Adoption of WBEM–based Systems Management

This Dell Technical White Paper explains the features and benefits of WBEM–based systems management in comparison to SNMP.
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Introduction

We are living in an information age. Billions in this earth at this moment are browsing through data on their laptops, tablets, and mobile phones. Behind this enormous data, running into petabytes, are workhorses of the computing world—servers. To keep businesses running smoothly, the servers need to be in ship-shape all the time. Businesses cannot have server downtimes and need to have administrators keeping an eagle eye on the health of IT systems. To help them in keeping everything running, server manufacturers such as Dell, provide systems management solution—iDRAC (integrated Dell Remote Access Control).

iDRAC forms the back-bone of Out-of-band server management in Dell Servers. To access iDRAC and the managed data, Dell provides the following interfaces:

a) Web-based Graphical User Interface (GUI)

b) Command line interface (CLI) that uses RACADM commands.

c) SNMP (Simple Network Management Protocol) agents

d) Web Services for Management—WSMAN

WSMAN is the web services-based interface of the WBEM (Web-based enterprise management) specification. WBEM is a set of systems management technologies developed to unify the management of distributed computing environments. WBEM is based on Internet standards and Distributed Management Task Force (DMTF) open standards: Common Information Model (CIM) infrastructure and schema, CIM-XML, CIM operations over HTTP, and WS-Management.

WBEM is a relatively new paradigm of systems management and a challenger to existing protocols such as SNMP. In some ways the behavior of WSMAN protocol reminds us a lot about the way SNMP behaves. How is it different? What is novel in this new kid on the block? How can WBEM make lives easier for administrators in the age of exponentially increasing information?

What is WBEM?

WBEM is a core set of standards for systems management comprising of Common Information Model (CIM), CIM-XML, CIM Query Language, WBEM Discovery using Service Location Protocol (SLP), and WBEM Universal Resource Identifier (URI) mapping. Equipped with the set of standards, one can model the management of a particular system, subsystem, service, or other entity.

WBEM provides the tools and technology of device, storage, network, and service management. WBEM has been here with us for about 20 years now. It emerged as desktop management standards, later blooming into full-fledged management architecture.
WBEM Architecture

The following diagram represents the WBEM architecture.

At the heart of the WBEM architecture lies the CIMOM (Common Information Model object manager). This component handles the bridging between the client and the instrumentation layers. The modeling of the managed entities as defined by profile documents are handled in the object manager.

The CIMOM exposes the interfaces using the CIM-XML or SOAP-based interfaces such as WS-MAN. An IT administrator can use WSMAN-based consoles to query about the data on managed elements. WBEM has an infrastructure to provide event notifications to a client which has subscribed to receive such alerts.

Web-Based Enterprise Management (WBEM) thus is a three-tiered model. The front-end is called the Common Information Model (CIM) client, also known as the management application. Open Source CIM clients such as SFCC (Small Footprint CIM Client) and WBEM-CLI are examples of CIM-based
Adoption of WBEM–based systems management

clients. The middle-layer, the CIM Object Manager, handles the communication between the CIM Client and the Provider. Examples of CIMOMs are OpenPegasus, OpenWBEM, and SFCC (Small Footprint CIM Broker). Developers write the layer underneath the CIMOM; this layer consists of providers, which manage resources. The last piece, which is part of the CIMOM, is the repository. It is used to store static and dynamic data.

**MOF: Managed Object Format**

Each CIM element (managed element) is represented as a class. The textual representation of the classes is defined in a MOF file. The MOF file is consumed as-is, or converted to an XML–based WSDL (Web services description language) by a client or console. The MOF describes the data and the methods that are supported on the managed element in a typical object-oriented-class format. The MOF supports inheritance.

**Simple Network Management Protocol (SNMP)**

In certain terms, the SNMP implementation has lot of similarities with the concepts of Web Services for management protocol; however, it cannot be directly tied to the concepts of the WBEM. SNMP used across the industry has the chosen protocol for management of different devices such as routers, switches, servers, workstations, printers, and modern racks.

![SNMP Architecture](image)

**Figure 1: SNMP Architecture**

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**Figure 2:**
Adoption of WBEM–based systems management

The above diagram depicts the overall architecture of the SNMP protocol. In a management system, an SNMP client must be installed that can Get and Set properties of the managed elements through SNMP agents running on the managed device. An agent is a network-management software module that resides on a managed device. An agent has local knowledge of management information and translates that information to or from an SNMP–specific form.

**MIB: Management Information Base**

SNMP itself does not define which information (or variables) a managed system should offer. Rather, SNMP uses an extensible design, where the available information is defined by management information bases (MIBs). MIBs describe the structure of the management data of a device subsystem—they use a hierarchical namespace containing object identifiers (OID).

**WBEM and SNMP: Are they Similar?**

In the earlier sections of this white paper, both the WBEM specification and the SNMP protocol have been described. They look to have uncanny similarities such as:

- Both are client-server–based architectures
- Central management module
  - CIMOM in WBEM
  - Agent in SNMP
- Data collector layer
  - Providers in WBEM
  - Subagents in SNMP
- Data representation
  - MOF files in WBEM
  - MIB files in SNMP.

But the question arises: Are they similar? Although both serves a similar purpose in providing a way to manage a set of devices, but looking deep we start seeing the inherent differences. In fact, the differences become so stark that the comparison becomes apples to oranges. Let us look at the differences in the next section.
Comparing WBEM and SNMP

Before looking at the specifics, we will look at the basic architectural differences in implementation of the two management paradigms. Figure 3 describes the implementation of SNMP and its coexistence in a traditional management framework; whereas, Figure 4 describes the way WBEM takes the center stage in the manageability framework.
In Figure-3, we can see that the SNMP is an interface-layer protocol, working alongside CLI and Web access to management devices. The mapping of the SNMP agents and the managed elements are direct one-one mapping.

From Figure-4, which depicts the WBEM-based architecture, where we see that all the user-level interfaces can use the CIMOM- or WBEM server as the central endpoint for all data transactions. The WBEM components can act as a data abstraction layer for multiple interfaces.

**Modeling**

SNMP follows a very simple modeling construct. The model is done in a flat tree structure and data can be represented as either a scalar- or in a tabular format. New managed objects form new nodes in the MIB tree.

WBEM follows a comprehensive Object Oriented modeling that enables complete modeling of large systems with relative ease. Any managed system can be described in the form of set of classes and the relationship between the classes. The model is extremely extensible with support of complete inheritance. Any new device can be derived from existing classes and can be modeled with new properties and methods to control the managed entity.

**Device Relationships**

WBEM provides a complete hierarchical representation of the managed system. It describes in details about the relation between two managed entities through association classes. For example, a CIM_FAN is associated to the CIM_Computersystem with CIM_SystemDevice association. This enables fluid traversal between managed elements with the knowledge of the relationships between two entities.

The data modeling in SNMP does not provide the complete relationship structure between devices.

**Data access and Control**

WBEM provides standard methods to gather data from the underlying managed elements. The data for all the instances of a particular managed element can be enumerated, all at one time, or got one by one using unique identifiers. The WBEM supports setting the properties on to the instances of the managed elements. The data access can be fine-tuned by using CQL (CIM Query Language) constructs in the data access request. Apart from standard data access methodology the WBEM modeling supports extrinsic methods. These are methods which can be called to have greater control over the managed devices. For example, consider a fan in a server whose speed can be controlled by setting the DesiredSpeed property in the CIM_FAN class. However, if we want to have customized control over the fan—such as, turn on for 5 mins, turn off for N number of minutes, and then turn on for 5 minutes. We can achieve this by introducing a method such as `CIM_Fan:SetFineControl(Int MinutesToOff)`.

SNMP is basic in its data access methodology. It allows basic Get and Set with the option of having a Bulk Get. We can only set properties, but not have enough granularities in device management.
The data access in WBEM is much more task-driven. Tasks can be scheduled across devices and monitored for changes or completion. The WBEM provides a more holistic model of the system and enables programmers and IT administrators a data model which is extensible and exhaustive.

However, SNMP is more restricted and is data-driven.

**Query Languages**

CQL is supported in WBEM implementation for granular access to data. It provides the capability to select properties from sets of CIM instances. The CQL specification is defined in DSP0202 in DMTF.

CQL queries are expressed as a statement in the following form:

```
SELECT <items> FROM <this> [ WHERE <conditions> ] [ ORDERED BY <sort specification> ]
```

**SELECT**

SELECT defines the columns of the table that results from the SELECT in its basic form (for example, the properties of the CIM Instance data to be returned as part of the result set).

**FROM**

FROM specifies the CIM Element from which to retrieve the data. For example, FROM could specify the name of one CIM class. All instances of this class and its subclasses are candidates for inclusion in the information that is returned as part of the result set.

**WHERE**

WHERE acts as a filter. The result set will not include items that do not match the set of conditions.

**ORDERED BY**

ORDERED BY sorts the results in the specified order.

SNMP and other traditional management protocols do not support such query driven data access.

**Usability**

SNMP is a one-one view of the managed device as described by the MIB modeling. SNMP may be used in lieu of a CLI for the managed system and to collect traps from the management system. However, its usage is restricted by the standard SNMP applications and MIB browsers.

WBEM through its SOAP–based WSMAN protocol provides a complete API–driven programming interface. The WSMAN exposes the CIM modeling as consumable APIs which can be used to describe and design a full-fledged console application.
Security

SNMPv1 and SNMPv2 were unsecure. Any one sniffing on the network would be able to capture SNMPv1 and SNMPv2 traffic. Security features were added on SNMPv3. SNMP follows a simple DES-based encryption methodology.

WBEM and its protocols, both CLI-based and web-based, support a complete certificate-based security. The data transaction is over HTTP's WBEM with its more secure data transaction.

Traps and Events

SNMP supports asynchronous events. If some unexpected event occurs, the SNMP agent will forward a trap packet to the SNMP listener, which is listening on UDP Port 162.

WBEM provides alert indication support, similar to SNMP. Through its WSMAN protocol, it provides more granularity of control over the events that must be received. WSMAN supports a subscription model, where an application can subscribe to a particular event class. The subscription can further be filtered on the basis of CQL queries, whereby the application can ask for an event after the change of a particular property in the class. The subscriptions can be time-bound or open for infinite time.

WSMAN protocol includes:

- Creation and deletion of event subscriptions
- Renewal of subscriptions before the expiry date/time
- Event message delivery configuration

Discovery

SLP (Service Location Protocol) is implemented in WBEM stack for easy discovery of its services. The SLP provides a flexible and scalable framework for providing clients, represented by User Agents (UA), with access to information about the existence, location, and configuration of services—represented by Service Agents (SA).

Traditionally, clients have had to know the name and access method of services. SLP eliminates this requirement. With SLP, the client requests a type of service that contains information about the requested services.

SLP uses Directory Agents (DA) that offer a centralized repository for advertised services. This feature enables the SLP to scale from very small to very large environments.

WBEM Servers acting as Service Agents (SA) advertise their services. WBEM Clients acting as User Agents (UA) query for the WBEM Server(s). A Directory Agent (DA) might be deployed in environments where many User Agents and Service Agents exist.

For each service access point (protocol/port) supported, the WBEM Server must supply an advertisement. For example, if a WBEM Server supports CLP and CIM-XML, it would supply at least two advertisements. Note that the WBEM Server would supply more than two advertisements if multiple ports were supported by the supported protocols. For example, it would supply four advertisements if it supported CLP over Telnet and SSH and CIM-XML over HTTP and HTTPS.
Traditional SNMP implementation however does not support any discovery protocols.

**In a Nutshell**

The following table enumerates the comparison between SNMP- and WBEM–based management.

<table>
<thead>
<tr>
<th>Features</th>
<th>WBEM</th>
<th>SNMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability of data</td>
<td>Profile and class definitions are extensible to multitude of systems</td>
<td>MIB descriptions may be platform specific</td>
</tr>
<tr>
<td>Data Access</td>
<td>WBEM provides multiple data access methodologies through enumeration get and extrinsic method support</td>
<td>Basic Get/Set</td>
</tr>
<tr>
<td>Method Support</td>
<td>Easy to provide methods like Updatefirmware, CreateCertificate, ExportLogs through WBEM infrastructure</td>
<td>Method support is absent</td>
</tr>
<tr>
<td>Security</td>
<td>High security. Complete certificate based HTTPs connection</td>
<td>Basic DES encryption only in SNMPv3</td>
</tr>
<tr>
<td>Easy to use for developers</td>
<td>Standardized interfaces and architecture. Complete modeling of the managed system in terms of UML gives complete picture of subsystem. Use of WSMAN APIs enables easy console deployment</td>
<td>SNMP is a simplistic protocol and is adapted widely because of that. However lacks the scalability of WBEM</td>
</tr>
<tr>
<td>Easy to use for system administrators</td>
<td>A slight learning curve if used as is. If used through a console as easy as using a GUI application</td>
<td>Basic SNMP configurations and a slight learning curve</td>
</tr>
<tr>
<td>Expandability of model</td>
<td>Extremely high with object oriented approach of modeling</td>
<td>Bound by the standard MIB construct</td>
</tr>
<tr>
<td>Event Support</td>
<td>High granularity on subscription of events and event delivery</td>
<td>Simple Trap support</td>
</tr>
<tr>
<td>Speed of retrieving/writing/querying data</td>
<td>Adding more layers of data transaction adds overhead. Usage of XML for data transaction may increase CPU overhead</td>
<td>Very fast as simple text data.</td>
</tr>
<tr>
<td>Platform support</td>
<td>Supports all known platforms. WBEM servers are open source cross platform implementation</td>
<td>Supports all platforms</td>
</tr>
<tr>
<td>Implementation Open Source</td>
<td>Open-Pegasus, SFCB, OpenWBEM, OMI, are open source implementation of WBEM stack</td>
<td>Yes. One OpenSource implementation: NetSNMP. Lots of propriety</td>
</tr>
<tr>
<td>Discovery support</td>
<td>Service Location Protocol Support</td>
<td>No discovery support</td>
</tr>
<tr>
<td>Query Language Support</td>
<td>CQL or WQL support</td>
<td>No query language support</td>
</tr>
</tbody>
</table>
Conclusion

SNMP, on the basis of its simplicity, became ubiquitous as a management protocol. Most devices worldwide support SNMP–based device management. However, WBEM–based management with its object-oriented-modeling paradigm has come as a serious contender as a systems management infrastructure. WBEM is not only extensible and scalable, but also extremely efficient and administrator-friendly. The modeling of the entire subsystem is possible through the WBEM–based infrastructure. WBEM was perceived to introduce extra data in terms of CIM-XML, however with binary interfaces and new age processors, it is slowly getting adopted for enterprise systems management. Dell provides a rich suite of systems management solutions and is a front-runner in promoting WBEM and WSMAN protocols. Across the industry we see a similar trend, which is slowly accepting the new paradigm of systems management in WBEM.