

Enhanced Object Oriented WBEM Enabled Solution for Non-Homogeneous Network

M. Mishra and S. S. Bedi

Abstract—In the present scenario due to rapid growth of Internet, increasing size and complexity of today's distributed network, providing a secure, reliable, efficient computing environment is one of the most challenging task faced by network administrator. Lack of single management model in enterprise management, lack of uniform, consistent framework for managing distributed, non-homogeneous computing environment, lack of standard-based interoperability and security of web technology arise the need of Web Based Enterprise Management (WBEM) initiatives. The present work depict an Object Oriented WBEM Enabled Solution for non-homogeneous network. It presents the enhance Object Oriented WBEM prototype which consist of gateway. The proposed WBEM is based on binary xml technology called EXI that overcome the limitations of existing binary technology named Fast Infoset (FI). By using EXI in the proposed WBEM prototype efficiency and performance of message communication between WBEM Client and WBEM Server can be increased. A mapping function has been developed that converts WBEM CIM operations into corresponding SNMP and CMIP operations for performing software gateway communication translation operation.

Index Terms—Binaryxml, CIM, WBEM, EXI, fastinfoset.

I. INTRODUCTION

A computer network is a collection of computers and devices interconnected by communications channels. It facilitates communication and shares resources among users. It is divided into two categories: Homogeneous Network and Non-homogeneous or Heterogeneous Network. A homogeneous network is a network of computers using similar configuration and multiple network layer protocols. A non-homogeneous network is a network connecting computers and other devices with different operating systems and protocols.

Today network administration is not up to the mark. Because of increased heterogeneity whether can be related to architecture, data protocols, hardware, and software. There are numerous management technologies and applications like Simple Network Management Protocol (SNMP), Common Management Information Protocol (CMIP) available but these technologies are unable to provide a consistent, portable and uniform solution of overall system. SNMP framework has been used for management of internet based

network. SNMP is an application layer protocol and transmit data in TCIP/IP network by User Datagram Protocol (UDP) which is a connectionless, unreliable communication protocol [1]. The CMIP provides a much richer network management environment than SNMP [2]. While SNMP only supports getting and setting the attributes and receiving notification of simple events, CMIP provides additional services including invoking operations on managed resources, sophisticated event notification and filtering to view of selected subset of management information. Besides traditional protocols like SNMP and CMIP, Web based solutions have become a more interesting and promising network-management approach. Web-Based Enterprise Management (WBEM) is a set of systems management technologies developed to unify the management of distributed computing environments [3]. In the WBEM initiative information communication between client and server are represented using Extensible Markup Language (XML) which is a set of rules for encoding documents in machine readable form [4]. But XML consist of some limitation. XML document Size is very large. Its data transmission is slow and inefficient. Parsing of XML document consume great deal of CPU times which reduces throughput and scalability. Business data encoded in XML takes more bandwidth to transmit in the network. XML consist of performance problem due to large size of file storage or memory requirement. To overcome these problems there is a technology named BinaryXML is used. It consists of new format and has the ability to compress the XML data transmission. Binary XML refers to any specification which defines the compact representation of xml document in Binary Format. It reduces verbosity of xml document. It minimizes cost of parsing and makes xml parsing more efficient. Therefore Binary XML technology is used in the proposed WBEM prototype. As IT environments get enlarged and distributed, there is a need of the integrated standardized solution for management of non-homogeneous network. But management solutions have been developed and used is not a standardized one to work in a non-homogeneous computing environment. This causes lack of interoperability among Non-homogeneous systems and ultimately it put enterprises to management standards and integration technology for expend a lot of total cost of ownership. In order to manage non-homogeneous enterprise computing that are not WBEM compliant (i.e., WBEM servers are not installed) but only SNMP and CMIP agents are installed, there is a requirement of specific gateway to manage SNMP and CMIP based non-homogeneous network. Gateway provides a solution of integrating two distinguish frameworks such as SNMP and CMIP.

The proposed solution is platform and technology neutral,

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consistent, specific management standard. It enables reliable end-to end message communication between Manager (server) and Agent (Client) efficiently and provides interoperability among non-homogeneous system. So the work depicts Object Oriented WBEM enabled solution for managing non-homogeneous network. This paper focuses on WBEM prototype which consists of software called gateway included in Common Information Model (CIM) repository of WBEM. A mapping function that converts WBEM CIM operations into corresponding SNMP and CMIP operations has been developed. This conversion operation of software gateway is referred to as Communication Translation.

II. WEB BASED ENTERPRISE MANAGEMENT (WBEM)

WBEM is a set of management and Internet standard technologies developed to unify the management of distributed computing environments, facilitating the exchange of data across otherwise disparate technologies and platforms. WBEM consist of three main standards [5]. The first standard is The Common Information Model (CIM) Specification, providing the knowledge model. Second standard is the CIM-XML encoding specification and the third is the CIM Operations over HTTP Specification providing the transport mechanism. CIM is object oriented schema and its purpose is to provide a unified model to represent every type of data, platform, and application. The goal of CIM-XML encoding specification is to create XML grammar written in Document Type Definition (DTD) that can be used to represent CIM classes and instances. The CIM operations over HTTP specification [6] define a mapping of CIM Operations in XML over HTTP that allows implementations of CIM to interoperate in an open, standardized manner.

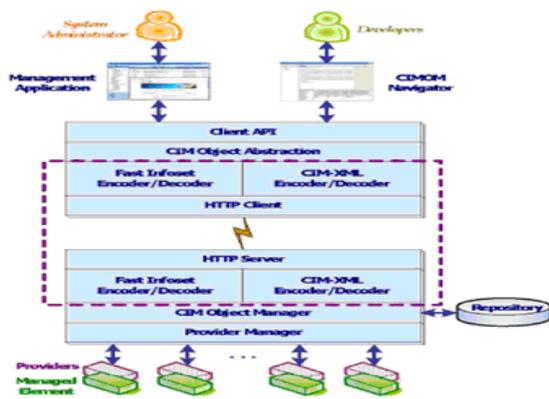


Fig. 1. Architecture for WBEM [3]

The Fig. 1 represents an example of WBEM architecture [3]. In this architecture Fast Infoset (FI), BinaryXML technology developed by Sun Microsystems is used. The DMTF working group is also standardizing additional technologies for WBEM such as WBEM CIM Query Language [7], WBEM Discovery using SLP [8] and WBEM URI mapping [9]. The Service Location Protocol (SLP) provides a flexible and scalable framework for providing clients, represented by User Agents, with access to information about existence, location and configuration of services, represented by Service Agents. WBEM Servers

acting as Service Agents advertise their services, and WBEM Clients acting as User Agents query for the WBEM Servers.

III. INTEGRATION APPROACHES FOR NON-HOMOGENEOUS NETWORK

Standards bodies have recognized the need for the technologies to co-exist, and provide specifications for the integration of SNMP, CMIP based non-homogeneous network. There is a requirement of integration approach to manage SNMP and CMIP based non-homogeneous network. These approaches can be classified mainly into two categories: The Protocol Neutral approach and the Specific Gateway Approach. The protocol neutral approach provides uniform access to both CMIP and SNMP services. SNMP objects are equivalent to OSI attributes, groups are mapped to classes and table entries become separate classes. Gateway provides interoperability and communication transparency among disparate systems. It facilitate information transfer that preserves the meaning and relationships of the information exchanged at every connection In this an application acts as a gateway for one or more agents of the other frameworks, exporting “converted” information model and providing service conversion from one access method to other. The conversion between information models can be performed automatically.

IV. OBJECT ORIENTED WBEM ENABLED SOLUTION FOR NON-HOMOGENEOUS NETWORK

To resolve Interoperability and compatibility issues of Non-homogeneous network, an Object Oriented WBEM Enabled solution has been proposed as depicted in fig 2.



Fig. 2. Proposed WBEM solution for non-homogeneous network

It contains three components: SNMP Agent, CMIP Manager and WBEM Gateway (Intermediate Agent) as depicted in Fig. 2. 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 solution allows the CMIP manager to communicate with the remote SNMP agent via Gateway. The CMIP Manager sends M-GET request to Gateway. The 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 Gateway. Gateway acts a Manager and converts the GET response to M-GET response which is submitted to the CMIP Manager. The solution permits system in a Non-homogeneous network environment to be managed regardless of the protocols and implementations in a different technology actually used using software gateway included in repository. The WBEM consists of a data definition format known as the Common Information Model (CIM) which is a mechanism for

modeling managed resources and representing those models in the Managed Object Format (MOF) language. It allows management information to be periodically observed, monitored and controlled and provides Single, unifying solution for Non-homogeneous network. It provides freedom from user interface, seamless integration of different framework, crosses the spectrum of management capabilities, ranging from simple workstation management to full scale enterprise management from remote location also. The Gateway is also responsible for communication translation as well as protocol translation between SNMP and CMIP based non-homogeneous network environment.

TABLE I: THE MAPPING TABLE FOR COMMUNICATION TRANSLATION OPERATION OF GATEWAY

Function	SNMP Operation	WBEM CIM Operation	CMIP Operations
General Read	SNMP Get, SNMP GetNext	GetClass, EnumerateClasses, GetProperty EnumerateClassNames, GetInstance, EnumerateInstance, EnumerateInstanceNames,	M-GET
General Write	SNMP Set	SetProperty	M-SET
Instance Manipulation	SNMP set	CreateInstance, ModifyInstance, DeleteInstance	M-CREATE, M-SET, M-DELETE
Schema Manipulation	--	CreateClass, ModifyClass, DeleteClass	--
Qualifier Oriented Methods	--	GetQualifier, SetQualifier, DeleteQualifier, EnumerateQualifier	--
Association Oriented Methods	--	Asociators, AssociatorNames, References, ReferenceNames	--
Query Execution	--	ExecQuery	--
Basic Notification	TRAP	--	M-Event Report

V. COMMUNICATION TRANSLATION OPERATION OF SOFTWARE GATEWAY

A mapping function that converts WBEM CIM operations into corresponding SNMP and CMIP operations has been developed. Using this function, mapping in Non-Homogeneous networks is obtained very easily as shown in Table I. It describes Communication Translation operation performed by the proposed WBEM Gateway. The general reading function, EnumerateInstances, GetInstance and GetProperty can get the property information. EnumerateInstances can acquire information about the property from all the instances that are created. All the management information from the agent through the EnumerateInstance operation may be retrieved. The

GetInstance operation may get the management information from only one SNMP Agent. The GetProperty operation may get one property value from one instance. Therefore EnumerateInstances operations may be converted to SNMP GetNext operation, and GetInstance or GetProperty operation may be replaced by the SNMP Get operation. M-GET operation is used to retrieve properties or attributes values of managed objects so GetInstance or GetProperty operations may be translated to M-GET operations. The instance Manipulation and general write function such as ModifyInstance and SetProperty can modify the property value. Therefore the ModifyInstance and SetProperty operations may be converted to the SNMP Set operation. In the same way M-SET operation is used to modify the values of attributes or properties values of managed objects. Therefore ModifyInstance and SetProperty operations may be replaced by CMIP M-SET operation. However, Schema Manipulation functions such as CreateClass, ModifyClass or DeleteClass operations and the General Read operation such as GetClass, EnumerateClasses, EnumerateClassNames or EnumerateInstanceNames operations do not access the SNMP Agent as well as CMIP Agent. Instead they directly query the repository and get the value. Therefore there is no SNMP and CMIP Operation to be converted. The Association Oriented method, Qualifier Oriented and Query Execution methods have no suitable SNMP and CMIP Operation to be replaced. In case of Basic Notification methods like TRAP (SNMP) and M-EventReport (CMIP) there are no appropriate CIM operation exists.

VI. PROPOSED ENHANCED OBJECT ORIENTED WBEM PROTOTYPE

Enhance Object Oriented WBEM enabled architecture based on binary xml technology EXI is depicted in fig 3. In the proposed WBEM architecture EXI is adopted rather than FI. EXI is a proposed data format from the Efficient XML Interchange Working Group of the W3C. EXI was chosen as W3C's Binary XML format after an evaluation of various protocols that included FI. EXI format is derived from Agile Delta Inc. Efficient XML format with a number of added features partly from contributor candidates like FI, Xebu etc. EXI is one of the most prominent Binary xml efforts to encode XML document in a binary data format rather than plain text. The main objective of EXI method adoption is to add-on the performance, efficiency of message communication between WBEM Client and WBEM Server. Network Administrator request is sent in a GUI or CUI mode which is the application logic layer (API). This request is transmitted through the CIM object Abstraction Layer. Then it is encoded by CIM-XML encoder or EXI Stream encoder. The encoded message is encapsulated as HTTP request message which is transferred to a corresponding WBEM Server via HTTP Web Client Connection Layer. When WBEM client has been sent HTTP request message, it waits for an HTTP response message from WBEM Server, if it may be received, the HTTP Web Client connection layer de-encapsulates the message and return the CIM operation response to either CIM-XML decoder or EXI decoder layer. An HTTP request message is delivered from WBEM Client is de-encapsulated on WBEM Server. A de-encapsulated CIM

operation request is transmitted to CIM-XML decoder or EXI decoder. The main task of this layer is to decode the entire message by applying appropriate decoding rule or specifications. At last its decoded CIM object is transmitted to CIM object Manager (CIMOM) which is the main crucial element of WBEM Server. It uses information stored in the repository to direct commands and response between WBEM Client and Providers. It provides four interfaces to execute the related task. First is Web Client Interface (WCI). Operators send request to the WBEM Server and CIMOM manipulate these request to formal commands to map standard models. Second is Indication Controller Interface (ICI). CIMOM sends notification about events that have occurred in the managed objects using ICI. Third is Protection Interface (PRI) and is used to authenticate operators to avoid unauthorized task. PRI may add some security mechanism (SM) like Authentication (A), Integrity (I), Access Control (AC), and Encryption (E). The Last interface is Persistence Interface (PEI) which is used to save or get CIM model from repository. In addition to it, there is a software gateway attached with PEI. The gateway performs communication translation operation. After this layer corresponding response message is encoded by CIM-XML encoder or EXI Stream encoder or EXI Stream encoder. At

This stage encoding rule is applied in the same way just like request message. Finally encoded CIM operation response is encapsulated and transferred to the WBEM Client by HTTP Web Server association layer.

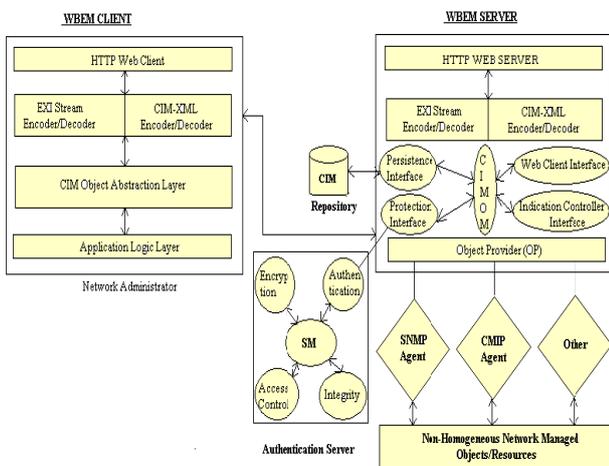


Fig 3. Proposed Enhance Object Oriented WBEM prototype

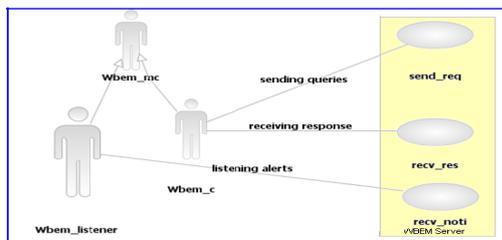


Fig. 5.UML use case diagram for WBEM

VII. RESULTS AND DISCUSSIONS

The UML is a language for visualizing, specifying constructing, documenting the artifacts of a software-intensive system. UML Modeling is done with the

help of IBM Rational Software Architect 6.0. UML Class diagram, Object diagram, Sequence diagram, Activity diagram, Collaboration diagram and Use case diagram are designed. The fig 4 outlines the steps involved in connecting to the CIMOM. This UML sequence diagram represents the authentication process.

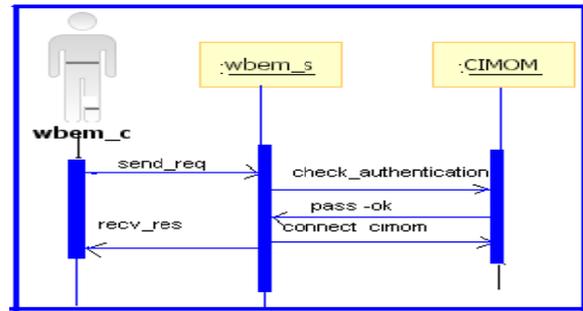


Fig. 4. UML sequence diagram for WBEM

Use case diagram shows a set of use cases and actors and their relationships. The Fig .5 depicts use case representation of proposed WBEM.As shown in Fig. 5 wbem_c and wbem_listener are the actors who can directly interact with the use cases in order to perform certain tasks. WBEM client send request to WBEM server and get response from it. Wbem_c may be wbem_listener and its work is listening notifications only.

After analyzing EXI & FI technologies on various issues, comparative results are shown in Table II.

The table II outlines the comparison analysis which helps in selection of EXI over FI.

TABLE II: COMPARATIVE STUDY BETWEEN EXI VS. FI

ISSUES	Efficient XML Interchange(EXI)	Fast Infoset (FI)
Organization	World Wide Web Consortium(W3C)	Sun Microsystems
Processing Speed	High	Low
Compactness	More	Less
XML Schema Constraint	More	Less
Generality	YES	No
Complexity	Low	Medium
Directly Readable and Writable	YES	YES
Transport Independence	YES	YES
Platform Independence	YES	YES

VIII. CONCLUSION

Present work proposed an Object Oriented WBEM Enabled Solution for managing Non-homogeneous Network. The work has been depicted an Enhance WBEM prototype based on binary xml technology called EXI. It overcomes the limitations of existing Binary XML technology named FI. By using EXI in the proposed WBEM architecture efficiency, performance of message communication between WBEM

Client and WBEM Server may be increased. A mapping function that converts WBEM CIM operations into corresponding SNMP and CMIP operations has been developed for performing software gateway communication translation operation. The results of comparative study outlined that EXI is better than FI. UML Structural Modeling and Behavioral Modeling are also done. The future task is to implement the proposed WBEM prototype.

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