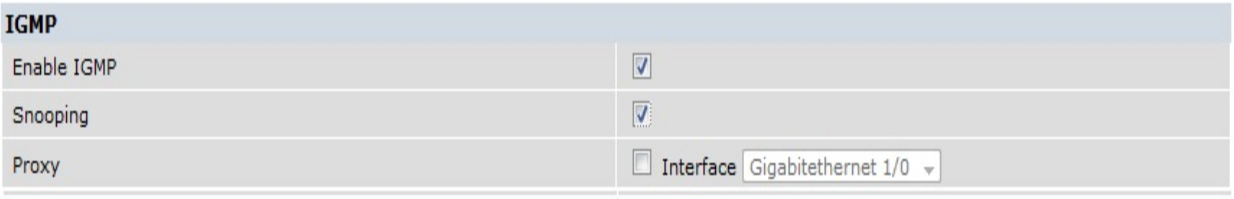
To enable IGMP snooping:

a. Navigate to the Configuration > Network > IP page. Under the IGMP settings, select the Enable IGMP checkbox.

b. Select the Snooping checkbox.

c. Click the Apply button to apply the settings and save the configurations.

Figure 164 *Enable IGMP Snooping*



2. Enable wireless multimedia and set a DSCP value for video traffic.

a. Navigate to the Configuration > Advanced Services > All Profiles page.

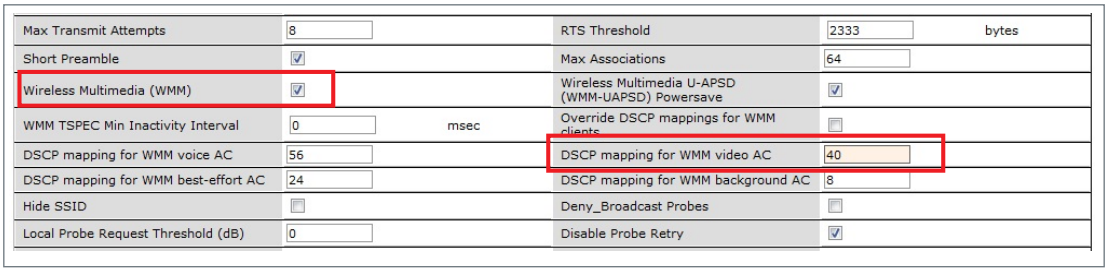
b. Under the Profiles column, expand Wireless LAN > SSID Profile and select the profile name.

This example uses the *default* profile.

c. Click the Advanced tab and select the Wireless Multimedia (WMM) checkbox.

d. Enter the DSCP value (integer number) in the DSCP mapping for WMM video AC field and click the Apply button.

Figure 165 *Enable Wireless Multimedia and Set DSCP Value*



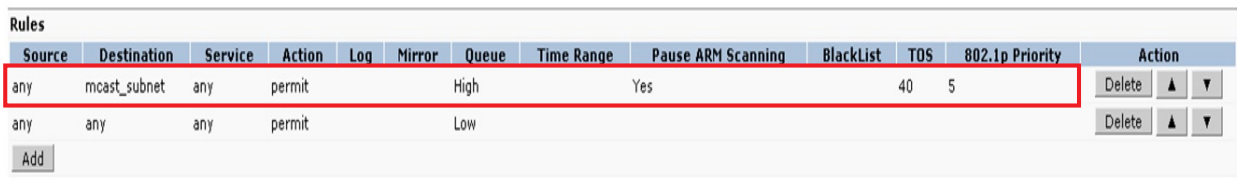
3. Create an ACL on the controller with the values equivalent to the DSCP mappings to prioritize the video traffic.

a. Navigate to the Configuration > Security> Access Control page and click the Policies tab.

b. Click the Add button to create a new policy.

c. Enter the appropriate values under Rules to match the DSCP mapping values.

Figure 166 *Set ACL to Prioritize Video Traffic*



You can also add this ACL to any user role or port.

To apply the ACL to a user role:

a. Navigate to the Configuration > Security> Access Control page and click the User Roles tab.

b. Edit the user role and click the Add button under Firewall Policies.

c. Select the ACL from the Choose From Configured Policies drop down and click the Done button.

d. Click the Apply button to save the configurations.

Figure 167 *Apply ACL to User Role*

Name	Firewall Policies
authenticate4d	Not Configured
authenticated	mcast_video_acl/,allowall/,v6-allowall/
authenticated_conf	authenticated_http_https_proxy_acl/,allowall/,v6-allowall/
default-vpn-role	allowall/,v6-allowall/
guest	http-acl/,https-acl/,dhcp-acl/,icmp-acl/,dns-acl/,v6-http-acl/,v6-https-acl/,v6-dhcp-acl /,v6-icmp-acl/,v6-dns-acl/
guest-logon	logon-control/,captiveportal/

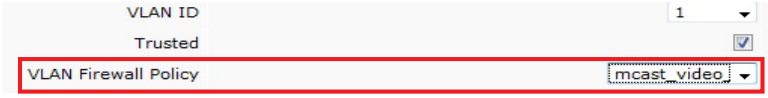
To apply the ACL to a port:

a. Navigate to the Configuration > Network> Port page and select the upstream port.

b. Under the VLAN Firewall Policy drop down, select the ACL.

c. Click the Apply button to save the configurations.

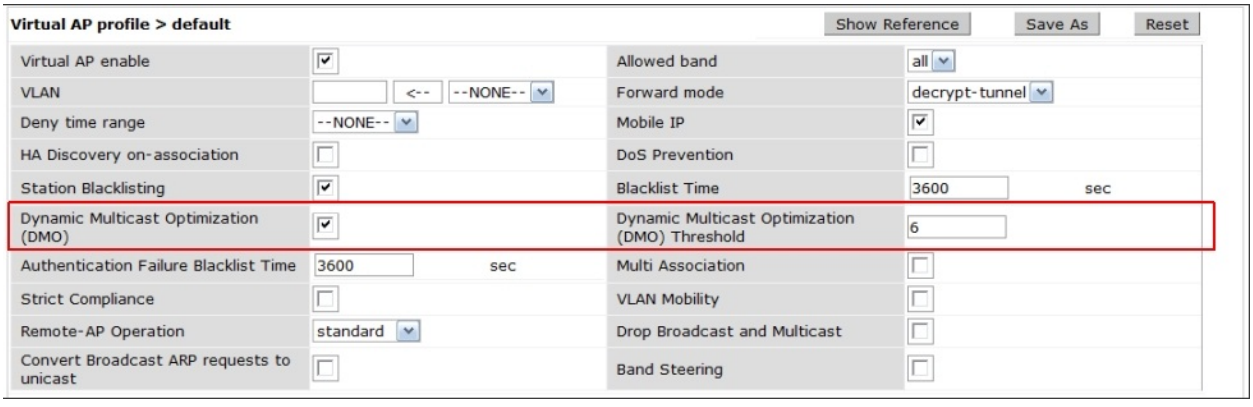
Figure 168 *Apply ACL to Port*



4. Configure dynamic multicast optimization for video traffic on a virtual AP profile.

   Under the Profiles column, expand Wireless LAN > Virtual AP Profile and select the profile name. This example uses the *default* profile. In the Profile Details section, select the Dynamic Multicast Optimization (DMO) option and enter the threshold value.

Figure 169 *Enabling Dynamic Multicast Optimization for Video and Set Threshold*



5. Configure multicast rate optimization for the video traffic.

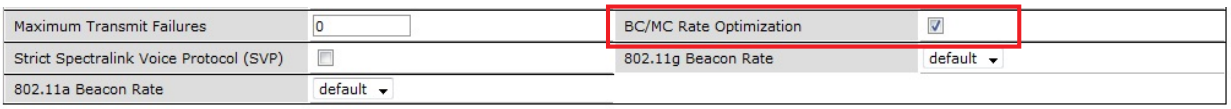
   a. Navigate to the Configuration > Advanced Services > All Profiles page.

   b. Under the Profiles column, expand Wireless LAN > SSID Profile and select the profile name.

   c. Click the Advanced tab and select the BC/MC Rate Optimization checkbox.

d. Click the Apply button to save the configurations.

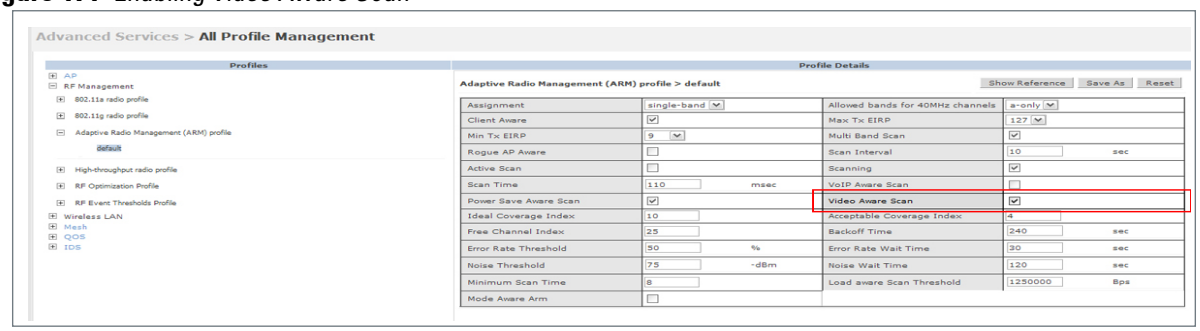
Figure 170 *Enable Multicast Rate Optimization*



6. Configure ARM scanning for video traffic.

   Under the Profiles column, expand RF Management > Adaptive Radio Management (ARM) Profile and select the profile name. This example uses the *default* profile. Select the Video Aware Scan option and click the Apply button.

Figure 171 *Enabling Video Aware Scan*



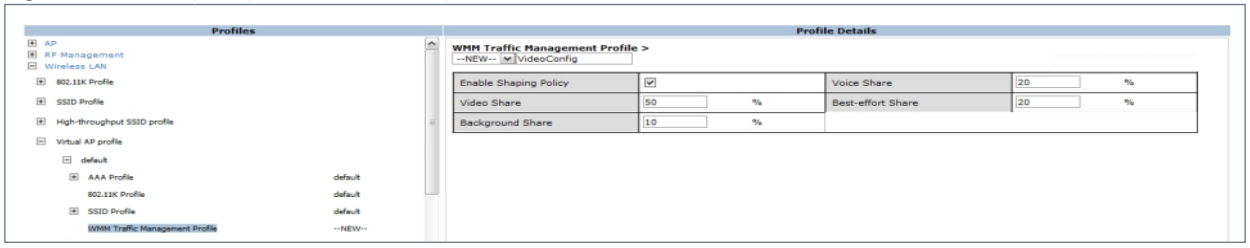
7. Configure and apply bandwidth management profile

   Under the Profiles column, expand Virtual AP > *[profile-name]* > WMM Traffic Management Profile. In the Profile Details section, select the profile name from the drop down list box. Select the Enable Shaping Policy option and enter the bandwidth share values. Click the Apply button to save the settings.

   This step is optional.

NOTE: Ensure that you configure the WMM traffic management profile to the virtual AP profile if you have configured the virtual AP traffic management profile.

Figure 172 *Configuring bandwidth management*



After you configure the WMM bandwidth management profile, apply it to the virtual AP profile.

8. Enable multicast shaping on the firewall.
   a. Navigate to the Configuration > Advanced Services > Stateful Firewall page.
   b. Click the Global Setting tab and select the Multicast automatic shaping checkbox.
   c. Click the Apply button to save the configurations.

Figure 173 *Enable Firewall Multicast Shaping*

QoS for Voice and Video

QoS settings for voice and video applications is configured when you configure firewall roles and policies.

VoIP Call Admission Control Profile

VoIP call admission control prevents any single AP from becoming congested with voice calls. You configure call admission control options in the VoIP Call Admission Control profile which you apply to an AP group or a specific AP.

You can use the WebUI or CLI to configure a VoIP Call Admission Control profile.

Using the WebUI

1. Navigate to the Configuration > AP Configuration page. Select either AP Group or AP Specific.
   - If you select AP Group, click Edit for the AP group name for which you want to configure VoIP CAC.
   - If you select AP Specific, select the name of the AP for which you want to configure VoIP CAC.
2. In the Profiles list, expand the QoS menu, then select the VoIP Call Admission Control profile.
3. In the Profile Details window pane, click the VoIP Call Admission Control profile drop-down list and select the profile you want to edit.
   -or-
   To create a new profile, click the VoIP Call Admission Control profile drop-down list and select New. Enter a new profile name in the field to the right of the drop-down list. You cannot use spaces in VoIP profile names.
4. Configure your desired VoIP Call Admission Control profile settings. Table 153 on page 688 describes the parameters you can configure in this profile.

Table 153 *VoIP Call Admission Control Configuration Parameters*

Parameter	Description
VoIP Call Admission Control	Select the Voip Call Admission Control checkbox to enable Wi-Fi VoIP Call Admission Control features.
VoIP Bandwidth based CAC	Select the VoIP Bandwidth based CAC checkbox to enable call admission controls based upon bandwidth. If this option is not selected, call admission controls are based on call counts.
VoIP Call Capacity	The maximum number of simultaneous calls that the AP radio can handle. The default value is 10. You can use the bandwidth calculator in the WebUI to calculate the call capacity. To access the bandwidth calculator, navigate to Configuration > Management > Bandwidth Calculator.
VoIP Bandwidth Capacity (kbps)	Enter a rate from 1 to 600000 (inclusive) to specify the maximum bandwidth rate that a radio can handle, in kbps. The default value is 2000 kbps.
VoIP Call Handoff Reservation	Specify the percentage of call capacity reserved for mobile VoIP clients on an active call. The default value is 20%.
VoIP Send SIP 100 Trying	The SIP invite call setup message is time-sensitive, as the originator retries the call as quickly as possible if it does not proceed. You can direct the controller to immediately reply to the call originator with a "SIP 100 - trying" message to indicate that the call is proceeding and to avoid a possible timeout. This is useful in conditions where the SIP invite may be redirected through a number of servers before reaching the controller. Select the VoIP Send SIP 100 Trying checkbox to send *SIP 100-trying* messages to a call originator to indicate that the call is proceeding. This is a useful option when the SIP invite is directed through many servers before reaching the controller.

Table 153 *VoIP Call Admission Control Configuration Parameters (Continued)*

Parameter	Description
VoIP Disconnect Extra Call	In the VoIP Call Admission Control (CAC) profile, you can limit the number of active voice calls allowed on a radio. This feature is disabled by default. When the disconnect extra call feature is enabled, the system monitors the number of active voice calls, and if the defined threshold is reached, any new calls are disconnected. The AP denies association requests from a device that is on call. To enable this feature, select the VoIP Disconnect Extra Call checkbox. You also need to enable call admission control in this profile.
VOIP TSPEC Enforcement	A WMM client can send a Traffic Specification (TSPEC) signaling request to the AP before sending traffic of a specific AC type, such as voice. You can configure the controller so that the TSPEC signaling request from a client is ignored if the underlying voice call is not active; this feature is disabled by default. If you enable this feature, you can also configure the time duration within which the station should start the voice call after sending the TSPEC request (the default is one second). Select the VoIP TSPEC Enforcement checkbox to validate TSPEC requests for CAC.
VOIP TSPEC Enforcement Period	Select the maximum time, in seconds, for the station to start the call after the TSPEC request.
VoIP Drop SIP Invite and send status code (client)	Click the VoIP Drop SIP Invite and send status code (client) drop-down list and select one of the following status codes to be sent back to the client: • 480: Temporary Unavailable • 486: Busy Here • 503: Service Unavailable • none: Don't send SIP status code
VoIP Drop SIP Invite and send status code (server)	Click the VoIP Drop SIP Invite and send status code (client) drop-down list and select one of the following status codes to be sent back to the server: • 480: Temporary Unavailable • 486: Busy Here • 503: Ser vice Unavailable • none: Don't send SIP status code

5. Click Apply to save your settings.

Using CLI

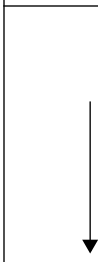
```
wlan voip-cac-profile <profile>
   bandwidth-cac
   bandwidth-capacity <bandwidth-capacity>
   call-admission-control
   call-capacity
   call-handoff-reservation <percent>
   disconnect-extra-call
   send-sip-100-trying
   send-sip-status-code client|server <code>
   wmm-tspec-enforcement
   wmm-tspec-enforcement-period <seconds>
```

Wi-Fi Multimedia

Wi-Fi Multimedia (WMM), is a Wi-Fi Alliance specification based on the IEEE 802.11e wireless Quality of Service (QoS) standard. WMM works with 802.11a, b, g, and n physical layer standards.

WMM supports four access categories (ACs): voice, video, best effort, and background. Table 154 on page 690 shows the mapping of the WMM access categories to 802.1p priority values. The 802.1p priority value is contained in a two-byte QoS control field in the WMM data frame.

Table 154 *WMM Access Category to 802.1p Priority Mapping*

Priority	802.1p Priority	WMM Access Category
Lowest	1	Background
	2	
	0	Best effort
	3	
	4	Video
	5	
	6	Voice
Highest	7	

In non-WMM, or hybrid environments where some clients are not WMM-capable, Dell uses voice and best effort to prioritize traffic from these clients.

Unscheduled Automatic Power Save Delivery (U-APSD) is a component of the IEEE 802.11e standard that extends the battery life on voice over WLAN devices. When enabled, clients trigger the delivery of buffered data from the AP by sending a data frame.

For the environments in which the wireless clients support WMM, you can enable both WMM and U-APSD in the SSID profile.

Enabling WMM

You can use the WebUI or CLI to enable WMM for wireless clients.

Using the WebUI

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. In the Profiles list, select Wireless LAN. Select Virtual AP, then select the applicable virtual AP profile. Select the SSID profile.
4. In the Profile Details, select the Advanced tab.
5. Scroll down to the Wireless Multimedia (WMM) option. Select (check) this option.
6. Click Apply.

Using CLI

```
wlan ssid-profile <profile> wmm
wlan ssid-profile <profile> wmm-uapsd
```

Configurable WMM AC Mapping

The IEEE 802.11e standard defines the mapping between WMM ACs and Differentiated Services Codepoint (DSCP) tags. The WMM AC mapping commands allow you to customize the mapping between WMM ACs and

DSCP tags to prioritize various traffic types. You apply and configure WMM AC mappings to a WMM-enabled SSID profile.

NOTE: The user-configured mapping only takes effect when WMM is enabled for the SSID profile.

DSCP classifies packets based on network policies and rules, not priority. The configured DSCP value defines per hop behaviors (PHBs). The PHB is a 6-bit value added to the 8-bit Differentiated Services (DS) field of the IP packet header. The PHB defines the policy and service applied to a packet when traversing the network. You configure these services in accordance with your network policies. Table 155 on page 691 shows the default WMM AC to DSCP decimal mappings and the recommended WMM AC to DSCP Hex mappings.

Table 155 *WMM Access Category to DSCP Mappings*

DSCP Decimal Value (default mappings)	DSCP Hex Value (recommended mappings)	WMM Access Category
8	0x08	Background
	0x10	
24	0x00	Best effort
	0x18	
40	0x20	Video
	0x28	
56	0x30	Voice
	0x38	

By customizing WMM AC mappings, both the controller and AP maintain a customized WMM AC mapping table for each configured SSID profile. All packets received are matched against the entries in the mapping table and prioritized accordingly. The mapping table contains information for upstream (client to AP) and downstream (AP to client) traffic.

NOTE: Default mappings exist for all SSIDs. After you customize a WMM AC mapping and apply it to the SSID, the controller overwrites the default mapping values and uses the configured values.

If you do not define a mapping for a particular DSCP tagged packet, default mappings are applied and prioritized accordingly (Best Effort uses 0x00).

When planning your mappings, make sure that any immediate switch or router does not have conflicting 802.1p or DSCP configurations/mappings. If this occurs, your traffic may not be prioritized correctly.

To view the mapping settings, use the following command:

```
show wlan ssid-profile <profile>
```

Using the WebUI to map between WMM AC and DSCP

1. Navigate to the Configuration > Wireless > AP Configuration page.
2. Select either the AP Group or AP Specific tab. Click Edit for the AP group or AP name.
3. In the Profiles list, select Wireless LAN. Select Virtual AP, then select the applicable virtual AP profile. Select the SSID profile.
4. In the Profile Details, select the Advanced tab.

5. Scroll down to the Wireless Multimedia (WMM) option. Select (check) this option.
6. Modify the DSCP mapping settings, as needed:
   - DSCP mapping for WMM voice AC—DSCP used to map voice traffic
   - DSCP mapping for WMM video AC—DSCP used to map video traffic
   - DSCP mapping for WMM best-effort AC—DSCP used to map best-effort traffic
   - DSCP mapping for WMM background AC—DSCP used to map background traffic
7. Click Apply.

Using the CLI to map between WMM AC and DSCP

```
wlan ssid-profile <profile>
   wmm-be-dscp <best-effort>
   wmm-bk-dscp <background>
   wmm-vi-dscp <video>
   wmm-vo-dscp <voice>
   wmm
```

Dynamic WMM Queue Management

Traditional wireless networks provide all clients with equal bandwidth access. However, delays or reductions in throughput can adversely affect voice and video applications, resulting in disrupted VoIP conversations or dropped frames in a streamed video. Thus, data streams that require strict latency and throughput need to be assigned higher traffic priority than other traffic types.

The Wi-Fi Alliance defined the Wi-Fi Multimedia (WMM) standard in response to industry requirements for Quality of Service (QoS) support for multimedia applications for wireless networks. This is defined as per the IEEE 802.11e standards.

WMM requires:

- The access point is Wi-Fi Certified and has WMM enabled
- The client device is Wi-Fi Certified
- The application supports WMM

Enhanced Distributed Channel Access

WMM provides media access prioritization through Enhanced Distributed Channel Access (EDCA). EDCA defines four access categories (ACs) to prioritize traffic: voice, video, best effort, and background. These ACs correspond to 802.1p priority tags, as shown in Table 156 on page 692.

Table 156 *WMM Access Categories and 802.1p Tags*

WMM Access Category	Description	802.1p Tag
Voice	Highest priority	7, 6
Video	Prioritize video traffic above other data traffic	5, 4
Best Effort	Traffic from legacy devices or traffic from applications or devices that do not support QoS	0, 3
Background	Low priority traffic (file downloads, print jobs)	2, 1

While the WMM ACs designate specific types of traffic, you can determine the priority of the ACs. For example, you can choose to give video traffic the highest priority. With WMM, applications assign data packets to an AC. In the client, the data packets are then added to one of the transmit queues for voice, video, best effort, or background.

WMM is an extension to the Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol's Distributed Coordination Function (DCF). The collision resolution algorithm responsible for traffic prioritization depends on the following configurable parameters for each AC:

- arbitrary inter-frame space number (AIFSN)
- minimum and maximum contention window (CW) size

For each AC, the backoff time is the sum of the AIFSN and a random value between 0 and the CW value. The AC with the lowest backoff time is granted the opportunity to transmit (TXOP). Frames with the highest-priority AC are more likely to get TXOP as they tend to have the lowest backoff times (a result of having smaller AIFSN and CW parameter values). The value of the CW varies through time as the CW doubles after each collision up to the maximum CW. The CW is reset to the minimum value after successful transmission. In addition, you can configure the TXOP duration for each AC.

On the controller, you configure the AC priorities in the WLAN EDCA parameters profile. There are two sets of EDCA profiles you can configure:

- AP parameters affect traffic from the AP to the client.
- STA parameters affect traffic from the client to the AP.

Using the WebUI to configure EDCA parameters

Use the following procedure to define an Enhanced Distributed Channel Access (EDCA) profile for APs or for clients (stations).

1. Navigate to the Configuration > AP Configuration page. Select either the AP Group tab or AP Specific tab.
   - If you selected AP Group, click Edit for the AP group name for which you want to configure EDCA parameters.
   - If you selected AP Specific, select the name of the AP for which you want to configure EDCA parameters.
2. Under Profiles, expand the Wireless LAN menu, then select Virtual AP. In the Virtual AP list, select the appropriate virtual AP.
3. Expand the SSID profile. Select the EDCA Parameters Station or EDCA Parameters AP profile.
4. Configure your desired EDCA Profile Parameters. Table 157 describes the parameters you can configure in this profile.

Table 157 *EDCA Parameters Station and EDCA Parameters AP Profile Settings*

Parameter	Description
Best Effort	Set the following parameters to define the best effort queue. • aifsn: Arbitrary inter-frame space number. Possible values are 1-15. • ecw-max: The exponential (n) value of the maximum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 1-15. • ecw-min: The exponential (n) value of the minimum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 0-15. • txop: Transmission opportunity, in units of 32 microseconds. Divide the desired transmission duration by 32 to determine the value to configure. For example, for a transmission duration of 3008 microseconds, enter 94 (3008/32). Possible values are 0-2047. • acm: This parameter specifies mandatory admission control. With a value of 1, the client reserves the access category through traffic specification (TSPEC) signaling. A value of 0 disables this option.

Table 157 *EDCA Parameters Station and EDCA Parameters AP Profile Settings (Continued)*

Parameter	Description
Background	Set the following parameters to define the background queue. • aifsn: Arbitrary inter-frame space number. Possible values are 1-15. • ecw-max: The exponential (n) value of the maximum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 1-15. • ecw-min: The exponential (n) value of the minimum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 0-15. • txop: Transmission opportunity, in units of 32 microseconds. Divide the desired transmission duration by 32 to determine the value to configure. For example, for a transmission duration of 3008 microseconds, enter 94 (3008/32). Possible values are 0-2047. • acm: This parameter specifies mandatory admission control. With a value of 1, the client reserves the access category through traffic specification (TSPEC) signaling. A value of 0 disables this option.
Video	Set the following parameters to define the background queue. • aifsn: Arbitrary inter-frame space number. Possible values are 1-15. • ecw-max: The exponential (n) value of the maximum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 1-15. • ecw-min: The exponential (n) value of the minimum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 0-15. • txop: Transmission opportunity, in units of 32 microseconds. Divide the desired transmission duration by 32 to determine the value to configure. For example, for a transmission duration of 3008 microseconds, enter 94 (3008/32). Possible values are 0-2047. • acm: This parameter specifies mandatory admission control. With a value of 1, the client reserves the access category through traffic specification (TSPEC) signaling. A value of 0 disables this option.
Voice	Set the following parameters to define the background queue. • aifsn: Arbitrary inter-frame space number. Possible values are 1-15. • ecw-max: The exponential (n) value of the maximum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 1-15. • ecw-min: The exponential (n) value of the minimum contention window size, as expressed by 2^n-1. A value of 4 computes to 2^4-1 = 15. Possible values are 0-15. • txop: Transmission opportunity, in units of 32 microseconds. Divide the desired transmission duration by 32 to determine the value to configure. For example, for a transmission duration of 3008 microseconds, enter 94 (3008/32). Possible values are 0-2047. • acm: This parameter specifies mandatory admission control. With a value of 1, the client reserves the access category through traffic specification (TSPEC) signaling. A value of 0 disables this option.

5. Click Apply.

Using the CLI to configure EDCA parameters

```
wlan edca-parameters-profile {ap|station} <profile>
{background | best-effort | video | voice}
[acm][aifsn <number>] [ecw-max <exponent> [ecw-min <exponent>] [txop <number>]
```

To associate the EDCA profile instance to a SSID profile:

```
wlan ssid-profile <profile>
   edca-parameters-profile {ap|sta} <profile>
```

WMM Queue Content Enforcement

WMM queue content enforcement is a firewall setting that you can enable to ensure that the voice priority is used for voice traffic. When this feature is enabled, if traffic to or from the user is inconsistent with the associated QoS policy for voice, the traffic is reclassified to best effort and data path counters incremented. If TSPEC admission were used to reserve bandwidth, then TSPEC signaling is used to inform the client that the reservation is terminated.

You can use the WebUI or CLI to enable WMM queue content enforcement.

Using the WebUI

1. Navigate to the Configuration > Advanced Services > Stateful Firewall page.
2. Select Enforce WMM Voice Priority Matches Flow Content.
3. Click Apply.

Using CLI

```
firewall wmm-voip-content-enforcement
```

Extended Voice and Video Functionalities

This section describes the other voice and video-related functionalities that are available on the controller.

QoS for Microsoft Office OCS and Apple Facetime

Voice and video devices use a signaling protocol to establish, control, and terminate voice and video calls. These control or signaling sessions are usually permitted using pre-defined ACLs. If, however, the control signaling packets are encrypted, the controller cannot determine which dynamic ports are used for voice or video traffic. In these cases, the controller has to use an ACL with the classify-media option enabled to identify the voice or video flow based on a deep packet inspection and analysis of the actual traffic.

Microsoft OCS

Microsoft Office Communications Server (OCS) uses Session Initiation Protocol (SIP) over TLS to establish, control, and terminate voice and video calls. The following example creates an ACL named ocs for Microsoft OCS traffic that identifies port 5061 as the reserved SIP-TLS port.

```
(host) (config) #ip access-list session ocs
(host) (config-sess-ocs)#any any tcp 5061 permit position 1 queue high classify-media
(host) (config-sess-ocs)#any any udp 1-65535  permit  position 2 queue low
```

Apple Facetime

When an Apple device starts a Facetime video call, it initiates a TCP session to the Apple Facetime server over port 5223, then sends SIP signaling messages over a non-default port. When media traffic starts flowing, audio and video data are sent through that same port using RTP. (The audio and video packets are interleaved in the air, though individual the sessions can be uniquely identified using their payload type and sequence numbers.) The RTP header and payload also get encapsulated under the TURN ChannelData Messages. The Facetime call is terminated with a SIP BYE message that can be sent by either party.

Table 158 lists the ports used by Apple Facetime. Facetime users need to be assigned a role where traffic is allowed on these ports

Table 158 *Ports used by the Apple Facetime Application*

Port	Packet Type
53	TCP/UDP
443	TCP
3478-3497	UDP
5223	TCP
16384-16387	UDP
16393-16402	UDP

The example below shows how to configure an ACL to identify and monitor Apple Facetime traffic.

```
(host) (config) #ip access-list session facetime
(host) (config-sess-facetime)#any any tcp 80 permit position 1 queue low
(host) (config-sess-facetime)#any any tcp 443 permit position 2 queue low
(host) (config-sess-facetime)#any network 17.0.0.0 255.0.0.0 tcp 5223 permit position 3
queue low classify-media
(host) (config-sess-facetime)#any any UDP 80 permit position 4 queue low
(host) (config-sess-facetime)#any network 17.0.0.0 255.0.0.0 UDP 16384-16387 permit
position 5 queue low
```

WPA Fast Handover

In the 802.1x Authentication profile, the WPA fast handover feature allows certain WPA clients to use a pre-authorized PMK, significantly reducing handover interruption. Check with the manufacturer of your handset to see if this feature is supported. This feature is disabled by default.

NOTE: This feature supports WPA clients, while opportunistic key caching (also configured in the 802.1x Authentication profile) supports WPA2 clients.

Using the WebUI to enable WPA fast handover

1. Navigate to the Configuration > AP Configuration page. Select either AP Group or AP Specific.
   - If you select AP Group, click Edit for the AP group name for which you want to enable WPA fast handover.
   - If you select AP Specific, select the name of the AP for which you want to enable WPA fast handover.
2. Under Profiles, select Wireless LAN, then select Virtual AP. In the Virtual AP list, select the appropriate virtual AP instance.
3. Select AAA profile. Select the 802.1x Authentication Profile to display in the Profile Details section.
4. Scroll down to select the WPA-Fast-Handover check box.
5. Click Apply.

Using the CLI to enable WPA fast handover

```
aaa authentication dot1x <profile>
   wpa-fast-handover
```

For deployments where there are expected to be considerable delays between the controller and APs (for example, in a remote location where an AP is not in range of another Dell AP) you can increase the value for the bootstrap threshold in the AP System profile to minimize the chance of the AP rebooting due to temporary loss of connectivity with the Dell controller.

Mobile IP Home Agent Assignment

When you enable IP mobility in a mobility domain, the proxy mobile IP module determines the home agent for a roaming client. An option related to voice clients that you can enable allows on-hook phones to be assigned a new home agent to load balance voice client home agents across controllers in the mobility domain. See Chapter 23, "IP Mobility" for more information about mobility.

VoIP-Aware ARM Scanning

ARM scanning on an AP during a call affects the voice quality. You can pause the ARM scanning on the AP when a call is active by turning on the VoIP-Aware ARM Scanning support to avoid voice quality issues.

You can use the WebUI or CLI to enable VoIP-aware ARM scanning in the ARM profile.

Using the WebUI

1. Navigate to the Configuration > AP Configuration page. Select either the AP Group or AP Specific tab.
   - If you selected the AP Group tab, click the Edit button by the name of the AP group with the ARM profile you want to configure.
   - If you selected the AP Specific tab, click the Edit button by the name of the AP with the ARM profile you want to configure.
2. In the Profiles list, Expand the RF Management section.
3. Select Adaptive Radio Management (ARM) Profile.
4. Select a profile instance from the drop-down menu to edit that profile.
5. Select (check) the VoIP Aware Scan option.
6. Click Apply.

For additional information on configuring an Adaptive Radio Management profile, see "ARM Profiles" on page 164.

Using CLI

```
rf arm-profile <profile-name>
   voip-aware-scan
```

Voice-Aware 802.1x

NOTE: The Voice-Aware 802.1x support is deprecated for ArubaOS 5.0 and later releases.

Although reauthentication and rekey timers are configurable on a per-SSID basis, an 802.1x transaction during a call can affect voice quality. If a client is on a call, 802.1x reauthentication and rekey are disabled by default until the call is completed. You disable or re-enable the "voice aware" feature in the 802.1x authentication profile.

Using the WebUI to disable voice awareness for 802.1x

1. Navigate to the Configuration > AP Configuration page. Select either AP Group or AP Specific.
   - If you select AP Group, click Edit for the AP group name for which you want to disable voice awareness for 802.1x.
   - If you select AP Specific, select the name of the AP for which you want to disable voice awareness for 802.1x.
2. Under Profiles, select Wireless LAN, then select Virtual AP. In the Virtual AP list, select the appropriate virtual AP instance.
3. Select AAA profile. Select the 802.1x Authentication Profile to display in the Profile Details section.
4. Scroll down and deselect the Disable rekey and reauthentication for clients on call check box.
5. Click Apply.

Using the CLI to disable voice awareness for 802.1x

```
aaa authentication dot1x <profile>
   no voice-aware
```

SIP Authentication Tracking

The controller supports the stateful tracking of session initiation protocol (SIP) authentication between a SIP client and a SIP registry server. Upon successful registration, a user role is assigned to the SIP client. You specify a configured user role for the SIP client in the AAA profile.

Using the WebUI to configure the SIP client user role

1. Navigate to the Configuration > AP Configuration page. Select either AP Group or AP Specific.
   - If you select AP Group, click Edit for the AP group name for which you want to configure the SIP client user role.
   - If you select AP Specific, select the name of the AP for which you want to configure the SIP client user role.
2. Under Profiles, select Wireless LAN, then select Virtual AP. In the Virtual AP list, select the appropriate virtual AP instance.
3. Select the AAA profile. Enter the configured user role for SIP authentication role.
4. Click Apply.

Using the CLI to configure the SIP client user role

```
aaa profile <profile>
   sip-authentication-role <role>
```

Use the `show voice client-status` command to view the state of the client registration.

Real Time Call Quality Analysis

Real Time Call Quality Analysis (RTCQA) enables the controller to compute the call quality parameters such as jitter, delay, packet loss, and call quality score (R-value) directly from the RTP media stream. Additionally, the controller saves the periodic samples of the quality parameters for detailed analysis of the results. You can monitor up to 30 active calls that are initiated after enabling RTCQA. You can avail the full benefits of Real Time Call Quality Analysis by setting the AP in the decrypt tunnel mode.

NOTE: Real Time Call Quality Analysis for the voice calls is supported in the following cases:

- when the signaling messages are not encrypted
- when the RTP streams are not encrypted
- when the voice client does not roam from one controller to another controller

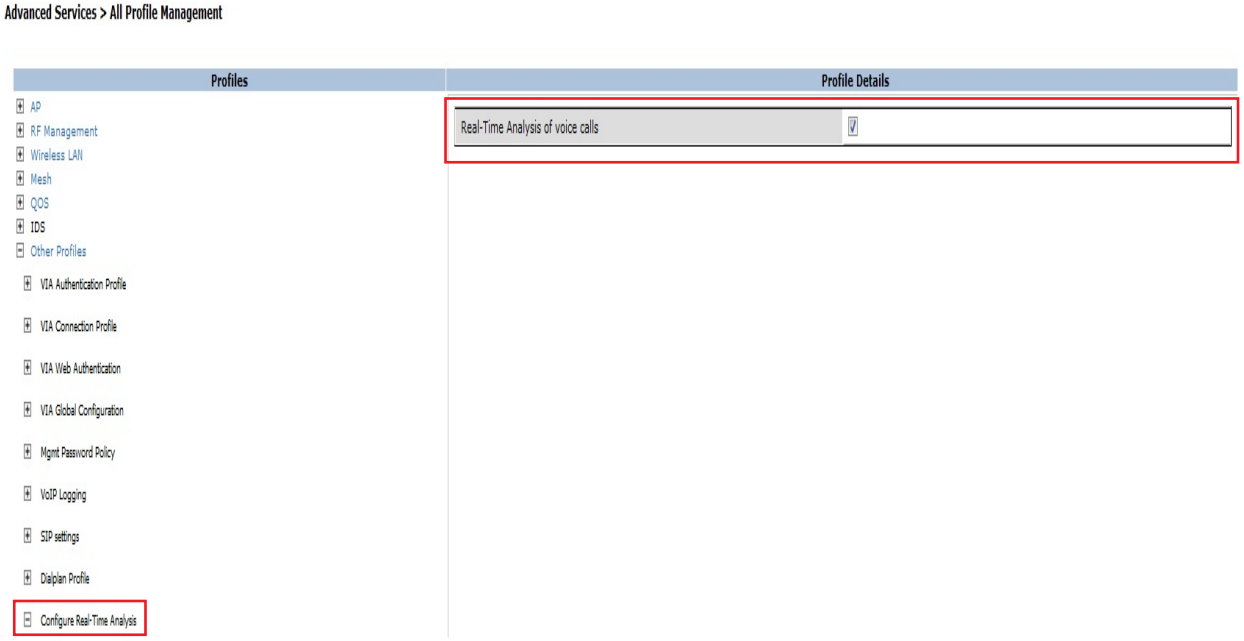
You can use the WebUI or CLI to enable Real Time Call Quality Analysis and view the call quality reports based on the analysis.

Using the Web UI

1. Navigate to the Configuration > Advanced services > All Profiles page.
2. Expand Other Profiles under the Profiles section and click Configure Real-Time Analysis.

3. Enable Real Time call quality analysis for the voice calls by selecting the Real-Time Analysis of voice calls check box.

Figure 174 *Enable Real Time Analysis*



4. Click the Apply button to apply the settings and save the configurations.

Viewing Real Time Call Quality Reports

1. To view the average Real Time analysis reports, navigate to the Monitoring > Voice > Real-Time Quality Analysis page.
2. To view the detailed Real Time analysis report of a specific client, select the client and click the View Details button.

Using CLI

To configure Real Time analysis on voice calls:

```
(host) (config) #voice real-time-config
(host) (Configure Real-Time Analysis) #config-enable
```

To view the average Real Time analysis reports for the voice clients:

```
(host) #show voice real-time-analysis

Real-Time Analysis Call Quality Reports
---------------------------------------
Client(IP)    Client(MAC)         Client(Name)   ALG    Jitter(U)(msec)   Pkt-loss(U)(%)
Delay(U)(usec)   rvalue(U)   Jitter(D)(msec)   Pkt-loss(D)(%)   Delay(D)(usec)   rvalue(D)
----------    -----------         ------------  ---    ---------------   --------------   --
------------  ---------  ---------------  --------------  --------------  ---------
10.15.20.52  00:00:f0:05:c9:dc  7811        h323  0.000         0.000         0.000
NA          0.000            0.000           0.000           NA
10.15.20.63  00:00:f0:05:c9:e3  7812        h323  0.000         0.000         0.000
NA          0.000            0.000           0.000           NA
Num Records:2
```

To view the detailed Real Time analysis report for a specific client:

```
(host) #show voice real-time-analysis sta 00:1f:6c:7a:d5:30
```

```
Real-Time Analysis detail report
--------------------------------
Time               Jitter(U)(msec)   Pkt-loss(U)(%)   Delay(U)(usec)   rvalue(U)
Jitter(D)(msec)   Pkt-loss(D)(%)   Delay(D)(usec)   rvalue(D)
----------------  ---------------  --------------  --------------  ---------  ---------
------  --------------  --------------  ---------
Aug 17 11:55:18   71.000          0.000          0.000          93.360     0.000
0.000           0.000           NA
Aug 17 11:55:13   76.000          0.000          0.000          93.360     0.000
0.000           0.000           NA
Aug 17 11:55:08   69.000          0.000          0.000          93.360     0.000
0.000           0.000           NA
Aug 17 11:55:03   71.000          0.000          0.000          93.360     0.000
0.000           0.000           NA
```

SIP Session Timer

SIP session timer is implemented in the SIP ALG as per RFC 4028.

SIP session timer defines a keep alive mechanism for the SIP sessions using the periodic session refresh requests from the user agents. The interval for the session refresh requests is determined through a negotiation mechanism. If a session refresh request is not received within the negotiated interval, the session is assumed to be terminated.

For more information on the SIP session timer support, See *section 8.0, Proxy Behaviour* in the RFC 4028.

NOTE: This release of ArubaOS does not support the configurable Min-SE parameter for SIP ALG. Therefore, the ALG will not generate the 422 responses for the session refresh requests.

You can use the WebUI or CLI to enable the SIP session timer and set the session-expiry timer value using the WebUI and CLI.

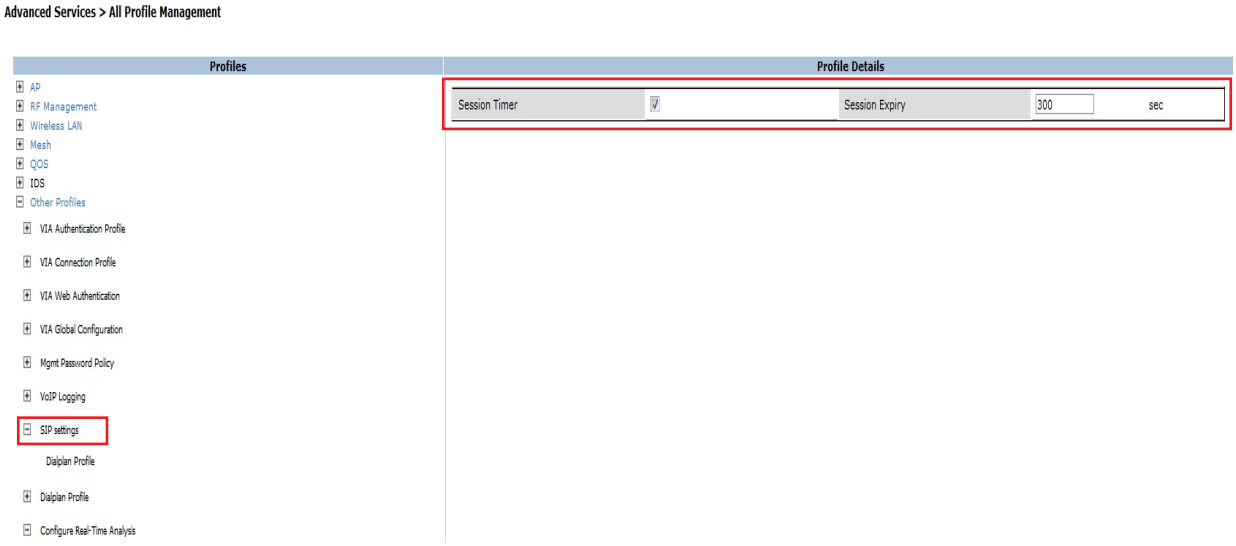
NOTE: SIP Session Timer can be configured only for SIP over UDP.

Using the WebUI

1. Navigate to the Configuration > Advanced services > All Profiles page.
2. Expand Other profiles under the Profiles section and click SIP Settings.
3. Enable the session timer by selecting the Session Timer check box under the Profile Details section.

4. Specify a timeout value in seconds in the Session Expiry field. The range is 240 - 1200 seconds. The default value is 300 seconds.

Figure 175 *Enabling SIP Session Timer*



5. Click the Apply button to apply the settings and save the configurations.

Using CLI

To configure the session timer and the timeout value:

```
(host) #configure terminal
(host) (config) #voice sip
(host) (SIP settings) #session-timer
(host) (SIP settings) #session-expiry 400
```

To view the SIP settings on the controller:

```
(host) #show voice sip

SIP settings
------------
Parameter         Value
---------         -----
Session Timer     Enabled
Session Expiry    400 sec
Dialplan Profile  N/A
```

Voice and Video Traffic Awareness for Encrypted Signaling Protocols

The Voice and Video Traffic Awareness for Encrypted Signaling Protocols support enables deep inspection of the traffic established over a secure layer to identify the voice or video sessions. Thus, the controller provides QoS for the voice or video sessions established even over the secure layers such as TLS or IP Sec. For example, the Microsoft Office Communicator uses SIP over TLS for call signaling. You can provide QoS for the voice and video calls through Microsoft Office Communicator by enabling the Classify Media option in the SIPS service policy.

You can use the WebUI or CLI for enabling the Classify Media option for the encrypted signaling protocols. In our example, we will configure this support for Microsoft Office Communicator.

Using the WebUI

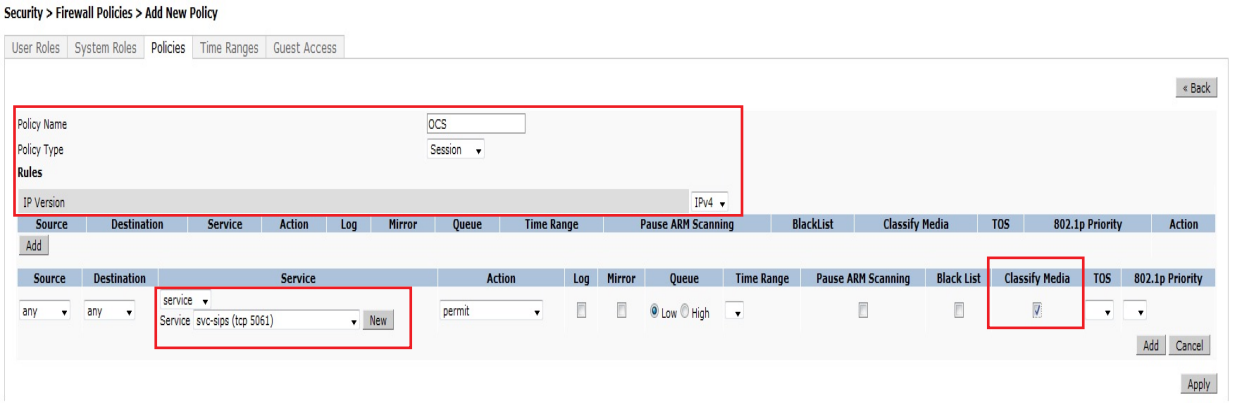
1. Navigate to the Configuration > Security > Access control page.
2. Click the Policies tab.

Figure 176 *Firewall Policies Tab*

3. Click the Add button to create a new policy.
4. Enter a name for the policy in the Policy Name field and choose Session in the Policy Type drop down menu.
5. Select IPv4 in the IP Version drop down menu and click the Add button.
6. In the Service column, choose service and Select svc-sips (tcp-5061) from the Service drop-down menu.
7. Select the Classify Media check box.

△ CAUTION: There will be a performance impact, if you choose any in the Service column and enable the Classify Media flag for the deep traffic inspection.

Figure 177 *Enabling Classify Media*



8. Click Apply to apply the settings and save the configurations.

Using the CLI

```
(host) (config) #ip access-list session ocs
(host) (config-sess-ocs)#any any tcp 5061 permit classify-media
```

Wi-Fi Edge Detection and Handover for Voice Clients

Voice clients in an infrastructure can be switched to an alternate carrier or connection when they leave their active Wi-Fi coverage or roam to an area with poor Wi-Fi coverage. The controller uses the best Wi-Fi signal

strength (dbm value) reported by the voice clients (received from all APs) to determine if the voice clients are within or leaving their active Wi-Fi connection. If the signal strength is weak, the controller will trigger the handover process to switch the voice client to an alternate carrier or connection. This process ensures QoS for voice calls.

NOTE: • The handover process is available for voice clients supporting the 802.11K standard and with the ability to transmit and receive beacon reports.

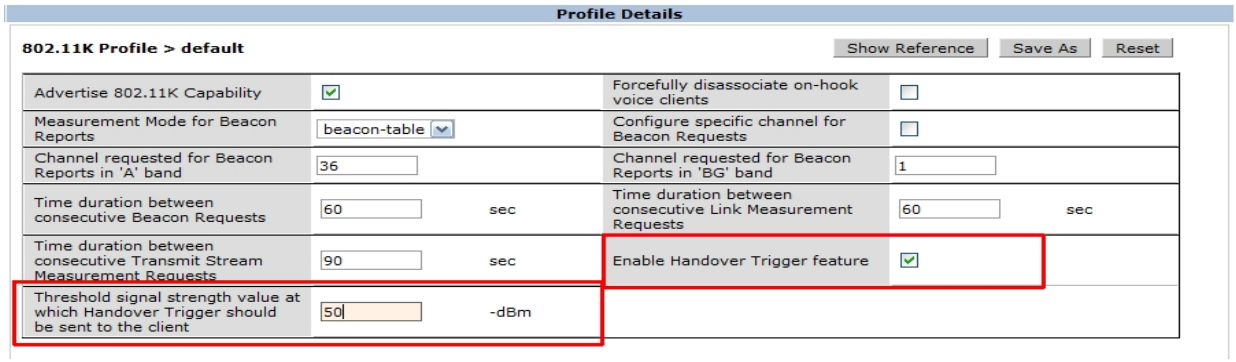
• The voice clients should have dual mode capabilities to ensure that they can switch to an alternate network in case of a loss in Wi-Fi coverage.

The handover process can be configured using the wlan dot11k-profile command. Use the handover-threshold parameter to specify the threshold value (dbm) and enable the handover-trigger parameter. If the best signal strength reported by a voice client is equal to or less than the threshold value, the handover process is initiated.

Using the WebUI

1. Navigate to the Configuration > Advanced Services > All Profiles page.
2. Expand Wireless Lan under the Profiles section.
3. Expand 802.11K Profile under Wireless Lan.
4. Select the default profile. To configure the handover process do the following:
   a. Select the Enable Handover Trigger feature checkbox
   b. Specify the handover threshold value in the Threshold signal strength value at which handover Trigger should be sent to the client field. The handover threshold value should be within the range 20 to 70 dbm. The default threshold value is -60 dbm.
5. Click the Apply button to save the configuration.

Figure 178 *Configuring Handover for Voice Clients*



Using CLI

The following command enables the dot11k profile and sets the handover threshold at -60dbm.

```
(host) (config) #wlan dot11k-profile default
(host) (802.11K Profile "default") #dot11k-enable
(host) (802.11K Profile "default") #handover-threshold 60
(host) (802.11K Profile "default") #handover-trigger
```

NOTE: The handover threshold value is a negative dbm value. In the CLI, enter the value without the negative (-) sign.

Dial Plan for SIP Calls

A PSTN call from a SIP device usually requires the user to prefix 9 or 0 before the destination number. You can configure dial plans (prefix codes) on the controller that are required by the local EPABX system to provide outgoing PSTN call facility from a SIP device. After the dial plan is configured, a user can make SIP calls by dialing the destination number without any prefixes.

NOTE: Dial plan can be configured only for SIP over UDP.

Dial Plan Format

The format of a SIP dial plan is `<sequence> <pattern> <action>`.

- sequence—is a number between 100 and 65535. The sequence number positions the dial plan in the list of dial plans configured in the controller.
- pattern—is the digit pattern or the number of digits that will be dialed by the user. You can specify digit pattern using 'X', 'Z', 'N' , '[]', and '.'.
  - X is a wild card that represents any character from 0 to 9.
  - Z is a wild card that represents any character from 1 to 9.
  - N is a wild card that represents any character from 2 to 9.
  - . (period) is a wild card that represents any-length digit strings.
- action—is the prefix code that is automatically prefixed to the dialed number. This is specified as <prefix-code>%e. Examples of prefix codes are:
  - 9%e: The number 9 is prefixed to the dialed number.
  - 91%e: The number 91 is prefixed to the dialed number.

Table 159 *Examples of Dial Plans*

Dialplan Pattern	Action	Description
XXXX	%e	When the user dials a four digit number, no action is taken and the call is allowed.
XXXXXXX	9%e	When the user dials a seven digit number, a nine (9) is prefixed to that number and the call is executed. Example, if the user dials 2274500, the call is executed by adding 9 to the number, 92274500.
XXXXXXXXXX	91%e	This dial plan prefixes 91 to the dialed number. Example, call to 4082274500 will be executed as 914082274500.
+1XXXXXXXXXX	9%e	This dial plan replaces '+' with 9 and executes the call. Example, call to +14082274500 is executed as 914082274500.
+.	9011%e	This dial plan removes '+' and prefixes 9011 for an international call. Example, call to +886212345678 is executed as 9011886212345678.

Configuring Dial Plans

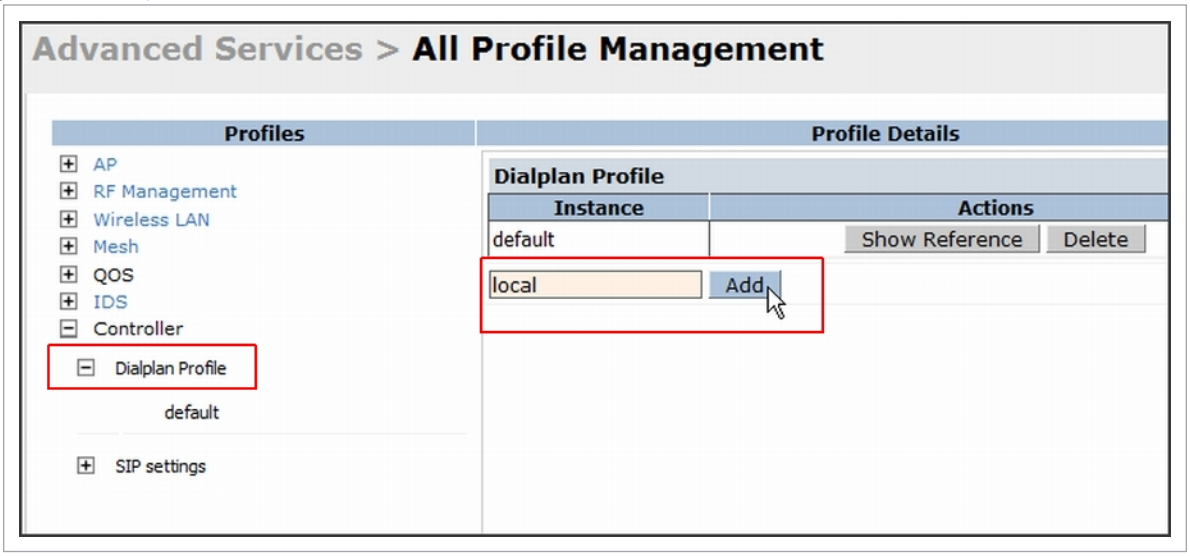
You can configure a maximum of two dial plan profiles and maximum of 20 dial plans per profile. The dial plan must be associated to a SIP ALG configuration.

To configure a dial plan for SIP devices:

1. Create a voice dial plan
2. Associate the dial plan with SIP ALG

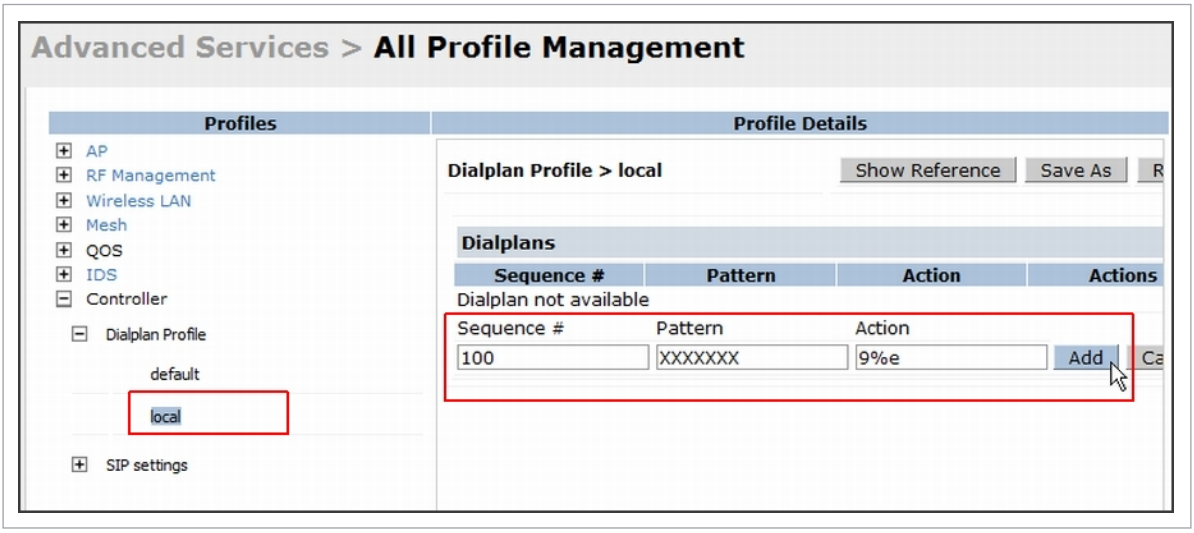
1. In the WebUI, navigate to Configuration > Advanced Services > All Profiles > Controller > Dialplan Profile. Enter a name for the dial plan profile and click the Add button.

Figure 179 *Dialplan Profile*



2. Under *Profiles*, expand Controller and select the newly created dial plan profile. Enter the following dial plan details and click the Add button.
   - Sequence number: The dial plan position in the list of dial plans.
   - Pattern: The number that the user will dial.
   - Action: Prefix to be added by the controller before forwarding the call to the EPABX.

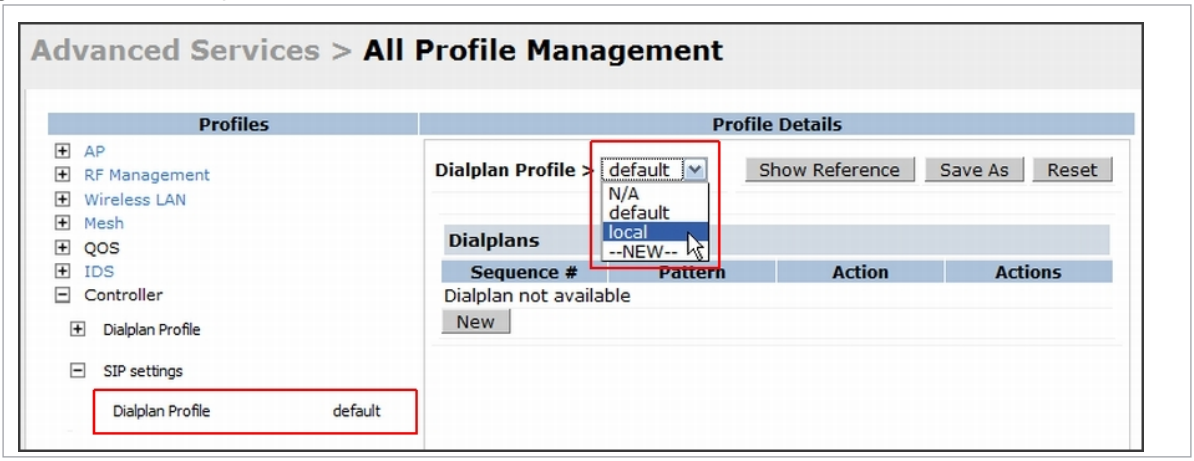
Figure 180 *Dialplan Details*



3. Click the Apply button to save the configuration.

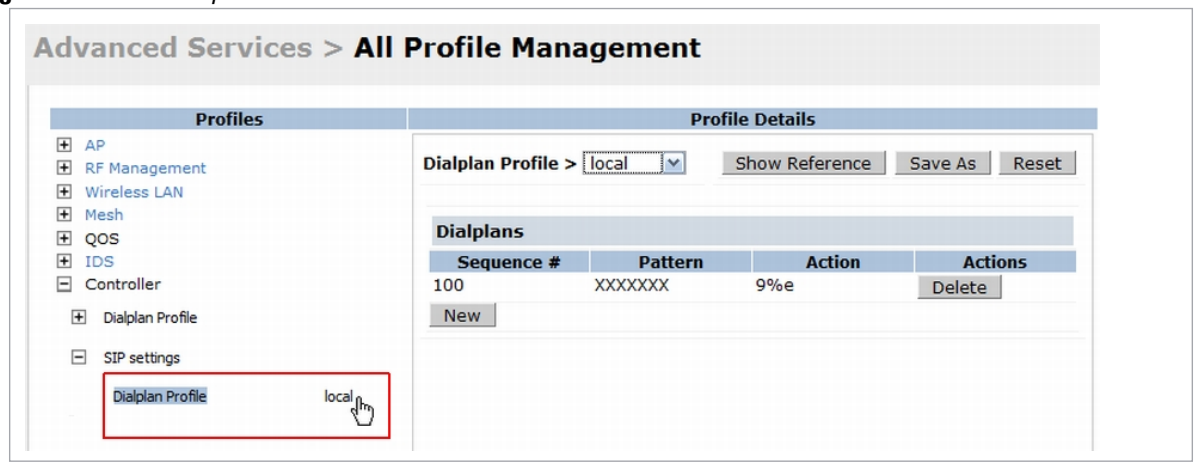
4. Under *Profile*, navigate to Controller > SIP settings and select Dialplan Profile. In the *Profile Details* section, select the *Dialplan Profile* from the drop down list and click the Apply button.

Figure 181 *Select Dialplan Profile*



The Dialplan Profile displays the dial plan details:

Figure 182 *View Dialplan Details*



Using CLI

To create a voice dial plan profile:

```
(host) (config) #voice dialplan-profile local
(host) (Dialplan Profile "local") #dialplan 100 XXXXXXX 9%e
(host) (Dialplan Profile "local") #!
```

To associate the dial plan with SIP ALG:

```
(host) (config) #voice sip
(host) (SIP settings) #dialplan-profile local
(host) (SIP settings) #!
```

To view the SIP dial plan profile:

```
(host) (config) #show voice sip

SIP settings
------------
Parameter         Value
---------         -----
Dialplan Profile  local
```

To view the dial plan details:

```
(host) (config) #show voice dialplan-profile local

Dialplan Profile "local"
-------------------------
Parameter  Value
---------  -----
dialplan   100 XXXXXXX 9%e
```

Enhanced 911 Support

ArubaOS provides seamless support for emergency calls in the Dell network by interoperating with RedSky emergency call server. The controller uses SNMP to interoperate with RedSky call handling system.

NOTE: This release of ArubaOS supports only RedSky emergency call server.

You must configure the Red Sky server as an SNMP host and enable SNMP traps to activate the E911 feature on the controller. For more information on configuring the RedSky server as SNMP host, see "Configuring SNMP" on page 585.

The E911 support has the following basic functions:

- Location tracking
- Call handling
- Caller identification and callback capability

For information on call-handling, caller identification and callback capability, see the RedSky documentation.

The controller tracks the location of the voice clients and notifies the emergency call server using SNMP traps. The controller notifies the location of a voice client to the emergency server:

- When it identifies a voice client
- When a voice client roams from one access point to another access point in the same controller
- When a voice client roams from one access point to another access point in a different controller
- When a voice client registers with a PBX system

The notification process ensures that the emergency call server is notified whenever a voice client is identified or the location of the client is updated. If a voice client roams outside of a WLAN coverage, the controller does not send any notifications to the emergency call handling system. This may happen when there is a sudden loss of WLAN coverage due to extreme conditions such as, fire accidents. In such cases, the last associated access point will be the location of the voice client.

NOTE: The controller tracks the location only for voice clients. To track the location of a remote voice client, the administrator must configure the location of the remote access point in the controller or emergency call server.

The emergency call server queries the controller using the SNMP 'get' request to get the location of a specific emergency caller. In response to the location query, the controller sends the following parameters to the emergency server:

- Client IP Address
- Client Mac Address
- AP Name
- AP Wired MAC

- AP Location
- AP Mode
- Controller IP Address

The controller also supports location queries for the clients that are not identified as voice clients on the controller.

Voice over Remote Access Point

Voice traffic support is enhanced on split tunnel mode over a remote access point. The voice traffic management for remote and local users are done on the controller. However, the sessions are created differently for both users. For remote users, the sessions are created on the remote access point and for local users, the sessions are created on the controller. This enhancement provides the following support for the voice traffic in the split tunnel over remote access point:

- Voice traffic QoS is consistent for both local and remote users
- All voice ALGs work reliably in split tunnel mode when the PBX traffic is destined to flow through the corporate network.
- Provides voice statistics and counters for remote voice clients in the split tunnel mode

  The `flag` parameter in the `show voice client-status` command is updated to indicate remote users.

```
(host) #show voice client-status
Voice Client(s) Status
----------------------
AP Name  BSSID            ESSID Client(MAC)       Client(IP)    Client Name  Server(IP)
Registration State   Call Status  ALG   Flags
-------  -----              -----  -----------        ----------    -----------  -------
---  ------------------  ------------  ---   -----
moscato 00:0b:11:5c:d6:80 home   00:00:5c:04:b3:10 10.20.1.100     Client
10.13.8.1   REGISTERED          Idle          h323  R
Num Clients:1
Flags:    R - Remote user
```

Battery Boost

Battery boost is an optional feature that can be enabled for any SSIDs that support voice traffic. This feature converts all broadcast and multicast traffic to unicast before delivery to the client. Enabling battery boost on an SSID allows you to set the DTIM interval from 10 - 100 (the previous allowed values were 1 or 2), equating to 1,000 - 10,000 milliseconds. This longer interval keeps associated wireless clients from activating their radios for multicast indication and delivery, leaving them in power-save mode longer, and thus lengthening battery life. The DTIM configuration is performed on the WLAN, so no configuration is necessary on the client.

An associated parameter available on some clients is the Listening Interval (LI). This defines the interval (in number of beacons) after which the client must wake to read the Traffic Indication Map (TIM). The TIM indicates whether there is buffered unicast traffic for each sleeping client. With battery boost enabled, the DTIM is increased but multicast traffic is buffered and delivered as unicast. Increasing the LI can further increase battery life, but can also decrease client responsiveness.

You can use the WebUI or CLI to enable the battery boost feature and set the DTIM interval in the SSID profile.

Using the WebUI

1. Navigate to the Configuration > AP Configuration page. Select either the AP Group tab or AP Specific tab.
   - If you selected AP Group, click Edit by the AP group name for which you want to enable battery boost.
   - If you selected AP Specific, select the name of the AP for which you want to enable battery boost.
2. Under Profiles, expand Wireless LAN, then select Virtual AP. In the Virtual AP list, select the appropriate virtual AP instance.

3. In the Profile Details section, select the SSID profile you want to configure.
4. Click the Advanced tab.
5. Scroll down the Advanced options and select the Battery Boost check box.
6. Scroll up to change the DTIM Interval to a longer interval time.
7. Click Apply.

Using the CLI

```
wlan ssid-profile <profile>
   battery-boost
   dtim-period <milliseconds>
```

Advanced Voice Troubleshooting

ArubaOS enables you to debug voice issues more efficiently and quickly by providing detailed information about the voice calls, voice client status, and Call Detail Records (CDR). You can obtain the advanced troubleshooting information such as time of failure of the call, status of the client during the call failure, signal strength of the call, AP handoff information, and signaling message issues.

The following options allow you to easily troubleshoot voice call issues:

- View troubleshooting information on voice client status
- View troubleshooting information on voice call CDRs
- Debug voice logs
- View voice traces
- View voice configuration details

Viewing Troubleshooting Details on Voice Client Status

ArubaOS enables you to view the status of the voice clients. Additionally, it allows you to view more details such as AP handoff information and AP station report of an active call based on the client's IP address, or the MAC address.

The AP handoff information includes the AP events such as association request, re-association request, and de-authentication request with timestamps. The AP station report includes the AP MAC address, association time, average RSSI value, and retries count.

You can use the WebUI or CLI to view up to 60 entries of AP events and 30 entries of AP station reports for a voice client.

Using the WebUI

1. Navigate to the Monitoring > Voice > Voice Clients page and select the voice client.
2. Click the HandOff Information button to view the AP station report and AP handoff information of the selected voice client.

Using CLI

To view the details of a voice client based on its IP address:

```
(host) #show voice client-status ip 10.15.20.63

Voice Client(s) Status
----------------------
Client(IP)   Client(MAC)       Client Name  ALG   Server(IP)    Registration State  Call
Status  BSSID             ESSID         AP Name   Flags
----------   -----------        -----------  ---   ----------    ------------------  --
---------  -----              -----         -------   -----
10.15.20.63  00:00:f0:05:c9:e3  7812         h323  10.3.113.239  REGISTERED          In-
Call      00:0b:86:b7:83:91  st-voice-raj  RAP2-Lab  R
Num Clients:1
Flags: V - Visitor, W - Wired, R - Remote

AP Events
---------
Timestamp        BSS Id             Category  Event
---------        ------             --------  -----
Aug 13 09:22:57  00:0b:86:b7:83:91  Call      Call Start
Aug 13 11:29:34  00:0b:86:b7:83:91  Call      Call End
Aug 13 11:29:41  00:0b:86:b7:83:91  Call      Call Start
Aug 13 11:30:29  00:0b:86:b7:83:91  Call      Call End
Aug 13 11:30:39  00:0b:86:b7:83:91  Call      Call Start

AP Station Reports
------------------
Timestamp        BSS Id             RSSI  Tx      Tx-Drop  Tx-Data  Tx-Data-Retry  Tx-
Data-Bytes  Tx-Data-Time  Rx        Rx-Retry
---------        ------             ----  --      -------  -------  -------------  ----
---------  -------------  --        --------
Aug 13 12:35:05  00:0b:86:b7:83:91  61    253845  6904     253469   59805
22945603       0             55171662  0

Current Active Calls
--------------------
Session Information               Peer Party  Dir  Status    Dur(sec)  Orig time
R-value  Codec  Band  Setup Time(sec)  Re-Assoc
-------------------               ----------  ---  ------    --------  ---------
-------  -----  ----  ---------------  --------
10.15.20.56:3034 - 10.15.20.63:3140  -           IC   CONNECTED  3925      Aug 13
11:30:39  NA       NA     NA    NA               0
```

To view the details of a voice client based on its MAC address:

```
(host) #show voice client-status sta 00:00:f0:05:c9:dc

Voice Client(s) Status
----------------------

Client(IP)   Client(MAC)       Client Name  ALG   Server(IP)    Registration State  Call
Status  BSSID             ESSID  AP Name  Flags
----------   -----------        -----------  ---   ----------    ------------------  --
---------  -----              -----  -------  -----
10.15.20.56  00:00:f0:05:c9:dc  7811         sh323  10.3.113.239  REGISTERED          In-
Call      00:1a:1e:a8:2d:80  legap -2

Num Clients:1
Flags: V - Visitor, W - Wired, R - Remote
```

```
AP Events
---------
Timestamp        BSS Id             Category  Event
---------        ------             --------  -----
Aug 13 09:22:54  00:1a:1e:a8:2d:80  Call      Call Start
Aug 13 09:22:58  00:1a:1e:a8:2d:80  Call      Call End
Aug 13 09:26:22  00:1a:1e:a8:2d:80  Call      Call Start
Aug 13 11:29:33  00:1a:1e:a8:2d:80  Call      Call End
Aug 13 11:29:39  00:1a:1e:a8:2d:80  Call      Call Start
Aug 13 11:30:29  00:1a:1e:a8:2d:80  Call      Call End
Aug 13 11:30:36  00:1a:1e:a8:2d:80  Call      Call Start


AP Station Reports
------------------
Timestamp        BSS Id             RSSI  Tx      Tx-Drop  Tx-Data  Tx-Data-Retry  Tx-
Data-Bytes  Tx-Data-Time  Rx        Rx-Retry
---------        ------             ----  --      -------  -------  -------------  ----
---------  ------------  --        --------
Aug 13 12:38:03  00:1a:1e:a8:2d:80  44    795216  44158    794838   147824
78010395       0             58366710  0

Current Active Calls
--------------------
Session Information               Peer Party  Dir  Status    Dur(sec)  Orig time
R-value  Codec  Band   Setup Time(sec)  Re-Assoc
-------------------               ----------  ---  ------    --------  ---------
-------  -----  ----   ---------------  --------
10.15.20.63:3140 - 10.15.20.56:3034  -           OG   CONNECTED  4079      Aug 13
11:30:36  93       NA     GREEN  NA               0
```

Viewing Troubleshooting Details on Voice Call CDRs

ArubaOS allows you to view the voice CDRs for the completed calls. Additionally, it enables you to view more details such as AP handoff information and AP station reports for a specific terminated call based on the CDR Id.

The AP handoff information includes the AP events such as association request, re-association request, and de-authentication request with timestamps. The AP station report includes the AP MAC address, association time, average RSSI value, and retries count.

NOTE: ArubaOS pushes the generated CDRs to the syslog server to retain the older CDR data for a later analysis. The CDR data pushed to the syslog server do not contain the details of the AP stats and AP events.

You can use the WebUI or CLI to view the troubleshooting information on a voice call based on the CDR Id.

Using the WebUI

1. Navigate to the Monitoring > Voice > Call Detail Report page.

This page displays the CDRs of the completed calls.

2. Click the CDR Id of a call to view the AP station reports, and the AP handoff information of the call.

Using CLI

To view the details of a completed call based on the CDR Id:

```
(host) #show voice call-cdrs cid 4

Voice Client(s) CDRs (Detail)
-----------------------------

CDR Id  Client IP    Client Name  ALG   Dir  Called/Calling Party  Status  Dur(sec)  Orig
time       R-value  Reason  Codec  Band    Setup Time(sec)  Re-Assoc  Initial-BSSID
Initial-ESSID  Initial-AP Name
------  ---------    -----------  ---   ---  --------------------  ------  --------  --
-------      -------  ------  -----  ----   ---------------  --------  -------------
-------------  ---------------
4       10.15.20.62  3011         sccp  IC   3042                  SUCC    34        Aug
14 06:48:44  77             G711   YELLOW  0              1         00:1a:1e:a8:2d:80
legap -2


AP Events
---------
Timestamp        BSS Id             Category       Event
---------        ------             --------       -----
Aug 14 06:48:53  00:1a:1e:a8:2d:80  AP Management  Assoc Req
Aug 14 06:48:53  00:1a:1e:a8:2d:80  AP Management  Assoc Resp


AP Station Reports
------------------
Timestamp        BSS Id             RSSI  Tx     Tx-Drop  Tx-Data  Tx-Data-Retry  Tx-
Data-Bytes  Tx-Data-Time  Rx     Rx-Retry
---------        ------             ----  --     -------  -------  -------------  -----
--------  ------------  --     --------
Aug 14 06:49:08  00:1a:1e:a8:2d:80  27   20466  6154    20460   2522        2310190
0             26245  0
```

Enabling Voice Logs

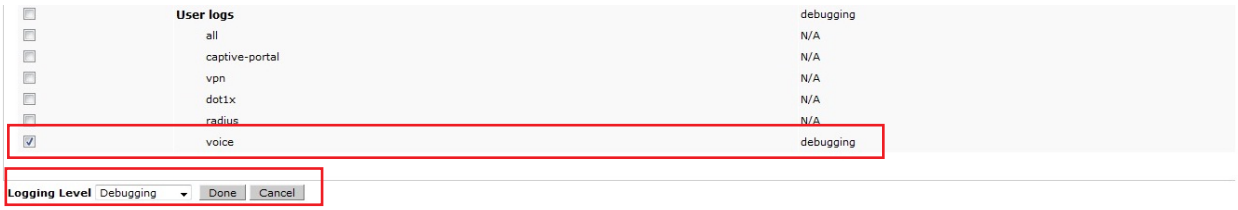
ArubaOS allows you to debug voice logs. Additionally, it allows you to debug the voice logs for a specific voice client based on the client's MAC address.

You can use the WebUI or CLI to set the voice logging level to debugging.

Using the WebUI

1. Navigate to the Configuration > Management > Logging page.
2. Click the Levels tab.
3. Select the voice check box under the User Logs category.
4. Select Debugging from the Log Level drop down menu and click the Done button.

Figure 183 *Enable Voice Logging*

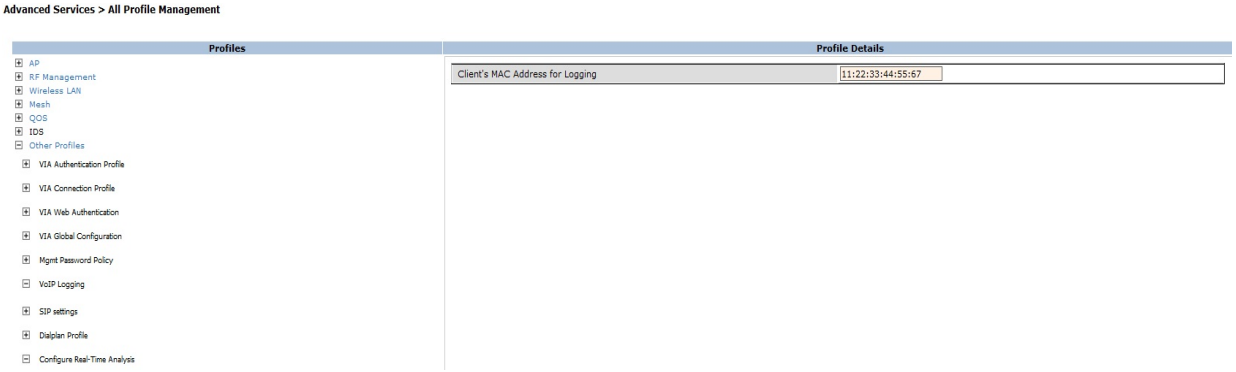


5. Click the Apply button to apply the settings and save the configurations.

Enabling Logging for a Specific Client

1. Navigate to the Configuration > Advanced Services > All Profiles page.
2. Expand Other Profiles under the Profiles section and click VoIP Logging.
3. Enter the MAC address of the voice client in the Client's MAC address for logging field.

Figure 184 *Enable Logging for a Voice Client*



4. Click the Apply button to apply the settings and save the configurations.

NOTE: To enable logging on a specific voice client, you must enable voice logs.

Using CLI

To set the voice logging level to debugging:

```
(host) #configure terminal
(config) #logging level debugging user subcat voice
```

To debug voice logs for a specific client:

```
(config) #voice logging
(VoIP Logging) #client-mac 11:22:33:44:55:67
```

To view the client's MAC address for logging:

```
(host) #show voice logging

VoIP Logging
------------
Parameter                          Value
---------                          -----
Client's MAC Address for Logging   11:22:33:44:55:67
```

Viewing Voice Traces

ArubaOS enables you to view the voice signaling message traces. You can view up to 8000 entries of trace messages. The trace message displays the ALG, client name, client's IP, event time, and the message direction. Additionally, it displays the BSSID information to help troubleshooting roaming issues.

You can use the WebUI or CLI to view the trace messages.

Using the WebUI

1. Navigate to the Monitoring > Voice > Voice Clients page and select the voice client.
2. Click the Troubleshooting button to view the voice traces.

Using CLI

To view the voice signaling message traces:

```
(host)#show voice trace sip count 5

SIP Voice Client(s) Message Trace
---------------------------------
ALG Client Name  Client(MAC)     Client(IP)   Event Time    Direction     Msg
BSSID
---  -----------  -----------        ----------    ----------       ---------         -
--                  -----
SIP  6202         00:03:2a:02:75:cc  10.15.20.123  Aug 14 13:14:32  Server-To-Client
200_OK              00:0b:86:b7:83:91
SIP  6202         00:03:2a:02:75:cc  10.15.20.123  Aug 14 13:14:32  Client-To-Server
REGISTER            00:0b:86:b7:83:91
SIP  6202         00:03:2a:02:75:cc  10.15.20.123  Aug 14 13:14:31  Server-To-Client
200_OK              00:0b:86:b7:83:91
SIP  6202         00:03:2a:02:75:cc  10.15.20.123  Aug 14 13:14:31  Client-To-Server
REGISTER            00:0b:86:b7:83:91
SIP  6202         00:03:2a:02:75:cc  10.15.20.123  Aug 14 13:14:29  Server-To-Client
4XX_REQUEST_FAILURE  00:0b:86:b7:83:91
Num of Rows:5
```

Viewing Voice Configurations

ArubaOS allows you to view the details of the voice related configurations on your controller such as firewall policies, AP group profiles, SSID profiles, virtual AP group profiles, VoIP Call Admission Control profiles, 802.11k profiles, and SIP settings. Additionally, you can view the status of RTCP analysis, and SIP mid-call request timeout.

NOTE: This release of ArubaOS does not support viewing the voice configuration details using the WebUI.

Using CLI

To view the voice configuration details on your controller:

```
(host) #show voice configurations

Voice firewall policies
-----------------------
Policy                      Action
------                      ------
Stateful SIP Processing     Enabled
Broadcast-filter ARP        Disabled

SSID Profiles
-------------
Profile Name            WMM       WMM-UAPSD  TSPEC Min Inactivity(msec)  ...  EDCA STA
prof  EDCA AP prof  Strict SVP
------------            ---       ---------  --------------------------  ...  ---------
----  ------------  ----------
default               Enabled   Enabled    100000                    ...  default
default       Disabled
qa-ma-vocera          Enabled   Enabled    0                              default
default       Disabled

AP Group Profiles
-----------------
```

```
Profile Name   VoIP CAC Profile
------------   ----------------
default        default
local          default

Virtual AP Group Profiles
-------------------------
Profile Name          802.11K Profile  HA Discovery on-assoc.  Drop Broadcast/Multicast
Broadcast ARP to Unicast
------------           ---------------  ----------------------  ------------------------
-  ----------------------
abcd                   default          Disabled                Disabled
Disabled

VoIP Call Admission Control Profiles
------------------------------------
Profile Name  VoIP CAC
------------  ---------
default       Disabled

802.11K Profiles
----------------
Profile Name  Advertise 802.11K Capability
------------  ----------------------------
default       Disabled

SIP settings
------------
Parameter         Value
---------         -----
Session Timer     Disabled
Session Expiry    300 sec
Dialplan Profile  N/A

Voice rtcp-inactivity:disable
Voice sip-midcall-req-timeout:disable
```

Chapter 37

External Services Interface

The Dell External Services Interface (ESI) provides an open interface that is used to integrate security solutions that solve interior network problems such as viruses, worms, spyware, and corporate compliance. ESI allows selective redirection of traffic to external service appliances such as anti-virus gateways, content filters, and intrusion detection systems. When "interesting" traffic is detected by these external devices, it can be dropped, logged, modified, or transformed according to the rules of the device. ESI also permits configuration of different server groups—with each group potentially performing a different action on the traffic.

You can configure Dell ESI to do one or more of the following for each group:

- Redirect specified types of traffic to the server
- Perform health checks on each of the servers in the group
- Perform per-session load balancing between the servers in each group
- Provide an interface for the server to return information about the client that can place the client in special roles such as "quarantine"

ESI also provides the ESI syslog parser, which is a mechanism for interpreting syslog messages from third-party appliances such as anti-virus gateways, content filters, and intrusion detection systems. The ESI syslog parser is a generic syslog parser that accepts syslog messages from external devices, processes them according to user-defined rules, and then takes configurable actions on system users.

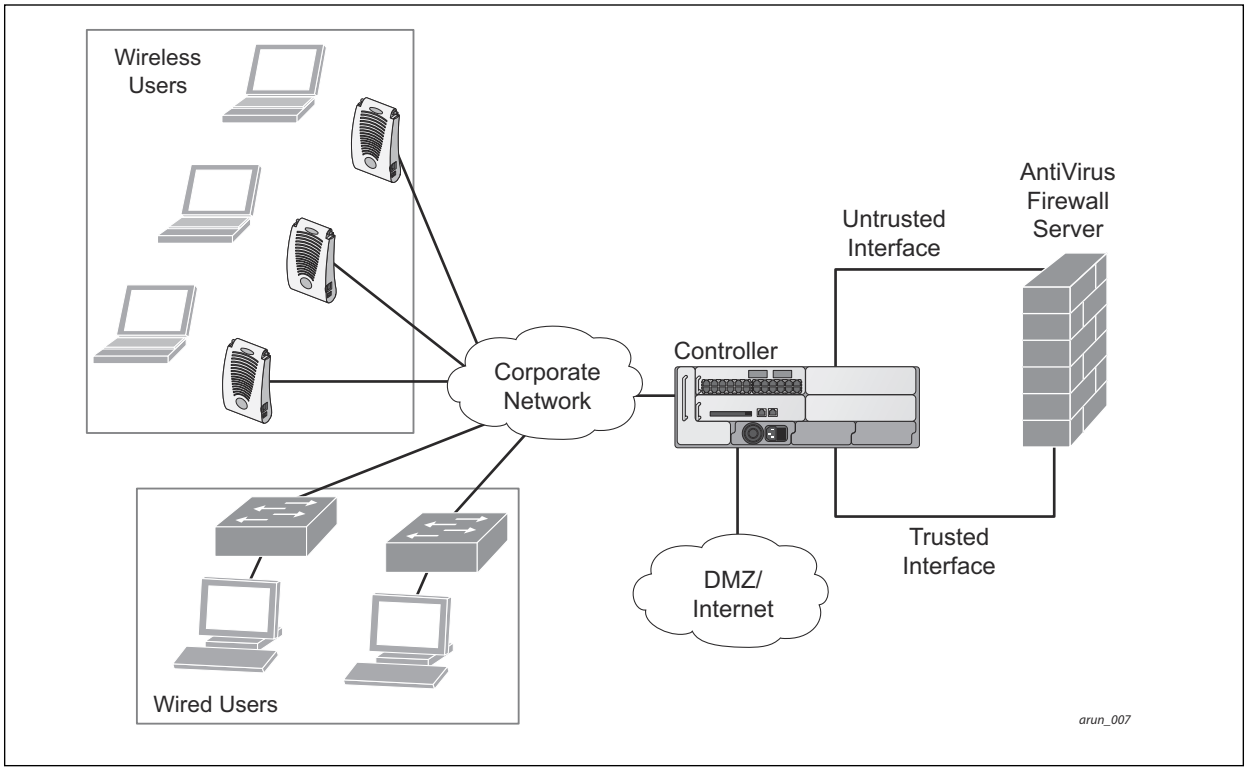
This chapter describes the following topics:

NOTE: The ESI feature requires the Policy Enforcement Firewall Next Generation (PEFNG) license installed on the controller.

Understanding ESI

In the example shown in this section, ESI is used to provide an interface to the AntiVirusFirewall (AVF) server device for providing virus inspection services. An AVF server device is one of many different types of services supported in the ESI.

Figure 185 *ESI-Fortinet Topology*



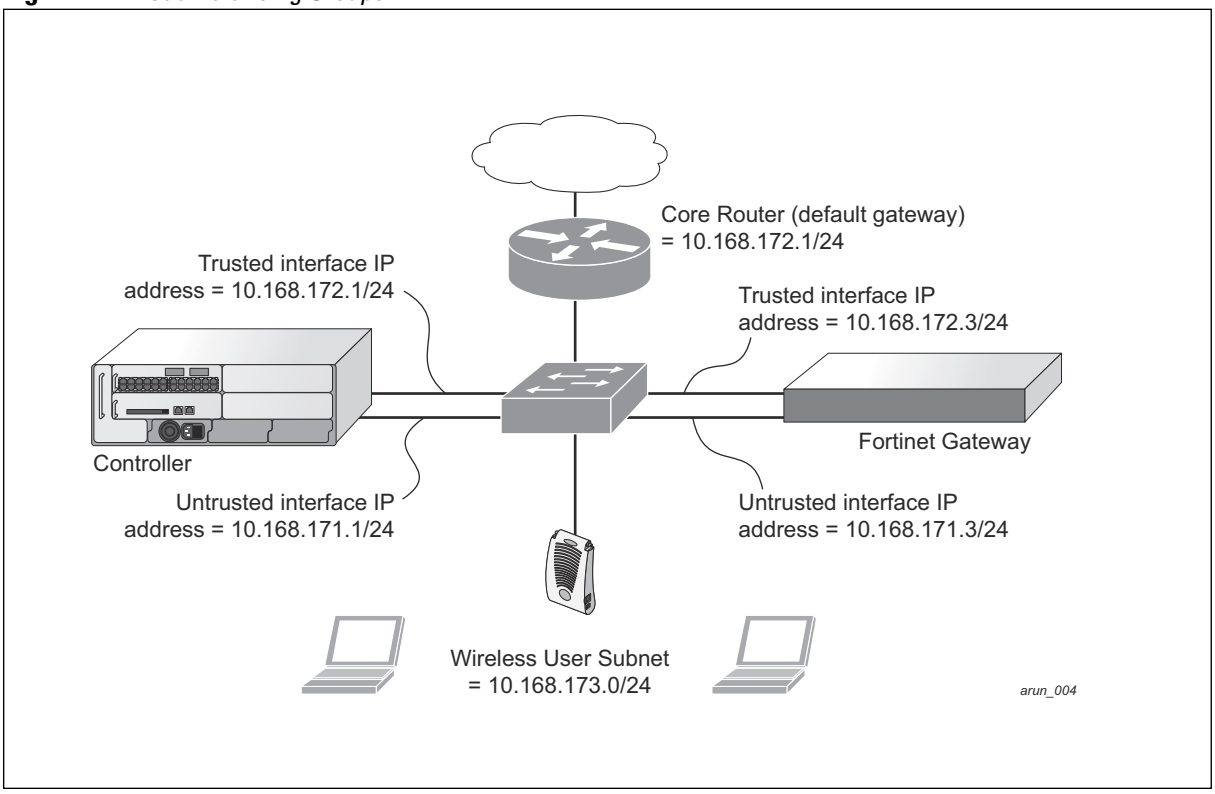
In the ESI–Fortnet topology , the clients connect to access points (both wireless and wired). The wired access points tunnel all traffic back to the controller over the existing network.

The controller receives the traffic and redirects relevant traffic (including but not limited to all HTTP/HTTPS and email protocols such as SMTP and POP3) to the AVF server device to provide services such as anti-virus scanning, email scanning, web content inspection, etc. This traffic is redirected on the "untrusted" interface between the controller and the AVF server device. The controller also redirects the traffic intended for the clients coming from either the Internet or the internal network. This traffic is redirected on the "trusted" interface between the controller and the AVF server device. The controller forwards all other traffic (for which the AVF server does not perform any of the required operations such as AV scanning). An example of such traffic would be database traffic running from a client to an internal server.

The controller can also be configured to redirect traffic only from clients in a particular role such as "guest" or "non-remediated client" to the AVF server device. This might be done to reduce the load on the AVF server device if there is a different mechanism such as the Dell-Sygate integrated solution to enforce client policies on the clients that are under the control of the IT department. These policies can be used to ensure that an anti-virus agent runs on the clients and the client can get access to the network only if this agent reports a "healthy" status for the client. See the paper (available from Sygate) on Sygate integrated solutions for more details on this solution.

The controller is also capable of load balancing between multiple external server appliances. This provides more scalability as well as redundancy by using multiple external server appliances. Also, the controller can be configured to have multiple groups of external server devices and different kinds of traffic can be redirected to different groups of devices with load balancing occurring within each group (see Figure 186 for an example).

Figure 186 *Load Balancing Groups*



Understanding the ESI Syslog Parser

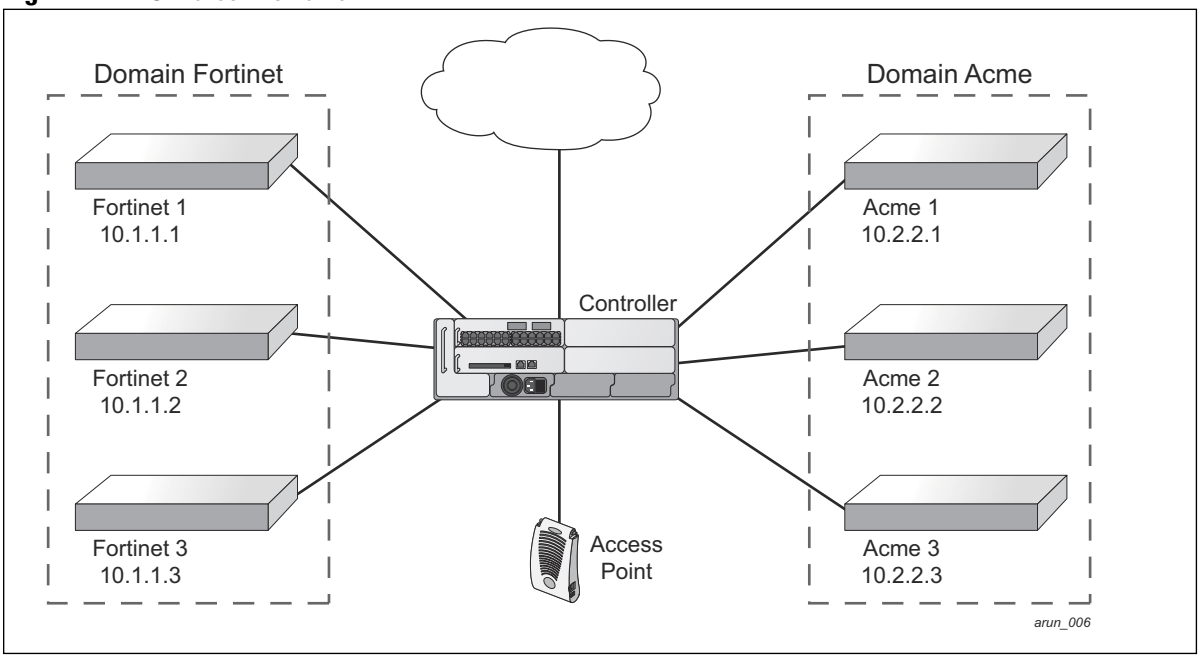
The ESI syslog parser adds a UNIX-style regular expression engine for parsing relevant fields in messages from third-party appliances such as anti-virus gateways, content filters, and intrusion detection systems.

The user creates a list of rules that identify the type of message, the username to which this message pertains, and the action to be taken when there is a match on the condition.

ESI Parser Domains

The ESI servers are configured into ESI parser domains (see Figure 187) to which the rules will be applied. This condition ensures that only messages coming from configured ESI parser domains are accepted, and reduces the number of rules that must be examined before a match is detected ("Syslog Parser Rules" on page 721). messages.When a syslog message is received, it is checked against the list of defined ESI servers. If a server match is found, the message is then tested against the list of predefined rules.

Figure 187 *ESI Parser Domains*



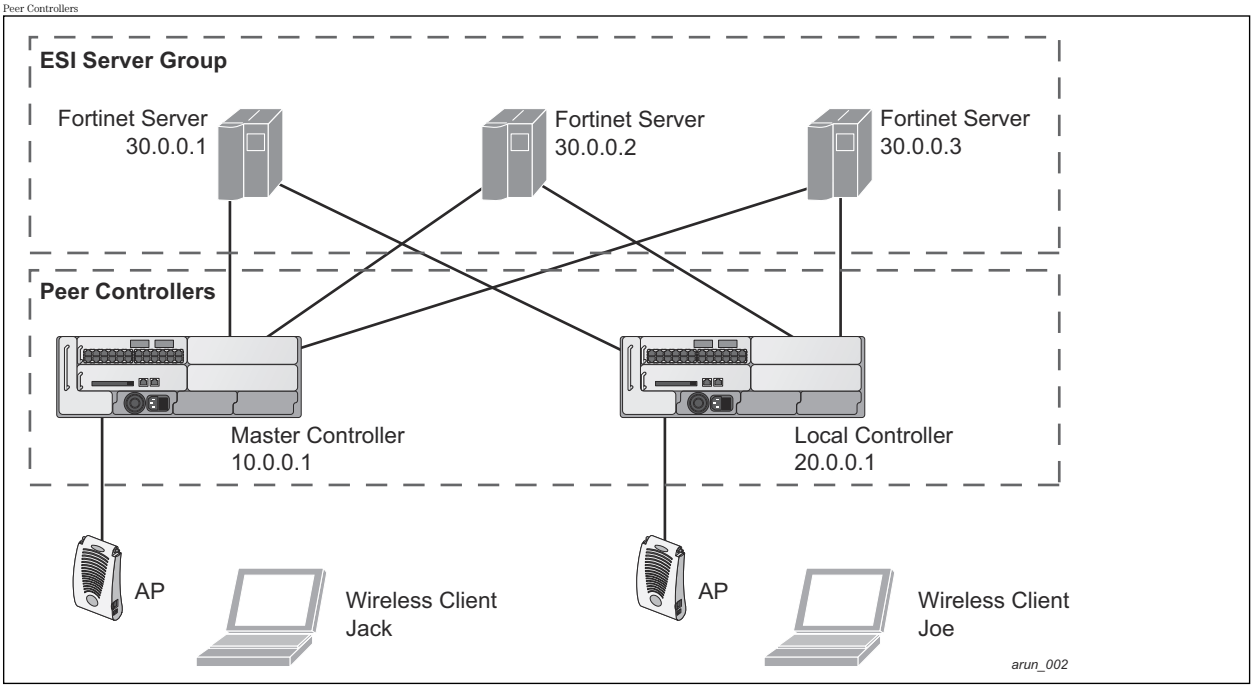
The ESI syslog parser begins with a list of configured IP interfaces which listen for ESI messages. When a syslog message is received, it is checked against the list of defined ESI servers. If a server match is found, the message is then tested against the list of predefined rules.

Within the rule-checking process, the incoming message is checked against the list of rules to search first for a condition match (see "Syslog Parser Rules" on page 721). If a condition match is made, and the user name can be extracted from the syslog message, the resulting user action is processed by first attempting to look up the user in the local user table. If the user is found, the appropriate action is taken on the user. The default behavior is to look for users only on the local controller. If the user is not found, the event is meaningless and is ignored. This is the typical situation when a single controller is connected to a dedicated ESI server.

Peer Controllers

As an alternative, consider a topology where multiple controllers share one or more ESI servers.

Figure 188 *Peer Controllers*



In this scenario, several controllers (master and local) are defined in the same syslog parser domain to act as *peers*. From the standpoint of the ESI servers, because there is no accurate way of determining from which controller a given user came. Thus, the event is flooded out to all controllers defined as peers within this ESI parser domain. The corresponding controller holding the user entry acts on the event, while other controllers ignore the event.

Syslog Parser Rules

The user creates an ESI rule by using characters and special operators to specify a pattern (regular expression) that uniquely identifies a certain amount of text within a syslog message. (Regular expression syntax is described in "Basic Regular Expression Syntax" on page 741.) This "condition" defines the type of message and the ESI domain to which this message pertains. The rule contains three major fields:

- Condition: The pattern that uniquely identifies the syslog message type.
- User: The username identifier. It can be in the form of a name, MAC address, or IP address.
- Action: The action to take when a rule match occurs.

Once a condition match has been made, no further rule-matching will be made. For the rule that matched, only one action can be defined.

After a condition match has been made, the message is parsed for the user information. This is done by specifying the target region with the regular expression (REGEX) regex() block syntax. This syntax generates two blocks: The first block is the matched expression; the second block contains the value inside the parentheses. For username matching, the focus is on the second block, as it contains the username.

Condition Pattern Matching

The following description uses the Fortigate virus syslog message format as an example to describe condition pattern matching. The Fortigate virus syslog message takes the form:

```
Sep 26 18:30:02 log_id=0100030101 type=virus subtype=infected src=1.2.3.4
```

This message example contains the Fortigate virus log ID number 0100030101 ("log_id=0100030101"), which can be used as the condition—the pattern that uniquely identifies this syslog message.

The parser expression that matches this condition is “log_id=0100030101”. This is a narrow match on the specific log ID number shown in the message, or “log_id=[0–9]{10}[ ]” ,which is a regular expression that matches any Fortigate log entry with a ten-digit log ID followed by a space.

User Pattern Matching

To extract the user identifier in the example Fortigate virus message shown above (“src=1.2.3.4”), use the following expression, “src=(.*)[ ]” to parse the user information contained between the parentheses. The () block specifies where the username will be extracted. Only the first block will be processed.

More examples:

Given a message wherein the username is a MAC address:

```
Sep 26 18:30:02 log_id=0100030101 type=virus subtype=infected mac 00:aa:bb:cc:dd:00
```

The expression “mac[ ](.{17})” will match “mac 00:aa:bb:cc:dd:00” in the example message.

Given a message wherein the username is a user name:

```
Sep 26 18:30:02 log_id=0100030101 type=virus subtype=infected user<johndoe>
```

The expression “user<(.*)>” will match “user<johndoe>” in the example message.

ESI Configuration Overview

You can use the following interfaces to configure and manage ESI and ESI syslog parser behavior:

- The Web user interface (WebUI), which is accessible through a standard Web browser from a remote management console or workstation.
- The command line interface (CLI), which is accessible from a local console device connected to the serial port on the controller or through a Telnet or Secure Shell (SSH) connection from a remote management console or workstation..

NOTE: By default, you can access the CLI only from the serial port or from an SSH session. To use the CLI in a Telnet session, you must explicitly enable Telnet on the controller. The general configuration descriptions in the following sections include both the WebUI pages and the CLI configuration commands. The configuration overview section is followed by several examples that show specific configuration procedures.

In general, there are three ESI configuration “phases” on the controller as a part of the solution:

- The first phase configures the ESI *ping health-check method*, *servers*, and *server groups*.The term *server* here refers to external server devices, for example, an AVF.
- The second phase configures the redirection policies instructing the controller how to redirect the different types of traffic to different server groups.
- The final phase configures the ESI syslog parser domains and the rules that interpret and act on syslog message contents.

NOTE: The procedures shown in the following sections are general descriptions. Your application might be broader or narrower than this example, but the same general operations apply.

Configuring Health-Check Method, Groups, and Servers

To configure the ESI health-check method, servers, and server groups, navigate to the Configuration > Advanced Services > External Services view on the WebUI.

In the WebUI

To configure a health check profile:

1. Navigate to the Configuration > Advanced Services > External Services page on the WebUI.
2. Click Add in the Health Check Configuration section.

   (To change an existing profile, click Edit.)
3. Provide the following details:
   a. Enter a Profile Name.
   b. Frequency (secs)—Indicates how often the controller checks to see if the server is up and running. Default: 5 seconds.
   c. Timeout (secs)—Indicates the number of seconds the controller waits for a response to its health check query before marking the health check as failed. Default: 2 seconds.
   d. Retry count—Is the number of failed health checks after which the controller marks the server as being down. Default: 2.
4. Click Done when you are finished.
5. Click Apply to apply the configuration changes.

In the CLI

Use these CLI commands to configure a health-check method:

```
esi ping profile_name
   frequency seconds
   retry-count count
   timeout seconds
```

For example:

```
esi ping default
   frequency 5
   retry-count 2
```

Defining the ESI Server

The following sections describe how to configure an ESI server using the WebUI and CLI.

In the WebUI

To configure an ESI server:

1. Navigate to the Configuration > Advanced Services > External Services page on the WebUI.
2. Click Add in the External Servers section.
3. Provide the following details:
   a. Server Name.
   b. Server Group. Use the drop-down list to assign this server to a group from the existing configured groups.
   c. Server Mode. Use the drop-down list to choose the mode (bridge, nat, or route) your topology requires. See the description above to understand the differences between these modes.

      For routed mode, enter the Trusted IP Address (the IP address of the trusted interface on the external server device) and the Untrusted IP Address (the IP address of the untrusted interface on the external server device). (You can also choose to enable a health check on either or both of these interfaces.)

      For bridged mode, enter the Trusted Port number (the port connected to the trusted side of the ESI server) and the Untrusted Port number (the port connected to the untrusted side of the ESI server).

For NAT mode, enter the Trusted IP Address (the trusted interface on the external server) and the NAT Destination Port number (the port a packet is redirected to rather than the original destination port in the packet). You can also choose to enable a health check on the trusted IP address interface.

4. Click Done when you are finished.
5. Click Apply to apply the configuration changes..

In the CLI

Use these CLI commands to configure an ESI server and identify its associated attributes:

```
esi server server_identity
   dport destination_tcp/udp_port
   mode {bridge | nat | route}
   trusted-ip-addr ip-addr [health-check]
   trusted-port slot/port
   untrusted-ip-addr ip-addr [health-check]
   untrusted-port slot/port
```

For example:

```
esi server forti_1
   mode route
   trusted-ip-addr 10.168.172.3
   untrusted-ip-addr 10.168.171.3
```

Defining the ESI Server Group

The following sections describe how to configure an ESI server group using the WebUI and CLI.

In the WebUI

To configure an ESI server group on the controller:

1. Navigate to the Configuration > Advanced Services > External Services page.
2. Click Add in the Server Groups section.

   (To change an existing group, click Edit.)
3. Provide the following details:
   a. Enter a Group Name.
   b. In the drop-down list, select a health check profile.
4. Click Done when you are finished.
5. Click Apply to apply the configuration changes.

In the CLI

Use these CLI commands to configure an ESI server group, identify its associated ping health-check method, and associate a server with this group:

```
esi group name
   ping profile_name
   server server_identity
```

For example:

```
esi group fortinet
   ping default
   server forti_1
```

Redirection Policies and User Role

The following sections describe how to configure the redirection policies and user role using the WebUI and CLI.

In the WebUI

To configure user roles to redirect the required traffic to the server(s), navigate to the Configuration > Access Control > User Roles view.

1. To add a new role, click Add.

   To change an existing role, click Edit for the firewall policy to be changed. The WebUI displays the User Roles tab on top.
2. Role Name. Enter the name for the role.
3. To add a policy for the new role, click Add in the Firewall Policies section. The WebUI expands the Firewall Policies section.

   Choose from existing configured policies, create a new policy based on existing policies, or create a new policy.

   a. If you elect to create a new policy, click on the radio button for Create New Policy and then click Create. The WebUI displays the Policies tab.

   b. In the Policies tab:

      Policy Name. Provide the policy name and select the IPv4 Session policy type from the drop-down list. The WebUI expands the Policies tab.

   c. In the drop-down lists, choose parameters such as source, destination, service in the same way as other firewall policy rules. For certain choices, the WebUI expands and adds drop-down lists.

   d. In the Action drop-down menu, select the redirect to ESI group option.

   e. In the Action drop-down menu, select the appropriate ESI group.

   f. Select the traffic direction. Forward refers to the direction of traffic from the (untrusted) client or user to the (trusted) server (such as the HTTP server or email server).

   g. To add this rule to the policy, click **Add**.

   h. Repeat the steps to configure additional rules.

   i. Click Done to return to the User Roles tab. The WebUI returns to the User Roles tab.
4. Click Apply to apply the configuration changes.
5. See Chapter 12, “Roles and Policies” on page 321, for directions on how to apply a policy to a user role.

In the CLI

Use these commands to define the redirection filter for sending traffic to the ESI server and apply the firewall policy to a user role.

```
ip access-list session policy
   any any any redirect esi-group group direction both blacklist
   //For any incoming traffic, going to any destination,
   //redirect the traffic to servers in the specified ESI group.
   any any any permit
   //For everything else, allow the traffic to flow normally.

user-role role
   access-list {eth | mac | session}
   bandwidth-contract name
   captive-portal name
   dialer name
   pool {l2tp | pptp}
   reauthentication-interval minutes
   session-acl name
   vlan vlan_id
```

For example:

```
ip access-list session fortinet
```

```
   any any svc-http redirect esi-group fortinet direction both blacklist
   any any any permit

user-role guest
   access-list session fortinet
```

ESI Syslog Parser Domains and Rules

To configure the ESI syslog parser, navigate to the Configuration > Advanced Services > External Services view on the WebUI (see).

The following sections describe how to manage syslog parser domains using the WebUI and CLI.

Managing Syslog Parser Domains in the WebUI

Click on the Syslog Parser Domains tab to display the Syslog Parser Domains view.

This view lists all the domains by domain name and server IP address, and includes a list of peer controllers (when peer controllers have been configured—as described in "Peer Controllers" on page 720).

Adding a new syslog parser domain

To add a new syslog parser domain:

1. Click Add in the Syslog Parser Domains section. The system displays the add domain view.
2. In the Domain Name text box, type the name of the domain to be added.
3. In the Server IP Address text box, type a valid IP address.

NOTE: You must ensure that you type a valid IP address, because the IP address you type is not automatically validated against the list of external servers that has been configured.

4. Click Add.
5. Click Apply.

Deleting an existing syslog parser domain

To delete an existing parser domain:

1. Identify the target parser domain in the list shown in the Domain section of the Syslog Parser Domains view.
2. Click Delete on the same row in the Actions column.

Editing an existing syslog parser domain

To change an existing syslog parser domain:

1. Identify the target parser domain in the list shown in the Syslog Parser Domains view (see on page 726).
2. Click Edit on the same row in the Actions column.The system displays the edit domain view.

NOTE: You cannot modify the domain name when editing a parser domain.

3. To delete a server from the selected domain, highlight the server IP address and click Delete, then click Apply to commit the change.
4. To add a server or a peer controller to the selected domain, type the server IP address into the text box next to the Add button, click Add, then click Apply to commit the change, or click Cancel to discard the changes you made and exit the parser domain editing process.

When you make a change in the domain, you can click the View Commands link in the lower right corner of the window to see the CLI command that corresponds to the edit action you performed.

Managing Syslog Parser Domains in the CLI

Use these CLI commands to manage syslog parser domains.

Adding a new syslog parser domain

```
esi parser domain name
   peer peer-ip
   server ipaddr
```

Showing ESI syslog parser domain information

```
show esi parser domains
```

Deleting an existing syslog parser domain

```
no esi parser domain name
```

Editing an existing syslog parser domain

```
esi parser domain name
   no
   peer peer-ip
   server ipaddr
```

For example (based on the example shown in on page 721):

```
esi parser domain forti_domain
   server 30.0.0.1
   server 30.0.0.2
   server 30.0.0.3
   peer 20.0.0.1
```

Managing Syslog Parser Rules

The following sections describe how to manage syslog parser domains using the WebUI and CLI.

In the WebUI

Click on the Syslog Parser Rules tab to display the Syslog Parser Rules view.This view displays a table of rules with the following columns:

- Name— rule name
- Ena—where “y” indicates the rule is enabled and “n” indicates the rule is disabled (not enabled)
- Condition—Match condition (a regular expression)
- Match—Match type (IP address, MAC address, or user)
- User—Match pattern (a regular expression)
- Set—Set type (blacklist or role)
- Value—Set value (role name)
- Domain—Parser domain to which this rule is to be applied
- Actions—The actions that can be performed on each rule.

Adding a new parser rule

To add a new syslog parser rule:

1. Click Add in the Syslog Parser Rules view. The system displays the new rule view.
1. In the Rule Name text box, type the name of the rule you want to add.
2. Click the Enable checkbox to enable the rule.
3. In the Condition Pattern text box, type the regular expression to be used as the condition pattern.

   For example, “log_id=[0–9]{10}[ ]” to search for and match a 10-digit string preceded by “log_id=” and followed by one space.
4. In the drop-down Match list, use the drop-down menu to select the match type (ipaddr, mac, or user).
5. In the Match Pattern text box, type the regular expression to be used as the match pattern.

   For example, if you selected “mac” as the match type, type the regular expression to be used as the match pattern. You could use “mac[ ](.{17})” to search for and match a 17-character MAC address preceded by the word “mac” plus one space.
6. In the drop-down Set list, select the set type (blacklist or role).

   When you select role as the Set type, the system displays a second drop-down list. Click the list to display the possible choices and select the appropriate role value. Validation on the entered value will be based on the Set selection.
7. In the drop-down Parser Group list, select one of the configured parser domain names.

Deleting a syslog parser rule

To delete an existing syslog parser rule:

1. Identify the target parser rule in the list shown in the Syslog Parser Rules view.
2. Click Delete on the same row in the Actions column.

Editing an existing syslog parser rule

To change an existing syslog parser rule:

1. Identify the target parser rule in the list shown in the Syslog Parser Rules view.
2. Click Edit on the same row in the Actions column. The system displays the attributes for the selected rule

NOTE: You cannot modify the rule name when editing a parser rule.

3. Change the other rule attributes as required:
   a. Click the Enable checkbox to enable the rule.
   b. In the Condition Pattern text box, type the regular expression to be used as the condition pattern.
   c. In the drop-down Match list, select the match type (ipaddr, mac, or user).
   d. In the Match Pattern text box, type the regular expression to be used as the match pattern.
   e. In the drop-down Set list, select the set type (blacklist or role).
   f. When you select role as the Set type, the system displays a second drop-down list. Click the list to display the possible choices and select the appropriate role value. Validation on the entered value will be based on the Set selection.

g. In the drop-down Parser Group list, select one of the configured parser domain names.

NOTE: At this point, you can test the rule you just edited by using the Test section of the edit rule view. You can also test rules outside the add or edit processes by using the rule test in the Syslog Parser Test view (accessed from the External Services page by clicking the Syslog Parser Test tab, described in "Testing a Parser Rule" on page 496.

4. Click Apply to apply the configuration changes.

Testing a Parser Rule

You can test or validate enabled Syslog Parser rules against a sample syslog message, or against a syslog message file containing multiple syslog messages. Access the parser rules test from the External Services page by clicking the Syslog Parser Test tab, which displays the Syslog Parser Rule Test view.

To test against a sample syslog message:

a. In the drop-down Test Type list, select Syslog message as the test source type.
b. In the Message text box, type the syslog message text.
c. Click Test to start the test.

   The test results are displayed in a box in the area below the Test button. The test results contain information about the matching rule and match pattern.

- To test against a syslog message file:

a. In the drop-down Test Type list, select Syslog file as the test type.
b. In the Filename text box, type the syslog file name.
c. Click Test to start the test.

   The test results are displayed in a box in the area below the Test button. The test results contain information about the matching rule and match pattern.

In the CLI

Use these CLI commands to manage syslog parser rules.

Adding a new parser rule

```
esi parser rule rule-name
   condition expression
   domain name
   enable
   match {ipaddr expression | mac expression | user expression}
   position position
   set {blacklist | role role}
```

For example:

```
esi parser rule forti_virus
   condition "log_id=[0-9]{10}[ ]"
   match "src=(.*)[ ]"
   set blacklist
   enable
```

Showing ESI syslog parser rule information:

```
show esi parser rules
```

Deleting a syslog parser rule:

```
no esi parser rule rule-name
```

Editing an existing syslog parser rule

```
esi parser rule rule-name
   condition expression
   domain name
   enable
   match {ipaddr expression | mac expression | user expression}
   no
   position position
   set {blacklist | role role}
```

Testing a parser rule

```
esi parser rule rule-name
   test {file filename | msg message}
```

Monitoring Syslog Parser Statistics

The following sections describe how to monitor syslog parser statistics using the WebUI and CLI.

In the WebUI

You can monitor syslog parser statistics in the External Servers monitoring page, accessed by selecting Monitoring > Switch > External Services Interface > Syslog Parser Statistics.

The Syslog Parser Statistics view displays statistics such as the number of matches and number of users per rule, as well as the number of respective actions fired by the syslog parser.

NOTE: The Syslog Parser Statistics view also displays the last refresh time stamp and includes a Refresh Now button, to allow the statistics information to be refreshed manually. There is no automatic refresh on this page.

In the CLI

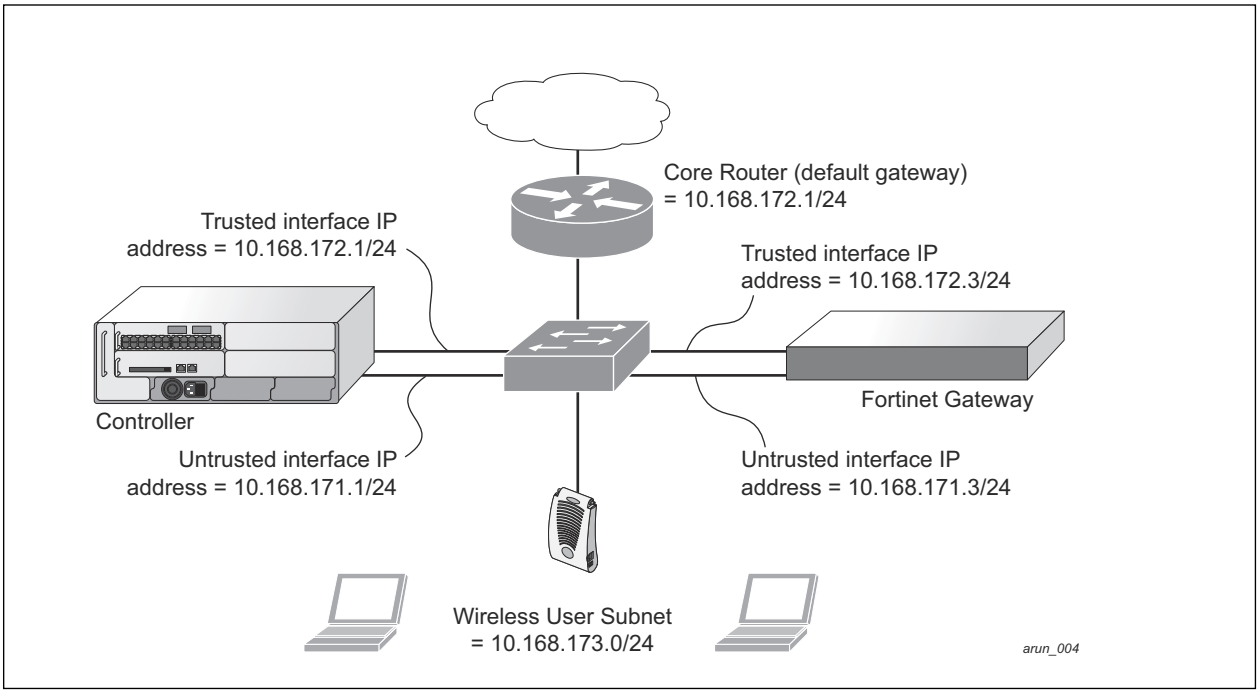
```
show esi parser stats
```

Example Route-mode ESI Topology

This section introduces the configuration for a sample route-mode topology using the controller and Fortinet Anti-Virus gateways. In route mode, the trusted and untrusted interfaces between the controller and the Fortinet gateways are on different subnets. The following figure shows an example route-mode topology.

NOTE: ESI with Fortinet Anti-Virus gateways is supported only in route mode.

Figure 189 *Example Route-Mode Topology*



In the topology shown, the following configurations are entered on the controller and Fortinet gateway:

ESI server configuration on controller

- Trusted IP address = 10.168.172.3 (syslog source)
- Untrusted IP address = 10.168.171.3
- Mode = route

IP routing configuration on Fortinet gateway

- Default gateway (core router) = 10.168.172.1
- Static route for wireless user subnet (10.168.173.0/24) through the controller (10.168.171.2)

Configuring the Example Routed ESI Topology

This section describes how to implement the example routed ESI topology shown in . The description includes the relevant configuration—both the WebUI and the CLI configuration processes are described—required on the controller to integrate with a AVF server appliance.

The ESI configuration process will redirect all HTTP user traffic to the Fortinet server for examination, and any infected user will be blacklisted. The configuration process consists of these general tasks:

- Defining the ESI server.
- Defining the default ping health check method.
- Defining the ESI group.
- Defining the HTTP redirect filter for sending HTTP traffic to the ESI server.
- Applying the firewall policy to the guest role.
- Defining ESI parser domains and rules.

There are three configuration "phases" on the controller as a part of the solution.

- The first phase configures the ESI *ping health-check method*, *servers*, and *server groups*.The term *server* here refers to external AVF server devices.

- In the second phase of the configuration task, the user roles are configured with the redirection policies (session ACL definition) instructing the controller to redirect the different types of traffic to different server groups.
- In the final phase, the ESI parser domains and rules are configured.

NOTE: The procedures shown in the following sections are based on the requirements in the example routed ESI topology. Your application might be broader or narrower than this example, but the same general operations apply.

Health-Check Method, Groups, and Servers

To configure the ESI health-check method, servers, and server groups, navigate to the Configuration > Advanced Services > External Services view on the WebUI.

Defining the Ping Health-Check Method

In the WebUI

To configure a health check profile:

1. Navigate to the Configuration > Advanced Services > External Services page on the WebUI.
2. Click Add in the Health Check Configuration section.

   To change an existing profile, click Edit.
3. Provide the following details:
   a. Enter enter the name default for the Profile Name.
   b. Frequency (secs)—Enter 5.)
   c. Timeout (secs)—Indicates the number of seconds the controller waits for a response to its health check query before marking the health check as failed. Default: 2 seconds. (In this example, enter 3.)
   d. Retry count—Is the number of failed health checks after which the controller marks the server as being down. Default: 2. (In this example, enter 3.)
4. Click Done when you are finished.
5. Click Apply.

In the CLI

Use these CLI commands to configure a health-check method:

```
esi ping profile_name
   frequency seconds
   retry-count count
   timeout seconds
```

For example:

```
esi ping default
   frequency 5
   retry-count 3
   timeout 3
```

Defining the ESI Server

The following sections describe how to configure an ESI server using the WebUI and CLI.

In the WebUI

To configure an ESI server:

1. Navigate to the Configuration > Advanced Services > External Services page on the WebUI.

2. Click Add in the External Servers section.
3. Provide the following details:
   a. Server Name. (This example uses the name forti_1.)
   b. Server Group. Use the drop-down list to assign this server to a group from the existing configured groups. (This example uses fortinet.)
   c. Server Mode. Use the drop-down list to choose the mode (bridge, nat, or route) your topology requires. See the description above to understand the differences between the modes. (This example uses route mode.)
   d. Trusted IP Address. Enter 10.168.172.3.)
   e. Untrusted IP Address. Enter 10.168.171.3.)
4. Click Done when you are finished.
5. Click Apply to apply the configuration changes.

In the CLI

Use these CLI commands to configure an ESI server and identify its associated attributes:

```
esi server server_identity
   dport destination_tcp/udp_port
   mode {bridge | nat | route}
   trusted-ip-addr ip-addr [health-check]
   trusted-port slot/port
   untrusted-ip-addr ip-addr [health-check]
   untrusted-port slot/port
```

For example:

```
esi server forti_1
   mode route
   trusted-ip-addr 10.168.172.3
   untrusted-ip-addr 10.168.171.3
```

Defining the ESI Server Group

The following sections describe how to configure an ESI server group using the WebUI and CLI.

In the WebUI

To configure an ESI server group on the controller:

1. Navigate to the Configuration > Advanced Services > External Services page.
2. Click Add in the Server Groups section.
3. Provide the following details:
   a. Enter a Group Name. Enter fortinet.)
   b. In the drop-down list, select default as the health check profile.
4. Click Done when you are finished.
5. Click Apply to apply the configuration changes.

In the CLI

Use these CLI commands to configure an ESI server group, identify its associated ping health-check method, and associate a server with this group:

```
esi group name
   ping profile_name
   server server_identity
```

For example:

```
esi group fortinet
   ping default
   server forti_1
```

Redirection Policies and User Role

The following sections describe how to configure the redirection policies and user role using the WebUI and CLI.

In the WebUI

To configure user roles to redirect the required traffic to the server(s), navigate to the Configuration > Access Control > User Roles view (see 1.).

1. To add a new role, click Add.The WebUI displays the Add Role view.

   Role Name. Enter “guest” as the name for the role.

2. To add a policy for the new role, click Add in the Firewall Policies section. The WebUI expands the Firewall Policies section.

   Choose from existing configured policies, create a new policy based on existing policies, or create a new policy.

   a. If you elect to create a new policy, click on the radio button for Create New Policy and then click Create. The WebUI displays the Policies tab.

   b. In the Policies tab:

      Policy Name. Enter the policy name fortinet and the IPv4 Session policy type.) Click Add to proceed. The WebUI expands the Policies tab.

      In the drop-down lists, choose parameters such as source, destination, service in the same way as other firewall policy rules. This example uses any source, any destination, service type svc-http (tcp 80). For certain choices, the WebUI expands and adds drop-down lists.

   c. In the Action drop-down menu, select the redirect to ESI group option.

      Select fortinet as the appropriate ESI group.

      The three steps above translate to “for any incoming HTTP traffic, going to any destination, redirect the traffic to servers in the ESI group named fortinet.”)

      Select both as the traffic direction. Forward refers to the direction of traffic from the untrusted client or user to the trusted server, such as the HTTP server or email server.

      To add this rule to the policy, click Add.

   d. Repeat the steps to configure additional rules. This example adds a rule that specifies any, any, any, permit.

   e. Click Done to return to the User Roles tab.

3. Click Apply to apply the configuration changes.

4. See Chapter 12, “Roles and Policies” on page 321, for directions on how to apply a policy to a user role.

In the CLI

Use these commands to define the redirection filter for sending traffic to the ESI server and apply the firewall policy to a user role in the route-mode ESI topology example.

```
ip access-list session policy
   any any any redirect esi-group group direction both blacklist
   //For any incoming traffic, going to any destination,
   //redirect the traffic to servers in the specified ESI group.
   any any any permit
   //For everything else, allow the traffic to flow normally.


user-role role
   access-list {eth | mac | session}
   bandwidth-contract name
   captive-portal name
   dialer name
   pool {l2tp | pptp}
   reauthentication-interval minutes
   session-acl name
   vlan vlan_id
```

For example:

```
ip access-list session fortinet
   any any svc-http redirect esi-group fortinet direction both blacklist
   any any any permit
user-role guest
   access-list session fortinet
```

Syslog Parser Domain and Rules

The following sections describe how to configure the syslog parser domain and rules for the route-mode example using the WebUI and CLI.

Add a New Syslog Parser Domain in the WebUI

To add a new syslog parser domain for the routed example:

1. Click Add in the Syslog Parser Domains tab (Advanced Services > External Services > Syslog Parser Domain).

   The system displays the new domain view.
2. In the Domain Name text box, type the name of the domain to be added.
3. In the Server (IP Address) text box, type a valid IP address.

NOTE: You must ensure that you type a valid IP address, because the IP address you type is not automatically validated against the list of external servers that has been configured.

4. Click << Add.
5. Click Apply.

Adding a New Parser Rule in the WebUI

To add a new syslog parser rule for the route-mode example:

1. Click Add in the Syslog Parser Rules tab (Advanced Services > External Services > Syslog Parser Rule).

   The system displays the new rule view.
2. In the Rule Name text box, type the name of the rule to be added (in this example, “forti_virus”).
3. Click the Enable checkbox to enable the rule.
4. In the Condition Pattern text box, type the regular expression to be used as the condition pattern. (In this example, the expression “log_id=[0–9]{10}[ ]” searches for and matches a 10-digit string preceded by “log_id=” and followed by one space.)
5. In the drop-down Match list, use the drop-down menu to select the match type (in this example, ipaddr).
6. In the Match Pattern text box, type the regular expression to be used as the match pattern (in this example, “src=(.*)[ ]”).
7. In the drop-down Set list, select the set type (in this example, blacklist).
8. In the drop-down Parser Group list, select one of the configured parser domain names (in this example, “forti_domain”).
9. Click Apply.

In the CLI

Use these CLI commands to define a syslog parser domain and the rule to be applied in the route-mode example shown in

```
esi parser domain name
   peer peer-ip
   server ipaddr

esi parser rule rule-name
   condition expression
   domain name
   enable
   match {ipaddr expression | mac expression | user expression }
   position position
   set {blacklist | role role}
```

For example:

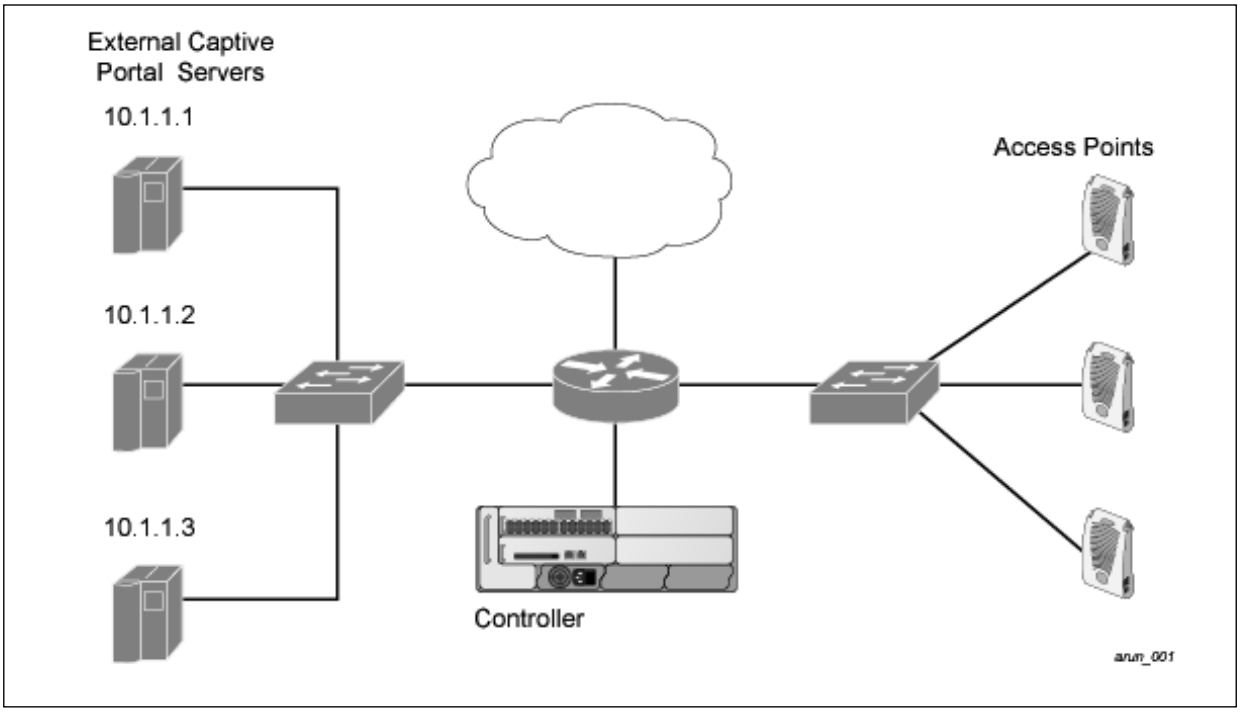
```
esi parser domain forti_domain
   server 10.168.172.3

esi parser rule forti_virus
   condition “log_id=[0-9]{10}[ ]”
   match ipaddr “src=(.*)[ ]”
   set blacklist
   enable
```

Example NAT-mode ESI Topology

This section describes the configuration for a sample NAT-mode topology using the controller and three external captive-portal servers. NAT mode uses a trusted interface for each external captive-portal server and a different destination port to redirect a packet to a port other than the original destination port in the packet. An example topology is shown below in .

Figure 190 *Example NAT-Mode Topology*



In this example, all HTTP traffic received by the controller is redirected to the external captive portal server group and load-balanced across the captive portal servers. All wireless client traffic with destination port 80 is redirected to the captive portal server group, with the new destination port 8080.

NOTE: The external servers do not necessarily have to be on the subnet as the controller. The policy that redirects traffic to the external servers for load balancing is routed to the external servers if they are on a different subnet.

In the topology shown, the following configurations are entered on the controller and external captive-portal servers:

ESI server configuration on the controller

- External captive-portal server 1:
  - Name = external_cp1
  - Mode = NAT
  - Trusted IP address = 10.1.1.1
  - Alternate destination port = 8080
- External captive-portal server 2:
  - Name = external_cp2
  - Mode = NAT
  - Trusted IP address = 10.1.1.2
- External captive-portal server 3:
  - Name = external_cp3
  - Mode = NAT
  - Trusted IP address = 10.1.1.3

- Health-check ping:
  - Name = externalcp_ping
  - Frequency = 30 seconds
  - Retry-count = 2 attempts
  - Timeout = 2 seconds (2 seconds is the default)
- ESI group = external_cps
- Session access control list (ACL)
  - Name = cp_redirect_acl
  - Session policy = user any svc-http redirect esi-group external_cps direction both

Configuring the Example NAT-mode ESI Topology

This section describes how to implement the example NAT-mode ESI topology shown in using both the WebUI, then the CLI.

The configuration process consists of these general tasks:

- Configuring captive portal (see the "Configuring Captive Portal" chapter).
- Configuring the health-check ping method.
- Configuring the ESI servers.
- Configuring the ESI group.
- Defining the redirect filter for sending traffic to the ESI server.

Configuring the NAT-mode ESI Example in the WebUI

Navigate to the Configuration > Advanced Services > External Services view on the WebUI (see on page 723).

In the WebUI

1. Click Add in the Health-Check Configuration section External Services view on the WebUI.
2. Provide the following details:
   a. Profile Name. This example uses externalcp_ping.
   b. Frequency seconds. This example uses 30.
   c. Retry Count. This example uses 3.

NOTE: If you do not specify a value for a parameter, the WebUI assumes the default value. In this example, the desired timeout value is two seconds; therefore, not specifying the timeout causes the WebUI to use the default value of two seconds.

3. Click Done when you are finished.

NOTE: To apply the configuration (changes), you must click Apply in the External Services view on the WebUI. In this example, you can wait until you finish configuring the servers and groups, or you can apply after each configuration portion.

Configuring the ESI Group in the WebUI

1. Click Add in the Server Groups section External Services view on the WebUI.
2. Provide the following details:
   a. Group Name. This example uses external_cps.
   b. Health-Check Profile. Select the health-check ping from the drop-down list. This example uses externalcp_ping.
3. Click Done when you are finished.

NOTE: To apply the configuration (changes), you must click Apply in the External Services view on the WebUI. In this example, you can wait until you finish configuring the servers and groups, or you can apply after each configuration portion.

Configure the ESI Servers in the WebUI

1. Click Add in the External Servers section.
2. Provide the following details:
   a. Server Name.
   b. Server Group. Use the drop-down list to assign this server to a group from the existing configured groups.
   c. Server Mode. Use the drop-down list to choose NAT mode.)
   d. Trusted IP Address. For nat mode, enter the IP address of the trusted interface on the external captive portal server.
   e. NAT Destination Port. Enter the port number (to redirect a packet to a port other than the original destination port in the packet).
3. Click Done when you are finished.
4. Repeat Step 1 through Step 3 for the remaining external captive portal servers.
5. Click Apply to apply the configuration changes.

Configuring the Redirection Filter in the WebUI

To redirect the required traffic to the server(s) using the WebUI, navigate to the Configuration > Access Control > User Roles view on the WebUI (see 1. on page 725).

1. Click the Policies tab.
2. Click Add in the Policies section of the Policies view on the WebUI.
3. Provide the following details:
   a. Policy Name. (This example uses cp_redirect_acl.)
   b. Policy Type. Select IPv4 Session from the drop-down list.
4. Click Add in the Rules section of the Policies view.
   a. Source. Select user from the drop-down list.
   b. Destination. Accept any.
   c. Service. Select service from the drop-down list; select svc-http (tcp 80) from the secondary drop-down list.
   d. Action. Select redirect to ESI group from the drop-down list; select external_cps from the secondary drop-down list; click <-- to add that group.
   e. Click Add.
5. Click Done when you are finished.
6. Click Apply to apply the configuration changes.

Configuring the Example NAT-mode Topology in the CLI

The CLI configuration process consists of these general tasks:

- Configuring captive portal (see Chapter 15, "Captive Portal" on page 351).
- Configuring the health-check ping method.
- Configuring the ESI servers.
- Configuring the ESI group.
- Defining the redirect filter for sending traffic to the ESI server.

Configuring a Health-Check Ping

The health-check ping will be associated with an ESI group, along with servers, so that controller will send ICMP echo requests to each server in the group and mark the server down if the controller does not hear from the server. The health-check parameters used in this example are:

- Frequency—30 seconds. (The default is 5 seconds.)
- Retry-count—3. (The default is 2.)
- Timeout—2 seconds. (The default is 2 seconds.)

Use these CLI commands to configure a health-check ping method:

```
esi ping profile_name
   frequency seconds
   retry-count count
   timeout seconds
```

Configuring ESI Servers

Here are the ESI server CLI configuration tasks:

- Configure server mode to be NAT.
- Configure the trusted IP address (the server IP address to which packets should be redirected).
- To redirect to a different port than the original destination port in the packet, configure an alternate destination port.

Use these CLI commands to configure an ESI server and identify its associated attributes:

```
esi server server_identity
   dport destination_tcp/udp_port
   mode {bridge | nat | route}
   trusted-ip-addr ip-addr [health-check]
```

Configure an ESI Group, Add the Health-Check Ping and ESI Servers

Use these CLI commands to configure an ESI server group, identify its associated ping health-check method, and associate a server with this group:

```
esi group name
   ping profile_name
   server server_identity
```

Using the ESI Group in a Session Access Control List

Use these CLI commands to define the redirection filter for sending traffic to the ESI server.

```
ip access-list session policy
   user any svc-http redirect esi-group group direction both
```

CLI Configuration Example 1

```
esi ping externalcp_ping
```

```
   frequency 30
   retry-count 3

esi server external_cp1
   dport 8080
   mode nat
   trusted-ip-addr 10.1.1.1

esi server external_cp2
   dport 8080
   mode nat
   trusted-ip-addr 10.1.1.2

esi server external_cp3
   dport 8080
   mode nat
   trusted-ip-addr 10.1.1.3

esi group external_cps
   ping externalcp_ping
   server external_cp1
   server external_cp2
   server external_cp3

ip access-list session cp_redirect_acl
   user any svc-http redirect esi-group external_cps direction both
```

CLI Configuration Example 2

```
esi server https-proxy1
   dport 44300
   mode nat
   trusted-ip-addr 1.2.3.4

esi server https-proxy2
   dport 44300
   mode nat
   trusted-ip-addr 1.2.3.5

esi group https-proxies
   ping default
   server https-proxy1
   server https-proxy2

ip access-list session https-proxy
   user any svc-https redirect esi-group https-proxies direction both
   any any permit
```

Basic Regular Expression Syntax

The ESI syslog parser supports regular expressions created using the Basic Regular Expression (BRE) syntax described in this section. BRE syntax consists of instructions—character-matching operators (described in Table 160), repetition operators (described in Table 161), or expression anchors (described in Table 162)—used to defined the search or match target.

This section contains the following topics:

Character-Matching Operators

Character-matching operators define what the search will match.

Table 160 *Character-matching operators in regular expressions*

Operator	Description	Sample	Result
.	Match any one character.	grep .ord sample.txt	Matches *ford*, *lord*, *2ord*, etc. in the file sample.txt.
[ ]	Match any one character listed between the brackets	grep [cng]ord sample.txt	Matches only *cord*, *nord*, and *gord*
[^]	Match any one character not listed between the brackets	grep [^cn]ord sample.txt	Matches *lord*, *2ord*, etc., but not *cord* or *nord*
		grep [a-zA-Z]ord sample.txt	Matches *aord*, *bord*, *Aord*, *Bord*, etc.
		grep [^0-9]ord sample.txt	Matches *Aord*, *aord*, etc., but not *2ord*, etc.

Regular Expression Repetition Operators

Repetition operators are *quantifiers* that describe how many times to search for a specified string. Use them in conjunction with the character-matching operators in Table 161 to search for multiple characters.

Table 161 *Regular expression repetition operators*

Operator	Description	Sample	Result
?	Match any character one time if it exists	egrep "?erd" sample text	Matches *berd*, *herd*, etc., *erd*
*	Match declared element multiple times if it exists	egrep "n.*rd" sample.txt	Matches *nerd*, *nrd*, *neard*, etc.
+	Match declared element one or more times	egrep "[n]+erd" sample.txt	Matches *nerd*, *nnerd*, etc., but not *erd*
{n}	Match declared element exactly *n* times	egrep "[a-z]{2}erd" sample.txt	Matches *cherd*, *blerd*, etc., but not *nerd*, *erd*, *buzzerd*, etc.
{n,}	Match declared element at least *n* times	egrep ".{2,}erd" sample.txt	Matches *cherd* and *buzzerd*, but not *nerd*
{n,N}	Match declared element at least *n* times, but not more than *N* times	egrep "n[e]{1,2}rd" sample.txt	Matches *nerd* and *neerd*

Regular Expression Anchors

Anchors describe where to match the pattern, and are a handy tool for searching for common string combinations. Some of the anchor examples use the vi line editor command *:s*, which stands for *substitute*. That command uses the syntax: *s/pattern_to_match/pattern_to_substitute*.

Table 162 *Regular expression anchors*

Operator	Description	Sample	Result
^	Match at the beginning of a line	s/^/blah /	Inserts “blah” at the beginning of the line
$	Match at the end of a line	s/$/ blah/	Inserts “ blah” at the end of the line
\<	Match at the beginning of a word	s/\</blah/	Inserts “blah” at the beginning of the word
		egrep “\<blah” sample.txt	Matches *blahfield*, etc.
\>	Match at the end of a word	s/\>/blah/	Inserts “blah” at the end of the word
		egrep “\>blah” sample.txt	Matches *soupblah*, etc.
\b	Match at the beginning or end of a word	egrep “\bblah” sample.txt	Matches *blahcake* and *countblah*
\B	Match in the middle of a word	egrep “\Bblah” sample.txt	Matches *sublahper*, etc.

References

This implementation is based, in part, on the following resources:

- Lonvick, C., “The BSD syslog Protocol”, RFC 3164, August 2001
- Regular expression (regex) reference: http://en.wikipedia.org/wiki/Regular_expression
- Regex syntax summary: http://www.greenend.org.uk/rjk/2002/06/regexp.html
- Basic regular expression (BRE) syntax: http://builder.com.com/5100-6372-1050915.html

Chapter 38

External User Management

This chapter introduces the ArubaOS XML API interface and briefly discusses how you can use the simple API calls to perform external user management tasks. A sample code listing at the end of the chapter to help you get started with using the XML API.

Topics in this chapter:

Overview

ArubaOS allows you to set up customized external captive portal user management using its native XML API interface. The XML API interface allows you to create and execute user management operations on behalf of the clients or users. You can use the XML API interface to add, delete, authenticate, or query a user or a client.

Before you Begin

- Enable the External Services Interface software module. This is available in the PEF license.
- Ensure that you have connectivity between your captive portal server and the controllers via HTTP or HTTPS.

How the ArubaOS XML API Works

The typical interaction between your external server and the controller happens over HTTPS post commands. A typical communication process using the XML API interface happens as follows:

1. An API command is issued from your server in XML format to the controller. The XML message or request can be composed using a language of your choice using the format described in the "XML Request" on page 750. Sample code in *C* gives a simple example. See the "Sample Code" on page 754.
2. The controller processes the XML request and sends the response to the authentication server in the XML format. The XML request is sent using HTTPS post. The common format of the HTTPS post is `https://<controller-ip>/auth/command.xml`. See "XML Request" on page 750 for more information.
3. You can use the response and take appropriate action that suit your requirements. The response from the controller is returned using predefined formats. See the "XML Response" on page 752 for more information.

Using the XML API Server

To use the XML API:

1. Configure an external XML API server
2. Associate the XML API server to an appropriate AAA profile
3. Configure a user role to direct un-authenticated users to the external captive portal server
4. Configure Captive Portal profile and associate that to an initial role (example `logon`)

5. Create an XML request with the appropriate API call
6. Process XML response appropriately

NOTE: The default logon role of a client or user must have captive-portal enabled.

Configuring the XML API Server

Configure an external XML API server in your AAA infrastructure. In this example, `10.11.12.13` is your server. The XML API interface on the controller will receive requests from this server.

- Define the XML API server and specify the key for verifying requests from your server

```
(host) (config) #aaa xml-api server 10.11.12.13
(host) (XML API Server "10.11.12.13") #key $abcd$1234$
```

- Verify the XML API server configuration

```
(host) (config) #show aaa xml-api server
XML API Server List
-------------------
Name        References  Profile Status
----        ----------  --------------
10.11.12.13 1                         <====== Reference Count is incremented for each
usage.

Total:1
```

Associate the XML API Server to AAA profile

After you define the XML API server profile associate it to the appropriate AAA profile. If the XML API server is not correctly configured in the appropriate profile, the controller will respond with the `client not authorized` error message. You can add XML API server references to the following AAA profile depending on your requirement:

- For wireless users—Associate the XML API server to the AAA profile of the virtual AP profile.

```
(host) (config) #aaa profile wirelessusers
(host) (AAA Profile "wirelessusers") #xml-api-server 10.11.12.13
(host) (XML API Server "10.11.12.13") #key aruba123
(host) (config) #show aaa profile wirelessusers

AAA Profile "wirelessusers"
---------------------------
Parameter                          Value
---------                          -----
Initial role                       logon
MAC Authentication Profile         N/A
MAC Authentication Default Role    guest
MAC Authentication Server Group    default
802.1X Authentication Profile      N/A
802.1X Authentication Default Role guest
802.1X Authentication Server Group N/A
RADIUS Accounting Server Group     N/A
XML API server                     10.11.12.13
RFC 3576 server                    N/A
User derivation rules              N/A
Wired to Wireless Roaming          Enabled
SIP authentication role            N/A
```

```
(host) (config) #wlan virtual-ap wireless-vap
(host) (Virtual AP profile "wireless-vap") #aaa-profile wirelessusers
(host) (config) #show wlan virtual-ap wireless-vap

Virtual AP profile "wireless-vap"
---------------------------------
Parameter                                       Value
---------                                       -----
Virtual AP enable                               Enabled
Allowed band                                    all
AAA Profile                                     wirelessusers
802.11K Profile                                 default
SSID Profile                                    default
VLAN                                            N/A
Forward mode                                    tunnel
Deny time range                                 N/A
Mobile IP                                       Enabled
HA Discovery on-association                     Disabled
DoS Prevention                                  Disabled
Station Blacklisting                            Enabled
Blacklist Time                                  3600 sec
Dynamic Multicast Optimization (DMO)            Disabled
Dynamic Multicast Optimization (DMO) Threshold  6
Authentication Failure Blacklist Time           3600 sec
Multi Association                               Disabled
Strict Compliance                               Disabled
VLAN Mobility                                   Disabled
Remote-AP Operation                             standard
Drop Broadcast and Multicast                    Disabled
Convert Broadcast ARP requests to unicast       Disabled
Band Steering                                   Disabled
WMM Traffic Management Profile                  N/A
```

- **For wired users—Associate the XML API server to the AAA profile of the appropriate wired profile.**

```
(host) (config) #aaa profile wiredusers
(host) (AAA Profile "wiredusers") #xml-api-server 10.11.12.13
(host) (AAA Profile "wiredusers") #!
(host) (config) #aaa authentication wired
(host) (Wired Authentication Profile) #profile wiredusers
(host) (Wired Authentication Profile) #show aaa authentication wired

Wired Authentication Profile
----------------------------
Parameter    Value
---------    -----
AAA Profile  wiredusers
```

- **Unknown wired users—Associate the XML API server to the `default-xml-api` AAA profile.**

NOTE: The `default-xml-api` AAA profile is used only to add or authenticate new users.

The following example illustrates using the `default-xml-api` AAA profile.

```
(host) (config) #aaa profile default-xml-api
(host) (AAA Profile "default-xml-api") #xml-api-server 10.11.12.13
(host) (config) #show aaa profile default-xml-api
```

```
AAA Profile "default-xml-api" (Predefined (changed))
----------------------------------------------------
Parameter                          Value
---------                          -----
Initial role                       logon
MAC Authentication Profile         N/A
MAC Authentication Default Role    guest
MAC Authentication Server Group    default
802.1X Authentication Profile      N/A
802.1X Authentication Default Role guest
802.1X Authentication Server Group N/A
RADIUS Accounting Server Group     N/A
XML API server                     10.11.12.13
RFC 3576 server                    N/A
User derivation rules              N/A
Wired to Wireless Roaming          Enabled
SIP authentication role            N/A
```

Your controller is now ready to receive API calls from your XML API server.

Set up Captive Portal profile

Set up a Captive Portal profile with a login page that will redirect users to the external Captive Portal server.

```
(host) (config-role) #aaa authentication captive-portal captive-portal-auth
(host) (Captive Portal Authentication Profile "captive-portal-auth") #default-role
authenticated
(host) (Captive Portal Authentication Profile "captive-portal-auth") #login-page
https://10.11.12.13/cgi-bin/login.pl
(host) (Captive Portal Authentication Profile "captive-portal-auth") #switch-in-
redirection-url
```

Associate Captive Portal profile to the an initial role

```
(host) (Captive Portal Authentication Profile "captive-portal-auth") #user-role logon
(host) (config-role) #captive-portal captive-portal-auth
(host) (config-role) #session-acl captiveportal
```

You can either create a new ACL or append specific rules to an exisiting ACLs. To create session ACL for the logon role do the following:

```
(host) (config-role) #netdestination xCP #an alias for the external Captive Portal
server
(host) (config-dest) #host 10.11.12.13 #IP address of the external Captive Portal
server
(host) (config-dest) #ip access-list session captiveportal #append or add rules to
session ACL
(host) (config-sess-captiveportal)#user alias xCP svc-https permit
(host) (config-sess-captiveportal)#user alias xCP svc-http permit
```

Creating an XML API Request

You can now create an XML request with an appropriate authentication command and send it to the controller via HTTPS post. The format of the URL to send the XML request is:

```
https://<controller-ip/auth/command.xml
```

- `controller-ip` is the IP address of the controller that will receive the authentication request
- `command.xml` is the XML request that contains the details of authentication.

The format of the XML API request is:

```
xml=<aruba command="<authentication_command>">
  <options>Value</options>
```

```
  ...
  <options>Value</options>
</aruba>
```

You can specify any of the following commands in the XML request:

Table 163 *XML API Authentication Command*

Authentication Command	Description
`user_add`	This command adds the user to the controllers user table.
`user_delete`	This command deletes the user from the controller
`user_authenticate`	This command will authentication the user based on the authentication rules defined in the controllers configuration.
`user_blacklist`	This command will block a user from connection to your network.
`user_query`	This command will display the current status of the user connected to your network.

The authentication command requires certain mandatory options to successfully execute the authentication tasks. The list of all available options are:

Table 164 *Authentication command options*

Options	Description	Range / Defaults
`ipaddr`	IP address of the user in A.B.C.D format.	—
`macaddr`	MAC address of the user aa:bb:cc:dd:ee:ff format.	Enter MAC address with colon.
`user`	Name of the user.	64 character string
`role`	Role name assigned after authenticating.	64 character string
`password`	The password of the user used for authentication.	—
`session_timeout`	Session time-out in minutes. User will be disconnected after this time.	—
`authentication`	Authentication method used to authenticate the message and the sender. You can use any of MD5, SHA-1 or clear text methods of authentication. This option is ignored if shared secret is not configured. It is, however, mandatory if it is configured.	—
`key`	This is the encoded SHA1/MD5 hash of shared secret or plaintext shared secret. This option is ignored if shared secret is not configured on the switch. The actual MD5/SHA-1 hash is 16/20 bytes and consists of binary data. It must be encoded as an ASCII based HEX string before sending. It must be present when the controller is configured with an xml-api key for the server. Encoded hash length is 32/40 bytes for MD5/SHA-1.	
`version`	The version of the XML API interface available in the controller. This field is mandatory is all requests.	Current version 1.0

Monitoring External Captive Portal Usage Statistics

To check the external captive portal authentication statistics use the `show aaa xml-api statistics` command. This command displays the number of times an authentication command was executed per client.

The command also displays the number of times an authentication event occurred and the number of new authentication events that occurred since the last status check.

```
(host) # show aaa xml-api statistics
ECP Statistics
--------------
Statistics                              10.10.10.249
----------                              ----------
user_authenticate                       1 (0)
user_add                                1 (0)
user_delete                             1 (0)
user_blacklist                          2 (0)
unknown user                            2 (0)
unknown role                            0 (0)
unknown external agent                  0 (0)
authentication failed                   0 (0)
invalid command                         0 (0)
invalid message authentication method   0 (0)
invalid message digest                  0 (0)

Packets received from unknown clients : 0 (0)
Packets received with unknown request : 0 (0)
Requests Received/Success/Failed      : 5/3/2 (0/0/0)
```

XML Request

You can create XML requests to add, delete, authenticate, blacklist, or query a user. This section provides XML request formats that you can use for each authentication tasks:

Adding a User

This XML requests uses the `user_add` command to create a new user entry in the controllers user table. If the user entry is already present in the user table, the command will modify the entry with the values defined in the XML request.

```
xml=<aruba command="user_add">
  <ipaddr>IP-address_of_the_user</ipaddr>
  <macaddr>MAC-address_of_the_user</macaddr>
  <name>User_Name</name>
  <role>Role_Name<role>
  <session_timeout>Session_timeout</session_timeout>
  <key>Shared_Key</key>
  <authentication>MD5|SHA-1|cleartext</authentication>        #select any one
  <version>1.0</version>
</aruba>
```

The following options are mandatory when you execute the `user_add` command:

- IP Address
- Version

Deleting a User

This XML requests uses the `user_delete` command to delete an existing user from the controllers user table. If the user entry contains multiple attributes these must be specified in the XML request

```
xml=<aruba command="user_delete">
  <ipaddr>IP-address_of_the_user</ipaddr>
  <macaddr>MAC-address_of_the_user</macaddr>
```

```
  <name>User_Name</name>
  <key>Shared_Key</key>
  <authentication>MD5|SHA-1|cleartext</authentication>        #select any one
  <version>1.0</version>
</aruba>
```

The following options are mandatory when you execute the `user_add` command:

- IP Address
- Version

Authenticating a User

This XML requests uses the `user_authenticate` command to authenticate and derive a new for the user.

```
xml=<aruba command="user_authenticate">
  <ipaddr>IP-address_of_the_user</ipaddr>
  <macaddr>MAC-address_of_the_user</macaddr>
  <name>User_Name</name>
  <password>Password_for_the_user</password>
  <key>Shared_Key</key>
  <authentication>MD5|SHA-1|cleartext</authentication>        #select any one
  <version>1.0</version>
</aruba>
```

The following options are mandatory when you execute the `user_authenticate` command:

- IP Address
- Version
- Name
- Password

Blacklisting a User

This XML requests uses the user_blacklist command to blacklist a user from connecting to your network.

```
xml=<aruba command="user_blacklist">
  <ipaddr>IP-address_of_the_user</ipaddr>
  <macaddr>MAC-address_of_the_user</macaddr>
  <name>User_Name</name>
  <key>Shared_Key</key>
  <authentication>MD5|SHA-1|cleartext</authentication>        #select any one
  <version>1.0</version>
</aruba>
```

The following options are mandatory when you execute the `user_blacklist` command:

- IP Address
- Version

Querying a User Status

This XML requests uses the `user_query` command to get the status and details of a user connected to your network.

```
xml=<aruba command="user_query">
  <ipaddr>IP-address_of_the_user</ipaddr>
  <macaddr>MAC-address_of_the_user</macaddr>
  <name>User_Name</name>
```

```
  <key>Shared_Key</key>
  <authentication>MD5|SHA-1|cleartext</authentication>        #select any one
  <version>1.0</version>
</aruba>
```

The following options are mandatory when you execute the `user_blacklist` command:

- IP Address
- Version

XML Response

For every successful XML request the controller will return the processed information as an XML response. There are two types of responses: Default response and Query response.

Default Response Format

The format of a default XML response from the controller is:

```
<aruba>
  <result>Error | Ok</result>
  <code>response_code</code>
  <reason>response_message</reason>
</aruba>
```

In which,

- Result specifies if the XML result was successful or failure. If the request was successful, the result tag will contain the **`Ok`** string. If the request was a failure, the result tag will contain the **`Error`** string.
- Code is an integer number that represents the error in the request. This tag is populated only if there is an error in the request.
- Reason is message that contain descriptive information about error.

Response Codes

The following response codes are returned if the XML request return an the Error string.

Table 165 *XML Response Codes*

Code	Reason message	Description
1	`unknown user` The user specified in the XML request does not exist or is incorrect.	Returned by the user_authenticate, user_delete, user_blacklist, and user_query commands.
2	`unknown role` The specified role in the XML request does not exist in the controller.	Returned by the user_add command.
3	`unknown external agent`	Returned by all commands.
4	`authentication failed` The username and the key does not match.	Returned by commands that contain the shared_key in XML request.
5	`invalid command` The XML request contains a command not supported by ArubaOS XML API interface.	—
6	`invalid message authentication method` The authentication method specified in the XML request is not supported by the ArubaOS XML API interface.	Returned by commands that contain the authentication method in the XML request.

Table 165 *XML Response Codes (Continued)*

Code	Reason message	Description
7	`invalid message digest`	Returned by commands that contain the shared_key in the XML request.
8	`missing message authentication` The authentication method is not specified in the XML request.	Returned by all commands that require the authentication method in the XML request.
9	`missing or invalid version number` The XML request does not contain the version number or the version number is incorrect.	Returned by all commands.
10	`internal error`	
11	`client not authorized` The shared key in the XML request does not match or the XML API server is not defined in the appropriate AAA profile.	Returned by all commands that require shared key to be specified in the XML request.
12	`Cant use VLAN IP`	—
13	`Invalid IP` The XML request contains invalid IP address of the user or client.	Returned by all commands that required IP address to be specified in the XML request.
14	`Cant use Switch IP` The XML request contains the controllers IP address instead of the client IP address.	Returned by all commands that required IP address to be specified in the XML request.
15	`missing MAC address` The XML request does not contain the MAC address of the user or client.	Returned by all commands that required MAC address to be specified in the XML request.

Query Command Response Format

The response of the XML request with the user_query command contains detailed information about the status of the user or client. The format of the response of a query command is:

```
<aruba>
  <result>Result</result>
  <code>Code</code>
  <reason>Reason</reason>
  <role>Role</role>
  <type>Type</type>
  <auth_status>Auth_status</auth_status>
  <auth_server>Auth_server</auth_server>
  <auth_method>Auth_method</auth_method>
  <location>Location</location>
  <age>Age</age>
  <essid>Essid</essid>
  <bssid>Bssid</bssid>
  <phy_type>Phy_type</phytype>
  <vlan>Vlan</vlan>
</aruba>
```

In which, the result, code and reason values are similar to the default response. The following responses, however, are returned only in the result code returns the **OK** string.

Table 166 *Query Response Code*

Response Code	Description
Role	Displays the current role of the authenticated user
Type	Displays is the user or client is **wired** or **wireless**.
Auth_status	Displays the authentication status of the user or client. Available values are: **authenticated** or **unauthenticated**.
Auth_server	Displays the name of the authentication server used for authenticating the user. This information is available only if the user is authenticated by the controller.
Auth_method	Displays the authentication mechanism used to authenticate the user. This information is available only if the user is authenticated by the controller.
Location	Displays the current location of the user / clients. For wireless clients, the location is displayed in the B.F.L format. For wired clients, the location is displayed in the slot/port format.
Age	Displays the age of user in the controller. The age is displayed in DD:HH:MM format (Day:Hours:Minutes).
ESSID	Displays the ESSID to which the user is associated.
BSSID	Displays the BSSID of the AP to which the user is associated.
Phy Type	Displays the physical connection type. One of a, b, or g.
Vlan	Displays the VLAN ID of the user.

Sample Code

This section lists a sample code that will help you get started in using the ArubaOS XML API interface. These codes have been tested in a controlled environment. We recommend that you test this code in a non-production environment before using it for actual user management tasks.

Using XML API in C Language

The example script is written in the C language. The example script (`auth.c`) sends an authentication request from your authentication server to the controller.

NOTE: This is an example code and is provided for illustration purposes. If you plan to use this code in your environment, ensure that the code meets your IT guidelines. Also create an error free executable to successfully execute the script.

Figure 191 *Authentication Script Listing*

```
##### auth.c listing
##### Authentication Script Example -- Start --
#include <stdio.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <getopt.h>

char *command, *ipaddr, *macaddr;
char *name, *password, *role;
char *tout, *secret;
char *auth, *key, enchashbuf[41];
unsigned char hashbuf[20];
char *version;

char post[4096], cmdbuf[512], encbuf[1024];

#define DEBUG
#ifdef DEBUG
```

```
#define debug(x...)fprintf(stderr, x)
#else
#define debug(x...)
#endif

extern int cgi_escape_url(char *t, int tl, char *s, int sl, int b_newline);
static void encode_message_digest (unsigned char *md, int mdlen, char *output);

static void usage (void)
{
    fprintf(stderr, "Usage: ecp [options] <switch> <command> [<secret>]\n");

    fprintf(stderr, "  \n");
    fprintf(stderr, "  <switch>     Switch IP address.\n");
    fprintf(stderr, "  <command>    One of add, del, or authenticate.\n");
    fprintf(stderr, "  <secret>     Shared secret.\n");
    fprintf(stderr, "  \n");

    fprintf(stderr, "  -i ipaddr    User IP address in A.B.C.D format.\n");
    fprintf(stderr, "  -m macaddr   User MAC address in aa:bb:cc:dd:ee:ff format.\n");
    fprintf(stderr, "  -n name      User name.\n");
    fprintf(stderr, "  -p passwd    User password.\n");
    fprintf(stderr, "  -r role      User role.\n");
    fprintf(stderr, "  -t timeout   User session timeout.\n");
    fprintf(stderr, "  -v version   API version number. Default is 1.0\n");
    fprintf(stderr, "  -a method    one of md5, sha-1 or cleartext.\n");

    exit(1);
}

main(int argc, char **argv)
{
    char c, *p;
    int fd, len, postlen;
    struct sockaddr_in sa;

    while ((c = getopt(argc, argv, "a:i:m:n:p:r:t:v:")) != EOF) switch(c) {
        case 'i':/* ipaddr */
            ipaddr = optarg;
            break;
        case 'm':/* macaddr */
            macaddr = optarg;
            break;
        case 'n':/* name */
            name = optarg;
            break;
        case 'p':/* password */
            password = optarg;
            break;
        case 'r':/* role */
            role = optarg;
            break;
        case 't':/* session timeout */
            tout = optarg;
            break;
        case 'v':/* version */
            version = optarg;
            break;
        case 'a':/* authentication */
            auth = optarg;
            if (!strcasecmp(auth, "sha-1") &&
            !strcasecmp(auth, "md5"))
            usage();
            break;
        default:
            usage();
            break;
    }
    argc -= (optind - 1);
    argv += (optind - 1);

    if ((argc < 3)) {
        usage();
    }
    if (version == NULL)
        version = "1.0";

    debug("server=%s, command=%s, version=%s, secret=%s\n",
        argv[1], argv[2], version, argv[3]?argv[3]:"<>");

    if (argv[3]) secret = argv[3];

    p = cmdbuf;
    sprintf(p, "xml=<aruba command='%s'>", argv[2]);
    p += strlen(p);
    if (ipaddr) {
        sprintf(p, "<ipaddr>%s</ipaddr>", ipaddr);
```

```
        p += strlen(p);
    }
    if (macaddr) {
        sprintf(p, "<macaddr>%s</macaddr>", macaddr);
        p += strlen(p);
    }
    if (name) {
        sprintf(p, "<name>%s</name>", name);
        p += strlen(p);
    }
    if (password) {
        sprintf(p, "<password>%s</password>", password);
        p += strlen(p);
    }
    if (role) {
        sprintf(p, "<role>%s</role>", role);
        p += strlen(p);
    }
    if (tout) {
        sprintf(p, "<session timeout>%s</session timeout>", tout);
        p += strlen(p);
    }
    if (secret) {
        if (auth == NULL) {
            key = secret;
            auth = "cleartext";
#ifndef OPENSSL_NO_SHA1
        } else if (!strcasecmp(auth, "sha-1")) {
            key = enchashbuf;
            SHA1(secret, strlen(secret), hashbuf);
            encode_message_digest(hashbuf, 20, enchashbuf);
#endif
        } else if (!strcasecmp(auth, "md5")) {
            key = enchashbuf;
            md5_calc(hashbuf, secret, strlen(secret));
            encode_message_digest(hashbuf, 16, enchashbuf);
        }
        debug("Message authentication is %s (%s)\n", auth, key);
        sprintf(p, "<authentication>%s</authentication><key>%s</key>",
            auth, key);
        p += strlen(p);
    }
    debug("\n");
    sprintf(p, "<version>%s</version>", version);
    sprintf(p, "</authresponse>");
    cgi_escape_url(encbuf, sizeof(encbuf), cmdbuf, strlen(cmdbuf), 0);

    postlen = sprintf(post,
        "POST /auth/command.xml HTTP/1.0\r\n"
        "User-Agent: ecp\r\n"
        "Host: %s\r\n"
        "Pragma: no-cache\r\n"
        "Content-Length: %d\r\n"
        /* "Content-Type: application/x-www-form-urlencoded\r\n" */
        "Content-Type: application/xml\r\n"
        "\r\n"
        "%s",
        argv[1], strlen(encbuf), encbuf);

    inet_aton(argv[1], &sa.sin_addr);
    sa.sin_family = AF_INET;
    sa.sin_port = htons(80);
    fd = socket(AF_INET, SOCK_STREAM, 0);
    if (fd < 0) {
        perror("socket");
        exit(1);
    }
    if (connect(fd, (struct sockaddr *) &sa, sizeof(sa)) < 0) {
        perror("connect");
        exit(1);
    }

    if (write(fd, post, postlen) != postlen) {
        perror("write");
        exit(1);
    }

    while ((len = read(fd, post, sizeof(post))) > 0)
        write(1, post, len);
    close(fd);
    exit(0);
}

static void encode_message_digest (unsigned char *md, int mdlen, char *output)
{
    int i;
```

```
    for (i=0; i<mdlen; i++) {
        sprintf(output, "%02x", md[i]);
        output += 2;
    }
}

}
##### Authentication Script Example -- END --
```

Request and Response

The controller processes the authentication task and sends a response to the authentication server in the XML format to the authentication server. The XML response contains the status of the request and a code in case of an error. The example script is listed in Figure 191 on page 754.

Request format: `<script_name> [options] <controller-ip> <command> <secret_key>`

XML API Request Parameters

The Table 167 on page 757list all parameter that you can use in a request.

Table 167 *XML API Request Parameters and Descriptions*

Parameter	Description
`script_name`	The name of the script executable.
Options	• `-i <ip_addr>`—Specify the client's IP address. • `-m <mac_addr>`—Specify the client's MAC address. • `-n <name>`—Specify the client's user name. • `-p <passwd>`—Specify the client password. • `-r role`—Specify the current user role of the client. • `-t timeout`—User session timeout. • `-v version`—API version number. Default is 1.0 • `-a method`—Specify the encryption method to send the secret key. You can specify MD5 or SHA-1 or cleartext as the encryption method. By default, cleartext method is used to send the key. • `-s sessid`—Active session Id
`controller-ip`	The IP address of the controller that will receive the authentication requests.
`command`	The authentication command sent to the controller. You can send one of the following commands per request: • `add`: Adds the client to your network. • `delete`: Deletes the client from your network • `query`: Fetches information about the client • `blacklist`: Blacklists or block the client from connecting to your network • `authenticate`: Authenticates the client and assigns the default authenticated role.
secret_key	The password used to validate the authentication request from your authentication server. See "Configuring the XML API Server" on page 746 for more information.

XMl API Response

The response message from the controller is sent in an XML format. The default format of the response is:

```
[Message header]
Displays the request parameters and other standard header details.
..
...
..

<response>
   <status>Status Message</status>
   <code>Code in case of an error</code>
</response>
```

Adding a Client

This command will add a client on your network.

Figure 192 *Adding a client—request and response*

```
john@linux:/home/john/tools/xml-api# ./auth -i 10.10.10.249 -m 00:19:d2:01:0b:aa -r
logon 10.11.12.13 add $abcd$1234$
```

The commands sends the following information in the authentication request to the controller:

- Client IP address: **10.10.10.249**
- Client MAC address: **00:19:d2:01:0b:aa**
- Authentication server IP address: **10.11.12.13**
- Authentication command: **add**
- Key to validate authentication request: **$abcd$1234$**
- Verification key is sent in cleartext format

Response from the controller

```
server=10.11.12.13, command=add, version=1.0, secret=$abcd$1234$ sessid=
Message authentication is cleartext ($abcd$1234$)

HTTP/1.1 200 OK
Date: Tue, 03 Aug 2010 23:32:16 GMT
Server:
Connection: close
Content-Type: text/xml

<authresponse>
  <status>Ok</status>
  <code>0</code>
</authresponse>
```

View the updated details of the client on the controller

```
(host) #show user-table

Users
-----
    IP              MAC             Name     Role      Age(d:h:m)  Auth  ......
----------    ------------       ------    ----      ----------  ----  ... [truncated]
10.10.10.249  00:19:d2:01:0b:aa             logon     00:00:00          ......

User Entries: 1/1
```

Deleting a Client

This command will delete a client from your network.Deleting a client—request and response

```
john@linux:/home/john/tools/xml-api# ./auth -i 10.10.10.248 10.11.12.13 delete
$abcd$1234$
```

This commands sends the following information in the request to the controller:

- Client IP address: **10.10.10.248**
- Authentication server IP address: **10.11.12.13**
- Authentication command: **delete**
- Key to validate authentication request: **$abcd$1234$**
- Key is sent in cleartext format

Response from the controller

```
server=10.11.12.13, command=delete, version=1.0, secret=$abcd$1234$ sessid=
Message authentication is cleartext ($abcd$1234$)

HTTP/1.1 200 OK
Date: Tue, 03 Aug 2010 23:30:32 GMT
Server:
Content-Length: 56
Connection: close
Content-Type: text/xml

<authresponse>
  <status>Ok</status>
  <code>0</code>
</authresponse>
```

Authenticating a Client

This command will authenticate and change the role of a client. To illustrate the authentication command request process this section displays status of the client before and after the authentication command request.

Status of the client before authentication

The following `show user` command shows the role of the client is `logon` before the authentication request is processed by the controller.

```
(host) #show user

Users
-----
    IP              MAC             Name      Role      Age(d:h:m)  Auth  .....
----------    ------------       ------    ----      ----------  ----  ... [truncated]
10.10.10.248  00:19:d2:01:0b:84              logon     00:00:00          .....

User Entries: 1/1
```

The following command shows the captive portal status of the logon role of the client.

```
(host) (config-role) #show rights logon | include "Captive Portal profile"
 Captive Portal profile = default
```

Sending the authentication command

Use the `authenticate` keyword in the script to send the authentication command request.

Figure 193 *Authenticating the client—request and response*

```
john@linux:/home/john/tools/xml-api# ./auth -i 10.10.10.248 -n john -p password
10.11.23.24 authenticate $abcd$1234$
```

This commands sends the following information in the request to the controller:

- Client IP address: **10.10.10.248**
- Client username: **john**
- Client password: **password**
- Authentication server IP address: **10.11.12.13**
- Authentication command: **authenticate**
- Key to validate authentication request: **$abcd$1234$**
- Key is sent in cleartext format

Response from the controller

```
server=10.11.12.13, command=authenticate, version=1.0, secret=$abcd$1234$ sessid=
Message authentication is cleartext ($abcd$1234$)

HTTP/1.1 200 OK
Date: Tue, 03 Aug 2010 23:23:42 GMT
Server:
Connection: close
Content-Type: text/xml

<authresponse>
  <status>Ok</status>
  <code>0</code>
</authresponse>
```

Status of the client after authentication

The following `show user` command shows the role of the client is change to `guest` after the authentication request is processed by the controller.

```
(host) (config) #show user
Users
-----
    IP              MAC             Name    Role      Age(d:h:m)  Auth  .....
----------    ------------       ------  ----      ----------  ----  ... [truncated] .
10.10.10.248  00:19:d2:01:0b:84  John    guest     00:00:04    Web   .....

User Entries: 1/1
```

Querying Client Information

This command will fetch a all details about a client connected in your network. Querying Client Information—request and response

```
john@linux:/home/john/tools/xml-api# ./auth -i 10.10.10.249 10.11.12.13 query
$abcd$1234$
```

This commands sends the following information in the request to the controller:

- Client IP address: **10.10.10.249**
- Client username: **john**
- Client password: **password**
- Authentication server IP address: **10.11.12.13**
- Authentication command: **query**
- Key to validate authentication request: **$abcd$1234$**
- Key is sent in cleartext format

Response from the controller

```
server=10.11.12.13, command=query, version=1.0, secret=$abcd$1234$ sessid=
Message authentication is cleartext ($abcd$1234$)

HTTP/1.1 200 OK
Date: Tue, 03 Aug 2010 23:34:30 GMT
Server:
Connection: close
Content-Type: text/xml

<authresponse>
  <status>Ok</status>
  <code>0</code>
  <macaddr>00:19:d2:01:0b:aa</macaddr>
  <name>john</name>
  <role>logon</role>
  <type>Wireless</type>
  <vlan>1</vlan>
  <location>N/A</location>
  <age>00:00:02</age>
  <auth_status>Unauthenticated</auth_status>
  <essid></essid>
  <bssid>00:00:00:00:00:00</bssid>
  <phy_type>b</phy_type>
  <mobility_state>Wireless</mobility_state>
  <in_packets>0</in_packets>
  <in_octets>0</in_octets>
  <out_packets>0</out_packets>
  <out_octets>0</out_octets>
</authresponse>
```

The output of the `show user` command displays the client information.

```
Users
-----
    IP              MAC             Name    Role      Age(d:h:m)  Auth  .....
----------    ------------       ------    ----      ----------  ----  ... [truncated]
10.10.10.249  00:19:d2:01:0b:aa  John      logon     00:00:01          .....

User Entries: 1/1
```

Blacklisting a Client

This command will blacklist a client and restrict it from connecting to your network. The `show user-table` lists the client connected on your network before processing the request to blacklist the client.

```
Users
-----
    IP              MAC             Name     Role      Age(d:h:m)  .....
----------    ------------       ------    ----      ----------  ... [truncated] ...
10.10.10.248  00:19:d2:01:0b:84  John      guest     00:00:00    .....

User Entries: 1/1
```

Figure 194 *Blacklisting a Client—request and response*

```
john@linux:/home/john/tools/xml-api# ./auth -i 10.10.10.248 10.11.12.13 blacklist
$abcd$1234$
```

This commands sends the following information in the request to the controller:

- Client IP address: **`10.10.10.248`**
- Authentication server IP address: **`10.11.12.13`**
- Authentication command: **`blacklist`**
- Key to validate authentication request: **`$abcd$1234$`**
- Key is sent in cleartext format

Response from the controller

```
server=10.11.12.13, command=blacklist, version=1.0, secret=$abcd$1234$ sessid=
Message authentication is cleartext ($abcd$1234$)

HTTP/1.1 200 OK
Date: Tue, 03 Aug 2010 23:29:11 GMT
Server:
Content-Length: 56
Connection: close
Content-Type: text/xml

<authresponse>
  <status>Ok</status>
  <code>0</code>
</authresponse>
```

The `show user-table` command does not list the blacklisted client. You can use the show ap blacklist-clients command on your controller to view the list of blacklisted clients

```
(host) (config) #show ap blacklist-clients

Blacklisted Clients
-------------------
STA                reason        block-time(sec)  remaining time(sec)
---                ------        ---------------  -------------------
00:19:d2:01:0b:84  user-defined  5                3595
```

Appendix A

DHCP with Vendor-Specific Options

This appendix describes how to configure several DHCP vendor-specific options. Topics include?

Windows-Based DHCP Server

Configuring a Microsoft Windows-based DHCP server to send option 43 to the DHCP client on an Dell AP consists of the following two tasks:

- Configuring Option 60
- Configuring Option 43

DHCP servers are a popular way of configuring clients with basic networking information such as an IP address, a default gateway, network mask, DNS server, and so on. Most DHCP servers have the ability to also send a variety of optional information, including the Vendor-Specific Option Code, also called option 43.

When a client or an AP requests for option 43 (Vendor Specific Information), the controller responds with the value configured by administrator in the DHCP pool.

Configuring Option 60

This section describes how to configure the Vendor Class Identifier Code (option 60) on a Microsoft Windows-based DHCP server.

As mentioned in the overview section, option 60 identifies and associates a DHCP client with a particular vendor. Any DHCP server configured to take action based on a client's vendor ID should also have this option configured.

Since option 60 is not a predefined option on a Windows DHCP server, you must add it to the option list for the server.

To configure option 60 on the Windows DHCP server

1. On the DHCP server, open the DHCP server administration tool by clicking Start > Administrative Tools > DHCP.
2. Find your server and right-click on the scope to be configured under the server name. Select Set Predefined Options.
3. In the Predefined Options and Values dialog box, click the Add button.
4. In the Option Type dialog box, enter the following information

Table 168 *Configure option 60 on the Windows DHCP server*

Field	Information
Name	Dell Access Point
Data Type	String
Code	60

Table 168 *Configure option 60 on the Windows DHCP server (Continued)*

Field	Information
Description	Dell AP vendor class identifier

5. Click OK to save this information.
6. In the Predefined Options and Values dialog box, make sure 060 Dell Access Point is selected from the Option Name drop-down list.
7. In the Value field, enter the following information:

   String : ArubaAP
8. Click OK to save this information.
9. Under the server, select the scope you want to configure and expand it. Select Scope Options and expand it. Then select Configure Options.
10. In the Scope Options dialog box, scroll down and select 060 Dell Access Point. Confirm the value is set to ArubaAP and click OK.
11. Confirm that the option 060 Dell Access Point is listed in the right pane.

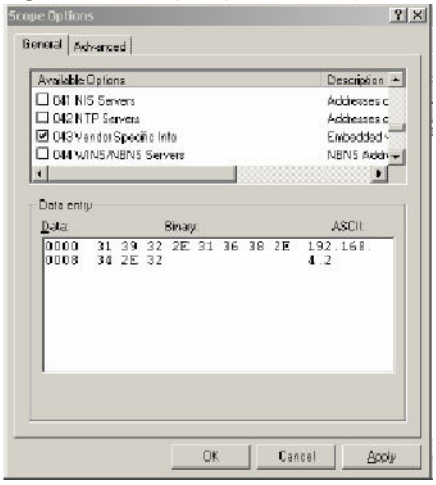
Configuring Option 43

Option 43 returns the IP address of the Dell master controller to an Dell DHCP client. This information allows Dell APs to auto-discover the master controller and obtain their configuration.

To configure option 43 on the Windows DHCP server:

1. On the DHCP server, open the DHCP server administration tool by clicking Start > Administration Tools > DHCP.
2. Find your server and right-click on the scope to be configured under the server name. Click on the Scope Options entry and select Configure Options.
3. In the Scope Options dialog box (Figure 195), scroll down and select 043 Vendor Specific Info

Figure 195 *Scope Options Dialog Box.*

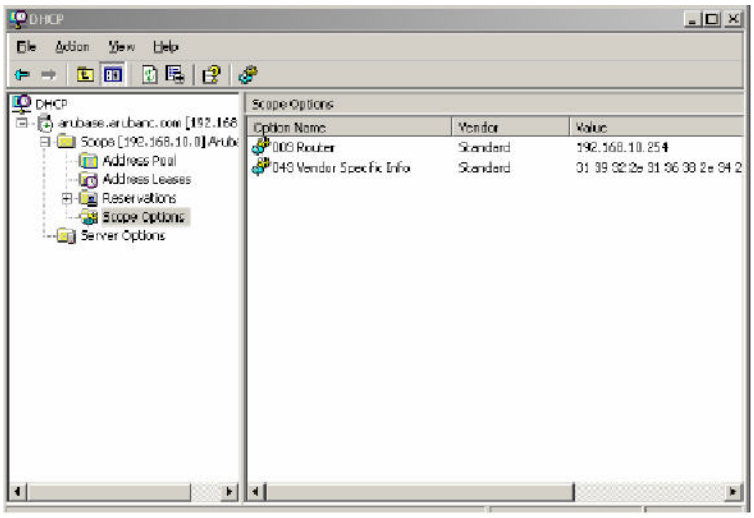


4. In the Data Entry field, click anywhere in the area under the ASCII heading and enter the following information:

   ASCII : Loopback address of the master controller
5. Click the OK button to save the configuration.

Option 43 is configured for this DHCP scope. Note that even though you entered the IP address in ASCII text, it displays in binary form.

Figure 196 *DHCP Scope Values*



DHCP Relay Agent Information Option (Option 82)

The DHCP Relay Agent Information option (Option 82) allows the DHCP Relay Agent to insert circuit specific information into a request that is being forwarded to a DHCP server.

The controller, when acting as a DHCP relay agent, inserts information about the AP and SSID through which a client is connecting into the DHCP request. Many service providers use this mechanism to make access control decisions.

Configuring Option 82

You can configure Option 82 using the WebUI or the CLI. You can include only the MAC address or MAC address and ESSID. The MAC address is the hardware address and ESSID is an alphanumeric name that uniquely identifies a wireless network.

In the WebUI

1. Navigate to Configuration > Network > IP >IP Interfaces.
2. Click Edit next to the VLAN ID for which you want to configure Option 82.
3. Under DHCP Helper Address select Mac or Mac Essid from the Option-82 drop-down menu.
4. Click Apply.

In the CLI

This example enables Option 82 for VLAN 5 using ESSID. You can include only the MAC address or MAC address and ESSID.

```
(host) (config) #interface vlan 5
(host) (config-subif)#option-82
(host) (config-subif)#option-82 mac essid
(host) (config-subif)#
```

Linux DHCP Servers

The following is an example configuration for the Linux dhcpd.conf file. After you enter the configuration, you must restart the DHCP service.

```
option serverip code 43 = ip-address;
class "vendor-class" {
      match option vendor-class-identifier;
}
.
.
.
subnet 10.200.10.0 netmask 255.255.255.0 {
   default-lease-time 200;
   max-lease-time 200;
   option subnet-mask 255.255.255.0;
   option routers 10.200.10.1;
   option domain-name-servers 10.4.0.12;
   option domain-name "vlan10.aa.mycorpnetworks.com";
   subclass "vendor-class" "ArubaAP" {
      option vendor-class-identifier "ArubaAP";
#
# option serverip <loopback-IP-address-of-master-controller>
#
      option serverip 10.200.10.10;
   }
   range 10.200.10.200 10.200.10.252;
}
```

Appendix B

External Firewall Configuration

In many deployment scenarios, an external firewall is situated between Dell devices. This appendix describes the network ports that need to be configured on the external firewall to allow proper operation of the Dell network. You can also use this information to configure session ACLs to apply to physical ports on the controller for enhanced security. Note, however, that this appendix does not describe requirements for allowing specific types of user traffic on the network.

NOTE: A controller uses both its loopback address and VLAN addresses for communications with other network elements. If the firewall uses host-specific ACLS, those ACLs must specify all IP addresses used on the controller.

This appendix includes the following topics:

Communication Between Dell Devices

This section describes the network ports that need to be configured on the firewall to allow proper operation of the network.

Between any two controllers:

- IPSec (UDP ports 500 and 4500) and ESP (protocol 50). PAPI between a master and a local controller is encapsulated in IPSec.
- IP-IP (protocol 94) and UDP port 443 if Layer-3 mobility is enabled.
- GRE (protocol 47) if tunneling guest traffic over GRE to DMZ controller.
- IKE (UDP 500).
- ESP (protocol 50).
- NAT-T (UDP 4500).

Between an AP and the controller:

- PAPI (UDP port 8211). If the AP uses DNS to discover the LMS controller, the AP first attempts to connect to the master controller. (Also allow DNS (UDP port 53) traffic from the AP to the DNS server.)
- PAPI (UDP port 8211). All APs running as Air Monitors (AMs) require a permanent PAPI connection to the master controller.
- FTP (TCP port 21).
- TFTP (UDP port 69) all APs, if there is no local image on the AP (for example, a new AP) the AP will use TFTP to retrieve the initial image.
- NTP (UDP port 123).
- SYSLOG (UDP port 514).
- PAPI (UDP port 8211).
- GRE (protocol 47).

Between a Remote AP (IPSec) and a controller:

- NAT-T (UDP port 4500).
- TFTP (UDP port 69) .

NOTE: TFTP is not needed for normal operation. If the remote AP loses its local image for any reason, it will use TFTP to download the latest image.

Network Management Access

This section describes the network ports that need to be configured on the firewall to manage the Dell network. For WebUI access between the network administrator's computer (running a Web browser) and a controller:

- HTTP (TCP ports 80 and 8888) or HTTPS (TCP ports 443 and 4343).
- SSH (TCP port 22) or TELNET (TCP port 23).

Virtual Internet Access (VIA)

The following ports are used with Dell VIA.

- For the reachability/trusted network check use port 443
- For the IPSec connection use port 4500
- To allow ISAKMP use port 500

Other Communications

This section describes the network ports that need to be configured on the firewall to allow other types of traffic in the Dell network. You should only allow traffic as needed from these ports.

- For logging: SYSLOG (UDP port 514) between the controller and syslog servers.
- For software upgrade or retrieving system logs: TFTP (UDP port 69) or FTP (TCP ports 21 and 22) between the controller and a software distribution server.
- If the controller is a PPTP VPN server, allow PPTP (UDP port 1723) and GRE (protocol 47) to the controller.
- If the controller is an L2TP VPN server, allow NAT-T (UDP port 4500), ISAKMP (UDP port 500) and ESP (protocol 50) to the controller.
- If a third-party network management system is used, allow SNMP (UDP ports 161 and 162) between the network management system and all controllers.
- For authentication with a RADIUS server: RADIUS (typically, UDP ports 1812 and 813, or 1645 and 1646) between the controller and the RADIUS server.
- For authentication with an LDAP server: LDAP (UDP port 389) or LDAPS (UDP port 636) between the controller and the LDAP server.
- For authentication with a TACACS+ server: TACACS (TCP port 49) between the controller and the TACACS+ server.
- For packet captures: UDP port 5555 from an AP to an Ethereal packet-capture station; UDP port 5000 from an AP to a Wildpackets packet-capture station.
- For telnet access: Telnet (TCP port 23) from the network administrator's computer to any AP, if "telnet enable" is present in the "ap location 0.0.0" section of the controller configuration.

- For External Services Interface (ESI): ICMP (protocol 1) and syslog (UDP port 514) between a controller and any ESI servers.
- For XML API: HTTP (TCP port 80) or HTTPS (TCP port 443) between a controller and an XML-API client.

Appendix C

Behavior and Defaults

This appendix contains the following topics:

Mode Support

Most ArubaOS features are supported in all forwarding modes. However, there are a some features that are not supported in one or more forwarding modes. Campus APs do not support split-tunnel forwarding mode and the decrypt-tunnel forwarding mode does not support TKIP Counter measure management on campus APs or remote APs.

Table 169 describes the features that are not supported in each forwarding mode.

Table 169 *Features not Supported in Each Forwarding Mode*

Forwarding Mode	Feature Not Supported
Split Tunnel Mode on Remote APs	VLAN Pooling Named VLAN Voice over Mesh Video over Mesh Layer-2 Mobility Layer-3 Mobility IGMP Proxy Mobility Mobile IP TKIP countermeasure mgmt Bandwidth based CAC Dynamic Multicast Optimization
Bridge Mode on Campus APs or Remote APs	Firewall—SIP/SCCP/RTP/RTSP Voice Support Firewall—Alcatel NOE Support Voice over Mesh Video over Mesh Named VLAN Captive portal Rate Limiting for broadcast/multicast Power save: Wireless battery boost Power save: Drop wireless multicast traffic Power save: Proxy ARP (global) Power save: Proxy ARP (per-SSID) Automatic Voice Flow Classification

Table 169 *Features not Supported in Each Forwarding Mode (Continued)*

Forwarding Mode	Feature Not Supported
Bridge Mode on Campus APs or Remote APs (continued)	SIP ALG SIP: SIP authentication tracking SIP: CAC enforcement enhancements SIP: Phone number awareness SIP: R-Value computation SIP: Delay measurement Management: Voice-specific views Management: Voice client statistics Management: Voice client troubleshooting Voice protocol monitoring/reporting SVP ALG H.323 ALG Vocera ALG SCCP ALG NOE ALG Layer 3 Mobility IGMP Proxy Mobility Mobile IP TKIP countermeasure mgmt Bandwidth based CAC Dynamic Multicast Optimization

Basic System Defaults

The default administrator user name is `admin`, and the default password is also `admin`. The ArubaOS software includes several predefined network services, firewall policies, and roles.

Network Services

Table 170 lists the predefined network services and their protocols and ports.

Table 170 *Predefined Network Services*

Name	Protocol	Port(s)
svc-dhcp	udp	67 68
svc-snmp-trap	udp	162
svc-smb-tcp	tcp	445
svc-https	tcp	443
svc-ike	udp	500
svc-l2tp	udp	1701
svc-syslog	udp	514
svc-pptp	tcp	1723
svc-telnet	tcp	23
svc-sccp	tcp	2000
svc-tftp	udp	69

Table 170 *Predefined Network Services (Continued)*

Name	Protocol	Port(s)
svc-sip-tcp	tcp	5060
svc-kerberos	udp	88
svc-pop3	tcp	110
svc-adp	udp	8200
svc-noe	udp	32512
svc-noe-oxo	udp	5000
svc-dns	udp	53
svc-msrpc-tcp	tcp	135 139
svc-rtsp	tcp	554
svc-http	tcp	80
svc-vocera	udp	5002
svc-nterm	tcp	1026 1028
svc-sip-udp	udp	5060
svc-papi	udp	8211
svc-ftp	tcp	21
svc-natt	udp	4500
svc-svp	119	0
svc-gre	gre	0
svc-smtp	tcp	25
svc-smb-udp	udp	445
svc-esp	esp	0
svc-bootp	udp	67 69
svc-snmp	udp	161
svc-icmp	icmp	0
svc-ntp	udp	123
svc-msrpc-udp	udp	135 139
svc-ssh	tcp	22
svc-h323-tcp	tcp	1720
svc-h323-udp	udp	1718 1719
svc-http-proxy1	tcp	3128
svc-http-proxy2	tcp	8080
svc-http-proxy3	tcp	8888
svc-sips	tcp	5061
svc-v6-dhcp	udp	546 547

Table 170 *Predefined Network Services (Continued)*

Name	Protocol	Port(s)
svc-v6-icmp	icmp	0
any	any	0

Policies

The following are predefined policies.

Table 171 *Predefined Policies*

Predefined Policy	Description
ip access-list session allowall any any any permit	An "allow all" firewall rule that permits all traffic.
ip access-list session control user any udp 68 deny any any svc-icmp permit any any svc-dns permit any any svc-papi permit any any svc-cfgm-tcp permit any any svc-adp permit any any svc-tftp permit any any svc-dhcp permit any any svc-natt permit	Controls traffic—Apply to untrusted wired ports in order to allow Dell APs to boot up. NOTE: In most cases wired ports should be made "trusted" when attached to an internal network.
ip access-list session captiveportal user alias mswitch svc-https dst-nat 8081 user any svc-http dst-nat 8080 user any svc-https dst-nat 8081 user any svc-http-proxy1 dst-nat 8088 user any svc-http-proxy2 dst-nat 8088 user any svc-http-proxy3 dst-nat 8088	Enables Captive Portal authentication. 1. Any HTTPS traffic destined for the controller will be NATed to port 8081, where the captive portal server will answer. 2. All HTTP traffic to any destination will be NATed to the controller on port 8080, where an HTTP redirect will be issued. 3. All HTTPS traffic to any destination will be NATed to the controller on port 8081, where an HTTP redirect will be issued. 4. All HTTP proxy traffic will be NATed to the controller on port 8088. NOTE: In order for captive portal to work properly, DNS must also be permitted. This is normally done in the "logon-control" firewall rule.
ip access-list session cplogout user alias mswitch svc-https dst-nat 8081	Used to enable the captive portal "logout" window. If the user attempts to connect to the controller on the standard HTTPS port (443) the client will be NATed to port 8081, where the captive portal server will answer. If this rule is not present, a wireless client may be able to access the controller's administrative interface.
ip access-list session vpnlogon any any svc-ike permit any any svc-esp permit any any svc-l2tp permit any any svc-pptp permit any any svc-gre permit	This policy permits VPN sessions to be established to any destination. IPsec (IKE, ESP, and L2TP) and PPTP (PPTP and GRE) are supported.

Table 171 *Predefined Policies (Continued)*

Predefined Policy	Description
ip access-list session ap-acl any any udp 5000 any any udp 5555 any any svc-gre permit any any svc-syslog permit any user svc-snmp permit user any svc-snmp-trap permit user any svc-ntp permit	This is a policy for internal use and should not be modified. It permits APs to boot up and communicate with the controller.
ip access-list session validuser any any any permit	This firewall rule controls which users will be added to the user-table of the controller through untrusted interfaces. Only IP addresses permitted by this ACL will be admitted to the system for further processing. If a client device attempts to use an IP address that is denied by this rule, the client device will be ignored by the controller and given no network access. You can use this rule to restrict foreign IP addresses from being added to the user-table. This policy should not be applied to any user role, it is an internal system policy.
ip access-list session vocera-acl any any svc-vocera permit queue high	Use for Vocera VoIP devices to automatically permit and prioritize Vocera traffic.
ip access-list session icmp-acl any any svc-icmp permit	Permits all ICMP traffic.
ip access-list session sip-acl any any svc-sip-udp permit queue high any any svc-sip-tcp permit queue high	Use for SIP VoIP devices to automatically permit and prioritize all SIP control and data traffic.
ip access-list session https-acl any any svc-https permit	Permits all HTTPS traffic.
ip access-list session dns-acl any any svc-dns permit	Permits all DNS traffic.
ip access-list session logon-control user any udp 68 deny any any svc-icmp permit any any svc-dns permit any any svc-dhcp permit any any svc-natt permit	The default pre-authentication role that should be used by all wireless clients. Prohibits the client from acting as a DHCP server. Permits all ICMP, DNS, and DHCP. Also permits IPsec NAT-T (UDP 4500). Remove NAT-T if not needed.
ip access-list session srcnat user any any src-nat	This policy can be used to source-NAT all traffic. Because no NAT pool is specified, traffic that matches this policy will be source NATed to the IP address of the controller.
ip access-list session skinny-acl any any svc-sccp permit queue high	Use for Cisco Skinny VoIP devices to automatically permit and prioritize VoIP traffic.
ip access-list session tftp-acl any any svc-tftp permit	Permits all TFTP traffic.
ip access-list session guest	This policy is not used.
ip access-list session dhcp-acl any any svc-dhcp permit	Permits all DHCP traffic. If DHCP is not allowed, clients will not be able to request or renew IP addresses.
ip access-list session http-acl any any svc-http permit	Permits all HTTP traffic.

Table 171 *Predefined Policies (Continued)*

Predefined Policy	Description
ip access-list session svp-acl any any svc-svp permit queue high user host 224.0.1.116 any permit	Use for Spectralink VoIP devices to automatically permit and prioritize Spectralink Voice Protocol (SVP).
ip access-list session noe-acl any any svc-noe permit queue high	Use for Alcatel NOE VoIP devices to automatically permit and prioritize NOE traffic.
ip access-list session h323-acl any any svc-h323-tcp permit queue high any any svc-h323-udp permit queue high	Use for H.323 VoIP devices to automatically permit and prioritize H.323 traffic.
ipv6 access-list session v6-control user any udp 68 deny any any svc-v6-icmp permit any any svc-v6-dhcp permit any any svc-dns permit any any svc-tftp permit	Provides equivalent functionality to the "control" policy, but for IPv6 clients.
ipv6 access-list session v6-icmp-acl any any svc-v6-icmp permit	Permits all ICMPv6 traffic.
ipv6 access-list session v6-https-acl any any svc-https permit	Permits all IPv6 HTTPS traffic.
ipv6 access-list session v6-dhcp-acl any any svc-v6-dhcp permit	Permits all IPv6 DHCP traffic.
ipv6 access-list session v6-dns-acl any any svc-dns permit	Permits all IPv6 DNS traffic.
ipv6 access-list session v6-allowall any any any permit	Permits all IPv6 traffic.
ipv6 access-list session v6-http-acl any any svc-http permit	Permits all IPv6 HTTP traffic.
ipv6 access-list session v6-tftp-acl any any svc-tftp permit	Permits all IPv6 TFTP traffic.
ipv6 access-list session v6-logon-control user any udp 68 deny any any svc-v6-icmp permit any any svc-v6-dhcp permit any any svc-dns permit	Provides equivalent functionality to the "logon-control" policy, but for IPv6 clients.

Roles

The following are predefined roles.

NOTE: If you upgrade from a previous ArubaOS release, your existing configuration may have additional or different predefined roles. The information in this section only describes the predefined roles for this release.

Table 172 *Predefined Roles*

Predefined Role	Description
user-role ap-role session-acl control session-acl ap-acl	This is an internal role and should not be edited.
user-role default-vpn-role session-acl allowall ipv6 session-acl v6-allowall	This is the default role used for VPN-connected clients. It is referenced in the default "aaa authentication vpn" profile.
user-role voice session-acl sip-acl session-acl noe-acl session-acl svp-acl session-acl vocera-acl session-acl skinny-acl session-acl h323-acl session-acl dhcp-acl session-acl tftp-acl session-acl dns-acl session-acl icmp-acl	This role can be applied to voice devices in order to automatically permit and prioritize all VoIP protocols.
user-role guest session-acl http-acl session-acl https-acl session-acl dhcp-acl session-acl icmp-acl session-acl dns-acl ipv6 session-acl v6-http-acl ipv6 session-acl v6-https-acl ipv6 session-acl v6-dhcp-acl ipv6 session-acl v6-icmp-acl ipv6 session-acl v6-dns-acl	This is a default role for guest users. It permits only HTTP, HTTPS, DHCP, ICMP, and DNS for the guest user. To increase security, a "deny" rule for internal network destinations could be added at the beginning.
user-role guest-logon captive-portal default session-acl logon-control session-acl captiveportal	This role is used as the pre-authentication role for guest SSIDs. It allows control traffic such as DNS, DHCP, and ICMP, and also enables captive portal.
user-role <ssid>-guest-logon captive-portal default session-acl logon-control session-acl captiveportal	This role is only generated when creating a new WLAN using the WLAN Wizard. The WLAN Wizard creates this role when captive portal is enabled. This is the initial role that a guest will be placed in prior to captive portal authentication. By using a different guest logon role for each SSID, it is possible to enable multiple captive portal profiles with different customization.
user-role stateful-dot1x	This is an internal role used for Stateful 802.1x. It should not be edited.
user-role authenticated session-acl allowall ipv6 session-acl v6-allowall	This is a default role that can be used for authenticated users. It permits all IPv4 and IPv6 traffic for users who are part of this role.
user-role logon session-acl logon-control session-acl captiveportal session-acl vpnlogon ipv6 session-acl v6-logon-control	This is a system role that is normally applied to a user prior to authentication. This applies to wired users and non-802.1x wireless users. The role allows certain control protocols such as DNS, DHCP, and ICMP, and also enables captive portal and VPN termination/pass through. The logon role should be edited to provide only the required services to a pre-authenticated user. For example, VPN pass through should be disabled if it is not needed.

Table 172 *Predefined Roles (Continued)*

Predefined Role	Description
user-role <ssid>-logon session-acl control session-acl captiveportal session-acl vpnlogon	This role is only generated when creating a new WLAN using the WLAN Wizard. The WLAN Wizard creates this role when captive portal is enabled and a PEFNG license is installed. This is the initial role that a client will be placed in prior to captive portal authentication. By using a different logon role for each SSID, it is possible to enable multiple captive portal profiles with different customization.
user-role <ssid>-captiveportal-profile	When utilizing the WLAN Wizard and you do not have a PEF NG installed and you are configuring an Internal or Guest WLAN with captive portal enabled, the controller creates an implicit user role with the same name as the captive portal profile, <ssid>-captiveportal-profile. This implicit user role allows only DNS and DHCP traffic between the client and network and directs all HTTP or HTTPS requests to the captive portal. You cannot directly modify the implicit user role or its rules. Upon authentication, captive portal clients are allowed full access to their assigned VLAN. Once the WLAN configuration is pushed to the controller, the WLAN wizard will associate the new role with the initial user role that you specify in the AAA profile. This role will not be visible to the user in the WLAN wizard.

Default Management User Roles

The ArubaOS software includes predefined management user roles.

NOTE: If you upgrade from a previous ArubaOS release, your existing configuration may have different management roles. The information in this section only describes the predefined management roles for this release.

Table 173 *Predefined Management Roles*

Predefined Role	Permissions
root	This role permits access to all management functions (commands and operations) on the controller.
read-only	This role permits access to CLI show commands or WebUI monitoring pages only.
guest-provisioning	This role permits access to configuring guest users in the controller's internal database only. This user only has access via the WebUI to create guest accounts; there is no CLI access. Guest-provisioning tasks include creating or generating the user name and password for a guest account as well as configuring when the account expires.
location-api-mgmt	This role permits access to location API information and the CLI; however, you cannot use any CLI commands. This role does not permit access to the WebUI. Using a third-party location appliance, you can gather information about the location of 802.11 stations. To log in to the controller using a third-party location appliance, enter: http[s]://<ipaddress>[:port]/screens/wms/wms.login. You are prompted to enter your username and password (for example, the username and password associated with the location API management role). Once authenticated, you can use an API call to request location information from the controller, for example: http[s]://<ipaddress>[:port]/screens/wms/wms.cgi?opcode=wlm-get-spot&campus-name=<campus id>&building-name<building id>&mac=<client1>,<client2>....

Table 173 *Predefined Management Roles (Continued)*

Predefined Role	Permissions
network-operations	This role supports a subset of show, configuration, action, and database commands that are used to monitor the controller. You can log into the CLI; however, you can only use a subset of CLI commands to monitor the controller. This role permits the following WebUI pages and associated CLI commands: As a network-operations user, commands with an asterisk (*) are hidden in the CLI but are executed and visible from the WebUI. Plan Page • You can move APs on the floor plan and save their new location. • You cannot change or modify the AP configuration. Reports Page • You can view all of the available reports. Events Page • You can view all of the available events. Monitoring Page You can view the reports created by the following CLI commands: • show keys all • show mobility-managers • show roleinfoshow license* • show ap essid • DB:opcode=cr-load Monitoring > Network > Network Summary You can view the reports created by the following CLI commands: • show interface vlan <id> • show interface loopback • show datapath utilization • show aaa state configuration • show user-table unique • show aaa authentication-server all • show switches summary • show ap blacklist-clients • show wlan-ap-count type access-points* • show wlan-ap-count type air-monitor* • show wlan-ap-count type secure-access* • show user-table verboseshow ap database unprovisioned page <page> • show ap-group default • show wlan virtual-ap • show rf dot11a-radio-profile • show rf dot11g-radio-profile • show ap wired-ap-profile • show ap enet-link-profile • show ap system-profile • show wlan voip-cac-profile • show wlan traffic-management-profile • show ap regulatory-domain-profile • show ap snmp-profile • show rf optimization-profile • show rf event-thresholds-profile • show ids profile • show rf arm-profile • show ap association bssid

Table 173 *Predefined Management Roles (Continued)*

Predefined Role	Permissions
network-operations (continued)	Monitoring > Network > All Access Points Monitoring > Network > All Wired Access Points You can view the reports created by the following CLI commands: • DB:opcode=monitor-summary • DB:opcode=cr-load • DB:opcode=wlm-search&class=probes&start • DB:opcode=wlm-search&class=amii • DB:opcode=monitor-get-all-gps&status=any • show ap-group • show vlan status Monitoring > Controller > Controller Summary You can view the reports created by the following CLI commands: • show switches • show switches summary Monitoring > Controller > Air Monitors You can view the reports created by the following CLI commands: • show wlan-ap start* Monitoring > Controller > Clients You can view the reports created by the following CLI commands: • show ip mobile host • show ip mobile trail {<ipaddr> | <macaddr>} • show esi groups • show esi servers • show esi ping • show esi parser stats • show private port status* • show vlan • show port stats • show spanning-tree interface fastethernet <slot/port> • show interface fastethernet <slot/port> counters • clear counters fastethernet <slot/port> • show snmp trap-queue <page> Monitoring > Controller > Clients > Packet Capture Monitoring > Controller > Clients > Locate Monitoring > Controller > Clients > Debug You can view the reports created by the following CLI commands: • aaa user debug mac Monitoring > Controller > Clients > Disconnect You can view the reports created by the following CLI commands: • stm kick-off-sta <macaddr> • aaa user logout <ipaddr>

Table 173 *Predefined Management Roles (Continued)*

Predefined Role	Permissions
network-operations (continued)	Monitoring > Controller > Clients > Blacklist You can view the reports created by the following CLI commands: • stm add-blacklist-client <macaddr> • aaa user delete {<ipaddr> | all | mac <macaddr> | name <username> | role <role>} Monitoring > Controller > Blacklist Clients You can view the reports created by the following CLI commands: • stm remove-blacklist-client <macaddr> Monitoring > Controller > External Services Interface You can view the reports created by the following CLI commands: • show esi groups • show esi servers • show esi ping • show esi parser stats Monitoring > Controller > Ports You can view the reports created by the following CLI commands: • show model-switch-internal* • show slots • show private port status* • show vlan Monitoring > Controller > Inventory You can view the reports created by the following CLI commands: • show keys Monitoring > WLAN You can view the reports created by the following CLI commands: • DB:opcode=get-permissions • DB:opcode=cr-load • show switches • show switches summary Monitoring > Voice You can view the reports created by the following CLI commands: • show ap association voip-only • show ap active voip-only • show voice call-counters • show voice client status • show voice call-quality • show voice call-density • show voice call-cdrs • show voice call-perf

Default Open Ports

By default, Dell controllers and access points treat ports as untrusted. However, certain ports are open by default only on the trusted side of the network. These open ports are listed in Table 174.

Table 174 *Default (Trusted) Open Ports*

Port Number	Protocol	Where Used	Description
17	TCP	controller	This is use for certain types of VPN clients that accept a banner (QOTD). During normal operation, this port will only accept a connection and immediately close it.

Table 174 *Default (Trusted) Open Ports (Continued)*

Port Number	Protocol	Where Used	Description
21	TCP	controller	FTP server for AP6X software download.
22	TCP	controller	SSH
23	TCP	AP and controller	Telnet is disabled by default but the port is still open.
53	UDP	controller	Internal domain.
67	UDP	AP (and controller if DHCP server is configured)	DHCP server.
68	UDP	AP (and controller if DHCP server is configured)	DHCP client.
69	UDP	controller	TFTP
80	TCP	AP and controller	HTTP Used for remote packet capture where the capture is saved on the Access Point. Provides access to the WebUI on the controller.
123	UDP	controller	NTP
161	UDP	AP and controller	SNMP. Disabled by default.
443	TCP	controller	Used internally for captive portal authentication (HTTPS) and is exposed to wireless users. A default self-signed certificate is installed in the controller. Users in a production environment are urged to install a certificate from a well known CA such as Verisign. Self-signed certs are open to man-in-the-middle attacks and should only be used for testing. Required for VIA: During the initializing phase, VIA uses HTTPS connections to perform trusted network and captive portal checks against the controller. It is mandatory that you enable port 443 on your network to allow VIA to perform these checks
500	UDP	controller	ISAKMP
514	UDP	controller	Syslog
1701	UDP	controller	L2TP
1723	TCP	controller	PPTP
2300	TCP	controller	Internal terminal server opened by `telnet soe` command.
3306	TCP	controller	Remote wired MAC lookup.
4343	TCP	controller	HTTPS. A different port is used from 443 in order to not conflict with captive portal. A default self-signed certificate is installed in the controller. Users in a production environment are urged to install a certificate from a well known CA such as Verisign. Self-signed certs are open to man-in-the-middle attacks and should only be used for testing
4500	UDP	controller	sae-urn Required for VIA: During the initializing phase, VIA uses HTTPS connections to perform trusted network and captive portal checks against the controller. It is mandatory that you enable port 4500 on your network to allow VIA to perform these checks
8080	TCP	controller	Used internally for captive portal authentication (HTTP-proxy). This port is not exposed to wireless users.

Table 174 *Default (Trusted) Open Ports (Continued)*

Port Number	Protocol	Where Used	Description
8081	TCP	controller	Used internally for captive portal authentication (HTTPS). Not exposed to wireless users. A default self-signed certificate is installed in the controller. Users in a production environment are urged to install a certificate from a well known CA such as Verisign. Self-signed certs are open to man-in-the-middle attacks and should only be used for testing.
8082	TCP	controller	Used internally for single sign-on authentication (HTTP). Not exposed to wireless users.
8083	TCP	controller	Used internally for single sign-on authentication (HTTPS). Not exposed to wireless users.
8088	TCP	controller	For internal use.
8200	UDP	controller	Aruba Discovery Protocol (ADP).
8211	UDP	controller	For internal use.
8888	TCP	controller	Used for HTTP access.

Appendix D

802.1x Configuration IAS Windows

This appendix provides examples of how to configure a Microsoft Internet Authentication Server, and a Windows XP wireless client for 802.1x authentication with the controller (see Chapter 10, "802.1x Authentication" on page 285 for information about configuring the controller).

For more information about configuring computers in a Windows environment for PEAP-MS-CHAPv2 and EAP-TLS authentication, see the Microsoft document *Step-by-Step Guide for Setting Up Secure Wireless Access in a Test Lab*, available from Microsoft's Download Center (at www.microsoft.com/downloads). Additional information on client configuration is available at http://www.microsoft.com/technet/prodtechnol/winxppro/maintain/wificomp.mspx#EQGAC.

This chapter describes the following topics:

Configuring Microsoft IAS

Microsoft Internet Authentication Server (IAS) provides authentication functions for the wireless network. IAS implements the RADIUS protocol, which is used between the Dell controller and the server. IAS uses Active Directory as the database for looking up computers, users, passwords, and group information.

RADIUS Client Configuration

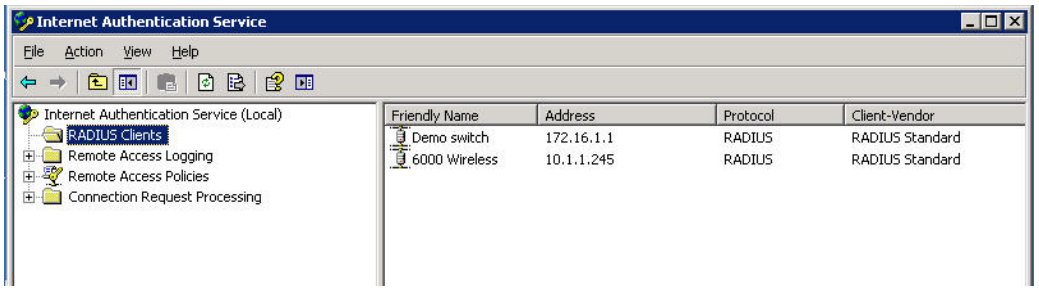
Each device in the network that needs to authenticate to a RADIUS server must be configured as a RADIUS client. You must configure the Dell controller as a RADIUS client.

NOTE: The steps to perform this task may very depending on the version of Windows currently running on your server. For complete details on configuring Windows IAS, see the Windows documentation available (at www.microsoft.com/downloads).

To configure a RADIUS client:

1. From your windows server, navigate to Start > Settings > Control Panel > Administrative Tools>Internet Authentication Service.
2. In the Internet Authentication Service window, select RADIUS Clients.

Figure 197 *IAS RADIUS Clients*



3. To configure a RADIUS client, select Action > New RADIUS Client from the menu at the top of the window.

4. In the New RADIUS Client dialog window, enter the name and IP address for the controller. Click Next.
5. In the next window that appears, enter and confirm a shared secret. The shared secret is configured on both the RADIUS server and client, and ensures that an unauthorized client cannot perform authentication against the server.
6. Click Finish.

Remote Access Policies

The IAS policy configuration defines all policies related to wireless access, including time of day restrictions, session length, authentication type, and group-related policies. See Microsoft product documentation for detailed descriptions and explanations of IAS policy settings.

Active Directory Database

The Active Directory database serves as the master authentication database for both the wired and wireless networks. The IAS authentication server bases all authentication decisions on information in the Active Directory database. IAS is normally used as an authentication server for remote access and thus looks to the Active Directory "Remote Access" property to determine whether authentication requests should be allowed or denied. This property is set on a per-user or per-computer basis. For a user or computer to be allowed access to the wireless network, the remote access property must be set to "Allow access".

The authentication policy configured in IAS depends on the group membership of the computer or user in Active Directory. These policies are responsible for passing group information back to the controller for use in assigning computers or users to the correct role, which determines their network access privileges. When the IAS server receives a request for authentication, it compares the request with the list of remote access policies. The first policy to match the request is executed; additional policies are not searched.

Configuring Policies

The policies in this 802.1x authentication example are designed to work by examining the username portion of the authentication request, searching the Active Directory database for a matching name, and then examining the group membership for a computer or user entry that matches. For example, the following policies would operate with the controller configuration shown in "Authentication with an 802.1x RADIUS Server" on page 297:

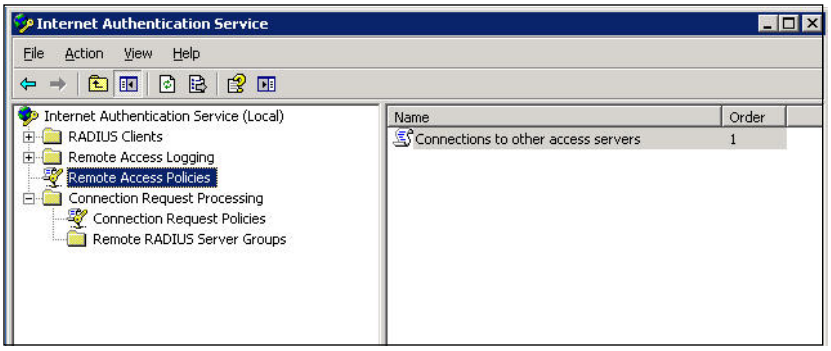
- The Wireless-Computers policy matches the "Domain Computers" group. This group contains the list of all computers that are members of the domain. This group is used for all computers to authenticate to the network.
- The Wireless-Student policy matches the "Student" group. This group is used for all student users.
- The Wireless-Faculty policy matches the "Faculty" group. This group is used for all faculty users.
- The Wireless-Sysadmin policy matches the "Sysadmin" group. This group is used for system administrators.

In addition to matching the respective group, the policy also specifies that the request must be from an 802.11 wireless device. The policy instructs IAS to grant remote access permission if all the conditions specified in the policy match, a valid username/password is supplied, the user's or computer's remote access permission is set to "Allow".

To configure a policy:

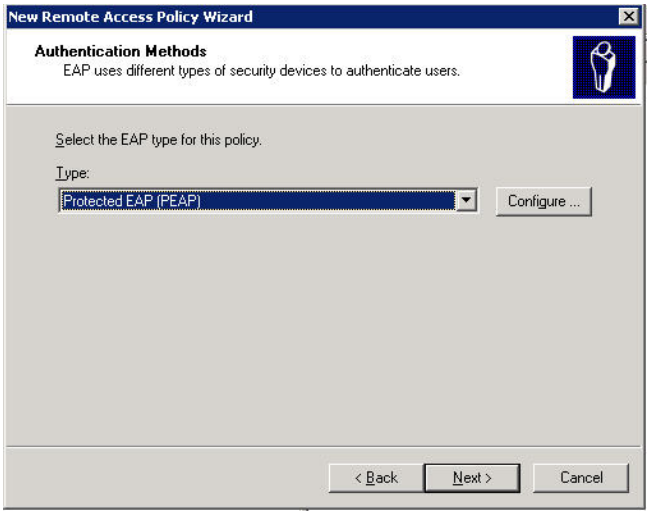
1. In the Internet Authentication Service window, select Remote Access Policies.

Figure 198 *IAS Remote Access Policies*



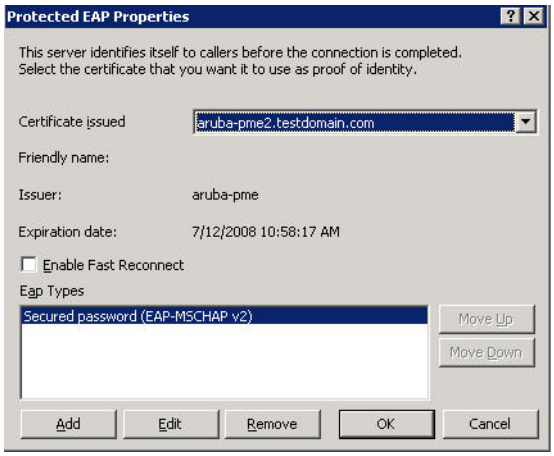
2. To add a new policy, select Action > New Remote Access Policy. This launches a wizard that steps you through configuring the remote access policy.
3. Click Next on the initial wizard window to proceed.
4. Enter the name for the policy, for example, “Wireless Computers” and click Next.
5. In the Access Method window, select the Wireless option, then click Next.
6. in the User or Group Access window, select Group and click Add to add the group of users to which this policy applies (for example, “Domain Computers”). Click Next.
7. For Authentication Methods, select either Protected EAP (PEAP) or Smart Card or other certificate.
8. Click Configure to select additional properties.

Figure 199 *Policy Configuration Wizard—Authentication Methods*



9. Select a server certificate. The list of available certificates is taken from the computer certificate store on which IAS is running. In this case, a self-signed certificate was generated by the local certificate authority and installed on the IAS system. On each wireless client device, the local certificate authority is added as a trusted certificate authority, thus allowing this certificate to be trusted.

Figure 200 *Policy Configuration Wizard—PEAP Properties*



10. For PEAP, select the “inner” authentication method. The authentication method shown is MS-CHAPv2. (Because password authentication is being used on this network, this is the only EAP authentication type that should be selected.)

    You can also enable fast reconnect in this screen. If you enable fast reconnect here and also on client devices, additional time can be saved when multiple authentications take place (such as when clients are roaming between APs frequently) because the server will keep the PEAP encrypted tunnel alive.

11. Click OK.

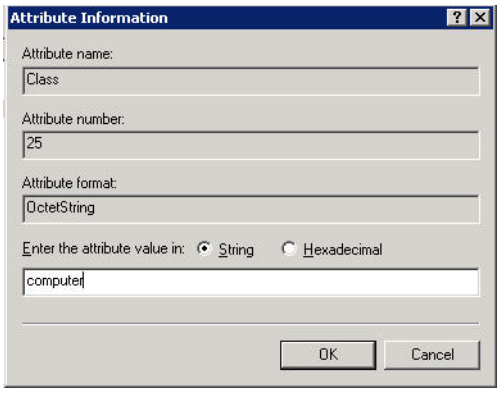
Configuring RADIUS Attributes

In the configuration example for 802.1x, the controller restricts network access privileges based on the group membership of the computer or user. In order for this to work, the controller must be told to which group the user belongs. This is accomplished using RADIUS attributes returned by the authentication server.

To configure RADIUS attributes:

1. In the Internet Authentication Service window, select Remote Access Policies.
1. Open the remote access policy you want to configure, and select the Advanced tab.
2. Click Add to configure an attribute.
3. Select the Class attribute.
4. Enter the value for this attribute. For example, for the Wireless-Computers policy, the Class attribute returned to the controller should contain the value “computer”.

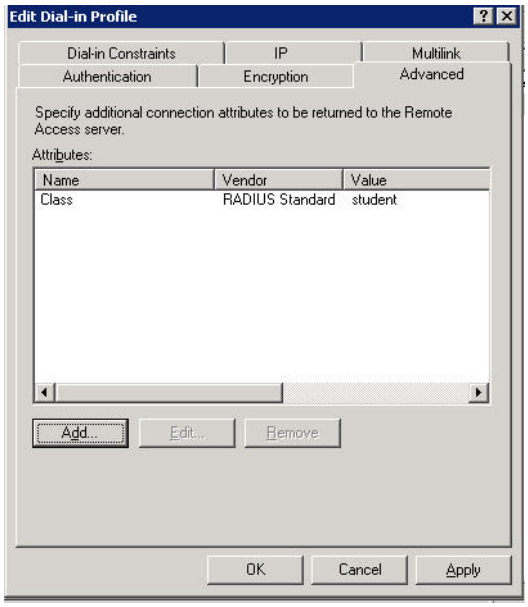
Figure 201 *RADIUS class Attribute Configuration*



5. Click OK.
6. Click OK.

Another example of a Class attribute configuration is shown below for the “Wireless-Student” policy. This policy returns the RADIUS attribute Class with the value “student” upon successful completion.

Figure 202 *Example RADIUS Class Attribute for “student”*



Configure Management Authentication using IAS

Before you can configure the controller for management authentication using Windows IAS, you must perform the following steps to configure a Windows IAS RADIUS server on your Windows client.

NOTE: The steps to perform this task may very depending on the version of Windows currently running on your server. For complete details on configuring Windows IAS, see the Windows documentation available (at www.microsoft.com/downloads).

1. From your windows server, navigate to Start > Settings > Control Panel > Administrative Tools>Internet Authentication Service. The Internet Authentication Service window opens.
2. Verify that the Internet Authentication Service is running. If it is running, a green arrow icon will appear at the top of this window. If it has stopped, a red stop icon will appear. If the service is not active, click the green arrow icon to restart the service.
3. From the Internet Authentication Service window, right click the Radius Clients folder and select New Radius Client. The New RADIUS Client window opens.
4. Define a friendly name for the RADIUS client and enter the controller’s IP address or DNS name. Click Next.
5. Enter and confirm the Shared Secret key for the controller then click Finish.

Next, create a remote policy for your new RADIUS client.

1. From the Internet Authentication Service window, right click the Remote Access Policies folder and select New Remote Access Policy.
2. The New Remote Access Policy Wizard opens. Click Next on the first window to start the wizard.
3. Select Use the wizard to set up a typical Policy for a common scenario and enter a name for the policy, e.g Remote-Policy. Click Next.
4. In the Access Method window of the wizard, select the method you will use to gain management access to the network. Click Next.

5. In the User or Group Access window of the wizard, select either user or group, depending upon how your user permissions are defined. Click Next.

6. In the Authentication Method window, click the Type drop-down list and select Protected EAP (PEAP). Click Next.

7. Click Finish.

Now you must define properties for the remote policy you just created.

1. 1. In the Internet Authentication Service window, click the Remote Access Policy icon. All configured remote access policies will appear in the right window pane.
2. Right-click the policy you just created, and select Properties. The Properties window opens.
3. Select the Grant remote access permission radio button, and click Edit Profile. The Edit Profile window opens.
4. Click the Authentication tab and select the authentication methods that include MS-CHAP, MS-CHAP V2 and PAP.
5. Click Apply.
6. Click the Advanced tab.
7. Click Add. The Add Attribute window opens.
8. Scroll down the list of attributes and select Vendor-Specific, then click Add. The MultiValued Attribute Information window appears.
9. Click Add again.
10. Enter the vendor code 14823 and select the option Yes, It conforms.
11. Click Configure Attribute. The Configure VSA window opens.
12. In the Vendor-assigned attribute number field, enter 3.
13. In the Attribute value field, enter 7.
14. Click OK to save your settings.
15. Click Apply.
16. Click Apply.

Now that you have defined your remote policy properties, you must create a user entry in the Windows active directory. The steps to complete this process will vary, depending on the version of Windows currently running on your server. The procedure below should be used only as a guideline.

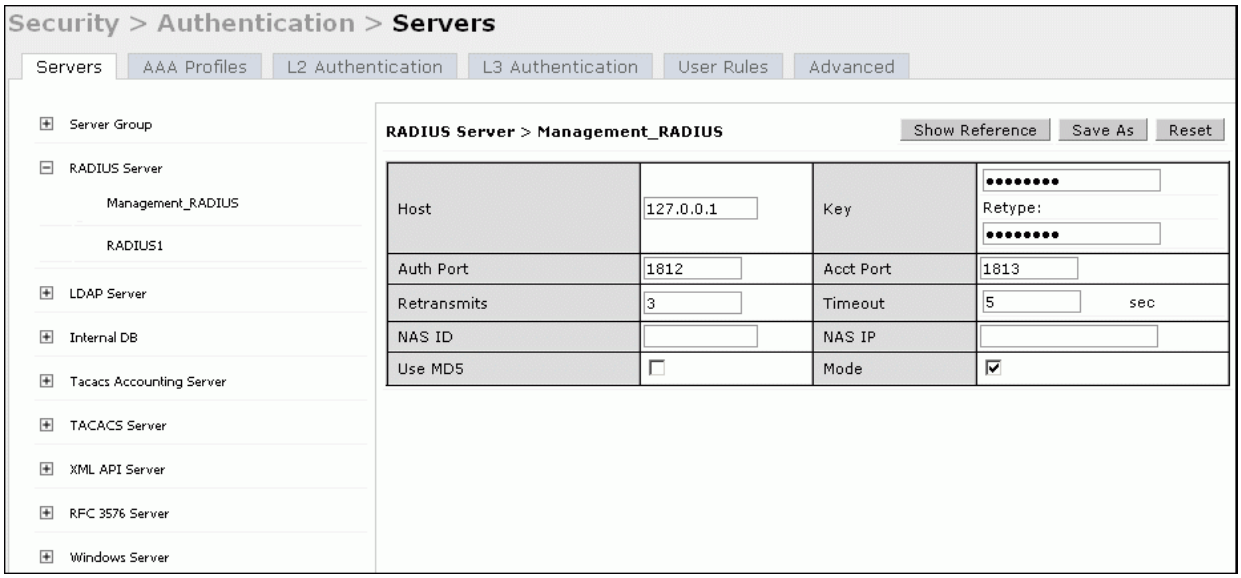
1. Open the “Active Directory Users and Computers” tool on your Windows server.
2. Create a new user entry on the Windows Active directory.
3. Once you have created the new user, right-click the user name and select Properties.
4. Click the Dial-in tab and select “Allow access” for the user.
5. Click Ok to save your settings.

Configure the Controller to use IAS Management Authentication

The following procedure describes the steps to configure the controller to user IAS management authentication.

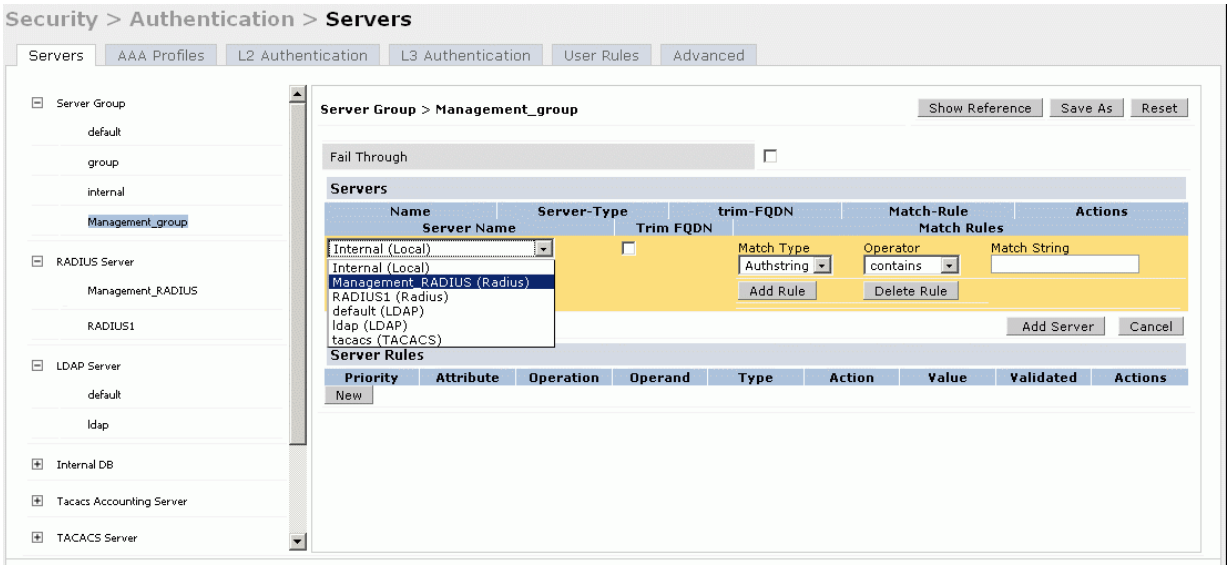
1. Access the controller WebUI and navigate to Configuration>Authentication.
2. Select the Servers tab.
3. Select RADIUS Server.
4. Enter a name for the RADIUS server in the entry field in the right window pane, then click Add.
5. Select the RADIUS server you just created from the list of servers in the left window pane to display configuration details for that server.

Figure 203 *Configuring a RADIUS Server for IAS Management Authentication*



6. In the Host field, enter the IP address of the RADIUS server you want to use for Management Authentication.
7. Enter and then retype the shared key for the server.
8. Click Apply
9. Select Server Group from the server list on the left window pane.
10. In the entry blank on the right window pane, enter the name of a new server group (for example, “Management_group”), then click Add.
11. Click Apply.
12. Select the server group you just created from the list of server groups in the left window pane.
13. In the Servers section, click New.
14. Click the Server Name drop-down list and select your RADIUS server.

Figure 204 *Configuring a Server Group for IAS Management Authentication*



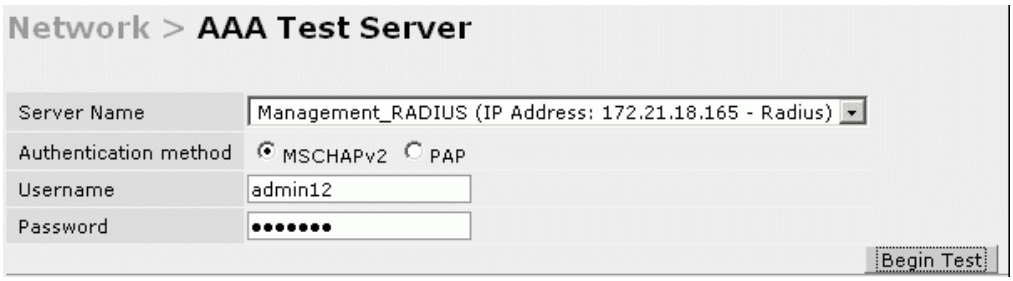
15. Click Apply.

Verify Communication between the Controller and the RADIUS Server

After you have configured your Windows Server and the Dell controller for Windows IAS Management Authentication, you can verify that the controller and server are communicating.

1. Navigate to Diagnostics>AAA Test Server.
2. Click the Server Name drop-down list and select the RADIUS server.
3. Select either MSCHAP-V2 or PAP as the authentication method.
4. Enter the user name and password in the Username and Password fields.
5. Click Begin Test.
6. If the controller displays the words Authentication Successful, then the controller is able to communicate with the RADIUS server.

Figure 205 *Testing a RADIUS Server*



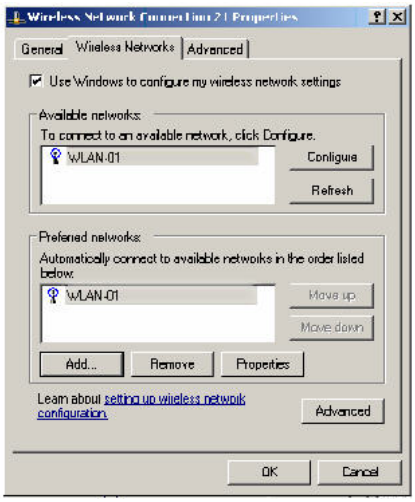
Window XP Wireless Client Example Configuration

This section shows an example of how to configure a Windows XP wireless client using Windows XP's Wireless Zero Configuration service.

NOTE: The following steps apply to a computer running Windows XP Professional Version 2002 with Service Pack 2. To configure a wireless client on other Windows platforms, see your Microsoft Windows documentation.

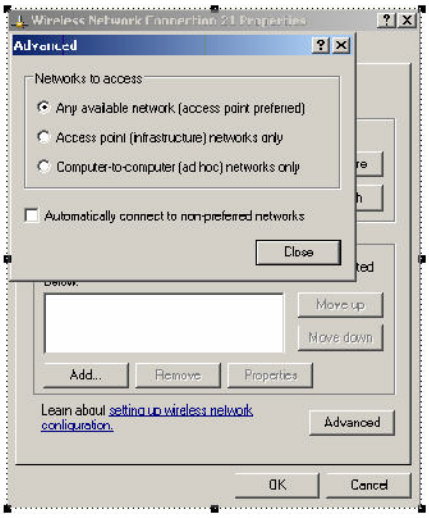
1. On the desktop, right-click My Network Places and select Properties.
2. In the Network Connections window, right-click on Wireless Network Connection and select Properties.
3. Select the Wireless Networks tab. This screen displays the available wireless networks and the list of preferred networks. Windows connects to the preferred networks in the order in which they appear in the list.

Figure 206 *Wireless Networks*



4. Click the Advanced button to display the Networks to access window.

Figure 207 *Networks to Access*



This window determines what types of wireless networks the client can access. By default, Windows connects to any type of wireless network. Make sure that the option Computer-to-computer (ad hoc) networks only is *not* selected. Click Close.

5. In the Wireless Networks tab, click Add to add a wireless network.
6. Click the Association tab to enter the network properties for the SSID.

NOTE: This tab configures the authentication and encryption used between the wireless client and the Dell user-centric network. Therefore, the settings for the SSID that you configure on the client must *match* the configuration for the SSID on the controller.

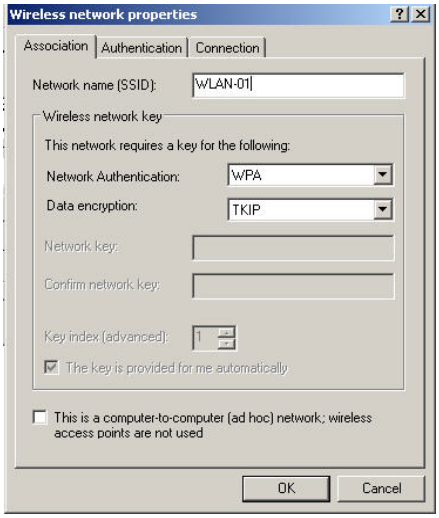
- For an SSID using dynamic WEP, enter the following:
  - Network Authentication: Open
  - Data Encryption: WEP
  - Select the option "The key is provided for me automatically". Each client will use a dynamically-generated WEP key that is automatically derived during the 802.1x process.
- For an SSID using WPA, enter the following:
  - Network Authentication: WPA
  - Data Encryption: TKIP
- For an SSID using WPA-PSK, enter the following:
  - Network Authentication: WPA-PSK
  - Data Encryption: TKIP
  - Enter the preshared key.
- For an SSID using WPA2, enter the following:
  - Network Authentication: WPA2
  - Data Encryption: AES
- For an SSID using WPA2-PSK, enter the following:
  - Network Authentication: WPA2-PSK
  - Data Encryption: AES

- Enter the preshared key

NOTE: Do *not* select the option "This is a computer-to-computer (ad hoc) network; wireless access points are not used".

Figure 208 shows the configuration for the SSID WLAN-01 which uses WPA network authentication with TKIP data encryption.

Figure 208 *Wireless Network Association*

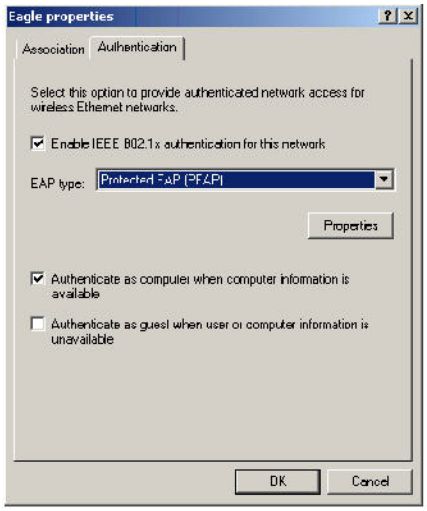


7. Click the Authentication tab to enter the 802.1x authentication parameters for the SSID. This tab configures the EAP type used between the wireless client and the authentication server.

   Configure the following, as shown in Figure 209:

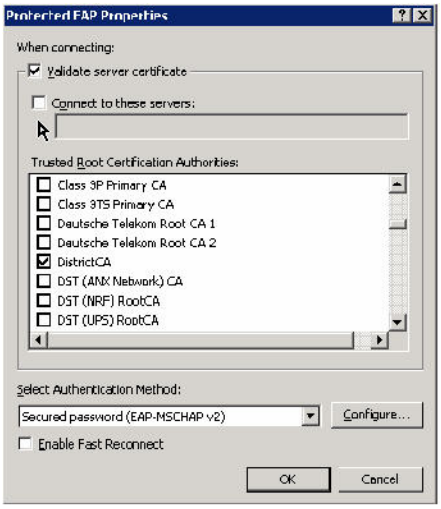
   - Select Enable IEEE 802.1x authentication for this network.
   - Select Protected EAP (PEAP) for the EAP type.
   - Select Authenticate as computer when computer information is available. The client will perform computer authentication when a user is not logged in.
   - Do not select Authenticate as guest when user or computer information is unavailable. The client will not attempt to authenticate as a guest.

Figure 209 *Wireless Network Authentication*



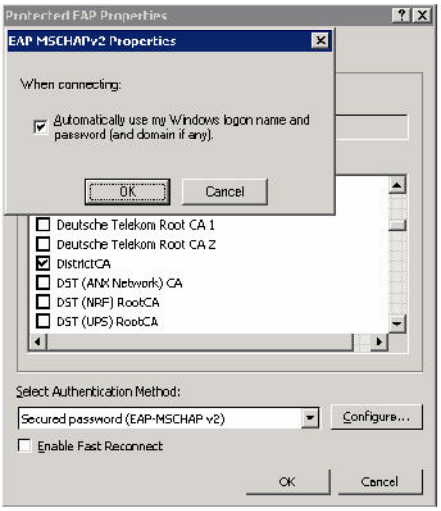
8. Under EAP type, select Properties to display the Protected EAP Properties window. Configure the client PEAP properties, as shown in Figure 210:
   - Select Validate server certificate. This instructs the client to check the validity of the server certificate from an expiration, identity, and trust perspective.
   - Select the trusted Certification Authority (CA) that can issue server certificates for the network.
   - Select Secured password (EAP-MSCHAP v2) — the PEAP "inner authentication" mechanism will be an MS-CHAPv2 password.
   - Select Enable Fast Reconnect to speed up authentication in some cases.

Figure 210 *Protected EAP Properties*



9. Under Select Authentication Method, click Configure to display the EAP-MSCHAPv2 Properties window. Select the option Automatically use my Windows logon name and password (and domain if any). This option specifies that the user's Windows logon information is used for authentication to the wireless network. This option allows the same logon credentials to be used for access to the Windows domain as well as the wireless network.

Figure 211 *EAP MSCHAPv2 Properties*



Appendix E

Internal Captive Portal

You can customize the default captive portal page through the WebUI, as detailed in Chapter 15, “Captive Portal” . This appendix discusses creating and installing a new internal captive portal page and other customization.

Creating a New Internal Web Page

You can also create your own internal web page. A custom web page must include an authentication form to authenticate a user. The authentication form can include any of the following variables listed in Table 175:

Table 175 *Web Page Authentication Variables*

Variable	Description
user	(Required)
password	(Required)
FQDN	The fully-qualified domain name (this is dependent on the setting of the controller and is supported only in Global Catalog Servers software.

The form can use either the "get" or the "post" methods, but the "post" method is recommended. The form's action must absolutely or relatively reference https://<controller_IP>/auth/index.html/u.

You can construct an authentication form using the following HTML:

```
<FORM method="post" ACTION="/auth/index.html/u">
...
</FORM>
```

A recommended option for the <FORM> element is:

```
autocomplete="off"
```

This option prevents Internet Explorer from caching the form inputs. The form variables are input using any form control method available such as INPUT, SELECT, TEXTAREA and BUTTON. Example HTML code follows.

Username:

Minimal:

```
<INPUT type="text" name="user">
```

Recommended Options:

```
accesskey="u" Sets the keyboard shortcut to 'u'
SIZE="25"Sets the size of the input box to 25
VALUE=""Ensures no default value
```

Password:

Minimal:

```
<INPUT type="password" name="password">
```

Recommended Options:

```
accesskey="p" Sets the keyboard shortcut to 'p'
SIZE="25"Sets the size of the input box to 25
VALUE=""Ensures no default value
```

FQDN:

Minimal:

```
<SELECT name=fqdn>
  <OPTION value="fqdn1" SELECTED>
  <OPTION value="fqdn2">
</SELECT>
```

Recommended Options:

```
None
```

Finally, an HTML also requires an input button:

```
<INPUT type="submit">
```

Basic HTML Example

```
<HTML>
  <HEAD>
  </HEAD>
  <BODY>
    <FORM method="post" autocomplete="off" ACTION="/auth/index.html/u">

    Username:<BR>
    <INPUT type="text" name="user" accesskey="u" SIZE="25" VALUE="">
    <BR>

    Password:<BR>
    <INPUT type="password" name="password" accesskey="p" SIZE="25"
        VALUE="">
    <BR>

    <INPUT type="submit">
    </FORM>
  </BODY>
</HTML>
```

You can find a more advanced example simply by using your browser's "view-source" function while viewing the default captive portal page.

Installing a New Captive Portal Page

You can install the captive portal page by using the Maintenance function of the WebUI.

Log into the WebUI and navigate to Configuration > Management >Captive Portal > Upload Custom Login Pages.

This page lets you upload your own files to the controller. There are different page types that you can choose:

- Captive Portal Login (top level): This type uploads the file into the controller and sets the captive portal page to reference the file that you are uploading. Use with caution on a production controller as this takes effect immediately.
- Captive Portal Welcome Page: This type uploads the file that appears after logon and before redirection to the web URL. The display of the welcome page can be disabled or enabled in the captive portal profile.
- Content: The content page type allows you to upload all miscellaneous files that you need to reference from your main captive portal login page. This can be used for images, CSS files, scripts or any other file that you need to reference. These files are uploaded into the same directory as the top level captive portal page and thus all files can be referenced relatively.

Uploaded files can be referenced using:

```
https://<controller_IP>/upload/custom/<CP-Profile-Name>/<file>
```

Displaying Authentication Error Message

This section contains a script that performs the following tasks:

- When the user is redirected to the main captive portal login when there is authentication failure, the redirect URL includes a query parameter "errmsg" which java script can extract and display.
- Store the originally requested URL in a cookie so that once the user has authenticated, they are automatically redirected to its original page. Note that for this feature to work, you need ArubaOS release 2.4.2.0 or later. If you don't want this feature, delete the part of the script shown in red.

```
<script>
{
function createCookie(name,value,days)
{
            if (days)
            {
                        var date = new Date();
                        date.setTime(date.getTime()+(days*24*60*60*1000));
                        var expires = "; expires="+date.toGMTString();
            }
            else var expires = "";
            document.cookie = name+"="+value+expires+"; path=/";
}
  var q = window.location.search;
  var errmsg = null;

  if (q && q.length > 1) {
    q = q.substring(1).split(/[=&]/);
    for (var i = 0; i < q.length - 1; i += 2) {
      if (q[i] == "errmsg") {
        errmsg = unescape(q[i + 1]);
          break;
      }
       if (q[i] == "host") {
          createCookie('url',unescape(q[i+1]),0)
        }
```

```
    }
  }

  if (errmsg && errmsg.length > 0) {
    errmsg = "<div id='errorbox'>\n" + errmsg + "\n</div>\n";
    document.write(errmsg);
  }
}
</script>
```

Reverting to the Default Captive Portal

You can reassign the default captive portal site using the "Revert to factory default settings" check box in the "Upload Custom Login Pages" section of the Maintenance tab in the WebUI.

Language Customization

The ability to customize the internal captive portal provides you with a very flexible interface to the Dell captive portal system. However, other than posting site-specific messages onto the captive portal website, the most common type of customization is likely to be language localization. This section describes a simple method for creating a native language captive portal implementation using the Dell internal captive portal system.

1. Customize the configurable parts of the captive portal settings to your liking. To do this, navigate to the Configuration > Management > Captive Portal > Customize Login Page in the WebUI:

   For example, choose a page design, upload a custom logo and/or a custom background. Also include any page text and acceptable use policy that you would like to include. Put this in your target language or else you will need to translate this at a later time.

   Ensure that Guest login is enabled or disabled as necessary by navigating to the Configuration > Security > Authentication > L3 Authentication > Captive Portal Authentication Profile page to create or edit the captive portal profile. Select or deselect "Guest Login".

2. Click Submit and then click on View Captive Portal. Check that your customization and text/html is correct, with the default interface still in English and the character set still autodetects to ISO-8859-1.

   Repeat steps 1 and 2 until you are satisfied with your page.

3. Once you have a page you find acceptable, click on View Captive Portal one more time to display your login page. From your browser, choose "View->Source" or its equivalent. Your system will display the HTML source for the captive portal page. Save this source as a file on your local system.

4. Open the file that you saved in step 3, using a standard text editor, and make the following changes:

   a. Fix the character set. The default <HEAD>...</HEAD> section of the file will appear as:

```
<head>
<title>Portal Login</title>

<link href="default1/styles.css" rel="stylesheet" media="screen" type="text/css" />
<script language="javascript" type="text/javascript">
   function showPolicy() {
        win = window.open("/auth/acceptableusepolicy.html", "policy",
"height=550,width=550,scrollbars=1");
   }
</script>
</head>
```

   In order to control the character set that the browser will use to show the text with, you will need to insert the following line inside the <HEAD>...</HEAD> element:

```
<meta http-equiv="Content-Type" content="text/html; charset=Shift_JIS"/>
```

Replace the "Shift_JIS" part of the above line with the character set that is used by your system. In theory, any character encoding that has been registered with IANA can be used, but you must ensure that any text you enter uses this character set and that your target browsers support the required character set encoding.

b. The final <HEAD>...</HEAD> portion of the document should look similar to this:

```
<head>
<meta http-equiv="Content-Type" content="text/html; charset=Shift_JIS"/>
<title>Portal Login</title>

<link href="default1/styles.css" rel="stylesheet" media="screen" type="text/css"
/>
<script language="javascript" type="text/javascript">
function showPolicy() {
   win = window.open("/auth/acceptableusepolicy.html", "policy",
"height=550,width=550,scrollbars=1");
}
</script>
</head>
```

c. Fix references: If you have used the built-in preferences, you will need to update the reference for the logo image and the CSS style sheet.

To update the CSS reference, search the text for "<link href" and update the reference to include "/auth/" in front of the reference. The original link should look similar to the following:

```
<link href="default1/styles.css" rel="stylesheet" media="screen" type="text/css"
/>
```

This should be replaced with a link like the following:

```
<link href="/auth/default1/styles.css" rel="stylesheet" media="screen"
type="text/css" />
```

The easiest way to update the image reference is to search for "src" using your text editor and updating the reference to include "/auth/" in front of the image file. The original link should look similar to the following:

```
<img src="default1/logo.gif"/>
```

This should be replaced with a link like this:

```
<img src="/auth/default1/logo.gif"/>
```

d. Insert javascript to handle error cases:

When the controller detects an error situation, it will pass the user's page a variable called "errmsg" with a value of what the error is in English. Currently, only "Authentication Failed" is supported as a valid error message.

To localize the authentication failure message, replace the following text (it is just a few lines below the <body> tag):

```
<div id="errorbox" style="display: none;">
</div>
```

with the script below. You will need to translate the "Authentication Failed" error message into your local language and add it into the script below where it states: localized_msg="...":

```
<script>
{
  var q = window.location.search;
  var errmsg = null;
  if (q && q.length > 1) {
    q = q.substring(1).split(/[=&]/);
    for (var i = 0; i < q.length - 1; i += 2) {
      if (q[i] == "errmsg") {
        errmsg = unescape(q[i + 1]);
        break;
      }
```

```
    }
  }

  if (errmsg && errmsg.length > 0) {
    switch(errmsg) {
    case "Authentication Failed":
    localized_msg="Authentication Failed";
    break;
    default:
      localised_msg=errmsg;
      break;
    }
    errmsg = "<div id='errorbox'>\n" + localised_msg + "\n</div>\n";
    document.write(errmsg);
  };
}
</script>
```

e. Translate the web page text. Once you have made the changes as above, you only need to translate the rest of the text that appears on the page. The exact text that appears will depend on the controller settings when you originally viewed the captive portal. You will need to translate all relevant text such as "REGISTERED USER", "USERNAME", "PASSWORD", the value="" part of the INPUT type="submit" button and all other text. Ensure that the character set you use to translate into is the same as you have selected in part i) above.

   Feel free to edit the HTML as you go if you are familiar with HTML.

5. After saving the changes made in step 4 above, upload the file to the controller using the Configuration > Management >Captive Portal > Upload Custom Login Pages section of the WebUI.

   Choose the captive portal profile from the drop-down menu. Browse your local computer for the file you saved. For Page Type, select “Captive Portal Login”. Ensure that the "Revert to factory default settings" box is NOT checked and click Apply. This will upload the file to the controller and set the captive portal profile to use this page as the redirection page.

   In order to check that your site is operating correctly, go back to the "Customize Login Page" and click on "View Captive Portal" to view the page you have uploaded. Check that your browser has automatically detected the character set and that your text is not garbled.

   To make any adjustments to your page, edit your file locally and simply re-upload to the controller in order to view the page again.

6. Finally, it is possible to customize the welcome page on the controller, however for language localization it is recommended to use an "external welcome page" instead. This can be a web site on an external server, or it can be a static page that is uploaded to a controller.

   You set the welcome page in the captive portal authentication profile. This is the page that the user will be redirected to after successful authentication.

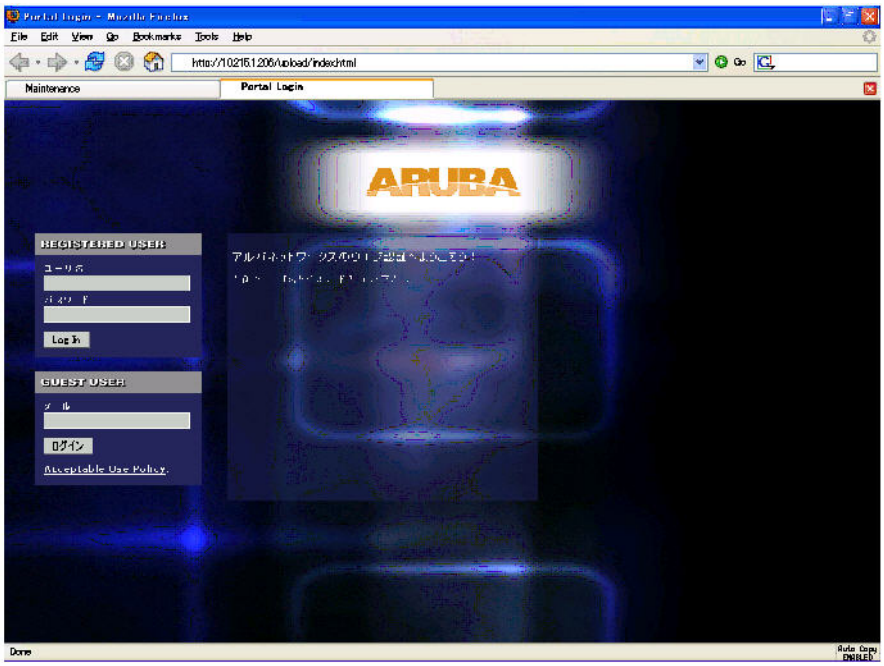
   If this is required to be a page on the controller, the user needs to create their own web page (using the charset meta attribute in step 4 above). Upload this page to the designated controller in the same manner as uploading the captive portal login page under "Configuration > Management >Captive Portal > Upload Custom Login Pages. For Page Type, select “Captive Portal Welcome Page”.

Any required client side script (CSS) and media files can also be uploaded using the “Content” Page Type, however file space is limited (use the CLI command show storage to see available space). Remember to leave ample room for system files.

NOTE: The "Registered User" and "Guest User" sections of the login page are implemented as graphics files, referenced by the default CSS styles. In order to change these, you will need to create new graphic files, download the CSS file, edit the reference to the graphics files, change the style reference in your index file and then upload all files as "content" to the controller.

A sample of a translated page is displayed in Figure 212.

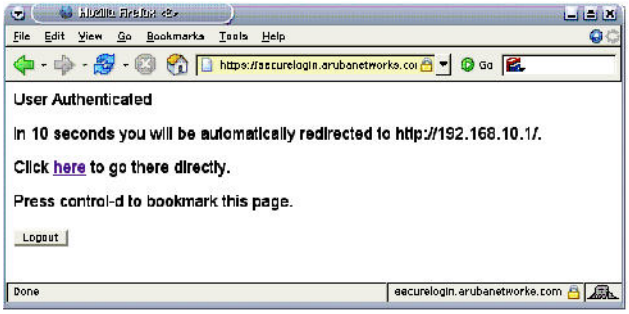
Figure 212 *Sample Translated Page*



Customizing the Welcome Page

Once a user is authenticated by the controller, a Welcome page is launched. The default welcome page depends on your configuration, but will look similar to Figure 213:

Figure 213 *Default Welcome Page*



You can customize this welcome page by building your own HTML page and uploading it to the controller. You upload it to the controller by navigating to Management > Captive Portal > Upload Login Pages and select “Captive Portal Welcome Page” from the Page Type drop-down menu. This file is stored in a directory called "/upload/" on the controller using the file's original name.

In order to actually use this file, you will need to configure the welcome page on the controller. To do this use the CLI command: "aaa captive-portal welcome-page /upload/welc.html" where "welc.html" is the name of the file that you uploaded, or you can change the Welcome page in the captive portal authentication profile in the WebUI.

An example that will create the same page as displayed in Figure 213 is shown below. The part in red will redirect the user to the web page you originally setup. For this to work, please follow the procedure described above in this document.

```
:

<html>
<head>
<script>
{

function readCookie(name)
{
            var nameEQ = name + "=";
            var ca = document.cookie.split(';');
            for(var i=0;i < ca.length;i++)
            {
                        var c = ca[i];
                        while (c.charAt(0)==' ') c = c.substring(1,c.length);
                        if (c.indexOf(nameEQ) == 0) return
c.substring(nameEQ.length,c.length);
            }
            return null;
}
var cookieval = readCookie('url');
            if (cookieval.length>0) document.write("<meta http-equiv=\"refresh\"
content=\"2;url=http://"+cookieval+"\""+">");


            }
</script>
</head>
<body bgcolor=white text=000000>
<font face="Verdana, Arial, Helvetica, sans-serif" size=+1>
  <b>User Authenticated </b>

<p>In 2 seconds you will be automatically redirected to your original web page</p>
<p> Press control-d to bookmark this page.</p>

<FORM ACTION="/auth/logout.html">
     <INPUT type="submit" name="logout" value="Logout">
</FORM>
</font>
</body>
</html>
```

Customizing the Pop-Up box

In order to customize the Pop-Up box, you must first customize your Welcome page. Once you have customized your welcome page, then you can configure your custom page to use a pop-up box. The default HTML for the pop-up box is:

```
<html>
<body bgcolor=white text=000000>
<font face="Verdana, Arial, Helvetica, sans-serif" size=+1>
 <b>Logout</b></font>
 <p>
  <a href="/auth/logout.html"> Click to Logout </a>
</body>
```

```
</html>
```

If you wish your users to be able to logout using this pop-up box, then you must include a reference to /auth/logout.html Once a user accesses this URL then the controller will log them out. It is easiest to simply edit the above HTML to suit your users and then upload the resulting file to the controller using the WebUI under Configuration > Management > Captive Portal > Upload custom pages and choose "content" as the page type.

Once you have completed your HTML, then you must get the clients to create the pop-up box once they have logged into the controller. This is done by inserting the following code into your welcome page text and re-uploading the welcome page text to your controller.

Common things to change:

- URL: set the URL to be the name of the pop-up HTML file that you created and uploaded. This should be preceded by "/upload/"
- Width: set w to be the required width of the pop-up box
- Height: set h to be the required height of the pop-up box
- Title: set the second parameter in the window.open command to be the title of the pop-up box. Be sure to include the quotes as shown:

```
<script language="JavaScript">
 var url="/upload/popup.html";
 var w=210;
 var h=80;
 var x=window.screen.width - w - 20;
 var y=window.screen.height - h - 60;
 window.open(url, 'logout',
"toolbar=no,location=no,width="+w+",height="+h+",top="+y+",left="+x+",screenX="+x+",
screenY="+y);
</script>
```

Customizing the Logged Out Box

In order to customize the Logged Out box, you must first customize your Welcome page and also your Pop-Up box. To customize the message that occurs after you have logged out then you need to replace the URL that the pop-up box will access in order to log out with your own HTML file.

First you must write the HTML web page that will actually log out the user and will also display page that you wish. An example page is shown below. The key part that must be included is the <iframe>..</iframe> section. This is the part of the HTML that actually does the user logging out. The logout is always performed by the client accessing the /auth/logout.html file on the controller and so it is hidden in the html page here in order to get the client to access this page and for the controller to update its authentication status. If a client does not support the iframe tag, then the text between the <iframe> and the </iframe> is used. This is simply a 0 pixel sized image file that references /auth/logout.html. Either method should allow the client to logout from the controller.

Everything else can be customized.

```
<html>
<body bgcolor=white text=000000>

<iframe src='/auth/logout.html' width=0 height=0 frameborder=0><img src=/auth/
logout.html width=0 height=0></iframe>

<P><font face="Verdana, Arial, Helvetica, sans-serif" size=+1>
You have now logged out.</font></P>

<form> <input type="button" onclick="window.close()" name="close" value="Close
Window"></form>
```

```
</body>
</html>
```

After writing your own HTML, then you need to ensure that your customized pop-up box will access your new logged out file. In the pop-up box example above, you simply replace the "/auth/logout.html" with your own file that you upload to the controller. For example, if your customized logout HTML is stored in a file called "loggedout.html" then your "pop-up.html" file should reference it like this:

```
<html>
<body bgcolor=white text=000000>
<font face="Verdana, Arial, Helvetica, sans-serif" size=+1>
 <b>Logout</b></font>
 <p>
  <a href="/upload/loggedout.html"> Click to Logout </a>
</body>
</html>
```

Appendix F

Tunneled Nodes

This appendix describes how to configure a Dell tunneled node, also known as a wired tunneled node. A Dell tunneled node provides access and security using an overlay architecture.

This chapter describes the following topics:

Configuration Overview

The Dell tunneled node connects to one or more client devices at the edge of the network and then establishes a secure GRE tunnel to the controlling concentrator server. This approach allows the controller to support all the centralized security features, such as 802.1x authentication, captive-portal authentication, and stateful firewall. The Dell tunneled node is required to handle only the physical connection to clients and support for its end of the GRE tunnel.

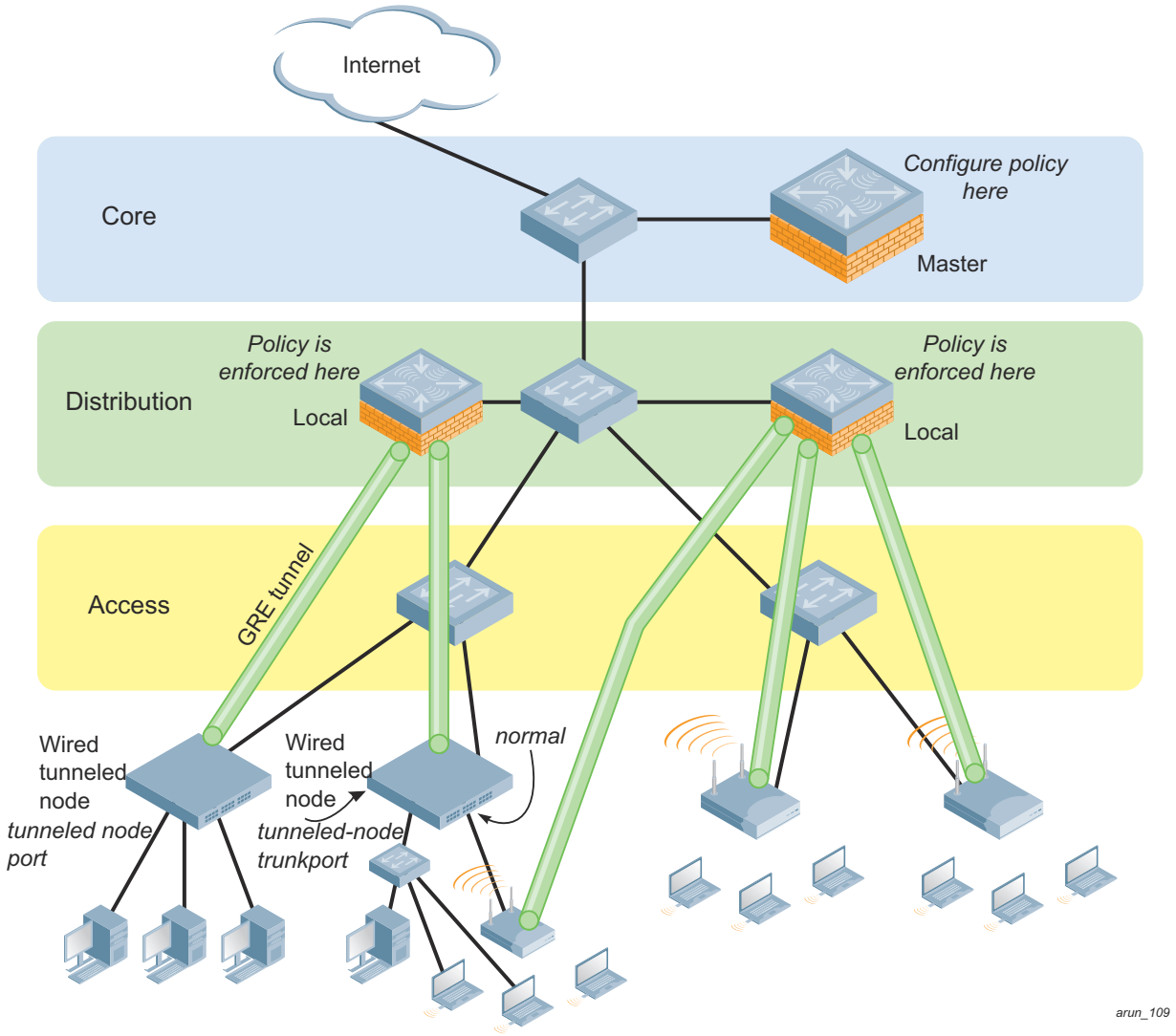
To support the wired concentrator, the controller must have a license to terminate access points (APs). No other configuration is required. To configure the Dell tunneled node, you must specify the IP address of the controller and identify the ports that are to be used as active tunneled node ports. Tunnels are established between the controller and each active tunneled node port on the tunneled node. All tunneled node units must be running the same version of software. The tunneled node port can also be configured as a trunk port. This allows customers to have multiple clients on different VLANs that come through the trunk port instead of having clients on a single vlan.

Figure 214 shows how the tunneled node fits into network operations. Traffic moves through GRE tunnels between the active tunneled node ports and the controller or controllers. Policies are configured on a master server and enforced on the local controllers. The master and the controller can run on the same or different systems. The tunneled node can connect to the master, but it is not required.

On the controlling controller, you can assign the same policy to tunneled node user traffic as you would to any untrusted wired traffic. The profile specified by the aaa authentication wired command determines the initial

role, which contains the policy. The VLAN setting on the concentrator port must match the VLAN that will be used for users at the local controller.

Figure 214 *Tunneled node configuration operation*



Configuring a Wired Tunneled Node Client

This section describes how to configure a tunneled node client. You can use the WebUI or the CLI to complete the configuration steps.

1. Access the Wired tunneled node CLI according to the instructions provided in the installation guide that shipped with your tunneled node. Console access (9600 8N1) and SSH access are supported.
2. Specify the IP address of the controller and specify tunnel loop prevention.
   - CLI:

   ```
   (host) (config) # tunneled-node-address ipaddress
   (host) (config) # tunnel-loop-prevention
   ```

   For example:

   ```
   (host (config) # tunneled-node-address 10.10.1.1
   ```

```
(host) (config) # tunnel-loop-prevention
```

- WebUI

a. Navigate to Configuration>Advanced Services>Wired Access page.

b. Locate the Wired Access Concentration Configuration section.

c. T o enable tunneled nodes, click the Enable Wired Access Concentrator checkbox.

d. Enter the IP address of the controller in the Wired Access Concentrator Server IP field.

e. To enable tunnel loop prevention, click the Enable Wired Access Concentrator Loop Prevention checkbox.

f. Click Apply.

3. Access each interface that you want to use, and assign it as a tunneled node port.

```
(host (config) # interface fastethernet n/m
(host (config-if) # tunneled-node port
```

Example:

```
(host) (config) # interface fastethernet 2/1
(host) (config-if) # tunneled-node-port
(host) (config) # interface fastethernet 2/3
(host) (config-if) # tunneled-node-port
```

4. Verify the configuration.

```
(host) (config-if) # exit
(host) # show tunneled-port config
```

Example:

```
(host) # show tunneled-node config
Tunneled Node Client:Enabled
Tunneled Node Server:10.10.1.1
```

Configuring an Access Port as a Tunneled Node Port

You can configure any port on any controller as a tunneled node port using the tunneled-node-port command. Set the tunneled-nod -address as the controller to act as the tunneled node termination point. The tunneled-node-port command tells the physical interface to tunnel that traffic to the controller.

1. Enable portfast on the Wired tunneled node.

```
(host) (config) # interface fastethernet <slot>/<port>
(host) (config-if) # spanning-tree portfast
```

Example:

```
(host) (config)# interface fastethernet 2/1
(host) (config-if)# spanning-tree portfast
```

2. Assign a VLAN to the tunneled node port.

```
(host) (config-if) # switchport mode access
(host) (config-if) # switchport access vlan <vlanid>
```

Example:

```
(host) (config-if) # switchport access vlan 10
```

Configuring a Trunk Port as a Tunneled Node Port

1. Enable portfast on the Wired tunneled node.

```
(host) (config-if) # switchport mode trunk
(host) (config-if) # switchport trunk allowed vlan <WORD>
```

Example:

```
(host) (config-if) # switch trunk allowed vlan 3-5,8,9
```

Example Output

Use the `show tunneled-node state` command to verify the status of the Wired tunneled node.

```
(show) # show tunneled-node state
Tunneled Node State
-------------------
IP              MAC               s/p   state     vlan  tunnel  inactive-time
--              ---               ---   -----     ----  ------  -------------
192.168.123.14  00:0b:86:40:32:40  1/23  complete  10    9       1
192.168.123.14  00:0b:86:40:32:40  1/22  complete  10    10      1
192.168.123.14  00:0b:86:40:32:40  1/20  complete  10    11      1

On the tunneled node client:
(host) # show tunneled-node state
Tunneled Node State
-------------------
IP              MAC               s/p   state     vlan  tunnel  inactive-time
--              ---               ---   -----     ----  ------  -------------
192.168.123.16  00:0b:86:40:32:40  1/23  complete  10    21      0
192.168.123.16  00:0b:86:40:32:40  1/22  complete  10    9       0
192.168.123.16  00:0b:86:40:32:40  1/20  complete  10    13      0

(host) # show tunneled-node config

Tunneled Node Client:Enabled
Tunneled Node Server:192.168.123.16
```

Use the show license-usage ap command to check current usage on the controller. Each tunneled node client uses one AP license. Attaching an additional wired client on the tunneled node client does not increment the AP license usage on the controller.

```
(host) #show license-usage ap

Total AP Licenses                     : 128
AP Licenses Used                      : 1
Tunneled Node Licenses Used           : 1
Unused AP Licenses                    : 127
Licenses used for Campus AP's         : 1
Available Campus AP's                 : 31
Licenses used for Remote AP's         : 0
Available Remote AP's                 : 127
Total Ortronics AP Licenses           : 128
Ortronics AP Licenses Used            : 0
Total Indoor Mesh AP's Supported      : 128
Indoor Mesh AP's Active               : 0
Total Outdoor Mesh AP's supported     : 128
Outdoor Mesh AP's Active              : 0
Total RF Protect Licenses             : 128
RF Protect Licenses Used              : 1
Total PEF Licenses                    : 128
PEF Licenses Used                     : 1
Total 802.11n-120abg Licenses   : 128
802.11n-120abg Licenses Used    : 0
Total 802.11n-121abg Licenses   : 128
802.11n-121abg Licenses Used    : 0
Total 802.11n-124abg Licenses   : 128
802.11n-124abg Licenses Used    : 0
Total 802.11n-125abg Licenses   : 128
802.11n-125abg Licenses Used    : 0
```

Appendix G

VIA: End User Instructions

This section of the document provides instructions and information on using VIA.

Pre-requisites

Ensure that the end-user system meets the following pre-requisites:

- VIA can be installed only on systems running:
  - Microsoft Windows XP with SP2
  - Microsoft Windows Vista (32-bit and 64-bit)
  - Microsoft Windows 7 (32-bit and 64-bit)

NOTE: VIA is supported only in the English versions of Microsoft Windows. International versions of Microsoft Windows is not supported.

- Requires the following Microsoft KB on the end-user systems:
  - On Microsoft Windows XP SP2—KB918997 (http://support.microsoft.com/kb/918997)

    Install this to see the list of detected wireless networks in the VIA client (Diagnostics tab > Detected Networks page).
  - On Microsoft Windows XP SP3—KB958071 (http://support.microsoft.com/kb/958071)

    Install this if you receive the "*1206 (ERROR_BAD_PROFILE)*" error code.
- Administrator rights on the computer.
- The computer must have a working wired or wireless network hardware.

Downloading VIA

In a typical scenario, end users will receive an email from their IT department with details to download VIA from a URL (controllers public IP address). See Table 76 on page 421.

In this example, they can download VIA set up files from *https://115.52.100.10/via* after entering their corporate credentials.

Figure 215 *Login to Download VIA*

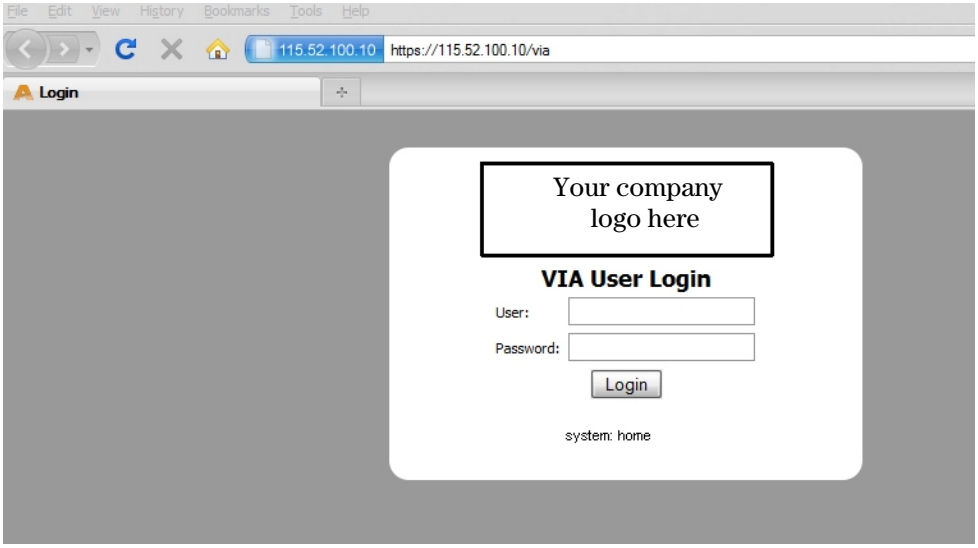
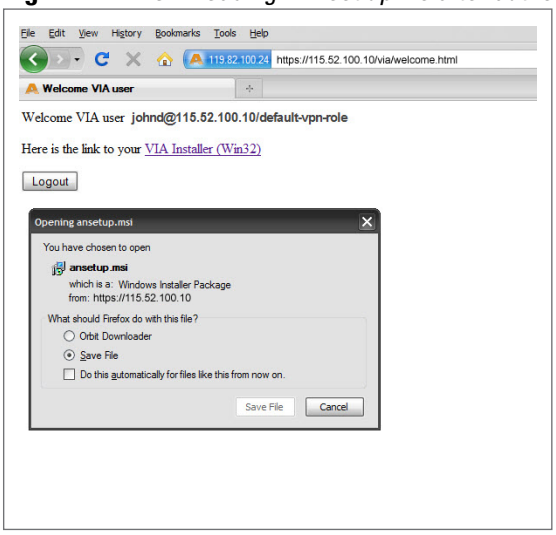


Figure 216 *Downloading VIA set up file after authentication*



Installing VIA

Double click the downloaded set up file (*ansetup.msi or ansetup64.msi*) to start the installation process. Ensure that you have met the pre-requisites before proceeding with the installation.

Using VIA

The VIA desktop application has three tabs:

- Connection Details
- Diagnostics
- Settings

Connection Details Tab

Provides all required details about your remote connection. After a successful connection, you can see the assigned IP from your remote server, the profile used for the connection and other network related information.

- Disconnect—Click this button to disconnect the current remote connection. You will have to manually connect for the next connection. VIA will not automatically start connection.
- View Connection Log—Click this button to view the sequence of events that took place during the last or current connection. The log also provide information about upgrade requirement, missing pre-requisites or other encountered errors.
- Change Profile—Click this button to select an alternate connection profile. This button is enabled only if your administrator has configured more than one connection profile. This button toggles to Download Profile, if you clear your profile from the Settings tab.

More Details

This section gives information about your local connection.

- Click Network Details to view local network connection information.
- Click VIA Details to view error or other connection messages.

Diagnostic Tab

Provides information and tools for troubleshooting your connectivity issues. Select a diagnostic tool from this tab for more information.

Diagnostics Tools

- Connection Logs—Sequence of events that happened during the recent connection.
- Send Logs—List of logs files collected by VIA. You can send this to your technical support when required. Click Open Folder to see the folder with the most recent logs and click the Send button to send log files archive using your default e-mail client.
- View system info & Advanced info—System and network configuration details of your system.
- Connectivity tests—Basic tests (ping and trace-route) to verify your network connection.
- Detected Networks—If your system has wireless network capability, this option will show all detected wireless networks.
- VIA info—Information about the current VIA installation.
- Compatibility info—Compatibility information about some applications detected in your system.

Settings Tab

This tab allows you to configure extra settings required to collect log, use a different connection profile and set up proxy server details.

- Log Settings—Allows you to set VIA log levels. By default, the log level is set to *Trace*. This setting captures extensive activity information about VIA.
- Connection Profile—Allows you to select and connect to a different connection profile. This is usually useful if you are in remote location and you need to connect to your corporate (secure) network. In such situation, you can select a profile that uses the nearest remote server to provide secure connection to your network. Alternate connection profiles are available only if it is configured by your IT administrator.
- Proxy Settings—Detects and displays Microsoft Internet Explorer proxy server details. It also allows you to enter the proxy authentication credentials to be used for HTTP/HTTPS connection to the controller.

Troubleshooting

To enable your support team to effectively resolve your VIA connection issues, it is mandatory that you send logs generated by VIA. To do this, click the Send Logs button from the Connection Details tab.

Appendix H

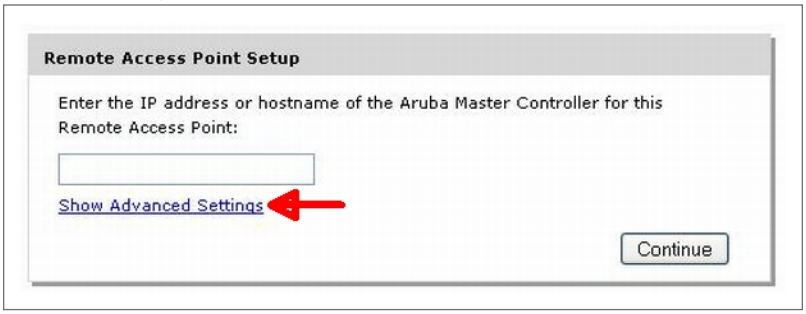
Provisioning RAP at Home

This document provides information on provisioning your remote AP (RAP) at home using a static IP address, PPPoE connection, or 3G/EVDO USB modem.

You provision the RAP using provisioning wizard:

1. Navigate to the RAP configuration URL —http://.
2. Enter the IP address or hostname of the controller.
3. Click the Show Advanced Settings link, shown in Figure 217 on page 819.

Figure 217 *Show Advanced Settings*



4. In the Advanced Settings wizard, you can select one of the following:
   a. Static IP—Select this tab to provision your RAP using a static IP address.
   b. PPPoE—Select this tab to provision your RAP on a PPPoE connection.
   c. USB—Select this tab to provision your RAP using 3G/EVDO USB modem.

Provision the RAP using a Static IP Address

Select the Static IP tab and enter the required details. See Table 176 for information on parameters.

Figure 218 *Provision RAP using Static IP*

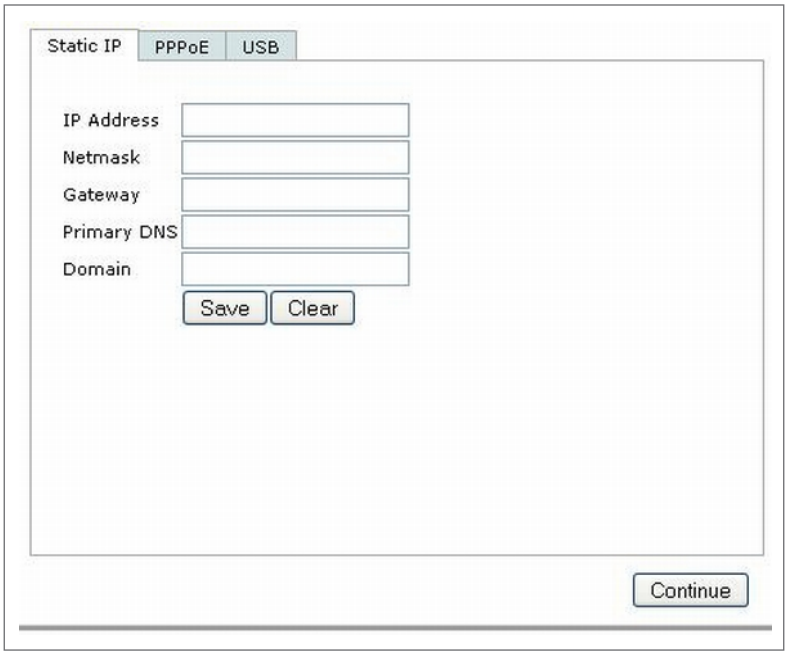


Table 176 *Provision using Static IP*

Item	Description
IP Address	Enter the static IP address that you want to configure for your remote access point.
Netmask	Enter the network mask.
Gateway	Enter the default gateway IP address of your network.
Primary DNS	Enter the IP address of your primary DNS server. This is an optional parameter.
Domain	Enter your domain name. This is an optional parameter.

Click the Save button after you have entered all the details.

Provision the RAP on a PPPoE Connection

Select the PPPoE tab and enter the required details. See Table 177 for information on parameters

Figure 219 *Provision RAP on a PPPoE Connection*

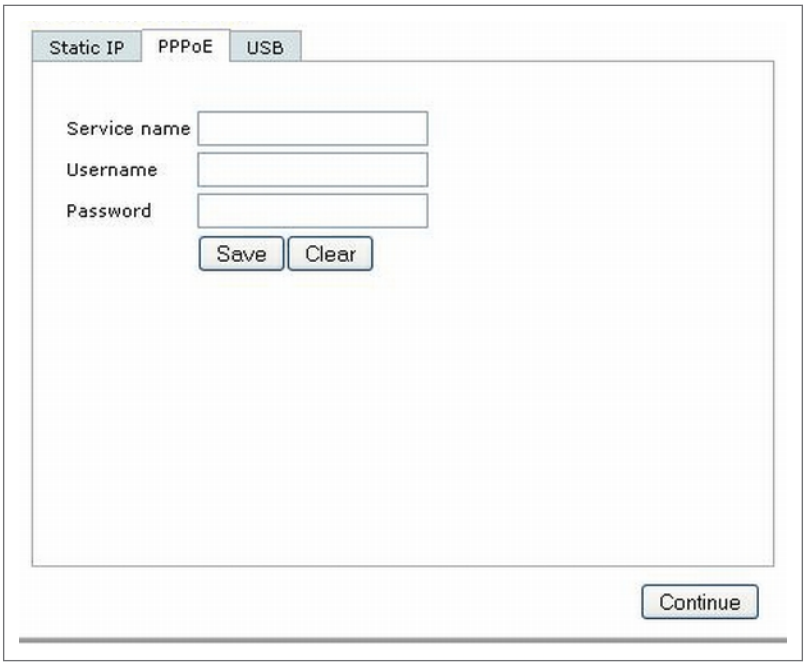


Table 177 *Provision using PPPoE Connection*

Item	Description
Service Name	Enter the PPPoE service name provided to you by your service provider. This parameter is optional.
Username	Enter the user name for the PPPoE connection.
Password	Enter your PPPoE password.

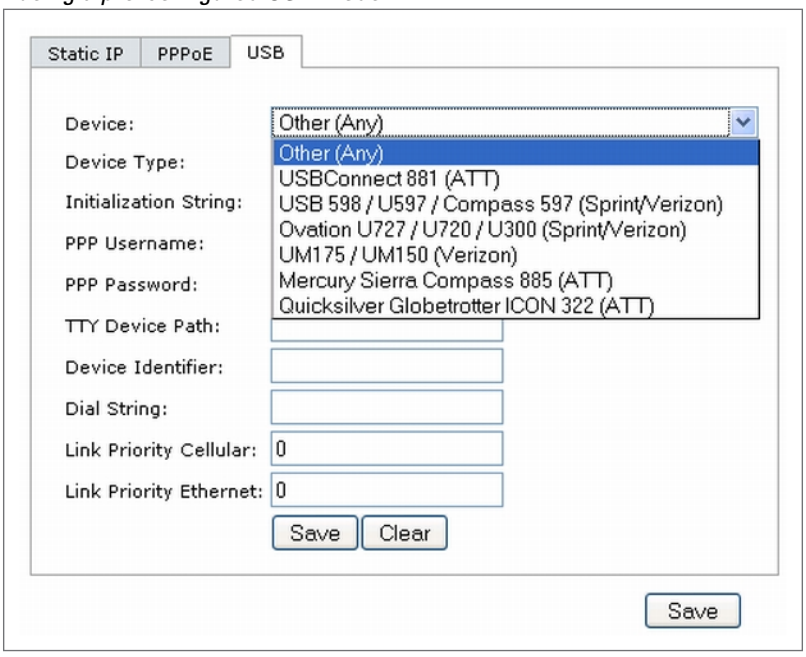
Click the Save button after you have entered all the details.

Using 3G/EVDO USB Modem

The following procedure illustrates provisioning your RAP using a 3G/EVDO USB modem.

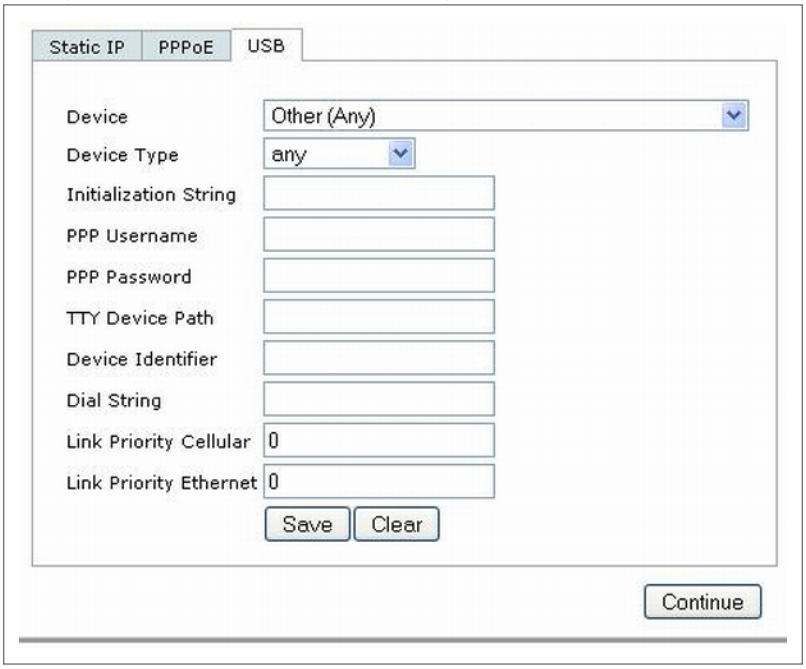
Select USB tab and select your modem from the drop down list. For some common modems, the details are automatically filled.

Figure 220 *Provision using a pre-configured USB Modem*



If your modem name is not listed, select Other and manually enter the following details. These are available from the manufacturer of your modem or from your IT administrator.

Figure 221 *Provision using a USB Modem with Custom Settings*



- Device Type
- Initializing String
- PPP Username
- PPP Password
- TTY Device Path
- Device Identifier
- Dial String
- Link Priority Cellular—This is a number that identifies the priority of the connection. If the *Link Priority Cellular* has a higher number than *Link Priority Ethernet*, then cellular connection is used.

- **Link Priority Ethernet—This is a number that identifies the priority of the connection. If the** *Link Priority Ethernet* **has a higher number than** *Link Priority Cellular*, **then ethernet connection is used.**

Click the Save button after you have entered all the details and click the Continue button to complete provisioning of your RAP.

Appendix I

Acronyms and Terms

Acronyms

The following table lists the acronyms and their definitions used in this guide.

Table 178 *List of acronyms*

Acronym	Definition
ABR	area border router
AC	access category
ACI	adjacent channel interference
ACL	access control list
ADP	Dell Discovery Protocol
AES	advanced encryption standard
AIFSN	arbitrary inter-frame space number
ALG	application level gateway
AM	air monitor
AP	access point
APM	AP air monitor
ARM	adaptive radio management
AVF	AntiVirus Firewall
A-MSDU	aggregate MAC service data unit
BCMC	broadcast and multicast
BRAS	broadband remote access server
BRE	basic regular expression
BPDU	bridge protocol data unit
BSSID	basic service set identifier
CA	certification authority
CAC	call admission control
CAP	campus AP
CCA	clear channel assessment
CDP	Cisco Discovery Protocol
CDR	call detail records
CHAP	Challenge Handshake Authentication Protocol
CRL	certificate revocation list

Table 178 *List of acronyms (Continued)*

Acronym	Definition
CSA	channel switch announcement
CSMA/CA	carrier sense multiple access with collision avoidance
CSR	certificate signing request
CTS	clear to send
CW	contention window
DAS	distributed antenna systems
DCF	distributed coordination function
DES	data encryption standard
DHCP	Dynamic Host Configuration Protocol
DS	differentiated services
DSCP	differentiated services codepoint
DSSS	direct sequence spread spectrum
DNS	domain name system
DoS	denial of service
DPD	dead peer detection
DR	designated router
DU	data unit
DMO	dynamic multicast optimization
EAP	Extensible Authentication Protocol
EAP-TLS	EAP-transport layer security
EDCA	enhanced distributed channel access
EIRP	effective isotropic radiated power
ESI	external service interfaces
ESS	extended service set
ESSID	extended service set identifier
FE	fast ethernet
FFT	fast fourier transform
FHSS	frequency-hopping spread spectrum
FIB	forwarding information base
FRER	frame receive error rate
FRR	frame retry rate
FSPL	free space path loss
FTP	File Transfer Protocol
FQLN	fully qualified location name

Table 178 *List of acronyms (Continued)*

Acronym	Definition
GRE	generic routing encapsulation
GIS	generic interface specification
GMT	Greenwich Mean Time
GPP	guest provisioning page
HMD	high mobility device
HSPA	high-speed packet access
HT	high throughput
IAS	internet authentication server
IDS	intrusion detection system
IE	information element
IEEE	Institute of Electrical and Electronics Engineer
IGMP	Internet Group Management Protocol
IGP	Interior Gateway Routing Protocol
IKE PSK	internet key exchange pre-shared key
ISAKMP	Internet Security Association and Key Management Protocol
LACP	Link Aggregation Control Protocol
LAG	link aggregation group
LD	local debug
LDAP	Lightweight Directory Access Protocol
LEAP	Lightweight Extensible Authentication Protocol
LI	listening interval
L2TP	Layer-2 Tunneling Protocol
MAC	media access control
MCS	modulation and coding scheme
MDPU	MAC protocol data unit
MIB	management information base
MIMO	multiple input, multiple output
MMS	mobility management system
MP	mesh point
MPP	mesh portal
MPV	mesh private VLAN
MSCHAP	Microsoft Challenge Handshake Authentication Protocol
MSCHAPv2	MSCHAP version 2
MSSID	mesh service set identifier

Table 178 *List of acronyms (Continued)*

Acronym	Definition
MPPE	Microsoft point-to-point encryption
MTU	maximum transmission unit
NAS	network access server
NAT	network address translation
NIC	network interface card
NOE	new office environment
NTP	Network Time Protocol
OCSP	Online Certificate Status Protocol
OFDM	orthogonal frequency division multiplexing
OKC	opportunistic key caching
OSPF	open shortest path first
OUI	organizationally unique identifier
PAC	protected access credential
PAP	Password Authentication Protocol
PAPI	proprietary access protocol interface
PFS	perfect forward secrecy
PHB	per hop behavior
PIN	personal identification number
PKI	public key infrastructure
PMK	pairwise master key
PoE	power over ethernet
PSK	pre-shared key
PPPoE	point-to-point protocol over ethernet
PPTP	Point-to-Point Tunneling Protocol
PVST	per VLAN spanning tree
QoS	quality of service
RADIUS	remote authentication dial-in user service
RAP	remote AP
REGEX	region with the regular expression
RF	radio frequency
RFID	radio frequency identification
RoW	rest of world
RSSI	received signal strength indication
RSTP	Rapid Spanning Tree Protocol

Table 178 *List of acronyms (Continued)*

Acronym	Definition
RTLS	real-time locating systems
RTS	request to send
SA	security association
SDR	software-defined radio
SIM	subscriber identity module
SIP	Session Initiation Protocol
SNIR	signal-to-noise-and-interference ratio
SNMP	Simple Network Management Protocol
SSID	service set identifier
STP	Spanning Tree Protocol
STRAP	secure thin remote access point
SVP	spectralink voice priority
TFTP	Trivial File Transfer Protocol
TIM	traffic indication map
TLS	transport layer security
TOS	type of service
TPM	trusted platform module
TSPEC	traffic specification
TXOP	opportunity to transmit
UDP	User Datagram Protocol
UTMS	universal mobile telecommunication systems
U-APSD	unscheduled automatic power save delivery
VBA	virtual branch networking
VIA	virtual intranet access
VoFI	voice over Wi-Fi
VoIP	voice over IP
VPN	virtual private network
VRD	validated reference design
VRRP	Virtual Router Redundancy Protocol
VSA	vendor specific attributes
VTP	Virtual Trunking Protocol
WIDS	wireless intrusion detection system
WINS	windows internet naming service
WIPS	wireless intrusion prevention system

Table 178 *List of acronyms (Continued)*

Acronym	Definition
WISPr	wireless internet service provider roaming
WLAN	wireless local area network
WMM	wireless multimedia
WMS	WLAN management system
WSIRT	wireless security incident response team
WZC	wireless zero config
XAuth	extended authentication

Terms

The following table lists the terms and their definitions used in this guide.

Table 179 *List of terms*

Term	Definition
802.11	An evolving family of specifications for wireless LANs developed by a working group of the Institute of Electrical and Electronics Engineers (IEEE). 802.11 standards use the Ethernet protocol and CSMA/CA (carrier sense multiple access with collision avoidance) for path sharing.
802.11a	Provides specifications for wireless systems. Networks using 802.11a operate at radio frequencies in the 5GHz band. The specification uses a modulation scheme known as orthogonal frequency-division multiplexing (OFDM) that is especially well suited to use in office settings.
802.11b	WLAN standard often called Wi-Fi; backward compatible with 802.11. Instead of the phase-shift keying (PSK) modulation method historically used in 802.11 standards, 802.11b uses complementary code keying (CCK), which allows higher data speeds and is less susceptible to multipath-propagation interference.
802.11d	A wireless network communications specification for use in countries where systems using other standards in the 802.11 family are not allowed to operate. Configuration can be fine-tuned at the Media Access Control layer (MAC layer) level to comply with the rules of the country or district in which the network is to be used. Rules subject to variation include allowed frequencies, allowed power levels, and allowed signal bandwidth. 802.11d facilitates global roaming.
802.11e	A proposed adaptation to the 802.11a and 802.11b specifications that enhances the 802.11 Media Access Control layer (MAC layer) with a coordinated time division multiple access (TDMA) construct, and adds error-correcting mechanisms for delay-sensitive applications such as voice and video. The 802.11e specification provides seamless interoperability between business, home, and public environments such as airports and hotels and offers all subscribers high-speed Internet access with full-motion video, high-fidelity audio, and Voice over IP (VoIP).
802.11g	Offers transmission over relatively short distances at up to 54 megabits per second (Mbps), compared with the 11 Mbps theoretical maximum of 802.11b. 802.11g employs orthogonal frequency division multiplexing (OFDM), the modulation scheme used in 802.11a, to obtain higher data speed. Computers or terminals set up for 802.11g can fall back to speeds of 11 Mbps, so that 802.11b and 802.11g devices can be compatible within a single network.

Table 179 *List of terms (Continued)*

Term	Definition
802.11h	Intended to resolve interference issues introduced by the use of 802.11a in some locations, particularly with military radar systems and medical devices. Dynamic frequency selection (DFS) detects the presence of other devices on a channel and automatically switches the network to another channel if and when such signals are detected. Transmit power control (TPC) reduces the radio-frequency (RF) output power of each network transmitter to a level that minimizes the risk of interference.
802.11i	Provides improved encryption for networks that use 802.11a, 802.11b, and 802.11g standards. Requires new encryption key protocols, known as Temporal Key Integrity Protocol (TKIP) and Advanced Encryption Standard (AES). Other features include key caching, which facilitates fast reconnection to the server for users who have temporarily gone offline, and pre-authentication, which allows fast roaming and is ideal for use with advanced applications such as Voice over Internet Protocol (VoIP).
802.11j	Proposed addition to the 802.11 family of standards that incorporates Japanese regulatory extensions to 802.11a; the main intent is to add channels in the radio-frequency (RF) band of 4.9 GHz to 5.0 GHz. WLANs using 802.11j will provide for speeds of up to 54 Mbps, and will employ orthogonal frequency division multiplexing (OFDM). The specification will define how Japanese 802.11 family WLANs and other wireless systems, particularly HiperLAN2 networks, can operate in geographic proximity without mutual interference.
802.11k	Proposed standard for how a WLAN should perform channel selection, roaming, and transmit power control (TPC) in order to optimize network performance. In a network conforming to 802.11k, if the access point (AP) having the strongest signal is loaded to capacity, a wireless device is connected to one of the underutilized APs. Even though the signal may be weaker, the overall throughput is greater because more efficient use is made of the network resources.
802.11n	Wireless networking standard to improve network throughput over the two previous standards 802.11a and 802.11g with a significant increase in the maximum raw data rate from 54 Mbit/s to 600 Mbit/s with the use of four spatial streams at a channel width of 40 MHz.
802.11m	An initiative to perform editorial maintenance, corrections, improvements, clarifications, and interpretations relevant to documentation for 802.11 family specifications. 802.11m also refers to the set of maintenance releases itself.
802.1X	Standard designed to enhance 802.11 WLAN security. 802.1X provides an authentication framework, allowing a user to be authenticated by a central authority. The actual algorithm that is used to determine whether a user is authentic is left open and multiple algorithms are possible.
access point (AP)	An access point connects users to other users within the network and also can serve as the point of interconnection between the WLAN and a fixed wire network. The number of access points a WLAN needs is determined by the number of users and the size of the network.
access point mapping	The act of locating and possibly exploiting connections to WLANs while driving around a city or elsewhere. To do war driving, you need a vehicle, a computer (which can be a laptop), a wireless Ethernet card set to work in promiscuous mode, and some kind of an antenna which can be mounted on top of or positioned inside the car. Because a WLAN may have a range that extends beyond an office building, an outside user may be able to intrude into the network, obtain a free Internet connection, and possibly gain access to company records and other resources.
ad-hoc network	A LAN or other small network, especially one with wireless or temporary plug-in connections, in which some of the network devices are part of the network only for the duration of a communications session or, in the case of mobile or portable devices, while in some close proximity to the rest of the network.
A-MSDU	A structure containing multiple MSDUs , transported within a single (unfragmented) data medium access control (MAC) protocol data unit (MPDU).
band	A specified range of frequencies of electromagnetic radiation.

Table 179 *List of terms (Continued)*

Term	Definition
digital wireless pulse	Wireless technology for transmitting large amounts of digital data over a wide spectrum of frequency bands with very low power for a short distance. Ultra wideband radio can carry a huge amount of data over a distance up to 230 feet at very low power (less than 0.5 milliwatts), and has the ability to carry signals through doors and other obstacles that tend to reflect signals at more limited bandwidths and a higher power.
evil twin	A home-made wireless access point that masquerades as a legitimate one to gather personal or corporate information without the end-user's knowledge. It's fairly easy for an attacker to create an evil twin by simply using a laptop, a wireless card and some readily-available software. The attacker positions himself in the vicinity of a legitimate Wi-Fi access point and lets his computer discover what name and radio frequency the legitimate access point uses. He then sends out his own radio signal, using the same name.
extensible authentication protocol (EAP)	Authentication protocol for wireless networks that expands on methods used by the point-to-point protocol (PPP), a protocol often used when connecting a computer to the Internet. EAP can support multiple authentication mechanisms, such as token cards, smart cards, certificates, one-time passwords, and public key encryption authentication.
fixed wireless	Wireless devices or systems in fixed locations such as homes and offices. Fixed wireless devices usually derive their electrical power from the utility mains, unlike mobile wireless or portable wireless which tend to be battery-powered. Although mobile and portable systems can be used in fixed locations, efficiency and bandwidth are compromised compared with fixed systems.
frequency allocation	Use of radio frequency spectrum regulated by governments.
frequency spectrum	Part of the electromagnetic spectrum.
hot spot	A WLAN node that provides Internet connection and virtual private network (VPN) access from a given location. A business traveller, for example, with a laptop equipped for Wi-Fi can look up a local hot spot, contact it, and get connected through its network to reach the Internet and their own company remotely with a secure connection. Increasingly, public places, such as airports, hotels, and coffee shops are providing free wireless access for customers.
hot zone	A wireless access area created by multiple hot spots located in close proximity to each other. Hot zones usually combine public safety access points with public hot spots. Each hot spot typically provides network access for distances between 100 and 300 feet; various technologies, such as mesh network topologies and fiber optic backbones, are used in conjunction with the hot spots to create areas of coverage.
Infrared Data Association(IrDA)	An industry-sponsored organization set up in 1993 to create international standards for the hardware and software used in infrared communication links. In this special form of radio transmission, a focused ray of light in the infrared frequency spectrum, measured in terahertz, or trillions of hertz (cycles per second), is modulated with information and sent from a transmitter to a receiver over a relatively short distance
IR wireless	The use of wireless technology in devices or systems that convey data through infrared (IR) radiation. Infrared is electromagnetic energy at a wavelength or wavelengths somewhat longer than those of red light. The shortest-wavelength IR borders visible red in the electromagnetic radiation spectrum; the longest-wavelength IR borders radio waves.
microwave	Electromagnetic energy having a frequency higher than 1 gigahertz (billions of cycles per second), corresponding to wavelength shorter than 30 centimeters. Microwave signals propagate in straight lines and are affected very little by the troposphere. They are not refracted or reflected by ionized regions in the upper atmosphere. Microwave beams do not readily diffract around barriers such as hills, mountains, and large human-made structures.

Table 179 *List of terms (Continued)*

Term	Definition
MIMO	An antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several forms of smart antenna technology, the others being MISO (multiple input, single output) and SIMO (single input, multiple output).
MISO	An antenna technology for wireless communications in which multiple antennas are used at the source (transmitter). The antennas are combined to minimize errors and optimize data speed. The destination (receiver) has only one antenna. MISO is one of several forms of smart antenna technology, the others being MIMO (multiple input, multiple output) and SIMO (single input, multiple output).
near field communication(NFC)	Ashort-range wireless connectivity standard (Ecma-340, ISO/IEC 18092) that uses magnetic field induction to enable communication between devices when they're touched together, or brought within a few centimeters of each other. The standard specifies a way for the devices to establish a peer-to-peer (P2P) network to exchange data.
optical wireless	The combined use of conventional radio-frequency (RF) wireless and optical fiber for telecommunication. Long-range links are provided by optical fiber and links from the long-range end-points to end users are accomplished by RF wireless or laser systems. RF wireless at ultra-high frequencies (UHF) and microwave frequencies can carry broadband signals to individual computers at substantial data speeds.
OCSP Client	The ArubaOS controller can act as an OCSP client and issues OCSP queries to remote OCSP responders located on the intranet or Internet.
OCSP Responder	The OCSP client retrieves certificate revocation status from an OCSP responder. The responder may be the certificate authority (CA) that has issued the certificate in question or it may be some other designated entity which provides the service on behalf of the CA.
radio frequency (RF)	Portion of electromagnetic spectrum in which electromagnetic waves are generated by feeding alternating current to an antenna.
RF plan	Dell deployment modeling tool. This tool is provided in the Dell Web-UI as well as the Dell Mobility Management System.
structured wireless-aware network (SWAN)	A technology that incorporates a WLAN into a wired wide-area network (WAN). SWAN technology can enable an existing wired network to serve hundreds of users, organizations, corporations, or agencies over a large geographic area. A SWAN is said to be scalable, secure, and reliable.
transponder	A wireless communications, monitoring, or control device that picks up and automatically responds to an incoming signal. The term is a contraction of the words transmitter and responder. Transponders can be either passive or active.
ultra high frequency (UHF)	International Telecommunication Union (ITU) band 9, 300-3000 MHz, 1m - 100 mm frequency wavelength.
ultra wideband (UVB)	Is a wireless technology for transmitting large amounts of digital data over a wide spectrum of frequency bands with very low power for a short distance. Ultra wideband broadcasts very precisely timed digital pulses on a carrier signal across a very wide spectrum (number of frequency channels) at the same time. UWB can carry a huge amount of data over a distance up to 230 feet at very low power (less than 0.5 milliwatts), and has the ability to carry signals through doors and other obstacles that tend to reflect signals at more limited bandwidths and a higher power.
virtual private network (VPN)	A network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization's network. A VPN ensures privacy through security procedures and tunneling protocols such as the Layer Two Tunneling Protocol (L2TP). Data is encrypted at the sending end and decrypted at the receiving end.

Table 179 *List of terms (Continued)*

Term	Definition
voice over WLAN (VoWLAN)	A method of routing telephone calls for mobile users over the Internet using the technology specified in IEEE 802.11b. Routing mobile calls over the Internet makes them free, or at least much less expensive than they would be otherwise.
wideband code-division multiple access (W-CDMA)	Officially known as IMT-2000 direct spread; ITU standard derived from Code-Division Multiple Access (CDMA). W-CDMA is a third-generation (3G) mobile wireless technology that promises much higher data speeds to mobile and portable wireless devices than commonly offered in today's market.
Wi-Fi	A term for certain types of WLANs. Wi-Fi can apply to products that use any 802.11 standard. Wi-Fi has gained acceptance in many businesses, agencies, schools, and homes as an alternative to a wired LAN. Many airports, hotels, and fast-food facilities offer public access to Wi-Fi networks.
WiMAX	A wireless industry coalition whose members organized to advance IEEE 802.16 standards for broadband wireless access (BWA) networks. WiMAX 802.16 technology is expected to enable multimedia applications with wireless connection and, with a range of up to 30 miles, enable networks to have a wireless last mile solution. According to the WiMAX forum, the group's aim is to promote and certify compatibility and interoperability of devices based on the 802.16 specification, and to develop such devices for the marketplace.
wired equivalent privacy (WEP)	A security protocol specified in 802.11b, designed to provide a WLAN with a level of security and privacy comparable to what is usually expected of a wired LAN. Data encryption protects the vulnerable wireless link between clients and access points; once this measure has been taken, other typical LAN security mechanisms such as password protection, end-to-end encryption, virtual private networks (VPNs), and authentication can be put in place to ensure privacy.
wireless	Describes telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or all of the communication path.
wireless abstract XML (WAX)	Describes telecommunications in which electromagnetic waves (rather than some form of wire) carry the signal over part or all of the communication path.
wireless application service provider (WASP)	Provides Web-based access to applications and services that would otherwise have to be stored locally and makes it possible for customers to access the service from a variety of wireless devices, such as a smartphone or personal digital assistant (PDA).
wireless ISP (WISP)	An internet service provider (ISP) that allows subscribers to connect to a server at designated hot spots (access points) using a wireless connection such as Wi-Fi. This type of ISP offers broadband service and allows subscriber computers, called stations, to access the Internet and the Web from anywhere within the zone of coverage provided by the server antenna, usually a region with a radius of several kilometers.
wireless service provider	A company that offers transmission services to users of wireless devices through radio frequency (RF) signals rather than through end-to-end wire communication.
wireless local area network (WLAN)	A local area network (LAN) that users access through a wireless connection. 802.11 standards specify WLAN technologies. WLANs are frequently some portion of a wired LAN.
yagi antenna	A unidirectional antenna commonly used in communications when a frequency is above 10 MHz.

Index

Numerics

A

B

C

N

O

P

Q

R

S

T

U

V

W

X