SNMP, CMIP based Distributed Heterogeneous Network Management using WBEM Gateway Enabled Integration Approach

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ABSTRACT

The rapid evolution of internet technologies raises the challenge of satisfying different management technologies and solution features for distributed heterogeneous networks in a unified architecture. The work proposes a novel Web Based Enterprise Management (WBEM) Gateway Enabled Integration Approach for SNMP, CMIP based heterogeneous networks. The solution is based on WBEM Common Information Model (CIM). The work involves network simulation and the mapping between SNMP, WBEM and CMIP, WBEM. A mapping function which converts SNMP Management Information Base (MIB) data to WBEM CIM Managed Object format (MOF) data and CMIP MIB data to corresponding WBEM CIM MOF data has been developed for performing specification translation operation of WBEM gateway. The SNMPv1MIB and SNMP v2 MIB information has been mapped to the corresponding WBEM CIM qualifier. In this way interoperability between heterogeneous networks has been obtained.

Keywords

WBEM, Gateway, SNMP, CMIP, Heterogeneous Network

1. INTRODUCTION

The computer networking is the practice of linking two or more computing devices together for the purpose of sharing data. A computer networks may be homogeneous network or heterogeneous network. A homogeneous network is a network of computers using similar configuration and multiple network layer protocols. A heterogeneous network is a network connecting computers and other devices with different operating systems and protocols. With the rapid growth of high speed computer network and advances in computing technology, the management issues of heterogeneous network become very exhaustive task for providing flexible, reliable services continuously. There are various management applications and technologies available most of which rely on SNMP [1], CMIP [2] but these technologies are unable to provide a consistent, portable and uniform solution of overall system. Besides traditional protocols like SNMP and CMIP, Web based solutions have become a more interesting and promising network-management approach. Distributed Management Task Force (DMTF) has been standardized the WBEM architecture [3]. WBEM is an object-oriented model to enterprise management, integrating heterogeneous network. It does not replace existing management protocol systems (SNMP, CMIP) but brings them

all under a common interface umbrella. Current computer network environments get distributed, but management solutions

have been developed and used is not a standardized one to work in a distributed heterogeneous network. This creates incompatibility and lack of interoperability among distributed heterogeneous system. Due to lack of interoperability between these various available distinguish management solutions; It is necessary to implement a standardized integration approach or a single operating panels that provides a consistent transition path between currently available management solutions of distributed computing environment. The integration approach unifies all the management functions in spite of their individual protocols and architecture.

The aim of present work is to manage distributed heterogeneous enterprise computing environment efficiently using WBEM Gateway enabled integration approach which provides an ideal solution for integrating two heterogeneous frameworks like SNMP and CMIP in a consistent manner.

2. INTEGRATION APPROACHES FOR HETEROGENEOUS NETWORK

Several researchers have been investigated the issues, strategies, and techniques related to the integration of SNMP and CMIP based network. Rose [4] describes methods for transition and coexistence for the management of TCP/IP based Internet and OSI networks. The two approaches, protocol-based approach and service-based approach, for the transition and coexistence for Internet and OSI protocol suites have been described. Mazundan [5] et al., at IBM Watson Research Center, presents the architecture of protocol independent management agent which can support both SNMP and CMIP protocols. Several architectures and algorithms for combining SNMP and OSI-based management have been proposed. A SNMP/OSI gateway is proposed in [6]. A prototype for the integration of CMIP and SNMP management has been described by Bob Moore and Jim Panian of IBM Corporation [7]. But the mapping of CMIP's security features to those of SNMPv1 and SNMPv2 did not addressed. In the present work a WBEM Gateway enabled integration approach for managing heterogeneous network is proposed. WBEM Gateways interconnect two different network systems like SNMP and CMIP and operate on their data formats or communications protocols.

3. WBEM GATEWAY ENABLED INTEGRATION APPROACH FOR HETEROGENEOUS NETWORK

To resolve interoperability and compatibility issues of heterogeneous network, a WBEM Gateway enabled integration approach has been proposed. The approach seems to deliver the most workable solution as the mapping between distinguishes domains like SNMP and CMIP is done very easily and efficiently.

Fig 1: Proposed WBEM Gateway Enabled Integration Solution for Heterogeneous Network

It contains three components: SNMP Agent, CMIP Manager and WBEM Gateway (Intermediate Agent) as depicted in fig1. The managed objects of the WBEM gateway take care of the actual translation of CMIP requests to SNMP requests and SNMP responses to CMIP responses. The WBEM gateway is responsible for emulating WBEM services by mapping to SNMP messages as well as CMIP messages. The gateway supports a forest of object instance trees, each contained by the root object, with one system object instance for each supported SNMP agent, and one system object instance for the gateway itself.
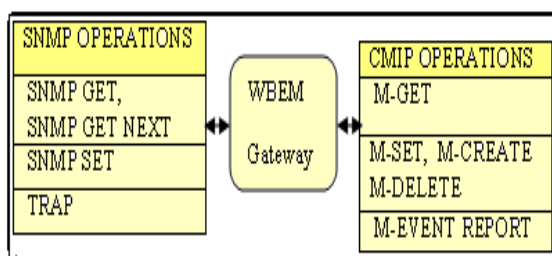

Fig 2: Service Mapping via WBEM Gateway

The fig 2 depicts Service Mapping between CMIP and SNMP based heterogeneous network environment. SNMP operations may be translated to CMIP operations and CMIP operations may be converted to SNMP operations using WBEM Gateway. The WBEM consists of a data definition format known as the CIM which is a mechanism for modeling managed resources and representing those models in the MOF language. CIM enables a wide variety of disparate management applications to share management data in a common format. WBEM Gateway provide the utility of MIB_ To_ MOF translation through which SNMP MIB (SMI) file is directly converted to WBEM CIM (MOF) file and CMIP MIB (GDMO) file is easily translated to WBEM CIM (MOF) file. This operation of WBEM gateway is referred to as Specification Translation. Specification Translation covers the process by which specifications are translated from one specification to another.

WBEM Gateway Specification Translation Operation for SNMPv1 and SNMP v2 based Networks

The MIB_TO_ MOF translation reads input MIB files and produces one or more MOF files. The table 1 depicts mapping table between SNMP MIB data type and WBEM CIM Data type. The table 1 object data type of SNMPv1 MIB (SMI) may be easily mapped to WBEM CIM (MOF) data type. Therefore SNMP data type may be efficiently used by WBEM SNMP Application Programming Interface (API).

Table 1 .The mapping table between SNMPv1 MIB Data type   and WBEM CIM Data type

SNMP MIB (SMI) Data type	SNMP Version	WBEM CIM (MOF) Data type
OBJCT IDENTIFIER	V1	String
IP Address	V1	String
OCTET STRING	V1	String
INTEGER	V1	Sint32
Gauge	V1	Unit32
Counter	V1	Unit32
Time Ticks	V1	Unit32
Display string	V1	String
Opaque	V1	Sint8[]
Network Address	V1	String

Similarly for SNMPv2, the table2 outlines mapping table between SNMPv2 MIB data type and WBEM CIM data type where object data type of SNMP v2 MIB (SMI) may be easily mapped to WBEM CIM (MOF) Data type.

Table 2.The mapping table between SNMPv2 MIB Data type and WBEMCIM Data type

| SNMP MIB (SMI) Data type	SNMP Version	WBEM CIM (MOF) Data type
Truth Value	V2	Sint32
Gauge32	V2	Unit32
BITS	V2	String
Unsigned32	V2	Unit32
Integer32	V2	Sint32
Counter32	V2	Unit32
Counter64	V2	Unit64
OBJCT IDENTIFIER	V2	String
OCTET STRING	V2	String
Time Ticks	V2	Unit32

WBEM Gateway Specification Translation Operation for CMIP based Networks

In case of CMIP based network, WBEM Gateway specification translation operation may also be performed. WBEM Gateway converts a CMIP MIB (GDMO) Data type to a WBEM CIM (MOF) Data type. The Table3 illustrates mapping table between CMIP MIB data type and WBEM CIM data type.

Table 3. The mapping table between CMIP MIB Data type and WBEM CIM (MOF) Data type

| CMIP MIB (ASN.1) Data type	WBEMCIM(MOF) Data type
INTEGER	Sint32
OBJECT IDENTIFIER	String
Time Type	Unit32
OCTET STRING	String
Character String	String

The WBEM Gateway is also responsible for communication and protocol translation between SNMP and CMIP based distributed heterogeneous network management system. The solution allows the CMIP manager to communicate with the remote SNMP agent via WBEM Gateway. The CMIP Manager sends M-GET request to WBEM Gateway. The WBEM Gateway acts as an Agent and works like a protocol converter. So it translate M-GET request to SNMP GET request and transfers the GET request to SNMP Agent. To provide response, SNMP Agent sends GET response to the WBEM Gateway. WBEM Gateway acts a Manager and converts the GET response to M-GET response which is submitted to the CMIP Manager. The Translation of CMIP Manager M-GET request to SNMP Agent GET request using WBEM Gateway is outlined in fig 3.
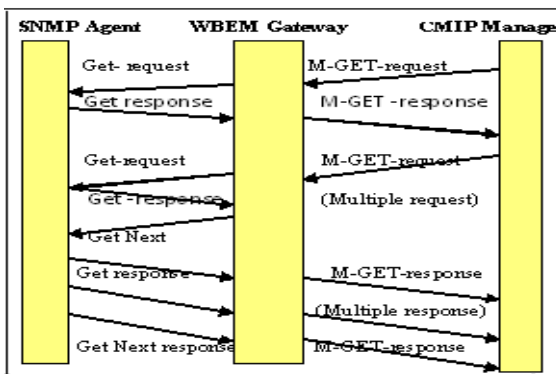
**Fig 3: Translation of M-GET request to GET request via WBEM Gateway**

4. RESULTS AND DISCUSSIONS

In the present work simulation of heterogeneous network has been obtained using Cisco Packet Tracer 5.0. When network is switched off, the ports are shown of Red Color. As soon as computer network is up and switched on, the color of all ports have been changed to Green. This represent successful establishment of heterogeneous network as depicted in fig 4.
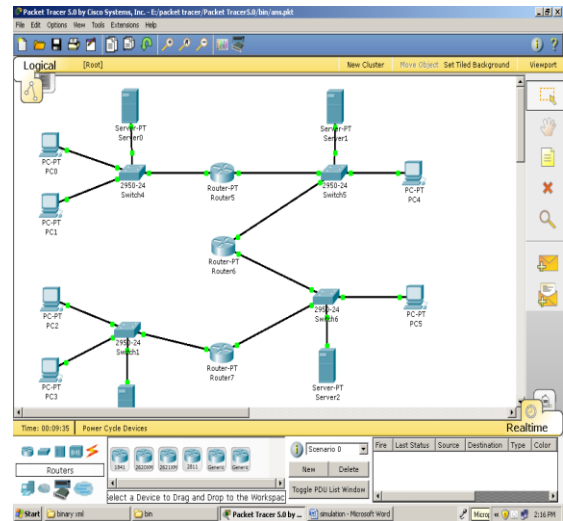
Fig 4: Heterogeneous Network Establishment

The results of Simulation in heterogeneous network are shown in fig 5. During the experiments it has been shown that message is successfully delivered in 3.612 seconds from client to server while routing between various hosts in the interconnected network. Therefore message communications between source pc and destination pc have been achieved.
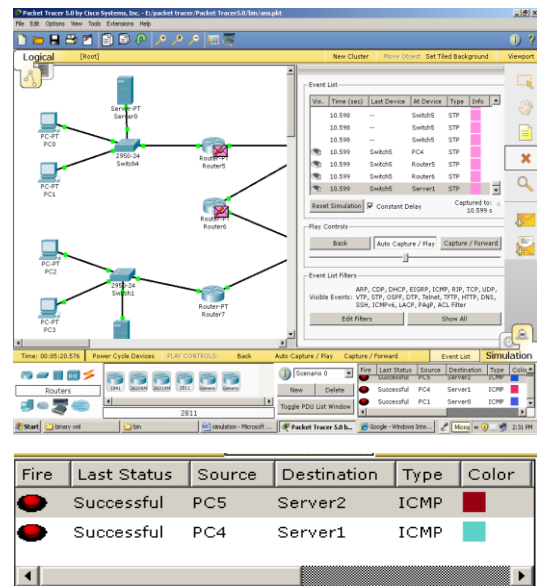
Fig 5: Results of Simulation in Heterogeneous Network

To implement Specification Translation operation of a WBEM Gateway, the MIB_To_MOF Translation utility has been used as illustrated in fig 6. By a MIB_To_MOF Translation, all management information that is defined as MIB may be translated to the MOF language format. The SNMP MIB and CMIP MIB are converted to CIM MOF format Then MOF file is compiled by the MOF compiler. The MOF compiler parses a file containing MOF statements and adds the management information i.e. the classes and class instances defined in the file to the CIM repository. Through this procedure the WBEM Gateway has flexibility to support any SNMP MIB or CMIP MIB.

The mapping rules have been applied to all of the SNMP data types described in mapping the SYNTAX Clause: The textual representation of the SYNTAX clause maps to the CIM property qualifier textual_convention. Qualifiers are values that provide additional information about classes, associations, indications, methods, method parameters, properties or references.
The named type definition in the SYNTAX clause maps to the CIM property qualifier object_syntax. This mapping differs depending on the data type. The SNMP type used when encoding SNMPv1 and SNMPv2C protocol frames maps to the CIM property qualifier encoding. The CIM property qualifier CIM type contains the textual representation that formats the underlying CIM protocol value. By using these mapping rules SNMPv1 and SNMP v2C MIB generates the WBEM CIM Qualifier as shown in fig 7 and 8. In this way SNMP v1 and SNMPv2C MIB information have been easily translated to WBEM CIM information and vice versa. Thus interoperability has been achieved between heterogeneous networks.
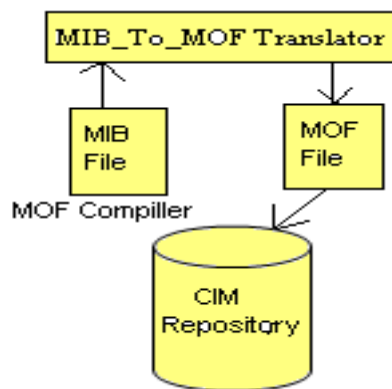

Fig 6: MIB_To_MOF Translation Utility

5. CONCLUSION

The present work depicted a novel WBEM Gateway enabled integration approach for managing SNMP, CMIP based heterogeneous network. The Simulation Results of heterogeneous network have been achieved. During the experiments it has been shown that message is successfully delivered from client to server while routing between various hosts in the interconnected network. The proposed WBEM Gateway solution provides specification translation mechanisms to support interoperability between WBEM, SNMP and WBEM, CMIP domains. The SNMPv1and SNMP v2 MIB information has been mapped to the corresponding WBEM CIM qualifier which represents interoperability between heterogeneous networks.

Pseudo SNMPv1-MIB (Textual Convention)

```
myNamedType ::= DISPLAYSTRING
(SIZE(0..127))
myNamedProperty OBJECT-TYPE
SYNTAX  myNamedType
ACCESS read-write
STATUS current
DESCRIPTION ""
```

This MIB produce the following WBEM CIM qualifiers:

Translated WBEM CIM

```
object_syntax("myNamedType"),
textual_convention("DISPLAYSTRING"),
encoding("OCTETSTRING"),
variable_length("0..127")
```

Fig 7: Mapping of SNMPv1- MIB to WBEM CIM Qualifier

Pseudo SNMPv2-MIB (Textual Convention)

```
myDisplaystring ::= TEXTUAL-
CONVENTION
DISPLAY-HINT "255a"
STATUS current
DESCRIPTION ""
SYNTAX OCTET STRING (SIZE (0..127))
myNamedProperty OBJECT-TYPE
SYNTAX  myDisplaystring
MAX-ACCESS read-only
STATUS current
DESCRIPTION ""
```

This MIB produce the following WBEM CIM qualifiers:

Translated WBEM CIM

```
object_syntax ("myDisplaystring"),
textual_convention("OCTETSTRING"),
encoding("OCTETSTRING"),
display_hint("255a"),
variable_length("0..127")
```

Fig 8: Mapping SNMPv2-MIB to WBEM CIM Qualifier

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