Dell PowerEdge Configuration Guide for the M I/O Aggregator

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Notes, Cautions, and Warnings

NOTE: A NOTE indicates important information that helps you make better use of your computer.

CAUTION: A CAUTION indicates either potential damage to hardware or loss of data and tells you how to avoid the problem.

WARNING: A WARNING indicates a potential for property damage, personal injury, or death.

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About this Guide

Objectives

This guide describes the supported protocols and software features, and provides configuration instructions and examples, for the Dell Force10 M I/O Aggregator running FTOS version 8.3.17.0.

The M I/O Aggregator is installed in a Dell PowerEdge M1000e Enclosure. For information about how to install and perform the initial switch configuration, refer to the *Getting Started Guides* on the Dell Support website at http://support.dell.com/manuals.

Though this guide contains information about protocols, it is not intended to be a complete reference. This guide is a reference for configuring protocols on Dell Force10 systems. For complete information about protocols, refer to other documentation, including IETF requests for comment (RFCs). The instructions in this guide cite relevant RFCs, and Standards Compliance contains a complete list of the supported RFCs and management information base files (MIBs).

Note: You can perform some of the configuration tasks described in this document by using either the FTOS command line or the Chassis Management Controller (CMC) graphical interface. Tasks supported by the CMC interface are shown with the CMC icon: CMC

Audience

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

Conventions

This document uses the following conventions to describe command syntax:

Convention	Description
keyword	Keywords are in bold and must be entered in the CLI as listed.
parameter	Parameters are in italics and require a number or word to be entered in the CLI.
{X}	Keywords and parameters within braces must be entered in the CLI.
[X]	Keywords and parameters within brackets are optional.
x | y	Keywords and parameters separated by bar require you to choose one.

Information Symbols

Table 1-1 describes symbols contained in this guide.

Table 1-1. Information Symbols

Symbol	Meaning	Description
	FTOS Behavior	This symbol informs you of an FTOS behavior. These behaviors are inherent to the Dell Force10 system or FTOS feature and are non-configurable.
	Exception	This symbol is a note associated with some other text on the page that is marked with an asterisk.
CMC	Chassis Management Controller (CMC) user interface	This symbol indicates that you can also perform the specified configuration task on an Aggregator by using the CMC graphical interface. For information about how to access the CMC to configure an Aggregator, refer to the *Dell PowerEdge M1000e Enclosure Hardware Owner's Manual* or Dell Chassis Management Controller (CMC) User's Guide on the Dell Support website at http://support.dell.com/support/edocs/systems/pem/en/index.htm.

Related Documents

For more information about the Dell Force10 MXL 10/40GbE Switch IO Module, refer to the following documents:

- *Dell Force10 FTOS Command Line Reference Guide for the M I/O Aggregator*
- *Dell PowerEdge M I/O Aggregator Getting Started Guide*
- *Release Notes for the M I/O Aggregator* (FTOS version 8.3.17.0)

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Before You Start

By following the instructions in the *Dell PowerEdge M I/O Aggregator Getting Started Guide* that is shipped with the product, you install the Aggregator in a Dell PowerEdge M1000e Enclosure.

The Aggregator installs with zero-touch configuration. After you power it on, an Aggregator boots up with default settings and auto-configures with software features enabled. This chapter describes the default settings and software features that are automatically configured at startup. Use the tasks described in the other chapters to reconfigure the Aggregator for customized network operation.

Default Settings

The I/O Aggregator provides zero-touch configuration with the following default configuration settings:

- Default user name (**root**)
- Password (**calvin**)
- VLAN (**vlan1**) and IP address for in-band management (**DHCP-assigned**)
- IP address for out-of-band (OOB) management (**DHCP-assigned**)
- Read-only SNMP community name (**public**)
- Broadcast storm control (**enabled**)
- Unregistered IGMP multicast packet flooding (**enabled**)
- IGMP snooping in all VLANs except the default VLAN (**enabled**)
- VLAN configuration (all ports belong to all VLANs)

You can change any of these default settings using the CLI. Refer to the appropriate chapter for details.

Note: You can also change many of the default settings using the chassis management controller (CMC) interface. In this document, configuration tasks that you can perform from the CMC interface are shown with a CMC icon: CMC

For information about how to access the CMC to configure an Aggregator, refer to the *Dell PowerEdge M1000e Enclosure Hardware Owner's Manual* or *Dell Chassis Management Controller (CMC) User's Guide* on the Dell Support website at http://support.dell.com/support/edocs/systems/pem/en/index.htm.

Other Auto-Configured Settings

After the Aggregator powers on, it auto-configures and is operational with software features enabled, including:

- Ports: Ports are administratively up and auto-configured to operate as hybrid ports to transmit tagged and untagged VLAN traffic.

  Ports 1 to 32 are internal server-facing ports, which can operate in either 1GbE or 10GbE mode. Ports 33 to 56 are external ports auto-configured to operate by default as follows:

  — The base-module ports operate in standalone 4x10GbE mode. You can configure these ports to operate in 40GbE stacking mode. When configured for stacking, the 40GbE base-module ports cannot be used for uplinks.

  — Ports on the 2-Port 40-GbE QSFP+ module operate only in 4x10GbE mode. They cannot be used for stacking.

  — Ports on the 4-Port 10-GbE SFP+ and 4-Port 10GBASE-T modules operate only in 10GbE mode.

  For more information on how ports are numbered, see Port Numbering.
- Link aggregation: All uplink ports are configured in a single LAG (LAG 128).
- VLANs: All ports are configured as members of all (4094) VLANs. All VLANs are up and can send or receive layer 2 traffic. For more information, see VLAN Membership.
- Data Center Bridging Capability Exchange Protocol (DCBX): Server-facing ports auto-configure in auto-downstream port roles; uplink ports auto-configure in auto-upstream port roles.
- Fibre Channel over Ethernet (FCoE) connectivity and FCoE Initiation Protocol (FIP) snooping: The uplink port channel (LAG 128) is enabled to operate in FCF port mode.
- Link Layer Discovery Protocol (LLDP): Enabled on all ports to advertise management TLV and system name with neighboring devices.
- iSCSI optimization
- IGMP snooping
- Jumbo frames: Ports are set to a maximum MTU of 12,000 bytes by default.
- Link tracking: Uplink-state group 1 is automatically configured. In uplink state-group 1, server-facing ports auto-configure as downstream interfaces; the uplink port-channel (LAG 128) auto-configures as an upstream interface. Server-facing links are auto-configured to be brought up only if the uplink port-channel is up.
- Stacking is not enabled by default and is supported in 40GbE mode only on the base-module ports. To configure a switch stack, you must use the CLI. See Stacking for more information.

DCB Support

DCB enhancements for data center networks are supported to eliminate packet loss and provision links with required bandwidth.

The Aggregator provides zero-touch configuration for DCB. The Aggregator auto-configures DCBX port roles as follows:

- Server-facing ports are configured as auto-downstream interfaces.
- Uplink ports are configured as auto-upstream interfaces.

In operation, DCBX auto-configures uplink ports to match the DCB configuration in the ToR switches to which they connect.

The Aggregator supports DCB only in standalone mode; DCB is not supported in stacking mode.

FCoE Connectivity and FIP Snooping

Many data centers use Fibre Channel (FC) in storage area networks (SANs). Fibre Channel over Ethernet (FCoE) encapsulates Fibre Channel frames over Ethernet networks.

On an Aggregator, the internal ports support FCoE connectivity and connect to the converged network adapter (CNA) in blade servers. FCoE allows Fibre Channel to use 10-Gigabit Ethernet networks while preserving the Fibre Channel protocol.

The Aggregator also provides zero-touch configuration for FCoE configuration. The Aggregator auto-configures to match the FCoE settings used in the ToR switches to which it connects through its uplink ports.

FIP snooping is automatically configured on an Aggregator. The auto-configured port channel (LAG 128) operates in FCoE forwarder (FCF) port mode.

iSCSI Operation

Support for iSCSI traffic is turned on by default when the Aggregator powers up. No configuration is required.

When the Aggregator powers up, it monitors known TCP ports for iSCSI storage devices on all interfaces. When a session is detected, an entry is created and monitored as long as the session is active.

The Aggregator also detects iSCSI storage devices on all interfaces and auto-configures to optimize performance. Performance optimization operations, such as Jumbo frame size support, STP port-state fast, and disabling of storm control on interfaces connected to an iSCSI storage device, are applied automatically.

CLI configuration is necessary only when the configuration includes iSCSI storage devices that cannot be automatically detected and when non-default QoS handling is required.

Link Aggregation

All uplink ports are configured in a single LAG (LAG 128). Server-facing ports are auto-configured as part of link aggregation groups if the corresponding server is configured for LACP-based NIC teaming. Static LAGs are not supported.

Tip: The recommended LACP timeout is long-timeout mode.

Link Tracking

By default, all server-facing ports are tracked by the operational status of the uplink LAG. If the uplink LAG goes down, the Aggregator loses its connectivity and is no longer operational; all server-facing ports are brought down.

Tip: If installed servers do not have connectivity to a ToR switch, check the Link Status LED of uplink ports on the Aggregator. If all LEDs are on, check the LACP configuration on the ToR switch that is connected to the Aggregator to ensure the LACP is correctly configured.

Note: Link tracking is also referred to as uplink failure detection (UFD).

VLANs

By default, all Aggregator ports belong to all 4094 VLANs and are members of untagged VLAN 1. You can use the CLI or CMC interface to configure only the required VLANs on a port.

When you configure VLANs on server-facing interfaces (ports 1 to 32), you can assign VLANs to a port or a range of ports by entering the vlan tagged or vlan untagged commands in interface configuration mode; for example:

```
FTOS(conf)# interface tengigabitethernet 0/2 - 4
FTOS(conf-if-range-te-0/2-4)# vlan tagged 5,7,10-12
FTOS(conf-if-range-te-0/2-4)# vlan untagged 3
```

Note: You can also use the CMC interface to configure VLANs.

Uplink LAG

The tagged VLAN membership of the uplink LAG is automatically configured based on the VLAN configuration of all server-facing ports (ports 1 to 32).

The untagged VLAN used for the uplink LAG is always the default VLAN.

Server-Facing LAGs

The tagged VLAN membership of a server-facing LAG is automatically configured based on the server-facing ports that are members of the LAG.

The untagged VLAN of a server-facing LAG is configured based on the untagged VLAN to which the lowest numbered server-facing port in the LAG belongs.

Tip: Dell Force10 recommends that you configure the same VLAN membership on all LAG member ports.

Stacking Mode

Stacking is supported only on the 40GbE ports on the base module. A single stack is limited to two Aggregators in the same chassis. Up to three stacks are supported in an M1000e chassis. To configure a switch stack, you must use the CLI. See Stacking for more information.

When you configure an Aggregator to operate in stacking mode, VLANs are reconfigured as follows:

- If an Aggregator port belonged to all 4094 VLANs in standalone mode (default), all VLAN membership is removed and the port is assigned only to default VLAN 1. You must configure additional VLAN membership as necessary.
- If you had manually configured an Aggregator port to belong to one or more VLANs (non-default) in standalone mode, the VLAN configuration is retained in stacking mode only on the master switch.

When you reconfigure an Aggregator from stacking to standalone mode, Aggregator ports that you manually configured for VLAN membership in stacking mode retain their VLAN configuration in standalone mode. To restore the default auto-VLAN mode of operation (in which all ports are members of all 4094 VLANs) on a port, enter the auto vlan command; for example:

```
FTOS(conf)# interface tengigabitethernet 0/2
FTOS(conf-if-te-0/2)# auto vlan
```

Where to Go From Here

You can customize the Aggregator for use in your data center network as necessary. To perform additional switch configuration, do one of the following:

- For remote out-of-band management, enter the OOB management interface IP address into a Telnet or SSH client and log in to the switch using the user ID and password to access the CLI.
- For local management using the CLI, use the attached console connection.
- For remote in-band management from a network management station, enter the IP address of the default VLAN and log in to the switch to access the CLI.

If you installed the Aggregator in a stack, you can configure additional settings for switch stacking.

In case of an FTOS upgrade, you can check to see that an Aggregator is running the latest FTOS version by entering the **show version** command. To download an FTOS version, go to http://support.dell.com.

Refer to the appropriate chapter for detailed information on how to reconfigure specific software settings.

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Configuration Fundamentals

The Dell Force10 operating software (FTOS) command line interface (CLI) is a text-based interface through which you can configure interfaces and protocols. The CLI is structured in modes for security and management purposes. Different sets of commands are available in each mode, and you can limit user access to modes using privilege levels.

In FTOS, after you enable a command, it is entered into the running configuration file. You can view the current configuration for the whole system or for a particular CLI mode. To save the current configuration, copy the running configuration to another location. For more information, refer to Save the Running-Configuration.

Note: You can use the chassis management controller (CMC) out-of-band management interface to access and manage an Aggregator using the FTOS command-line interface. For information about how to access the CMC to configure an Aggregator, refer to the *Dell Chassis Management Controller (CMC) User's Guide* on the Dell Support website at http://support.dell.com/support/edocs/systems/pem/en/index.htm.

Accessing the Command Line

Access the command line through a serial console port or a Telnet session (Figure 3-1). When the system successfully boots, enter the command line in EXEC mode.

Figure 3-1. Logging into the System using Telnet

```
telnet 172.31.1.53
Trying 172.31.1.53...
Connected to 172.31.1.53.
Escape character is '^]'.
Login: username
Password:
FTOS>
```

EXEC mode prompt

CLI Modes

Different sets of commands are available in each mode. A command found in one mode cannot be executed from another mode (with the exception of EXEC mode commands preceded by the command do; for more information, refer to do Command and EXEC Privilege Mode commands).

The FTOS CLI is divided into three major mode levels:

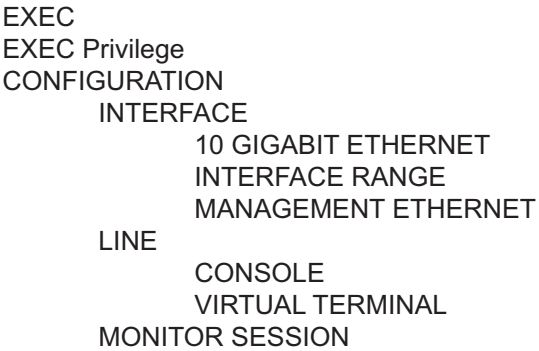
- **EXEC mode** is the default mode and has a privilege level of 1, which is the most restricted level. Only a limited selection of commands is available, notably the show commands, which allow you to view system information.
- **EXEC Privilege mode** has commands to view configurations, clear counters, manage configuration files, run diagnostics, and enable or disable debug operations. The privilege level is 15, which is unrestricted. You can configure a password for this mode. For more information, refer to Configure the Enable Password.
- **CONFIGURATION mode** allows you to configure security features, time settings, set logging and simple network management protocol (SNMP) functions, and static address resolution protocol (ARP) and MAC addresses on the system.

Beneath CONFIGURATION mode are sub-modes that apply to interfaces, protocols, and features. Figure 3-2 shows this sub-mode command structure. When configuring the chassis for the first time, the following two sub-CONFIGURATION modes are important:

- **INTERFACE sub-mode** is the mode in which you configure Layer 2 and Layer 3 protocols and IP services specific to an interface. An interface can be physical (management interface, 10-Gigabit Ethernet, or 40-Gigabit Ethernet) or logical (Loopback, Null, port channel, or VLAN).
- **LINE sub-mode** is the mode in which you configure the console and virtual terminal lines.

Note: At any time, entering a question mark (?) displays the available command options. For example, when you are in CONFIGURATION mode, entering the question mark first lists all the available commands, including the possible sub-modes.

Figure 3-2. FTOS CLI Modes Supported on the Aggregator



Navigating CLI Modes

The FTOS prompt changes to indicate the CLI mode. Table 3-1 lists the CLI mode, its prompt, and information about how to access and exit this CLI mode. You must move linearly through the command modes, with the exception of the end command, which takes you directly to EXEC Privilege mode and the exit command moves you up one command mode level.

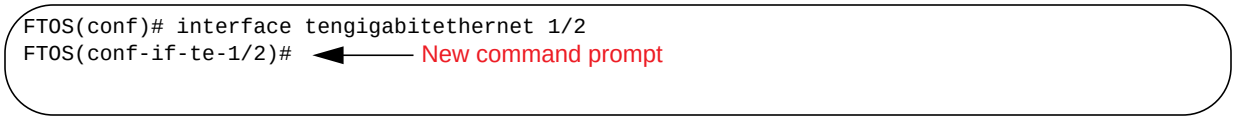
Note: Sub-CONFIGURATION modes all have the letters “conf” in the prompt with additional modifiers to identify the mode and slot/port information. These are shown in Table 3-1.

Table 3-1. FTOS Command Modes

	CLI Command Mode	Prompt	Access Command
	EXEC	FTOS>	Access the router through the console or Telnet.
	EXEC Privilege	FTOS#	• From EXEC mode, enter the command enable. • From any other mode, enter the command end.
	CONFIGURATION	FTOS(conf)#	• From EXEC privilege mode, enter the command configure. • From every mode except EXEC and EXEC Privilege, enter the command exit.
	Note: Access the following modes from CONFIGURATION mode:		
INTERFACE modes	10 Gigabit Ethernet Interface	FTOS(conf-if-te-0/1)#	interface
	Interface Range	FTOS(conf-if-range)#	interface
	Management Ethernet Interface	FTOS(conf-if-ma-0/0)#	interface
	Monitor Session	FTOS(conf-mon-sess)	monitor session
	IP COMMUNITY-LIST	FTOS(conf-community-list)#	ip community-list
LINE	CONSOLE	FTOS(conf-line-console)#	line
	VIRTUAL TERMINAL	FTOS(conf-line-vty)#	line

Figure 3-3 shows how to change the command mode from CONFIGURATION mode to INTERFACE configuration mode.

Figure 3-3. Changing CLI Modes

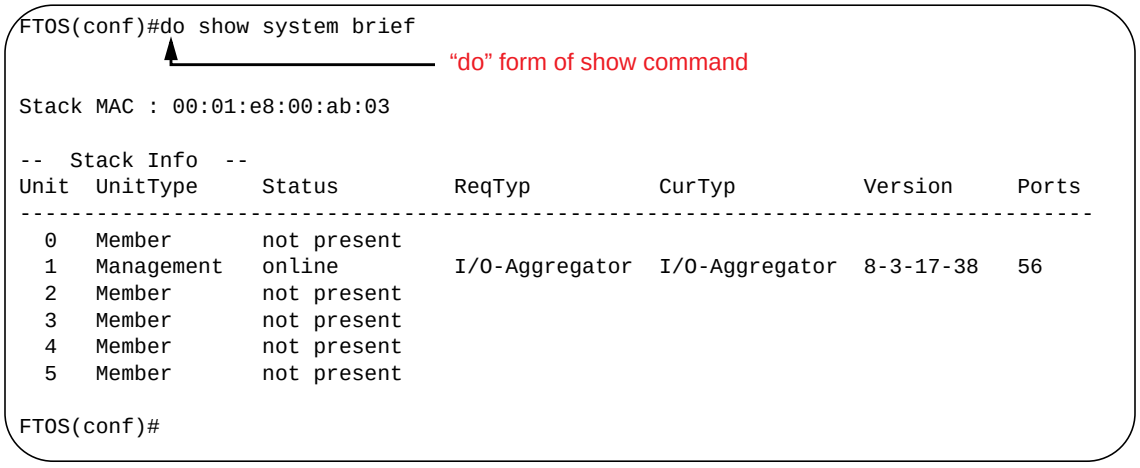


do Command

Enter an EXEC mode or EXEC privilege mode command from any CONFIGURATION mode (such as CONFIGURATION, INTERFACE, etc.) without returning to EXEC mode by preceding the EXEC mode command with the command do. Figure 3-4 illustrates the do command.

Note: The following commands cannot be modified by the do command: enable, disable, exit, and configure.

Figure 3-4. Using the do Command



Undoing Commands

When you enter a command, the command line is added to the running configuration file. Disable a command and remove it from the running-config by entering the original command preceded by the command *no*. For example, to delete an ip address configured on an interface, use the no ip-address *ip-address* command, as shown in Figure 3-5.

Note: Use the help or ? command as described in Obtaining Help to help you construct the *no* form of a command.

Figure 3-5. Undoing a command with the no Command

```
FTOS(conf)# interface managementethernet 0/0
FTOS(conf-if-ma-0/0)# ip address 192.168.5.6/16      <-- Assign an IP address
FTOS(conf-if-ma-0/0)#
FTOS(conf-if-ma-0/0)#
FTOS(conf-if-ma-0/0)#show config
!
interface ManagementEthernet 0/0
 ip address 192.168.5.6/16
no shutdown
FTOS(conf-if-ma-0/0)#
FTOS(conf-if-ma-0/0)# no ip address      <-- Enter "no" form of IP address command
FTOS(conf-if-ma-0/0)#
FTOS(conf-if-ma-0/0)# show config
!
interface ManagementEthernet 0/0
 no ip address      <-- Verify that the IP address was removed
 no shutdown
FTOS(conf-if-ma-0/0)#
```

Obtaining Help

Obtain a list of keywords and a brief functional description of those keywords at any CLI mode using the ? or help commands:

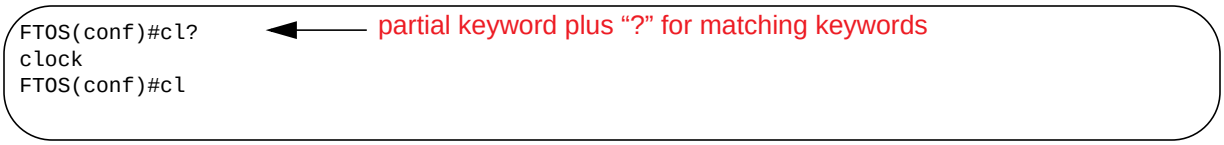
- Enter ? at the prompt or after a keyword to list the keywords available in the current mode.
  - ? after a prompt lists all of the available keywords. The output of this command is the same for the help command.

Figure 3-6. ? Command Example

```
FTOS#?          <-- "?" at prompt for list of commands
start                Start Shell
capture              Capture Packet
cd                   Change current directory
clear                Reset functions
clock                Manage the system clock
configure            Configuring from terminal
copy                 Copy from one file to another
--More--
```

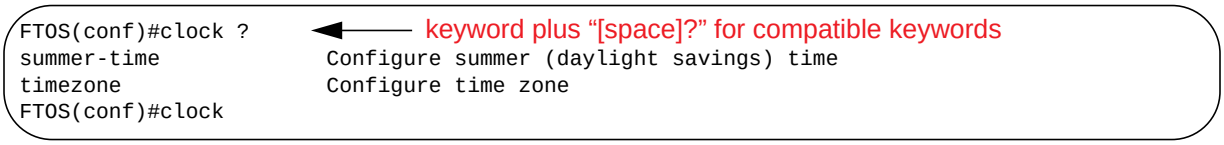
  - ? after a partial keyword lists all of the keywords that begin with the specified letters.

Figure 3-7. Keyword? Command Example



- A keyword followed by [space]? lists all of the keywords that can follow the specified keyword.

Figure 3-8. Keyword ? Command Example



Entering and Editing Commands

When entering commands:

- The CLI is not case sensitive.
- You can enter partial CLI keywords.
  - You must enter the minimum number of letters to uniquely identify a command. For example, cl cannot be entered as a partial keyword because both the clock and class-map commands begin with the letters “cl.” You can, however, enter clo as a partial keyword because only one command begins with those three letters.
  - The TAB key auto-completes keywords in commands.
  - The UP and DOWN arrow keys display previously entered commands (refer to Command History).
  - The BACKSPACE and DELETE keys erase the previous letter.
  - Key combinations are available to move quickly across the command line, refer to Table 3-2.

Table 3-2. Short-Cut Keys and their Actions

Key Combination	Action
CNTL-A	Moves the cursor to the beginning of the command line.
CNTL-B	Moves the cursor back one character.
CNTL-D	Deletes the character at cursor.
CNTL-E	Moves the cursor to the end of the line.
CNTL-F	Moves the cursor forward one character.
CNTL-I	Completes a keyword.
CNTL-K	Deletes all characters from the cursor to the end of the command line.
CNTL-L	Re-enters the previous command.
CNTL-N	Return to more recent commands in the history buffer after recalling commands with CTRL-P or the UP arrow key.
CNTL-P	Recalls commands, beginning with the last command.

Table 3-2. Short-Cut Keys and their Actions (continued)

Key Combination	Action
CNTL-R	Re-enters the previous command.
CNTL-U	Deletes the line.
CNTL-W	Deletes the previous word.
CNTL-X	Deletes the line.
CNTL-Z	Ends continuous scrolling of command outputs.
Esc B	Moves the cursor back one word.
Esc F	Moves the cursor forward one word.
Esc D	Deletes all characters from the cursor to the end of the word.

Command History

FTOS maintains a history of previously-entered commands for each mode. For example:

- When you are in EXEC mode, the UP and DOWN arrow keys display the previously-entered EXEC mode commands.
- When you are in CONFIGURATION mode, the UP or DOWN arrows keys recall the previously-entered CONFIGURATION mode commands.

Filtering show Command Outputs

Filter the output of a show command to display specific information by adding | [except | find | grep | no-more | save] *specified_text* after the command. The variable *specified_text* is the text for which you are filtering and it IS case sensitive unless you use the ignore-case sub-option.

The grep command accepts an ignore-case sub-option that forces the search to be case-*in*sensitive. For example, the commands:

- show run | grep Ethernet returns a search result with instances containing a capitalized “Ethernet,” such as `interface TenGigabitEthernet 0/0.`
- show run | grep ethernet would not return that search result because it only searches for instances containing a non-capitalized “ethernet.”

Executing the show run | grep Ethernet ignore-case command would return instances containing both “Ethernet” and “ethernet.”

- grep displays only the lines containing specified text. Figure 3-9 shows this command used in combination with the do show stack-unit all stack-ports pfc details | grep 0 command.

Figure 3-9. Filtering Command Outputs with the grep Command

```
FTOS(conf)#do show stack-unit all stack-ports all pfc details | grep 0
 stack unit 0 stack-port all
     0 Pause Tx pkts, 0 Pause Rx pkts
     0 Pause Tx pkts, 0 Pause Rx pkts
     0 Pause Tx pkts, 0 Pause Rx pkts
     0 Pause Tx pkts, 0 Pause Rx pkts
     0 Pause Tx pkts, 0 Pause Rx pkts
     0 Pause Tx pkts, 0 Pause Rx pkts
```

Note: FTOS accepts a space or no space before and after the pipe. To filter on a phrase with spaces, underscores, or ranges, enclose the phrase with double quotation marks.

- except displays text that does not match the specified text. Figure 3-10 shows this command used in combination with the do show stack-unit all stack-ports all pfc details | except 0 command.

Figure 3-10. Filtering Command Outputs with the except Command

```
FTOS(conf)#do show stack-unit all stack-ports all pfc details | except 0

     Admin mode is On
     Admin is enabled
     Local is enabled
     Link Delay 45556 pause quantum

 stack unit 1 stack-port all
     Admin mode is On
     Admin is enabled
```

- find displays the output of the show command beginning from the first occurrence of specified text Figure 3-11 shows this command.

Figure 3-11. Filtering Command Outputs with the find Command

```
FTOS(conf)#do show stack-unit all stack-ports all pfc details | find 0
 stack unit 0 stack-port all
     Admin mode is On
     Admin is enabled
     Local is enabled
     Link Delay 45556 pause quantum
     0 Pause Tx pkts, 0 Pause Rx pkts

 stack unit 1 stack-port all
```

- no-more displays the output all at once rather than one screen at a time. This is similar to the terminal length command except that the no-more option affects the output of the specified command only.
- save copies the output to a file for future reference.

Note: You can filter a single command output multiple times. The save option should be the last option entered. For example:
FTOS# *command* | grep *regular-expression* | except *regular-expression* | grep *other-regular-expression* | find *regular-expression* | save

Multiple Users in Configuration Mode

FTOS notifies all users in the event that there are multiple users logged into CONFIGURATION mode. A warning message indicates the username, type of connection (console or vty), and in the case of a vty connection, the IP address of the terminal on which the connection was established. For example:

- On the system that telnets into the switch, Message 1 appears:

Message 1 Multiple Users in Configuration Mode Telnet Message

```
% Warning: The following users are currently configuring the system:

User "<username>" on line console0
```

- On the system that is connected over the console, Message 2 appears:

Message 2 Multiple Users in Configuration Mode Telnet Message

```
% Warning: User "<username>" on line vty0 "10.11.130.2" is in configuration mode
```

If either of these messages appear, Dell Force10 recommends coordinating with the users listed in the message so that you do not unintentionally overwrite each other's configuration changes.

4

Getting Started

This chapter contains the following major sections:

- Front Panel
- Port Numbering
- Console access
- Boot Process
- Configure a Host Name
- Configure a Host Name
- Access the System Remotely
- Configure the Enable Password
- Configuration File Management
- File System Management
- View the Command History
- Upgrading and Downgrading FTOS

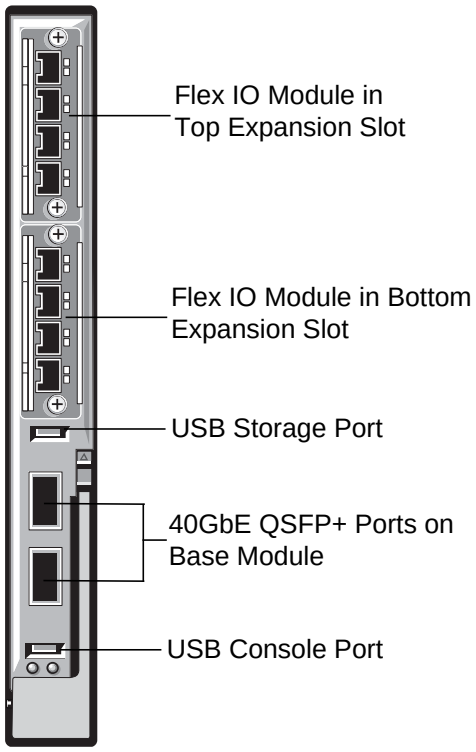
When the boot process is complete, the console monitor displays the Dell Force10 operating software (FTOS) banner and EXEC mode prompt (Figure 4-3).

For details about using the command line interface (CLI), refer to the Accessing the Command Line section in the Configuration Fundamentals chapter.

Front Panel

Figure 4-1 shows the Aggregator front panel:

Figure 4-1. Front Panel of the M I/O Aggregator



Port Numbering

When installed in a PowerEdge M1000e Enclosure, Aggregator ports are numbered 1 to 56 and consist of internal server-facing ports, uplink ports, and stacking ports (Figure 4-2).

Server-Facing Ports

Ports 1 to 32 are internal server-facing ports, which can operate in either 1GbE or 10GbE mode and connect to servers installed in the M1000e chassis over the midplane.

Uplink Ports

Ports 33 to 56 are external ports used for uplinks and numbered from the bottom to the top of the switch as follows:

- The two base module ports operate by default in standalone 4x10GbE mode and are numbered 33 to 36 and 37 to 40.
- Ports on the 2-Port 40-GbE QSFP+ module operate only in 4x10GbE mode:
  - In the bottom expansion slot, ports are numbered 41 to 44 and 45 to 48.
  - In the top expansion slot, ports are numbered 49 to 52 and 53 to 56.
- Ports on the 4-Port 10-GbE SFP+ and 4-Port 10GBASE-T modules operate only in 10GbE mode:
  - In the bottom expansion slot, ports are numbered 41 to 44.
  - In the top expansion slot, ports are numbered 49 to 52.

Stacking Ports

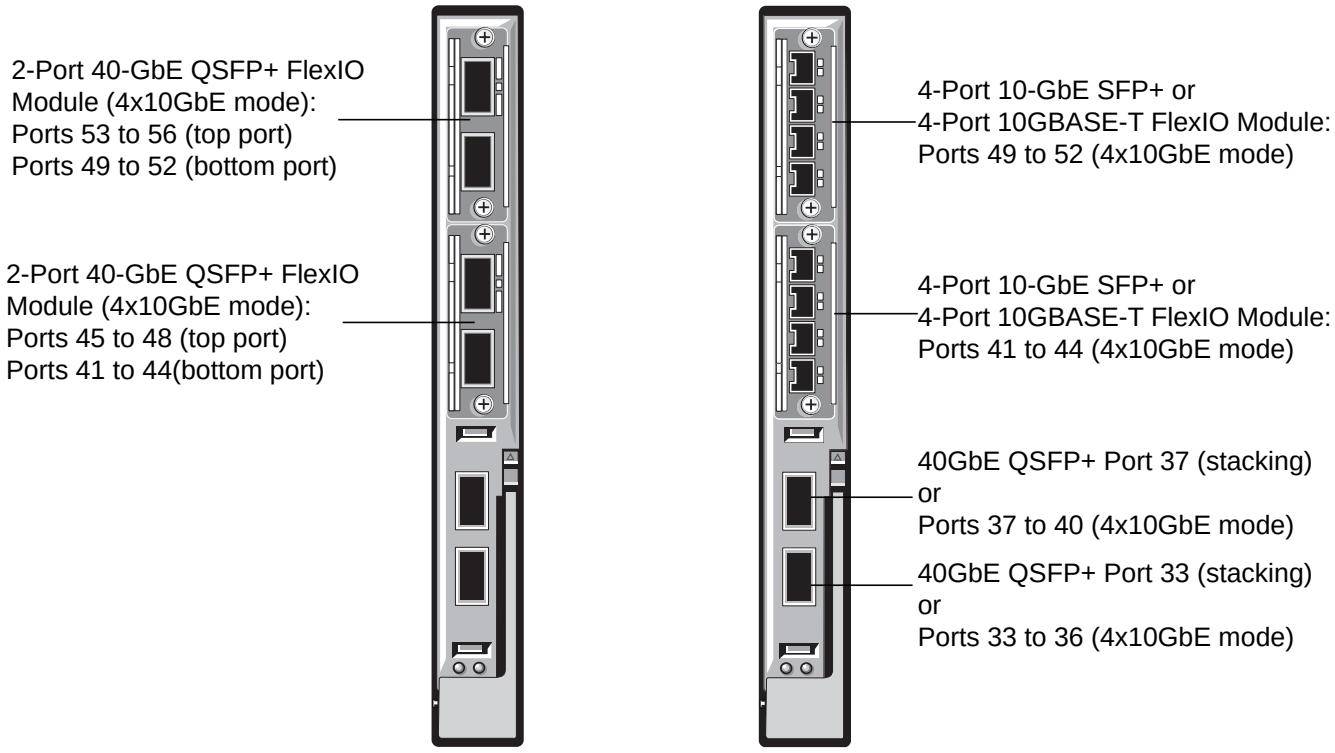
Stacking is supported only on the ports on the base module. When you configure the Aggregator for stacking, the base module ports operate in 40GbE mode and are numbered 33 and 37. When configured for stacking, the 40GbE base-module ports cannot be used for uplinks.

Port Configuration

To configure a port, you must specify the slot (0-5; default: 0) and port number (1 to 56) in the **interface** *port-type slot*/*port* command, where *slot* is the unit number of the Aggregator displayed in the **show system brief** command; for example:

```
FTOS(conf)# interface tengigabitethernet 0/4
```

Figure 4-2. Port Numbering on an Aggregator



Console access

The Aggregator has two management ports available for system access: a serial console port and an out-of-bounds (OOB) port.

Serial Console

A universal serial bus (USB) (A-Type) connector is located on the front panel. The USB can be defined as an External Serial Console (RS-232) port, and is labeled on the Aggregator. The USB is on the lower side of an installed Aggregator, as you face the I/O side of the M1000e chassis (Figure 4-1). For the console port piMnout, refer to Table 4-1.

To access the console port, follow these steps.

Step	Task
1	Connect the USB connector to the front panel. Use the RS-232 Serial Line cable to connect the Aggregator console port to a terminal server.
2	Connect the other end of the cable to the DTE terminal server.

Step	Task (continued)

Note: Terminal settings on the console port cannot be changed in the software and are set as follows:

- 9600 baud rate
- No parity
- 8 data bits
- 1 stop bit
- No flow control

External Serial Port with a USB Connector

Table 4-1 lists the pin assignments.

Table 4-1. Pin Assignments

USB Pin Number	Signal Name
Pin 1	RTS
Pin 2	RX
Pin 3	TX
Pin 4	CTS
Pin 5, 6	GND
RxD	Chassis GND

Boot Process

After you follow the instructions in the *Installation Procedure* in the *Getting Started Guide*, the Aggregator boots up. The Aggregator with FTOS version 8.3.17.0 requires boot flash version 4.0.1.0 and boot selector version 4.0.0.0. Figure 4-3 through Figure 4-7 show the completed boot process.

Figure 4-3. Completed Boot Process

```
syncing disks... done
unmounting file systems...
unmounting /f10/flash (/dev/ld0e)...
unmounting /usr (mfs:31)...
unmounting /lib (mfs:23)...
unmounting /f10 (mfs:20)...
unmounting /tmp (mfs:15)...
unmounting /kern (kernfs)...
unmounting / (/dev/md0a)... done
rebooting...
þ

NetLogic XLP Stage 1 Loader
Built by build at tools-sjc-01 on Fri Mar 16  9:03:43 2012
Navasota IOM Boot Selector Label 4.0.0.0bt

##############################################
#                                            #
#      x-loader:  for Navasota board         #
#                                            #
##############################################

Nodes online: 1
GPIO 22 init'ed as an output
GPIO 23 init'ed as an output
I2C0 speed = 30 KHz, prescaler = 0x0377.
Initialized I2C0 Controller.
I2C1 speed = 100 KHz, prescaler = 0x0109.
Initialized I2C1 Controller.
DDR SPD: Node 0 Channel 0 Mem size = 2048 MB
DDR SPD: Node 0 DRAM frequency 666 MHz
DDR SPD: Node 0 CPU frequency 1200 MHz
RTT Norm:44
NBU0 DRAM BAR0 base: 00000000 limit: 0013f000 xlate: 00000001 node: 00000000 (    0 MB ->   320 MB,
size:   320 MB)
NBU0 DRAM BAR1 base: 001d0000 limit: 0088f000 xlate: 00090001 node: 00000000 (  464 MB ->  2192 MB,
size:  1728 MB)
Modifying Default Flash Address map..Done
Initialized e.MMC Host Controller
Detected SD Card
BLC is 1 (preset 10)
Hit any key to stop autoboot:  0
F10 Boot Image selection
Reading the Boot Block Info...Passed !!
Images are OK A:0x0 B:0x0
Boot Selector set to Bootflash Partition A image...
Verifying Copyright Information..success for  Image - 0
Boot Selector: Booting Bootflash Partition A image...
Copying stage-2 loader from 0xb6120000 to 0x8c100000(size = 0x100000)
F10 Boot Image selection DONE.
## Starting application at 0x8C100000 ...


U-Boot 2010.03-rc1(Dell Force10)
Built by antonyr at login-sjc-05 on Wed May  2  0:57:04 2012
Navasota IOM Boot Label 4.0.1.0bt

DRAM:   2 GB
```

Figure 4-4. Completed Boot Process (Contd.)

```
##########################################
#                                        #
#      u-boot:  for Navasota board       #
#                                        #
##########################################

Initialized CPLD on CS3
Detected [XLP308 (Lite)  Rev A0]

CPLD reg 06 val 0xf7

This is a NAVASOTA ...
Initializing I2C0: speed = 30 KHz, prescaler = 0x0377 -- done.
Initializing I2C1: speed = 100 KHz, prescaler = 0x0109 -- done.
Initialized eMMC Host Controller
Detected SD Card
Now running in RAM - U-Boot [N64 ABI, Big-Endian] at: ffffffff8c100000
Flash: 256 MB
PCIE (B0:D01:F0) : Link up.
In:    serial
Out:   serial
Err:   serial
Net:   nae-0: PHY is Broadcom BCM54616S

--More--

RELEASE IMAGE HEADER DATA :
---------------------------
--More--

SOFTWARE IMAGE HEADER DATA :
----------------------------
--More--
Starting Dell Force10 application

00:00:15: %STKUNIT0-M:CP %RAM-6-ELECTION_ROLE: Stack unit 0 is transitioning to Management unit.
00:00:16: %STKUNIT0-M:CP %CHMGR-5-STACKUNITDETECTED: Stack unit 0 present
00:00:18: %STKUNIT0-M:CP %CHMGR-5-CHECKIN: Checkin from Stack unit 0 (type I/O-Aggregator, 56 ports)
00:00:18: %I/O-Aggregator:0 %LCMGR-5-IOM_STATE: Switch status of stack-unit 0 is set to Good
00:00:18: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed uplink state group Admin state to up: Group 1
00:00:18: %STKUNIT0-M:CP %CHMGR-5-STACKUNITUP: Stack unit 0 is up
00:00:20: %STKUNIT0-M:CP %CHMGR-5-SYSTEM_READY: System ready
00:00:20: %STKUNIT0-M:CP %IFMGR-5-OSTATE_UP: Changed interface state to up: Ma 0/0
00:00:22: %I/O-Aggregator:0 %POLLMGR-2-MODULE_POWER_STATE: Module 0 in unit 0 changed to POWER GOOD
state
00:00:23: %STKUNIT0-M:CP %CHMGR-0-TEMP_STATUS_CHANGE:  Unit 0 temperature state changed to 1.

00:00:24: %STKUNIT0-M:CP %RAM-5-STACK_STATE: Stack unit 0 is in Active State.
00:00:25: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_QSFP: Optics QSFP inserted in slot 0 port 33
00:00:25: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_QSFP: Optics QSFP inserted in slot 0 port 34
00:00:25: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_QSFP: Optics QSFP inserted in slot 0 port 35
00:00:26: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_QSFP: Optics QSFP inserted in slot 0 port 36
00:00:26: %STKUNIT0-M:CP %CHMGR-5-MODULE_INSERTED: SFP+ module has been inserted in stack-unit 0
optional slot 0
00:00:27: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_PLUS: Optics SFP+ inserted in slot 0 port 41
00:00:28: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_PLUS: Optics SFP+ inserted in slot 0 port 42
00:00:28: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_PLUS: Optics SFP+ inserted in slot 0 port 43
00:00:28: %I/O-Aggregator:0 %IFAGT-5-INSERT_OPTICS_PLUS: Optics SFP+ inserted in slot 0 port 44
```

Figure 4-5. Completed Boot Process (Contd.)

```
FTOS>00:00:30: %STKUNIT0-M:CP %IFMGR-5-IFM_ISCSI_ENABLE: iSCSI has been enabled causing flow control
to be enabled on all interfaces. EQL detection and enabling iscsi profile-compellent on an interface
may cause some automatic configurations to occur like jumbo frames on all ports and no storm control
on the port of detection
00:00:30: %STKUNIT0-M:CP %SEC-5-LOGIN_SUCCESS: Login successful for user  on line console
00:00:31: %STKUNIT0-M:CP %SNMP-6-SNMP_WARM_START: Agent Initialized - SNMP WARM_START.
00:00:31: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Changed uplink state group state to down: Group 1
00:00:32: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/1
00:00:32: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/1
00:00:43: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/2
00:00:44: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/2
00:00:44: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/3
00:00:44: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/3
00:00:45: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/4
00:00:45: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/4
00:00:45: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/5
00:00:45: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/5
00:00:46: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/6
00:00:46: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/6
00:00:46: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/7
00:00:46: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/7
00:00:47: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/8
00:00:47: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/8
00:00:47: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/9
00:00:47: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/9
00:00:48: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/10
00:00:48: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/10
00:00:48: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/11
00:00:48: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/11
00:00:49: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/12
00:00:49: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/12
00:00:49: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/13
00:00:50: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/13
00:00:50: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/14
00:00:50: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/14
00:00:51: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/15
00:00:51: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/15
00:00:51: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/16
00:00:51: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/16
00:00:52: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/17
00:00:52: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/17
00:00:52: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/18
00:00:52: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/18
00:00:52 : IO-AGG [Active]: Informing IOM booted successfully to CMC : Passed
00:00:53: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/19
00:00:53: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/19
00:00:53: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/20
00:00:53: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/20
00:00:54: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/21
00:00:54: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/21
00:00:54: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/22
00:00:55: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/22
00:00:55: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/23
00:00:55: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/23
00:00:56: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/24
00:00:56: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/24
00:00:56: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/25
00:00:56: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/25
00:00:57: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/26
00:00:57: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/26
00:00:57: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/27
00:00:57: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/27
00:00:58: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/28
00:00:58: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/28
```

Figure 4-6. Completed Boot Process (Contd.)

```
00:00:59: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/29
00:00:59: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/30
00:00:59: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/30
00:01:00: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/31
00:01:00: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/31
00:01:00: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/32
00:01:00: %STKUNIT0-M:CP %IFMGR-5-OSTATE_DN: Downstream interface set to UFD error-disabled: Te 0/32
00:01:01: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/33
00:01:01: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/34
00:01:02: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/35
00:01:03: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides
theconfiguration of ETS Recommend TLV transmitstatus: Te 0/33
00:01:03: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/34
00:01:03: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/35
00:01:03: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/36
00:01:03: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/37
00:01:04: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/36
00:01:04: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/37
00:01:04: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/38
00:01:04: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/38
00:01:04: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/39
00:01:04: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/40
00:01:04: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/39
00:01:04: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/40
00:01:05: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/41
00:01:05: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/41
00:01:05: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/42
00:01:06: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/43
00:01:06: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/42
00:01:06: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/43
00:01:06: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/44
00:01:07: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/44
00:01:07: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/45
0:01:07: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/46
00:01:08: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/45
00:01:08: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/46
00:01:08: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/47
00:01:08: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/47
00:01:09: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/48
00:01:09: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/48
00:01:09: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/49
00:01:09: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/50
00:01:10: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/49
00:01:10: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/50
00:01:10: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/51
00:01:10: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/51
00:01:10: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/52
00:01:10: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/53
00:01:11: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/52
00:01:11: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/53
```

Figure 4-7. Completed Boot Process (Contd.)

```
00:01:11: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/54
00:01:11: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/54
00:01:11: %STKUNIT0-M:CP %IFMGR-5-ASTATE_UP: Changed interface Admin state to up: Te 0/54
00:01:11: %STKUNIT0-M:CP %DIFFSERV-4-DSM_DCBX_ETS_RECO_TX_OVERRIDE: Port Role Change overrides the
configuration of ETS Recommend TLV transmitstatus: Te 0/54
```

Configure a Host Name

The host name appears in the prompt. The default host name is FTOS.

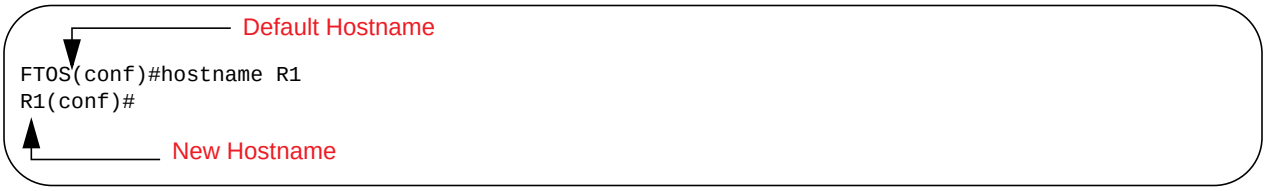
- Host names must start with a letter and end with a letter or digit.
- Characters within the string can be letters, digits, and hyphens.

To configure a host name, follow this steps:

Step	Task	Command Syntax	Command Mode
1	Create a new host name.	hostname *name*	CONFIGURATION

Figure 4-8 shows the hostname command.

Figure 4-8. Configuring a Hostname



Access the System Remotely

You can configure the system to access it remotely by Telnet. The Aggregator has a dedicated management port and a management routing table that is separate from the IP routing table.

Access the Aggregator Remotely

Configuring the Aggregator for Telnet access is a three-step process:

1. Configure an IP address for the management port. Refer to Configure the Management Port IP Address.
2. Configure a management route with a default gateway. Refer to Configure a Management Route.
3. Configure a username and password. Refer to Configure a Username and Password.

Configure the Management Port IP Address CMC

Assign IP addresses to the management ports in order to access the system remotely. To configure the management port IP address, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Enter INTERFACE mode for the Management port.	interface ManagementEthernet *slot/port* • *slot*: 0 • *port*: 0	CONFIGURATION
2	Assign an IP address to the interface.	ip address *ip-address/mask* • *ip-address:* an address in dotted-decimal format (A.B.C.D). • *mask:* a subnet mask in /prefix-length format (/xx).	INTERFACE
3	Enable the interface.	no shutdown	INTERFACE

You can also configure a management port to acquire its IP address dynamically from a DHCP server by using the **ip address dhcp** command:

Task	Command Syntax	Command Mode
Acquire an IP address from the DHCP server.	ip address dhcp	INTERFACE

Configure a Management Route CMC

Define a path from the system to the network from which you are accessing the system remotely. Management routes are separate from IP routes and are only used to manage the system through the management port.

To configure a management route, follow this step:

Step	Task	Command Syntax	Command Mode
1	Configure a management route to the network from which you are accessing the system.	management route *ip-address*/*mask gateway* • *ip-address:* the network address in dotted-decimal format (A.B.C.D). • *mask:* a subnet mask in /prefix-length format (/xx). • *gateway*: the next hop for network traffic originating from the management port.	CONFIGURATION

Configure a Username and Password CMC

Configure a system username and password to access the system remotely.

To configure a username and password, follow this step:

Step	Task	Command Syntax	Command Mode
1	Configure a username and password to access the system remotely.	username *username* password [*encryption-type*] *password* *encryption-type* specifies how you are inputting the password, is 0 by default, and is not required. • 0 is for inputting the password in clear text. • 7 is for inputting a password that is already encrypted using a Type 7 hash. Obtaining the encrypted password from the configuration of another Dell Force10 system.	CONFIGURATION

Configure the Enable Password

Access EXEC Privilege mode using the enable command. EXEC Privilege mode is unrestricted by default. Configure a password as a basic security measure. There are two types of enable passwords:

- enable password stores the password in the running/startup configuration using a DES encryption method.
- enable secret is stored in the running/startup configuration in using a stronger, MD5 encryption method.

Dell Force10 recommends using the enable secret password.

To configure an enable password:

Task	Command Syntax	Command Mode
Create a password to access EXEC Privilege mode.	enable [password | secret] [level *level*] [*encryption-type*] *password* *level* is the privilege level, is 15 by default, and is not required. *encryption-type* specifies how you are inputting the password, is 0 by default, and is not required. • 0 is for inputting the password in clear text. • 7 is for inputting a password that is already encrypted using a DES hash. Obtain the encrypted password from the configuration file of another Dell Force10 system. Can be used only for enable password. • 5 is for inputting a password that is already encrypted using an MD5 hash. Obtain the encrypted password from the configuration file of another Dell Force10 system. Can be used only for enable secret password.	CONFIGURATION

Configuration File Management

You can store on and access files from various storage media. Rename, delete, and copy files on the system from EXEC Privilege mode.

Note: Using flash memory cards in the system that have not been approved by Dell Force10 can cause unexpected system behavior, including a reboot.

Copy Files to and from the System

The command syntax for copying files is similar to UNIX. The copy command uses the format copy *source-file-url destination-file-url*.

Note: For a detailed description of the copy command, refer to the *FTOS Command Reference Guide*.

- To copy a local file to a remote system, combine the *file-origin* syntax for a local file location with the *file-destination* syntax for a remote file location (Table 4-2).
- To copy a remote file to a Dell Force10 system, combine the *file-origin* syntax for a remote file location with the *file-destination* syntax for a local file location (Table 4-2).

Table 4-2. Forming a copy Command

	source-file-url Syntax	*destination-file-url* Syntax
Local File Location		
Internal flash:		
flash	copy flash://*filename*	flash://*filename*
USB flash:		
usbflash	usbflash://*filename*	usbflash://*filename*
Remote File Location		
FTP server	copy ftp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*	ftp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*
TFTP server	copy tftp://{*hostip* | *hostname*}/*filepath*/*filename*	tftp://{*hostip* | *hostname*}/*filepath*/*filename*
SCP server	copy scp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*	scp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*

Important Points to Remember

- You may not copy a file from one remote system to another.
- You may not copy a file from one location to the same location.
- When copying to a server, you can only use a hostname if a DNS server is configured.

Figure 4-9 shows an example of using the copy command to save a file to an FTP server.

Figure 4-9. Copying a file to a Remote System

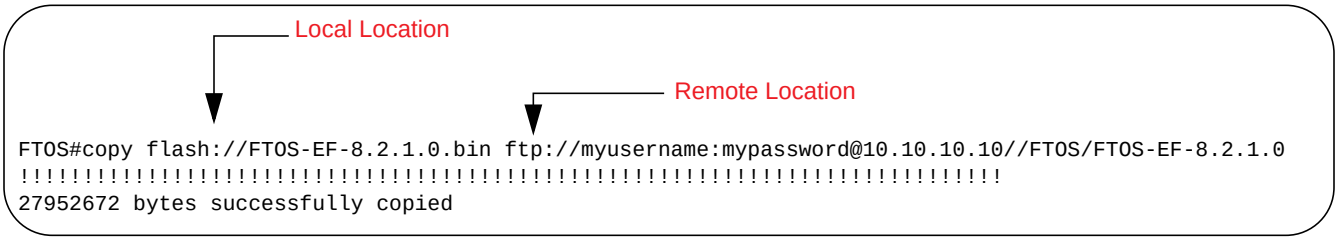


Figure 4-10 shows an example of using the copy command to import a file to the Dell Force10 system from an FTP server.

Figure 4-10. Copying a file from a Remote System

Save the Running-Configuration CMC

The running-configuration contains the current system configuration. Dell Force10 recommends copying your running-configuration to the startup-configuration. The system uses the startup-configuration during boot-up to configure the system. The startup-configuration is stored in the internal flash on the IOM by default, but you can save the startup-configuration to a USB flash device or on a remote server.

To save the running-configuration:

Task	Command Syntax	Command Mode
Save re-configured settings to the startup configuration.	write memory	CONFIGURATION

Note: The following commands are the same format as those in Copy Files to and from the System on page 31 but use the filenames *startup-config* and *running-config*. These commands assume that current directory is the internal flash, which is the system default.

Task	Command Syntax	Command Mode
Save the running-configuration to:		
the startup-configuration on the internal flash	copy running-config startup-config	EXEC Privilege
the usb flash on the IOM	copy running-config usbflash://*filename*	EXEC Privilege
an FTP server	copy running-config ftp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*	EXEC Privilege
a TFTP server	copy running-config tftp://{*hostip* | *hostname*}/*filepath*/*filename*	EXEC Privilege

Task	Command Syntax	Command Mode
an SCP server	copy running-config scp://*username*:*password*@{*hostip* | *hostname*}/*filepath*/*filename*	EXEC Privilege

Note: When copying to a server, you can only use a hostname if a DNS server is configured.

View Files

You can only view file information and content on local file systems.

To view a list of files on the internal or external Flash, follow this step:

Step	Task	Command Syntax	Command Mode
1	View a list of files on:		
	the internal flash	dir flash:	EXEC Privilege
	the usbflash	dir usbflash:	EXEC Privilege

The output of the command dir also shows the read/write privileges, size (in bytes), and date of modification for each file (Figure 4-11).

Figure 4-11. Viewing a List of Files in the Internal Flash

```
FTOS#dir
Directory of flash:

  1  drwx       4096   Jan 01 1980 00:00:00 +00:00 .
  2  drwx       2048   Jul 24 2012 09:46:34 +00:00 ..
  3  drwx       4096   Apr 03 2012 20:25:02 +00:00 TRACE_LOG_DIR
  4  drwx       4096   Apr 03 2012 20:25:02 +00:00 CORE_DUMP_DIR
  5  d---       4096   Apr 03 2012 20:25:02 +00:00 ADMIN_DIR
  6  -rwx  506724352   Apr 19 2012 23:32:02 +00:00 out3
  7  -rwx  715651180   Apr 17 2012 23:17:30 +00:00 out1
  8  -rwx   30670080   May 18 2012 04:42:06 +00:00 FTOS-nav_ascii.bin
  9  -rwx         76   May 02 2012 05:37:42 +00:00 dhcpBindConflict
 10  -rwx          1   Jul 06 2012 07:30:44 +00:00 testhttp
 11  -rwx      56839   May 17 2012 01:05:24 +00:00 writefru
 12  -rwx     150227   Jun 07 2012 16:57:24 +00:00 aaa
 13  -rwx     150227   Jun 07 2012 17:31:52 +00:00 bbb
 14  -rwx        561   Jun 26 2012 06:36:46 +00:00 jumpstartcfg
 15  -rwx     149553   Jul 04 2012 04:27:48 +00:00 startup-config.bak
--More--
```

To view the contents of a file, follow this step:

Step	Task	Command Syntax	Command Mode
1	View the:		
	contents of a file in the internal flash	show file flash://*filename*	EXEC Privilege
	contents of a file in the usb flash	show file usbflash://*filename*	EXEC Privilege
	running-configuration	show running-config	EXEC Privilege
	startup-configuration	show startup-config	EXEC Privilege

View Configuration Files

Configuration files have three commented lines at the beginning of the file (Figure 4-12), to help you track the last time any user made a change to the file, which user made the change(s), and when the file was last saved to the startup-configuration.

In the running-configuration file, if there is a difference between the timestamp on the “Last configuration change,” and “Startup-config last updated,” you have made changes that have not been saved and will not be preserved upon a system reboot.

Figure 4-12. Tracking Changes with Configuration Comments

```
FTOS#show running-config
Current Configuration ...
! Version E8-3-17-38
! Last configuration change at Tue Jul 24 20:33:08 2012 by default
!
boot system stack-unit 1 primary tftp://10.11.9.21/dv-m1000e-2-b2
boot system stack-unit 1 default system: A:
boot system gateway 10.11.209.62
!
redundancy auto-synchronize full
!
service timestamps log datetime
!
hostname FTOS
!
--More--
```

File System Management

The Dell Force10 system can use the internal Flash, USB Flash, or remote devices to store files. The system stores files on the internal Flash by default, but you can configure it to store files elsewhere.

To view file system information:

Task	Command Syntax	Command Mode
View information about each file system.	show file-systems	EXEC Privilege

The output of the show file-systems command (Figure 4-13) shows the total capacity, amount of free memory, file structure, media type, and read/write privileges for each storage device in use.

Figure 4-13. show file-systems Command Example

```
FTOS#show file-systems

      Size(b)     Free(b)      Feature      Type   Flags  Prefixes
   2143281152   836878336        FAT32 USERFLASH      rw  flash:
            -           -            -   network      rw  ftp:
            -           -            -   network      rw  tftp:
            -           -            -   network      rw  scp:
FTOS#
```

You can change the default file system so that file management commands apply to a particular device or memory.

To change the default storage location:

Task	Command Syntax	Command Mode
Change the default directory.	cd *directory*	EXEC Privilege

You can change the default storage location to the USB Flash (Figure 4-14). File management commands then apply to the USB Flash rather than the internal Flash.

Figure 4-14. Alternative Storage Location

```
FTOS#cd usbflash:
FTOS#copy running-config test          <-- No File System Specified
!
3998 bytes successfully copied

FTOS#dir
Directory of usbflash:

  1  drwx       4096   Jan 01 1980 00:00:00 +00:00 .
  2  drwx       2048   May 02 2012 07:05:06 +00:00 ..
  3 -rwx        1272 Apr 29 2011 16:15:14 +00:00 startup-config
  4 -rwx        3998 May 11 2011 23:36:12 +00:00 test   <-- File Saved to USB Flash
```

View the Command History

The command-history trace feature captures all commands entered by all users of the system with a time stamp and writes these messages to a dedicated trace log buffer. The system generates a trace message for each executed command. No password information is saved to the file.

To view the command-history trace, use the show command-history command (Figure 4-15).

Figure 4-15. show command-history Command Example

```
FTOS# show command-history
[5/18 21:58:32]: CMD-(TEL0):[enable]by admin from vty0 (10.11.68.5)
[5/18 21:58:48]: CMD-(TEL0):[configure]by admin from vty0 (10.11.68.5)
         - Repeated 1 time.
[5/18 21:58:57]: CMD-(TEL0):[interface port-channel 1]by admin from vty0 (10.11.68.5)
[5/18 21:59:9]: CMD-(TEL0):[show config]by admin from vty0 (10.11.68.5)
[5/18 22:4:32]: CMD-(TEL0):[exit]by admin from vty0 (10.11.68.5)
[5/18 22:4:41]: CMD-(TEL0):[show interfaces port-channel brief]by admin from vty0
(10.11.68.5)
```

Upgrading and Downgrading FTOS CMC

Note: To upgrade or downgrade FTOS, refer to the Release Notes for the FTOS version you want to load on the Aggregator.

5

Aggregator Management

This chapter explains the different protocols or services used to manage an Aggregator including:

Logging

FTOS tracks changes in the system using event and error messages. By default, FTOS logs these messages on:

- the internal buffer
- console and terminal lines
- any configured syslog servers

Log Messages in the Internal Buffer

All error messages, except those beginning with %BOOTUP (Message), are logged in the internal buffer.

Message 1 BootUp Events

```
%BOOTUP:RPM0:CP %PORTPIPE-INIT-SUCCESS: Portpipe 0 enabled
```

Disabling System Logging

By default, logging is enabled and log messages are sent to the logging buffer, all terminal lines, console, and syslog servers.

To enable and disable system logging:

Task	Command Syntax	Command Mode
Disable all logging except on the console.	no logging on	CONFIGURATION
Disable logging to the logging buffer.	no logging buffer	CONFIGURATION
Disable logging to terminal lines.	no logging monitor	CONFIGURATION
Disable console logging.	no logging console	CONFIGURATION

Send System Messages to a Syslog Server CMC

To send system messages to a syslog server:

Task	Command Syntax	Command Mode
Specify the server to which you want to send system messages. You can configure up to eight syslog servers.	logging {*ip-address* | *hostname*}	CONFIGURATION

Using a Unix System as a Syslog Server

Configure a UNIX system as a syslog server by adding the following lines to */etc/syslog.conf* on the Unix system and assigning write permissions to the file.

- on a 4.1 BSD UNIX system, add the line: local7.debugging /var/log/log7.log
- on a 5.7 SunOS UNIX system, add the line: local7.debugging /var/adm/ftos.log

In the lines above, local7 is the logging facility level and debugging is the severity level.

Changing System Logging Settings

You can change the default settings of the system logging by changing the severity level and the storage location. The default is to log all messages up to debug level, that is, all system messages. By changing the severity level in the logging commands, you control the number of system messages logged.

To change the severity level of messages logged to a syslog server, use any or all of the following commands in CONFIGURATION mode:

Task	Command Syntax	Command Mode
Specify the minimum severity level for logging to the logging buffer.	logging buffered *level*	CONFIGURATION
Specify the minimum severity level for logging to the console.	logging console *level*	CONFIGURATION
Specify the minimum severity level for logging to terminal lines.	logging monitor *level*	CONFIGURATION
Specifying the minimum severity level for logging to a syslog server.	logging trap *level*	CONFIGURATION
Specify the minimum severity level for logging to the syslog history table.	logging history *level*	CONFIGURATION

Task	Command Syntax	Command Mode
Specify the size of the logging buffer. **Note**: When you decrease the buffer size, FTOS deletes all messages stored in the buffer. Increasing the buffer size does not affect messages in the buffer.	logging buffered *size*	CONFIGURATION
Specify the number of messages that FTOS saves to its logging history table.	logging history size *size*	CONFIGURATION

To view the logging buffer and configuration, enter the show logging command in EXEC privilege mode (Figure 5-1).

To view the logging configuration, enter the show running-config logging command in EXEC privilege mode (Figure 5-2).

Displaying the Logging Buffer and Logging Configuration

To display the current contents of the logging buffer and the logging settings for the system, enter the show logging command in EXEC privilege mode (Figure 5-1).

Figure 5-1. show logging Command Example

```
FTOS#show logging
Syslog logging: enabled
    Console logging: level debugging
    Monitor logging: level debugging
    Buffer logging: level debugging, 58 Messages Logged, Size (40960 bytes)
    Trap logging: level informational
        Logging to 172.31.1.4
        Logging to 172.16.1.162
        Logging to 133.33.33.4
        Logging to 10.10.10.4
        Logging to 10.1.2.4
May 20 20:00:10: %STKUNIT0-M:CP %SYS-5-CONFIG_I: Configured from vty0 (10.11.68
.5 )by admin
May 20 19:57:45: %STKUNIT0-M:CP %SEC-3-AUTHENTICATION_ENABLE_SUCCESS: Enable pas
sword authentication success on vty0 ( 10.11.68.5 )
May 20 19:57:40: %STKUNIT0-M:CP %SEC-5-LOGIN_SUCCESS: Login successful for user
admin on vty0 (10.11.68.5)
May 20 19:37:08: %STKUNIT0-M:CP %SEC-5-LOGOUT: Exec session is terminated for us
er admin on line vty0 (10.11.68.5)
May 20 18:59:36: %STKUNIT0-M:CP %SYS-5-CONFIG_I: Configured from vty0 ( 10.11.68
.5 )by admin
May 20 18:45:44: %STKUNIT0-M:CP %SEC-3-AUTHENTICATION_ENABLE_SUCCESS: Enable pas
sword authentication success on vty0 ( 10.11.68.5 )
May 20 18:45:39: %STKUNIT0-M:CP %SEC-5-LOGIN_SUCCESS: Login successful for user
admin on vty0 (10.11.68.5)
May 20 17:18:08: %STKUNIT0-M:CP %SEC-5-LOGOUT: Exec session is terminated for us
er admin on line vty0 (10.11.68.5)
May 20 16:42:40: %STKUNIT0-M:CP %SYS-5-CONFIG_I: Configured from vty0 ( 10.11.68
.5 )by admin
 - repeated 2 times
May 20 16:37:41: %STKUNIT0-M:CP %SEC-3-AUTHENTICATION_ENABLE_SUCCESS: Enable pas
sword authentication success on vty0 ( 10.11.68.5 )
May 20 16:37:28: %STKUNIT0-M:CP %SEC-5-LOGIN_SUCCESS: Login successful for user
admin on vty0 (10.11.68.5)
May 20 16:37:17: %STKUNIT0-M:CP %SEC-5-LOGOUT: Exec session is terminated for us
er admin on line vty0 (10.11.68.5)
May 20 16:37:08: %STKUNIT0-M:CP %SEC-3-AUTHENTICATION_ENABLE_SUCCESS: Enable pas
sword authentication success on vty0 ( 10.11.68.5 )
sword authentication success on vty0 ( 10.11.68.5 )
--More--
```

To view any changes made, use the show running-config logging command (Figure 5-2) in the EXEC privilege mode.

Configuring a UNIX Logging Facility Level

You can save system log messages with a UNIX system logging facility.

To configure a UNIX logging facility level, use the following command in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
logging facility [*facility-type*]	CONFIGURATION	Specify one of the following parameters. • auth (for authorization messages) • cron (for system scheduler messages) • daemon (for system daemons) • kern (for kernel messages) • local0 (for local use) • local1 (for local use) • local2 (for local use) • local3 (for local use) • local4 (for local use) • local5 (for local use) • local6 (for local use) • local7 (for local use). This is the default. • lpr (for line printer system messages) • mail (for mail system messages) • news (for USENET news messages) • sys9 (system use) • sys10 (system use) • sys11 (system use) • sys12 (system use) • sys13 (system use) • sys14 (system use) • syslog (for syslog messages) • user (for user programs) • uucp (UNIX to UNIX copy protocol) The default is local7.

To view non-default settings, use the show running-config logging command (Figure 4-3) in EXEC mode.

Figure 5-2. show running-config logging Command Example

```
FTOS#show running-config logging
!
service timestamps log datetime
!
logging 172.16.1.162
logging 10.10.10.4
logging 10.1.2.4
logging 172.31.1.4
logging 133.33.33.4
FTOS#
```

Enabling Time Stamps on Syslog Messages

By default, syslog messages do not include a time/date stamp stating when the error or message was created.

To have FTOS include a timestamp with the syslog message, use the following command syntax in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
service timestamps [log | debug] [datetime [localtime] [msec] [show-timezone] | uptime]	CONFIGURATION	Add timestamp to syslog messages. Specify the following optional parameters: • datetime: You can add the keyword localtime to include the localtime, msec, and show-timezone. If you do not add the keyword localtime, the time is UTC. • uptime. To view time since last boot. If neither parameter is specified, FTOS configures uptime.

To view the configuration, enter the show running-config logging command in EXEC privilege mode.

To disable time stamping on syslog messages, enter the no service timestamps [log | debug] command.

File Transfer Services

With FTOS, you can configure the system to transfer files over the network using file transfer protocol (FTP). One FTP application copies the system image files over an interface on to the system; however, FTP is not supported on VLAN interfaces.

For more information about FTP, refer to RFC 959, *File Transfer Protocol*.

Configuration Task List for File Transfer Services

The following list includes the configuration tasks for file transfer services:

- Enabling the FTP Server (mandatory)
- Configuring the FTP Server Parameters (optional)

For a complete listing of FTP related commands, refer to RFC 959, *File Transfer Protocol*.

Enabling the FTP Server

To enable the system as an FTP server, use the following command in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
ftp-server enable	CONFIGURATION	Enable FTP on the system.

To view the FTP configuration, enter the show running-config ftp command in EXEC privilege mode (Figure 5-3).

Figure 5-3. show running-config ftp Command Example

```
FTOS#show running-config ftp
!
ftp-server enable
ftp-server username nairobi password 0 zanzibar
FTOS#
```

Configuring the FTP Server Parameters

After you enable the FTP server on the system, you can configure different parameters.

To configure FTP server parameters, use any or all of the following commands in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
ftp-server topdir *dir*	CONFIGURATION	Specify the directory for users using FTP to reach the system. The default is the internal flash directory.
ftp-server username *username* password [*encryption-type*] *password*	CONFIGURATION	Specify a user name for all FTP users and configure either a plain text or encrypted password. Configure the following optional and required parameters: • *username*: Enter a text string • *encryption-type:* Enter 0 for plain text or 7 for encrypted text. • *password:* Enter a text string.

Note: You cannot use the change directory (cd) command until you configure ftp-server topdir.

To view the FTP configuration, enter the show running-config ftp command in EXEC privilege mode.

Terminal Lines

You can access the system remotely and restrict access to the system by creating user profiles. The terminal lines on the system provide different means of accessing the system. The virtual terminal lines (VTY) connect you through Telnet to the system.

Telnet to Another Network Device

To telnet to another device (Figure 5-4):

Task	Command Syntax	Command Mode
Telnet to the stack-unit.You do not need to configure the management port on the stack-unit to be able to telnet to it.	telnet-peer-stack-unit	EXEC Privilege
Telnet to a device with an IPv4 address. If you do not enter an IP address, FTOS enters a Telnet dialog that prompts you for one. • Enter an IPv4 address in dotted decimal format (A.B.C.D)	telnet [*ip-address*]	EXEC Privilege

Figure 5-4. Telnet to Another Network Device

```
FTOS#telnet 10.11.206.66
Trying 10.11.206.66...
Connected to 10.11.206.66.
Exit character is '^]'.

cmc-9MZ0TS1.localdomain login: root
Password:

Welcome to the CMC firmware version 4.30.X03.201207271729

$
```

Recovering from a Forgotten Password

If you configure authentication for the console and you exit out of EXEC mode or your console session times out, you are prompted to re-enter the password.

If you forget your password, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Log onto the system using the console.		
2	Power-cycle the Aggregator by using the CMC interface or removing it from the M1000e and re-inserting it in the chassis.		
3	During bootup, press any key during the second countdown to abort the boot process and access the uBoot command-line interface. You are placed at the Boot User command prompt.		
4	Set the system parameters to ignore the startup configuration when the system reloads.	ignore startup-config	BOOT USER
5	Reload the system.	reload	BOOT USER
6	Copy startup-config.bak to the running config.	copy flash://startup-config.bak running-config	EXEC Privilege
7	Remove all authentication parameters configured for the console.	no authentication login no password	LINE
8	Save the running-config to the startup-config.	copy running-config startup-config	EXEC Privilege

Note: The startup configuration is ignored only the first time the Aggregator reloads. During subsequent reloads, the startup configuration is loaded and its configured settings are applied.

Recovering from a Forgotten Enable Password

If you forget the enable password, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Log onto the system via console.		
2	Power-cycle the Aggregator by using the CMC interface or removing it from the M1000e and re-inserting it in the chassis.		
3	During bootup, press any key during the second countdown to abort the boot process and access the uBoot command-line interface. You are placed at the Boot User command prompt.		

Step	Task	Command Syntax	Command Mode
4	Set the system parameters to ignore the enable password when the system reloads.	ignore enable-password	BOOT USER
5	Reload the system.	reload	BOOT USER
6	Configure a new enable password.	copy flash://startup-config.bak running-config	EXEC Privilege
7	Configure a new enable password.	enable {secret | password)	CONFIGURATION
8	Save the running-config to the startup-config.	copy running-config startup-config	EXEC Privilege

Note: The enable password is ignored only the first time the Aggregator reloads. If you do not reconfigure the enable password before the session times out, you will be placed in EXEC mode and prompted to enter the enable password again.

Recovering from a Failed Start

An Aggregator that does not start correctly might be attempting to boot from a corrupted FTOS image or from a mis-specified location. In that case, you can restart the system and interrupt the boot process to point the system to another boot location.

For more information about uBoot commands, refer to the Boot User chapter in the *FTOS Command Line Reference for the M IO Aggregator*.

To recover from failed start, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Log onto the system via console.		
2	Power-cycle the Aggregator by using the CMC interface or removing it from the M1000e and re-inserting it in the chassis.		
3	During bootup, press any key during the second countdown to abort the boot process and access the uBoot command-line interface. You are placed at the Boot User command prompt.		
4	Reconfigure the default image paths to be used to load the primary FTOS image when the system reloads.	boot change primary	BOOT USER
5	Assign an IP address to the management Ethernet interface.	interface management ethernet ip address *ip-address*/*mask*	BOOT USER
6	Assign an IP address as the default gateway for the system.	default-gateway *ip-address*	BOOT USER
7	Reload the system.	reload	BOOT USER

Figure 5-5. Recovering from a Failed Start: Example

```
U-Boot 2010.03-rc1(Dell Force10)
Built by build at tools-sjc-01 on Thu May 31 23:53:38 2012
IOM Boot Label 4.0.1.0

DRAM:   2 GB
Initialized CPLD on CS3
Detected [XLP308 (Lite+)  Rev A0]
Initializing I2C0: speed = 30 KHz, prescaler = 0x0377 -- done.
Initializing I2C1: speed = 100 KHz, prescaler = 0x0109 -- done.
Initialized eMMC Host Controller
Detected SD Card
Now running in RAM - U-Boot [N64 ABI, Big-Endian] at: ffffffff8c100000
Flash: 256 MB
PCIE (B0:D01:F0) : Link up.
PCIE (B0:D01:F1) : No Link.
In:    serial
Out:   serial
Err:   serial
Net:   nae-0: PHY is Broadcom BCM54616S


IOM MAC Addr: 00:1E:C9:F1:00:99

Hit any key to stop autoboot:  0

***** Welcome to Dell Force10 Boot Interface *****
Use "help" or "?" for more information.
BOOT_USER #
BOOT_USER # boot change primary

'-' = go to previous field;  '.' = clear non-essential field

boot device                    : tftp
file name                      : IOA
Server IP address              : 10.16.127.34

BOOT_USER #
BOOT_USER # interface management ethernet ip address  10.16.130.149/16

Management ethernet IP address: 10.16.130.149/16

BOOT_USER #
BOOT_USER # default-gateway 10.16.130.254

Gateway IP address 10.16.130.254

BOOT_USER #
BOOT_USER # reload

NetLogic XLP Stage 1 Loader
Built by build at tools-sjc-01 on Thu May 31 23:53:38 2012
IOM Boot Selector Label 4.0.0.0
```

6

Data Center Bridging (DCB)

On an Aggregator, data center bridging (DCB) features are auto-configured in standalone mode. You can display information on DCB operation by using **show** commands.

Note: DCB features are not supported on an Aggregator in stacking mode.

This chapter describes the following data center bridging topics:

Ethernet Enhancements in Data Center Bridging

Data center bridging (DCB) refers to a set of IEEE Ethernet enhancements that provide data centers with a single, robust, converged network to support multiple traffic types, including local area network (LAN), server, and storage traffic. Through network consolidation, DCB results in reduced operational cost, simplified management, and easy scalability by avoiding the need to deploy separate application-specific networks.

For example, instead of deploying an Ethernet network for LAN traffic, additional storage area networks (SANs) to ensure lossless fibre-channel traffic, and a separate InfiniBand network for high-performance inter-processor computing within server clusters, only one DCB-enabled network is required in a data center. The Dell Force10 switches that support a unified fabric and consolidate multiple network infrastructures use a single input/output (I/O) device called a converged network adapter (CNA).

A CNA is a computer input/output device that combines the functionality of a host bus adapter (HBA) with a network interface controller (NIC). Multiple adapters on different devices for several traffic types are no longer required.

Data center bridging satisfies the needs of the following types of data center traffic in a unified fabric:

- LAN traffic consists of a large number of flows that are generally insensitive to latency requirements, while certain applications, such as streaming video, are more sensitive to latency. Ethernet functions as a best-effort network that may drop packets in case of network congestion. IP networks rely on transport protocols (for example, TCP) for reliable data transmission with the associated cost of greater processing overhead and performance impact.
- Storage traffic based on Fibre Channel media uses the SCSI protocol for data transfer. This traffic typically consists of large data packets with a payload of 2K bytes that cannot recover from frame loss. To successfully transport storage traffic, data center Ethernet must provide no-drop service with lossless links.
- Servers use InterProcess Communication (IPC) traffic within high-performance computing clusters to share information. Server traffic is extremely sensitive to latency requirements.

To ensure lossless delivery and latency-sensitive scheduling of storage and service traffic and I/O convergence of LAN, storage, and server traffic over a unified fabric, IEEE data center bridging adds the following extensions to a classical Ethernet network:

- 802.1Qbb - Priority-based Flow Control (PFC)
- 802.1Qaz - Enhanced Transmission Selection (ETS)
- 802.1Qau - Congestion Notification
- Data Center Bridging Exchange (DCBX) protocol

Note: In FTOS version 8.3.17.0, only the PFC, ETS, and DCBX features are supported in data center bridging.

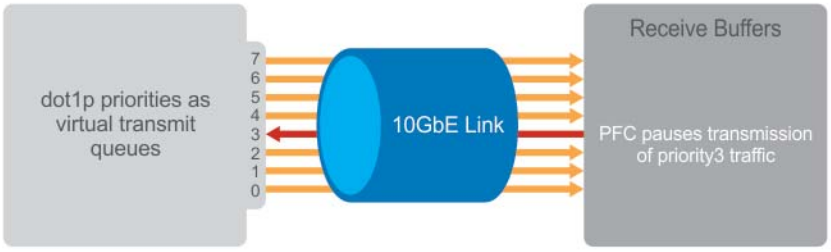
Priority-Based Flow Control

In a data center network, priority-based flow control (PFC) manages large bursts of one traffic type in multiprotocol links so that it does not affect other traffic types and no frames are lost due to congestion. When PFC detects congestion on a queue for a specified priority, it sends a pause frame for the 802.1p priority traffic to the transmitting device. In this way, PFC ensures that large amounts of queued LAN traffic do not cause storage traffic to be dropped, and that storage traffic does not result in high latency for high-performance computing (HPC) traffic between servers.

PFC enhances the existing 802.3x pause and 802.1p priority capabilities to enable flow control based on 802.1p priorities (classes of service). Instead of stopping all traffic on a link (as performed by the traditional Ethernet pause mechanism), PFC pauses traffic on a link according to the 802.1p priority set on a traffic type. You can create lossless flows for storage and server traffic while allowing for loss in case of LAN traffic congestion on the same physical interface.

Figure 6-1 shows how PFC handles traffic congestion by pausing the transmission of incoming traffic with dot1p priority 3.

Figure 6-1. Priority-Based Flow Control



PFC is implemented as follows in the Dell Force10 operating software (FTOS):

- PFC is supported on specified 802.1p priority traffic (dot1p 0 to 7) and is configured per interface. However, only two lossless queues are supported on an interface: one for FCoE converged traffic and one for SCSI storage traffic. You must configure the same lossless queues on all ports.
- PFC delay constraints place an upper limit on the transmit time of a queue after receiving a message to pause a specified priority.
- By default, PFC is enabled on an interface with no dot1p priorities configured. You can configure the PFC priorities if the switch negotiates with a remote peer using DCBX.
- During DCBX negotiation with a remote peer:
  - If the negotiation succeeds and the port is in DCBX Willing mode to receive a peer configuration, PFC parameters from the peer are used to configured PFC priorities on the port. If you enable the link-level flow control mechanism on the interface, DCBX negotiation with a peer is not performed.
  - If the negotiation fails and PFC is enabled on the port, any user-configured PFC input policies are applied. If no PFC input policy has been previously applied, the PFC default setting is used (no priorities configured). If you do not enable PFC on an interface, you can enable the 802.3x link-level pause function. By default, the link-level pause is disabled.
- PFC supports buffering to receive data that continues to arrive on an interface while the remote system reacts to the PFC operation.
- PFC uses the DCB MIB IEEE802.1azd2.5 and the PFC MIB IEEE802.1bb-d2.2.

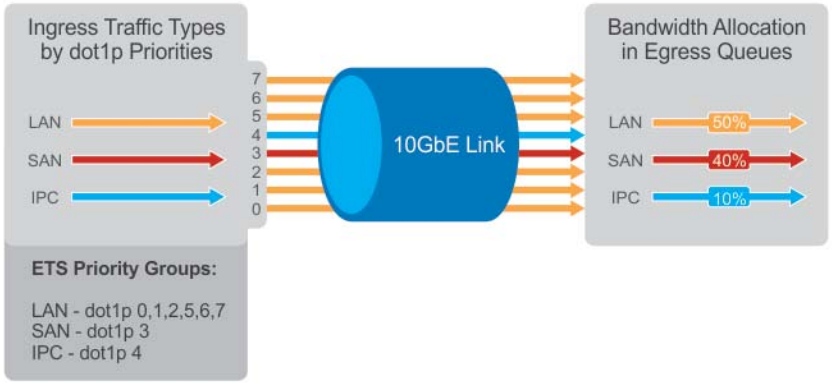
Enhanced Transmission Selection

Enhanced transmission selection (ETS) supports optimized bandwidth allocation between traffic types in multiprotocol (Ethernet, FCoE, SCSI) links. ETS allows you to divide traffic according to its 802.1p priority into different priority groups (traffic classes) and configure bandwidth allocation and queue scheduling for each group to ensure that each traffic type is correctly scheduled and receives its required bandwidth. For example, you can prioritize low-latency storage or server cluster traffic in a traffic class to receive more bandwidth and restrict best-effort LAN traffic assigned to a different traffic class.

Although you can configure strict-priority queue scheduling for a priority group, ETS introduces flexibility that allows the bandwidth allocated to each priority group to be dynamically managed according to the amount of LAN, storage, and server traffic in a flow. Unused bandwidth in a priority-group is dynamically allocated to other priority groups for which traffic is available to be scheduled. Traffic is queued according to its 802.1p priority assignment, while flexible bandwidth allocation and the configured queue-scheduling for a priority group is supported.

Figure 6-2 shows how ETS allows you to allocate bandwidth when different traffic types are classed according to 802.1p priority and mapped to priority groups.

Figure 6-2. Enhanced Transmission Selection



ETS uses the following traffic groupings to select multiprotocol traffic for transmission:

- Priority group: A group of 802.1p priorities used for bandwidth allocation and queue scheduling. All 802.1p priority traffic in a group should have the same traffic handling requirements for latency and frame loss.
- Group ID: A 4-bit identifier assigned to each priority group. Valid values are from 0 to 7.
- Group bandwidth: Percentage of available bandwidth allocated to a priority group.
- Group transmission selection algorithm (TSA): Type of queue scheduling used by a priority group.

ETS is implemented as follows in FTOS:

- ETS supports groups of 802.1p priorities that have:
  - PFC enabled or disabled
  - No bandwidth limit or no ETS processing
- Bandwidth allocated by the ETS algorithm is made available after strict-priority groups are serviced. If a priority group does not use its allocated bandwidth, the unused bandwidth is made available to other priority groups.
- For ETS traffic selection, an algorithm is applied to priority groups using:
  - Strict-priority shaping
  - ETS shaping

  Credit-based shaping is not supported.
- ETS uses the DCB MIB IEEE802.1azd2.5.

Data Center Bridging Exchange Protocol (DCBX)

The data center bridging exchange (DCBX) protocol is enabled by default on any switch on which PFC or ETS are enabled. DCBX allows a switch to automatically discover DCB-enabled peers and exchange configuration information. PFC and ETS use DCBX to exchange and negotiate parameters with peer devices. DCBX capabilities include:

- Discovery of DCB capabilities on peer-device connections
- Determination of possible mismatch in DCB configuration on a peer link
- Configuration of a peer device over a DCB link

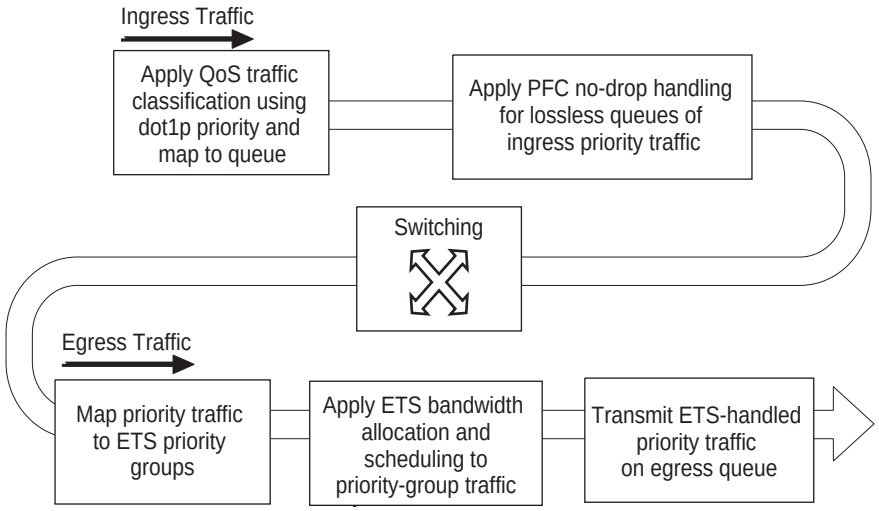
DCBX requires the link layer discovery protocol (LLDP) to provide the path to exchange DCB parameters with peer devices. Exchanged parameters are sent in organizationally specific type, length, values (TLVs) in LLDP data units. For more information, refer to the Link Layer Discovery Protocol (LLDP) chapter. The following LLDP TLVs are supported for DCB parameter exchange:

- PFC parameters: PFC Configuration TLV and Application Priority Configuration TLV.
- ETS parameters: ETS Configuration TLV and ETS Recommendation TLV.

Data Center Bridging in a Traffic Flow

Figure 6-3 shows how DCB handles a traffic flow on an interface.

Figure 6-3. DCB PFC and ETS Traffic Handling



Data Center Bridging: Auto-Configuration

Data center bridging is enabled by default on an Aggregator in standalone mode to support converged enhanced Ethernet (CEE) in a data center network, and is a required for:

- Priority-based flow control
- Enhanced transmission selection
- Data center bridging exchange protocol
- FCoE initialization protocol (FIP) snooping

DCB processes virtual local area network (VLAN)-tagged packets and dot1p priority values. Untagged packets are treated with a dot1p priority of 0.

For DCB to operate effectively, ingress traffic is classified according to its dot1p priority so that it maps to different data queues. The dot1p-queue assignments used on an Aggregator are shown in Table 6-1 in QoS dot1p Traffic Classification and Queue Assignment.

Disabling DCB

In some network topologies, you may want to disable DCB on an Aggregator and allow link-level flow control to control data transmission between the Aggregator and other network devices (Flow Control Using Ethernet Pause Frames).

Task	Command	Command Mode
Disable DCB.	no dcb enable	CONFIGURATION

After you enter the **no dcb enable** command, you are prompted to reload the Aggregator to disable DCB and enable link-level flow control.

Re-enabling DCB

You can later re-enable DCB on an Aggregator by entering the **dcb enable** command.

Task	Command	Command Mode
Re-enable DCB.	dcb enable	CONFIGURATION

After you enter the **dcb enable** command, you are prompted to reload the Aggregator to enable DCB and disable link-level flow control.

QoS dot1p Traffic Classification and Queue Assignment

DCB supports PFC, ETS, and DCBX to handle converged Ethernet traffic that is assigned to an egress queue according to the following quality of service (QoS) methods:

- Honor dot1p: dot1p priorities in ingress traffic are used at the port or global switch level.
- Layer 2 class maps: dot1p priorities are used to classify traffic in a class map and apply a service policy to an ingress port to map traffic to egress queues.

Note: Dell Force10 does not recommend mapping all ingress traffic to a single queue when using PFC and ETS. Ingress traffic classification using the **service-class dynamic dot1p** command (honor dot1p) is recommended on all DCB-enabled interfaces. If you use L2 class maps to map dot1p priority traffic to egress queues, take into account the default dot1p-queue assignments in Table 6-1 and the maximum number of two lossless queues supported on a port.

Although FTOS allows you to change the default dot1p priority-queue assignments, DCB policies applied to an interface may become invalid if dot1p-queue mapping is reconfigured. If the configured DCB policy remains valid, the change in the dot1p-queue assignment is allowed. For DCB ETS enabled interfaces, traffic destined to queue that is not mapped to any dot1p priority will be dropped.

Table 6-1. dot1p Priority-Queue Assignment

dot1p Value in Incoming Frame	Egress Queue Assignment
0	0
1	0
2	0
3	1
4	2
5	3
6	3
7	3

How Priority-Based Flow Control is Implemented

Priority-based flow control provides a flow control mechanism based on the 802.1p priorities in converged Ethernet traffic received on an interface and is enabled by default. As an enhancement to the existing Ethernet pause mechanism, PFC stops traffic transmission for specified priorities (CoS values) without impacting other priority classes. Different traffic types are assigned to different priority classes.

When traffic congestion occurs, PFC sends a pause frame to a peer device with the CoS priority values of the traffic that needs to be stopped. DCBX provides the link-level exchange of PFC parameters between peer devices. PFC creates zero-loss links for SAN traffic that requires no-drop service, while at the same time retaining packet-drop congestion management for LAN traffic.

PFC is implemented on an Aggregator as follows:

- As soon as a DCB policy with PFC is applied to on an interface, DCBX starts exchanging information with PFC-enabled peers. The IEEE802.1Qbb, CEE and CIN versions of PFC TLV are supported. DCBX also validates PFC configurations received in TLVs from peer devices.
- PFC operation is enabled on ingress port traffic. PFC is enabled on all DCB egress ports to achieve complete lossless handling of traffic.
- All 802.1p priorities are enabled for PFC. Queues to which PFC priority traffic is mapped are lossless by default. Traffic may be interrupted due to an interface flap (going down and coming up).
- For PFC to be applied on an Aggregator port, the auto-configured priority traffic must be supported by a PFC peer (as detected by DCBX).
- A DCB input policy for PFC applied to an interface may become invalid if dot1p-queue mapping is reconfigured (refer to Create Input Policy Maps). This situation occurs when the new dot1p-queue assignment exceeds the maximum number (2) of lossless queues supported globally on the switch. In this case, all PFC configurations received from PFC-enabled peers are removed and re-synchronized with the peer devices.
- FTOS does not support MACsec Bypass Capability (MBC).

How Enhanced Transmission Selection is Implemented

Enhanced transmission selection (ETS) provides a way to optimize bandwidth allocation to outbound 802.1p classes of converged Ethernet traffic. Different traffic types have different service needs. Using ETS, groups within an 802.1p priority class are auto-configured to provide different treatment for traffic with different bandwidth, latency, and best-effort needs.

For example, storage traffic is sensitive to frame loss; interprocess communication (IPC) traffic is latency-sensitive. ETS allows different traffic types to coexist without interruption in the same converged link.

Note: The IEEE 802.1Qaz, CEE, and CIN versions of ETS are supported.

ETS is implemented on an Aggregator as follows:

- Traffic in priority groups is assigned to strict-queue or WERR scheduling in an ETS output policy and is managed using the ETS bandwidth-assignment algorithm. FTOS de-qeues all frames of strict-priority traffic before servicing any other queues. A queue with strict-priority traffic can starve other queues in the same port.
- ETS-assigned bandwidth allocation and scheduling apply only to data queues, not to control queues.
- FTOS supports hierarchical scheduling on an interface. FTOS control traffic is redirected to control queues as higher priority traffic with strict priority scheduling. After control queues drain out, the remaining data traffic is scheduled to queues according to the bandwidth and scheduler configuration in the ETS output policy. The available bandwidth calculated by the ETS algorithm is equal to the link bandwidth after scheduling non-ETS higher-priority traffic.
- By default, equal bandwidth is assigned to each port queue and each dot1p priority in a priority group.
- By default, equal bandwidth is assigned to each priority group in the ETS output policy applied to an egress port. The sum of auto-configured bandwidth allocation to dot1p priority traffic in all ETS priority groups is 100%.
- dot1p priority traffic on the switch is scheduled according to the default dot1p-queue mapping. dot1p priorities within the same queue should have the same traffic properties and scheduling method.
- A priority group consists of 802.1p priority values that are grouped together for similar bandwidth allocation and scheduling, and that share the same latency and loss requirements. All 802.1p priorities mapped to the same queue should be in the same priority group.
  - By default:
    - — All 802.1p priorities are grouped in priority group 0.
    - — 100% of the port bandwidth is assigned to priority group 0. The complete bandwidth is equally assigned to each priority class so that each class has 12 to 13%.
  - The maximum number of priority groups supported in ETS output policies on an interface is equal to the number of data queues (4) on the port. The 802.1p priorities in a priority group can map to multiple queues.
- A DCB output policy is created to associate a priority group with an ETS output policy with scheduling and bandwidth configuration, and applied on egress ports.
  - The ETS configuration associated with 802.1p priority traffic in a DCB output policy is used in DCBX negotiation with ETS peers.

- When an ETS output policy is applied to an interface, ETS-configured scheduling and bandwidth allocation take precedence over any auto-configured settings in the QoS output policies.
- ETS is enabled by default with the default ETS configuration applied (all dot1p priorities in the same group with equal bandwidth allocation).

ETS Operation with DCBX

In DCBX negotiation with peer ETS devices, ETS configuration is handled as follows:

- ETS TLVs are supported in DCBX versions CIN, CEE, and IEEE2.5.
- ETS operational parameters are determined by the DCBX port-role configurations.
- ETS configurations received from TLVs from a peer are validated.
- In case of a hardware limitation or TLV error:
  - DCBX operation on an ETS port goes down.
  - New ETS configurations are ignored and existing ETS configurations are reset to the previously configured ETS output policy on the port or to the default ETS settings if no ETS output policy was previously applied.
- ETS operates with legacy DCBX versions as follows:
  - In the CEE version, the priority group/traffic class group (TCG) ID 15 represents a non-ETS priority group. Any priority group configured with a scheduler type is treated as a strict-priority group and is given the priority-group (TCG) ID 15.
  - The CIN version supports two types of strict-priority scheduling:
    - — Group strict priority: Allows a single priority flow in a priority group to increase its bandwidth usage to the bandwidth total of the priority group. A single flow in a group can use all the bandwidth allocated to the group.
    - — Link strict priority: Allows a flow in any priority group to increase to the maximum link bandwidth.

    CIN supports only the default dot1p priority-queue assignment in a priority group.

Bandwidth Allocation for DCBX CIN

After an ETS output policy is applied to an interface, if the DCBX version used in your data center network is CIN, a QoS output policy is automatically configured to overwrite the default CIN bandwidth allocation. This default setting divides the bandwidth allocated to each port queue equally between the dot1p priority traffic assigned to the queue.

DCB Policies in a Switch Stack

A DCB input policy with PFC and ETS configuration is applied to all stacked ports in a switch stack or on a stacked switch.

DCBX Operation

The data center bridging exchange protocol (DCBX) is used by DCB devices to exchange configuration information with directly connected peers using the link layer discovery protocol (LLDP) protocol. DCBX can detect the misconfiguration of a peer DCB device, and optionally, configure peer DCB devices with DCB feature settings to ensure consistent operation in a data center network.

DCBX is a prerequisite for using DCB features, such as priority-based flow control (PFC) and enhanced traffic selection (ETS), to exchange link-level configurations in a converged Ethernet environment. DCBX is also deployed in topologies that support lossless operation for FCoE or iSCSI traffic. In these scenarios, all network devices are DCBX-enabled (DCBX is enabled end-to-end).

The following versions of DCBX are supported on an Aggregator: CIN, CEE, and IEEE2.5.

DCBX requires the LLDP to be enabled on all DCB devices.

DCBX Operation

DCBX performs the following operations:

- Discovers DCB configuration (such as PFC and ETS) in a peer device.
- Detects DCB misconfiguration in a peer device; that is, when DCB features are not compatibly configured on a peer device and the local switch. Misconfiguration detection is feature-specific because some DCB features support asymmetric configuration.
- Reconfigures a peer device with the DCB configuration from its configuration source if the peer device is willing to accept configuration.
- Accepts the DCB configuration from a peer if a DCBX port is in “willing” mode to accept a peer’s DCB settings and then internally propagates the received DCB configuration to its peer ports.

DCBX Port Roles

The following DCBX port roles are auto-configured on an Aggregator to propagate DCB configurations learned from peer DCBX devices internally to other switch ports:

- Auto-upstream: The port advertises its own configuration to DCBX peers and receives its configuration from DCBX peers (ToR or FCF device). The port also propagates its configuration to other ports on the switch.

  The first auto-upstream that is capable of receiving a peer configuration is elected as the *configuration source*. The elected configuration source then internally propagates the configuration to auto-downstream ports. A port that receives an internally propagated configuration overwrites its local configuration with the new parameter values.

  When an auto-upstream port (besides the configuration source) receives and overwrites its configuration with internally propagated information, one of the following actions is taken:

  - If the peer configuration received is compatible with the internally propagated port configuration, the link with the DCBX peer is enabled.
  - If the received peer configuration is not compatible with the currently configured port configuration, the link with the DCBX peer port is disabled and a syslog message for an incompatible configuration is generated. The network administrator must then reconfigure the peer device so that it advertises a compatible DCB configuration.

  The configuration received from a DCBX peer or from an internally propagated configuration is not stored in the switch’s running configuration.

  On a DCBX port in an auto-upstream role, the PFC and application priority TLVs are enabled. ETS recommend TLVs are disabled and ETS configuration TLVs are enabled.
- Auto-downstream - The port advertises its own configuration to DCBX peers but is *not willing* to receive remote peer configuration. The port always accepts internally propagated configurations from a configuration source. An auto-downstream port that receives an internally propagated configuration overwrites its local configuration with the new parameter values.

  When an auto-downstream port receives and overwrites its configuration with internally propagated information, one of the following actions is taken:

  - If the peer configuration received is compatible with the internally propagated port configuration, the link with the DCBX peer is enabled.
  - If the received peer configuration is not compatible with the currently configured port configuration, the link with the DCBX peer port is disabled and a syslog message for an incompatible configuration is generated. The network administrator must then reconfigure the peer device so that it advertises a compatible DCB configuration.

  The internally propagated configuration is not stored in the switch's running configuration.

  On a DCBX port in an auto-downstream role, all PFC, application priority, ETS recommend, and ETS configuration TLVs are enabled.

Default DCBX port role: Uplink ports are auto-configured in an auto-upstream role. Server-facing ports are auto-configured in an auto-downstream role.

Note: On a DCBX port, application priority TLV advertisements are handled as follows:
- The application priority TLV is transmitted only if the priorities in the advertisement match the configured PFC priorities on the port.
- On auto-upstream and auto-downstream ports:
  - If a configuration source is elected, the ports send an application priority TLV based on the application priority TLV received on the configuration-source port. When an application priority TLV is received on the configuration-source port, the auto-upstream and auto-downstream ports use the internally propagated PFC priorities to match against the received application priority. Otherwise, these ports use their locally configured PFC priorities in application priority TLVs.
  - If no configuration source is configured, auto-upstream and auto-downstream ports check to see that the locally configured PFC priorities match the priorities in a received application priority TLV.
- On manual ports: An application priority TLV is advertised only if the priorities in the TLV match the PFC priorities configured on the port.

DCB Configuration Exchange

On an Aggregator, the DCBX protocol supports the exchange and propagation of configuration information for the following DCB features.

- Enhanced transmission selection (ETS)
- Priority-based flow control (PFC)

DCBX uses the following methods to exchange DCB configuration parameters:

- Asymmetric: DCB parameters are exchanged between a DCBX-enabled port and a peer port without requiring that a peer port and the local port use the same configured values for the configurations to be compatible. For example, ETS uses an asymmetric exchange of parameters between DCBX peers.
- Symmetric: DCB parameters are exchanged between a DCBX-enabled port and a peer port with the requirement that each configured parameter value is the same for the configurations to be compatible. For example, PFC uses an symmetric exchange of parameters between DCBX peers.

Configuration Source Election

When an auto-upstream or auto-downstream port receives a DCB configuration from a peer, the port first checks to see if there is an active configuration source on the switch.

- If a configuration source already exists, the received peer configuration is checked against the local port configuration. If the received configuration is compatible, the DCBX marks the port as DCBX-enabled. If the configuration received from the peer is not compatible, a warning message is logged and the DCBX frame error counter is incremented. Although DCBX is operationally disabled, the port keeps the peer link up and continues to exchange DCBX packets. If a compatible peer configuration is later received, DCBX is enabled on the port.
- If there is no configuration source, a port may elect itself as the configuration source. A port may become the configuration source if the following conditions exist:
  - No other port is the configuration source.
  - The port role is auto-upstream.
  - The port is enabled with link up and DCBX enabled.
  - The port has performed a DCBX exchange with a DCBX peer.
  - The switch is capable of supporting the received DCB configuration values through either a symmetric or asymmetric parameter exchange.

A newly elected configuration source propagates configuration changes received from a peer to the other auto-configuration ports. Ports receiving auto-configuration information from the configuration source ignore their current settings and use the configuration source information.

Propagation of DCB Information

When an auto-upstream or auto-downstream port receives a DCB configuration from a peer, the port acts as a DCBX client and checks if a DCBX configuration source exists on the switch.

- If a configuration source is found, the received configuration is checked against the currently configured values that are internally propagated by the configuration source. If the local configuration is compatible with the received configuration, the port is enabled for DCBX operation and synchronization.
- If the configuration received from the peer is not compatible with the internally propagated configuration used by the configuration source, the port is disabled as a client for DCBX operation and synchronization and a syslog error message is generated. The port keeps the peer link up and continues to exchange DCBX packets. If a compatible configuration is later received from the peer, the port is enabled for DCBX operation.

Note: When a configuration source is elected, all auto-upstream ports other than the configuration source are marked as *willing disabled*. The internally propagated DCB configuration is refreshed on all auto-configuration ports and each port may begin configuration negotiation with a DCBX peer again.

Auto-Detection of the DCBX Version

The Aggregator operates in auto-detection mode so that a DCBX port automatically detects the DCBX version on a peer port. Legacy CIN and CEE versions are supported in addition to the standard IEEE version 2.5 DCBX.

A DCBX port detects a peer version after receiving a valid frame for that version. The local DCBX port reconfigures to operate with the peer version and maintains the peer version on the link until one of the following conditions occurs:

- The switch reboots.
- The link is reset (goes down and up).
- The peer times out.
- Multiple peers are detected on the link.

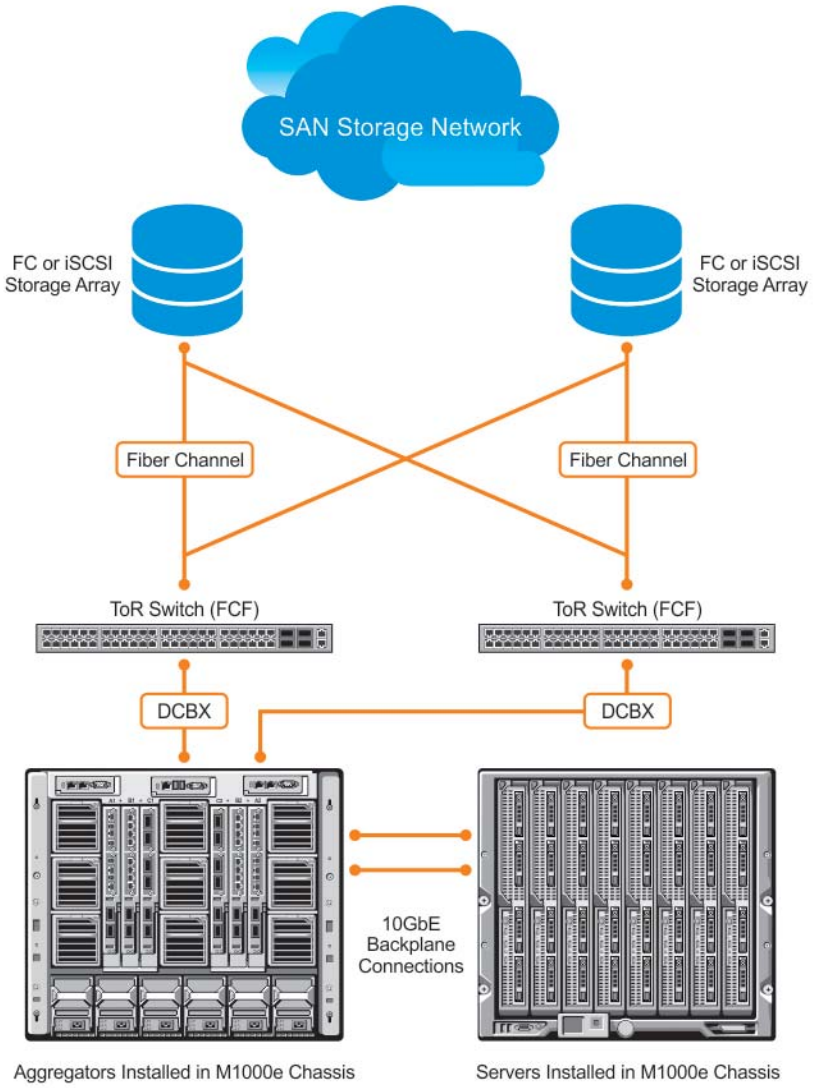
DCBX operations on a port are performed according to the auto-configured DCBX version, including fast and slow transmit timers and message formats. If a DCBX frame with a different version is received, a syslog message is generated and the peer version is recorded in the peer status table. If the frame cannot be processed, it is discarded and the discard counter is incremented.

DCBX Example

Figure 6-4 shows how DCBX is used on an Aggregator installed in a PowerEdge M1000e chassis in which servers are also installed.

- The external 40GbE ports on the base module (ports 33 and 37) of two switches are used for uplinks configured as DCBX auto-upstream ports. The Aggregator is connected to third-party, top-of-rack (ToR) switches through 40GbE uplinks. The ToR switches are part of a Fibre Channel storage network.
- The internal ports (ports 1-32) connected to the 10GbE backplane are configured as auto-downstream ports.
- On the Aggregator, PFC and ETS use DCBX to exchange link-level configuration with DCBX peer devices.

Figure 6-4. DCBX Sample Topology



DCBX Prerequisites and Restrictions

- DCBX requires LLDP in both send (TX) and receive (RX) mode to be enabled on a port interface. If multiple DCBX peer ports are detected on a local DCBX interface, LLDP is shut down.
- The CIN version of DCBX supports only PFC, ETS, and FCOE; it does not support iSCSI, backward congestion management (BCN), logical link down (LLD), and network interface virtualization (NIV).

DCBX Error Messages

An error in DCBX operation is displayed using the following syslog messages:

```
LLDP_MULTIPLE_PEER_DETECTED: DCBX is operationally disabled after detecting more than one DCBX
peer on the port interface.

LLDP_PEER_AGE_OUT: DCBX is disabled as a result of LLDP timing out on a DCBX peer interface.

DSM_DCBX_PEER_VERSION_CONFLICT: A local port expected to receive the IEEE, CIN, or CEE version
in a DCBX TLV from a remote peer but received a different, conflicting DCBX version.

DSM_DCBX_PFC_PARAMETERS_MATCH and DSM_DCBX_PFC_PARAMETERS_MISMATCH: A local DCBX port received
a compatible (match) or incompatible (mismatch) PFC configuration from a peer.

DSM_DCBX_ETS_PARAMETERS_MATCH and DSM_DCBX_ETS_PARAMETERS_MISMATCH: A local DCBX port received
a compatible (match) or incompatible (mismatch) ETS configuration from a peer.

LLDP_UNRECOGNISED_DCBX_TLV_RECEIVED: A local DCBX port received an unrecognized DCBX TLV from
a peer.
```

Debugging DCBX on an Interface

To enabled DCBX debug traces for all or a specific control path, use the following command:

Task	Command	Command Mode
Enable DCBX debugging, where: • all: Enables all DCBX debugging operations. • auto-detect-timer: Enables traces for DCBX auto-detect timers. • config-exchng: Enables traces for DCBX configuration exchanges. • fail: Enables traces for DCBX failures. • mgmt: Enables traces for DCBX management frames. • resource: Enables traces for DCBX system resource frames. • sem: Enables traces for the DCBX state machine. • tlv: Enables traces for DCBX TLVs.	debug dcbx {all | auto-detect-timer | config-exchng | fail | mgmt | resource | sem | tlv}	EXEC PRIVILEGE

Verifying DCB Configuration

Use the **show** commands in Table 6-2 to display DCB configurations and statistics.

Table 6-2. Displaying DCB Configurations

Command	Output
show dcb [stack-unit *unit-number*] (Figure 6-5)	Displays data center bridging status, number of PFC-enabled ports, and number of PFC-enabled queues. On the master switch in a stack, you can specify a stack-unit number. Valid values: 0 to 5.
show interface *port-type slot*/*port* pfc statistics (Figure 6-6)	Displays counters for the PFC frames received and transmitted (by dot1p priority class) on an interface.
show interface *port-type slot*/*port* pfc {summary | detail} (Figure 6-7)	Displays the PFC configuration applied to ingress traffic on an interface, including priorities and link delay. To clear PFC TLV counters on all ports or a specified port, use the clear pfc counters {stack-unit *unit-number* | tengigabitethernet *slot*/*port*} command.
show interface *port-type slot*/*port* ets {summary | detail} (Figure 6-8 and Figure 6-9)	Displays the ETS configuration applied to egress traffic on an interface, including priority groups with priorities and bandwidth allocation. To clear ETS TLV counters on all ports or a specified port, enter the clear ets counters stack-unit *unit-number* command.

Figure 6-5. show dcb Command Example

```
FTOS# show dcb
stack-unit 0 port-set 0
      DCB Status :  Enabled
  PFC Port Count :  56 (current), 56 (configured)
 PFC Queue Count :  2  (current), 2  (configured)
```

Figure 6-6. show interface pfc statistics Command Example

```
FTOS#show interfaces  te 0/0 pfc  statistics
Interface TenGigabitEthernet 0/0
Priority Received PFC Frames Transmitted PFC Frames
-------- ------------------- ----------------------
0           0                  0
1           0                  0
2           0                  0
3           0                  0
4           0                  0
5           0                  0
6           0                  0
7           0                  0
```

Figure 6-7. show interfaces pfc summary Command Example

```
FTOS# show  interfaces  tengigabitethernet 0/49 pfc  summary
Interface TenGigabitEthernet 0/49
     Admin mode is on
     Admin is enabled
     Remote is enabled, Priority list is 4
     Remote Willing Status is enabled
     Local is enabled
     Oper status is Recommended
     PFC DCBX Oper status is Up
     State Machine Type is Feature
     TLV Tx Status is enabled
     PFC Link Delay 45556 pause quantams
     Application Priority TLV  Parameters :
     ------------------------------------
     FCOE TLV Tx Status is disabled
     ISCSI TLV Tx Status is disabled
     Local FCOE PriorityMap is 0x8
     Local ISCSI PriorityMap is 0x10
     Remote FCOE PriorityMap is 0x8
     Remote ISCSI PriorityMap is 0x8


FTOS# show  interfaces tengigabitethernet 0/49 pfc detail
Interface TenGigabitEthernet 0/49
     Admin mode is on
     Admin is enabled
     Remote is enabled
     Remote Willing Status is enabled
     Local is enabled
     Oper status is recommended
     PFC DCBX Oper status is Up
     State Machine Type is Feature
     TLV Tx Status is enabled
     PFC Link Delay 45556 pause quanta
     Application Priority TLV  Parameters :
     ------------------------------------
     FCOE TLV Tx Status is disabled
     ISCSI TLV Tx Status is disabled
     Local FCOE PriorityMap is 0x8
     Local ISCSI PriorityMap is 0x10
     Remote FCOE PriorityMap is 0x8
     Remote ISCSI PriorityMap is 0x8

     0 Input TLV pkts, 1 Output TLV pkts, 0 Error pkts, 0 Pause Tx pkts, 0 Pause Rx pkts
```

Table 6-3. show interface pfc summary Command Description

Field	Description
Interface	Interface type with stack-unit and port number.
Admin mode is on Admin is enabled	PFC Admin mode is on or off with a list of the configured PFC priorities. When PFC admin mode is on, PFC advertisements are enabled to be sent and received from peers; received PFC configuration takes effect. The admin operational status for a DCBX exchange of PFC configuration is enabled or disabled.

Table 6-3. show interface pfc summary Command Description

Field	Description
Remote is enabled, Priority list Remote Willing Status is enabled	Operational status (enabled or disabled) of peer device for DCBX exchange of PFC configuration with a list of the configured PFC priorities. Willing status of peer device for DCBX exchange (Willing bit received in PFC TLV): enabled or disabled.
Local is enabled	DCBX operational status (enabled or disabled) with a list of the configured PFC priorities.
Operational status (local port)	Port state for current operational PFC configuration: Init: Local PFC configuration parameters were exchanged with peer. Recommend: Remote PFC configuration parameters were received from peer. Internally propagated: PFC configuration parameters were received from configuration source.
PFC DCBX Oper status	Operational status for exchange of PFC configuration on local port: match (up) or mismatch (down).
State Machine Type	Type of state machine used for DCBX exchanges of PFC parameters: Feature - for legacy DCBX versions; Symmetric - for an IEEE version.
TLV Tx Status	Status of PFC TLV advertisements: enabled or disabled.
PFC Link Delay	Link delay (in quanta) used to pause specified priority traffic.
Application Priority TLV: FCOE TLV Tx Status	Status of FCoE advertisements in application priority TLVs from local DCBX port: enabled or disabled.
Application Priority TLV: ISCSI TLV Tx Status	Status of ISCSI advertisements in application priority TLVs from local DCBX port: enabled or disabled.
Application Priority TLV: Local FCOE Priority Map	Priority bitmap used by local DCBX port in FCoE advertisements in application priority TLVs.
Application Priority TLV: Local ISCSI Priority Map	Priority bitmap used by local DCBX port in ISCSI advertisements in application priority TLVs.
Application Priority TLV: Remote FCOE Priority Map	Priority bitmap received from the remote DCBX port in FCoE advertisements in application priority TLVs.
Application Priority TLV: Remote ISCSI Priority Map	Priority bitmap received from the remote DCBX port in iSCSI advertisements in application priority TLVs.
PFC TLV Statistics: Input TLV pkts	Number of PFC TLVs received.
PFC TLV Statistics: Output TLV pkts	Number of PFC TLVs transmitted.
PFC TLV Statistics: Error pkts	Number of PFC error packets received.
PFC TLV Statistics: Pause Tx pkts	Number of PFC pause frames transmitted.

Table 6-3. show interface pfc summary Command Description

Field	Description
PFC TLV Statistics: Pause Rx pkts	Number of PFC pause frames received

Figure 6-8. show interface ets summary Command Example

```
FTOS(conf)# show interfaces  tengigabitethernet 0/0 ets  summary
Interface TenGigabitEthernet 0/0
Max Supported TC Groups is 4
Number of Traffic Classes is 8
Admin mode is on
Admin Parameters:
------------------
Admin is enabled
TC-grp   Priority#         Bandwidth       TSA
0        0,1,2,3,4,5,6,7   100%            ETS
1                            0%            ETS
2                            0%            ETS
3                            0%            ETS
4                            0%            ETS
5                            0%            ETS
6                            0%            ETS
7                            0%            ETS
Priority#                  Bandwidth       TSA
0                             13%          ETS
1                             13%          ETS
2                             13%          ETS
3                             13%          ETS
4                             12%          ETS
5                             12%          ETS
6                             12%          ETS
7                             12%          ETS
Remote Parameters:
-------------------
Remote is disabled
Local Parameters:
------------------
Local is enabled
TC-grp   Priority#         Bandwidth       TSA
0        0,1,2,3,4,5,6,7   100%            ETS
1                            0%            ETS
2                            0%            ETS
3                            0%            ETS
4                            0%            ETS
5                            0%            ETS
6                            0%            ETS
7                            0%            ETS

Priority#                  Bandwidth       TSA
0                             13%          ETS
1                             13%          ETS
2                             13%          ETS
3                             13%          ETS
4                             12%          ETS
5                             12%          ETS
6                             12%          ETS
7                             12%          ETS
Oper status is init
Conf TLV Tx Status is disabled
Traffic Class TLV Tx Status is disabled
```

Figure 6-9. show interface ets detail Command Example

```
FTOS# show  interfaces  tengigabitethernet 0/34 ets  detail
Interface TenGigabitEthernet 0/34
Max Supported PG is 4
Number of Traffic Classes is 8
Admin mode is on

Admin Parameters :
------------------
Admin is enabled

PG-grp     Priority#         Bandwidth       TSA
-----------------------------------------------
0          0,1,2,3,4,5,6,7   100%            ETS
1                            -               -
2                            -               -
3                            -               -
4                            -               -
5                            -               -
6                            -               -
7                            -               -

Remote Parameters :
-------------------
Remote is disabled

Local Parameters :
------------------
Local is enabled

PG-grp     Priority#         Bandwidth       TSA
-----------------------------------------------
0          0,1,2,3,4,5,6,7   100%            ETS
1                            -               -
2                            -               -
3                            -               -
4                            -               -
5                            -               -
6                            -               -
7                            -               -

Oper status is init
ETS DCBX Oper status is Down
State Machine Type is Asymmetric
Conf TLV Tx Status is enabled
Reco TLV Tx Status is enabled

0 Input Conf TLV Pkts, 0 Output Conf TLV Pkts, 0 Error Conf TLV Pkts
0 Input Reco TLV Pkts, 0 Output Reco TLV Pkts, 0 Error Reco TLV Pkts
```

Table 6-4. show interface ets detail Command Description

Field	Description
Interface	Interface type with stack-unit and port number.
Max Supported TC Group	Maximum number of priority groups supported.
Number of Traffic Classes	Number of 802.1p priorities currently configured.

Table 6-4. show interface ets detail Command Description

Field	Description
Admin mode	ETS mode: on or off. When on, the scheduling and bandwidth allocation configured in an ETS output policy or received in a DCBX TLV from a peer can take effect on an interface.
Admin Parameters	ETS configuration on local port, including priority groups, assigned dot1p priorities, and bandwidth allocation.
Remote Parameters	ETS configuration on remote peer port, including Admin mode (enabled if a valid TLV was received or disabled), priority groups, assigned dot1p priorities, and bandwidth allocation. If the ETS Admin mode is enabled on the remote port for DCBX exchange, the Willing bit received in ETS TLVs from the remote peer is included.
Local Parameters	ETS configuration on local port, including Admin mode (enabled when a valid TLV is received from a peer), priority groups, assigned dot1p priorities, and bandwidth allocation.
Operational status (local port)	Port state for current operational ETS configuration: Init: Local ETS configuration parameters were exchanged with peer. Recommend: Remote ETS configuration parameters were received from peer. Internally propagated: ETS configuration parameters were received from configuration source.
ETS DCBX Oper status	Operational status of ETS configuration on local port: match or mismatch.
State Machine Type	Type of state machine used for DCBX exchanges of ETS parameters: Feature - for legacy DCBX versions; Asymmetric - for an IEEE version.
Conf TLV Tx Status	Status of ETS Configuration TLV advertisements: enabled or disabled.
Reco TLV Tx Status	Status of ETS Recommendation TLV advertisements: enabled or disabled.
Input Conf TLV pkts Output Conf TLV pkts Error Conf TLV pkts	Number of ETS Configuration TLVs received and transmitted, and number of ETS Error Configuration TLVs received.
Input Reco TLV pkts Output Reco TLV pkts Error Reco TLV pkts	Number of ETS Recommendation TLVs received and transmitted, and number of ETS Error Recommendation TLVs received.

Figure 6-10. show stack-unit all stack-ports all pfc details Command Example

```
FTOS# show stack-unit all  stack-ports all pfc details

 stack unit 0 stack-port all
     Admin mode is On
     Admin is enabled, Priority list is 4-5
     Local is enabled, Priority list is 4-5
     Link Delay 45556 pause quantum
     0 Pause Tx pkts, 0 Pause Rx pkts

 stack unit 1 stack-port all
     Admin mode is On
     Admin is enabled, Priority list is 4-5
     Local is enabled, Priority list is 4-5
     Link Delay 45556 pause quantum
     0 Pause Tx pkts, 0 Pause Rx pkts
```

Figure 6-11. show stack-unit all stack-ports all ets details Command Example

```
FTOS# show stack-unit all  stack-ports all ets details

Stack unit 0 stack port all
Max Supported TC Groups is 4
Number of Traffic Classes is 1
Admin mode is on

Admin Parameters:
--------------------
Admin is enabled
TC-grp     Priority#         Bandwidth       TSA
------------------------------------------------
0          0,1,2,3,4,5,6,7   100%            ETS
1                            -               -
2                            -               -
3                            -               -
4                            -               -
5                            -               -
6                            -               -
7                            -               -
8                            -               -

Stack unit 1 stack port all
Max Supported TC Groups is 4
Number of Traffic Classes is 1
Admin mode is on
Admin Parameters:
--------------------
Admin is enabled
TC-grp     Priority#         Bandwidth       TSA
------------------------------------------------
0          0,1,2,3,4,5,6,7   100%            ETS
1                            -               -
2                            -               -
3                            -               -
4                            -               -
5                            -               -
6                            -               -
7                            -               -
8                            -               -
```

Figure 6-12. show interface dcbx detail Command Example

```
FTOS# show interface tengigabitethernet 0/49 dcbx detail
FTOS# show interface te 0/49 dcbx detail

E-ETS Configuration TLV enabled                 e-ETS Configuration TLV disabled
R-ETS Recommendation TLV enabled                r-ETS Recommendation TLV disabled
P-PFC Configuration TLV enabled                 p-PFC Configuration TLV disabled
F-Application priority for FCOE enabled         f-Application Priority for FCOE disabled
I-Application priority for iSCSI enabled        i-Application Priority for iSCSI disabled
---------------------------------------------------------------------------------------

Interface TenGigabitEthernet 0/49
   Remote Mac Address 00:00:00:00:00:11
    Port Role is Auto-Upstream
   DCBX Operational Status is Enabled
   Is Configuration Source? TRUE

Local DCBX Compatibility mode is CEE
   Local DCBX Configured mode is CEE
   Peer Operating version is CEE
   Local DCBX TLVs Transmitted: ErPfi

Local DCBX Status
-----------------
     DCBX Operational Version is 0
     DCBX Max Version Supported is 0
     Sequence Number: 2
     Acknowledgment Number: 2
     Protocol State: In-Sync

Peer DCBX Status:
----------------
     DCBX Operational Version is 0
     DCBX Max Version Supported is 255
     Sequence Number: 2
     Acknowledgment Number: 2
     Total DCBX Frames transmitted 27
     Total DCBX Frames received 6
     Total DCBX Frame errors 0
     Total DCBX Frames unrecognized 0
```

Table 6-5. show interface dcbx detail Command Description

Field	Description
Interface	Interface type with chassis slot and port number.
Port-Role	Configured DCBX port role: auto-upstream or auto-downstream.
DCBX Operational Status	Operational status (enabled or disabled) used to elect a configuration source and internally propagate a DCB configuration. The DCBX operational status is the combination of PFC and ETS operational status.
Configuration Source	Specifies whether the port serves as the DCBX configuration source on the switch: true (yes) or false (no).
Local DCBX Compatibility mode	DCBX version accepted in a DCB configuration as compatible. In auto-detection mode, a port can only operate on a DCBX version supported on the remote peer.
Local DCBX Configured mode	DCBX version configured on the port: CEE, CIN, IEEE v2.5, or Auto (port auto-configures to use the DCBX version received from a peer).

Table 6-5. show interface dcbx detail Command Description

Field	Description
Peer Operating version	DCBX version that the peer uses to exchange DCB parameters.
Local DCBX TLVs Transmitted	Transmission status (enabled or disabled) of advertised DCB TLVs (see TLV code at the top of the show command output).
Local DCBX Status: DCBX Operational Version	DCBX version advertised in Control TLVs.
Local DCBX Status: DCBX Max Version Supported	Highest DCBX version supported in Control TLVs.
Local DCBX Status: Sequence Number	Sequence number transmitted in Control TLVs.
Local DCBX Status: Acknowledgment Number	Acknowledgement number transmitted in Control TLVs
Local DCBX Status: Protocol State	Current operational state of DCBX protocol: Waiting for ACK or IN-SYNC.
Peer DCBX Status: DCBX Operational Version	DCBX version advertised in Control TLVs received from peer device.
Peer DCBX Status: DCBX Max Version Supported	Highest DCBX version supported in Control TLVs received from peer device.
Peer DCBX Status: Sequence Number	Sequence number transmitted in Control TLVs received from peer device.
Peer DCBX Status: Acknowledgment Number	Acknowledgement number transmitted in Control TLVs received from peer device.
Total DCBX Frames transmitted	Number of DCBX frames sent from local port.
Total DCBX Frames received	Number of DCBX frames received from remote peer port.
Total DCBX Frame errors	Number of DCBX frames with errors received.
Total DCBX Frames unrecognized	Number of unrecognizable DCBX frames received.

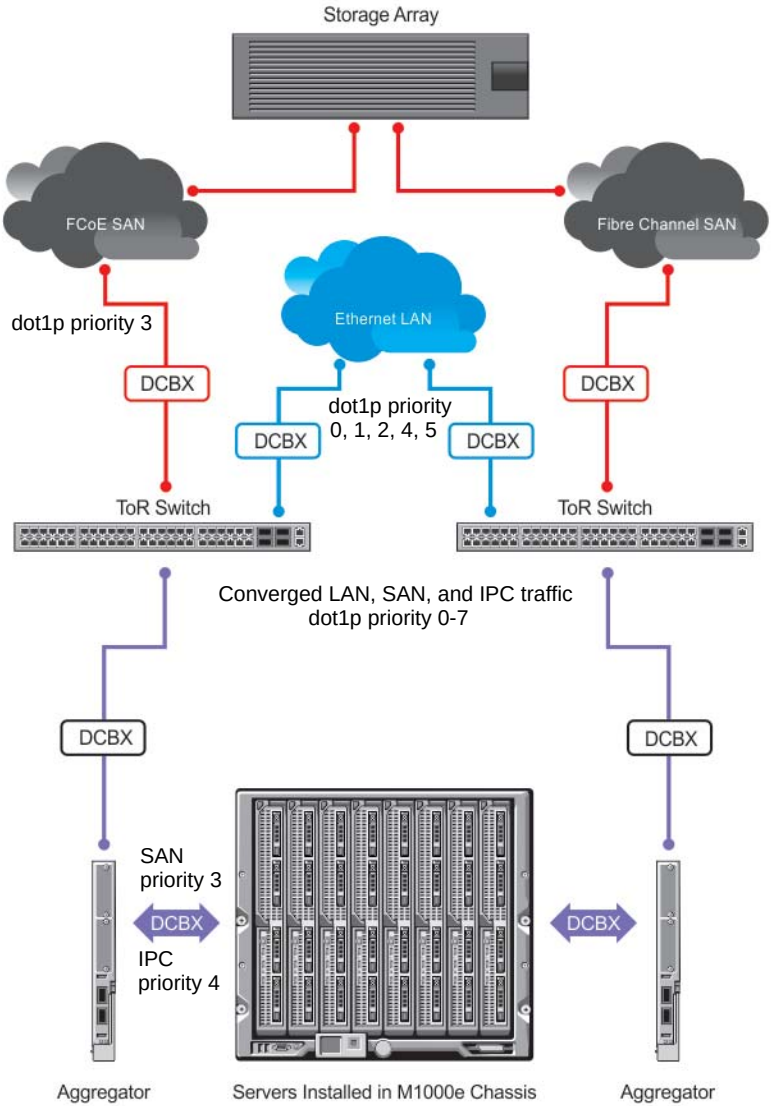
Example: PFC and ETS Operation

This section contains examples of DCB input and output policies applied on an interface.

In the example shown in Figure 6-13 for an Aggregator:

- Incoming SAN traffic is configured for priority-based flow control.
- Outbound LAN, IPC, and SAN traffic is mapped into three ETS priority groups and configured for enhanced traffic selection (bandwidth allocation and scheduling).
- One lossless queue is used.

Figure 6-13. Example: PFC and ETS Applied to LAN, IPC, and SAN Priority Traffic



QoS Traffic Classification: On the Aggregator, the service-class dynamic dot1p command has been used in Global Configuration mode to map ingress dot1p frames to the queues shown in Table 6-6. For more information, refer to QoS dot1p Traffic Classification and Queue Assignment.

Table 6-6. Example: dot1p-Queue Assignment

dot1p Value in Incoming Frame	Queue Assignment
0	0
1	0
2	0
3	1
4	2
5	3
6	3
7	3

Lossless SAN traffic with dot1p priority 3 is assigned to queue 1. Other traffic types are assigned the 802.1p priorities shown in Table 6-7 and the bandwidth allocations shown in Table 6-8.

Table 6-7. Example: dot1p-priority class group Assignment

dot1p Value in Incoming Frame	Priority Group Assignment
0	LAN
1	LAN
2	LAN
3	SAN
4	IPC
5	LAN
6	LAN
7	LAN

Table 6-8. Example: priority group-bandwidth Assignment

Priority Group	Bandwidth Assignment
IPC	5%
SAN	50%
LAN	45%

Hierarchical Scheduling in ETS Output Policies

On an Aggregator, ETS supports up to three levels of hierarchical scheduling. For example, ETS output policies with the following configurations can be applied:

- Priority group 1 assigns traffic to one priority queue with 20% of the link bandwidth and strict-priority scheduling.
- Priority group 2 assigns traffic to one priority queue with 30% of the link bandwidth.
- Priority group 3 assigns traffic to two priority queues with 50% of the link bandwidth and strict-priority scheduling.

In this example, ETS bandwidth allocation and scheduler behavior is as follows:

- Unused bandwidth usage: Normally, if there is no traffic or unused bandwidth for a priority group, the bandwidth allocated to the group is distributed to the other priority groups according to the bandwidth percentage allocated to each group. However, when three priority groups with different bandwidth allocations are used on an interface:
  - If priority group 3 has free bandwidth, it is distributed as follows: 20% of the free bandwidth to priority group 1 and 30% of the free bandwidth to priority group 2.
  - If priority group 1 or 2 has free bandwidth, (20 + 30)% of the free bandwidth is distributed to priority group 3. Priority groups 1 and 2 retain whatever free bandwidth remains up to the (20+ 30)%.

- Strict-priority groups: If two priority groups have strict-priority scheduling, traffic assigned from the priority group with the higher priority-queue number is scheduled first. However, when three priority groups are used and two groups have strict-priority scheduling (such as groups 1 and 3 in the example), the strict priority group whose traffic is mapped to one queue takes precedence over the strict priority group whose traffic is mapped to two queues.

  Therefore, in the example, scheduling traffic to priority group 1 (mapped to one strict-priority queue) takes precedence over scheduling traffic to priority group 3 (mapped to two strict-priority queues).

7

Dynamic Host Configuration Protocol (DHCP)

The Aggregator is auto-configured to operate as a DHCP client. The DHCP server, DHCP relay agent, and secure DHCP features are not supported.

DHCP Overview

Dynamic host configuration protocol (DHCP) is an application layer protocol that dynamically assigns IP addresses and other configuration parameters to network end-stations (hosts) based on configuration policies determined by network administrators. DHCP:

- relieves network administrators of manually configuring hosts, which can be a tedious and error-prone process when hosts often join, leave, and change locations on the network.
- reclaims IP addresses that are no longer in use to prevent address exhaustion.

DHCP is based on a client-server model. A host discovers the DHCP server and requests an IP address, and the server either leases or permanently assigns one. There are three types of devices that are involved in DHCP negotiation:

- **DHCP Server**—a network device offering configuration parameters to the client.
- **DHCP Client**—a network device requesting configuration parameters from the server.
- **Relay agent**—an intermediary network device that passes DHCP messages between the client and server when the server is not on the same subnet as the host.

Note: The DHCP server and relay agent features are not supported on an Aggregator.

DHCP Packet Format and Options

DHCP uses the user datagram protocol (UDP) as its transport protocol. The server listens on port 67 and transmits to port 68; the client listens on port 68 and transmits to port 67. The configuration parameters are carried as options in the DHCP packet in type, length, value (TLV) format; many options are specified in RFC 2132. To limit the number parameters that servers must provide, hosts specify the parameters that they require, and the server sends only those; some common options are given in Table 7-1.

Figure 7-1. DHCP Packet Format

Table 7-1. Common DHCP Options

Option	Code	Description
Subnet Mask	1	Specifies the clients subnet mask.
Router	3	Specifies the router IP addresses that may serve as the client's default gateway.
Domain Name Server	6	Specifies the DNS servers that are available to the client.
Domain Name	15	Specifies the domain name that client should use when resolving hostnames via DNS.
IP Address Lease Time	51	Specifies the amount of time that the client is allowed to use an assigned IP address.
DHCP Message Type	53	1: DHCPDISCOVER 2: DHCPOFFER 3: DHCPREQUEST 4: DHCPDECLINE 5: DHCPACK 6: DHCPNACK 7: DHCPRELEASE 8: DHCPINFORM
Parameter Request List	55	Clients use this option to tell the server which parameters it requires. It is a series of octets where each octet is DHCP option code.
Renewal Time	58	Specifies the amount of time after the IP address is granted that the client attempts to renew its lease with the *original* server.
Rebinding Time	59	Specifies the amount of time after the IP address is granted that the client attempts to renew its lease with *any* server, if the original server does not respond.
End	255	Signals the last option in the DHCP packet.

Assigning an IP Address Using DHCP

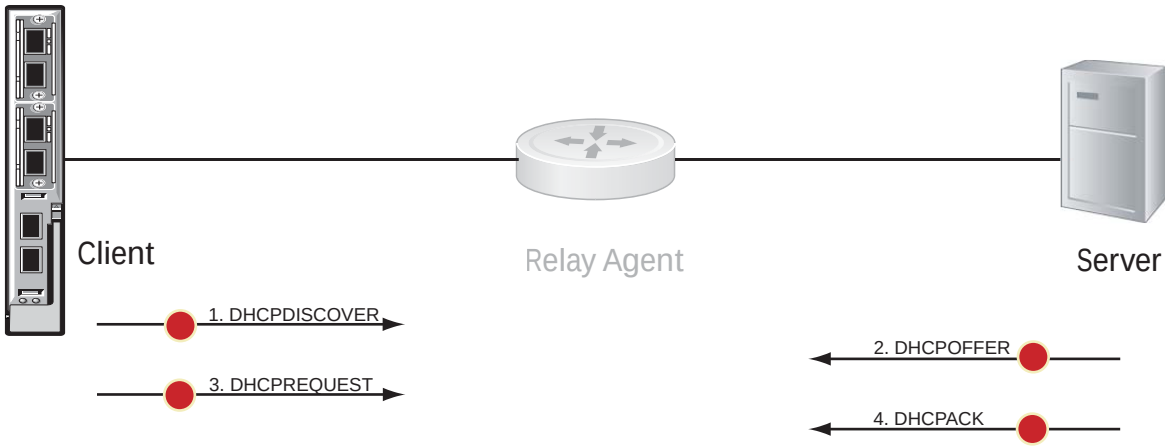
When a client joins a network:

1. The client initially broadcasts a **DHCPDISCOVER** message on the subnet to discover available DHCP servers. This message includes the parameters that the client requires and might include suggested values for those parameters.
2. Servers unicast or broadcast a **DHCPOFFER** message in response to the DHCPDISCOVER that offers to the client values for the requested parameters. Multiple servers might respond to a single DHCPDISCOVER; the client might wait a period of time and then act on the most preferred offer.
3. The client broadcasts a **DHCPREQUEST** message in response to the offer, requesting the offered values.
4. After receiving a DHCPREQUEST, the server binds the clients' unique identifier (the hardware address plus IP address) to the accepted configuration parameters and stores the data in a database called a *binding table*. The server then broadcasts a **DHCPACK** message, which signals to the client that it may begin using the assigned parameters.

There are additional messages that are used in case the DHCP negotiation deviates from the process described above and shown in Figure 7-2.

- **DHCPDECLINE—**A client sends this message to the server in response to a DHCPACK if the configuration parameters are unacceptable, for example, if the offered address is already in use. In this case, the client starts the configuration process over by sending a DHCPDISCOVER.
- **DHCPINFORM—**A client uses this message to request configuration parameters when it assigned an IP address manually rather than with DHCP. The server responds by unicast.
- **DHCPNAK—**A server sends this message to the client if it is not able to fulfill a DHCPREQUEST, for example, if the requested address is already in use. In this case, the client starts the configuration process over by sending a DHCPDISCOVER.
- **DHCPRELEASE—**A DHCP client sends this message when it is stopped forcefully to return its IP address to the server.

Figure 7-2. Assigning Network Parameters using DHCP



FTOS Behavior: DHCP is implemented in FTOS based on RFC 2131 and 3046.

DHCP Client

An Aggregator is auto-configured to operate as a DHCP client. The DHCP client functionality is enabled only on the default VLAN and the management interface.

A DHCP client is a network device that requests an IP address and configuration parameters from a DHCP server. On an Aggregator, the DHCP client functionality is implemented as follows:

- The public out-of-band management (OOB) interface and default VLAN 1 are configured, by default, as a DHCP client to acquire a dynamic IP address from a DHCP server.

  You can override the DHCP-assigned address on the OOB management interface by manually configuring an IP address using the CLI or CMC interface. If no user-configured IP address exists for the OOB interface exists and if the OOB IP address is not in the startup configuration, the Aggregator will automatically obtain it using DHCP.

  You can also manually configure an IP address for the VLAN 1 default management interface using the CLI. If no user-configured IP address exists for the default VLAN management interface exists and if the default VLAN IP address is not in the startup configuration, the Aggregator will automatically obtain it using DHCP.
- The default VLAN 1 with all ports configured as members is the only L3 interface on the Aggregator. When the default management VLAN has a DHCP-assigned address and you reconfigure the default VLAN ID number, the Aggregator:
  - Sends a DHCP release to the DHCP server to release the IP address.
  - Sends a DHCP request to obtain a new IP address. The IP address assigned by the DHCP server is used for the new default management VLAN.

Releasing and Renewing DHCP-based IP Addresses

On an Aggregator configured as a DHCP client, you can release a dynamically-assigned IP address without removing the DHCP client operation on the interface. You can later manually acquire a new IP address from the DHCP server as follows:

Task	Command Syntax	Command Mode
Release a dynamically-acquired IP address while retaining the DHCP client configuration on the interface.	release dhcp interface *type slot/port*	EXEC Privilege
Acquire a new IP address with renewed lease time from a DHCP server.	renew dhcp interface *type slot/port*	EXEC Privilege

Viewing DHCP Statistics and Lease Information

To display DHCP client information, enter the following **show** commands:

Task	Command Syntax	Command Mode
Display statistics about DHCP client interfaces (Figure 7-3).	show ip dhcp client statistics interface *type slot/port*	EXEC Privilege
Clear DHCP client statistics on a specified or on all interfaces.	clear ip dhcp client statistics {all | interface *type slot/port*}	EXEC Privilege
Display lease information about the dynamic IP address currently assigned to a DHCP client interface (Figure 7-4).	show ip dhcp lease [interface *type slot/port*]	EXEC Privilege

Figure 7-3. show ip dhcp client statistics

```
FTOS# show ip dhcp client statistics interface tengigabitethernet 0/0
Interface Name          Ma 0/0
Message                     Received
DHCPOFFER                   0
DHCPACK                     0
DHCPNAK                     0
Message                     Sent
DHCPDISCOVER                13
DHCPREQUEST                 0
DHCPDECLINE                 0
DHCPRELEASE                 0
DHCPREBIND                  0
DHCPRENEW                   0
DHCPINFORM                  0
```

Figure 7-4. show ip dhcp lease

```
FTOS# show ip dhcp

Interface  Lease-IP  Def-Router  ServerId  State  Lease Obtnd At       Lease Expires At
=========  ========  ==========  ========  =====  ==============       ================
Ma 0/0     0.0.0.0/0  0.0.0.0    0.0.0.0   INIT   -----NA-----         ----NA----

Vl 1   10.1.1.254/24  0.0.0.0   10.1.1.1   BOUND  08-26-2011 04:33:39  08-27-2011 04:33:39

Renew Time           Rebind Time
==========           ========
----NA----           ----NA----

08-26-2011 16:21:50  08-27-2011 01:33:39
```

Debugging DHCP Client Operation

To enable debug messages for DHCP client operation, enter the following **debug** commands:

Task	Command Syntax	Command Mode
Enable the display of log messages for all DHCP packets sent and received on DHCP client interfaces.	[no] debug ip dhcp client packets [interface *type slot/port*]	EXEC Privilege
Enable the display of log messages for the following events on DHCP client interfaces: • IP address acquisition • IP address release • Renewal of IP address and lease time • Release of an IP address	[no] debug ip dhcp client events [interface *type slot/port*]	EXEC Privilege

Figure 7-5 shows an example of the packet- and event-level debug messages displayed for the packet transmissions and state transitions on a DHCP client interface.

Figure 7-5. DHCP Client: Debug Messages Logged during DHCP Client Enabling/Disabling

```
FTOS (conf-if-Ma-0/0)# ip address dhcp
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :DHCP ENABLE CMD
Received in state START
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state SELECTING
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:  DHCP DISCOVER sent in Interface
Ma 0/0
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:  Received DHCPOFFER packet in
Interface Ma 0/0 with Lease-ip:10.16.134.250, Mask:255.255.0.0,Server-Id:10.16.134.249
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state REQUESTING
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:DHCP REQUEST sent in Interface
Ma 0/0
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:Received DHCPACK packet in Interface
Ma 0/0 with Lease-IP:10.16.134.250, Mask:255.255.0.0,DHCP REQUEST sent in Interface Ma 0/0
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state BOUND


FTOS(conf-if-ma-0/0)# no ip address
FTOS(conf-if-ma-0/0)#1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface
Ma 0/0 :DHCP DISABLE CMD Received in state SELECTING
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state START
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :DHCP DISABLED CMD
sent to FTOS in state START


FTOS# release dhcp int Ma 0/0
FTOS#1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :DHCP RELEASE
CMD Received in state BOUND
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT: DHCP RELEASE sent in Interface
Ma 0/0
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state STOPPED
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :DHCP IP RELEASED
CMD sent to FTOS in state STOPPED

FTOS# renew dhcp int Ma 0/0
FTOS#1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :DHCP RENEW
CMD Received in state STOPPED
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :Transitioned to
state SELECTING
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT: DHCP DISCOVER sent in Interface
Ma 0/0
1w2d23h: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT: Received DHCPOFFER packet in
Interface Ma 0/0 with Lease-Ip:10.16.134.250, Mask:255.255.0.0,Server-Id:10.16.134.249
```

Figure 7-6 shows an example of the packet- and event-level debug messages displayed for the packet transmissions and state transitions on a DHCP client interface when you release and renew a DHCP client.

Figure 7-6. DHCP Client: Debug Messages Logged during DHCP Client Release/Renew

```
FTOS# release dhcp interface managementethernet 0/0
May 27 15:55:22: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :
DHCP RELEASE CMD Received in state BOUND
May 27 15:55:22: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:
DHCP RELEASE sent in Interface Ma 0/0
May 27 15:55:22: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :
Transitioned to state STOPPED
May 27 15:55:22: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :
DHCP IP RELEASED CMD sent to FTOS in state STOPPED


FTOS# renew dhcp interface tengigabitethernet 0/1
FTOS#May 27 15:55:28: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :
DHCP RENEW CMD Received in state STOPPED
May 27 15:55:31: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_EVT: Interface Ma 0/0 :
Transitioned to state SELECTING
May 27 15:55:31: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:
DHCP DISCOVER sent in Interface Ma 0/0
May 27 15:55:31: %STKUNIT0-M:CP %DHCLIENT-5-DHCLIENT-LOG: DHCLIENT_DBG_PKT:
Received DHCPOFFER packet in Interface Ma 0/0 with Lease-Ip:10.16.134.250,
Mask:255.255.0.0,Server-Id:10.16.134.249
```

How DHCP Client is Implemented

The Aggregator is enabled by default to receive DHCP server-assigned dynamic IP addresses on an interface. This setting persists after a switch reboot. If you enter the **shutdown** command on the interface, DHCP transactions are stopped and the dynamically-acquired IP address is saved. Use the **show interface** *type slot*/*port* command to display the dynamic IP address and DHCP as the mode of IP address assignment. If you later enter the **no shutdown** command and the lease timer for the dynamic IP address has expired, the IP address is unconfigured and the interface tries to acquire a new dynamic address from DHCP server.

If you later enter the **no shutdown** command and the lease timer for the dynamic IP address has expired, the IP address is released.

When you enter the **release dhcp** command, although the IP address that was dynamically-acquired from a DHCP server is released from an interface, the ability to acquire a new DHCP server-assigned address remains in the running configuration for the interface. To acquire a new IP address, enter either the **renew dhcp** command at the EXEC privilege level or the **ip address dhcp** command at the interface configuration level.

If you enter **renew dhcp** command on an interface already configured with a dynamic IP address, the lease time of the dynamically acquired IP address is renewed.

Important: To verify the currently configured dynamic IP address on an interface, enter the **show ip dhcp lease** command. The **show running-configuration** command output only displays `ip address dhcp`; the currently assigned dynamic IP address is not displayed.

DHCP Client on a Management Interface CMC

The following conditions apply on a management interface that operates as a DHCP client:

- The management default route is added with the gateway as the router IP address received in the DHCP ACK packet. This is required to send and receive traffic to and from other subnets on the external network. This route is added irrespective both when the DHCP client and server are in the same or different subnets.

  The management default route is deleted if the management IP address is released like other management routes added by the DHCP client.
- If "ip route for 0.0.0.0" is present or added later, it will take precedence.
- Management routes added by a DHCP client are displayed with Route Source as DHCP in **show ip management route** and **show ip management-route dynamic** command output.
- If a static IP route configured with the **ip route** command replaces a management route added by the DHCP client and then if the statically-configured IP route is removed (**no ip route** command), the management route added by DHCP is automatically re-installed. The management routes added by the DHCP client must be manually deleted.
- If a management route added by the DHCP client is removed or replaced by the same statically-configured management route, it is not re-installed unless you release the DHCP IP address and renew it on the management interface.
- A management route added by the DHCP client has higher precedence over the same statically-configured management route. If a dynamically-acquired management route added by the DHCP client overwrites a static management route, the static route is not removed from the running configuration.
- Management routes added by the DHCP client are not added to the running configuration.

Note: Management routes added by the DHCP client include the specific routes to reach a DHCP server in a different subnet and the default management route.

DHCP Client on a VLAN

The following conditions apply on a VLAN that operates as a DHCP client:

- The default VLAN 1 with all ports auto-configured as members is the only L3 interface on the Aggregator.
- When the default management VLAN has a DHCP-assigned address and you reconfigure the default VLAN ID number, the Aggregator:
  - Sends a DHCP release to the DHCP server to release the IP address.
  - Sends a DHCP request to obtain a new IP address. The IP address assigned by the DHCP server is used for the new default management VLAN.

DHCP Client Operation with Stacking

The DHCP client daemon runs only on the master unit and handles all DHCP packet transactions. The DHCP client running on the master unit periodically synchronizes the lease file with the standby unit.

When a stack failover occurs, the new master requests the same DHCP server-assigned IP address on DHCP client interfaces. On non-bound interfaces, the new master re-initiates a DHCP packet transaction by sending a DHCP discovery packet.

8

FIP Snooping

FIP snooping is auto-configured on an Aggregator in standalone mode. You can display information on FIP snooping operation and statistics by entering **show** commands.

This chapter describes FIP snooping concepts and configuration procedures:

- Fibre Channel over Ethernet
- Ensuring Robustness in a Converged Ethernet Network
- FIP Snooping on Ethernet Bridges
- FIP Snooping in a Switch Stack
- How FIP Snooping is Implemented
- Displaying FIP Snooping Information
- FIP Snooping Example

Fibre Channel over Ethernet

Fibre Channel over Ethernet (FCoE) provides a converged Ethernet network that allows the combination of storage-area network (SAN) and LAN traffic on a Layer 2 link by encapsulating Fibre Channel data into Ethernet frames.

FCoE works with the Ethernet enhancements provided in data center bridging (DCB) to support lossless (no-drop) SAN and LAN traffic. In addition, DCB provides flexible bandwidth sharing for different traffic types, such as LAN and SAN, according to 802.1p priority classes of service. For more information, refer to the Data Center Bridging (DCB) chapter.

Ensuring Robustness in a Converged Ethernet Network

Fibre Channel networks used for SAN traffic employ switches that operate as trusted devices. End devices log into the switch to which they are attached in order to communicate with other end devices attached to the Fibre Channel network. Because Fibre Channel links are point-to-point, a Fibre Channel switch controls all storage traffic that an end device sends and receives over the network. As a result, the switch can enforce zoning configurations, ensure that end devices use their assigned addresses, and secure the network from unauthorized access and denial-of-service attacks.

To ensure similar Fibre Channel robustness and security with FCoE in an Ethernet cloud network, the Fibre Channel over Ethernet initialization protocol (FIP) establishes virtual point-to-point links between FCoE end-devices (server ENodes and target storage devices) and FCoE forwarders (FCFs) over transit FCoE-enabled bridges.

Ethernet bridges commonly provide access control list (ACLs) that can emulate a point-to-point link by providing the traffic enforcement required to create a Fibre Channel-level of robustness. In addition, FIP serves as a Layer 2 protocol to:

- Operate between FCoE end-devices and FCFs over intermediate Ethernet bridges to prevent unauthorized access to the network and achieve the required security.
- Allow transit Ethernet bridges to efficiently monitor FIP frames passing between FCoE end-devices and an FCF, and use the FIP snooping data to dynamically configure ACLs on the bridge to only permit traffic authorized by the FCF.

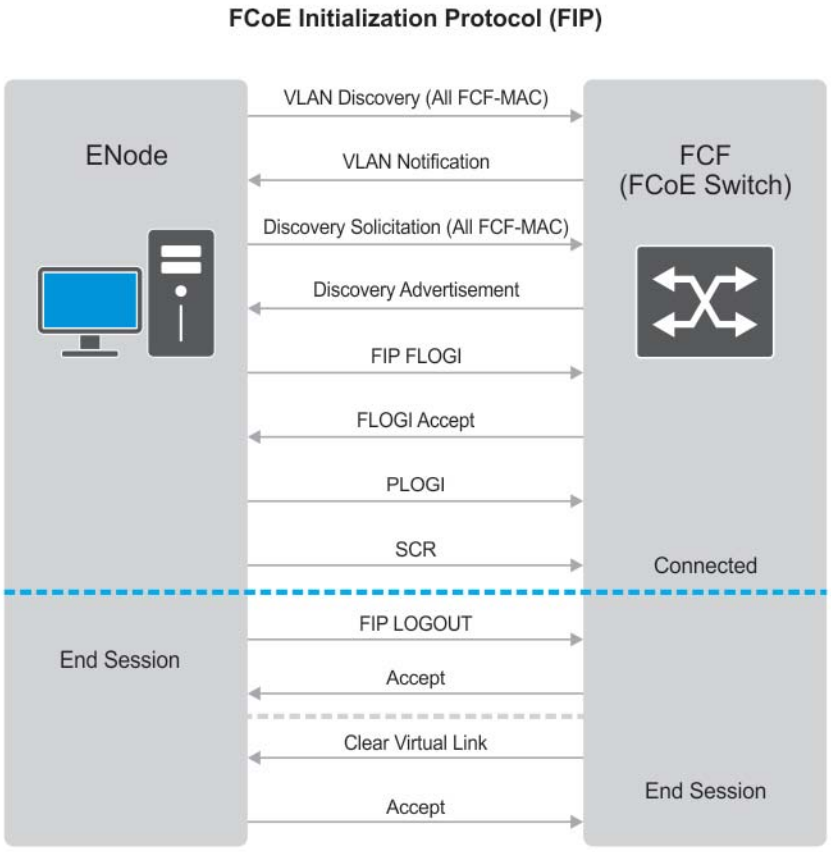
FIP enables FCoE devices to discover one another, initialize and maintain virtual links over an Ethernet network, and access storage devices in a storage area network. FIP satisfies the Fibre Channel requirement for point-to-point connections by creating a unique virtual link for each connection between an FCoE end-device and an FCF via a transit switch.

FIP provides functionality for discovering and logging in to an FCF. After discovering and logging in, FIP allows FCoE traffic to be sent and received between FCoE end-devices (ENodes) and the FCF. FIP uses its own EtherType and frame format. Figure 8-1 shows the communication that occurs between an ENode server and an FCoE switch (FCF).

FIP performs the following functions:

- FIP virtual local area network (VLAN) discovery: FCoE devices (ENodes) discover the FCoE VLANs on which to transmit and receive FIP and FCoE traffic.
- FIP discovery: FCoE end-devices and FCFs are automatically discovered.
- Initialization: FCoE devices perform fabric login (FLOGI) and fabric discovery (FDISC) to create a virtual link with an FCoE switch.
- Maintenance: A valid virtual link between an FCoE device and an FCoE switch is maintained and the link termination logout (LOGO) functions properly.

Figure 8-1. FIP discovery and login between an ENode and an FCF



FIP Snooping on Ethernet Bridges

In a converged Ethernet network, intermediate Ethernet bridges can snoop on FIP packets during the login process on an FCF. Then, using ACLs, a transit bridge can permit only authorized FCoE traffic to be transmitted between an FCoE end-device and an FCF. An Ethernet bridge that provides these functions is called a FIP snooping bridge (FSB).

On a FIP snooping bridge, ACLs are created dynamically as FIP login frames are processed. The ACLs are installed on switch ports configured for the following port modes:

- ENode mode for server-facing ports
- FCF mode for a trusted port directly connected to an FCF

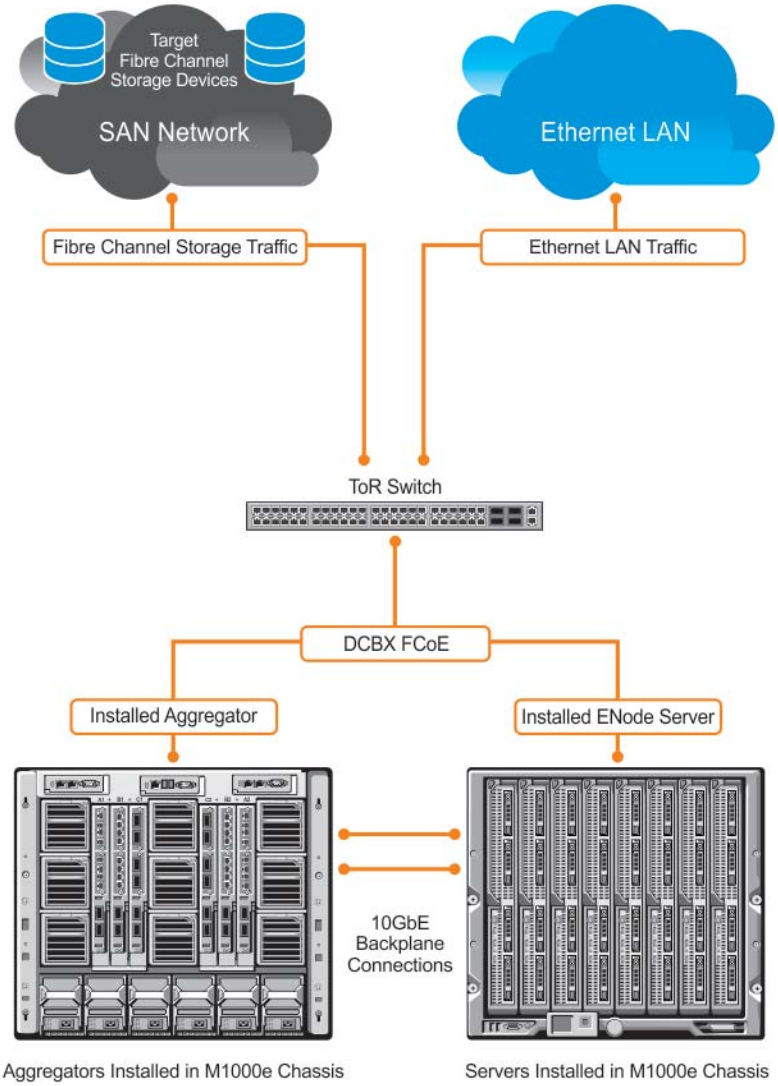
You must enable FIP snooping on an Aggregator and configure the FIP snooping parameters. When you enable FIP snooping, all ports on the switch by default become ENode ports.

Dynamic ACL generation on an Aggregator operating as a FIP snooping bridge functions as follows:

- Global ACLs are applied on server-facing ENode ports.
- Port-based ACLs are applied on ports directly connected to an FCF and on server-facing ENode ports.
- Port-based ACLs take precedence over global ACLs.
- FCoE-generated ACLs take precedence over user-configured ACLs. A user-configured ACL entry cannot deny FCoE and FIP snooping frames.

Figure 8-2 shows an Aggregator used as a FIP snooping bridge in a converged Ethernet network. The ToR switch operates as an FCF for FCoE traffic. Converged LAN and SAN traffic is transmitted between the ToR switch and an Aggregator. The Aggregator operates as a lossless FIP snooping bridge to transparently forward FCoE frames between the ENode servers and the FCF switch.

Figure 8-2. FIP Snooping on an Aggregator



The following sections describe how to configure the FIP snooping feature on a switch that functions as a FIP snooping bridge so that it can perform the following functions:

- Perform FIP snooping (allowing and parsing FIP frames) globally on all VLANs or on a per-VLAN basis.
- Set the FCoE MAC address prefix (FC-MAP) value used by an FCF to assign a MAC address to an FCoE end-device (server ENode or storage device) after a server successfully logs in.
- Set the FCF mode to provide additional port security on ports that are directly connected to an FCF.
- Check FIP snooping-enabled VLANs to ensure that they are operationally active.
- Process FIP VLAN discovery requests and responses, advertisements, solicitations, FLOGI/FDISC requests and responses, FLOGO requests and responses, keep-alive packets, and clear virtual-link messages.

FIP Snooping in a Switch Stack

FIP snooping supports switch stacking as follows:

- A switch stack configuration is synchronized with the standby stack unit.
- Dynamic population of the FCoE database (ENode, Session, and FCF tables) is synchronized with the standby stack unit. The FCoE database is maintained by snooping FIP keep-alive messages.
- In case of a failover, the new master switch starts the required timers for the FCoE database tables. Timers run only on the master stack unit.

Note: As a best practice, Dell Force10 recommends that you do not configure FIP Snooping on a stacked Aggregator.

How FIP Snooping is Implemented

As soon as the Aggregator is activated in an M1000e chassis as a switch-bridge, existing VLAN-specific and FIP snooping auto-configurations are applied. The Aggregator snoops FIP packets on VLANs enabled for FIP snooping and allows legitimate sessions. By default, all FCoE and FIP frames are dropped unless specifically permitted by existing FIP snooping-generated ACLs.

FIP Snooping on VLANs

FIP snooping is enabled globally on an Aggregator on all VLANs:

- FIP frames are allowed to pass through the switch on the enabled VLANs and are processed to generate FIP snooping ACLs.
- FCoE traffic is allowed on VLANs only after a successful virtual-link initialization (fabric login FLOGI) between an ENode and an FCF. All other FCoE traffic is dropped.
- At least one interface is auto-configured for FCF (FIP snooping bridge-FCF) mode on a FIP snooping-enabled VLAN. Multiple FCF trusted interfaces are auto-configured in a VLAN.
- A maximum of eight VLANS are supported for FIP snooping on an Aggregator. FIP snooping processes FIP packets in traffic only from the first eight incoming VLANs.

FC-MAP Value

The FC-MAP value that is applied globally by the Aggregator on all FCoE VLANs to authorize FCoE traffic is auto-configured.

The FC-MAP value is used to check the FC-MAP value for the MAC address assigned to ENodes in incoming FCoE frames. If the FC-MAP value does not match, FCoE frames are dropped. A session between an ENode and an FCF is established by the switch-bridge only when the FC-MAP value on the FCF matches the FC-MAP value on the FIP snooping bridge.

Bridge-to-FCF Links

A port directly connected to an FCF is auto-configured in FCF mode. Initially, all FCoE traffic is blocked; only FIP frames are allowed to pass.

FCoE traffic is allowed on the port only after a successful FLOGI request/response and confirmed use of the configured FC-MAP value for the VLAN.

Impact on other Software Features

FIP snooping affects other software features on an Aggregator as follows:

- MAC address learning: MAC address learning is not performed on FIP and FCoE frames, which are denied by ACLs dynamically created by FIP snooping on server-facing ports in ENode mode.
- MTU auto-configuration: MTU size is set to mini-jumbo (2500 bytes) when a port is in Switchport mode, the FIP snooping feature is enabled on the switch, and FIP snooping is enabled on all or individual VLANs.
- Link aggregation group (LAG): FIP snooping is supported on port channels on ports on which PFC mode is on (PFC is operationally up).

FIP Snooping Prerequisites

On an Aggregator, FIP snooping requires the following conditions:

- A FIP snooping bridge requires DCBX and PFC to be enabled on the switch for lossless Ethernet connections (refer to Data Center Bridging (DCB)). Dell recommends that you also enable ETS; ETS is recommended but not required.

  DCBX and PFC mode are auto-configured on Aggregator ports and FIP snooping is operational on the port. If the PFC parameters in a DCBX exchange with a peer are not synchronized, FIP and FCoE frames are dropped on the port.
- VLAN membership:
  - The Aggregator auto-configures the VLANs which handle FCoE traffic. You can reconfigure VLAN membership on a port (`vlan tagged` command).
  - Each FIP snooping port is auto-configured to operate in Hybrid mode so that it accepts both tagged and untagged VLAN frames.
  - Tagged VLAN membership is auto-configured on each FIP snooping port that sends and receives FCoE traffic and has links with an FCF, ENode server, or another FIP snooping bridge.

    The default VLAN membership of the port should continue to operate with untagged frames. FIP snooping is not supported on a port that is configured for non-default untagged VLAN membership.

FIP Snooping Restrictions

The following restrictions apply to FIP snooping on an Aggregator:

- The maximum number of FCoE VLANs supported on the Aggregator is eight.
- The maximum number of FIP snooping sessions (including NPIV sessions) supported per ENode server is 16.

  In a full FCoE N port ID virtualization (NPIV) configuration, 16 sessions (one FLOGI + fifteen NPIV sessions) are supported per ENode. In an FCoE NPV configuration, only one session is supported per ENode.
- The maximum number of FCFs supported per FIP snooping-enabled VLAN is four.
- Links to other FIP snooping bridges on a FIP snooping-enabled port (bridge-to-bridge links) are not supported on the Aggregator.

Displaying FIP Snooping Information

Use the show commands in Table 8-1 to display information on FIP snooping.

Table 8-1. Displaying FIP Snooping Information

Command	Output
show fip-snooping sessions [interface vlan *vlan-id*] (Figure 8-3)	Displays information on FIP-snooped sessions on all VLANs or a specified VLAN, including the ENode interface and MAC address, the FCF interface and MAC address, VLAN ID, FCoE MAC address and FCoE session ID number (FC-ID), worldwide node name (WWNN) and the worldwide port name (WWPN). Information on NPIV sessions is also displayed.
show fip-snooping config (Figure 8-4)	Displays the FIP snooping status and configured FC-MAP values.
show fip-snooping enode [*enode-mac-address*] (Figure 8-5)	Displays information on the ENodes in FIP-snooped sessions, including the ENode interface and MAC address, FCF MAC address, VLAN ID and FC-ID.
show fip-snooping fcf [*fcf-mac-address*] (Figure 8-6)	Displays information on the FCFs in FIP-snooped sessions, including the FCF interface and MAC address, FCF interface, VLAN ID, FC-MAP value, FKA advertisement period, and number of ENodes connected.
clear fip-snooping database interface vlan *vlan-id* {*fcoe-mac-address* | *enode-mac-address* | *fcf-mac-address*}	Clears FIP snooping information on a VLAN for a specified FCoE MAC address, ENode MAC address, or FCF MAC address, and removes the corresponding ACLs generated by FIP snooping.
show fip-snooping statistics [interface vlan *vlan-id* | interface *port-type port*/*slot* | interface port-channel *port-channel-number*] (Figure 8-7 and Figure 8-8)	Displays statistics on the FIP packets snooped on all interfaces, including VLANs, physical ports, and port channels.
clear fip-snooping statistics [interface vlan *vlan-id* | interface *port-type port*/*slot* | interface port-channel *port-channel-number*]	Clears the statistics on the FIP packets snooped on all VLANs, a specified VLAN, or a specified port interface.
show fip-snooping system (Figure 8-9)	Display information on the status of FIP snooping on the switch (enabled or disabled), including the number of FCoE VLANs, FCFs, ENodes, and currently active sessions.
show fip-snooping vlan (Figure 8-10)	Display information on the FCoE VLANs on which FIP snooping is enabled.

Figure 8-3. show fip-snooping sessions Command Example

```
FTOS#show fip-snooping sessions
Enode MAC           Enode Intf     FCF MAC             FCF Intf       VLAN
aa:bb:cc:00:00:00   Te 0/42        aa:bb:cd:00:00:00   Te 0/43        100
aa:bb:cc:00:00:00   Te 0/42        aa:bb:cd:00:00:00   Te 0/43        100
aa:bb:cc:00:00:00   Te 0/42        aa:bb:cd:00:00:00   Te 0/43        100
aa:bb:cc:00:00:00   Te 0/42        aa:bb:cd:00:00:00   Te 0/43        100
aa:bb:cc:00:00:00   Te 0/42        aa:bb:cd:00:00:00   Te 0/43        100

FCoE MAC            FC-ID          Port WWPN                  Port WWNN
0e:fc:00:01:00:01   01:00:01  31:00:0e:fc:00:00:00:00   21:00:0e:fc:00:00:00:00
0e:fc:00:01:00:02   01:00:02  41:00:0e:fc:00:00:00:00   21:00:0e:fc:00:00:00:00
0e:fc:00:01:00:03   01:00:03  41:00:0e:fc:00:00:00:01   21:00:0e:fc:00:00:00:00
0e:fc:00:01:00:04   01:00:04  41:00:0e:fc:00:00:00:02   21:00:0e:fc:00:00:00:00
0e:fc:00:01:00:05   01:00:05  41:00:0e:fc:00:00:00:03   21:00:0e:fc:00:00:00:00
```

Table 8-2. show fip-snooping sessions Command Description

Field	Description
ENode MAC	MAC address of the ENode.
ENode Interface	Slot/ port number of the interface connected to the ENode.
FCF MAC	MAC address of the FCF.
FCF Interface	Slot/ port number of the interface to which the FCF is connected.
VLAN	VLAN ID number used by the session.
FCoE MAC	MAC address of the FCoE session assigned by the FCF.
FC-ID	Fibre Channel ID assigned by the FCF.
Port WWPN	Worldwide port name of the CNA port.
Port WWNN	Worldwide node name of the CNA port.

Figure 8-4. show fip-snooping config Command Example

```
FTOS# show fip-snooping config
FIP Snooping Feature enabled Status: Enabled
FIP Snooping Global enabled Status: Enabled
Global FC-MAP Value: 0X0EFC00

FIP Snooping enabled VLANs
VLAN    Enabled          FC-MAP
----    -------         --------
100     TRUE            0X0EFC00
```

Figure 8-5. show fip-snooping enode Command Example

```
FTOS# show fip-snooping enode
Enode MAC           Enode Interface     FCF MAC             VLAN      FC-ID
---------           ---------------     -------             ----      -----
d4:ae:52:1b:e3:cd   Te 0/11             54:7f:ee:37:34:40   100       62:00:11
```

Table 8-3. show fip-snooping enode Command Description

Field	Description
ENode MAC	MAC address of the ENode.
ENode Interface	Slot/ port number of the interface connected to the ENode.
FCF MAC	MAC address of the FCF.
VLAN	VLAN ID number used by the session.
FC-ID	Fibre Channel session ID assigned by the FCF.

Figure 8-6. show fip-snooping fcf Command Example

```
FTOS# show fip-snooping fcf
FCF MAC             FCF Interface       VLAN      FC-MAP    FKA_ADV_PERIOD   No. of Enodes
-------             -------------       ----      ------    --------------   -------------
54:7f:ee:37:34:40   Po 22               100       0e:fc:00  4000             2
```

Table 8-4. show fip-snooping fcf Command Description

Field	Description
FCF MAC	MAC address of the FCF.
FCF Interface	Slot/port number of the interface to which the FCF is connected.
VLAN	VLAN ID number used by the session.
FC-MAP	FC-Map value advertised by the FCF.
ENode Interface	Slot/ number of the interface connected to the ENode.
FKA_ADV_PERIOD	Period of time (in milliseconds) during which FIP keep-alive advertisements are transmitted.
No of ENodes	Number of ENodes connected to the FCF.
FC-ID	Fibre Channel session ID assigned by the FCF.

Figure 8-7. show fip-snooping statistics (VLAN and port) Command Example

```
FTOS# show fip-snooping statistics interface vlan 100
Number of Vlan Requests                                :0
Number of Vlan Notifications                           :0
Number of Multicast Discovery Solicits                 :2
Number of Unicast Discovery Solicits                   :0
Number of FLOGI                                        :2
Number of FDISC                                        :16
Number of FLOGO                                        :0
Number of Enode Keep Alive                             :9021
Number of VN Port Keep Alive                           :3349
Number of Multicast Discovery Advertisement            :4437
Number of Unicast Discovery Advertisement              :2
Number of FLOGI Accepts                                :2
Number of FLOGI Rejects                                :0
Number of FDISC Accepts                                :16
Number of FDISC Rejects                                :0
Number of FLOGO Accepts                                :0
Number of FLOGO Rejects                                :0
Number of CVL                                          :0
Number of FCF Discovery Timeouts                       :0
Number of VN Port Session Timeouts                     :0
Number of Session failures due to Hardware Config      :0
FTOS(conf)#

FTOS# show fip-snooping statistics int tengigabitethernet 0/11
Number of Vlan Requests                                :1
Number of Vlan Notifications                           :0
Number of Multicast Discovery Solicits                 :1
Number of Unicast Discovery Solicits                   :0
Number of FLOGI                                        :1
Number of FDISC                                        :16
Number of FLOGO                                        :0
Number of Enode Keep Alive                             :4416
Number of VN Port Keep Alive                           :3136
Number of Multicast Discovery Advertisement            :0
Number of Unicast Discovery Advertisement              :0
Number of FLOGI Accepts                                :0
Number of FLOGI Rejects                                :0
Number of FDISC Accepts                                :0
Number of FDISC Rejects                                :0
Number of FLOGO Accepts                                :0
Number of FLOGO Rejects                                :0
Number of CVL                                          :0
Number of FCF Discovery Timeouts                       :0
Number of VN Port Session Timeouts                     :0
Number of Session failures due to Hardware Config      :0
```

Figure 8-8. show fip-snooping statistics (port channel) Command Example

```
FTOS# show fip-snooping statistics interface port-channel 22
Number of Vlan Requests                                 :0
Number of Vlan Notifications                            :2
Number of Multicast Discovery Solicits                  :0
Number of Unicast Discovery Solicits                    :0
Number of FLOGI                                         :0
Number of FDISC                                         :0
Number of FLOGO                                         :0
Number of Enode Keep Alive                              :0
Number of VN Port Keep Alive                            :0
Number of Multicast Discovery Advertisement             :4451
Number of Unicast Discovery Advertisement               :2
Number of FLOGI Accepts                                 :2
Number of FLOGI Rejects                                 :0
Number of FDISC Accepts                                 :16
Number of FDISC Rejects                                 :0
Number of FLOGO Accepts                                 :0
Number of FLOGO Rejects                                 :0
Number of CVL                                           :0
Number of FCF Discovery Timeouts                        :0
Number of VN Port Session Timeouts                      :0
Number of Session failures due to Hardware Config       :0
```

Table 8-5. show fip-snooping statistics Command Descriptions

Field	Description
Number of Vlan Requests	Number of FIP-snooped VLAN request frames received on the interface.
Number of VLAN Notifications	Number of FIP-snooped VLAN notification frames received on the interface.
Number of Multicast Discovery Solicits	Number of FIP-snooped multicast discovery solicit frames received on the interface.
Number of Unicast Discovery Solicits	Number of FIP-snooped unicast discovery solicit frames received on the interface.
Number of FLOGI	Number of FIP-snooped FLOGI request frames received on the interface.
Number of FDISC	Number of FIP-snooped FDISC request frames received on the interface.
Number of FLOGO	Number of FIP-snooped FLOGO frames received on the interface.
Number of ENode Keep Alives	Number of FIP-snooped ENode keep-alive frames received on the interface.
Number of VN Port Keep Alives	Number of FIP-snooped VN port keep-alive frames received on the interface.
Number of Multicast Discovery Advertisements	Number of FIP-snooped multicast discovery advertisements received on the interface.
Number of Unicast Discovery Advertisements	Number of FIP-snooped unicast discovery advertisements received on the interface.
Number of FLOGI Accepts	Number of FIP FLOGI accept frames received on the interface.
Number of FLOGI Rejects	Number of FIP FLOGI reject frames received on the interface.
Number of FDISC Accepts	Number of FIP FDISC accept frames received on the interface.
Number of FDISC Rejects	Number of FIP FDISC reject frames received on the interface.
Number of FLOGO Accepts	Number of FIP FLOGO accept frames received on the interface.
Number of FLOGO Rejects	Number of FIP FLOGO reject frames received on the interface.
Number of CVLs	Number of FIP clear virtual link frames received on the interface.
Number of FCF Discovery Timeouts	Number of FCF discovery timeouts that occurred on the interface.
Number of VN Port Session Timeouts	Number of VN port session timeouts that occurred on the interface.
Number of Session failures due to Hardware Config	Number of session failures due to hardware configuration that occurred on the interface.

Figure 8-9. show fip-snooping system Command Example

```
FTOS# show fip-snooping system
Global Mode                     : Enabled
FCOE VLAN List (Operational)    : 1, 100
FCFs                            : 1
Enodes                          : 2
Sessions                        : 17
```

Note: NPIV sessions are included in the number of FIP-snooped sessions displayed.

Figure 8-10. show fip-snooping vlan Command Example

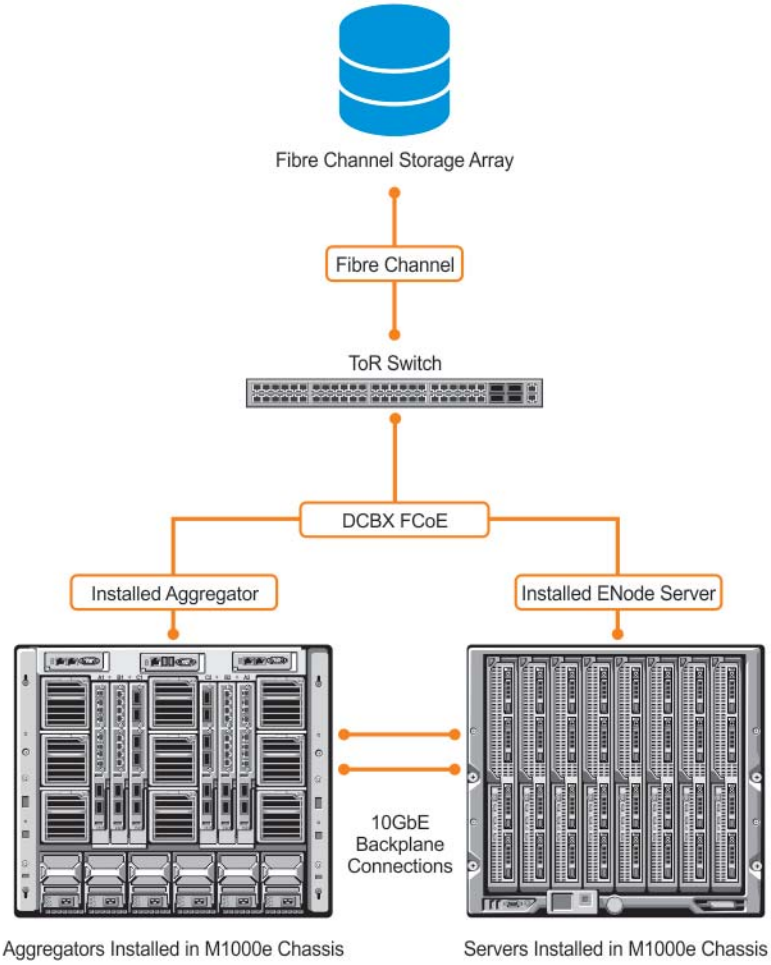
```
FTOS# show fip-snooping vlan
* = Default VLAN

VLAN    FC-MAP          FCFs    Enodes  Sessions
----    ------          ----    ------  --------
*1      -               -       -       -
100     0X0EFC00        1       2       17
```

Note: NPIV sessions are included in the number of FIP-snooped sessions displayed.

FIP Snooping Example

Figure 8-11 shows an Aggregator used as a FIP snooping bridge for FCoE traffic between an ENode (server blade) and an FCF (ToR switch). The ToR switch operates as an FCF and FCoE gateway.

Figure 8-11. Example: FIP Snooping on an Aggregator



In Figure 8-11, DCBX and PFC are enabled on the Aggregator (FIP snooping bridge) and on the FCF ToR switch. On the FIP snooping bridge, DCBX is configured as follows:

- A server-facing port is configured for DCBX in an auto-downstream role.
- An FCF-facing port is configured for DCBX in an auto-upstream or configuration-source role.

The DCBX configuration on the FCF-facing port is detected by the server-facing port and the DCB PFC configuration on both ports is synchronized. For more information about how to configure DCBX and PFC on a port, refer to FIP Snooping.

After FIP packets are exchanged between the ENode and the switch, a FIP snooping session is established. ACLS are dynamically generated for FIP snooping on the FIP snooping bridge/switch.

Debugging FIP Snooping

To enable debug messages for FIP snooping events, enter the **debug fip-snooping** command.

Task	Command	Command Mode
Enable FIP snooping debugging on for all or a specified event type, where: all enables all debugging options. acl enables debugging only for ACL-specific events. error enables debugging only for error conditions. ifm enables debugging only for IFM events. info enables debugging only for information events. ipc enables debugging only for IPC events. rx enables debugging only for incoming packet traffic.	debug fip-snooping [all | acl | error | ifm | info | ipc | rx]	EXEC PRIVILEGE

To turn off debugging event messages, enter the **no debug fip-snooping** command.

9

Internet Group Management Protocol (IGMP)

On an Aggregator, IGMP snooping is auto-configured. You can display information on IGMP by using **show** commands.

Multicast is based on identifying many hosts by a single destination IP address. Hosts represented by the same IP address are a *multicast group*. The internet group management protocol (IGMP) is a Layer 3 multicast protocol that hosts use to join or leave a multicast group. Multicast routing protocols (such as protocol-independent multicast [PIM]) use the information in IGMP messages to discover which groups are active and to populate the multicast routing table.

This chapter contains the following sections:

IGMP Overview

IGMP has three versions. Version 3 obsoletes and is backwards-compatible with version 2; version 2 obsoletes version 1.

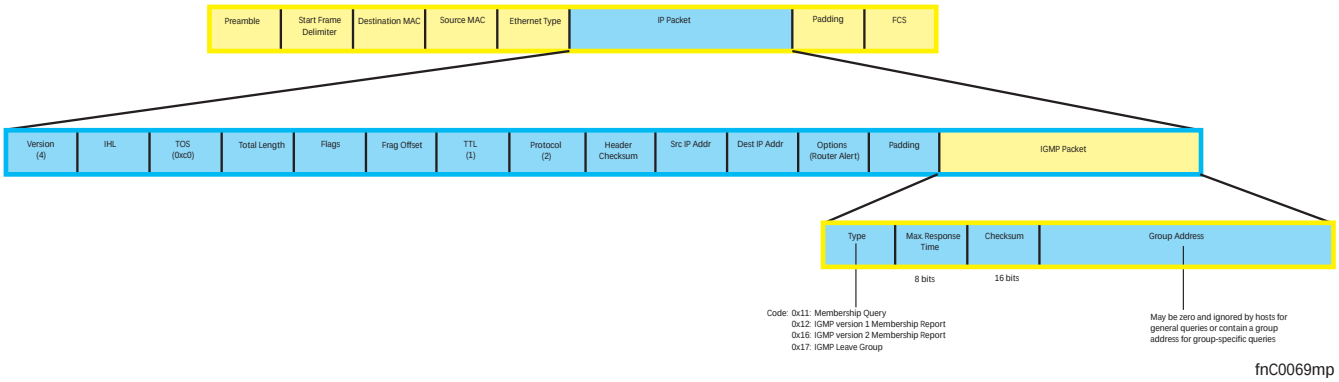
IGMP Version 2

IGMP version 2 improves upon version 1 by specifying IGMP Leave messages, which allows hosts to notify routers that they no longer care about traffic for a particular group. Leave messages reduce the amount of time that the router takes to stop forwarding traffic for a group to a subnet (leave latency) after the last host leaves the group. In version 1 hosts quietly leave groups, and the router waits for a query response timer several times the value of the query interval to expire before it stops forwarding traffic.

To receive multicast traffic from a particular source, a host must join the multicast group to which the source is sending traffic. A host that is a member of a group is called a “receiver.” A host may join many groups, and may join or leave any group at any time. A host joins and leaves a multicast group by sending an IGMP message to its IGMP querier. The querier is the router that surveys a subnet for multicast receivers and processes survey responses to populate the multicast routing table.

IGMP messages are encapsulated in IP packets (Figure 9-1).

Figure 9-1. IGMP Version 2 Packet Format



Joining a Multicast Group

There are two ways that a host may join a multicast group: it may respond to a general query from its querier, or it may send an unsolicited report to its querier.

- Responding to an IGMP Query
  - One router on a subnet is elected as the querier. The querier periodically multicasts (to all-multicast-systems address 224.0.0.1) a general query to all hosts on the subnet.
  - A host that wants to join a multicast group responds with an IGMP membership report that contains the multicast address of the group it wants to join (the packet is addressed to the same group). If multiple hosts want to join the same multicast group, only the report from the first host to respond reaches the querier, and the remaining hosts suppress their responses (for how the delay timer mechanism works, refer to IGMP Snooping).
  - The querier receives the report for a group and adds the group to the list of multicast groups associated with its outgoing port to the subnet. Multicast traffic for the group is then forwarded to that subnet.
- Sending an Unsolicited IGMP Report
  - A host does not have to wait for a general query to join a group. It may send an unsolicited IGMP membership report, also called an IGMP Join message, to the querier.

Leaving a Multicast Group

- A host sends a membership report of type 0x17 (IGMP Leave message) to the all routers multicast address 224.0.0.2 when it no longer cares about multicast traffic for a particular group.
- The querier sends a group-specific query to determine whether there are any remaining hosts in the group. There must be at least one receiver in a group on a subnet for a router to forward multicast traffic for that group to the subnet.
- Any remaining hosts respond to the query according to the delay timer mechanism (refer to IGMP Snooping). If no hosts respond (because there are none remaining in the group), the querier waits a specified period and sends another query. If it still receives no response, the querier removes the group from the list associated with forwarding port and stops forwarding traffic for that group to the subnet.

IGMP Version 3

Conceptually, IGMP version 3 behaves the same as version 2. However, there are differences:

- Version 3 adds the ability to filter by multicast source, which helps the multicast routing protocols avoid forwarding traffic to subnets where there are no interested receivers.
- To enable filtering, routers must keep track of more state information, that is, the list of sources that must be filtered. An additional query type, the group-and-source-specific query, keeps track of state changes, while the group-specific and general queries still refresh existing state.
- Reporting is more efficient and robust. Hosts do not suppress query responses (non-suppression helps track state and enables the immediate-leave and IGMP snooping features), state-change reports are retransmitted to insure delivery, and a single membership report bundles multiple statements from a single host, rather than sending an individual packet for each statement.

To accommodate these protocol enhancements, the IGMP version 3 packet structure is different from version 2. Queries (Figure 9-2) are still sent to the all-systems address 224.0.0.1, but reports (Figure 9-3) are sent to all the IGMP version 3-capable multicast routers address 244.0.0.22.

Figure 9-2. IGMP version 3 Membership Query Packet Format

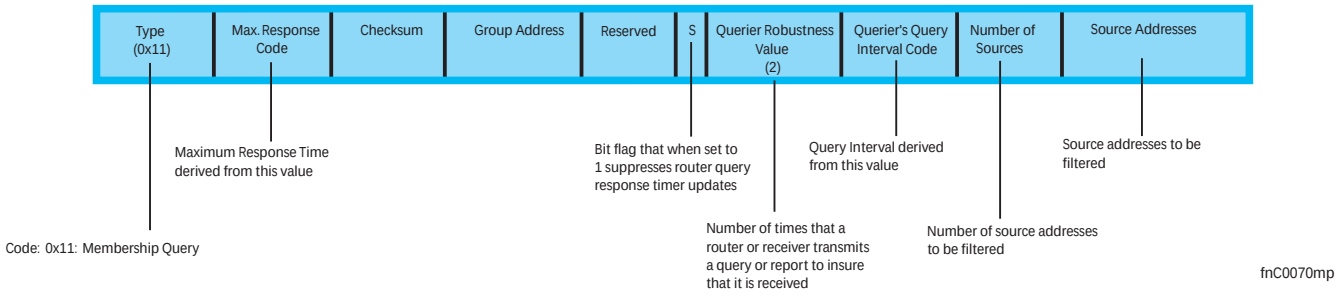
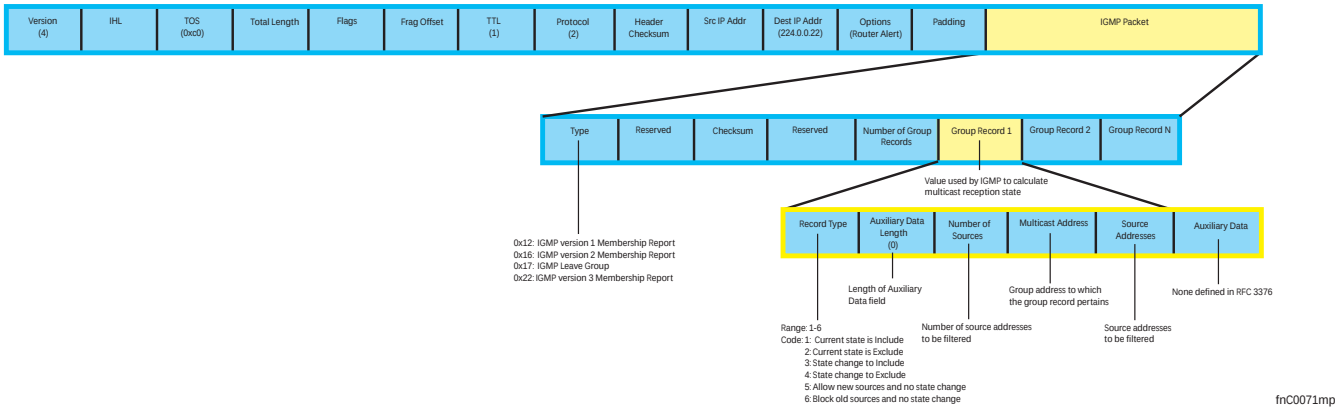


Figure 9-3. IGMP version 3 Membership Report Packet Format

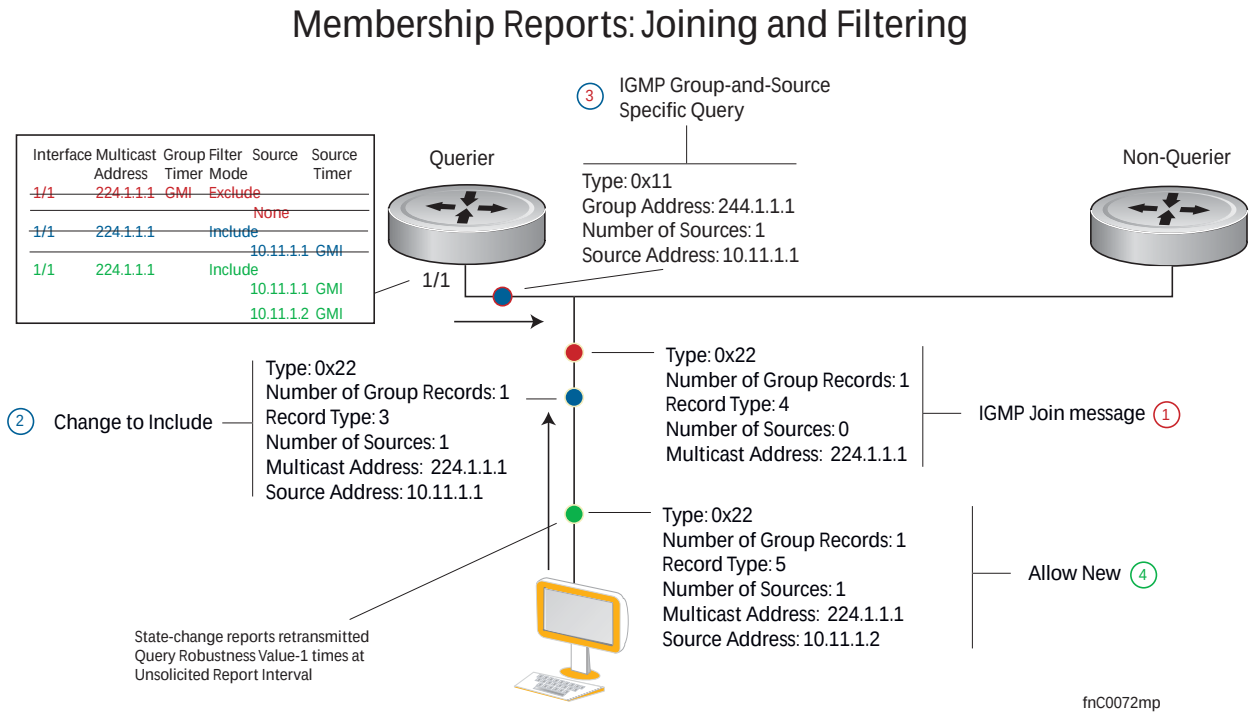


Joining and Filtering Groups and Sources

Figure 9-4 shows how multicast routers maintain the group and source information from unsolicited reports.

1. The first unsolicited report from the host indicates that it wants to receive traffic for group 224.1.1.1.
2. The host's second report indicates that it is only interested in traffic from group 224.1.1.1, source 10.11.1.1. Include messages prevent traffic from all other sources in the group from reaching the subnet, so before recording this request, the querier sends a group-and-source query to verify that there are no hosts interested in any other sources. The multicast router must satisfy all hosts if they have conflicting requests. For example, if another host on the subnet is interested in traffic from 10.11.1.3, the router cannot record the include request. There are no other interested hosts, so the request is recorded. At this point, the multicast routing protocol prunes the tree to all but the specified sources.
3. The host's third message indicates that it is only interested in traffic from sources 10.11.1.1 and 10.11.1.2. Because this request again prevents all other sources from reaching the subnet, the router sends another group-and-source query so that it can satisfy all other hosts. There are no other interested hosts, so the request is recorded.

Figure 9-4. IGMP Membership Reports: Joining and Filtering

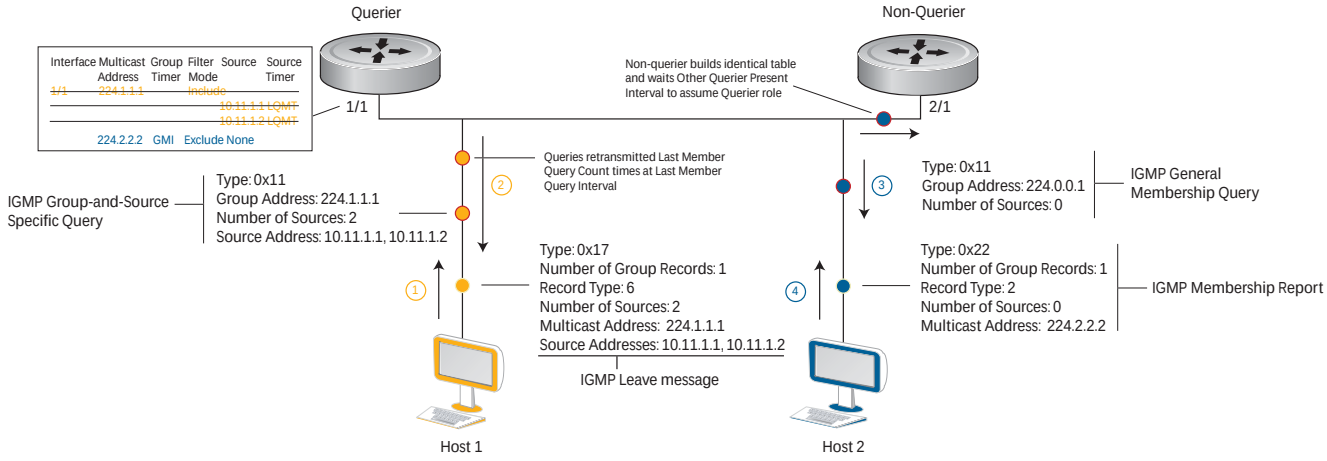


Leaving and Staying in Groups

Figure 9-5 shows how multicast routers track and refresh state changes in response to group-and-specific and general queries.

1. Host 1 sends a message indicating it is leaving group 224.1.1.1 and that the included filter for 10.11.1.1 and 10.11.1.2 are no longer necessary.
2. The querier, before making any state changes, sends a group-and-source query to see if any other host is interested in these two sources; queries for state-changes are retransmitted multiple times. If any are interested, they respond with their current state information and the querier refreshes the relevant state information.
3. Separately in Figure 9-5, the querier sends a general query to 224.0.0.1.
4. Host 2 responds to the periodic general query so the querier refreshes the state information for that group.

Figure 9-5. IGMP Membership Queries: Leaving and Staying in Groups



IGMP Snooping

IGMP snooping is auto-configured on an Aggregator.

Multicast packets are addressed with multicast MAC addresses, which represent a group of devices rather than one unique device. Switches forward multicast frames out of all ports in a VLAN by default, even if there are only a small number of interested hosts, resulting in a waste of bandwidth. IGMP snooping enables switches to use information in IGMP packets to generate a forwarding table that associates ports with multicast groups so that received multicast frames are forwarded only to interested receivers.

How IGMP Snooping is Implemented on an Aggregator

- IGMP snooping is enabled by default on the switch.
- FTOS supports version 1, version 2, and version 3 hosts.
- FTOS IGMP snooping is based on the IP multicast address (not on the Layer 2 multicast MAC address). IGMP snooping entries are stored in the Layer 3 flow table instead of in the Layer 2 forwarding information base (FIB).
- FTOS IGMP snooping is based on draft-ietf-magma-snoop-10.
- IGMP snooping is supported on all M I/O Aggregator stack members.
- A maximum of 8k groups and 4k virtual local area networks (VLAN) are supported.
- IGMP snooping is not supported on the default VLAN interface.
- Flooding of unregistered multicast traffic is enabled by default.
- Queries are not accepted from the server side ports and are only accepted from the uplink LAG.
- Reports and Leaves are flooded by default to the uplink LAG irrespective of whether it is an mrouter port or not.

Disabling Multicast Flooding

If the switch receives a multicast packet that has an IP address of a group it has not learned (unregistered frame), the switch floods that packet out of all ports on the VLAN. To disable multicast flooding on all VLAN ports, enter the **no ip igmp snooping flood** command in global configuration mode.

When multicast flooding is disabled, unregistered multicast data traffic is forwarded to only multicast router ports on all VLANs. If there is no multicast router port in a VLAN, unregistered multicast data traffic is dropped.

Displaying IGMP Information

Use the show commands in Table 9-1 to display information on IGMP. If you specify a group address or interface:

- Enter a group address in dotted decimal format; for example, 225.0.0.0.
- Enter an interface in one of the following formats: **tengigabitethernet** *slot*/*port*, **port-channel** *port-channel-number*, or **vlan** *vlan-number*.

Table 9-1. Displaying IGMP Information

Command	Output
show ip igmp groups [*group-address* [detail] | detail | *interface* [*group-address* [detail]] (Figure 9-6)	Displays information on IGMP groups.
show ip igmp interface [*interface*] (Figure 9-7)	Displays IGMP information on IGMP-enabled interfaces.
show ip igmp snooping mrouter [vlan *vlan-number*] (Figure 9-8)	Displays information on IGMP-enabled multicast router (mrouter) interfaces.
clear ip igmp groups [*group-address* | *interface*]	Clears IGMP information for group addresses and IGMP-enabled interfaces.

Figure 9-6. show ip igmp groups Command Example

```
FTOS# show ip igmp groups
Total Number of Groups: 2
IGMP Connected Group Membership
Group Address    Interface               Mode          Uptime    Expires   Last Reporter
226.0.0.1        Vlan 1500               INCLUDE       00:00:19  Never     1.1.1.2
226.0.0.1        Vlan 1600               INCLUDE       00:00:02  Never     1.1.1.2
FTOS#show ip igmp groups detail

Interface             Vlan 1500
Group                 226.0.0.1
Uptime                00:00:21
Expires               Never
Router mode           INCLUDE
Last reporter         1.1.1.2
Last reporter mode    INCLUDE
Last report received  IS_INCL
Group source list
Source address                  Uptime      Expires
1.1.1.2                         00:00:21    00:01:48
  Member Ports: Po 1

Interface             Vlan 1600
Group                 226.0.0.1
Uptime                00:00:04
Expires               Never
Router mode           INCLUDE
Last reporter         1.1.1.2
Last reporter mode    INCLUDE
Last report received  IS_INCL
Group source list
Source address                  Uptime      Expires
1.1.1.2                         00:00:04    00:02:05
  Member Ports: Po 1
FTOS#
```

Figure 9-7. show ip igmp interface Command Example

```
FTOS# show ip igmp interface

Vlan 2 is up, line protocol is down
  Inbound IGMP access group is not set
  Interface IGMP group join rate limit is not set
  IGMP snooping is enabled on interface
  IGMP Snooping query interval is 60 seconds
  IGMP Snooping querier timeout is 125 seconds
  IGMP Snooping last member query response interval is 1000 ms
  IGMP snooping fast-leave is disabled on this interface
  IGMP snooping querier is disabled on this interface
Vlan 3 is up, line protocol is down
  Inbound IGMP access group is not set
  Interface IGMP group join rate limit is not set
  IGMP snooping is enabled on interface
  IGMP Snooping query interval is 60 seconds
  IGMP Snooping querier timeout is 125 seconds
  IGMP Snooping last member query response interval is 1000 ms
  IGMP snooping fast-leave is disabled on this interface
  IGMP snooping querier is disabled on this interface
--More--
```

Figure 9-8. show ip igmp snooping mrouter Command Example

```
"FTOS# show ip igmp snooping mrouter
Interface Router Ports
Vlan 1000 Po 128
FTOS#
```

10

Interfaces

This chapter describes the auto-configuration of 1 Gigabit and 10 Gigabit Ethernet interfaces (physical and logical) on an Aggregator.

Basic Interface Configuration:

- Interface Auto-Configuration
- Interface Types
- Viewing Interface Information
- Disabling and Re-enabling a Physical Interface
- Layer 2 Mode
- Management Interfaces
- VLAN Membership
- Port Channel Interfaces

Advanced Interface Configuration:

- Monitor and Maintain Interfaces
- Flow Control Using Ethernet Pause Frames
- MTU Size
- Auto-Negotiation on Ethernet Interfaces
- Viewing Interface Information

Interface Auto-Configuration

An Aggregator auto-configures interfaces as follows:

- All interfaces operate as layer 2 interfaces at 10GbE in standalone mode. FlexIO module interfaces support only uplink connections. Only the 40GbE ports on the base module can be used for stacking.
  - By default, the two fixed 40GbE ports on the base module operate in 4x10GbE mode with breakout cables and support up to eight 10GbE uplinks. You can configure the base-module ports as 40GbE links for stacking.
  - The interfaces on a 40GbE QSFP+ FlexIO module auto-configure to support only 10GbE SFP+ connections using 4x10GbE breakout cables.
- All 10GbE uplink interfaces belong to the same 10GbE link aggregation group (LAG).
  - The tagged VLAN membership of the uplink LAG is automatically configured based on the VLAN configuration of all server-facing ports (ports 1 to 32). The untagged VLAN used for the uplink LAG is always the default VLAN 1.
  - The tagged VLAN membership of a server-facing LAG is automatically configured based on the server-facing ports that are members of the LAG. The untagged VLAN of a server-facing LAG is auto-configured based on the untagged VLAN to which the lowest numbered server-facing port in the LAG belongs.
- All interfaces are auto-configured as members of all (4094) VLANs and untagged VLAN 1. All VLANs are up and can send or receive layer 2 traffic. You can use the CLI or CMC interface to configure only the required VLANs on a port interface.
- Aggregator ports are numbered 1 to 56. Ports 1 to 32 are internal server-facing interfaces. Ports 33 to 56 are external ports numbered from the bottom to the top of the Aggregator. For port numbering of Aggregator interfaces in standalone and stacking mode, see Figure 4-2.

Interface Types

The following interface types are supported on an Aggregator.

Interface Type	Supported Modes	Default Mode	Requires Creation	Default State
Physical	L2	10GbE uplink	No	No Shutdown (enabled)
Management	L3	L3	No	No Shutdown (enabled)
Port Channel	L2	L2	No	L2 - No Shutdown (enabled)
Default VLAN	L2 and L3	L2 and L3 (VLAN 1)	No	L2 - No Shutdown (enabled) L3 - No Shutdown (enabled)
Non-default VLANs (VLANs 2 - 4094)	L2 and L3	L2 and L3	Yes	L2 - No Shutdown (enabled) L3 - No Shutdown (enabled)

Viewing Interface Information

You can use show commands to view interface status and auto-configured parameters.

The show interfaces command in EXEC mode lists all configurable interfaces on the chassis and has options to display the interface status, IP and MAC addresses, and multiple counters for the amount and type of traffic passing through the interface. If a port channel interface is configured, the show interfaces command can list the interfaces configured in the port channel.

Note: To end output from the system, such as the output from the show interfaces command, enter CTRL+C and FTOS returns to the command prompt.

Note: The command line interface (CLI) output may be incorrectly displayed as 0 (zero) for the Rx/Tx power values. Perform an simple network management protocol (SNMP) query to obtain the correct power information.

Figure 10-1 shows the configuration and status information for one interface.

Figure 10-1. show interfaces Command Example (Partial)

```
FTOS#show interface tengig 1/16
TenGigabitEthernet 1/16 is up, line protocol is up
Hardware is DellForce10Eth, address is 00:01:e8:00:ab:01
    Current address is 00:01:e8:00:ab:01
Server Port AdminState is Up
Pluggable media not present
Interface index is 71635713
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :tenG2730001e800ab01
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 1000 Mbit
Flowcontrol rx off tx off
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 11:04:02
Queueing strategy: fifo
Input Statistics:
     0 packets, 0 bytes
     0 64-byte pkts, 0 over 64-byte pkts, 0 over 127-byte pkts
     0 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     0 Multicasts, 0 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     14856 packets, 2349010 bytes, 0 underruns
     0 64-byte pkts, 4357 over 64-byte pkts, 8323 over 127-byte pkts
     2176 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     12551 Multicasts, 2305 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
     Output 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
Time since last interface status change: 11:01:23
```

Use the show ip interfaces brief command in EXEC Privilege mode to view which interfaces are enabled for Layer 3 data transmission. In Figure 10-2, the TenGigabitEthernet interface 1/5 is in Layer 3 mode because an IP address has been assigned to it and the interface's status is operationally up.

Figure 10-2. show ip interfaces brief Command Example (Partial)

```
FTOS#show ip interface brief
Interface                IP-Address      OK  Method Status                Protocol
TenGigabitEthernet 1/1   unassigned      NO  None   up                    down
TenGigabitEthernet 1/2   unassigned      NO  None   up                    down
TenGigabitEthernet 1/3   unassigned      NO  None   up                    down
TenGigabitEthernet 1/4   unassigned      NO  None   up                    down
TenGigabitEthernet 1/5   unassigned      YES None   up                    up
TenGigabitEthernet 1/6   unassigned      NO  None   up                    down
TenGigabitEthernet 1/7   unassigned      NO  None   up                    down
TenGigabitEthernet 1/8   unassigned      NO  None   up                    down
TenGigabitEthernet 1/9   unassigned      NO  None   up                    down
--More--
```

Use the show interfaces configured command in EXEC Privilege mode to view only configured interfaces.

To determine which physical interfaces are available, use the show running-config command in EXEC mode. This command displays all physical interfaces available on the switch (Figure 10-3).

Figure 10-3. show running-config Command Example (Partial)

```
FTOS#show running config
Current Configuration ...
! Version E8-3-17-38
! Last configuration change at Tue Jul 24 20:48:55 2012 by default
!
boot system stack-unit 1 primary tftp://10.11.9.21/dv-m1000e-2-b2
boot system stack-unit 1 default system: A:
boot system gateway 10.11.209.62
!
redundancy auto-synchronize full
!
service timestamps log datetime
!
hostname FTOS
!
username root password 7 d7acc8a1dcd4f698 privilege 15
mac-address-table aging-time 300
!
stack-unit 1 provision I/O-Aggregator
!
stack-unit 1 port 33 portmode quad
!
stack-unit 1 port 37 portmode quad
--More--
```

Disabling and Re-enabling a Physical Interface

By default, all port interfaces on an Aggregator are operationally enabled (no shutdown) to send and receive Layer 2 traffic. You can reconfigure a physical interface to shut it down by entering the **shutdown** command. To re-enable the interface, enter the **no shutdown** command.

Step	Command Syntax	Command Mode	Purpose
1	interface *interface*	CONFIGURATION	Enter the keyword interface followed by the type of interface and slot/port information: • For a 10GbE interface, enter the keyword TenGigabitEthernet followed by the *slot*/*port* numbers; for example, **interface tengigabitethernet 0/56**. • For the management interface on a stack-unit, enter the keyword ManagementEthernet followed by the *slot*/*port* numbers; for example, **interface managementethernet 0/33**.
2	shutdown	INTERFACE	Enter the shutdown command to disable the interface.

To confirm that the interface is enabled, use the show config command in INTERFACE mode.

To leave INTERFACE mode, use the exit command or end command.

You cannot delete a physical interface.

The management IP address on the D-fabric provides a dedicated management access to the system.

The switch interfaces support Layer 2 and Layer 3 traffic over the 100/1000/10000, 10-Gigabit, and 40-Gigabit Ethernet interfaces. These interfaces can also become part of virtual interfaces such as virtual local area networks (VLANs) or port channels.

For more information about VLANs, refer to VLANs and Port Tagging. For more information about port channels, refer to Port Channel Interfaces.

FTOS Behavior: The Aggregator uses a single MAC address for all physical interfaces.

Layer 2 Mode

On an Aggregator, physical interfaces, port channels, and VLANs auto-configure to operate in Layer 2 mode. Figure 10-4 shows the basic configuration found in a Layer 2 interface.

Note: Layer 3 (network) mode is not supported on Aggregator physical interfaces, port channels, and VLANs. Only management interfaces operate in Layer 3 mode.

Figure 10-4. show config Command Example of a Layer 2 Interface

```
FTOS(conf-if-te-1/1)#show config
!
interface TenGigabitEthernet 1/1
 mtu 12000
 portmode hybrid
 switchport
 auto vlan
!
 protocol lldp
  advertise management-tlv system-name
  dcbx port-role auto-downstream
 no shutdown
FTOS(conf-if-te-1/1)#
```

To view the interfaces in Layer 2 mode, use the command show interfaces switchport in EXEC mode.

Management Interfaces

An Aggregator auto-configures with a DHCP-based IP address for in-band management on VLAN 1 and remote out-of-band (OOB) management.

The IOM management interface has both a public IP and private IP address on the internal Fabric D interface. The public IP address is exposed to the outside world for WebGUI configurations/WSMAN and other proprietary traffic. You can statically configure the public IP address or obtain the IP address dynamically using the dynamic host configuration protocol (DHCP).

Accessing an Aggregator

You can access the Aggregator using:

- Internal RS-232 using the chassis management controller (CMC). Telnet into CMC and do a connect -b switch-id to get console access to corresponding IOM.
- External serial port with a universal serial bus (USB) connector (front panel): connect using the IOM front panel USB serial line to get console access (Labeled as USB B).
- Telnet/others using the public IP interface on the fabric D interface.
- CMC through the private IP interface on the fabric D interface.

The Aggregator supports the management ethernet interface as well as the standard interface on any front-end port. You can use either method to connect to the system.

Configuring a Management Interface CMC

On the Aggregator, the dedicated management interface provides management access to the system.You can configure this interface with FTOS, but the configuration options on this interface are limited. You cannot configure gateway addresses and IP addresses if it appears in the main routing table of FTOS. In addition, the proxy address resolution protocol (ARP) is not supported on this interface.

For additional management access, IOM supports the default VLAN (VLAN 1) L3 interface in addition to the public fabric D management interface. You can assign the IP address for the VLAN 1 default management interface using the setup wizard or through the CLI.

If you do not configure the default VLAN 1 in the startup configuration using the wizard or CLI, by default, the VLAN 1 management interface gets its IP address using DHCP.

To configure a management interface, use the following command in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
interface Managementethernet *interface*	CONFIGURATION	Enter the slot and the port (0). Slot range: 0-0

To configure an IP address on a management interface, use either of the following commands in MANAGEMENT INTERFACE mode:

Command Syntax	Command Mode	Purpose
ip address *ip-address mask*	INTERFACE	Configure an IP address and mask on the interface. • *ip-address mask:* enter an address in dotted-decimal format (A.B.C.D), the mask must be in /prefix format (/x)
ip address dhcp	INTERFACE	Acquire an IP address from the DHCP server.

To access the management interface from another LAN, you must configure the management route command to point to the management interface.

There is only one management interface for the whole stack.

You can manage the Aggregator from any port. Configure an IP address for the port using the ip address command. Enable the IP address for the port using the no shutdown command. You can use the description command from INTERFACE mode to note that the interface is the management interface. There is no separate management routing table, so you must configure all routes in the IP routing table (use the ip route command).

To display the configuration for a given port, use the show interface command from EXEC Privilege mode (Figure 10-5).

To display the routing table for a given port, use the show ip route command from EXEC Privilege mode.

Figure 10-5. Viewing Management Routes

```
FTOS#show interface tengigabit 0/46
TenGigabitEthernet 0/4 is up, line protocol is up
Port is part of Port-channel 1
Hardware is DellForce10Eth, address is 00:01:e8:e1:e1:c1
    Current address is 00:01:e8:e1:e1:c1
Server Port AdminState is Up
Pluggable media not present
Interface index is 34935553
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :tenG1330001e8e1e1c1
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 10000 Mbit
Flowcontrol rx off tx off
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:10:18
Queueing strategy: fifo
Input Statistics:
     202 packets, 24015 bytes
     103 64-byte pkts, 20 over 64-byte pkts, 52 over 127-byte pkts
     27 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     163 Multicasts, 39 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     356 packets, 80597 bytes, 0 underruns
     36 64-byte pkts, 34 over 64-byte pkts, 44 over 127-byte pkts
     242 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     271 Multicasts, 85 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
     Output 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
Time since last interface status change: 00:10:23

FTOS#
```

Configuring a Static Route for a Management Interface

When an IP address used by a protocol and a static management route exists for the same prefix, the protocol route takes precedence over the static management route.

To configure a static route for the management port, use the following command in CONFIGURATION mode:

Command Syntax	Command Mode	Purpose
management route *ip-address mask* {*forwarding-router-address* | ManagementEthernet *slot/port*}	CONFIGURATION	Assign a static route to point to the management interface or forwarding router.

To view the configured static routes for the management port, use the show ip management-route command in EXEC privilege mode (Figure 10-6).

Figure 10-6. show ip management-route Command Example

```
FTOS#show ip management-route all

Destination        Gateway                      State
-----------        -------                      -----
1.1.1.0/24         172.31.1.250                 Active
172.16.1.0/24      172.31.1.250                 Active
172.31.1.0/24      ManagementEthernet 1/0       Connected

FTOS#
```

VLAN Membership

A virtual LAN (VLANs) is a logical broadcast domain or logical grouping of interfaces in a LAN in which all data received is kept locally and broadcast to all members of the group. In Layer 2 mode, VLANs move traffic at wire speed and can span multiple devices. FTOS supports up to 4093 port-based VLANs and one default VLAN, as specified in IEEE 802.1Q.

VLANs provide the following benefits:

- Improved security because you can isolate groups of users into different VLANs
- Ability to create one VLAN across multiple devices

On an Aggregator in standalone mode, all ports are configured by default as members of all (4094) VLANs, including the default VLAN. All VLANs operate in Layer 2 mode. You can reconfigure the VLAN membership for individual ports by using the **vlan tagged** or **vlan untagged** commands in INTERFACE configuration mode (Configuring VLAN Membership). Physical interfaces and port channels can be members of VLANs.

Note: You can assign a static IP address to default VLAN 1 using the **ip address** command. To assign a different VLAN ID to the default VLAN, use the **default vlan-id** *vlan-id* command.

If you configure an Aggregator to operate in stacking mode, only the default VLAN is supported. All ports are automatically configured as untagged members of default VLAN 1. To configure additional VLANs in stacking mode, use the **vlan tagged** and **vlan untagged** commands.

Table 10-1 lists the defaults for VLANs in FTOS.

Table 10-1. VLAN Defaults on FTOS

Feature	Default
Mode	Layer 2 (no IP address is assigned)
Default VLAN ID	VLAN 1

Default VLAN

When an Aggregator boots up, all interfaces are up in Layer 2 mode and placed in the default VLAN as untagged interfaces. Only untagged interfaces can belong to the default VLAN.

By default, VLAN 1 is the default VLAN. To change the default VLAN ID, use the default vlan-id command in CONFIGURATION mode. You cannot delete the default VLAN.

Port-Based VLANs

Port-based VLANs are a broadcast domain defined by different ports or interfaces. In FTOS, a port-based VLAN can contain interfaces from different stack units within the chassis. FTOS supports 4094 port-based VLANs.

Port-based VLANs offer increased security for traffic, conserve bandwidth, and allow switch segmentation. Interfaces in different VLANs do not communicate with each other, adding some security to the traffic on those interfaces. Different VLANs can communicate between each other by means of IP routing. Because traffic is only broadcast or flooded to the interfaces within a VLAN, the VLAN conserves bandwidth. Finally, you can have multiple VLANs configured on one switch, thus segmenting the device.

Interfaces within a port-based VLAN must be in Layer 2 mode and can be tagged or untagged in the VLAN ID.

VLANs and Port Tagging

To add an interface to a VLAN, it must be in Layer 2 mode. After you place an interface in Layer 2 mode, it is automatically placed in the default VLAN. FTOS supports IEEE 802.1Q tagging at the interface level to filter traffic. When you enable tagging, a tag header is added to the frame after the destination and source MAC addresses. That information is preserved as the frame moves through the network. Figure 10-7 shows the structure of a frame with a tag header. The VLAN ID is inserted in the tag header.

Figure 10-7. Tagged Frame Format

Ethernet

Preamble	Destination Address	Source Address	Tag Header	Protocol Type	Data	Frame Check Sequence
	6 octets	6 octets	4 octets	2 octets	45 - 1500 octets	4 octets

FN00001B

The tag header contains some key information used by FTOS:

- The VLAN protocol identifier identifies the frame as tagged according to the IEEE 802.1Q specifications (2 bytes).
- Tag control information (TCI) includes the VLAN ID (2 bytes total). The VLAN ID can have 4,096 values, but two are reserved.

Note: The insertion of the tag header into the Ethernet frame increases the size of the frame to more than the 1518 bytes specified in the IEEE 802.3 standard. Some devices that are not compliant with IEEE 802.3 may not support the larger frame size.

Information contained in the tag header allows the system to prioritize traffic and to forward information to ports associated with a specific VLAN ID. Tagged interfaces can belong to multiple VLANs, while untagged interfaces can belong only to one VLAN.

Configuring VLAN Membership CMC

By default, all Aggregator ports are member of all (4094) VLANs, including the default untagged VLAN 1. You can use the CLI or CMC interface to reconfigure VLANs only on server-facing interfaces (1 to 32) so that an interface has membership only in specified VLANs.

To assign an Aggregator interface in Layer 2 mode to a specified group of VLANs, use the vlan tagged and vlan untagged commands. To view which interfaces are tagged or untagged and to which VLAN they belong, use the show vlan command (Displaying VLAN Membership).

To reconfigure an interface as a member of only specified tagged VLANs, enter the **vlan tagged** command in INTERFACE mode:

Command Syntax	Command Mode	Purpose
vlan tagged {*vlan-id* | *vlan-range*}	INTERFACE	Add the interface as a tagged member of one or more VLANs, where: *vlan-id* specifies a tagged VLAN number. Range: 2-4094 *vlan-range* specifies a range of tagged VLANs. Separate VLAN IDs with a comma; specify a VLAN range with a dash; for example, **vlan tagged 3,5-7**.

To reconfigure an interface as a member of only specified untagged VLANs, enter the **vlan untagged** command in INTERFACE mode:

Command Syntax	Command Mode	Purpose
vlan untagged {*vlan-id* | *vlan-range*}	INTERFACE	Add the interface as an untagged member of one or more VLANs, where: *vlan-id* specifies an untagged VLAN number. Range: 2-4094 *vlan-range* specifies a range of untagged VLANs. Separate VLAN IDs with a comma; specify a VLAN range with a dash; for example, **vlan tagged 3,5-7**.

When you delete a VLAN (using the no vlan *vlan-id* command), any interfaces assigned to the VLAN are assigned to the default VLAN as untagged interfaces.

If you configure additional VLAN membership and save it to the startup configuration, the new VLAN configuration is activated following a system reboot.

FTOS Behavior: When two or more server-facing ports with VLAN membership are configured in a LAG based on the NIC teaming configuration in connected servers learned via LACP, the resulting LAG is a tagged member of all the configured VLANs and an untagged member of the VLAN to which the port with the lowest port ID belongs.
For example, if port 0/3 is an untagged member of VLAN 2 and port 0/4 is an untagged member of VLAN 3, the resulting LAG consisting of the two ports is an untagged member of VLAN 2 and a tagged member of VLANs 2 and 3.

Displaying VLAN Membership CMC

To view the configured VLANs, enter the show vlan command in EXEC privilege mode:

Figure 10-8. show vlan Command Example

```
FTOS#show vlan

Codes: * - Default VLAN, G - GVRP VLANs, R - Remote Port Mirroring VLANs, P - Primary, C -
Community, I - Isolated
Q: U - Untagged, T - Tagged
   x - Dot1x untagged, X - Dot1x tagged
   G - GVRP tagged, M - Vlan-stack, H - VSN tagged
   i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged

    NUM    Status    Description                    Q Ports
    1      Inactive  a
*   20     Active                                   U Po32()
                                                    U Te 0/3,5,13,53-56
    1002   Active                                   T Te 0/3,13,55-56
FTOS#
```

Note: A VLAN is active only if the VLAN contains interfaces and those interfaces are operationally up. In Figure 10-8, VLAN 1 is inactive because it contains the interfaces that are not active. The other VLANs listed contain enabled interfaces and are active.

In a VLAN, the shutdown command stops Layer 3 (routed) traffic only. Layer 2 traffic continues to pass through the VLAN. If the VLAN is not a routed VLAN (that is, configured with an IP address), the shutdown command has no affect on VLAN traffic.

Adding an Interface to a Tagged VLAN

Figure 10-9 shows an example of how to add a tagged interface (port channel 1) to a VLAN (VLAN 4).

Figure 10-9. Adding an Interface to Another VLAN

```
FTOS(conf-if-te-1/7)# vlan tagged 2
FTOS(conf-if-te-1/7)# exit
FTOS(conf)# exit
FTOS# show vlan id 2

Codes: * - Default VLAN, G - GVRP VLANs, R - Remote Port Mirroring VLANs, P - Primary, C - Community,
I - Isolated
Q: U - Untagged, T - Tagged
   x - Dot1x untagged, X - Dot1x tagged
   G - GVRP tagged, M - Vlan-stack, H - VSN tagged
   i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged, C - CMC tagged

    NUM    Status    Description                  Q Ports
    2      Active                                 U Po1(Te 0/7,18)
                                                  T Po128(Te 0/50-51)
                                                  T Te 1/7
FTOS(conf-if-te-1/7)
```

Enter the **vlan tagged** command to add interface Te 1/7 to VLAN 4.

Enter the **show vlan** command to verify that interface Te 1/7 is a tagged member of VLAN 2.

Except for hybrid ports, only a tagged interface can be a member of multiple VLANs. You can assign hybrid ports to two VLANs if the port is untagged in one VLAN and tagged in all others.

Note: When you remove a tagged interface from a VLAN (using the **no vlan tagged** command), it remains tagged only if it is a tagged interface in another VLAN. If you remove the tagged interface from the only VLAN to which it belongs, the interface is placed in the default VLAN as an untagged interface.

Adding an Interface to an Untagged VLAN

To move an untagged interfaces from the default VLAN to another VLAN, use the vlan untagged command as shown in Figure 10-10.

Figure 10-10. Moving an Untagged Interface to Another VLAN

```
FTOS(conf)# interface tengigabit 0/16
FTOS(conf-if-te-0/16)# vlan untagged 4
FTOS(conf-if-te-0/16)# exit
FTOS(conf)# exit
FTOS#00:23:49: %STKUNIT0-M:CP %SYS-5-CONFIG_I: Configured from  console

FTOS# show vlan id 4


Codes: * - Default VLAN, G - GVRP VLANs, R - Remote Port Mirroring VLANs, P - Primary,
C - Community, I - Isolated
Q: U - Untagged, T - Tagged
   x - Dot1x untagged, X - Dot1x tagged
   G - GVRP tagged, M - Vlan-stack, H - VSN tagged
   i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged, C - CMC tagged

    NUM    Status    Description                  Q Ports
    4      Active                                 U Po1(Te 0/16)
                                                  T Po128(Te 0/33,39,51,56)
                                                  T Te 0/1-15,17-32
FTOS#
```

Enter the vlan untagged command to add interface Te 0/16 as an untagged member of VLAN 4.

Enter the show vlan command to verify that interface Te 0/16 is an untagged member of VLAN 4.

Port Channel Interfaces

On an Aggregator, port channels are auto-configured as follows:

- All 10GbE uplink interfaces (ports 33 to 56) are auto-configured to belong to the same 10GbE port channel (LAG 128).
- Server-facing interfaces (ports 1 to 32) auto-configure in LAGs (1 to 127) according to the NIC teaming configuration on the connected servers.

Port channel interfaces support link aggregation, as described in IEEE Standard 802.3ad. .

Note: A port channel may also be referred to as a *link aggregation group* (LAG).

Port Channel Definition and Standards

Link aggregation is defined by IEEE 802.3ad as a method of grouping multiple physical interfaces into a single logical interface—a link aggregation group (LAG) or port channel. A LAG is “a group of links that appear to a MAC client as if they were a single link” according to IEEE 802.3ad. In FTOS, a LAG is referred to as a port channel interface.

A port channel provides redundancy by aggregating physical interfaces into one logical interface. If one physical interface goes down in the port channel, another physical interface carries the traffic.

Port Channel Benefits

A port channel interface provides many benefits, including easy management, link redundancy, and sharing.

Port channels are transparent to network configurations and can be modified and managed as one interface. For example, you configure one IP address for the group and that IP address is used for all routed traffic on the port channel.

With this feature, you can create larger-capacity interfaces by utilizing a group of lower-speed links. For example, you can build a 40-Gigabit interface by aggregating four 10-Gigabit Ethernet interfaces together. If one of the four interfaces fails, traffic is redistributed across the three remaining interfaces.

Port Channel Implementation

An Aggregator supports only port channels that are dynamically configured using the link aggregation control protocol (LACP). For more information, refer to Link Aggregation. Statically-configured port channels are not supported.

Table 10-2 lists the number of port channels per platform.

Table 10-2. Number of Port Channels per Platform

Platform	Port-channels	Members/Channel
M IO Aggregator	128	16

As soon as a port channel is auto-configured, FTOS treats it like a physical interface. For example, IEEE 802.1Q tagging is maintained while the physical interface is in the port channel.

Member ports of a LAG are added and programmed into hardware in a predictable order based on the port ID, instead of in the order in which the ports come up. With this implementation, load balancing yields predictable results across switch resets and chassis reloads.

A physical interface can belong to only one port channel at a time.

Each port channel must contain interfaces of the same interface type/speed.

Port channels can contain a mix of 100, 1000, or 10000 Mbps Ethernet interfaces and TenGigabit Ethernet interfaces. The interface speed (100, 1000, or 10000 Mbps) used by the port channel is determined by the first port channel member that is physically up. FTOS disables the interfaces that do not match the interface speed set by the first channel member. That first interface may be the first interface that is physically brought up or was physically operating when interfaces were added to the port channel. For example, if the first operational interface in the port channel is a TenGigabit Ethernet interface, all interfaces at 1000 Mbps are kept up, and all 100/1000/10000 interfaces that are not set to 1000 Mbps speed or auto negotiate are disabled.

1GbE and 10GbE Interfaces in Port Channels

When both Gigabit and TenGigabitEthernet interfaces are added to a port channel, the interfaces must share a common speed. When interfaces have a configured speed different from the port channel speed, the software disables those interfaces.

The common speed is determined when the port channel is first enabled. At that time, the software checks the first interface listed in the port channel configuration. If that interface is enabled, its speed configuration becomes the common speed of the port channel. If the other interfaces configured in that port channel are configured with a different speed, FTOS disables them.

For example, if four interfaces (TenGig 0/0, 0/1, 0/2, 0/3) in which TenGig 0/0 and TenGig 0/3 are set to speed 100 Mb/s and the others are set to 1000 Mb/s, with all interfaces enabled, and you add them to a port channel by entering channel-member tengigabitethernet 0/0-3 while in port channel interface mode, and FTOS determines if the first interface specified (TenGig 0/0) is up. After it is up, the common speed of the port channel is 100 Mb/s. FTOS disables those interfaces configured with speed 1000 Mb/s or whose speed is 1000 Mb/s as a result of auto-negotiation.

In this example, you can change the common speed of the port channel by changing its configuration so the first enabled interface referenced in the configuration is a 1000 Mb/s speed interface. You can also change the common speed of the port channel by setting the speed of the TenGig 0/0 interface to 1000 Mb/s.

Uplink Port Channel: VLAN Membership

The tagged VLAN membership of the uplink LAG is automatically configured based on the VLAN configuration of all server-facing ports (ports 1 to 32).

The untagged VLAN used for the uplink LAG is always the default VLAN 1.

Server-Facing Port Channel: VLAN Membership

The tagged VLAN membership of a server-facing LAG is automatically configured based on the server-facing ports that are members of the LAG.

The untagged VLAN of a server-facing LAG is auto-configured based on the untagged VLAN to which the lowest numbered server-facing port in the LAG belongs.

Displaying Port Channel Information

To view the port channel's status and channel members in a tabular format, use the show interfaces port-channel brief command in EXEC Privilege mode (Figure 10-11).

Figure 10-11. show interfaces port-channel brief Command Example

```
FTOS#show int port brief
Codes: L - LACP Port-channel


    LAG  Mode  Status       Uptime      Ports
    1    L3    down         00:00:00    Te 0/16    (Down)
FTOS#
```

To display detailed information on a port channel, enter the show interfaces port-channel command in EXEC Privilege mode. Figure 10-12 shows the port channel's mode (L2 for Layer 2, L3 for Layer 3, and L2L3 for a Layer 2 port channel assigned to a routed VLAN), the status, and the number of interfaces belonging to the port channel.

Figure 10-12. show interface port-channel Command Example

```
FTOS#show interface port-channel
Port-channel 1 is up, line protocol is up
Created by LACP protocol
Hardware address is 00:1e:c9:f1:03:58, Current address is 00:1e:c9:f1:03:58
Interface index is 1107755009
Minimum number of links to bring Port-channel up is 1
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :lag1001ec9f10358
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 50000 Mbit
Members in this channel:  Te 1/2(U) Te 1/3(U) Te 1/4(U) Te 1/5(U) Te 1/7(U)
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:13:56
Queueing strategy: fifo
Input Statistics:
     836 packets, 108679 bytes
     412 64-byte pkts, 157 over 64-byte pkts, 135 over 127-byte pkts
     132 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     836 Multicasts, 0 Broadcasts
     0 runts, 0 giants, 0 throttles, 0 CRC, 0 overrun, 0 discarded
Output Statistics:
     9127965 packets, 3157378990 bytes, 0 underruns
     0 64-byte pkts, 133 over 64-byte pkts, 3980 over 127-byte pkts
     9123852 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     4113 Multicasts, 9123852 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          1 packets/sec, 0.00% of line-rate
     Output 34.00 Mbits/sec,      12318 packets/sec, 0.07% of line-rate
Time since last interface status change: 00:13:49

Port-channel 128 is up, line protocol is up
Created by LACP protocol
Hardware address is 00:1e:c9:f1:03:58, Current address is 00:1e:c9:f1:03:58
Interface index is 1107755136
Minimum number of links to bring Port-channel up is 1
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :lag128001ec9f10358
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 10000 Mbit
Members in this channel:  Te 1/49(U)
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:14:06
Queueing strategy: fifo
Input Statistics:
     476 packets, 33180 bytes
     414 64-byte pkts, 33 over 64-byte pkts, 29 over 127-byte pkts
     0 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     476 Multicasts, 0 Broadcasts
     0 runts, 0 giants, 0 throttles, 0 CRC, 0 overrun, 0 discarded
Output Statistics:
     9124688 packets, 3156959396 bytes, 0 underruns
     0 64-byte pkts, 30 over 64-byte pkts, 804 over 127-byte pkts
     9123854 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     834 Multicasts, 9123854 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          1 packets/sec, 0.00% of line-rate
     Output 34.00 Mbits/sec,      12314 packets/sec, 0.36% of line-rate
Time since last interface status change: 00:13:57
```

Port-channel 1 is a dynamically-created port channel based on the NIC teaming configuration in connected servers learned via LACP.

Port-channel 128 is the default port channel to which all uplink ports are assigned by default.

Interface Range

An interface range is a set of interfaces to which other commands may be applied, and may be created if there is at least one valid interface within the range. Bulk configuration excludes from configuring any non-existing interfaces from an interface range. A default VLAN may be configured only if the interface range being configured consists of only VLAN ports.

The interface range command allows you to create an interface range allowing other commands to be applied to that range of interfaces.

The interface range prompt offers the interface (with slot and port information) for valid interfaces. The maximum size of an interface range prompt is 32. If the prompt size exceeds this maximum, it displays (...) at the end of the output.

Note: Non-existing interfaces are excluded from interface range prompt.

Note: When creating an interface range, interfaces appear in the order they were entered and are not sorted.

To display all interfaces that have been validated under the interface range context, use the show range command in Interface Range mode.

To display the running configuration only for interfaces that are part of interface range, use the show configuration command in Interface Range mode.

Bulk Configuration Examples

The following are examples of using the interface range command for bulk configuration:

- Create a Single-Range
- Create a Multiple-Range
- Exclude a Smaller Port Range
- Overlap Port Ranges
- Commas

Create a Single-Range

Figure 10-13. Creating a Single-Range Bulk Configuration

```
FTOS(conf)# interface range tengigabitethernet 5/1 - 23
FTOS(conf-if-range-te-5/1-23)# no shutdown
FTOS(conf-if-range-te-5/1-23)#
```

Create a Multiple-Range

Figure 10-14. Creating a Multiple-Range Prompt

```
FTOS(conf)#interface range tengigabitethernet 3/0 , tengigabitethernet 2/1 - 47 , vlan 1000
FTOS(conf-if-range-te-2/1-47)#
```

Exclude a Smaller Port Range

If the interface range has multiple port ranges, the smaller port range is excluded from the prompt.

Figure 10-15. Interface Range Prompt Excluding a Smaller Port Range

```
FTOS(conf)#interface range tengigabitethernet 2/0 - 23 , tengigab 2/1 - 10
FTOS(conf-if-range-te-2/0-23)#
```

Overlap Port Ranges

If overlapping port ranges are specified, the port range is extended to the smallest start port number and largest end port number.

Figure 10-16. Interface Range Prompt Including Overlapping Port Ranges

```
FTOS(conf)#inte ra tengig 2/1 - 11 , tengig 2/1 - 23
FTOS(conf-if-range-te-2/1-23)#
```

Commas

The example below shows how to use commas to add different interface types to the range, enabling all Ten Gigabit Ethernet interfaces in the range 5/1 to 5/23 and both Ten Gigabit Ethernet interfaces 1/1 and 1/2.

Figure 10-17. Multiple-Range Bulk Configuration Gigabit Ethernet and Ten-Gigabit Ethernet

```
FTOS(conf-if)# interface range tengigabitethernet 5/1 - 23, tengigabitethernet 1/1 - 2
FTOS(conf-if-range-te-5/1-23)# no shutdown
FTOS(conf-if-range-te-5/1-23)#
```

Monitor and Maintain Interfaces

You can display interface statistics with the **monitor interface** command. This command displays an ongoing list of the interface status (up/down), number of packets, traffic statistics, etc.

Command Syntax	Command Mode	Purpose
monitor interface *interface*	EXEC Privilege	View interface statistics. Enter the type of interface and slot/port information: • For a 1GbE interface, enter the keyword GigabitEthernet followed by the *slot*/*port* numbers; for example, **interface tengigabitethernet 0/12**. • For a 10GbE interface, enter the keyword TenGigabitEthernet followed by the *slot*/*port* numbers; for example, **interface tengigabitethernet 0/44**.

The information displays in a continuous run, refreshes every two seconds by default (Figure 10-18). Use the following keys to manage the output.

m - Change mode
c - Clear screen
l - Page up
a - Page down
T - Increase refresh interval (by 1 second)
t - Decrease refresh interval (by 1 second)
q - Quit

Figure 10-18. monitor interface Command Example

```
FTOS#monitor interface tengig 3/1


 Dell Force10 uptime is 1 day(s), 4 hour(s), 31 minute(s)
   Monitor time: 00:00:00   Refresh Intvl.: 2s

 Interface: TenGig 3/1, Disabled, Link is Down, Linespeed is 1000 Mbit

  Traffic statistics:              Current           Rate                Delta
         Input bytes:                    0          0 Bps                   0
        Output bytes:                    0          0 Bps                   0
      Input packets:                     0          0 pps                   0
     Output packets:                     0          0 pps                   0
        64B packets:                     0          0 pps                   0
    Over 64B packets:                    0          0 pps                   0
   Over 127B packets:                    0          0 pps                   0
   Over 255B packets:                    0          0 pps                   0
   Over 511B packets:                    0          0 pps                   0
  Over 1023B packets:                    0          0 pps                   0
 Error statistics:
     Input underruns:                    0          0 pps                   0
        Input giants:                    0          0 pps                   0
     Input throttles:                    0          0 pps                   0
           Input CRC:                    0          0 pps                   0
   Input IP checksum:                    0          0 pps                   0
       Input overrun:                    0          0 pps                   0
    Output underruns:                    0          0 pps                   0
    Output throttles:                    0          0 pps                   0

       m - Change mode                          c - Clear screen
       l - Page up                              a - Page down
       T - Increase refresh interval            t - Decrease refresh interval
       q - Quit
```

Maintenance Using TDR

The time domain reflectometer (TDR) is supported on all Dell Force10 switch/routers. TDR is an assistance tool to resolve link issues that helps detect obvious open or short conditions within any of the four copper pairs. TDR sends a signal onto the physical cable and examines the reflection of the signal that returns. By examining the reflection, TDR is able to indicate whether there is a cable fault (when the cable is broken, becomes unterminated, or if a transceiver is unplugged).

TDR is useful for troubleshooting an interface that is not establishing a link, that is, when the link is flapping or not coming up. Do not use TDR on an interface that is passing traffic. When a TDR test is run on a physical cable, it is important to shut down the port on the far end of the cable. Otherwise, it may lead to incorrect test results.

Note: TDR is an intrusive test. Do not run TDR on a link that is up and passing traffic.

To test the condition of cables on 100/1000/10000 BASE-T modules, following these steps using the tdr-cable-test command.

Step	Command Syntax	Command Mode	Usage
1	tdr-cable-test tengigabitethernet <*slot*>/<*port*>	EXEC Privilege	To test for cable faults on the TenGigabitEthernet cable. • Between two ports, you must not start the test on both ends of the cable. • Enable the interface before starting the test. • The port must be enabled to run the test or the test prints an error message.
2	show tdr tengigabitethernet <*slot*>/<*port*>	EXEC Privilege	Displays TDR test results.

Flow Control Using Ethernet Pause Frames

An Aggregator auto-configures with Layer 2 (link level) flow control disabled and DCB enabled. When you disable DCB, link-level flow control is automatically enabled (Disabling DCB).

Link-level flow control uses Ethernet pause frames to signal the other end of the connection to pause data transmission for a certain amount of time as specified in the frame. Ethernet pause frames allow for a temporary stop in data transmission. A situation may arise where a sending device may transmit data faster than a destination device can accept it. The destination sends a pause frame back to the source, stopping the sender's transmission for a period of time.

The globally assigned 48-bit Multicast address 01-80-C2-00-00-01 is used to send and receive pause frames. To allow full duplex flow control, stations implementing the pause operation instruct the MAC to enable reception of frames with a destination address equal to this multicast address.

The pause frame is defined by IEEE 802.3x and uses MAC Control frames to carry the pause commands. Ethernet pause frames are supported on full duplex only. The only configuration applicable to half duplex ports is rx off tx off.

Note that if a port is over-subscribed, Ethernet Pause Frame flow control does not ensure no loss behavior.

The following error message appears when trying to enable flow control when half duplex is already configured:

```
Can't configure flowcontrol when half duplex is configure, config ignored.
```

The following error message appears when trying to enable half duplex and flow control configuration is on:

```
Can't configure half duplex when flowcontrol is on, config ignored.
```

MTU Size

The Aggregator auto-configures interfaces to use a maximum MTU size of 12,000 bytes.

If a packet includes a Layer 2 header, the difference in bytes between the link MTU and IP MTU must be enough to include the Layer 2 header. For example, for VLAN packets, if the IP MTU is 1400, the link MTU must be no less than 1422:

1400-byte IP MTU + 22-byte VLAN Tag = 1422-byte link MTU

The MTU range is 592-12000, with a default of 1554.

Table 10-3 lists the various Layer 2 overheads found in FTOS and the number of bytes.

Table 10-3. Difference between Link MTU and IP MTU

Layer 2 Overhead	Difference between Link MTU and IP MTU
Ethernet (untagged)	18 bytes
VLAN Tag	22 bytes
Untagged Packet with VLAN-Stack Header	22 bytes
Tagged Packet with VLAN-Stack Header	26 bytes

Link MTU and IP MTU considerations for port channels and VLANs are as follows.

Port Channels:

- All members must have the same link MTU value and the same IP MTU value.
- The port channel link MTU and IP MTU must be less than or equal to the link MTU and IP MTU values configured on the channel members.

For example, if the members have a link MTU of 2100 and an IP MTU 2000, the port channel's MTU values cannot be higher than 2100 for link MTU or 2000 bytes for IP MTU.

VLANs:

- All members of a VLAN must have the same IP MTU value.
- Members can have different link MTU values. Tagged members must have a link MTU 4 bytes higher than untagged members to account for the packet tag.
- The VLAN link MTU and IP MTU must be less than or equal to the link MTU and IP MTU values configured on the VLAN members.

For example, the VLAN contains tagged members with a link MTU of 1522 and an IP MTU of 1500 and untagged members with a link MTU of 1518 and an IP MTU of 1500. The VLAN's Link MTU cannot be higher than 1518 bytes and its IP MTU cannot be higher than 1500 bytes.

Auto-Negotiation on Ethernet Interfaces

Setting Speed and Duplex Mode of Ethernet Interfaces

By default, auto-negotiation of speed and duplex mode is enabled on 1GbE and 10GbE Ethernet interfaces on an Aggregator.

The local interface and the directly connected remote interface must have the same setting. Auto-negotiation is the easiest way to accomplish these settings, as long as the remote interface is capable of auto-negotiation.

Note: As a best practice, Dell Force10 recommends keeping auto-negotiation enabled. Auto-negotiation should only be disabled on switch ports that attach to devices not capable of supporting negotiation or where connectivity issues arise from interoperability issues.

For 100/1000/10000 Ethernet interfaces, the `negotiation auto` command is tied to the `speed` command. Auto-negotiation is always enabled when the `speed` command is set to `1000` or `auto`. In FTOS, the `speed 1000` command is an exact equivalent of `speed auto 1000` in IOS.

To discover whether the remote and local interface require manual speed synchronization, and to manually synchronize them if necessary, follow these steps (also refer to Figure 10-20 on page 141).

Step	Task	Command Syntax	Command Mode
1	Determine the local interface status. Refer to Figure 10-19.	show interfaces [*interface*] status	EXEC Privilege
2	Determine the remote interface status.	[Use the command on the remote system that is equivalent to the above command.]	EXEC EXEC Privilege
3	Access CONFIGURATION mode.	config	EXEC Privilege
4	Access the port.	interface *interface slot*/*port*	CONFIGURATION
5	Set the local port speed.	speed {100 | 1000 | 10000 | auto}	INTERFACE
6	Optionally, set full- or half-duplex.	duplex {half | full}	INTERFACE
7	Disable auto-negotiation on the port. If the speed is set to 1000, you do not need to disable auto-negotiation	no negotiation auto	INTERFACE
8	Verify configuration changes.	show config	INTERFACE

Note: The `show interfaces status` command (Figure 10-19) displays link status, but not administrative status. For link and administrative status, use the `show ip interface [`*interface*` | brief] [configuration]` command.

Figure 10-19. show interfaces status Command Example

```
FTOS#show interfaces status
Port     Description  Status Speed     Duplex Vlan
Te 0/1                Down   Auto      Auto   --
Te 0/2                Down   Auto      Auto   --
Te 0/3                Down   Auto      Auto   --
Te 0/4                Down   Auto      Auto   --
Te 0/5                Down   Auto      Auto   --
Te 0/6                Down   Auto      Auto   --
Te 0/7                Down   Auto      Auto   --
Te 0/8                Down   Auto      Auto   --
Te 0/9                Down   Auto      Auto   --
Te 0/10               Down   Auto      Auto   --
Te 0/11               Down   Auto      Auto   --
Te 0/12               Down   Auto      Auto   --
Te 0/13               Down   Auto      Auto   --
[output omitted]
```

In Figure 10-19, several ports display “Auto” in the Speed field, including port 0/1. In Figure 10-20, the speed of port 0/1 is set to 100 Mb and then its auto-negotiation is disabled.

Figure 10-20. Setting Port Speed Example

```
FTOS#configure
FTOS(conf)#interface tengig 0/1
FTOS(Interface 0/1)#speed 100
FTOS(Interface 0/1)#duplex full
FTOS(Interface 0/1)#no negotiation auto
FTOS(Interface 0/1)#show config
!
interface TenGigabitEthernet 0/1
no ip address
speed 100
duplex full
no shutdown
```

Setting Auto-Negotiation Options

The negotiation auto command provides a mode option for configuring an individual port to forced master/forced slave after you enable auto-negotiation.

△ **Caution:** Ensure that only one end of the node is configured as forced-master and the other is configured as forced-slave. If both are configured the same (that is, both as forced-master or both as forced-slave), the show interface command flaps between an auto-neg-error and forced-master/slave states.

Table 10-4. Auto-Negotiation, Speed, and Duplex Settings on Different Optics

Command	mode	10GbaseT module	10G SFP+ optics	1G SFP optics	Copper SFP - 1000baseT	Comments

speed 100	interface-config mode	Supported	Not supported (Error message is thrown) (*% Error: Speed 100 not supported on this interface, config ignored Te 0/49*)	Not supported (Error message is thrown) (*% Error: Speed 100 not supported on this interface, config ignored Te 0/49*)	% Error: Speed 100 not supported on this interface,	
speed auto	interface-config mode	Supported	Not supported	Not supported	Not supported	Error messages not thrown wherever it says not supported
speed 1000	interface-config mode	Supported	Supported	Supported	Supported	
speed 10000	interface-config mode	Supported	Supported	Not Supported	Not supported	Error messages not thrown wherever it says not supported
negotiation auto	interface-config mode	Supported	Not supported *(Should some error message be thrown?)*	Not supported	Not supported	Error messages not thrown wherever it says not supported
duplex half	interface-config mode	Supported	CLI not available	CLI not available	Invalid Input error- CLI not available	
duplex full	interface-config mode	Supported	CLI not available	CLI not available	Invalid Input error-CLI not available	

Figure 10-21 shows the auto-negotiation options.

Figure 10-21. Setting Auto-Negotiation Options

```
FTOS(conf)# int tengig 0/0
FTOS(conf-if)#neg auto
FTOS(conf-if-autoneg)# ?

end                     Exit from configuration mode
exit                    Exit from autoneg configuration mode
mode                    Specify autoneg mode
no                      Negate a command or set its defaults
show                    Show autoneg configuration information
FTOS(conf-if-autoneg)#mode ?
forced-master           Force port to master mode
forced-slave            Force port to slave mode
FTOS(conf-if-autoneg)#
```

Viewing Interface Information

Displaying Non-Default Configurations

The **show** [**ip** | **running-config**] **interfaces configured** command allows you to display only interfaces that have non-default configurations are displayed.

Figure 10-22 shows the possible **show** commands that have the configured keyword available.

Figure 10-22. show Commands with configured Keyword Examples

```
FTOS#show interfaces configured
FTOS#show interfaces tengigabitEthernet 0 configured
FTOS#show ip interface configured
FTOS#show ip interface tengigabitEthernet 1 configured
FTOS#show ip interface brief configured
FTOS#show running-config interfaces configured
FTOS#show running-config interface tengigabitEthernet 1 configured
```

In EXEC mode, the show interfaces switchport command displays only interfaces in Layer 2 mode and their relevant configuration information. The show interfaces switchport command (Figure 10-23) displays the interface, whether the interface supports IEEE 802.1Q tagging or not, and the VLANs to which the interface belongs.

Figure 10-23. show interfaces switchport Command Example

```
FTOS#show interfaces switchport
Name: TenGigabitEthernet 13/0
802.1QTagged: True
Vlan membership:
Vlan    2


Name: TenGigabitEthernet 13/1
802.1QTagged: True
Vlan membership:
Vlan    2


Name: TenGigabitEthernet 13/2
802.1QTagged: True
Vlan membership:
Vlan    2


Name: TenGigabitEthernet 13/3
802.1QTagged: True
Vlan membership:
Vlan    2
--More--
```

Clearing Interface Counters

The counters in the show interfaces command are reset by the clear counters command. This command does not clear the counters captured by any SNMP program.

To clear the counters, use the following command in EXEC Privilege mode:

Command Syntax	Command Mode	Purpose
clear counters [*interface*]	EXEC Privilege	Clear the counters used in the show interface commands for all VRRP groups, VLANs, and physical interfaces or selected ones. Without an interface specified, the command clears all interface counters. • (OPTIONAL) Enter the following interface keywords and slot/port or number information: • For a Loopback interface, enter the keyword loopback followed by a number from 0 to 16383. • For a Port Channel interface, enter the keyword port-channel followed by a number from 1 to 128. • For a 10-Gigabit Ethernet interface, enter the keyword **TenGigabitEthernet** followed by the slot/port numbers. • For a VLAN, enter the keyword **vlan** followed by a number from 1 to 4094.

When you enter this command, you must confirm that you want FTOS to clear the interface counters for that interface (Figure 10-24).

Figure 10-24. Clearing an Interface

```
FTOS#clear counters tengig 0/0
Clear counters on TenGigabitEthernet 0/0 [confirm]
FTOS#
```

11

iSCSI Optimization

An Aggregator auto-configures to enable internet small computer system interface (iSCSI) optimization with default iSCSI parameter settings (Default iSCSI Optimization Values) and is auto-provisioned to support:

- Detection and Autoconfiguration for Dell EqualLogic Arrays
- Detection and Port Configuration for Dell Compellent Arrays

You can use **show** commands to display information on iSCSI configuration and sessions (Displaying iSCSI Optimization Information).

iSCSI optimization enables quality-of-service (QoS) treatment for iSCSI traffic.

iSCSI Optimization Overview

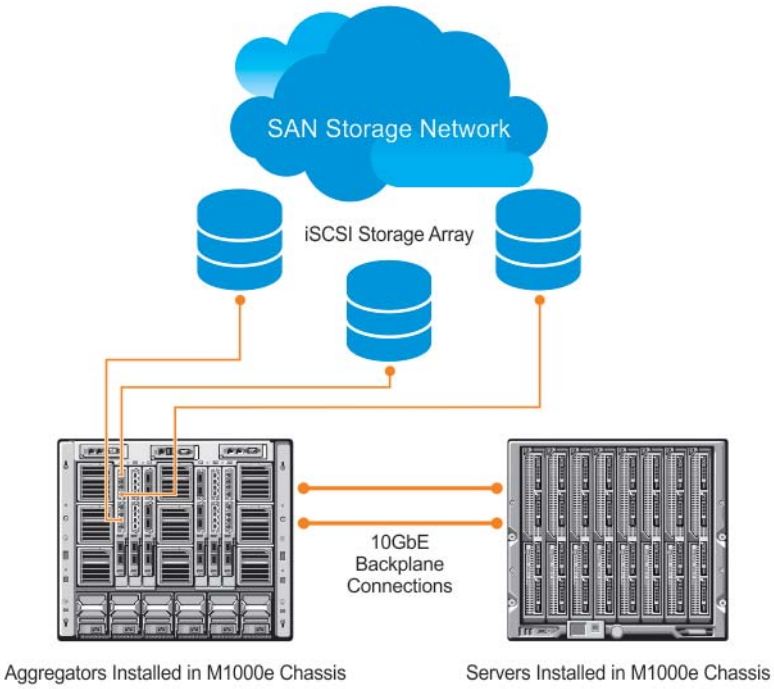
iSCSI is a TCP/IP-based protocol for establishing and managing connections between IP-based storage devices and initiators in a storage area network (SAN).

iSCSI optimization provides a means of monitoring iSCSI sessions and applying QoS policies on iSCSI traffic. When enabled, iSCSI optimization allows a switch to monitor (snoop) the establishment and termination of iSCSI connections. The switch uses the snooped information to detect iSCSI sessions and connections established through the switch.

iSCSI optimization allows you to reduce deployment time and management complexity in data centers. In a data center network, Dell EqualLogic and Compellent iSCSI storage arrays are connected to a converged Ethernet network using the data center bridging exchange protocol (DCBX) through stacked and/or non-stacked Ethernet switches.

Figure 11-1 shows iSCSI optimization between servers in an M1000e enclosure and a storage array in which a stack an Aggregator connects installed servers (iSCSI initiators) to a storage array (iSCSI targets) in a SAN network. iSCSI optimization running on the Aggregator is configured to use dot1p priority-queue assignments to ensure that iSCSI traffic in these sessions receives priority treatment when forwarded on Aggregator hardware.

Figure 11-1. iSCSI Optimization Example



Monitoring iSCSI Traffic Flows

The switch snoops iSCSI session-establishment and termination packets by installing classifier rules that trap iSCSI protocol packets to the CPU for examination. Devices that initiate iSCSI sessions usually use well-known TCP ports 3260 or 860 to contact targets. When you enable iSCSI optimization, by default the switch identifies IP packets to or from these ports as iSCSI traffic.

You can configure the switch to monitor traffic for additional port numbers or a combination of port number and target IP address, and you can remove the well-known port numbers from monitoring.

Information Monitored in iSCSI Traffic Flows

iSCSI optimization examines the following data in packets and uses the data to track the session and create the classifier entries that enable QoS treatment:

- Initiator's IP Address
- Target's IP Address
- ISID (Initiator defined session identifier)
- Initiator's IQN (iSCSI qualified name)
- Target's IQN
- Initiator's TCP Port
- Target's TCP Port

If no iSCSI traffic is detected for a session during a user-configurable aging period, the session data is cleared.

Detection and Autoconfiguration for Dell EqualLogic Arrays

The iSCSI optimization feature includes auto-provisioning support with the ability to detect directly connected Dell EqualLogic storage arrays and automatically reconfigure the switch to enhance storage traffic flows.

The Aggregator uses the link layer discovery protocol (LLDP) to discover Dell EqualLogic devices on the network. LLDP is enabled by default. For more information about LLDP, see Link Layer Discovery Protocol (LLDP).

The following message is displayed the first time a Dell EqualLogic array is detected and describes the configuration changes that are automatically performed:

```
%STKUNIT0-M:CP %IFMGR-5-IFM_ISCSI_AUTO_CONFIG: This switch is being configured
for optimal conditions to support iSCSI traffic which will cause some automatic
configuration to occur including jumbo frames and flow-control on all ports; no
storm control to be enabled on the port of detection.
```

The following syslog message is generated the first time an EqualLogic array is detected:

```
%STKUNIT0-M:CP %LLDP-5-LLDP_EQL_DETECTED: EqualLogic Storage Array detected on
interface Te 1/43
```

- At the first detection of an EqualLogic array, an MTU of 12000 is enabled on all ports and port-channels (if it is has not already been enabled).
- Spanning-tree portfast is enabled on the interface identified by LLDP if the port is in L2 mode.
- Unicast storm control is disabled on the interface identified by LLDP.

Detection and Port Configuration for Dell Compellent Arrays

An Aggregator auto-configures a port connected to a Dell Compellent storage array for the best iSCSI traffic conditions.

The following message is displayed the first time a Dell Compellent array is detected and describes the configuration changes that are automatically performed:

```
%STKUNIT0-M:CP %IFMGR-5-IFM_ISCSI_AUTO_CONFIG: This switch is being configured
for optimal conditions to support iSCSI traffic which will cause some automatic
configuration to occur including jumbo frames and flow-control on all ports; no
storm control to be enabled on the port of detection.
```

The Aggregator auto-configures as follows:

- Jumbo frame size is set to 12000 for all interfaces on all ports and port-channels, if it is not already enabled.
- Unicast storm control is disabled on the interface identified by LLDP.

iSCSI Optimization: Operation

When the Aggregator auto-configures with iSCSI enabled, the following actions occur:

- Link-level flow control is globally enabled and PFC is disabled.
- iSCSI session snooping is enabled.
- iSCSI LLDP monitoring starts to automatically detect EqualLogic arrays.

iSCSI optimization requires LLDP to be enabled. LLDP is enabled by default when an Aggregator auto-configures.

The following message is displayed when you enable iSCSI on a switch and describes the configuration changes that are automatically performed:

```
%STKUNIT0-M:CP %IFMGR-5-IFM_ISCSI_ENABLE: iSCSI has been enabled causing flow
control to be enabled on all interfaces. EQL detection and enabling iscsi
profile-compellent on an interface may cause some automatic configurations to
occur like jumbo frames on all ports and no storm control and spanning tree
port-fast on the port of detection.
```

Default iSCSI Optimization Values

Table 11-1 shows the default values for the iSCSI optimization feature.

Table 11-1. iSCSI Optimization: Default Parameters

Parameter	Default Value
iSCSI Optimization global setting	Enabled
iSCSI CoS mode (802.1p priority queue mapping)	Enabled: dot1p priority 4 without **remark** setting
iSCSI CoS Packet classification	iSCSI packets are classified by VLAN instead of by DSCP values.
VLAN priority tag	iSCSI flows are assigned by default to dot1p priority 4 without **remark** setting.
DSCP	None: user-configurable.
Remark	Not configured.
iSCSI session aging time	10 minutes
iSCSI optimization target ports	iSCSI well-known ports 3260 and 860 are configured as default (with no IP address or name) but can be removed as any other configured target.

Displaying iSCSI Optimization Information

Use the show commands in Table 11-2 to display information on iSCSI optimization.

Table 11-2. Displaying iSCSI Optimization Information

Command	Output
show iscsi (Figure 11-2)	Displays the currently configured iSCSI settings.
show iscsi sessions (Figure 11-3)	Displays information on active iSCSI sessions on the switch.
show iscsi sessions detailed [session *isid*] (Figure 11-4)	Displays detailed information on active iSCSI sessions on the switch. To display detailed information on specified iSCSi session, enter the session's iSCSi ID.
show run iscsi	Displays all globally-configured non-default iSCSI settings in the current FTOS session.

Figure 11-2. show iscsi Command Example

```
FTOS# show isci

iSCSI is enabled
iSCSI COS : dot1p is 4 no-remark
Session aging time: 10
Maximum number of connections is 256
-----------------------------------------------
iSCSI Targets and TCP Ports:
-----------------------------------------------
TCP Port    Target IP Address
3260
860
```

Figure 11-3. show iscsi sessions Command Example

```
FTOS# show isci sessions
Session 0:
-------------------------------------------------------------------------------------
Target: iqn.2001-05.com.equallogic:0-8a0906-0e70c2002-10a0018426a48c94-iom010
Initiator: iqn.1991-05.com.microsoft:win-x9l8v27yajg
ISID: 400001370000

Session 1:
-------------------------------------------------------------------------------------
Target: iqn.2001-05.com.equallogic:0-8a0906-0f60c2002-0360018428d48c94-iom011
Initiator: iqn.1991-05.com.microsoft:win-x9l8v27yajg
ISID: 400001370000.
```

Figure 11-4. show iscsi sessions detailed Command Example

```
FTOS# show isci sessions detailed
Session 0       :
--------------------------------------------------------------------------------
Target:iqn.2010-11.com.ixia:ixload:iscsi-TG1
Initiator:iqn.2010-11.com.ixia.ixload:initiator-iscsi-2c
Up Time:00:00:01:28(DD:HH:MM:SS)
Time for aging out:00:00:09:34(DD:HH:MM:SS)
ISID:806978696102
Initiator        Initiator      Target         Target     Connection
IP Address       TCP Port       IP Address     TCPPort    ID
10.10.0.44          33345      10.10.0.101     3260       0
Session 1       :
--------------------------------------------------------------------------------
Target:iqn.2010-11.com.ixia:ixload:iscsi-TG1
Initiator:iqn.2010-11.com.ixia.ixload:initiator-iscsi-35
Up Time:00:00:01:22(DD:HH:MM:SS)
Time for aging out:00:00:09:31(DD:HH:MM:SS)
ISID:806978696102
Initiator        Initiator       Target        Target     Connection
IP Address       TCP Port        IP Address    TCPPort    ID
10.10.0.53           33432      10.10.0.101    3260       0
```

12

Link Aggregation

The Aggregator auto-configures with link aggregation groups (LAGs) as follows:

- All uplink ports are automatically configured in a single port channel (LAG 128).
- Server-facing LAGs are automatically configured if server NICs are configured for LACP-based NIC teaming (Network Interface Controller (NIC) Teaming).

No manual configuration is required to configure Aggregator ports in the uplink or a server-facing LAG.

Note: Static LAGs are not supported on the Aggregator.

How the LACP is Implemented on an Aggregator

The Link Aggregation Control Protocol (LACP) provides a means for two systems (also called partner systems) to exchange information through dynamic negotiations to aggregate two or more ports with common physical characteristics to form a link aggregation group.

Note: A link aggregation group is referred to as a *port channel* by the Dell Force10 operating software

A LAG provides both load-sharing and port redundancy across stack units. An Aggregator supports LACP for the auto-configuration of dynamic LAGs. You can use CLI commands to display LACP information, clear port-channel counters, and debug LACP operation for auto-configured LAG on an Aggregator.

The FTOS implementation of LACP is based on the standards specified in the IEEE 802.3: "Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications."

LACP functions by constantly exchanging custom MAC protocol data unit (PDUs) across LAN Ethernet links. The protocol packets are only exchanged between ports that are configured as LACP-capable.

Uplink LAG

When the Aggregator powers on, all uplink ports are configured in a single LAG (LAG 128).

Server-Facing LAGs

Server-facing ports are configured as individual ports by default. If a server NIC is configured for LACP-based NIC teaming, server-facing ports are automatically configured as part of dynamic LAGs. The LAG range 1 to127 is reserved for server-facing LAGs.

Once the Aggregator receives LACPDU from server-facing ports, the information embedded in the LACPDU (remote-system ID and port key) is used to form a server-facing LAG. The LAG/port-channel number is assigned based on the first available number in the range 1 to 127. For each unique remote system-id and port-key combination, a new LAG is formed and the port automatically becomes a member of the LAG.

All ports with the same combination of system ID and port key automatically become members of the same LAG. Ports are automatically removed from the LAG if the NIC teaming configuration on a server-facing port changes or if the port goes operationally down. Also, a server-facing LAG is removed when the last port member is removed from the LAG.

The benefit of supporting a dynamic LAG is that the Aggregator's server-facing ports can toggle between participating in the LAG or acting as individual ports based on the dynamic information exchanged with a server NIC. LACP supports the exchange of messages on a link to allow their LACP instances to:

- Reach agreement on the identity of the LAG to which the link belongs.
- Attach the link to that LAG.
- Enable the transmission and reception functions in an orderly manner.
- Detach the link from the LAG if one of the partner stops responding.

LACP Modes

The Aggregator supports only LACP active mode as the default mode of operation. In active mode, a port interface is considered to be not part of a LAG but rather in an active negotiating state.

A port in active mode automatically initiates negotiations with other ports by sending LACP packets. If server-facing ports are configured for LACP-based NIC teaming, LACP negotiations will take place to aggregate the port in a dynamic LAG. If server-facing ports are not configured for LACP-based NIC teaming, a port will be treated as an individual port in the active negotiating state.

Auto-Configured LACP Timeout

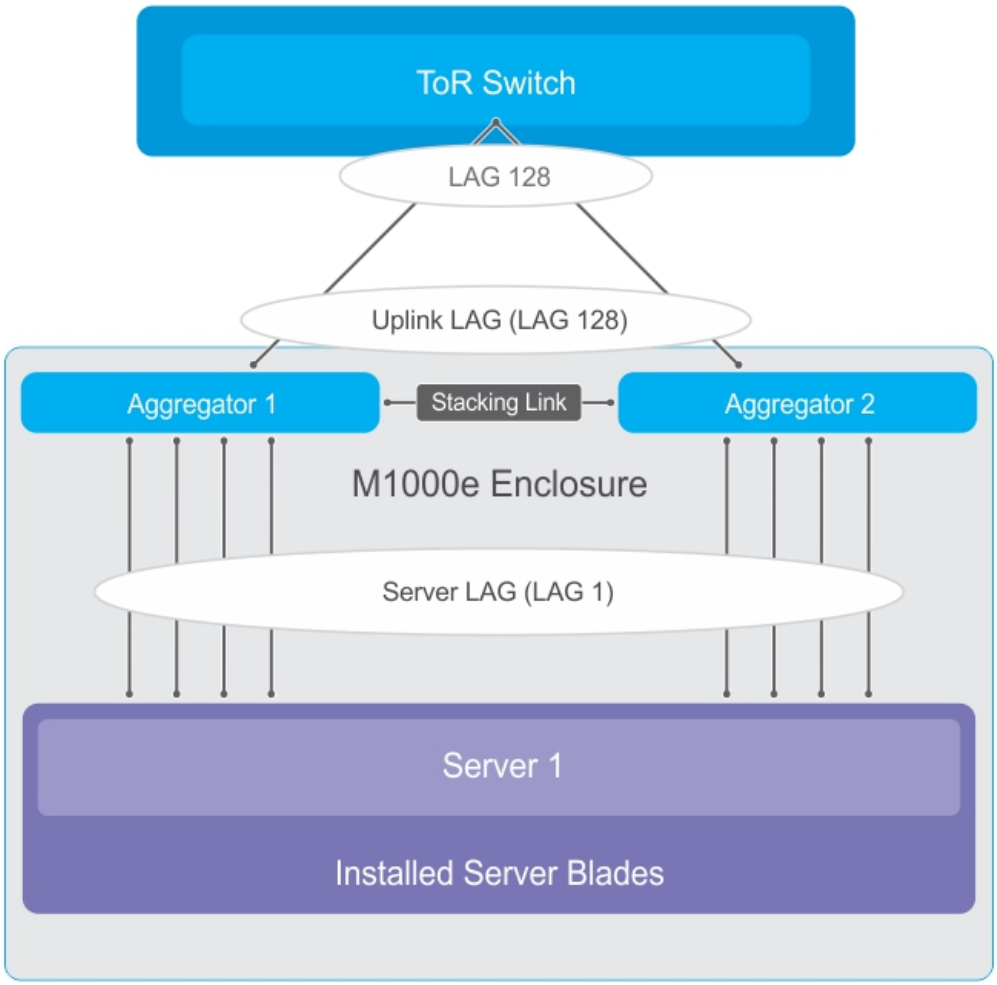
LACPDUs are exchanged between port channel (LAG) interfaces to maintain LACP sessions. LACPDUs are transmitted at either at a slow or fast transmission rate, depending on the LACP timeout value configured on the partner system.

The timeout value is the amount of time that a LAG interface waits for a PDU from the partner system before bringing the LACP session down. The default timeout is long-timeout (30 seconds) and is not user-configurable on the Aggregator.

LACP Example

Figure 12-1 shows an example of how LACP operates in an Aggregator stack by auto-configuring the uplink LAG 128 for the connection to a ToR switch and a server-facing LAG for the connection to an installed server that is configured for LACP-based NIC teaming.

Figure 12-1. LACP Operation on an Aggregator



Verifying LACP Operation and LAG Configuration

To verify the operational status and configuration of a dynamically created LAG, and LACP operation on a LAG on an Aggregator, enter the **show interfaces port-channel** *port-channel-number* and **show lacp** *port-channel-number* commands.

The **show** outputs in this section for uplink LAG 128 and server-facing LAG 1 refer to the example shown in Figure 12-1.

Figure 12-2. show interfaces port-channel 128 Command Example

```
FTOS# show interfaces port-channel 128

Port-channel 128 is up, line protocol is up
Created by LACP protocol
Hardware address is 00:01:e8:e1:e1:c1, Current address is 00:01:e8:e1:e1:c1
Interface index is 1107755136
Minimum number of links to bring Port-channel up is 1
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :lag1280001e8e1e1c1
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 40000 Mbit
Members in this channel:  Te 0/41(U) Te 0/42(U) Te 0/43(U) Te 0/44(U)
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:11:50
Queueing strategy: fifo
Input Statistics:
     182 packets, 17408 bytes
     92 64-byte pkts, 0 over 64-byte pkts, 90 over 127-byte pkts
     0 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     182 Multicasts, 0 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     2999 packets, 383916 bytes, 0 underruns
     5 64-byte pkts, 214 over 64-byte pkts, 2727 over 127-byte pkts
     53 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     2904 Multicasts, 95 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
     Output 00.00 Mbits/sec,          4 packets/sec, 0.00% of line-rate
Time since last interface status change: 00:11:42
```

Figure 12-3. show lacp 128 Command Example

```
FTOS# show lacp 128

Port-channel 128 admin up, oper up, mode lacp
Actor   System ID:  Priority 32768, Address 0001.e8e1.e1c3
Partner System ID:  Priority 32768, Address 0001.e88b.253d
Actor Admin Key 128, Oper Key 128, Partner Oper Key 128, VLT Peer Oper Key 128
LACP LAG 128 is an aggregatable link
LACP LAG 128 is a normal LAG

A - Active LACP, B - Passive LACP, C - Short Timeout, D - Long Timeout
E - Aggregatable Link, F - Individual Link, G - IN_SYNC, H - OUT_OF_SYNC
I - Collection enabled, J - Collection disabled, K - Distribution enabled
L - Distribution disabled, M - Partner Defaulted, N - Partner Non-defaulted,
O - Receiver is in expired state, P - Receiver is not in expired state

Port Te 0/41 is enabled, LACP is enabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEGIKNP Key 128 Priority 32768
  Partner Admin: State BDFHJLMP Key 0 Priority 0
           Oper: State ACEGIKNP Key 128 Priority 32768

Port Te 0/42 is enabled, LACP is enabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEGIKNP Key 128 Priority 32768
  Partner Admin: State BDFHJLMP Key 0 Priority 0
           Oper: State ACEGIKNP Key 128 Priority 32768

Port Te 0/43 is enabled, LACP is enabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEGIKNP Key 128 Priority 32768
  Partner Admin: State BDFHJLMP Key 0 Priority 0
           Oper: State ACEGIKNP Key 128 Priority 32768

Port Te 0/44 is enabled, LACP is enabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEGIKNP Key 128 Priority 32768
  Partner Admin: State BDFHJLMP Key 0 Priority 0
           Oper: State ACEGIKNP Key 128 Priority 32768

Port Te 0/45 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/46 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/47 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present
```

Figure 12-4. show lacp 128 Command Example (Continued)

```
Port Te 0/48 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/49 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/50 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/51 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/52 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/53 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/54 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/55 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present

Port Te 0/56 is disabled, LACP is disabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 128 Priority 32768
           Oper: State ADEHJLMP Key 128 Priority 32768
  Partner is not present
```

Figure 12-5. show interfaces port-channel 1 Command Example

```
FTOS# show interfaces port-channel 1

Port-channel 1 is up, line protocol is up
Created by LACP protocol
Hardware address is 00:01:e8:e1:e1:c1, Current address is 00:01:e8:e1:e1:c1
Interface index is 1107755009
Minimum number of links to bring Port-channel up is 1
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :lag10001e8e1e1c1
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed 10000 Mbit
Members in this channel:  Te 0/12(U)
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:12:41
Queueing strategy: fifo
Input Statistics:
     112 packets, 18161 bytes
     0 64-byte pkts, 46 over 64-byte pkts, 37 over 127-byte pkts
     29 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     59 Multicasts, 53 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     135 packets, 19315 bytes, 0 underruns
     0 64-byte pkts, 79 over 64-byte pkts, 32 over 127-byte pkts
     24 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     93 Multicasts, 42 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
     Output 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
Time since last interface status change: 00:12:38
```

Figure 12-6. show lacp 1 Command Example

```
FTOS# show lacp 1

Port-channel 1 admin up, oper up, mode lacp
Actor   System ID:  Priority 32768, Address 0001.e8e1.e1c3
Partner System ID:  Priority 65535, Address 24b6.fd87.d8ac
Actor Admin Key 1, Oper Key 1, Partner Oper Key 33, VLT Peer Oper Key 1
LACP LAG 1 is an aggregatable link
LACP LAG 1 is a normal LAG

A - Active LACP, B - Passive LACP, C - Short Timeout, D - Long Timeout
E - Aggregatable Link, F - Individual Link, G - IN_SYNC, H - OUT_OF_SYNC
I - Collection enabled, J - Collection disabled, K - Distribution enabled
L - Distribution disabled, M - Partner Defaulted, N - Partner Non-defaulted,
O - Receiver is in expired state, P - Receiver is not in expired state

Port Te 0/4 is enabled, LACP is enabled and mode is lacp
Port State: Bundle
  Actor   Admin: State ADEHJLMP Key 1 Priority 32768
           Oper: State ADEGIKNP Key 1 Priority 32768
  Partner Admin: State BDFHJLMP Key 0 Priority 0
           Oper: State ADEGIKNP Key 33 Priority 255
```

13

Layer 2

The Aggregator supports CLI commands to manage the MAC address table:

- Clearing MAC Address Entries
- Displaying the MAC Address Table

The Aggregator auto-configures with support for Network Interface Controller (NIC) Teaming.

Note: On an Aggregator, all ports are configured by default as members of all (4094) VLANs, including the default VLAN. All VLANs operate in Layer 2 mode. You can reconfigure the VLAN membership for individual ports by using the **vlan tagged** or **vlan untagged** commands in INTERFACE configuration mode. See VLAN Membership for more information.

Managing the MAC Address Table

Note: The tasks for managing the MAC address table that are described in this section can be performed only if the Aggregator is configured to operate in stacking mode. See Configuring a Switch Stack.

On an Aggregator in stacking mode, you can manage the MAC address table by:

- Clearing MAC Address Entries
- Displaying the MAC Address Table

Clearing MAC Address Entries

Learned MAC addresses are entered in the table as dynamic entries, which means that they are subject to aging. For any dynamic entry, if no packet arrives on the switch with the MAC address as the source or destination address within the timer period, the address is removed from the table. The default aging time is 1800 seconds.

You can manually clear the MAC address table of dynamic entries by using the **clear mac-address-table dynamic** command.

Note: On an Aggregator, you cannot manually configure static MAC addresses. A static entry is not subject to aging.

Task	Command Syntax	Command Mode
Clear a MAC address table of dynamic entries. • address deletes the specified entry • all deletes all dynamic entries • interface deletes all entries for the specified interface • vlan deletes all entries for the specified VLAN	clear mac-address-table dynamic {address | all | *interface* | vlan}	EXEC Privilege

Displaying the MAC Address Table

To display the contents of the MAC address table, use the **show mac-address-table** command:

Task	Command Syntax	CommandMode
Display the contents of the MAC address table. • address displays the specified entry. • aging-time displays the configured aging-time. • count displays the number of dynamic and static entries for all VLANs, and the total number of entries. • dynamic displays only dynamic entries • interface displays only entries for the specified interface. • static displays only static entries. • vlan displays only entries for the specified VLAN.	show mac-address-table [address | aging-time [vlan *vlan-id*]| count | dynamic | interface | static | vlan]	EXEC Privilege

Network Interface Controller (NIC) Teaming

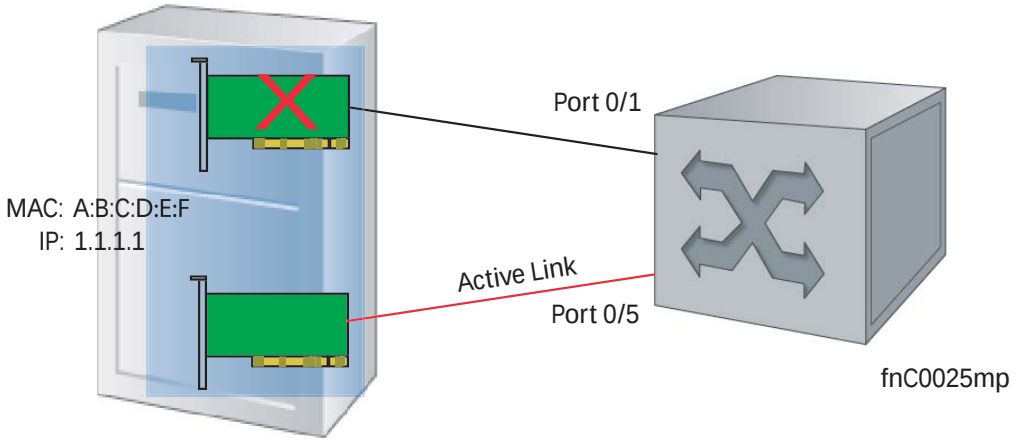
NIC teaming is a feature that allows multiple network interface cards in a server to be represented by one MAC address and one IP address in order to provide transparent redundancy, balancing, and to fully utilize network adapter resources.

Support for NIC teaming is auto-configured on the Aggregator, including support for:

- MAC Address Station Move
- MAC Address Station Move

Figure 13-1 shows a topology where two NICs have been teamed together. In this case, if the primary NIC fails, traffic switches to the secondary NIC, because they are represented by the same set of addresses.

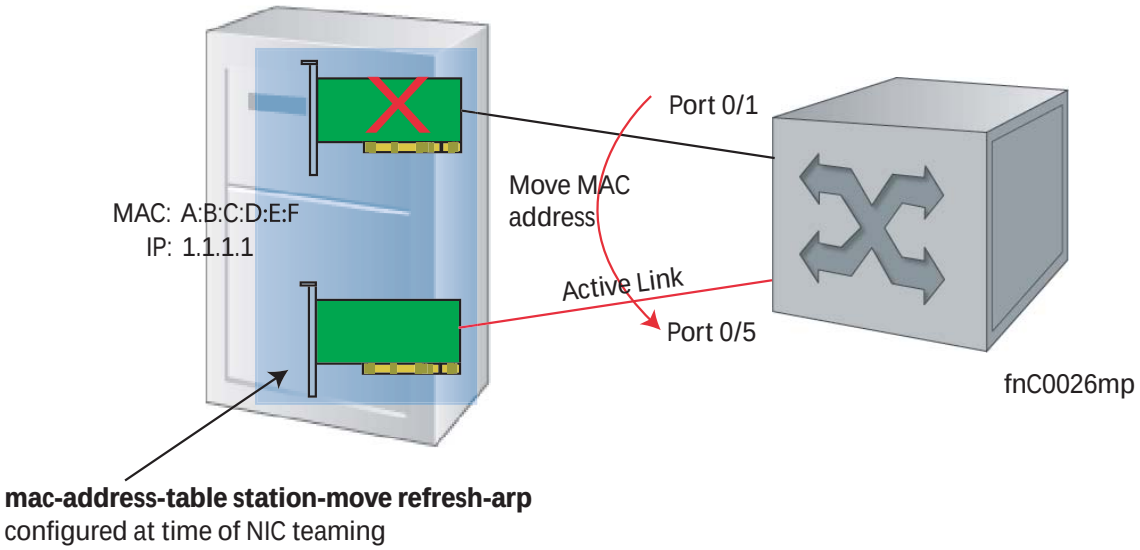
Figure 13-1. Redundant NICs with NIC Teaming



MAC Address Station Move

When you use NIC teaming, consider that the server MAC address is originally learned on Port 0/1 of the switch (Figure 13-2). If the NIC fails, the same MAC address is learned on Port 0/5 of the switch. The MAC address is disassociated with the one port and re-associated with another in the ARP table; in other words, the ARP entry is “moved”. The Aggregator is auto-configured to support MAC Address station moves.

Figure 13-2. MAC Address Station Move



MAC Move Optimization

Station-move detection takes 5000ms because this is the interval at which the detection algorithm runs.

14

Link Layer Discovery Protocol (LLDP)

An Aggregator auto-configures to support the link layer discovery protocol (LLDP) for the auto-discovery of network devices. You can use CLI commands to display acquired LLDP information, clear LLDP counters, and debug LACP operation.

Overview

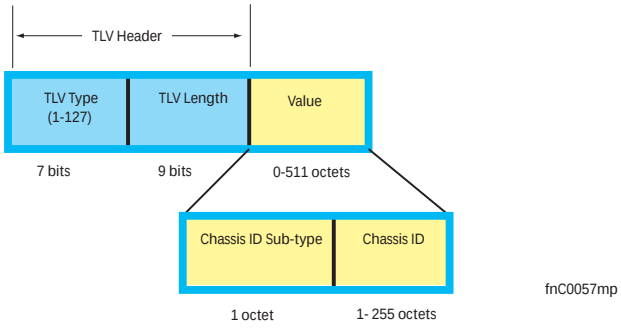
LLDP—defined by IEEE 802.1AB—is a protocol that enables a local area network (LAN) device to advertise its configuration and receive configuration information from adjacent LLDP-enabled LAN infrastructure devices. The collected information is stored in a management information base (MIB) on each device, and is accessible via a simple network management protocol (SNMP).

Protocol Data Units

Configuration information is exchanged in the form of type, length, value (TLV) segments. Figure 14-1 shows the Chassis ID TLV.

- **Type—**Indicates the type of field that a part of the message represents.
- **Length—**Indicates the size of the value field (in bytes).
- **Value—**Indicates the data for this part of the message.

Figure 14-1. Type, Length, Value (TLV) Segment



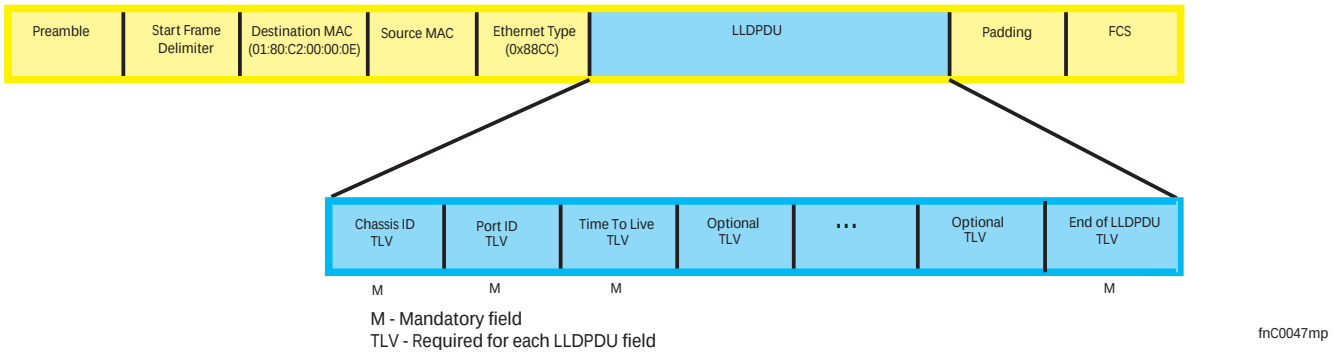
TLVs are encapsulated in a frame called an LLDP data unit (LLDPDU) (Figure 14-2), which is transmitted from one LLDP-enabled device to its LLDP-enabled neighbors. LLDP is a one-way protocol. LLDP-enabled devices (LLDP agents) can transmit and/or receive advertisements, but they cannot solicit and do not respond to advertisements.

There are five types of TLVs (Table 14-1). All types are mandatory in the construction of an LLDPDU except Optional TLVs. You can configure the inclusion of individual Optional TLVs.

Table 14-1. Type, Length, Value (TLV) Types

Type	TLV	Description
0	End of LLDPDU	Marks the end of an LLDPDU.
1	Chassis ID	The Chassis ID TLV is a mandatory TLV that identifies the chassis containing the IEEE 802 LAN station associated with the transmitting LLDP agent.
2	Port ID	The Port ID TLV is a mandatory TLV that identifies the port component of the MSAP identifier associated with the transmitting LLDP agent.
3	Time to Live	The Time To Live TLV indicates the number of seconds that the recipient LLDP agent considers the information associated with this MSAP identifier to be valid.
—	Optional	Includes sub-types of TLVs that advertise specific configuration information. These sub-types are Management TLVs, IEEE 802.1, IEEE 802.3, and TIA-1057 Organizationally Specific TLVs.

Figure 14-2. LLDPDU Frame



Optional TLVs

The Dell Force10 operating software (FTOS) supports the following optional TLVs:

- Management TLVs
- IEEE 802.1 and 802.3 Organizationally Specific TLVs
- TIA-1057 Organizationally Specific TLVs

Management TLVs

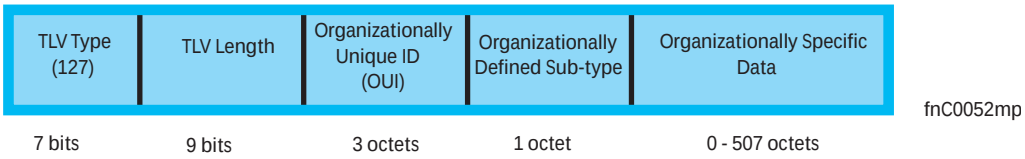
A Management TLV is an Optional TLVs sub-type. This kind of TLV contains essential management information about the sender. The five types are described in Table 14-2.

Organizationally Specific TLVs

Organizationally specific TLVs can be defined by a professional organization or a vendor. They have two mandatory fields (Figure 14-3) in addition to the basic TLV fields (Figure 14-1):

- Organizationally Unique Identifier (OUI)—a unique number assigned by the IEEE to an organization or vendor.
- OUI Sub-type—These sub-types indicate the kind of information in the following data field. The sub-types are determined by the owner of the OUI.

Figure 14-3. Organizationally Specific TLV



IEEE Organizationally Specific TLVs

Eight TLV types have been defined by the IEEE 802.1 and 802.3 working groups (Table 14-2) as a basic part of LLDP; the IEEE OUI is 00-80-C2. You can configure an Aggregator to advertise any or all of these TLVs.

Table 14-2. Optional TLV Types

Type	TLV	Description
Optional TLVs		
4	Port description	A user-defined alphanumeric string that describes the port. FTOS does not currently support this TLV.
5	System name	A user-defined alphanumeric string that identifies the system.
6	System description	A user-defined alphanumeric string that describes the system.
7	System capabilities	An optional TLV that identifies the primary functions of the system and whether or not these primary functions are enabled; for example, repeater, bridge, WLAN access point, router, telephone, DOCSIS cable device, end station only).
8	Management address	Indicates the network address of the management interface. FTOS does not currently support this TLV.
IEEE 802.1 Organizationally Specific TLVs		
127	Port-VLAN ID	On Dell Force10 systems, indicates the untagged VLAN to which a port belongs.
127	Port and Protocol VLAN ID	On Dell Force10 systems, indicates the tagged VLAN to which a port belongs (and the untagged VLAN to which a port belongs if the port is in hybrid mode).
127	VLAN Name	Indicates the user-defined alphanumeric string that identifies the VLAN.
127	Protocol Identity	Indicates the protocols that the port can process. FTOS does not currently support this TLV.

Table 14-2. Optional TLV Types

Type	TLV	Description
IEEE 802.3 Organizationally Specific TLVs		
127	MAC/PHY Configuration/Status	Indicates the capability and current setting of the duplex status and bit rate, and whether the current settings are the result of auto-negotiation. This TLV is not available in the FTOS implementation of LLDP, but is available and mandatory (non-configurable) in the LLDP-MED implementation.
127	Power via MDI	Dell Force10 supports the LLDP-MED protocol, which recommends that Power via MDI TLV is not implemented, and therefore Dell Force10 implements Extended Power via MDI TLV only.
127	Link Aggregation	Indicates whether the link is capable of being aggregated, whether it is currently in a LAG, and the port identification of the LAG. FTOS does not currently support this TLV.
127	Maximum Frame Size	Detects mis-configurations or incompatibility between two stations with different maximum supported frame sizes.

TIA-1057 (LLDP-MED) Overview

Link layer discovery protocol—media endpoint discovery (LLDP-MED)—as defined by ANSI/TIA-1057— provides additional organizationally specific TLVs so that endpoint devices and network connectivity devices can advertise their characteristics and configuration information; the OUI for the Telecommunications Industry Association (TIA) is 00-12-BB.

- **LLDP-MED Endpoint Device**—any device that is on an IEEE 802 LAN network edge can communicate using IP and uses the LLDP-MED framework.
- **LLDP-MED Network Connectivity Device**—any device that provides access to an IEEE 802 LAN to an LLDP-MED endpoint device and supports IEEE 802.1AB (LLDP) and TIA-1057 (LLDP-MED). The Dell Force10 system is an LLDP-MED network connectivity device.

With regard to connected endpoint devices, LLDP-MED provides network connectivity devices with the ability to:

- manage inventory
- manage Power over Ethernet (PoE)
- identify physical location
- identify network policy

LLDP-MED is designed for, but not limited to, voice over IP (VoIP) endpoints.

TIA Organizationally Specific TLVs

The Dell Force10 system is an LLDP-MED Network Connectivity Device (Device Type 4). Network connectivity devices are responsible for:

- transmitting an LLDP-MED capabilities TLV to endpoint devices
- storing the information that endpoint devices advertise

Table 14-3 list the five types of TIA-1057 Organizationally Specific TLVs.

Table 14-3. TIA-1057 (LLDP-MED) Organizationally Specific TLVs

Type	Sub-type	TLV	Description
127	1	LLDP-MED Capabilities	Indicates: • whether the transmitting device supports LLDP-MED • what LLDP-MED TLVs it supports • LLDP device class
127	2	Network Policy	Indicates the application type, VLAN ID, Layer 2 Priority, and DSCP value
127	3	Location Identification	Indicates the physical location of the device expressed in one of three possible formats: • Coordinate Based LCI • Civic Address LCI • Emergency Call Services ELIN
127	4	Extended Power via MDI	Indicates power requirements, priority, and power status
Inventory Management TLVs			Implementation of this set of TLVs is optional in LLDP-MED devices. None or all TLVs must be supported. FTOS does not currently support these TLVs.
127	5	Inventory - Hardware Revision	Indicates the hardware revision of the LLDP-MED device.
127	6	Inventory - Firmware Revision	Indicates the firmware revision of the LLDP-MED device.
127	7	Inventory - Software Revision	Indicates the software revision of the LLDP-MED device.
127	8	Inventory - Serial Number	Indicates the device serial number of the LLDP-MED device.
127	9	Inventory - Manufacturer Name	Indicates the manufacturer of the LLDP-MED device.
127	10	Inventory - Model Name	Indicates the model of the LLDP-MED device.
127	11	Inventory - Asset ID	Indicates a user specified device number to manage inventory.
127	12-255	Reserved	—

LLDP-MED Capabilities TLV

The LLDP-MED Capabilities TLV communicates the types of TLVs that the endpoint device and the network connectivity device support. LLDP-MED network connectivity devices must transmit the Network Policies TLV.

- The value of the LLDP-MED Capabilities field in the TLV is a 2 octet bitmap (Figure 14-4), each bit represents an LLDP-MED capability (Table 14-4).
- The possible values of the LLDP-MED Device Type is listed in Table 14-5. The Dell Force10 system is a Network Connectivity device, which is Type 4.

When you enable LLDP-MED in FTOS (using the advertise med command), the system begins transmitting this TLV.

Figure 14-4. LLDP-MED Capabilities TLV

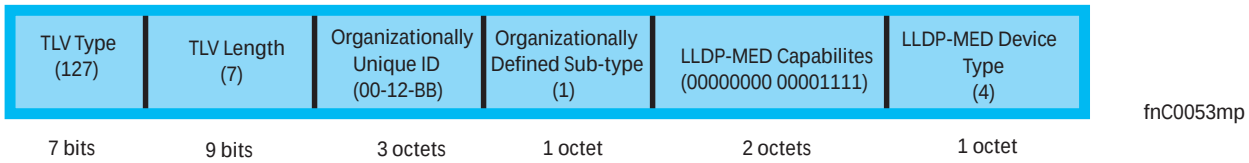


Table 14-4. FTOS LLDP-MED Capabilities

Bit Position	TLV	FTOS Support
0	LLDP-MED Capabilities	Yes
1	Network Policy	Yes
2	Location Identification	Yes
3	Extended Power via MDI-PSE	Yes
4	Extended Power via MDI-PD	No
5	Inventory	No
6-15	reserved	No

Table 14-5. LLDP-MED Device Types

Value	Device Type
0	Type Not Defined
1	Endpoint Class 1
2	Endpoint Class 2
3	Endpoint Class 3
4	Network Connectivity
5-255	Reserved

LLDP-MED Network Policies TLV

A network policy in the context of LLDP-MED is a device's virtual local area network (VLAN) configuration and associated Layer 2 and Layer 3 configurations, specifically:

- VLAN ID
- VLAN tagged or untagged status
- Layer 2 priority
- DSCP value

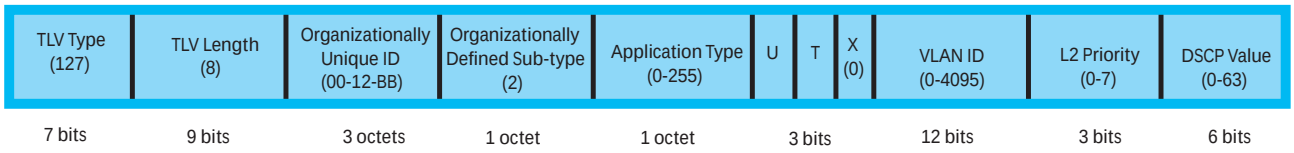
The application type is represented by an integer (the Type integer in Table 14-6), which indicates a device function for which a unique network policy is defined. An individual LLDP-MED Network Policy TLV is generated for each application type that you specify with the FTOS command line interface (CLI).

Note: With regard to Table 14-6, signaling is a series of control packets that are exchanged between an endpoint device and a network connectivity device to establish and maintain a connection. These signal packets might require a different network policy than the media packets for which a connection is made. In this case, configure the signaling application.

Table 14-6. Network Policy Applications

Type	Application	Description
0	Reserved	—
1	Voice	Specify this application type for dedicated IP telephony handsets and other appliances supporting interactive voice services.
2	Voice Signaling	Specify this application type only if voice control packets use a separate network policy than voice data.
3	Guest Voice	Specify this application type for a separate limited voice service for guest users with their own IP telephony handsets and other appliances supporting interactive voice services.
4	Guest Voice Signaling	Specify this application type only if guest voice control packets use a separate network policy than voice data.
5	Softphone Voice	Softphone is a computer program that enables IP telephony on a computer, rather than using a phone. Specify this application type for this type of endpoint device.
6	Video Conferencing	Specify this application type for dedicated video conferencing and other similar appliances supporting real-time interactive video.
7	Streaming Video	Specify this application type for broadcast or multicast based video content distribution and other similar applications supporting streaming video services. This does not include video applications relying on TCP with buffering.
8	Video Signaling	Specify this application type only if video control packets use a separate network policy than video data.
9-255	Reserved	—

Figure 14-5. LLDP-MED Policies TLV

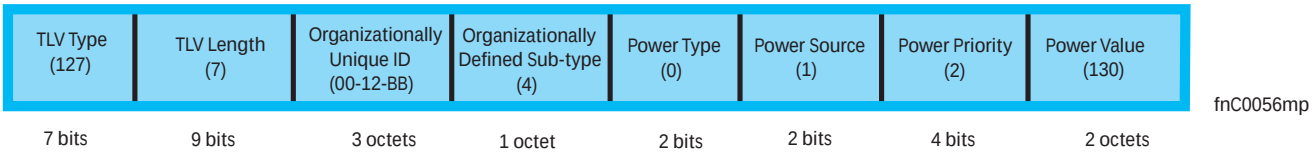


Extended Power via MDI TLV

The Extended Power via MDI TLV enables advanced power over ethernet (PoE) management between LLDP-MED endpoints and network connectivity devices (Figure 14-6). Advertise the Extended Power via MDI on all ports that are connected to an 802.3af powered, LLDP-MED endpoint device.

- **Power Type—**there are two possible power types: power sourcing entity (PSE) or power device (PD). The Dell Force10 system is a PSE, which corresponds to a value of 0, based on the TIA-1057 specification.
- **Power Source**—there are two possible power sources: Primary and Backup. The Dell Force10 system is a Primary Power Source, which corresponds to a value of 1, based on the TIA-1057 specification.
- **Power Priority**—there are three possible priorities: Low, High, and Critical. On Dell Force10 systems, the default power priority is High, which corresponds to a value of 2 based on the TIA-1057 specification. You can configure a different power priority through the CLI. Dell Force10 also honors the power priority value sent by the powered device. However, the CLI configuration takes precedence.
- **Power Value**—Dell Force10 advertises the maximum amount of power that can be supplied on the port. By default it is 15.4W, which corresponds to a Power Value of 130, based on the TIA-1057 specification. You can advertise a different Power Value using the max-milliwatts option with the power inline auto | static command. Dell Force10 also honors the power value (power requirement) sent by the powered device when the port is configured for power inline auto.

Figure 14-6. Extended Power via MDI TLV



LLDP Operation

On an Aggregator, LLDP operates as follows:

- LLDP is enabled by default.
- LLDPDUs are transmitted and received by default. LLDPDUs are transmitted periodically. The default interval is 30 seconds.
- LLDPDU information received from a neighbor expires after the default Time to Live (TTL) value: 120 seconds.
- FTOS supports up to eight neighbors per interface.
- FTOS supports a maximum of 8000 total neighbors per system. If the number of interfaces multiplied by eight exceeds the maximum, the system does not configure more than 8000.
- LLDP is not hitless.

Viewing the LLDP Configuration

To display the LLDP configuration, use the show config command in either CONFIGURATION or INTERFACE mode (Figure 14-7) and (Figure 14-8).

Figure 14-7. Viewing LLDP Global Configurations

```
R1(conf)#protocol lldp
R1(conf-lldp)#show config
!
protocol lldp
 advertise dot1-tlv port-protocol-vlan-id port-vlan-id
 advertise dot3-tlv max-frame-size
 advertise management-tlv system-capabilities system-description
 hello 10
 no disable
R1(conf-lldp)#
```

Figure 14-8. Viewing LLDP Interface Configurations

```
R1(conf)#interface tengigabitethernet 1/31
R1(conf-if-te-1/31)#show config
!
interface TenGigabitEthernet 1/31
 no ip address
!
 no shutdown
R1(conf-if-te-1/31)#protocol lldp
R1(conf-if-te-1/31-lldp)#show config
!
 protocol lldp
R1(conf-if-te-1/31-lldp)#
```

Viewing Information Advertised by Adjacent LLDP Agents

To display brief information about adjacent devices, use the show lldp neighbors command (Figure 14-9). To display all of the information that neighbors are advertising, use the show lldp neighbors detail command (Figure 14-10).

Figure 14-9. Viewing Brief Information Advertised by Adjacent LLDP Agents

```
R1(conf-if-te-1/31)#do show lldp neighbors
Loc PortID   Rem Host Name     Rem Port Id               Rem Chassis Id
 -------------------------------------------------------------------------

 Te 0/2       -                 00:00:c9:b1:3b:82         00:00:c9:b1:3b:82
 Te 0/3       -                 00:00:c9:ad:f6:12         00:00:c9:ad:f6:12
```

Figure 14-10. Viewing All Information Advertised by Adjacent LLDP Agent

```
FTOS#show lldp neighbors detail
================================================================================
 Local Interface Te 0/2 has 1 neighbor
  Total Frames Out: 16843
  Total Frames In: 17464
  Total Neighbor information Age outs: 0
  Total Multiple Neighbors Detected: 0
  Total Frames Discarded: 0
  Total In Error Frames: 0
  Total Unrecognized TLVs: 0
  Total TLVs Discarded: 0
  Next packet will be sent after 16 seconds
  The neighbors are given below:
  ------------------------------------------------------------------------

    Remote Chassis ID Subtype: Mac address (4)
    Remote Chassis ID:  00:00:c9:b1:3b:82
    Remote Port Subtype:  Mac address (3)
    Remote Port ID:  00:00:c9:b1:3b:82
    Local Port ID: TenGigabitEthernet 0/2
    Locally assigned remote Neighbor Index: 7
    Remote TTL:  120
    Information valid for next 105 seconds
    Time since last information change of this neighbor:  1d21h56m
    Remote System Desc:  Emulex OneConnect 10Gb Multi function Adapter
    Existing System Capabilities:  Station only
    Enabled System Capabilities:  Station only
   ---------------------------------------------------------------------------

================================================================================
 Local Interface Te 0/3 has 1 neighbor
  Total Frames Out: 39165
  Total Frames In: 40650
  Total Neighbor information Age outs: 0
  Total Multiple Neighbors Detected: 0
  Total Frames Discarded: 0
  Total In Error Frames: 0
  Total Unrecognized TLVs: 0
  Total TLVs Discarded: 0
  Next packet will be sent after 4 seconds
  The neighbors are given below:
  ------------------------------------------------------------------------

    Remote Chassis ID Subtype: Mac address (4)
    Remote Chassis ID:  00:00:c9:ad:f6:12
    Remote Port Subtype:  Mac address (3)
    Remote Port ID:  00:00:c9:ad:f6:12
    Local Port ID: TenGigabitEthernet 0/3
```

Clearing LLDP Counters

You can clear LLDP statistics that are maintained on an Aggregator for LLDP counters for frames transmitted to and received from neighboring devices on all or a specified physical interface.

To clear LLDP counters, enter the **clear lldp counters** command.

Command Syntax	Command Mode	Purpose
clear lldp counters [*interface*]	EXEC Privilege	Clear counters for LLDP frames sent to and received from neighboring devices on all Aggregator interfaces or on a specified interface. *interface* specifies a 10GbE uplink port in the format: **tenGigabitEthernet** *slot*/*port*.

Debugging LLDP

The debug lldp command allows you to view the TLVs that your system is sending and receiving.

- Use the debug lldp brief command to view a readable version of the TLVs.
- Use the debug lldp detail command to view a readable version of the TLVs plus a hexadecimal version of the entire LLDPDU.

Figure 14-11. debug lldp detail—LLDPDU Packet Dissection

Relevant Management Objects

FTOS supports all IEEE 802.1AB MIB objects.

- Table 14-7 lists the objects associated with received and transmitted TLVs.
- Table 14-8 lists the objects associated with the LLDP configuration on the local agent.
- Table 14-9 lists the objects associated with IEEE 802.1AB Organizationally Specific TLVs.
- Table 14-10 lists the objects associated with received and transmitted LLDP-MED TLVs.

Table 14-7. LLDP Configuration MIB Objects

MIB Object Category	LLDP Variable	LLDP MIB Object	Description
LLDP Configuration	adminStatus	lldpPortConfigAdminStatus	Whether the local LLDP agent is enabled for transmit, receive, or both
	msgTxHold	lldpMessageTxHoldMultiplier	Multiplier value
	msgTxInterval	lldpMessageTxInterval	Transmit Interval value
	rxInfoTTL	lldpRxInfoTTL	Time to Live for received TLVs
	txInfoTTL	lldpTxInfoTTL	Time to Live for transmitted TLVs
Basic TLV Selection	mibBasicTLVsTxEnable	lldpPortConfigTLVsTxEnable	Indicates which management TLVs are enabled for system ports
	mibMgmtAddrInstanceTxEnable	lldpManAddrPortsTxEnable	The management addresses defined for the system and and the ports through which they are enabled for transmission
LLDP Statistics	statsAgeoutsTotal	lldpStatsRxPortAgeoutsTotal	Total number of times that a neighbors information is deleted on the local system due to an rxInfoTTL timer expiration
	statsFramesDiscardedTotal	lldpStatsRxPortFramesDiscardedTotal	Total number of LLDP frames received then discarded
	statsFramesInErrorsTotal	lldpStatsRxPortFramesErrors	Total number of LLDP frames received on a port with errors
	statsFramesInTotal	lldpStatsRxPortFramesTotal	Total number of LLDP frames received through the port
	statsFramesOutTotal	lldpStatsTxPortFramesTotal	Total number of LLDP frames transmitted through the port
	statsTLVsDiscardedTotal	lldpStatsRxPortTLVsDiscardedTotal	Total number of TLVs received then discarded
	statsTLVsUnrecognizedTotal	lldpStatsRxPortTLVsUnrecognizedTotal	Total number of all TLVs the local agent does not recognize

Table 14-8. LLDP System MIB Objects

TLV Type	TLV Name	TLV Variable	System	LLDP MIB Object
1	Chassis ID	chassis ID subtype	Local	lldpLocChassisIdSubtype
			Remote	lldpRemChassisIdSubtype
		chassid ID	Local	lldpLocChassisId
			Remote	lldpRemChassisId
2	Port ID	port subtype	Local	lldpLocPortIdSubtype
			Remote	lldpRemPortIdSubtype
		port ID	Local	lldpLocPortId
			Remote	lldpRemPortId
4	Port Description	port description	Local	lldpLocPortDesc
			Remote	lldpRemPortDesc
5	System Name	system name	Local	lldpLocSysName
			Remote	lldpRemSysName
6	System Description	system description	Local	lldpLocSysDesc
			Remote	lldpRemSysDesc
7	System Capabilities	system capabilities	Local	lldpLocSysCapSupported
			Remote	lldpRemSysCapSupported
8	Management Address	enabled capabilities	Local	lldpLocSysCapEnabled
			Remote	lldpRemSysCapEnabled
		management address length	Local	lldpLocManAddrLen
			Remote	lldpRemManAddrLen
		management address subtype	Local	lldpLocManAddrSubtype
			Remote	lldpRemManAddrSubtype
		management address	Local	lldpLocManAddr
			Remote	lldpRemManAddr
		interface numbering subtype	Local	lldpLocManAddrIfSubtype
			Remote	lldpRemManAddrIfSubtype
		interface number	Local	lldpLocManAddrIfId
			Remote	lldpRemManAddrIfId
		OID	Local	lldpLocManAddrOID
			Remote	lldpRemManAddrOID

Table 14-9. LLDP 802.1 Organizationally Specific TLV MIB Objects

TLV Type	TLV Name	TLV Variable	System	LLDP MIB Object
127	Port-VLAN ID	PVID	Local	lldpXdot1LocPortVlanId
			Remote	lldpXdot1RemPortVlanId
127	Port and Protocol VLAN ID	port and protocol VLAN supported	Local	lldpXdot1LocProtoVlanSupported
			Remote	lldpXdot1RemProtoVlanSupported
		port and protocol VLAN enabled	Local	lldpXdot1LocProtoVlanEnabled
			Remote	lldpXdot1RemProtoVlanEnabled
		PPVID	Local	lldpXdot1LocProtoVlanId
			Remote	lldpXdot1RemProtoVlanId
127	VLAN Name	VID	Local	lldpXdot1LocVlanId
			Remote	lldpXdot1RemVlanId
		VLAN name length	Local	lldpXdot1LocVlanName
			Remote	lldpXdot1RemVlanName
		VLAN name	Local	lldpXdot1LocVlanName
			Remote	lldpXdot1RemVlanName

Table 14-10. LLDP-MED System MIB Objects

TLV Sub-Type	TLV Name	TLV Variable	System	LLDP-MED MIB Object
1	LLDP-MED Capabilities	LLDP-MED Capabilities	Local	lldpXMedPortCapSupported lldpXMedPortConfigTLVsTx Enable
			Remote	lldpXMedRemCapSupported, lldpXMedRemConfigTLVsTx Enable
		LLDP-MED Class Type	Local	lldpXMedLocDeviceClass
			Remote	lldpXMedRemDeviceClass

Table 14-10. LLDP-MED System MIB Objects

TLV Sub-Type	TLV Name	TLV Variable	System	LLDP-MED MIB Object
2	Network Policy	Application Type	Local	lldpXMedLocMediaPolicyAppType
			Remote	lldpXMedRemMediaPolicyAppType
		Unknown Policy Flag	Local	lldpXMedLocMediaPolicyUnknown
			Remote	lldpXMedLocMediaPolicyUnknown
		Tagged Flag	Local	lldpXMedLocMediaPolicyTagged
			Remote	lldpXMedLocMediaPolicyTagged
		VLAN ID	Local	lldpXMedLocMediaPolicyVlanID
			Remote	lldpXMedRemMediaPolicyVlanID
		L2 Priority	Local	lldpXMedLocMediaPolicyPriority
			Remote	lldpXMedRemMediaPolicyPriority
		DSCP Value	Local	lldpXMedLocMediaPolicyDscp
			Remote	lldpXMedRemMediaPolicyDscp
3	Location Identifier	Location Data Format	Local	lldpXMedLocLocationSubtype
			Remote	lldpXMedRemLocationSubtype
		Location ID Data	Local	lldpXMedLocLocationInfo
			Remote	lldpXMedRemLocationInfo

Table 14-10. LLDP-MED System MIB Objects

TLV Sub-Type	TLV Name	TLV Variable	System	LLDP-MED MIB Object
4	Extended Power via MDI	Power Device Type	Local	lldpXMedLocXPoEDeviceType
			Remote	lldpXMedRemXPoEDeviceType
		Power Source	Local	lldpXMedLocXPoEPSEPowerSource, lldpXMedLocXPoEPDPowerSource
			Remote	lldpXMedRemXPoEPSEPowerSource, lldpXMedRemXPoEPDPowerSource
		Power Priority	Local	lldpXMedLocXPoEPDPowerPriority, lldpXMedLocXPoEPSEPortPDPriority
			Remote	lldpXMedRemXPoEPSEPowerPriority, lldpXMedRemXPoEPDPowerPriority
		Power Value	Local	lldpXMedLocXPoEPSEPortPowerAv, lldpXMedLocXPoEPDPowerReq
			Remote	lldpXMedRemXPoEPSEPowerAv, lldpXMedRemXPoEPDPowerReq

15

Port Monitoring

The Aggregator supports user-configured port monitoring. See Configuring Port Monitoring for the configuration commands to use.

Port monitoring copies all incoming or outgoing packets on one port and forwards (mirrors) them to another port. The source port is the monitored port (MD) and the destination port is the monitoring port (MG).

Important Points to Remember

- Port monitoring is supported on physical ports only; virtual local area network (VLAN) and port-channel interfaces do not support port monitoring.
- The monitored (source, MD) and monitoring ports (destination, MG) must be on the same switch.
- The monitored (source) interface must be a server-facing interface in the format *slot*/*port*, where the valid slot numbers are 0 or 1 and server-facing port numbers are from 1 to 32.
- The destination interface must be an uplink port (ports 33 to 56).
- In general, a monitoring port should have no ip address and no shutdown as the only configuration; FTOS permits a limited set of commands for monitoring ports. To display these commands, use the command ?.
- A monitoring port may not be a member of a VLAN.
- There may only be one destination port in a monitoring session.
- A source port (MD) can only be monitored by one destination port (MG). If you try to assign a monitored port to more than one monitoring port, the following error is displayed (Message 1).

Message 1 Assign a Monitored Port to More than One Monitoring Port

```
FTOS(conf)#mon ses 1
FTOS(conf-mon-sess-1)#source tengig 0/1 destination tengig 0/33 direction both
FTOS(conf-mon-sess-1)#do show monitor session
     SessionID       Source       Destination     Direction      Mode        Type
     ---------       ------       -----------     ---------      ----        ----
             1       TenGig 0/1   TenGig 0/33     both           interface   Port-based
FTOS(conf-mon-sess-1)#mon ses 2
FTOS(conf-mon-sess-2)#source tengig 0/1 destination tengig 0/33 direction both
% Error: MD port is already being monitored.
```

Note: There is no limit to the number of monitoring sessions per system, provided that there are only four destination ports per port-pipe. If each monitoring session has a unique destination port, the maximum number of session is four per port-pipe.

Port Monitoring

The Aggregator supports multiple source-destination statements in a monitor session, but there may only be one destination port in a monitoring session (Message 2).

Message 2 One Destination Port in a Monitoring Session Error Message

```
% Error: Only one MG port is allowed in a session.
```

The number of source ports supported in a port pipe is equal to the number of physical ports in the port pipe. Multiple source ports may have up to four different destination ports (Message 3).

In Figure 15-1, ports 0/13, 0/14, 0/15, and 0/16 all belong to the same port-pipe. These ports mirror traffic to four different destinations (0/33, 0/34 0/35, and 0/37). Another source port from the same port-pipe (for example, 0/17) does not support a new destination (for example, 0/40). If you attempt to configure another destination, an error message is displayed (Message 3). However, you can configure another monitoring session that uses one of previously configured destination ports.

Figure 15-1. Number of Monitoring Ports

```
FTOS#show mon session
     SessionID       Source       Destination     Direction      Mode        Type
     ---------       ------       -----------     ---------      ----        ----
             0       TenGig 0/13   TenGig 0/33         rx        interface   Port-based
             10      TenGig 0/14   TenGig 0/34         rx        interface   Port-based
            20       TenGig 0/15   TenGig 0/35         rx        interface   Port-based
            30       TenGig 0/16   TenGig 0/37         rx        interface   Port-based
FTOS(conf)# monitor session 300
FTOS(conf-mon-sess-300)# source tengig 0/17 destination tengig 0/40 direction tx
% Error: Exceeding max MG ports for this MD port pipe.
FTOS(conf-mon-sess-300)#
FTOS(conf-mon-sess-300)# source tengig 0/17 destination tengig 0/33 direction tx
FTOS(conf-mon-sess-300)# do show monitor session
     SessionID       Source       Destination     Direction      Mode        Type
     ---------       ------       -----------     ---------      ----        ----
            0       TenGig 0/13    TenGig 0/33         rx            interface   Port-based
           10       TenGig 0/14    TenGig 0/34         rx            interface   Port-based
           20       TenGig 0/15    TenGig 0/35         rx            interface   Port-based
           30       TenGig 0/16    TenGig 0/37         rx            interface   Port-based
          300       TenGig 0/17    TenGig 0/33         tx            interface   Port-based
FTOS(conf-mon-sess-300)#
```

Figure 15-2 shows ports 0/25 and 0/26 that belong to port pipe 1 with a maximum of four destination ports.

Figure 15-2. Number of Monitoring Ports

```
FTOS(conf-mon-sess-300)#do show mon session
     SessionID       Source       Destination     Direction      Mode        Type
     ---------       ------       -----------     ---------      ----        ----
            0       TenGig 0/13     TenGig 0/33        rx            interface   Port-based
           10       TenGig 0/14     TenGig 0/34        rx            interface   Port-based
           20       TenGig 0/15     TenGig 0/35        rx            interface   Port-based
           30      TenGig 0/16     TenGig 0/37        rx            interface   Port-based
          100      TenGig 0/25     TenGig 0/38        tx            interface   Port-based
          110      TenGig 0/26     TenGig 0/39        tx            interface   Port-based
          300      TenGig 0/17     TenGig 0/33        tx            interface   Port-based
FTOS(conf-mon-sess-300)#
```

A source port may only be monitored by one destination port (Message 3), but a destination port may monitor more than one source port.

Message 3 One Destination Port in a Monitoring Session Error Message

```
% Error: Exceeding max MG ports for this MD port pipe.
```

Message 4 One Destination Port per Source Port Error Message

```
% Error: MD port is already being monitored.
```

FTOS Behavior: All monitored frames are tagged if the configured monitoring direction is transmit (TX), regardless of whether the monitored port is a Layer 2 or Layer 3 port.
- If the source port is a Layer 2 port, the frames are tagged with the VLAN ID of the VLAN to which the port belongs.
- If the source port is a Layer 3 port, the frames are tagged with VLAN ID 4095.
- If the source port is in a Layer 3 VLAN, the frames are tagged with the corresponding Layer 3 VLAN ID.

For example, in the configuration *source tengig 1/1 destination tengig 1/41 direction tx*, if the source port 1/1 is an untagged member of any VLAN, all monitored frames that the destination port 1/41 receives are tagged with the VLAN ID of the source port.

Configuring Port Monitoring

To configure port monitoring, use the following example:

Step	Task	Command Syntax	Command Mode
1	Verify that the intended monitoring port has no configuration other than no shutdown (Figure 15-3).	show interface	EXEC Privilege
2	Create a monitoring session using the command monitor session from CONFIGURATION mode (Figure 15-3).	monitor session	CONFIGURATION
3	Specify the source and destination port and direction of traffic (Figure 15-3).	source	MONITOR SESSION

Note: By default, all uplink ports are assigned to port-channel (LAG) 128 and the destination port in a port monitoring session must be an uplink port. When you configure the destination port using the **source** command, the destination port is removed from LAG 128. To display the uplink ports currently assigned to LAG 128, enter the **show lag 128** command.

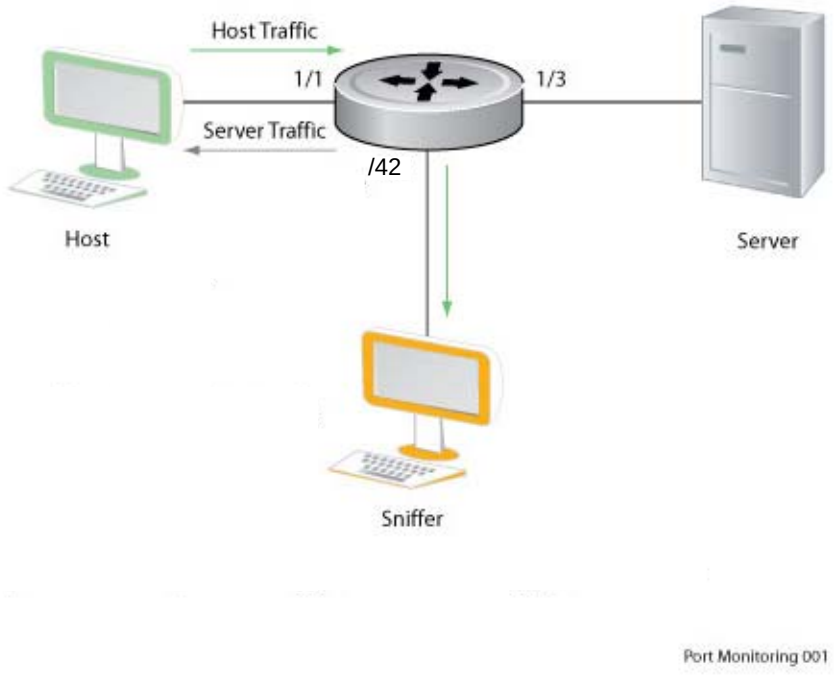
To display information on currently configured port-monitoring sessions, use the **show monitor session** command from EXEC Privilege mode (Figure 15-3).

Figure 15-3. Displaying Port-based Monitoring

```
FTOS(conf)# monitor session 0
FTOS(conf-mon-sess-0)# source tengig 1/1 dest tengig 1/42 direction rx
FTOS(conf-mon-sess-0)#exit
FTOS(conf)# do show monitor session 0
     SessionID       Source       Destination     Direction      Mode        Type
     ---------       ------       -----------     ---------      ----        ----
            0       TenGig 1/1    TenGig 1/42     rx             interface   Port-based
FTOS(conf)#
```

In Figure 15-4, the host and server are exchanging traffic which passes through the uplink interface 1/1. Port 1/1 is the monitored port and port 1/42 is the destination port, which is configured to only mirror traffic received on tengigabitethernet 1/1 (host-originated traffic).

Figure 15-4. Port Monitoring Example



16

Simple Network Management Protocol (SNMP)

Network management stations use the Simple Network Management Protocol (SNMP) to retrieve or alter management data from network elements. A datum of management information is called a *managed object*; the value of a managed object can be static or variable. Network elements store managed objects in a database called a *Management Information Base* (MIB).

MIBs are hierarchically structured and use object identifiers to address managed objects, but managed objects also have a textual name called an *object descriptor*.

Note: An Aggregator supports standard and private SNMP MIBs, including Get operations in supported MIBs.

Implementation Information

- FTOS supports SNMP version 1 as defined by RFC 1155, 1157, and 1212, SNMP version 2c as defined by RFC 1901.

Configuring the Simple Network Management Protocol

Note: The configurations in this chapter use a UNIX environment with net-snmp version 5.4. This is only one of many RFC-compliant SNMP utilities you can use to manage the Aggregator using SNMP. Also, these configurations use SNMP version 2c.

Configuring SNMP version 1 or version 2 requires only a single step:

1. Create a community. See page 190.

Note: SNMP version 3 is not supported on the Aggregator.

Important Point to Remember

- Typically, 5-second timeout and 3-second retry values on an SNMP server are sufficient for both LAN and WAN applications. If you experience a timeout with these values, increase the timeout value to greater than 3 seconds, and increase the retry value to greater than 2 on your SNMP server.

Setting up SNMP

FTOS supports SNMP version 1 and version 2 which are community-based security models. The primary difference between the two versions is that version 2 supports two additional protocol operations (informs operation and **snmpgetbulk** query) and one additional object (counter64 object).

Creating a Community CMC

For SNMPv1 and SNMPv2, you must create a community to enable the community-based security in FTOS. The management station generates requests to either retrieve or alter the value of a management object and is called the *SNMP manager*. A network element that processes SNMP requests is called an *SNMP agent*. An *SNMP community* is a group of SNMP agents and managers that are allowed to interact. Communities are necessary to secure communication between SNMP managers and agents; SNMP agents do not respond to requests from management stations that are not part of the community.

FTOS enables SNMP automatically when you create an SNMP community and displays Message 1. You must specify whether members of the community may retrieve values in read-only mode. Read-write access is not supported.

To create an SNMP community:

Task	Command	Command Mode
Choose a name for the community.	**snmp-server community** *name* **ro**	CONFIGURATION

Message 1 SNMP Enabled

```
22:31:23: %STKUNIT0-M:CP %SNMP-6-SNMP_WARM_START: Agent Initialized - SNMP WARM_START.
```

View your SNMP configuration, using the command **show running-config snmp** from EXEC Privilege mode, as shown in Figure 16-1.

Figure 16-1. Creating an SNMP Community

```
FTOS(conf)#snmp-server community my-snmp-community ro
22:31:23: %STKUNIT0-M:CP %SNMP-6-SNMP_WARM_START: Agent Initialized - SNMP WARM_START.
FTOS#do show running-config snmp
!
snmp-server community mycommunity ro
FTOS#
```

Read Managed Object Values

You may only retrieve (read) managed object values if your management station is a member of the same community as the SNMP agent.

Dell Force10 supports RFC 4001, *Textual Conventions for Internet Work Addresses* that defines values representing a type of internet address. These values display for ipAddressTable objects using the **snmpwalk** command.

In the following figure, the value "4" displays in the OID before the IP address for IPv4.

```
>snmpwalk -v 2c -c public 10.11.195.63 1.3.6.1.2.1.4.34
IP-MIB::ip.34.1.3.1.4.1.1.1.1 = INTEGER: 1107787778
IP-MIB::ip.34.1.3.1.4.2.1.1.1 = INTEGER: 1107787779
IP-MIB::ip.34.1.3.2.16.254.128.0.0.0.0.0.2.1.232.255.254.139.5.8 = INTEGER: 1107787778
IP-MIB::ip.34.1.4.1.4.1.1.1.1 = INTEGER: 1
IP-MIB::ip.34.1.4.1.4.2.1.1.1 = INTEGER: 1
IP-MIB::ip.34.1.4.2.16.0.1.0.0.0.0.0.0.0.0.0.0.0.0.1 = INTEGER: 1
```

There are several UNIX SNMP commands that read data:

Task	Command
Read the value of a single managed object as shown in Figure 16-2.	**snmpget -v** *version* **-c** *community agent-ip {identifier.instance | descriptor.instance}*

Figure 16-2. Reading the Value of a Managed Object

```
> snmpget -v 2c -c mycommunity 10.11.131.161 sysUpTime.0
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (32852616) 3 days, 19:15:26.16
> snmpget -v 2c -c mycommunity 10.11.131.161 .1.3.6.1.2.1.1.3.0
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (32856932) 3 days, 19:16:09.32
```

Read the value of the managed object directly below the specified object as shown in Figure 16-3.	**snmpgetnext -v** *version* **-c** *community agent-ip {identifier.instance | descriptor.instance}*

Figure 16-3. Reading the Value of the Next Managed Object in the MIB

```
> snmpgetnext -v 2c -c mycommunity 10.11.131.161 .1.3.6.1.2.1.1.3.0
SNMPv2-MIB::sysContact.0 = STRING:
> snmpgetnext -v 2c -c mycommunity 10.11.131.161 sysContact.0
SNMPv2-MIB::sysName.0 = STRING:
```

Read the value of many objects at once as shown in Figure 16-4.	**snmpwalk -v** *version* **-c** *community agent-ip {identifier.instance | descriptor.instance}*

Figure 16-4. Reading the Value of Many Managed Objects at Once

```
>snmpwalk -v 2c -c public 10.16.130.148 .1.3.6.1.2.1.1
SNMPv2-MIB::sysDescr.0 = STRING: Dell Force10 OS
Operating System Version: 1.0
Application Software Version: E8-3-17-46
Series: I/O-Aggregator
Copyright (c) 1999-2012 by Dell Inc. All Rights Reserved.
Build Time: Sat Jul 28 03:20:24 PDT 2012
SNMPv2-MIB::sysObjectID.0 = OID: SNMPv2-SMI::enterprises.6027.1.4.2
DISMAN-EVENT-MIB::sysUpTimeInstance = Timeticks: (77916) 0:12:59.16
SNMPv2-MIB::sysContact.0 = STRING:
SNMPv2-MIB::sysName.0 = STRING: FTOS
SNMPv2-MIB::sysLocation.0 = STRING:
SNMPv2-MIB::sysServices.0 = INTEGER: 4
>
```

Displaying the Ports in a VLAN Using SNMP

FTOS identifies VLAN interfaces using an interface index number that is displayed in the output of the command show interface vlan, as shown in Figure 16-5.

Figure 16-5. Identifying the VLAN Interface Index Number

```
FTOS(conf)#do show interface vlan 10
Vlan 10 is down, line protocol is down
Address is 00:01:e8:cc:cc:ce, Current address is 00:01:e8:cc:cc:ce
Interface index is 1107787786
Internet address is not set
MTU 1554 bytes, IP MTU 1500 bytes
LineSpeed auto
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:12:42
Queueing strategy: fifo
Time since last interface status change: 00:12:42
```

To display the ports in a VLAN, send an snmpget request for the object dot1qStaticEgressPorts using the interface index as the instance number, as shown in Figure 16-6.

Figure 16-6. Display the Ports in a VLAN in SNMP

```
> snmpget -v2c -c mycommunity 10.11.131.185 .1.3.6.1.2.1.17.7.1.4.3.1.2.1107787786
SNMPv2-SMI::mib-2.17.7.1.4.3.1.2.1107787786 = Hex-STRING:
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00
```

The table that the Aggregator system sends in response to the snmpget request is a table that contains hexadecimal (hex) pairs, each pair representing a group of eight ports.

- 7 hex pairs represents a stack unit. Seven pairs accommodates the greatest number of ports available on an Aggregator, 56 ports. The last stack unit is assigned 8 pairs; the eighth pair is unused.

The first hex pair, 00 in Figure 16-6, represents ports 1-7 in Stack Unit 0. The next pair to the right represents ports 8-15. To resolve the hex pair into a representation of the individual ports, convert the hex pair to binary. Consider the first hex pair 00, which resolves to 0000 0000 in binary:

- Each position in the 8-character string is for one port, starting with Port 1 at the left end of the string, and ending with Port 8 at the right end. A 0 indicates that the port is not a member of the VLAN; a 1 indicates VLAN membership.

Figure 16-6 shows the output for an Aggregator. All hex pairs are 00, indicating that no ports are assigned to VLAN 10. In Figure 16-7, Port 0/2 is added to VLAN 10 as untagged. And the first hex pair changes from 00 to 04.

Figure 16-7. Displaying Ports in a VLAN using SNMP

```
[Dell Force10 system output]

FTOS(conf)#do show vlan id 10

Codes: * - Default VLAN, G - GVRP VLANs
Q: U - Untagged, T - Tagged
   x - Dot1x untagged, X - Dot1x tagged
   G - GVRP tagged, M - Vlan-stack

    NUM    Status    Description                    Q Ports
    10     Inactive                                 U Tengig 0/2

[Unix system output]

> snmpget -v2c -c mycommunity 10.11.131.185 .1.3.6.1.2.1.17.7.1.4.3.1.2.1107787786
SNMPv2-SMI::mib-2.17.7.1.4.3.1.2.1107787786 = Hex-STRING: 40 00 00 00 00 00 00 00 00 00
00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00
```

The value 40 is in the first set of 7 hex pairs, indicating that these ports are in Stack Unit 0. The hex value 40 is 0100 0000 in binary. As described above, the left-most position in the string represents Port 1. The next position from the left represents Port 2 and has a value of 1, indicating that Port 0/2 is in VLAN 10. The remaining positions are 0, so those ports are not in the VLAN.

Note that the table contains none of the other information provided by the show vlan command, such as port speed or whether the ports are tagged or untagged.

Fetching Dynamic MAC Entries Using SNMP

The Aggregator supports the RFC 1493 dot1d table for the default VLAN and the dot1q table for all other VLANs.

Note: The 802.1q Q-BRIDGE MIB defines VLANs with regard to 802.1d, as 802.1d itself does not define them. As a switchport must belong to a VLAN (the default VLAN or a configured VLAN), all MAC address learned on a switchport are associated with a VLAN. For this reason, the Q-Bridge MIB is used for MAC address query. Moreover, specific to MAC address query, dot1dTpFdbTable is indexed by MAC address only for a single forwarding database, while dot1qTpFdbTable has two indices —VLAN ID and MAC address —to allow for multiple forwarding databases and considering that the same MAC address is learned on multiple VLANs. The VLAN ID is added as the first index so that MAC addresses can be read by VLAN, sorted lexicographically. The MAC address is part of the OID instance, so in this case, lexicographic order is according to the most significant octet.

Table 16-1. MIB Objects for Fetching Dynamic MAC Entries in the Forwarding Database

MIB Object	OID	Description	MIB
dot1dTpFdbTable	.1.3.6.1.2.1.17.4.3	List the learned unicast MAC addresses on the default VLAN.	Q-BRIDGE MIB
dot1qTpFdbTable	.1.3.6.1.2.1.17.7.1.2.2	List the learned unicast MAC addresses on non-default VLANs.	
dot3aCurAggFdbTable	.1.3.6.1.4.1.6027.3.2.1.1.5	List the learned MAC addresses of aggregated links (LAG).	F10-LINK-AGGREGATION-MIB

In Figure 16-8, R1 has one dynamic MAC address, learned off of port TenGigabitEthernet 1/21, which is a member of the default VLAN, VLAN 1. The SNMP walk returns the values for dot1dTpFdbAddress, dot1dTpFdbPort, and dot1dTpFdbStatus.

Each object is comprised an OID concatenated with an instance number. In the case of these objects, the instance number is the decimal equivalent of the MAC address; derive the instance number by converting each hex pair to its decimal equivalent. For example, the decimal equivalent of E8 is 232, and so the instance number for MAC address 00:01:e8:06:95:ac is .0.1.232.6.149.172.

The value of dot1dTpFdbPort is the port number of the port off which the system learns the MAC address. In this case, of TenGigabitEthernet 1/21, the manager returns the integer 118.

Figure 16-8. Fetching Dynamic MAC Addresses on the Default VLAN

```
----------------------------MAC Addresses on Dell Force10
System-------------------------------
FTOS#show mac-address-table
VlanId     Mac Address           Type   Interface        State
 1      00:01:e8:06:95:ac       Dynamic Tengig 1/21         Active
-----------------------------Query from Management Station-------------------------------
>snmpwalk -v 2c -c techpubs 10.11.131.162 .1.3.6.1.2.1.17.4.3.1
SNMPv2-SMI::mib-2.17.4.3.1.1.0.1.232.6.149.172 = Hex-STRING: 00 01 E8 06 95 AC
SNMPv2-SMI::mib-2.17.4.3.1.2.0.1.232.6.149.172 = INTEGER: 118
SNMPv2-SMI::mib-2.17.4.3.1.3.0.1.232.6.149.172 = INTEGER: 3
```

In Figure 16-9, TenGigabitEthernet 1/21 is moved to VLAN 1000, a non-default VLAN. Use the objects dot1qTpFdbTable to fetch the MAC addresses learned on non-default VLANs. The instance number is the VLAN number concatenated with the decimal conversion of the MAC address.

Figure 16-9. Fetching Dynamic MAC Addresses on Non-default VLANs

```
----------------------------MAC Addresses on Dell Force10
System-------------------------------
FTOS#show mac-address-table
VlanId     Mac Address           Type   Interface        State
 1000   00:01:e8:06:95:ac       Dynamic Tengig 1/21         Active
-----------------------------Query from Management Station-------------------------------
>snmpwalk -v 2c -c techpubs 10.11.131.162 .1.3.6.1.2.1.17.7.1.2.2.1
SNMPv2-SMI::mib-2.17.7.1.2.2.1.2.1000.0.1.232.6.149.172 = INTEGER: 118
SNMPv2-SMI::mib-2.17.7.1.2.2.1.3.1000.0.1.232.6.149.172 = INTEGER: 3
```

Use dot3aCurAggFdbTable to fetch the learned MAC address of a port-channel. The instance number is the decimal conversion of the MAC address concatenated with the port-channel number.

Figure 16-10. Fetching Dynamic MAC Addresses on the Default VLAN

```
----------------------------MAC Addresses on Dell Force10
System-------------------------------
FTOS(conf)#do show mac-address-table
VlanId     Mac Address           Type   Interface        State
 1000   00:01:e8:06:95:ac       Dynamic Po 1            Active
-----------------------------Query from Management Station-------------------------------
>snmpwalk -v 2c -c techpubs 10.11.131.162 .1.3.6.1.4.1.6027.3.2.1.1.5
SNMPv2-SMI::enterprises.6027.3.2.1.1.5.1.1.1000.0.1.232.6.149.172.1 = INTEGER: 1000
SNMPv2-SMI::enterprises.6027.3.2.1.1.5.1.2.1000.0.1.232.6.149.172.1 = Hex-STRING: 00 01 E8
06 95 AC
SNMPv2-SMI::enterprises.6027.3.2.1.1.5.1.3.1000.0.1.232.6.149.172.1 = INTEGER: 1
SNMPv2-SMI::enterprises.6027.3.2.1.1.5.1.4.1000.0.1.232.6.149.172.1 = INTEGER: 1
```

Deriving Interface Indices

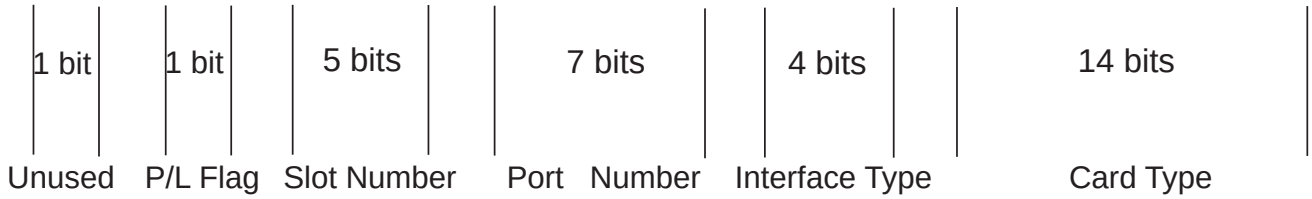
FTOS assigns an interface number to each (configured or unconfigured) physical and logical interface. Display the interface index number using the command **show interface** from EXEC Privilege mode, as shown in Figure 16-11.

Figure 16-11. Display the Interface Index Number

```
FTOS#show interface tengig 1/21
TenGigabitEthernet 1/21 is up, line protocol is up
Hardware is Dell Force10Eth, address is 00:01:e8:0d:b7:4e
    Current address is 00:01:e8:0d:b7:4e
Interface index is 72925242
[output omitted]
```

The interface index is a binary number with bits that indicate the slot number, port number, interface type, and card type of the interface. FTOS converts this binary index number to decimal, and displays it in the output of the **show interface** command.

Figure 16-12. Interface Index Binary Calculations

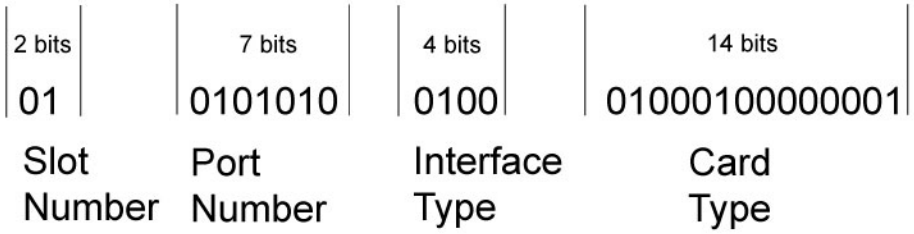


Starting from the least significant bit (LSB):

- the first 14 bits represent the card type
- the next 4 bits represent the interface type
- the next 7 bits represent the port number
- the next 5 bits represent the slot number
- the next 1 bit is 0 for a physical interface and 1 for a logical interface
- the next 1 bit is unused

For example, the index 44634369 is 10101010010001000100000001 in binary. The binary interface index for TenGigabitEthernet 0/41 of an Aggregator is shown in Figure 16-13. Notice that the physical/logical bit and the final, unused bit are not given. The interface is physical, so this must be represented by a 0 bit, and the unused bit is always 0. These two bits are not given because they are the most significant bits, and leading zeros are often omitted.

Figure 16-13. Binary Representation of Interface Index



For interface indexing, slot and port numbering begins with binary one. If the Dell Force10 system begins slot and port numbering from 0, then binary 1 represents slot and port 0. In S4810, the first interface is 0/0, but in the Aggregator the first interface is 0/1. Hence, in the Aggregator 0/0s Ifindex is unused and Ifindex creation logic is not changed. Since Zero is reserved for logical interfaces, it starts from 1. For the first interface, port number is set to 1. Adding it causes an increment by 1 for the next interfaces, so it only starts from 2.Therefore, the port number is set to 42 for 0/41.

Note that the interface index does not change if the interface reloads or fails over. If the unit is renumbered (for any reason) the interface index will change during a reload.

Monitor Port-channels

To check the status of a Layer 2 port-channel, use f10LinkAggMib (.1.3.6.1.4.1.6027.3.2). Below, Po 1 is a switchport and Po 2 is in Layer 3 mode.

```
[senthilnathan@lithium ~]$ snmpwalk -v 2c -c public 10.11.1.1 .1.3.6.1.4.1.6027.3.2.1.1
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.1.1 = INTEGER: 1
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.1.2 = INTEGER: 2
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.2.1 = Hex-STRING: 00 01 E8 13 A5 C7
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.2.2 = Hex-STRING: 00 01 E8 13 A5 C8
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.3.1 = INTEGER: 1107755009
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.3.2 = INTEGER: 1107755010
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.4.1 = INTEGER: 1
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.4.2 = INTEGER: 1
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.5.1 = Hex-STRING: 00 00
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.5.2 = Hex-STRING: 00 00
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.6.1 = STRING: "Tengig 5/84 " << Channel member for Po1
SNMPv2-SMI::enterprises.6027.3.2.1.1.1.6.2 = STRING: "Tengig 5/85 " << Channel member for Po2
dot3aCommonAggFdbIndex
SNMPv2-SMI::enterprises.6027.3.2.1.1.6.1.1.1107755009.1 = INTEGER: 1107755009
dot3aCommonAggFdbVlanId
SNMPv2-SMI::enterprises.6027.3.2.1.1.6.1.2.1107755009.1 = INTEGER: 1
dot3aCommonAggFdbTagConfig
SNMPv2-SMI::enterprises.6027.3.2.1.1.6.1.3.1107755009.1 = INTEGER: 2 (Tagged 1 or Untagged 2)
dot3aCommonAggFdbStatus
SNMPv2-SMI::enterprises.6027.3.2.1.1.6.1.4.1107755009.1 = INTEGER: 1 << Status active, 2 – status inactive
```

If we learn the MAC address for the LAG, the LAG status is also displayed.

```
dot3aCurAggVlanId
SNMPv2-SMI::enterprises.6027.3.2.1.1.4.1.1.1.0.0.0.0.0.1.1 = INTEGER: 1
dot3aCurAggMacAddr
SNMPv2-SMI::enterprises.6027.3.2.1.1.4.1.2.1.0.0.0.0.0.1.1 = Hex-STRING: 00 00 00 00 00 01
dot3aCurAggIndex
SNMPv2-SMI::enterprises.6027.3.2.1.1.4.1.3.1.0.0.0.0.0.1.1 = INTEGER: 1
dot3aCurAggStatus
SNMPv2-SMI::enterprises.6027.3.2.1.1.4.1.4.1.0.0.0.0.0.1.1 = INTEGER: 1 << Status active, 2 – status
inactive
```

For L3 LAG we do not have this support.

```
SNMPv2-MIB::sysUpTime.0 = Timeticks: (8500842) 23:36:48.42
SNMPv2-MIB::snmpTrapOID.0 = OID: IF-MIB::linkDown
IF-MIB::ifIndex.33865785 = INTEGER: 33865785
SNMPv2-SMI::enterprises.6027.3.1.1.4.1.2 = STRING: "OSTATE_DN: Changed interface state to down: Tengig 0/
0"
2010-02-10 14:22:39 10.16.130.4 [10.16.130.4]:
SNMPv2-MIB::sysUpTime.0 = Timeticks: (8500842) 23:36:48.42
SNMPv2-MIB::snmpTrapOID.0 = OID: IF-MIB::linkDown
IF-MIB::ifIndex.1107755009 = INTEGER: 1107755009
SNMPv2-SMI::enterprises.6027.3.1.1.4.1.2 = STRING: "OSTATE_DN: Changed interface state to down: Po 1"
2010-02-10 14:22:40 10.16.130.4 [10.16.130.4]:
SNMPv2-MIB::sysUpTime.0 = Timeticks: (8500932) 23:36:49.32      SNMPv2-MIB::snmpTrapOID.0 = OID:
IF-MIB::linkUp IF-MIB::ifIndex.33865785 = INTEGER: 33865785    SNMPv2-SMI::enterprises.6027.3.1.1.4.1.2 =
STRING: "OSTATE_UP: Changed interface state to up: Tengig 0/0"
2010-02-10 14:22:40 10.16.130.4 [10.16.130.4]:
SNMPv2-MIB::sysUpTime.0 = Timeticks: (8500934) 23:36:49.34      SNMPv2-MIB::snmpTrapOID.0 = OID:
IF-MIB::linkUp IF-MIB::ifIndex.1107755009 = INTEGER: 1107755009
SNMPv2-SMI::enterprises.6027.3.1.1.4.1.2 = STRING: "OSTATE_UP: Changed interface state to up: Po 1"
```

Entity MIBS

The Entity MIB provides a mechanism for presenting hierarchies of physical entities using SNMP tables. The Entity MIB contains the following groups, which describe the physical elements and logical elements of a managed system The following tables are implemented for the Aggregator.

- Physical Entity: A physical entity or physical component represents an identifiable physical resource within a managed system. Zero or more logical entities may utilize a physical resource at any given time. Determining which physical components are represented by an agent in the EntPhysicalTable is an implementation-specific matter. Typically, physical resources (e.g., communications ports, backplanes, sensors, daughter-cards, power supplies, the overall chassis), which can be managed via functions associated with one or more logical entities, are included in the MIB.
- Containment Tree: Each physical component may be modeled as contained within another physical component. A containment-tree is the conceptual sequence of *entPhysicalIndex* values that uniquely specifies the exact physical location of a physical component within the managed system. It is generated by following and recording each *entPhysicalContainedIn* instance up the tree towards the root, until a value of zero indicating no further containment is found.

Figure 16-14. Sample Entity MIBS outputs

```
FTOS#show inventory optional-module
Unit  Slot    Expected     Inserted    Next Boot    Status/Power(On/Off)
-------------------------------------------------------------------------
   1     0        SFP+        SFP+          AUTO     Good/On
   1     1       QSFP+       QSFP+          AUTO     Good/On

 * - Mismatch

FTOS#
```

The status of the MIBS is as follows:

```
$ snmpwalk -c public -v 2c 10.16.130.148 1.3.6.1.2.1.47.1.1.1.1.2
SNMPv2-SMI::mib-2.47.1.1.1.1.2.1 = ""
SNMPv2-SMI::mib-2.47.1.1.1.1.2.2 = STRING: "PowerConnect I/O-Aggregator"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.3 = STRING: "Module 0"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.4 = STRING: "Unit: 0 Port 1 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.5 = STRING: "Unit: 0 Port 2 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.6 = STRING: "Unit: 0 Port 3 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.7 = STRING: "Unit: 0 Port 4 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.8 = STRING: "Unit: 0 Port 5 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.9 = STRING: "Unit: 0 Port 6 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.10 = STRING: "Unit: 0 Port 7 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.11 = STRING: "Unit: 0 Port 8 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.12 = STRING: "Unit: 0 Port 9 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.13 = STRING: "Unit: 0 Port 10 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.14 = STRING: "Unit: 0 Port 11 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.15 = STRING: "Unit: 0 Port 12 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.16 = STRING: "Unit: 0 Port 13 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.17 = STRING: "Unit: 0 Port 14 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.18 = STRING: "Unit: 0 Port 15 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.19 = STRING: "Unit: 0 Port 16 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.20 = STRING: "Unit: 0 Port 17 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.21 = STRING: "Unit: 0 Port 18 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.22 = STRING: "Unit: 0 Port 19 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.23 = STRING: "Unit: 0 Port 20 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.24 = STRING: "Unit: 0 Port 21 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.25 = STRING: "Unit: 0 Port 22 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.26 = STRING: "Unit: 0 Port 23 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.27 = STRING: "Unit: 0 Port 24 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.28 = STRING: "Unit: 0 Port 25 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.29 = STRING: "Unit: 0 Port 26 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.30 = STRING: "Unit: 0 Port 27 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.31 = STRING: "Unit: 0 Port 28 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.32 = STRING: "Unit: 0 Port 29 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.33 = STRING: "Unit: 0 Port 30 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.34 = STRING: "Unit: 0 Port 31 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.35 = STRING: "Unit: 0 Port 32 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.36 = STRING: "40G QSFP+ port"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.37 = STRING: "Unit: 0 Port 33 40G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.41 = STRING: "40G QSFP+ port"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.42 = STRING: "Unit: 0 Port 37 40G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.46 = STRING: "Optional module 0"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.56 = STRING: "Optional module 1"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.57 = STRING: "4-port 10GE 10BASE-T (XL) "
SNMPv2-SMI::mib-2.47.1.1.1.1.2.58 = STRING: "Unit: 0 Port 49 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.59 = STRING: "Unit: 0 Port 50 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.60 = STRING: "Unit: 0 Port 51 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.61 = STRING: "Unit: 0 Port 52 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.66 = STRING: "PowerConnect I/O-Aggregator"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.67 = STRING: "Module 0"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.68 = STRING: "Unit: 1 Port 1 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.69 = STRING: "Unit: 1 Port 2 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.70 = STRING: "Unit: 1 Port 3 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.71 = STRING: "Unit: 1 Port 4 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.72 = STRING: "Unit: 1 Port 5 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.73 = STRING: "Unit: 1 Port 6 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.74 = STRING: "Unit: 1 Port 7 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.75 = STRING: "Unit: 1 Port 8 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.76 = STRING: "Unit: 1 Port 9 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.77 = STRING: "Unit: 1 Port 10 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.78 = STRING: "Unit: 1 Port 11 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.79 = STRING: "Unit: 1 Port 12 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.80 = STRING: "Unit: 1 Port 13 10G Level"
```

```
SNMPv2-SMI::mib-2.47.1.1.1.1.2.81 = STRING: "Unit: 1 Port 14 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.82 = STRING: "Unit: 1 Port 15 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.83 = STRING: "Unit: 1 Port 16 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.84 = STRING: "Unit: 1 Port 17 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.85 = STRING: "Unit: 1 Port 18 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.86 = STRING: "Unit: 1 Port 19 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.87 = STRING: "Unit: 1 Port 20 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.88 = STRING: "Unit: 1 Port 21 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.89 = STRING: "Unit: 1 Port 22 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.90 = STRING: "Unit: 1 Port 23 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.91 = STRING: "Unit: 1 Port 24 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.92 = STRING: "Unit: 1 Port 25 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.93 = STRING: "Unit: 1 Port 26 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.94 = STRING: "Unit: 1 Port 27 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.95 = STRING: "Unit: 1 Port 28 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.96 = STRING: "Unit: 1 Port 29 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.97 = STRING: "Unit: 1 Port 30 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.98 = STRING: "Unit: 1 Port 31 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.99 = STRING: "Unit: 1 Port 32 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.100 = STRING: "40G QSFP+ port"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.101 = STRING: "Unit: 1 Port 33 40G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.105 = STRING: "40G QSFP+ port"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.106 = STRING: "Unit: 1 Port 37 40G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.110 = STRING: "Optional module 0"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.111 = STRING: "4-port 10GE SFP+ (XL) "
SNMPv2-SMI::mib-2.47.1.1.1.1.2.112 = STRING: "Unit: 1 Port 41 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.113 = STRING: "Unit: 1 Port 42 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.114 = STRING: "Unit: 1 Port 43 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.115 = STRING: "Unit: 1 Port 44 10G Level"
SNMPv2-SMI::mib-2.47.1.1.1.1.2.120 = STRING: "Optional module 1"
```

17

Stacking

Overview

An Aggregator auto-configures to operate in standalone mode. To use an Aggregator in a stack, you must manually configure it using the CLI to operate in stacking mode.

Stacking is supported only on the 40GbE ports on the base module. Stacking is limited to two Aggregators in the same chassis in a single stack. Up to three stacks of Aggregators are supported in an M1000e chassis. To configure a stack, you must use the CLI.

Stacking provides a single point of management for high availability and higher throughput.

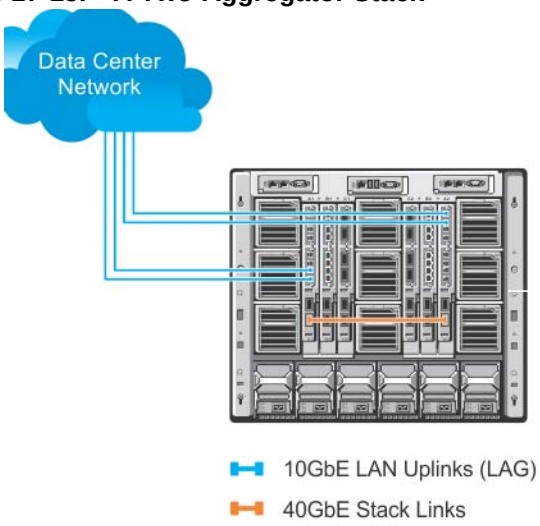
This chapter contains the following sections:

Stacking Aggregators

A stack of Aggregators operates as a virtual chassis with management units (primary and standby) and member units. The Dell Force10 operating software (FTOS) elects a primary (master) and secondary (standby) management unit. The forwarding database resides on the master switch; the standby unit maintains a synchronized local copy. Each unit in the stack makes forwarding decisions based on their local copy.

Figure 17-15 shows an example of how you can stack two Aggregators. The Aggregators are connected to operate as a single stack in a ring topology using only the 40GbE ports on the base modules.

Figure 17-15. A Two-Aggregator Stack



Stack Management Roles

The stack elects the management units for the stack management:

- Stack master: primary management unit
- Standby: secondary management unit

The master holds the control plane and the other units maintain a local copy of the forwarding databases. From Stack master you can configure:

- System-level features that apply to all stack members
- Interface-level features for each stack member

The master synchronizes the following information with the standby unit:

- Stack unit topology
- Stack running Configuration (which includes LACP, SNMP, etc.)
- Logs

The master switch maintains stack operation with minimal impact in the event of:

- Switch failure
- Inter-switch stacking link failure
- Switch insertion
- Switch removal

If the master switch goes off line, the standby replaces it as the new master.

Note: For the Aggregator, the entire stack has only one management IP address.

Stack Master Election

The stack elects a master and standby unit at bootup time based on MAC address. The unit with the higher MAC value becomes master.

To view which switch is the stack master, use the show system command. Figure 17-16 shows sample output from an established stack.

A change in the stack master occurs when:

- You power down the stack master or bring the master switch offline.
- A failover of the master switch occurs.
- You disconnect the master switch from the stack.

Note: When a stack reloads and all the units come up at the same time; for example, when all units boot up from flash, all units participate in the election and the master and standby are chosen based on the MAC address. When the units do not boot up at the same time; for example, some units are powered down just after reloading and powered up later to join the stack, they do not participate in the election process, even though the units that boot up late may have a higher priority configured. This happens because the master and standby have already been elected; therefore, the unit that boots up late joins only as a member. Also, when an up and running standalone unit or stack is merged with another stack, based on election, the losing stack reloads and the master unit of the winning stack becomes the master of the merged stack. To ensure a fully synchronised bootup, it is possible to reset individual units to force them to give up the management role; or reload the whole stack from the command line interface (CLI).

Figure 17-16. Displaying the Stack Master

```
FTOS# show system  brief

Stack MAC : 00:1e:c9:f1:00:9b

--  Stack Info  --
Unit  UnitType     Status         ReqTyp          CurTyp          Version     Ports
-------------------------------------------------------------------------------
  0   Management   online         I/O-Aggregator  I/O-Aggregator  8-3-17-46   56
  1   Standby      online         I/O-Aggregator  I/O-Aggregator  8-3-17-46   56
  2   Member       not present
  3   Member       not present
  4   Member       not present
  5   Member       not present

FTOS#
```

Failover Roles

If the stack master fails (for example, powered off), it is removed from the stack topology. The standby unit detects the loss of peering communication and takes ownership of the stack management, switching from standby to master. The lack of a standby unit triggers an election within the remaining units for a standby role.

After the former master switch recovers, despite having a higher priority or MAC address, it does not recover its master role but instead take the next available role.

MAC Addressing

All port interfaces in the stack use the MAC address of the management interface on the master switch. The MAC address of the chassis in which the master Aggregator is installed is used as the stack MAC address.

The stack continues to use the master's chassis MAC address even after a failover. The MAC address is not refreshed until the stack is reloaded and a different unit becomes the stack master.

Stacking LAG

When you use multiple links between stack units, FTOS automatically bundles them in a stacking link aggregation group (LAG) to provide aggregated throughput and redundancy. The stacking LAG is established automatically and transparently by FTOS (without user configuration) after peering is detected and behaves as follows:

- The stacking LAG dynamically aggregates; it can lose link members or gain new links.
- Shortest path selection inside the stack: if multiple paths exist between two units in the stack, the shortest path is used.

Stacking VLANs

When you configure an Aggregator to operate in stacking mode (Configuring and Bringing Up a Stack), VLANs are reconfigured as follows:

- If an Aggregator port belonged to all 4094 VLANs in standalone mode (default), all VLAN membership is removed and the port is assigned only to default VLAN 1. You must configure additional VLAN membership as necessary.
- If you had manually configured an Aggregator port to belong to one or more VLANs (non-default) in standalone mode, the VLAN configuration is retained in stacking mode only on the master switch.

When you reconfigure an Aggregator from stacking to standalone mode:

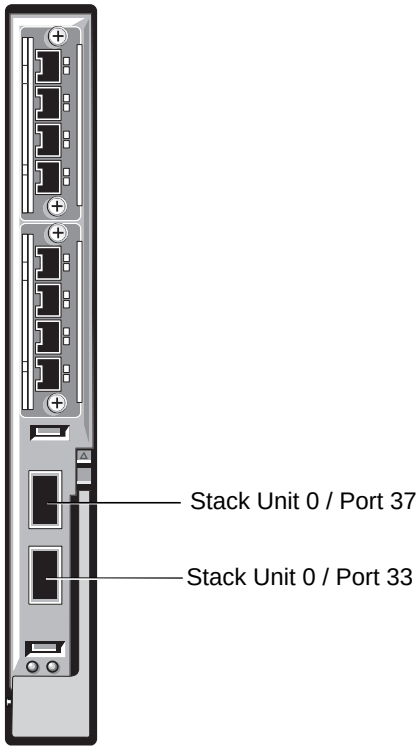
- Aggregator ports that you manually configured for VLAN membership in stacking mode retain their VLAN configuration in standalone mode.
- To restore the default auto-VLAN mode of operation (in which all ports are members of all 4094 VLANs) on a port, enter the auto vlan command; for example:

```
FTOS(conf)# interface tengigabitethernet 0/2
FTOS(conf-if-te-0/2)# auto vlan
```

Stacking Port Numbers

By default, each Aggregator in Standalone mode is numbered stack-unit 0. Stack-unit numbers are assigned to member switches when the stack comes up. Figure 17-17 shows the numbers of the 40GbE stacking ports on an Aggregator.

Figure 17-17. Stack Groups on an Aggregator



Configuring a Switch Stack

To configure and bring up a switch stack, follow these steps:

1. Connect the 40GbE ports on the base module of two Aggregators using 40G direct attach or QSFP fibre cables.
2. Configure each Aggregator to operate in stacking mode.
3. Reload each Aggregator, one after the other in quick succession.

Stacking Prerequisites

Before you cable and configure a stack of Aggregators, review the following prerequisites:

- All Aggregators in the stack must be powered up with the initial or startup configuration before you attach the cables.
- All stacked Aggregators must run the same FTOS version. The minimum FTOS version required is 8.3.17.0. To check the FTOS version that a switch is running, use the show version command. To download an FTOS version, go to http://support.dell.com.
- Stacking is supported only with other Aggregators. A maximum of two Aggregators is supported in a single stack. You cannot stack the Aggregator with MXL 10/40GbE Switches or another type of switch.
- A maximum of two stack groups (40GbE ports) is supported on a stacked Aggregator.
- Interconnect the stack units by following the instructions in Cabling Stacked Switches.

Cabling Stacked Switches

Before you configure Aggregators in a stack, connect the 40G direct attach or QSFP cables and transceivers to connect 40GbE ports on two Aggregators in the same chassis.

Cabling Restrictions

The following restrictions apply when setting up a stack of Aggregators:

- Only daisy-chain or ring topologies are supported; star and full mesh topologies are not supported.
- Stacking is supported only on 40GbE links by connecting 40GbE ports on the base module. Stacking is not supported on 10GbE ports or 4x10GbE ports.
- Use only QSFP transceivers and QSFP or direct attach cables (purchased separately) to connect stacking ports.

Cabling Redundancy

Connect the units in a stack with two or more stacking cables to avoid a stacking port or cable failure. Removing one of the stacked cables between two stacked units does not trigger a reset.

Cabling Procedure

The following cabling procedure uses the stacking topology in Figure 17-15. To connect the cabling:

1. Connect a 40GbE base port on the first Aggregator to a 40GbE base port on another Aggregator in the same chassis.
2. Connect a 40GbE base port on the second Aggregator to a 40GbE port on the first Aggregator.

The resulting ring topology allows the entire stack to function as a single switch with resilient fail-over capabilities. If you do not connect the last switch to the first switch (Step 4), the stack operates in a daisy chain topology with less resiliency. Any failure in a non-edge stack unit causes a split stack.

Accessing the CLI

To configure a stack, you must access the stack master in one of the following ways:

- For remote out-of-band management (OOB), enter the OOB management interface IP address into a Telnet or secure shell (SSH) client and log in to the switch using the user ID and password to access the CLI.
- For local management, use the attached console connection to the master switch to log in to the CLI. Console access to the stack CLI is available on the master only.
- For remote in-band management from a network management station, enter the virtual local area network (VLAN) IP address of the management port and log in to the switch to access the CLI.

Configuring and Bringing Up a Stack

After you attach the 40G QSFP or direct attach cables in a stack of Aggregators, to bring up the stack, follow these steps.

Note: The procedure uses command examples for the stacking topology in Figure 17-15.

Step	Task	Command Syntax	Command Mode
1	Set up a connection to the CLI on an Aggregator as described in Accessing the CLI.		
2	Log on to the CLI and enter Global Configuration mode.	Login: username Password: ***** FTOS> enable FTOS# configure	---
3	Configure the Aggregator to operate in stacking mode.	stack-unit 0 iom-mode stack	CONFIGURATION
4	Repeat Steps 1 to 3 on the second Aggregator in the stack.		
5	Log on to the CLI and reboot each switch, one after another, in as short a time as possible.	reload	EXEC PRIVILEGE

Note: If the stacked switches all reboot at approximately the same time, the switch with the highest MAC address is automatically elected as the master switch. The switch with the next highest MAC address is elected as standby. As each switch joins the stack, it is assigned the lowest available stack-unit number from 0 to 5. The default configuration of each stacked switch is stored in the running configuration of the stack. The stack-unit ID numbers are retained after future stack reloads.
To verify the stack-unit number assigned to each switch in the stack, use the show system brief command (Figure 17-18).

Adding a Stack Unit

You can add a new unit to an existing stack both when the unit has no stacking ports (stack groups) configured and when the unit already has stacking ports configured. If the units to be added to the stack have been previously used, they are assigned the smallest available unit ID in the stack.

To add a standalone Aggregator to a stack, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Power on the switch.		
2	Attach QSFP or direct attach cables to connect 40GbE ports on the switch to one or more switches in the stack.		
3	Log on to the CLI and enter global configuration mode.	Login: username Password: ***** FTOS> enable FTOS# configure	---
4	Configure the Aggregator to operate in stacking mode.	stack-unit 0 iom-mode stack	CONFIGURATION
5	Reload the switch. FTOS automatically assigns a number to the new unit and adds it as member switch in the stack. The new unit synchronizes its running and startup configurations with the stack.	reload	EXEC Privilege

If an Aggregator is already configured to operate in stacking mode, simply attach QSFP or direct attach cables to connect 40GbE ports on the base module of each stacked Aggregator. The new unit synchronizes its running and startup configurations with the stack.

FTOS Behavior: When you add a new Aggregator to a stack:

- If the new unit has been configured with a stack number that is already assigned to a stack member, the stack avoids a numbering conflict by assigning the new switch the first available stack number.
- If the stack has been provisioned for the stack number that is assigned to the new unit, the pre-configured provisioning must match the switch type. If there is a conflict between the provisioned switch type and the new unit, a mismatch error message is displayed.

Resetting a Unit on a Stack

Use the following **reset** commands to reload any of the member units or the standby in a stack. If you try to reset the stack master, an error message is displayed: `Reset of master unit is not allowed.`

Task	Command Syntax	Command Mode
Reload a stack unit from the master switch	reset stack-unit *unit-number*	EXEC Privilege
Reset a stack-unit when the unit is in a problem state.	reset stack-unit *unit-number* hard	EXEC Privilege

Removing an Aggregator from a Stack and Restoring Quad Mode

To remove an Aggregator from a stack and return the 40GbE stacking ports to 4x10GbE quad mode:

Step	Task	Command Syntax	Command Mode
1	Disconnect the stacking cables from the unit. The unit can be powered on or off and can be online or offline..		
2	Log on to the CLI and enter Global Configuration mode.	Login: username Password: ***** FTOS> enable FTOS# configure	---
3	Configure the Aggregator to operate in standalone mode.	stack-unit 0 iom-mode standalone	CONFIGURATION
4	Log on to the CLI and reboot each switch, one after another, in as short a time as possible.	reload	EXEC PRIVILEGE

When the reload completes, the base-module ports comes up in 4x10GbE (quad) mode. The switch functions in standalone mode but retains the running and startup configuration that was last synchronized by the master switch while it operated as a stack unit.

Verifying a Stack Configuration

Using LEDs

Table 17-2 lists the status of a stacked switch according to the color of the System Status light emitting diodes (LEDs) on its front panel.

Table 17-2. System Status LED on a Stacked Switch

Color	Meaning
Blue	The switch is operating as the stack master or as a standalone unit.
Off	The switch is a member or standby unit.
Amber	The switch is booting or a failure condition has occurred.

Using Show Commands

To display information on the stack configuration, use the show commands in Table 17-3 on the master switch.

Table 17-3. Displaying Stack Configurations

Command	Output
show system [brief] (Figure 17-18 and Figure 17-19)	Displays stacking roles (master, standby, and member units) and the stack MAC address.
show inventory optional-module (Figure 17-20)	Displays the FlexIO modules currently installed in expansion slots 0 and 1 on a switch and the expected module logically provisioned for the slot.
show system stack-unit *unit-number* stack-group configured (Figure 17-21)	Displays the stack groups allocated on a stacked switch. Valid stack-unit numbers: 0 or 1.
show system stack-unit *unit-number* stack-group (Figure 17-22)	Displays the port numbers that correspond to the stack groups on a switch. Valid stack-unit numbers: 0 or 1.
show system stack-ports [status | topology] (Figure 17-23)	Displays the type of stack topology (ring or daisy chain) with a list of all stacked ports, port status, link speed, and peer stack-unit connection.

Figure 17-18. show system brief Command Example

```
FTOS# show system  brief

StStack MAC : 00:1e:c9:f1:00:9b

--  Stack Info  --
Unit  UnitType     Status         ReqTyp          CurTyp          Version     Ports
-------------------------------------------------------------------------------
  0   Management   online         I/O-Aggregator  I/O-Aggregator  8-3-17-46   56
  1   Standby      online         I/O-Aggregator  I/O-Aggregator  8-3-17-46   56
  2   Member       not present
  3   Member       not present
  4   Member       not present
  5   Member       not present
```

Figure 17-19. show system Command Example

```
FTOS# show system

Stack MAC : 00:1e:c9:f1:00:9b

Reload Type : normal-reload [Next boot : normal-reload]

--  Unit 0 --
Unit Type       : Management Unit
Status          : online
Next Boot       : online
Required Type   : I/O-Aggregator - 34-port GE/TE (XL)
Current Type    : I/O-Aggregator - 34-port GE/TE (XL)
Master priority : 0
Hardware Rev    :
Num Ports       : 56
Up Time         : 2 hr, 41 min
FTOS Version    : 8-3-17-46
Jumbo Capable   : yes
POE Capable     : no
Burned In MAC   : 00:1e:c9:f1:00:9b
No Of MACs      : 3

--  Unit 1 --
Unit Type       : Standby Unit
Status          : online
Next Boot       : online
Required Type   : I/O-Aggregator - 34-port GE/TE (XL)
Current Type    : I/O-Aggregator - 34-port GE/TE (XL)
Master priority : 0
Hardware Rev    :
Num Ports       : 56
Up Time         : 2 hr, 27 min
FTOS Version    : 8-3-17-46
Jumbo Capable   : yes
POE Capable     : no
Burned In MAC   : 00:1e:c9:f1:04:82
No Of MACs      : 3

--  Unit 2 --
Unit Type       : Member Unit
Status          : not present
Required Type   :
```

Figure 17-20. show inventory optional-module Command Example

```
FTOS# show inventory optional-module

Unit  Slot    Expected     Inserted    Next Boot    Power
-------------------------------------------------------------
   0     0    SFP+         SFP+        AUTO         Good
   0     1    QSFP+        QSFP+       AUTO         Good

 * - Mismatch
```

Figure 17-21. show system stack-unit stack-group configured Command Example

```
FTOS# show system stack-unit 1 stack-group configured
Configured stack groups in stack-unit 1
----------------------------------------
0
1
```

Figure 17-22. show system stack-unit stack-group Command Example

```
FTOS# show system stack-unit 1 stack-group
Stack group             Ports
-----------------------------------
          0              1/33
          1              1/37
          4              1/49
          5              1/53
```

Figure 17-23. show system stack-ports (ring) Command Example

```
FTOS# show system stack-ports
Topology: Ring
Interface  Connection    Link Speed      Admin     Link     Trunk
                           (Gb/s)        Status    Status   Group
-----------------------------------------------------------------
  0/33        1/33          40             up        up
  0/37        1/37          40             up        up
  1/33        0/33          40             up        up
  1/37        0/37          40             up        up
```

Figure 17-24. show system stack-ports (daisy chain) Command Example

```
FTOS# show system stack-ports
Topology: Daisy chain
Interface  Connection    Link Speed      Admin     Link     Trunk
                           (Gb/s)        Status    Status   Group
-----------------------------------------------------------------
  0/33                      40             up        down
  0/37        1/37          40             up        up
  1/33                      40             up        down
  1/37        0/37          40             up        up
```

Troubleshooting a Switch Stack

Troubleshooting Commands

To perform troubleshooting operations on a switch stack, use the commands in Table 17-4 on the master switch.

Table 17-4. Troubleshooting Stack Commands

Command	Output
show system stack-ports (Figure 17-25)	Displays the status of stacked ports on stack units.
show redundancy (Figure 17-26)	Displays the master standby unit status, failover configuration, and result of the last master-standby synchronization; allows you to verify the readiness for a stack failover.
show hardware stack-unit *unit-number* stack-port *port-number* (Figure 17-25)	Displays input and output flow statistics on a stacked port.
clear hardware stack-unit *unit-number* counters	Clears statistics on the specified stack unit. Valid stack-unit numbers: 0 to 5.
show system stack-unit *unit-number* iom-mode	Displays the current operational mode of the Aggregator (standalone or stacking) and the mode in which the Aggregator will operate at the next reload.

Figure 17-25. show system stack-ports Command Example

```
FTOS# show system stack-ports
Topology: Ring
Interface  Connection    Link Speed      Admin     Link     Trunk
                           (Gb/s)        Status    Status   Group
-----------------------------------------------------------------
  0/33        1/33          40            up        up
  0/37        1/37          40            up        up
  1/33        0/33          40            up        up
  1/37        0/37          40            up        up
```

Figure 17-26. show redundancy Command Example

```
FTOS#show redundancy

--  Stack-unit Status  --
-----------------------------------------------
 Mgmt ID:                          0
 Stack-unit ID:                    0
 Stack-unit Redundancy Role:       Primary
 Stack-unit State:                 Active      <-- Indicates master unit
 Stack-unit SW Version:            E8-3-17-46
 Link to Peer:                     Up

--  PEER Stack-unit Status  --
-----------------------------------------------
 Stack-unit State:                 Standby     <-- Indicates standby unit
 Peer stack-unit ID:               1
 Stack-unit SW Version:            E8-3-17-46

--  Stack-unit Redundancy Configuration  --
-----------------------------------------------
 Primary Stack-unit:               mgmt-id    0
 Auto Data Sync:                   Full
 Failover Type:                    Hot Failover   <-- Failover type with redundancy
 Auto reboot Stack-unit:           Enabled
 Auto failover limit:              3 times in 60 minutes

--  Stack-unit Failover Record  --
-----------------------------------------------
 Failover Count:                   0
 Last failover timestamp:          None
 Last failover Reason:             None
 Last failover type:               None

--  Last Data Block Sync Record:  --
-----------------------------------------------
 Stack Unit Config:         succeeded  Sep 03 1993 09:36:52
   Start-up Config:         succeeded  Sep 03 1993 09:36:52   <-- Last synch of startup configuration
 Runtime Event Log:         succeeded  Sep 03 1993 09:36:52
    Running Config:         succeeded  Sep 03 1993 09:36:52
           ACL Mgr:         succeeded  Sep 03 1993 09:36:52
              LACP:         no block sync done
               STP:         no block sync done
              SPAN:         no block sync done
```

Figure 17-27. show hardware stack-unit stack-port Command Example

```
FTOS# show  hardware stack-unit 1 stack-port 33

Input Statistics:
       7934 packets, 1049269 bytes
       0 64-byte pkts, 7793 over 64-byte pkts, 100 over 127-byte pkts
       0 over 255-byte pkts, 7 over 511-byte pkts, 34 over 1023-byte pkts
       70 Multicasts, 0 Broadcasts
       0 runts, 0 giants, 0 throttles
       0 CRC, 0 overrun, 0 discarded
Output Statistics:
       438 packets, 270449 bytes, 0 underruns
        0 64-byte pkts, 57 over 64-byte pkts, 181 over 127-byte pkts
        54 over 255-byte pkts, 0 over 511-byte pkts, 146 over 1023-byte pkts
        72 Multicasts, 0 Broadcasts, 221 Unicasts
        0 throttles, 0 discarded, 0 collisions, 0 wredDrops
Rate info (interval 45 seconds):
        Input 00.00 Mbits/sec,         0 packets/sec, 0.00% of line-rate
        Output 00.00 Mbits/sec,        0 packets/sec, 0.00% of line-rate
```

Failure Scenarios

The following sections describe some of the common fault conditions that can happen in a switch stack and how they are resolved.

Stack Member Fails

Problem: A unit that is not the stack master fails in an operational stack.

Resolution: If a stack member fails in a daisy chain topology, a split stack occurs. If a member unit fails in a ring topology, traffic is re-routed over existing stack links.

The following syslog messages are generated when a member unit fails:

```
FTOS#May 31 01:46:17: %STKUNIT3-M:CP %IPC-2-STATUS: target stack unit 4 not responding

May 31 01:46:17: %STKUNIT3-M:CP %CHMGR-2-STACKUNIT_DOWN: Major alarm: Stack unit 4 down - IPC
timeout

FTOS#May 31 01:46:17: %STKUNIT3-M:CP %IFMGR-1-DEL_PORT: Removed port: Te 4/1-32,41-48, Fo 4/
49,53

FTOS#May 31 01:46:18: %STKUNIT5-S:CP %IFMGR-1-DEL_PORT: Removed port: Te 4/1-32,41-48, Fo 4/
49,53
```

Unplugged Stacking Cable

Problem: A stacking cable is unplugged from a member switch. The stack loses half of its bandwidth from the disconnected switch.

Resolution: Intra-stack traffic is re-routed on a another link using the redundant stacking port on the switch. A recalculation of control plane and data plane connections is performed.

Master Switch Fails

Problem: The master switch fails due to a hardware fault, software crash, or power loss.

Resolution: A failover procedure begins:

1. Keep-alive messages from the Aggregator master switch time out after 60 seconds and the switch is removed from the stack.
2. The standby switch takes the master role. Data traffic on the new master switch is uninterrupted. Protocol traffic is managed by the control plane.
3. A member switch is elected as the new standby. Data traffic on the new standby is uninterrupted. The control plane prepares for operation in Warm Standby mode.

Stack-Link Flapping Error

Problem/Resolution: Stacked Aggregators monitor their own stack ports and disable any stack port that flaps five times within 10 seconds. If the stacking ports that flap are on the master or standby, KERN-2-INT error messages note the units (Figure 17-28).

To re-enable a downed stacking port, power cycle the stacked switch on which the port is installed.

Figure 17-28. Recovering from a Stack-Link Flapping Error

```
--------------------------------------MANAGMENT UNIT-----------------------------------------
Error: Stack Port 49 has flapped 5 times within 10 seconds.Shutting down this stack port now.
Error: Please check the stack cable/module and power-cycle the stack.
10:55:20: %STKUNIT1-M:CP %KERN-2-INT: Error: Stack Port 50 has flapped 5 times within 10
seconds.Shutting down this stack port now.
10:55:20: %STKUNIT1-M:CP %KERN-2-INT: Error: Please check the stack cable/module and
power-cycle the stack.
--------------------------------------STANDBY UNIT-------------------------------------------
10:55:18: %STKUNIT1-M:CP %KERN-2-INT: Error: Stack Port 50 has flapped 5 times within 10
seonds.Shutting down this stack port now.
10:55:18: %STKUNIT1-M:CP %KERN-2-INT: Error: Please check the stack cable/module
 and power-cycle the stack.
```

Master Switch Recovers from Failure

Problem: The master switch recovers from a failure after a reboot and rejoins the stack as the standby unit. Protocol and control plane recovery requires time before the switch is fully online.

Resolution: When the entire stack is reloaded, the recovered master switch becomes the master unit of the stack.

Stack Unit in Card-Problem State Due to Incorrect FTOS Version

Problem: A stack unit enters a Card-Problem state because the switch has a different FTOS version than the master unit (Figure 17-29). The switch does not come online as a stack unit.

Resolution: To restore a stack unit with an incorrect FTOS version as a member unit, disconnect the stacking cables on the switch and install the correct FTOS version. Then add the switch to the stack as described in Adding a Stack Unit. To verify that the problem has been resolved and the stacked switch is back online, use the show system brief command (Figure 17-30).

Figure 17-29. Card Problem Error - Different FTOS Versions

```
FTOS#show system brief

Stack MAC : 00:1e:c9:f1:00:9b

--  Stack Info  --
Unit  UnitType     Status         ReqTyp          CurTyp          Version     Ports
-------------------------------------------------------------------------------
  0   Management   online         I/O-Aggregator  I/O-Aggregator  8-3-17-46   56
  1   Standby      card problem   I/O-Aggregator  unknown                     56
  2   Member       not present
  3   Member       not present
  4   Member       not present
  5   Member       not present
```

Figure 17-30. Card Problem Error - Different FTOS Versions: Resolved

```
FTOS#show system brief

Stack MAC : 00:1e:c9:f1:04:82

--  Stack Info  --
Unit  UnitType     Status         ReqTyp          CurTyp          Version     Ports
-------------------------------------------------------------------------------
  0   Management   online         I/O-Aggregator  I/O-Aggregator  8-3-17-52   56
  1   Standby      online         I/O-Aggregator  I/O-Aggregator  8-3-17-52   56
  2   Member       not present
  3   Member       not present
  4   Member       not present
  5   Member       not present
```

Stack Unit in Card-Problem State Due to Configuration Mismatch

Problem: A stack unit enters a card-problem state because there is a configuration mismatch between the logical provisioning stored for the stack-unit number on the master switch and the newly added unit with the same number.

Resolution: From the master switch, reload the stack by entering the **reload** command in EXEC Privilege mode. When the stack comes up, the card problem will be resolved

Upgrading a Switch Stack

To upgrade all switches in a stack with the same FTOS version, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Copy the new FTOS image to a network server.		
2	Download the FTOS image by accessing an interactive CLI that requests the server IP address and image filename, and prompts you to upgrade all member stack units. Specify the system partition on the master switch into which you want to copy the FTOS image. Valid partition values are **a:** and **b:**. As shown in Figure 17-31, the system then prompts you to upgrade all member units with the new FTOS version.	upgrade system { flash: | ftp: | scp: | tftp: | usbflash: } *partition*	EXEC Privilege
3	Reboot all stack units to load the FTOS image from the same partition on all switches in the stack.	boot system stack-unit all primary system *partition*	CONFIGURATION
4	Save the configuration.	write memory	EXEC Privilege
5	Reload the stack unit to activate the new FTOS version.	reload	CONFIGURATION

Figure 17-31 shows an example of how to upgrade all switches in a stack, including the master switch.

Figure 17-31. Upgrading all Stacked Switches Example

```
FTOS# upgrade system ftp: A:
Address or name of remote host []: 10.11.200.241
Source file name []: //FTOS-XL-8.3.17.0.bin
User name to login remote host: ftp
Password to login remote host:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
Erasing IOM Primary Image, please wait
.!...................................................................................
...................................Writing........................................
.................................................................................
.................................................................................
31972272 bytes successfully copied
System image upgrade completed successfully.
Upgrade system image for all stack-units [yes/no]: yes
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
Image upgraded to all
FTOS# configure
FTOS(conf)# boot system stack-unit all primary system: A:
FTOS(conf)# end
FTOS# write memory
Jan 3 14:01:48: %STKUNIT0-M:CP %FILEMGR-5-FILESAVED: Copied running-config to startup-config
in flash by default
Synchronizing data to peer Stack-unit
!!!!
FTOS# reload
Proceed with reload [confirm yes/no]: yes
```

Upgrading a Single Stack Unit

Upgrading a single stacked switch is necessary when the unit was disabled due to an incorrect FTOS version. This procedure upgrades the image in the boot partition of the member unit from the corresponding partition in the master unit.

To upgrade an individual stack unit with a new FTOS version, follow these steps:

Step	Task	Command Syntax	Command Mode
1	Download the FTOS image from the master's boot partition to the member unit, and upgrade the relevant boot partition in the single stack-member unit.	upgrade system stack-unit *unit-number partition*	EXEC Privilege
2	Reboot the stack unit from the master switch to load the FTOS image from the same partition.	boot system stack-unit *unit-number* primary system *partition*	CONFIGURATION
3	Save the configuration.	write memory	EXEC Privilege
4	Reset the stack unit to activate the new FTOS version.	power-cycle stack-unit *unit-number*	EXEC Privilege

Figure 17-32 shows an example of how to upgrade an individual stack unit.

Figure 17-32. Upgrading a Single Stack Unit Example

```
FTOS# upgrade system stack-unit 1 A:
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!!!!!!!!!!!!!!!!!!!!!!
Image upgraded to Stack unit 1

FTOS# configure
FTOS(conf)# boot system stack-unit 1 primary system: A:
FTOS(conf)# end
FTOS#Jan 3 14:27:00: %STKUNIT0-M:CP %SYS-5-CONFIG_I: Configured from  console
FTOS# write memory
Jan 3 14:27:10: %STKUNIT0-M:CP %FILEMGR-5-FILESAVED: Copied running-config to startup-config in flash
by default
Synchronizing data to peer Stack-unit
!!!!

....
FTOS# power-cycle stack-unit 1
Proceed with power-cycle? Confirm [yes/no]:yes
```

18

Broadcast Storm Control

On the Aggregator, the broadcast storm control feature is enabled by default on all ports, and disabled on a port when an iSCSI storage device is detected. Broadcast storm control is re-enabled as soon as the connection with an iSCSI device ends.

Broadcast traffic on Layer 2 and Layer 3 interfaces is limited or suppressed during a broadcast storm. You can view the status of a broadcast-storm control operation by using the **show io-aggregator broadcast storm-control status** command. You can disable broadcast storm control by using the **no io-aggregator broadcast storm-control** command.

FTOS Behavior: If broadcast traffic exceeds 1000 Mbps, the Aggregator limits it to 1000 Mbps per port-pipe.

Displaying Broadcast-Storm Control Status

To display the status of a current storm control operation, enter the following command:

Task	Command	Command Mode
Display status (enabled/disabled) of broadcast storm control and the traffic limit applied.	show io-aggregator broadcast storm-control status	EXEC Privilege

Disabling Broadcast Storm Control

To disable broadcast storm control on an Aggregator, enter the following command:

Task	Command	Command Mode
Disable broadcast storm control.	no io-aggregator broadcast storm-control	CONFIGURATION

To re-enable broadcast storm control, enter the **io-aggregator broadcast storm-control** command.

19

System Time and Date

The Aggregator auto-configures the hardware and software clocks with the current time and date. If necessary, you can manually set and maintain the system time and date using the CLI commands described in this chapter.

Setting the Time for the Hardware Clock

To set the time and date for the hardware clock, use the following command:

Command Syntax	Command Mode	Purpose
calendar set *time month day year*	EXEC Privilege	Set the hardware clock to the current time and date. • *time:* Enter the time in hours:minutes:seconds. For the hour variable, use the 24-hour format, for example, 17:15:00 is 5:15 pm. • *month:* Enter the name of one of the 12 months in English.You can enter the name of a day to change the order of the display to *time day month year*. • *day:* Enter the number of the day. Range: 1 to 31. You can enter the name of a month to change the order of the display to *time day month year* • *year:* Enter a four-digit number as the year. Range: 1993 to 2035.
		`FTOS#calendar set 12:11:00 21 may 2012` `FTOS#`

Setting the Time for the Software Clock

You can change the order of the *month* and *day* parameters to enter the time and date as *time day month year*. You cannot delete the software clock.

The software clock runs only when the software is up. The clock restarts, based on the hardware clock, when the switch reboots. To set the time and date for the software clock, use the following command:

Command Syntax	Command Mode	Purpose
clock set *time month day year*	EXEC Privilege	Set the system software clock to the current time and date. • *time:* Enter the time in hours:minutes:seconds. For the hour variable, use the 24-hour format, for example, 17:15:00 is 5:15 pm. • *month:* Enter the name of one of the 12 months in English. You can enter the name of a day to change the order of the display to *time day month year*. • *day:* Enter the number of the day. Range: 1 to 31. You can enter the name of a month to change the order of the display to *time day month year* • *year:* Enter a four-digit number as the year. Range: 1993 to 2035.

```
FTOS#clock set 12:11:00 21 may 2012
FTOS#
```

Synchronizing the Hardware Clock Using the Software Clock

The Aggregator allows you to synchronize the hardware clock with the time setting on the software clock. Perform this operation only if you are sure that the hardware clock is inaccurate and the software clock is correct.

Note: You cannot undo the result of this operation by entering the **no** form of the command.

To set the hardware clock according to the time on the software clock, enter the **clock update-calendar** command.

Command Syntax	Command Mode	Purpose
clock update-calendar	EXEC Privilege	Reset the hardware clock to the current time and date on the software clock.

Setting the Time Zone

Universal time coordinated (UTC) is the time standard based on the International Atomic Time standard, commonly known as Greenwich Mean time. When determining system time, you must include the differentiator between the UTC and your local timezone. For example, San Jose, CA is the Pacific Timezone with a UTC offset of -8.

To set the timezone, use the following command:

Command Syntax	Command Mode	Purpose
clock timezone *timezone-name offset*	CONFIGURATION	Set the clock to the appropriate timezone. *timezone-name:* Enter the name of the timezone. Do not use spaces. offset: Enter one of the following: • a number from 1 to 23 as the number of hours in addition to UTC for the timezone. • a minus sign (-) followed by a number from 1 to 23 as the number of hours.

```
FTOS#conf
FTOS(conf)#clock timezone Pacific -8
FTOS#
```

Setting Daylight Savings Time

FTOS supports setting the system to daylight savings time once or on a recurring basis every year.

Setting Daylight Saving Time Once

Set a date (and time zone) on which to convert the switch to daylight savings time on a one-time basis.

To set daylight saving time once, use the following command:

Command Syntax	Command Mode	Purpose
clock summer-time *time-zone date start-month start-day start-year start-time end-month end-day end-year end-time [offset]*	CONFIGURATION	Set the clock to the appropriate timezone and daylight savings time. • *time-zone:* Enter the three-letter name for the time zone. This name is displayed in the show clock output. • *start-month:* Enter the name of one of the 12 months in English. You can enter the name of a day to change the order of the display to *time day month year* • *start-day:* Enter the number of the day. Range: 1 to 31. You can enter the name of a month to change the order of the display to *time day month year*. • *start-year:* Enter a four-digit number as the year. Range: 1993 to 2035 • *start-time:* Enter the time in hours:minutes. For the hour variable, use the 24-hour format, example, 17:15 is 5:15 pm. • *end-month:* Enter the name of one of the 12 months in English. You can enter the name of a day to change the order of the display to *time day month year*. • *end-day:* Enter the number of the day. Range: 1 to 31. You can enter the name of a month to change the order of the display to *time day month year*. • *end-year:* Enter a four-digit number as the year. Range: 1993 to 2035. • *end-time:* Enter the time in hours:minutes. For the hour variable, use the 24-hour format, example, 17:15 is 5:15 pm. • *offset:* (OPTIONAL) Enter the number of minutes to add during the summer-time period. Range: 1 to1440. Default: 60 minutes

```
FTOS(conf)#clock summer-time pacific date Mar 14 2012 00:00 Nov 7 2012 00:00

FTOS(conf)#
```

Setting Recurring Daylight Saving Time

Set a date (and time zone) on which to convert the switch to daylight savings time on a specific day every year.

If you have already set daylight savings for a one-time setting, you can set that date and time as the recurring setting using the clock summer-time time-zone recurring command.

To set a recurring daylight saving time, use the following command:

Command Syntax	Command Mode	Purpose
clock summer-time *time-zone* recurring *start-week start-day start-month start-time end-week end-day end-month end-time [offset]*	CONFIGURATION	Set the clock to the appropriate timezone and adjust to daylight savings time every year. • time-zone: Enter the three-letter name for the time zone. This name is displayed in the show clock output. • *start-week:* (OPTIONAL) Enter one of the following as the week that daylight savings begins and then enter values for *start-day* through *end-time:* • week-number: Enter a number from 1-4 as the number of the week in the month to start daylight savings time. • *first:* Enter this keyword to start daylight savings time in the first week of the month. • *last:* Enter this keyword to start daylight savings time in the last week of the month. • *start-month:* Enter the name of one of the 12 months in English. You can enter the name of a day to change the order of the display to *time day month year.* • *start-day:* Enter the number of the day. Range: 1 to 31. You can enter the name of the month to change the order of the display to *time day month year.* • *start-year:* Enter a four-digit number as the year. Range: 1993 to 2035 • *start-time:* Enter the time in hours:minutes. For the hour variable, use the 24-hour format, example, 17:15 is 5:15 pm.

Command Syntax	Command Mode	Purpose
		• *end-week:* If you entered a start-week, enter one of the following as the week that daylight savings ends: • *week-number:* enter a number from 1 to 4 as the number of the week to end daylight savings time. • *first:* enter the keyword first to end daylight savings time in the first week of the month. • *last:* enter the keyword last to end daylight savings time in the last week of the month. • *end-month:* Enter the name of one of the 12 months in English. You can enter the name of a day to change the order of the display to *time day month year.* • *end-day:* Enter the number of the day. Range: 1 to 31. You can enter the name of a day to change the order of the display to *time day month year.* • *end-year:* Enter a four-digit number as the year. Range: 1993 to 2035. • *end-time:* Enter the time in hours:minutes. For the hour variable, use the 24-hour format, example, 17:15 is 5:15 pm. • *offset:* (OPTIONAL) Enter the number of minutes to add during the summer-time period. Range: 1 to1440. Default: 60 minutes

```
FTOS(conf)#clock summer-time pacific recurring Mar 14 2012 00:00 Nov 7 2012 00:00

FTOS(conf)#
```

Note: If you enter <CR> after entering the recurring command parameter, and you have already set a one-time daylight saving time/date, the system uses that time and date as the recurring setting.

```
FTOS(conf)#clock summer-time pacific recurring ?
<1-4>                   Week number to start
first                   Week number to start
last                    Week number to start
<cr>
FTOS(conf)#clock summer-time pacific recurring

FTOS(conf)#
```

20

Uplink Failure Detection (UFD)

Uplink failure detection (UFD) is enabled by default on the Aggregator.

Note: Uplink failure detection is also referred to as *link tracking*.

UFD provides detection of the loss of upstream connectivity and, if used with NIC teaming, automatic recovery from a failed link.

An Aggregator auto-configures with UFD enabled. You can use CLI commands to display the status and configuration of uplink-state groups, and enable UFD debugging.

Feature Description

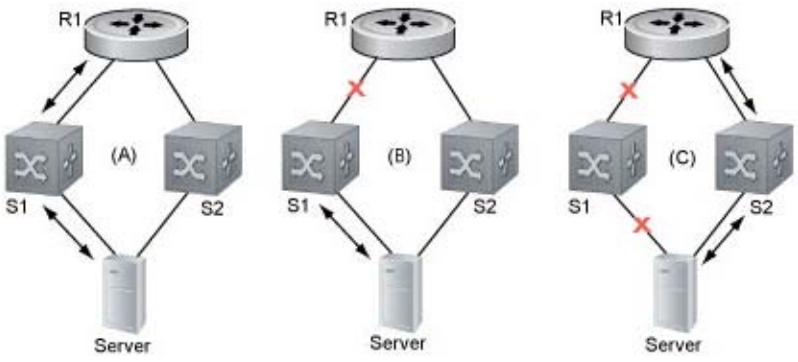
A switch provides upstream connectivity for devices, such as servers. If a switch loses its upstream connectivity, downstream devices also lose their connectivity. However, the devices do not receive a direct indication that upstream connectivity is lost since connectivity to the switch is still operational.

UFD allows a switch to associate downstream interfaces with upstream interfaces. When upstream connectivity fails, the switch disables the downstream links. Failures on the downstream links allow downstream devices to recognize the loss of upstream connectivity.

For example, in Figure 20-1 Switches S1 and S2 both have upstream connectivity to Router R1 and downstream connectivity to the server. UFD operation is shown in Steps A through C:

- In Step A, the server configuration uses the connection to S1 as the primary path. Network traffic flows from the server to S1 and then upstream to R1.
- In Step B, the upstream link between S1 and R1 fails. The server continues to use the link to S1 for its network traffic, but the traffic is not successfully switched through S1 because the upstream link is down.
- In Step C, UFD on S1 disables the link to the server. The server then stops using the link to S1 and switches to using its link to S2 to send traffic upstream to R1.

Figure 20-1. Uplink Failure Detection



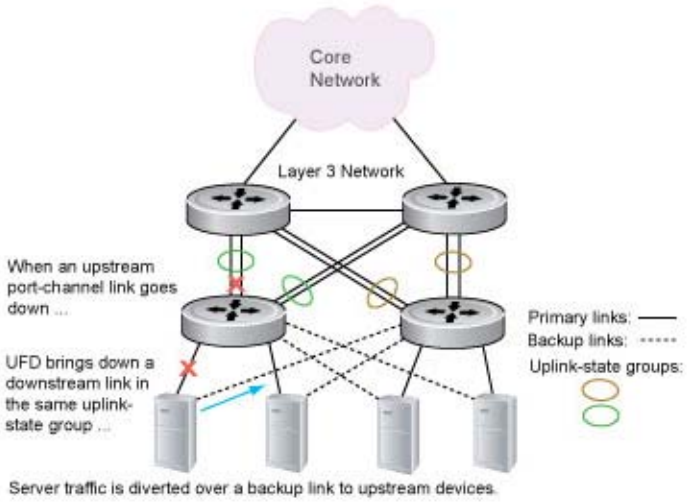
A: Switches1 and 2 have upstream and downstream connections to Router1 and Server via primary links.
B: Upstream link between Switch1 and Router1 fails. Downstream link with Server stays up temporarily.
C: Switch1 disables downstream link to Server. Server starts to connect with Router1 using backup link to Switch2; Switch2 starts to use the backup link to Router1.

How Uplink Failure Detection Works

UFD creates an association between upstream and downstream interfaces. The association of uplink and downlink interfaces is called an *uplink-state group*. An interface in an uplink-state group can be a physical interface or a port-channel (LAG) aggregation of physical interfaces.

An enabled uplink-state group tracks the state of all assigned upstream interfaces. Failure on an upstream interface results in the automatic disabling of downstream interfaces in the uplink-state group. As a result, downstream devices can execute the protection or recovery procedures they have in place to establish alternate connectivity paths as shown in Figure 20-2.

Figure 20-2. Uplink Failure Detection Example



If only one of the upstream interfaces in an uplink-state group goes down, a specified number of downstream ports associated with the upstream interface are put into a link-down state. This number is user-configurable and is calculated by the ratio of upstream port bandwidth to downstream port bandwidth in the same uplink-state group. This calculation ensures that there are no traffic drops due to insufficient bandwidth on the upstream links to the routers/switches.

By default, if all upstream interfaces in an uplink-state group go down, all downstream interfaces in the same uplink-state group are put into a link-down state.

Using UFD, you can configure the automatic recovery of downstream ports in an uplink-state group when the link status of an upstream port changes. The tracking of upstream link status does not have a major impact on CPU usage.

UFD and NIC Teaming

Uplink Failure Detection on a switch can be used with network adapter teaming on a server (see Network Interface Controller (NIC) Teaming) to implement a rapid failover solution. For example, in Figure 20-2 the switch/router with UFD detects the uplink failure and automatically disables the associated downstream link port to the server. The server with NIC teaming detects the disabled link and automatically switches over to the backup link in order to continue to transmit traffic upstream.

Important Points to Remember

UFD operates as follows on an Aggregator:

- Uplink-state group 1 is created by default with the uplink LAG 128 as the upstream interface and all server ports as downstream interfaces.

  When the uplink LAG goes down, all server interfaces are brought down and placed in UFD error-disabled state.

  When the uplink LAG comes up again, server interfaces are brought up (Oper UP) and the error-disabled state is cleared.

- A defer timer of 10 seconds is enabled in the uplink-state group. This defer timer prevents unwanted flapping of server ports when the uplink LAG flaps.

  The defer timer is also helpful in scenarios similar to this one:
  The uplink LAG consists of ports connected to two ToR switches. The currently active LAG goes down. Without the defer timer, the server ports would be shut down before even trying to bring up the LAG with the second ToR switch.

- To enable the debug messages for events related to a specified uplink-state group or all groups, enter the **debug uplink-state-group** [*group-id*] command, where *group-id* is 1 to 16.

  To turn off debugging event messages, enter the **no debug uplink-state-group** [*group-id*] command.

Displaying Uplink Failure Detection

To display information on the Uplink Failure Detection feature, enter any of the following **show** commands:

Show Command Syntax	Description
show uplink-state-group [*group-id***] [detail]** Command Mode: EXEC	Displays status information on a specified uplink-state group or all groups. Valid *group-id* values are 1 to 16. **detail** displays additional status information on the upstream and downstream interfaces in each group (see Figure 20-3).
show interfaces *interface* Command Mode: EXEC	Displays the current status of a port or port-channel interface assigned to an uplink-state group. *interface* specifies one of the following interface types: 10-Gigabit Ethernet: Enter **tengigabitethernet** *slot*/*port*. 40-Gigabit Ethernet: Enter **fortygigabitethernet** *slot*/*port*. Port channel: Enter **port-channel** {1-512}. If a downstream interface in an uplink-state group has been disabled (Oper Down state) by uplink-state tracking because an upstream port went down, the message error-disabled[UFD] is displayed in the output (see Figure 20-4).

Show Command Syntax	Description
show running-config uplink-state-group [*group-id*] Command Mode: EXEC Or **show configuration** Command Mode: UPLINK-STATE-GROUP	Displays the current configuration of all uplink-state groups (Figure 20-5) or a specified group. Valid *group-id* values are 1 to 16.

Figure 20-3. show uplink-state-group Command Output

```
FTOS# show uplink-state-group

Uplink State Group: 1   Status: Enabled, Down
FTOS#
FTOS#show uplink-state-group 1

Uplink State Group: 1   Status: Enabled, Down
FTOS#
FTOS#show uplink-state-group detail

(Up): Interface up   (Dwn): Interface down   (Dis): Interface disabled

Uplink State Group    : 1       Status: Enabled, Down
Defer Timer           : 10 sec
Upstream Interfaces   : Po 128(Dwn)
Downstream Interfaces : Te 0/1(Dis) Te 0/2(Dis) Te 0/3(Dis) Te 0/4(Dis) Te 0/5(Dis)
                        Te 0/6(Dis) Te 0/7(Dis) Te 0/8(Dis) Te 0/9(Dis) Te 0/10(Dis)
                        Te 0/11(Dis) Te 0/12(Dis) Te 0/13(Dis) Te 0/14(Dis) Te 0/15(Dis)
                        Te 0/16(Dis) Te 0/17(Dis) Te 0/18(Dis) Te 0/19(Dis) Te 0/20(Dis)
                        Te 0/21(Dis) Te 0/22(Dis) Te 0/23(Dis) Te 0/24(Dis) Te 0/25(Dis)
                        Te 0/26(Dis) Te 0/27(Dis) Te 0/28(Dis) Te 0/29(Dis) Te 0/30(Dis)
                        Te 0/31(Dis) Te 0/32(Dis) Te 1/1(Dis) Te 1/2(Dis) Te 1/3(Dis)
                        Te 1/4(Dis) Te 1/5(Dis) Te 1/6(Dis) Te 1/7(Dis) Te 1/8(Dis)
                        Te 1/9(Dis) Te 1/10(Dis) Te 1/11(Dis) Te 1/12(Dis) Te 1/13(Dis)
                        Te 1/14(Dis) Te 1/15(Dis) Te 1/16(Dis) Te 1/17(Dis) Te 1/18(Dis)
                        Te 1/19(Dis) Te 1/20(Dis) Te 1/21(Dis) Te 1/22(Dis) Te 1/23(Dis)
                        Te 1/24(Dis) Te 1/25(Dis) Te 1/26(Dis) Te 1/27(Dis) Te 1/28(Dis)
                        Te 1/29(Dis) Te 1/30(Dis) Te 1/31(Dis) Te 1/32(Dis)
```

Figure 20-4. show interfaces Command Output

```
FTOS#show interfaces tengigabitethernet 0/5

TenGigabitEthernet 0/5 is up, line protocol is down(error-disabled[UFD])
Hardware is DellForce10Eth, address is 00:1e:c9:f1:04:80
    Current address is 00:1e:c9:f1:04:80
Server Port AdminState is N/A
Pluggable media not present
Interface index is 35197697
Internet address is not set
Mode of IP Address Assignment : NONE
DHCP Client-ID :tenG134001ec9f10480
MTU 12000 bytes, IP MTU 11982 bytes
LineSpeed auto
Flowcontrol rx on tx off
ARP type: ARPA, ARP Timeout 04:00:00
Last clearing of "show interface" counters 00:28:09
Queueing strategy: fifo
Input Statistics:
     0 packets, 0 bytes
     0 64-byte pkts, 0 over 64-byte pkts, 0 over 127-byte pkts
     0 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     0 Multicasts, 0 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     0 packets, 0 bytes, 0 underruns
     0 64-byte pkts, 0 over 64-byte pkts, 0 over 127-byte pkts
     0 over 255-byte pkts, 0 over 511-byte pkts, 0 over 1023-byte pkts
     0 Multicasts, 0 Broadcasts, 0 Unicasts
     0 throttles, 0 discarded, 0 collisions, 0 wreddrops
Rate info (interval 299 seconds):
     Input 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
     Output 00.00 Mbits/sec,          0 packets/sec, 0.00% of line-rate
Time since last interface status change: 00:25:03
```

Figure 20-5. show running-config uplink-state-group Command: UFD Output

```
FTOS# show running-config uplink-state-group
!
uplink-state-group 1
 downstream TenGigabitEthernet 0/1-32
 downstream TenGigabitEthernet 1/1-32
 upstream Port-channel 128
 defer-timer 10
```

Debugging UFD on an Interface

To enable debug messages for events related to a specified uplink-state group or all groups, enter the **debug uplink-state-group** command.

Task	Command	Command Mode
Enable UFD debugging on all or a specified uplink-state group, where: *group-id* specifies an uplink-state group. Valid group-id values are 1 to 16.	debug uplink-state-group [*group-id*]	EXEC PRIVILEGE

To turn off debugging event messages, enter the **no debug uplink-state-group** [*group-id*] command.

21

Upgrade Procedures

To view the requirements for upgrading the Dell Force10 operating software (FTOS) on an Aggregator, refer to the *FTOS Release Notes for the M I/O Aggregator*. Follow the procedures in the *FTOS Release Notes* for the software version you wish to upgrade to.

Direct any questions or concerns about FTOS upgrades to the Dell Force10 Technical Support Center. You can reach technical support:

- On the Web: www.force10networks.com/support/
- By email: support@force10networks.com
- By phone: US and Canada: 866.965.5800, International: 408.965.5800

22

Debugging and Diagnostics

The chapter contains the following sections:

Debugging Aggregator Operation

This section describes common troubleshooting procedures to use for error conditions that may arise during Aggregator operation.

All interfaces on the Aggregator are operationally down

Symptom: All Aggregator interfaces are down.

Resolution: Ensure that port channel 128 is up and that the Aggregator-facing port channel on the top-of-rack switch is correctly configured.

Steps to Take:

1. Verify that uplink port-channel 128 i s up (**show interfaces port-channel 128 brief** command) and display the status of member ports (**show uplink-state-group 1 detail** command).

```
FTOS#show interfaces port-channel 128 brief
Codes: L - LACP Port-channel

    LAG  Mode  Status       Uptime      Ports
L   128  L2L3  up           17:36:24    Te 0/33    (Up)
                                        Te 0/35    (Up)
                                        Te 0/36    (Up)
                                        Te 0/39    (Up)
                                        Te 0/51    (Up)
                                        Te 0/53    (Up)
                                        Te 0/54    (Up)
                                        Te 0/56    (Up)

FTOS#show uplink-state-group 1 detail

(Up): Interface up   (Dwn): Interface down   (Dis): Interface disabled

Uplink State Group    : 1       Status: Enabled, Up
Defer Timer           : 10 sec
Upstream Interfaces   : Po 128(Up)
Downstream Interfaces : Te 0/1(Up) Te 0/2(Up) Te 0/3(Dwn) Te 0/4(Dwn) Te 0/5(Up)
                        Te 0/6(Dwn) Te 0/7(Dwn) Te 0/8(Up) Te 0/9(Up) Te 0/10(Up)
                        Te 0/11(Dwn) Te 0/12(Dwn) Te 0/13(Up) Te 0/14(Dwn) Te 0/15(Up)
                        Te 0/16(Up) Te 0/17(Dwn) Te 0/18(Dwn) Te 0/19(Dwn) Te 0/20(Dwn)
                        Te 0/21(Dwn) Te 0/22(Dwn) Te 0/23(Dwn) Te 0/24(Dwn) Te 0/25(Dwn)
                        Te 0/26(Dwn) Te 0/27(Dwn) Te 0/28(Dwn) Te 0/29(Dwn) Te 0/30(Dwn)
                        Te 0/31(Dwn) Te 0/32(Dwn)
```

2. Verify that the downstream port channel in the top-of-rack switch that connects to the Aggregator is configured correctly.

Broadcast, unknown multicast, and DLF packets are switched at a very low rate

Symptom: Broadcast, unknown multicast, and DLF packets are switched at a very low rate.

By default, broadcast storm control is enabled on an Aggregator and rate limits the transmission of broadcast, unknown multicast, and DLF packets to 1Gbps. This default behavior is designed to avoid unnecessarily flooding these packets on all (4094) VLANs on all Aggregator interfaces (default configuration).

Resolution: Disable broadcast storm control globally on the Aggregator.

Steps to Take:

1. Display the current status of broadcast storm control on the Aggregator (**show io-aggregator broadcast storm-control status** command).

```
FTOS#show io-aggregator broadcast storm-control status

Storm-Control Enabled

Broadcast Traffic limited to 1000 Mbps
```

2. Disable broadcast storm control (**no io-aggregator broadcast storm-control** command) and re-display its status.

```
FTOS#config terminal
FTOS(conf)#no io-aggregator broadcast storm-control
FTOS(conf)#end
FTOS#show io-aggregator broadcast storm-control status

Storm-Control Disabled
```

Flooded packets on all VLANs are received on a server

Symptom: All packets flooded on all VLANs on an Aggregator are received on a server, even if the server is configured as a member of only a subset of VLANs. This behavior happens because all Aggregator ports are, by default, members of all (4094) VLANs.

Resolution: Configure a port that is connected to the server with restricted VLAN membership.

Steps to Take:

1. Display the current port mode for Aggregator L2 interfaces (**show interfaces switchport** *interface* command).

```
FTOS#show interfaces switchport tengigabitethernet 0/1

Codes:  U - Untagged, T - Tagged
        x - Dot1x untagged, X - Dot1x tagged
        G - GVRP tagged, M - Trunk, H - VSN tagged
        i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged

Name: TenGigabitEthernet 0/1
802.1QTagged: Hybrid
SMUX port mode: Auto VLANs enabled
Vlan membership:
Q       Vlans
U       1
T       2-4094

Native VlanId:    1
```

2. Assign the port to a specified group of VLANs (**vlan tagged** command) and re-display the port mode status.

```
FTOS(conf)#interface tengigabitethernet 0/1
FTOS(conf-if-te-0/1)#vlan tagged 2-5,100,4010
FTOS(conf-if-te-0/1)#

FTOS#show interfaces switchport tengigabitethernet 0/1

Codes:  U - Untagged, T - Tagged
        x - Dot1x untagged, X - Dot1x tagged
        G - GVRP tagged, M - Trunk, H - VSN tagged
        i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged

Name: TenGigabitEthernet 0/1
802.1QTagged: Hybrid
SMUX port mode: Admin VLANs enabled
Vlan membership:
Q       Vlans
U       1
T       2-5,100,4010

Native VlanId:    1
```

Auto-configured VLANs do not exist on a stacked Aggregator

Symptom: When an Aggregator is configured and used in a stack, traffic does not flow and the VLAN auto-configuration on all ports is lost. This behavior happens because an Aggregator in stacking mode does not support auto-configured VLANs. Only VLANs that were previously manually configured are retained on the master stack unit.

Resolution: You must manually configure VLAN membership on each stack-unit port.

Steps to Take:

1. Configure VLAN membership on individual ports (**vlan tagged** command).

```
FTOS(conf)# interface tengigabitethernet 0/1
FTOS(conf-if-te-0/1)#vlan tagged 2-5,100,4010
FTOS(conf-if-te-0/1)#
```

2. Verify the manually configured VLAN membership (**show interfaces switchport** *interface* command).

```
FTOS#show interfaces switchport tengigabitethernet 0/1

Codes:  U - Untagged, T - Tagged
        x - Dot1x untagged, X - Dot1x tagged
        G - GVRP tagged, M - Trunk, H - VSN tagged
        i - Internal untagged, I - Internal tagged, v - VLT untagged, V - VLT tagged

Name: TenGigabitEthernet 0/1
802.1QTagged: Hybrid
SMUX port mode: Admin VLANs enabled
Vlan membership:
Q       Vlans
U       1
T       2-5,100,4010

Native VlanId:    1
```

Software show Commands

Use the **show version** and **show system stack-unit 0** commands as a part of troubleshooting an Aggregator's software configuration in a standalone or stacking scenario.

Table 22-1. Software show Commands

Command	Description
show version	Display the current version of FTOS software running on an Aggregator.
show system stack-unit 0	Display software configuration on an Aggregator in stacking mode.

Figure 22-1. show version Command Example

```
FTOS#show version
Dell Force10 Real Time Operating System oftware
Dell Force10 Operating System Version: 1.0
Dell Force10 Application Software Version: E8-3-17-24
Copyright (c) 1999-2012 by Dell Inc. All Rights Reserved.
Build Time: Thu Jul 5 11:20:28 PDT 2012
Build Path: /sites/sjc/work/build/buildSpaces/build05/E8-3-17/SW/SRC/Cp_src/Tacacs
st-sjc-m1000e-3-72 uptime is 17 hour(s), 1 minute(s)

System image file is "st-sjc-m1000e-3-c2"

System Type: I/O-Aggregator
Control Processor: MIPS RMI XLP with 2147483648 bytes of memory.

256M bytes of boot flash memory.

  1 34-port GE/TE (XL)
 56 Ten GigabitEthernet/IEEE 802.3 interface(s)
```

Figure 22-2. show system stack-unit 0 Command Example

```
FTOS#show system stack-unit 0
--  Unit 0 --
Unit Type       : Management Unit
Status          : online
Next Boot       : online
Required Type   : I/O-Aggregator - 34-port GE/TE (XL)
Current Type    : I/O-Aggregator - 34-port GE/TE (XL)
Master priority : 0
Hardware Rev    :
Num Ports       : 56
Up Time         : 17 hr, 8 min
FTOS Version    : 8-3-17-15
Jumbo Capable   : yes
POE Capable     : no
Boot Flash      : A: 4.0.1.0 [booted]    B: 4.0.1.0bt
Boot Selector   : 4.0.0.0
Memory Size     : 2147483648 bytes
Temperature     : 64C
Voltage         : ok
Switch Power    : GOOD
Product Name    : I/O Aggregator
Mfg By          : DELL
Mfg Date        : 2012-05-01
Serial Number   : TW282921F00038
Part Number     : 0NVH81
Piece Part ID   : TW-0NVH81-28292-1F0-0038
PPID Revision   :
Service Tag     : N/A
Expr Svc Code   : N/A
PSOC FW Rev     : 0xb
ICT Test Date   : 0-0-0
ICT Test Info   : 0x0
Max Power Req   : 31488
Fabric Type     : 0x3
Fabric Maj Ver  : 0x1
Fabric Min Ver  : 0x0
SW Manageability: 0x4
HW Manageability: 0x1
Max Boot Time   : 3 minutes
Link Tuning     : unsupported
Auto Reboot     : enabled
Burned In MAC   : 00:1e:c9:f1:03:42
No Of MACs      : 3
```

Offline Diagnostics

The offline diagnostics test suite is useful for isolating faults and debugging hardware.The diagnostics tests are grouped into three levels:

- **Level 0**—Level 0 diagnostics check for the presence of various components and perform essential path verifications. In addition, they verify the identification registers of the components on the board.
- **Level 1**—A smaller set of diagnostic tests. Level 1 diagnostics perform status, self-test, access, and read/write tests for all the components on the board and test their registers for appropriate values. In addition, they perform extensive tests on memory devices (for example, SDRAM, flash, NVRAM, EEPROM) wherever possible.
- **Level 2**—The full set of diagnostic tests. Level 2 diagnostics are used primarily for on-board MAC level, Physical level, and external loopback tests and more extensive component diagnostics. Various components on the board are put into loopback mode, and test packets are transmitted through those components. These diagnostics also perform snake tests using virtual local area network (VLAN) configurations.

Note: Diagnostic is not allowed in Stacking mode, including member stacking. Avoid stacking before executing the diagnostic tests in the chassis.

Important Points to Remember

- You can only perform offline diagnostics on an offline standalone unit. You cannot perform diagnostics if the ports are configured in a stacking group. Remove the port(s) from the stacking group before executing the diagnostic test.
- Diagnostics only test connectivity, not the entire data path.
- Diagnostic results are stored on the flash of the unit on which you performed the diagnostics.
- When offline diagnostics are complete, the unit or stack member reboots automatically.

Running Offline Diagnostics

To run offline diagnostics, follow these steps:

1. Place the unit in the offline state using the offline stack-unit command from EXEC Privilege mode (Figure 22-3).

The system reboots when the off-line diagnostics complete. This is an automatic process. A warning message appears when you implement the offline stack-unit command.

```
Warning - Diagnostic execution will cause stack-unit to reboot after completion of
diags.
Proceed with Offline-Diags [confirm yes/no]:y
```

Figure 22-3. Taking a Stack Unit Offline

```
FTOS#offline stack-unit 2
Warning - Diagnostic execution will cause stack-unit to reboot after completion of diags.
Proceed with Offline-Diags [confirm yes/no]:y
5w6d12h: %STKUNIT0-M:CP %CHMGR-2-STACKUNIT_DOWN: Stack unit 2 down - stack unit offline
5w6d12h: %STKUNIT0-M:CP %IFMGR-1-DEL_PORT: Removed port: Tengig 2/1-48
FTOS#5w6d12h: %STKUNIT1-S:CP %IFMGR-1-DEL_PORT: Removed port: Tengig 2/1-48
```

2. Use the show system brief command from EXEC Privilege mode to confirm offline status (Figure 22-4).

Figure 22-4. Verifying the Offline/Online Status of a Stack Unit

```
FTOS#show system brief | no-more

Stack MAC : 00:01:e8:00:ab:03

--  Stack Info  --
Unit  UnitType     Status         ReqTyp          CurTyp          Version     Ports
-------------------------------------------------------------------------------
  0   Member       not present
  1   Management   online         I/O-Aggregator  I/O-Aggregator  8-3-17-38   56
  2   Member       not present
  3   Member       not present
  4   Member       not present
  5   Member       not present

FTOS#
```

Trace Logs

In addition to the syslog buffer, the Dell Force10 operating software (FTOS) buffers trace messages which are continuously written by various FTOS software tasks to report hardware and software events and status information. Each trace message provides the date, time, and name of the FTOS process. All messages are stored in a ring buffer and can be saved to a file either manually or automatically upon failover.

Auto Save on Crash or Rollover

Exception information on Master or Standby units is stored in the **flash:/TRACE_LOG_DIR** directory. This directory contains files that save trace information when there has been a task crash or timeout.

On a Master unit, you can reach the **TRACE_LOG_DIR** files by file transfer protocol (FTP) or by using the show file command from the **flash://TRACE_LOG_DIR** directory.

On a Standby unit, you can reach the **TRACE_LOG_DIR** files only by using the show file command from the **flash://TRACE_LOG_DIR** directory.

Note: Non-management Member units do not support this functionality.

Figure 22-5. Command Example

```
FTOS#dir flash://TRACE_LOG_DIR
Directory of flash:/TRACE_LOG_DIR

  1  drwx       4096   Jan 17 2011 15:02:16 +00:00 .
  2  drwx       4096   Jan 01 1980 00:00:00 +00:00 ..
  3  -rwx     100583   Feb 11 2011 20:41:36 +00:00 failure_trace0_RPM0_CP

flash: 2143281152 bytes total (2069291008 bytes free)
```

Show Hardware Commands

The show hardware command tree consists of EXEC Privilege commands used with the Aggregator. These commands display information from a hardware sub-component and from hardware-based feature tables.

Table 22-2 lists the show hardware commands available as of the latest FTOS version.

Note: Use the show hardware commands only under the guidance of Dell Force10 Technical Assistance Center.

Table 22-2. show hardware Commands

Command	Description
show hardware stack-unit {*0-5*} cpu management statistics	View the internal interface status of the stack-unit CPU port which connects to the external management interface.
show hardware stack-unit {*0-5*} cpu data-plane statistics	View the driver-level statistics for the data-plane port on the CPU for the specified stack-unit. It provides insight into the packet types entering the CPU to see whether CPU-bound traffic is internal (IPC traffic) or network control traffic, which the CPU must process.
show hardware stack-unit {*0-5*} buffer total-buffer	View the modular packet buffers details per stack unit and the mode of allocation.
show hardware stack-unit {*0-5*} buffer unit {*0-1*} total-buffer	View the modular packet buffers details per unit and the mode of allocation.
show hardware stack-unit {*0-5*} buffer unit {*0-1*} port {*1-64* | *all*} buffer-info	View the forwarding plane statistics containing the packet buffer usage per port per stack unit.
show hardware stack-unit {*0-5*} buffer unit {*0-1*} port {*1-64*} queue {*0-14* | *all*} buffer-info	View the forwarding plane statistics containing the packet buffer statistics per COS per port.
show hardware stack-unit {*0-5*} cpu party-bus statistics	View input and output statistics on the party bus, which carries inter-process communication traffic between CPUs.
show hardware stack-unit {*0-5*} drops unit {*0-0}* port {*33-56*}	View the ingress and egress internal packet-drop counters, MAC counters drop, and FP packet drops for the stack unit on per port basis. It assists in identifying the stack unit/port pipe/port that may experience internal drops.

Table 22-2. show hardware Commands

Command	Description
show hardware stack-unit {*0-5*} stack-port {*33-56*}	View the input and output statistics for a stack-port interface.
show hardware stack-unit {*0-5* unit {*0-0*} counters	View the counters in the field processors of the stack unit.
show hardware stack-unit {*0-5*} unit {*0-0*} details	View the details of the FP devices and Hi gig ports on the stack-unit.
show hardware stack-unit {*0-5*} unit {*0-0*} execute-shell-cmd *{command}*	Execute a specified bShell commands from the CLI without going into the bShell.
show hardware stack-unit {*0-5*} unit {*0-0*} ipmc-replication	View the Multicast IPMC replication table from the bShell.
show hardware stack-unit {*0-5*} unit {*0-0*} port-stats [detail]	View the internal statistics for each port-pipe (unit) on per port basis.
show hardware stack-unit {*0-5*} unit {*0-0*} register	View the stack-unit internal registers for each port-pipe.
show hardware stack-unit {*0-5*} unit {*0-0*} table-dump {*table name*}	View the tables from the bShell through the CLI without going into the bShell.

Environmental Monitoring

Aggregator components use environmental monitoring hardware to detect transmit power readings, receive power readings, and temperature updates. To receive periodic power updates, you must enable the enable optic-info-update interval command. The output in Figure 22-6 shows the environment status.

Figure 22-6. show interfaces transceiver Command Example

```
FTOS#show int ten 0/49 transceiver
SFP is present
SFP 49 Serial Base ID fields
SFP 49 Id                       = 0x03
SFP 49 Ext Id                   = 0x04
SFP 49 Connector                = 0x07
SFP 49 Transceiver Code         = 0x00 0x00 0x00 0x01 0x20 0x40 0x0c 0x01
SFP 49 Encoding                 = 0x01
SFP 49 BR Nominal               = 0x0c
SFP 49 Length(9um)    Km        = 0x00
SFP 49 Length(9um)    100m      = 0x00
SFP 49 Length(50um)   10m       = 0x37
SFP 49 Length(62.5um) 10m       = 0x1e
SFP 49 Length(Copper) 10m       = 0x00
SFP 49 Vendor Rev               =
SFP 49 Laser Wavelength         = 850 nm
SFP 49 CheckCodeBase            = 0x78
SFP 49 Serial Extended ID fields
SFP 49 Options                  = 0x00 0x12
SFP 49 BR max                   = 0
SFP 49 BR min                   = 0
SFP 49 Vendor SN                = P11C0B0
SFP 49 Datecode                 = 020919
SFP 49 CheckCodeExt             = 0xb6

SFP 49 Diagnostic Information
=================================
SFP 49 Rx Power measurement type        = Average
=================================
SFP 49 Temp High Alarm threshold        = 100.000C
SFP 49 Voltage High Alarm threshold     = 5.000V
SFP 49 Bias High Alarm threshold        = 100.000mA
SFP 49 TX Power High Alarm threshold    = 5.000mW
SFP 49 RX Power High Alarm threshold    = 5.000mW
SFP 49 Temp Low Alarm threshold         = -50.000C
SFP 49 Voltage Low Alarm threshold      = 0.000V
SFP 49 Bias Low Alarm threshold         = 0.000mA
SFP 49 TX Power Low Alarm threshold     = 0.000mW
SFP 49 RX Power Low Alarm threshold     = 0.000mW
=================================
SFP 49 Temp High Warning threshold      = 100.000C
SFP 49 Voltage High Warning threshold   = 5.000V
SFP 49 Bias High Warning threshold      = 100.000mA
SFP 49 TX Power High Warning threshold  = 5.000mW
SFP 49 RX Power High Warning threshold  = 5.000mW
SFP 49 Temp Low Warning threshold       = -50.000C
SFP 49 Voltage Low Warning threshold    = 0.000V
SFP 49 Bias Low Warning threshold       = 0.000mA
SFP 49 TX Power Low Warning threshold   = 0.000mW
SFP 49 RX Power Low Warning threshold   = 0.000mW
=================================
SFP 49 Temperature                      = 40.844C
SFP 49 Voltage                          = 3.169V
SFP 49 Tx Bias Current                  = 0.000mA
SFP 49 Tx Power                         = 0.000mW
SFP 49 Rx Power                         = 0.227mW
=================================
SFP 49 Data Ready state Bar             = False
SFP 49 Rx LOS state                     = False
SFP 49 Tx Fault state                   = False
```

Recognize an Over-Temperature Condition

An over-temperature condition occurs for one of two reasons:

- The card genuinely is too hot.
- A sensor has malfunctioned.

Inspect cards adjacent to the one reporting condition to discover the cause.

- If directly adjacent cards are not a normal temperature, suspect a genuine overheating condition.
- If directly adjacent cards are a normal temperature, suspect a faulty sensor.

When the system detects a genuine over-temperature condition, it powers off the card. To recognize this condition, look for the system messages in Message 1.

Message 1 Over Temperature Condition System Messages

```
CHMGR-2-MAJOR_TEMP: Major alarm: chassis temperature high (temperature reaches or exceeds threshold of
[value]C)
CHMGR-2-TEMP_SHUTDOWN_WARN: WARNING! temperature is [value]C; approaching shutdown threshold of [value]C
```

To view the programmed alarm thresholds levels, including the shutdown value, use the show alarms threshold command (Figure 22-7).

Figure 22-7. show alarms threshold Command Example

```
FTOS#show alarms threshold

--  Temperature Limits (deg C)  --
-------------------------------------------------------------------------
         BelowNormal    Normal    Elevated    Critical    Trip/Shutdown
 Unit0         <=40        41          71          81              86
FTOS#
```

Troubleshoot an Over-Temperature Condition

To troubleshoot an over-temperature condition:

1. Use the show environment commands to monitor the temperature levels.
2. Check air flow through the system. Ensure the air ducts are clean and that all fans are working correctly.
3. After the software has determined that the temperature levels are within normal limits, the card can be re-powered safely. To bring the stack unit back online, use the power-on command in EXEC mode.

In addition, Dell Force10 requires that you install blanks in all slots without a line card to control airflow for adequate system cooling.

Figure 22-8. show environment Command Example

```
FTOS#show environment

-- Unit Environment Status  --
Unit  Status        Temp   Voltage
--------------------------------------------------------------------------
* 0   online        71C    ok

* Management Unit

--  Thermal Sensor Readings (deg C)  --
Unit  Sensor0  Sensor1  Sensor2  Sensor3  Sensor4  Sensor5  Sensor6  Sensor7  Sensor8
Sensor9
-------------------------------------------------------------------------------------------
------
  0       45       43       66       61       66       62       70       65       67       71
```

Note: Exercise care when removing a card; if it has exceeded the major or shutdown thresholds, the card could be hot to the touch

Recognize an Under-Voltage Condition

If the system detects an under-voltage condition, it sends an alarm. To recognize this condition, look for the system messages in Message 2.

Message 2 Under-Voltage Condition System Messages

```
%CHMGR-1-CARD_SHUTDOWN: Major alarm: Line card 2 down - auto-shutdown due to under voltage
```

Message 2 indicates that the specified card is not receiving enough power. In response, the system first shuts down Power over Ethernet (PoE).

Troubleshoot an Under-Voltage Condition

To troubleshoot an under-voltage condition, check that the correct number of power supplies are installed and their Status light emitting diodes (LEDs) are lit.

The simple network management protocol (SNMP) traps and OIDs in Table 22-3 provide information about environmental monitoring hardware and hardware components.

Table 22-3. SNMP Traps and OIDs

OID String	OID Name	Description
Receiving power		
.1.3.6.1.4.1.6027.3.10.1.2.5.1.6	chSysPortXfpRecvPower	OID to display the receiving power of the connected optics.
Transmitting power		
.1.3.6.1.4.1.6027.3.10.1.2.5.1.8	chSysPortXfpTxPower	OID to display the transmitting power of the connected optics.
Temperature		
.1.3.6.1.4.1.6027.3.10.1.2.5.1.7	chSysPortXfpRecvTemp	OID to display the Temperature of the connected optics. **Note:** These OIDs are only generated if you enable the CLI enable optic-info-update-interval is enabled command.
Hardware MIB Buffer Statistics		
.1.3.6.1.4.1.6027.3.16.1.1.4	fpPacketBufferTable	View the modular packet buffers details per stack unit and the mode of allocation.
.1.3.6.1.4.1.6027.3.16.1.1.5	fpStatsPerPortTable	View the forwarding plane statistics containing the packet buffer usage per port per stack unit.
.1.3.6.1.4.1.6027.3.16.1.1.6	fpStatsPerCOSTable	View the forwarding plane statistics containing the packet buffer statistics per COS per port.

Buffer Tuning

Buffer tuning allows you to modify the way your switch allocates buffers from its available memory and helps prevent packet drops during a temporary burst of traffic. The application-specific integrated circuit (ASICs) implement the key functions of queuing, feature lookups, and forwarding lookups in the hardware.

- Forwarding processor (FP) ASICs provide Ethernet MAC functions, queueing and buffering, as well as store feature and forwarding tables for hardware-based lookup and forwarding decisions. 10G and 40G interfaces use different FPs.

You can tune buffers at three locations (Figure 22-9).

1. CSF – Output queues going from the CSF.
2. FP Uplink—Output queues going from the FP to the CSF IDP links.
3. Front-End Link—Output queues going from the FP to the front-end PHY.

All ports support eight queues, four for data traffic and four for control traffic. All eight queues are tunable.

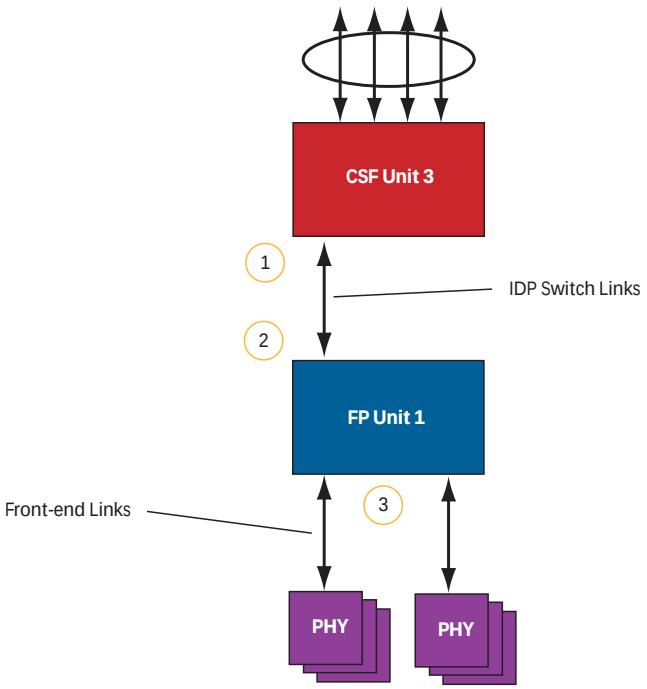
Physical memory is organized into cells of 128 bytes. The cells are organized into two buffer pools—a dedicated buffer and a dynamic buffer.

- **Dedicated buffer** is reserved memory that cannot be used by other interfaces on the same ASIC or by other queues on the same interface. This buffer is always allocated, and no dynamic recarving takes place based on changes in interface status. Dedicated buffers introduce a trade-off. They provide each interface with a guaranteed minimum buffer to prevent an overused and congested interface from starving all other interfaces. However, this minimum guarantee means the buffer manager does not reallocate the buffer to an adjacent congested interface, which means that in some cases, memory is underused.
- **Dynamic buffer** is shared memory that is allocated as needed, up to a configured limit. Using dynamic buffers provides the benefit of statistical buffer sharing. An interface requests dynamic buffers when its dedicated buffer pool is exhausted. The buffer manager grants the request based on three conditions:
  - The number of used and available dynamic buffers.
  - The maximum number of cells that an interface can occupy.
  - Available packet pointers (2k per interface). Each packet is managed in the buffer using a unique packet pointer. Thus, each interface can manage up to 2k packets.

You can configure dynamic buffers per port on both 1G and 10G FPs and per queue on CSFs. By default, the FP dynamic buffer allocation is 10 times oversubscribed. For the 48-port 1G card:

- Dynamic Pool= Total Available Pool(16384 cells) – Total Dedicated Pool = 5904 cells
- Oversubscription ratio = 10
- Dynamic Cell Limit Per port = 59040/29 = 2036 cells

Figure 22-9. Buffer Tuning Points



Deciding to Tune Buffers

Dell Force10 recommends exercising caution when configuring any non-default buffer settings, as tuning can significantly affect system performance. The default values work for most cases.

As a guideline, consider tuning buffers if traffic is very bursty (and coming from several interfaces). In this case:

- Reduce the dedicated buffer on all queues/interfaces.
- Increase the dynamic buffer on all interfaces.
- Increase the cell pointers on a queue that you are expecting will receive the largest number of packets.

Buffer Tuning Commands

To tune the buffers, use the following commands:

Task	Command	Command Mode
Define a buffer profile for the FP queues.	buffer-profile fp fsqueue	CONFIGURATION
Define a buffer profile for the CSF queues.	buffer-profile csf csqueue	CONFIGURATION
Change the dedicated buffers on a physical 1G interface.	buffer dedicated	BUFFER PROFILE
Change the maximum amount of dynamic buffers an interface can request.	buffer dynamic	BUFFER PROFILE
Change the number of packet-pointers per queue.	buffer packet-pointers	BUFFER PROFILE
Apply the buffer profile to a CSF to FP link.	buffer csf linecard	CONFIGURATION

FTOS Behavior: If you attempt to apply a buffer profile to a non-existent port-pipe, FTOS displays the following message. However, the configuration still appears in the running-config.

```
%DIFFSERV-2-DSA_BUFF_CARVING_INVALID_PORT_SET: Invalid FP port-set 2 for linecard 2. Valid
range of port-set is <0-1>
```

Configuration changes take effect immediately and appear in the running configuration. Because under normal conditions all ports do not require the maximum possible allocation, the configured dynamic allocations can exceed the actual amount of available memory; this is called oversubscription. If you choose to oversubscribe the dynamic allocation, a burst of traffic on one interface might prevent other interfaces from receiving the configured dynamic allocation, which causes packet loss.

You cannot allocate more than the available memory for the dedicated buffers. If the system determines that the sum of the configured dedicated buffers allocated to the queues is more than the total available memory, the configuration is rejected, returning a syslog message similar to the following.

Table 22-4. Buffer Allocation Error

00:04:20: %S50N:0 %DIFFSERV-2-DSA_DEVICE_BUFFER_UNAVAILABLE: Unable to allocate dedicated buffers for stack-unit 0, port pipe 0, egress port 25 due to unavailability of cells

FTOS Behavior: When you remove a buffer-profile using the no buffer-profile [fp | csf] command from CONFIGURATION mode, the buffer-profile name still appears in the output of show buffer-profile [detail | summary].
After a stack unit is reset, the buffer profile correctly returns to the default values, but the profile name remains. Remove it from the show buffer-profile [detail | summary] command output by using the no buffer [fp-uplink |csf] stack-unit port-set buffer-policy command from CONFIGURATION mode and the no buffer-policy command from INTERFACE mode.

Display the allocations for any buffer profile using the show commands in Figure 22-11. Display the default buffer profile using the show buffer-profile {summary | detail} command from EXEC Privilege mode (Figure 22-10).

Figure 22-10. Display the Default Buffer Profile

```
FTOS#show buffer-profile detail interface tengigabitethernet 0/1
Interface Tengig 0/1
Buffer-profile -
Dynamic buffer 194.88 (Kilobytes)
Queue#               Dedicated Buffer     Buffer Packets
                     (Kilobytes)
0                    2.50                 256
1                    2.50                 256
2                    2.50                 256
3                    2.50                 256
4                    9.38                 256
5                    9.38                 256
6                    9.38                 256
7                    9.38                 256
```

Figure 22-11. Displaying Buffer Profile Allocations

```
FTOS#show running-config interface tengigabitethernet 2/0 !
interface TenGigabitEthernet 2/0
no ip address
mtu 9252
switchport
no shutdown
buffer-policy myfsbufferprofile

FTOS#show buffer-profile detail int tengig 0/10
Interface Tengig 0/10
Buffer-profile fsqueue-fp
Dynamic buffer 1256.00 (Kilobytes)
Queue#               Dedicated Buffer     Buffer Packets
                     (Kilobytes)
0                    3.00                 256
1                    3.00                 256
2                    3.00                 256
3                    3.00                 256
4                    3.00                 256
5                    3.00                 256
6                    3.00                 256
7                    3.00                 256

FTOS#show buffer-profile detail fp-uplink stack-unit 0 port-set 0
Linecard 0 Port-set 0
Buffer-profile fsqueue-hig
Dynamic Buffer 1256.00 (Kilobytes)
Queue#               Dedicated Buffer     Buffer Packets
                     (Kilobytes)
0                    3.00                 256
1                    3.00                 256
2                    3.00                 256
3                    3.00                 256
4                    3.00                 256
5                    3.00                 256
6                    3.00                 256
7                    3.00                 256
```

Using a Pre-Defined Buffer Profile

FTOS provides two pre-defined buffer profiles, one for single-queue (for example, non-QoS) applications, and one for four-queue (for example, QoS) applications.

Task	Command	Mode
Apply one of two pre-defined buffer profiles for all port pipes in the system.	buffer-profile global [1Q|4Q]	CONFIGURATION

You must reload the system for the global buffer profile to take effect (Message 3).

Message 3 Reload After Applying Global Buffer Profile

```
% Info: For the global pre-defined buffer profile to take effect, please save the config and reload the
system.
```

FTOS Behavior: After you configure buffer-profile global 1Q, Message 3 is displayed during every bootup. Only one reboot is required for the configuration to take effect; afterwards this bootup message may be ignored.

FTOS Behavior: The buffer profile does not returned to the default, 4Q. If you configure 1Q, save the running-config to the startup-config, and then delete the startup-config and reload the chassis. The only way to return to the default buffer profile is to explicitly configure 4Q, and then reload the chassis.

The buffer-profile global command fails if you have already applied a custom buffer profile on an interface.

Message 4 Global Buffer Profile Error

```
% Error: User-defined buffer profile already applied. Failed to apply global pre-defined buffer profile.
Please remove all user-defined buffer profiles.
```

Similarly, when you configure buffer-profile global, you cannot not apply a buffer profile on any single interface.

Message 5 Global Buffer Profile Error

```
% Error: Global pre-defined buffer profile already applied. Failed to apply user-defined buffer profile
on interface Tengig 0/1. Please remove global pre-defined buffer profile.
```

If the default buffer profile (4Q) is active, FTOS displays an error message instructing you to remove the default configuration using the no buffer-profile global command.

Sample Buffer Profile Configuration

The two general types of network environments are sustained data transfers and voice/data. Dell Force10 recommends a single-queue approach for data transfers (Figure 22-12).

Figure 22-12. Single Queue Application with Default Packet Pointers

```
!
buffer-profile fp fsqueue-fp
buffer dedicated queue0 3 queue1 3 queue2 3 queue3 3 queue4 3 queue5 3 queue6 3 queue7 3
buffer dynamic 1256
!
 buffer-profile fp fsqueue-hig
 buffer dedicated queue0 3 queue1 3 queue2 3 queue3 3 queue4 3 queue5 3 queue6 3 queue7 3
 buffer dynamic 1256

!
buffer fp-uplink stack-unit 0 port-set 0 buffer-policy fsqueue-hig
buffer fp-uplink stack-unit 0 port-set 1 buffer-policy fsqueue-hig
!
Interface range tengig 0/1 - 48
buffer-policy fsqueue-fp

FTOS#sho run int Tengig 0/10
!
interface TenGigabitEthernet 0/10
 no ip address
```

Troubleshooting Packet Loss

The show hardware stack-unit command is intended primarily to troubleshoot packet loss.

- show hardware stack-unit 0-5 cpu data-plane statistics
- show hardware stack-unit 0-5 cpu party-bus statistics
- show hardware stack-unit 0-5 drops unit 0-0 port 1-56
- show hardware stack-unit 0-5 stack-port 33-56
- show hardware stack-unit 0-5 unit 0-0 {counters | details | port-stats [detail] | register | ipmc-replication | table-dump}:
- show hardware {layer2| layer3} {eg acl | in acl} stack-unit 0-5 port-set 0-0
- show hardware layer3 qos stack-unit 0-5 port-set 0-0
- show hardware system-flow layer2 stack-unit 0-5 port-set 0-1 [counters]
- clear hardware stack-unit 0-5 counters
- clear hardware stack-unit 0-5 unit 0-0 counters
- clear hardware stack-unit 0-5 cpu data-plane statistics
- clear hardware stack-unit 0-5 cpu party-bus statistics
- clear hardware stack-unit 0-5 stack-port 33-56

Displaying Drop Counters

The show hardware stack-unit 0–11 drops [unit 0 [port 0–63]] command assists in identifying which stack unit, port pipe, and port is experiencing internal drops (Figure 22-13) and (Figure 22-14).

Figure 22-13. Displaying Drop Counter Statistics

```
FTOS#show hardware stack-unit 0 drops
UNIT No: 0
Total Ingress Drops :0
Total IngMac Drops :0
Total Mmu Drops :0
Total EgMac Drops :0
Total Egress Drops :0
UNIT No: 1
Total Ingress Drops :0
Total IngMac Drops :0
Total Mmu Drops :0
Total EgMac Drops :0
Total Egress Drops :0

FTOS#show hardware stack-unit 0 drops unit 0
Port# :Ingress Drops :IngMac Drops :Total Mmu Drops :EgMac Drops :Egress
Drops
1 0 0 0 0 0
2 0 0 0 0 0
3 0 0 0 0 0
4 0 0 0 0 0
5 0 0 0 0 0
6 0 0 0 0 0
7 0 0 0 0 0
8 0 0 0 0 0
```

Display drop counters with the show hardware stack-unit drops unit port command (Figure 22-14).

Figure 22-14. Displaying Buffer Statistics, Displaying Drop Counters

```
FTOS#show hardware stack-unit 0 drops unit 0 port 1
 --- Ingress Drops      ---
Ingress Drops                 : 30
IBP CBP Full Drops            : 0
PortSTPnotFwd Drops           : 0
IPv4 L3 Discards              : 0
Policy Discards               : 0
Packets dropped by FP         : 14
(L2+L3) Drops                 : 0
Port bitmap zero Drops        : 16
Rx VLAN Drops                 : 0

--- Ingress MAC counters---
Ingress FCSDrops              : 0
Ingress MTUExceeds            : 0

--- MMU Drops          ---
HOL DROPS                     : 0
TxPurge CellErr               : 0
Aged Drops                    : 0

--- Egress MAC counters---
Egress FCS Drops              : 0

--- Egress FORWARD PROCESSOR Drops   ---
IPv4 L3UC Aged & Drops        : 0
TTL Threshold Drops           : 0
INVALID VLAN CNTR Drops       : 0
L2MC Drops                    : 0
PKT Drops of ANY Conditions   : 0
Hg MacUnderflow               : 0
TX Err PKT Counter            : 0
```

Dataplane Statistics

The show hardware stack-unit cpu data-plane statistics command provides insight into the packet types coming to the CPU. As shown in Figure 22-15, the command output has been augmented, providing detailed RX/TX packet statistics on a per-queue basis. The objective is to see whether CPU-bound traffic is internal (so-called party bus or IPC traffic) or network control traffic, which the CPU must process.

Figure 22-15. Displaying Buffer Statistics, Displaying Dataplane Statistics

```
FTOS#show hardware stack-unit 2 cpu data-plane statistics

bc pci driver statistics for device:
 rxHandle        :0
 noMhdr          :0
 noMbuf          :0
 noClus          :0
 recvd           :0
 dropped         :0
 recvToNet       :0
 rxError         :0
 rxDatapathErr   :0
 rxPkt(COS0)     :0
 rxPkt(COS1)     :0
 rxPkt(COS2)     :0
 rxPkt(COS3)     :0
 rxPkt(COS4)     :0
 rxPkt(COS5)     :0
 rxPkt(COS6)     :0
 rxPkt(COS7)     :0
 rxPkt(UNIT0)    :0
 rxPkt(UNIT1)    :0
 rxPkt(UNIT2)    :0
 rxPkt(UNIT3)    :0
 transmitted     :0
 txRequested     :0
 noTxDesc        :0
 txError         :0
 txReqTooLarge   :0
 txInternalError :0
 txDatapathErr   :0
 txPkt(COS0)     :0
 txPkt(COS1)     :0
 txPkt(COS2)     :0
 txPkt(COS3)     :0
 txPkt(COS4)     :0
 txPkt(COS5)     :0
 txPkt(COS6)     :0
 txPkt(COS7)     :0
 txPkt(UNIT0)    :0
```

The show hardware stack-unit cpu party-bus statistics command displays input and output statistics on the party bus, which carries inter-process communication traffic between CPUs (Figure 22-16).

Figure 22-16. Displaying Party Bus Statistics

```
FTOS#sh hardware stack-unit 2 cpu party-bus statistics
Input Statistics:
    27550 packets, 2559298 bytes
    0 dropped, 0 errors
Output Statistics:
    1649566 packets, 1935316203 bytes
    0 errors
```

Displaying Stack Port Statistics

The show hardware stack-unit stack-port command displays input and output statistics for a stack-port interface (Figure 22-17).

Figure 22-17. Displaying Stack Unit Statistics

```
FTOS#show hardware stack-unit 2 stack-port 49
Input Statistics:
     27629 packets, 3411731 bytes
     0 64-byte pkts, 27271 over 64-byte pkts, 207 over 127-byte pkts
     17 over 255-byte pkts, 56 over 511-byte pkts, 78 over 1023-byte pkts
     0 Multicasts, 5 Broadcasts
     0 runts, 0 giants, 0 throttles
     0 CRC, 0 overrun, 0 discarded
Output Statistics:
     1649714 packets, 1948622676 bytes, 0 underruns
     0 64-byte pkts, 27234 over 64-byte pkts, 107970 over 127-byte pkts
     34 over 255-byte pkts, 504838 over 511-byte pkts, 1009638 over 1023-byte pkts
     0 Multicasts, 0 Broadcasts, 1649714 Unicasts
     0 throttles, 0 discarded, 0 collisions
Rate info (interval 45 seconds):
     Input 00.00 Mbits/sec,          2 packets/sec, 0.00% of line-rate
     Output 00.06 Mbits/sec,          8 packets/sec, 0.00% of line-rate
FTOS#
```

Displaying Stack Member Counters

The show hardware stack-unit 0–5 {counters | details | port-stats [detail] | register} command displays internal receive and transmit statistics, based on the selected command option. A sample of the output is shown for the counters option in Figure 22-18.

Figure 22-18. Displaying Stack Unit Counters

```
RIPC4.ge0       :                1,202             +1,202
RUC.ge0         :                1,224             +1,217
RDBGC0.ge0      :                   34                +24
RDBGC1.ge0      :                  366               +235
RDBGC5.ge0      :                   16                +12
RDBGC7.ge0      :                   18                +12
GR64.ge0        :                5,176                +24
GR127.ge0       :                1,566             +1,433
GR255.ge0       :                    4                 +4
GRPKT.ge0       :                1,602             +1,461
GRBYT.ge0       :              117,600           +106,202
GRMCA.ge0       :                  366               +235
GRBCA.ge0       :                   12                 +9
GT64.ge0        :                    4                 +3
GT127.ge0       :                  964               +964
GT255.ge0       :                    4                 +4
GT511.ge0       :                    1                 +1
GTPKT.ge0       :                  973               +972
GTBCA.ge0       :                    1                 +1
GTBYT.ge0       :               71,531            +71,467
RUC.cpu0        :                  972               +971
TDBGC6.cpu0     :                1,584             +1,449=
```

Application Core Dumps

Application core dumps are disabled by default. A core dump file can be very large. Due to memory requirements, the file can only be sent directly to an FTP server. It is not stored on the local flash. To enable full application core dumps, use the following command:

Task	Command Syntax	Command Mode
Enable RPM core dumps and specify the shutdown mode.	logging coredump server	CONFIGURATION

To undo this command, use the no logging coredump server command.

Mini Core Dumps

FTOS supports mini core dumps for application and kernel crashes. The mini core dump applies to Master, Standby, and Member units.

Application and kernel mini core dumps are always enabled. The mini core dumps contain the stack space and some other very minimal information that you can use to debug a crash. These files are small files and are written into flash until space is exhausted. When the flash is full, the write process is stopped.

A mini core dump contains critical information in the event of a crash.

- Mini core dump files are located in flash:/ (root dir).
- The application mini core file name format is f10StkUnit<*Stack_unit_no*>.<*Application name*>.acore.mini.txt.
- The kernel mini core file name format is f10StkUnit<*Stack_unit_no*>.kcore.mini.txt.

Sample files names are shown in Figure 22-19 and a sample file text is shown in Figure 22-20.

Figure 22-19. Mini application core file naming example

```
FTOS#dir
Directory of flash:

  1  drw-      16384   Jan 01 1980 00:00:00 +00:00 .
  2  drwx       1536   Sep 03 2009 16:51:02 +00:00 ..
  3  drw-        512   Aug 07 2009 13:05:58 +00:00 TRACE_LOG_DIR
  4  d---        512   Aug 07 2009 13:06:00 +00:00 ADMIN_DIR
  5  -rw-       8693   Sep 03 2009 16:50:56 +00:00 startup-config
  6  -rw-       8693   Sep 03 2009 16:44:22 +00:00 startup-config.bak
  7  -rw-        156   Aug 28 2009 16:16:10 +00:00 f10StkUnit0.mrtm.acore.mini.txt
  8  -rw-        156   Aug 28 2009 17:17:24 +00:00 f10StkUnit0.vrrp.acore.mini.txt
  9  -rw-        156   Aug 28 2009 18:25:18 +00:00 f10StkUnit0.sysd.acore.mini.txt
 10  -rw-        156   Aug 28 2009 19:07:36 +00:00 f10StkUnit0.frrp.acore.mini.txt
 11  -rw-        156   Aug 31 2009 16:18:50 +00:00 f10StkUnit2.sysd.acore.mini.txt
 12  -rw-        156   Aug 29 2009 14:28:34 +00:00 f10StkUnit0.ipm1.acore.mini.txt
 13  -rw-        156   Aug 31 2009 16:14:56 +00:00 f10StkUnit0.acl.acore.mini.txt

flash: 3104256 bytes total (2959872 bytes free)
FTOS#
```

When a member or standby unit crashes, the mini core file gets uploaded to master unit. When the master unit crashes, the mini core file is uploaded to new master. In the Aggregator, only the master unit has the ability to upload the coredump.

Figure 22-20. Mini core text file example

```
                      VALID MAGIC
------------------------PANIC STRING -----------------
panic string is :<null>
----------------------STACK TRACE START---------------
0035d60c <f10_save_mmu+0x120>:
00274f8c <panic+0x144>:
0024e2b0 <db_fncall+0x134>:
0024dee8 <db_command+0x258>:
0024d9c4 <db_command_loop+0xc4>:
002522b0 <db_trap+0x158>:
0026a8d0 <mi_switch+0x1b0>:
0026a00c <bpendtsleep>:
------------------------STACK TRACE END----------------

---------------------------FREE MEMORY---------------
uvmexp.free = 0x2312
```

The panic string contains key information regarding the crash. Several panic string types exist, and they are displayed in regular English text to allow easier understanding of the crash cause.

TCP Dumps

TCP dump captures CPU bound control plane traffic to improve troubleshooting and system manageability. When enabled, a TCP dump captures all the packets on the local CPU, as specified in the CLI.

You can save the traffic capture files to flash, FTP, SCP, or TFTP. The files saved on the flash are located in the flash://TCP_DUMP_DIR/Tcpdump_<time_stamp_dir>/ directory, and labeled **tcpdump_*.pcap**. There can be up to 20 Tcpdump_<time_stamp_dir> directories. The file after 20 overwrites the oldest saved file. The maximum file size for a TCP dump capture is 1MB. When a file reaches 1MB, a new file is created, up to the specified total number of files.

Maximize the number of packets recorded in a file by specifying the snap-length to capture the file headers only.

The tcpdump command has a finite run process. When you enable the command, it runs until the capture-duration timer and/or the packet-count counter threshold is met. If no threshold is set, the system uses a default of five minute capture-duration and/or a single 1k file as the stopping point for the dump.

You can use the capture-duration timer and the packet-count counter at the same time. The TCP dump stops when the first of the thresholds is met. That means that even if the duration timer is 9000 seconds, if the maximum file count parameter is met first, the dumps stop.

Task	Command Syntax	Command Mode
Enable a TCP dump for CPU bound traffic.	tcpdump cp [capture-duration *time* | filter *expression* | max-file-count *value* | packet-count *value* | snap-length *value* | write-to path]	CONFIGURATION

23

Standards Compliance

This chapter contains the following sections:

Note: Unless noted, when a standard cited here is listed as supported by Dell Force10 operating software (FTOS), FTOS also supports predecessor standards. One way to search for predecessor standards is to use the http://tools.ietf.org/ website. Click on "**Browse and search IETF documents**", enter an RFC number, and inspect the top of the resulting document for obsolescence citations to related RFCs.

IEEE Compliance

- 802.1AB — LLDP
- 802.1p — L2 Prioritization
- 802.1Q — VLAN Tagging, Double VLAN Tagging, GVRP
- 802.3ad — Link Aggregation with LACP
- 802.3ae — 10 Gigabit Ethernet (10GBASE-W, 10GBASE-X)
- 802.3ak — 10 Gigabit Ethernet (10GBASE-CX4)
- 802.3i — Ethernet (10BASE-T)
- 802.3x — Flow Control
- 802.1Qaz — Enhanced Transmission Selection
- 802.1Qbb — Priority-based Flow Control
- ANSI/TIA-1057— LLDP-MED
- SFF-8431 — SFP+ Direct Attach Cable (10GSFP+Cu)
- MTU — 12,000 bytes

RFC and I-D Compliance

The following standards are supported by FTOS on an Aggregator and are grouped by related protocol. The columns showing support by platform indicate which version of FTOS first supports the standard.

General Internet Protocols

RFC#	Full Name
768	User Datagram Protocol
793	Transmission Control Protocol
854	Telnet Protocol Specification
959	File Transfer Protocol (FTP)
1321	The MD5 Message-Digest Algorithm
1350	The TFTP Protocol (Revision 2)
3164	The BSD syslog Protocol
draft-ietf-bfd-base-03	Bidirectional Forwarding Detection

General IPv4 Protocols

RFC#	**Full Name**
791	Internet Protocol
792	Internet Control Message Protocol
826	An Ethernet Address Resolution Protocol
1027	Using ARP to Implement Transparent Subnet Gateways
1042	A Standard for the Transmission of IP Datagrams over IEEE 802 Networks
1519	Classless Inter-Domain Routing (CIDR): an Address Assignment and Aggregation Strategy
1812	Requirements for IP Version 4 Routers
2131	Dynamic Host Configuration Protocol
3021	Using 31-Bit Prefixes on IPv4 Point-to-Point Links

Network Management

RFC#	Full Name
1155	Structure and Identification of Management Information for TCP/IP-based Internets
1156	Management Information Base for Network Management of TCP/IP-based internets
1157	A Simple Network Management Protocol (SNMP)
1212	Concise MIB Definitions
1215	A Convention for Defining Traps for use with the SNMP
1493	Definitions of Managed Objects for Bridges [except for the dot1dTpLearnedEntryDiscards object]
1901	Introduction to Community-based SNMPv2
2011	SNMPv2 Management Information Base for the Internet Protocol using SMIv2
2012	SNMPv2 Management Information Base for the Transmission Control Protocol using SMIv2
2013	SNMPv2 Management Information Base for the User Datagram Protocol using SMIv2
2024	Definitions of Managed Objects for Data Link Switching using SMIv2
2570	Introduction and Applicability Statements for Internet Standard Management Framework
2571	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks
2572	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
2574	User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
2575	View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)
2576	Coexistence Between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework
2578	Structure of Management Information Version 2 (SMIv2)
2579	Textual Conventions for SMIv2
2580	Conformance Statements for SMIv2
3416	Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)
3418	Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)
ANSI/TIA-1057	The LLDP Management Information Base extension module for TIA-TR41.4 Media Endpoint Discovery information
IEEE 802.1AB	Management Information Base module for LLDP configuration, statistics, local system data and remote systems data components.
IEEE 802.1AB	The LLDP Management Information Base extension module for IEEE 802.1 organizationally defined discovery information. (LLDP DOT1 MIB and LLDP DOT3 MIB)

Network Management (continued)

RFC#	**Full Name**
IEEE 802.1AB	The LLDP Management Information Base extension module for IEEE 802.3 organizationally defined discovery information. (LLDP DOT1 MIB and LLDP DOT3 MIB)
ruzin-mstp-mib-02 (Traps)	Definitions of Managed Objects for Bridges with Multiple Spanning Tree Protocol
sFlow.org	sFlow Version 5
sFlow.org	sFlow Version 5 MIB
FORCE10-IF-EXTENSION-MIB	Force10 Enterprise IF Extension MIB (extends the Interfaces portion of the MIB-2 (RFC 1213) by providing proprietary SNMP OIDs for other counters displayed in the “show interfaces” output)
FORCE10-LINKAGG-MIB	Force10 Enterprise Link Aggregation MIB
FORCE10-COPY-CONFIG-MIB	Force10 File Copy MIB (supporting SNMP SET operation)
FORCE10-MON-MIB	Force10 Monitoring MIB
FORCE10-PRODUCTS-MIB	Force10 Product Object Identifier MIB
FORCE10-SS-CHASSIS-MIB	Force10 S-Series Enterprise Chassis MIB
FORCE10-SMI	Force10 Structure of Management Information
FORCE10-SYSTEM-COMPONENT-MIB	Force10 System Component MIB (enables the user to view CAM usage information)
FORCE10-TC-MIB	Force10 Textual Convention
FORCE10-TRAP-ALARM-MIB	Force10 Trap Alarm MIB
FORCE10-FIPSNOOPING-MIB	Force10 FIP Snooping MIB (Based on T11-FCoE-MIB mentioned in FC-BB-5)
FORCE10-DCB-MIB	Force10 DCB MIB
IEEE 802.1Qaz	Management Information Base extension module for IEEE 802.1 organizationally defined discovery information (LDP-EXT-DOT1-DCBX-MIB)
IEEE 802.1Qbb	Priority-based Flow Control module for managing IEEE 802.1Qbb

MIB Location

Force10 MIBs are under the **Force10 MIBs** subhead on the **Documentation** page of iSupport:
https://www.force10networks.com/csportal20/KnowledgeBase/Documentation.aspx

You also can obtain a list of selected MIBs and their OIDs at the following URL:
https://www.force10networks.com/csportal20/MIBs/MIB_OIDs.aspx

Some pages of iSupport require a login. To request an iSupport account, go to:
https://www.force10networks.com/CSPortal20/Support/AccountRequest.aspx

If you have forgotten or lost your account information, contact Dell Force10 TAC for assistance.