UNIVERSITI PUTRA MALAYSIA

WEB-BASED NETWORK DEVICE MONITORING TOOL USING SIMPLE NETWORK MANAGEMENT PROTOCOL (SNMP)

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By

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To My Parents, Brothers and Sisters

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

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The Internet enables different computer networks to join together into one network in which many different models of network devices can co-exist with each other. Standard management protocol is necessary for the purpose of managing these networks. SNMP (Simple Network Management Protocol), one of the standard protocols, is designed for this open-class management function and is successfully implemented.

This thesis suggests a monitoring of network device statistical data from a remote place. This approach reduced the complexity of existing techniques, which are basically operable in specific operating system and having no standard Graphical User Interface (GUI). To address this problem, a system based on WWW standard tool is developed which is SNMP compatible as well as operable with any network device.

The network device monitoring tool is a client program, which is managed and could be contacted with the server program. A web server and a browser are to provide static, dynamic, and interactive management information. A web server, which plays a

managing role, offers a variety of types of information. An SNMP agent, which co-operates with a web server, uses SNMP protocol and provides access to management information of network devices/agents. The implementation of the user interface using the web-based technique of Java Applet makes it possible for a manager to easily search and manage agent Management Information Base (MIB) through a browser. Java SNMP class files and SNMP Applet Server (SAS) classes are used inside the Web-server to communicate with network devices. The network device monitoring tool is configured to collect network statistical data. It can monitor the real time graph on the basis of MIB variable from remote place and shows more efficient than the existing tool.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia untuk memenuhi syarat penganugerahan Master Sains

PERALATAN UNTUK PEMANTAUAN PERKAKASAN RANGKAIAN MELALUI WEB MENGGUNAKAN PROTOKOL (SNMP)

Oleh

MD. JAKIR HOSSEN

Mei 2003

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Internet membolehkan pelbagai jenis rangkaian komputer disambungkan bersama dengan menggunakan pelbagai model perkakasan rangkaian. Justeru itu, suatu teknik yang piawai diperlukan untuk menguruskan perkakasan-perkakasan tersebut. SNMP merupakan protokol pengurusan perkakasan rangkaian piawai yang utama pada masa ini.

Tesis ini mencadangkan pemantauan data statistik perkakasan rangkaian dari jarak jauh. Pendekatan ini lebih mudah digunakan berbanding teknik yang sedia ada yang lebih kompleks. Teknik yang sedia ada cuma boleh berfungsi pada sistem operasi tertentu dan tiada pengantaramuka pengguna. Suatu sistem pemantauan yang berdasarkan piawai WWW telah dibangunkan untuk mengatasi kelemahan ini dan memudahkan pemantauan ke atas perkakasan rangkaian yang memahami protokol SNMP.

Perkakasan pemantuan rangkaian terdiri daripada program pelanggan yang diuruskan dan boleh menghubungi program pelayan. Pelayan web dan pelayar web digunakan

untuk menyediakan pengurusan maklumat yang statik, dinamik dan interaktif. Pelayan web memainkan peranan sebagai pengurus dengan menawarkan pelbagai jenis maklumat. Suatu agen SNMP yang bekerjasama dengan pelayan web menggunakan protokol SNMP dan menyediakan capaian kepada maklumat pengurusan perkakasan/agen rangkaian. Pengantaramuka pengguna dibangunkan dengan menggunakan teknologi aplet Java yang berdasarkan web yang membolehkan penyelia rangkaian mencari dan menguruskan Pengkalan Maklumat Pengurusan (MIB) melalui pelayar web. Fail-fail kelas SNMP Java dan Pelayan Aplet SNMP (SAS) digunakan di dalam pelayan web untuk berhubungan dengan perkakasan rangkaian. Alat pemantauan perkakasan rangkaian dikonfigurasi untuk mengambil data statistik rangkaian. Ia boleh memantau graf pada masa nyata berdasarkan pemboleh-ubah MIB dari jarak jauh dengan lebih cekap daripada alat yang sedia ada.

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LIST OF ABBREVIATIONS

API	Application Programming Interface
ASN.1	Abstract Syntax Notation One
AT	Address Translation
ATM	Asynchronous Transfer Mode
BER	Basic Encoding Rule
CGI	Common Gateway Interface
CIM	Common Information Model
CORBA	Common Object Request Broker Architecture
DBMS	Data Base Management System
EGP	Exterior Group Protocol
GUI	Graphical User Interface
HTML	Hyper Text Markup Language
HTTP	Hyper Text Transfer Protocol
IBM	International Business Machine
ICMP	Internet Control Message Protocol
IP	Internet Protocol
ISO	International Standard Organization
IT	Information Technology
JDBC	Java Data Base Connectivity
JDK	Java Development Kit
JMX	Java Management Extension
JPEG	Joint Picture Expert Group
JVM	Java Virtual Machine
LAN	Local Area Network
MIB	Management Information Base
MIME	Multipurpose Internet Mail Extension
MTA	Mail Transfer Agents
NHD	Network Hardware Division
NMS	Network Management System

OID	Object Identifier
OS	Operating System
OSI	Open System Interconnect
PDU	Portable Data Unit
PERL	Practical Extraction and Report Language
QOS	Quality Of Service
RDMS	Relational Data Base Management System
RFC	Request For Comments
RMI	Remote Method Invocation
SAS	SNMP Applet Server
SMI	Structure of Management Information
SNMP	Simple Network Management Protocol
SSI	Server Side Include
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
URL	Uniform/Universe Resource Locator
VOIP	Voice Over Internet Protocol
WAN	Wide Area Network
WBEM	Web-Based Enterprise Management
WIMA	Web Integrated Management Architecture
WWW	World Wide Web
XML	Extensible Markup Language

CHAPTER 1

INTRODUCTION

1.1 Introduction

There has been an explosive growth in the Internet for the last few years. Millions of computer are connected together and can exchange information through the World Wide Web (WWW), or global networking. The availability of connection through the Web has introduced many new services such as e-commerce, Voice Over Internet Protocol (VOIP), telemedicine, and virtual library.

Network management includes the deployment, integration and coordination of the hardware, software, and human elements to monitor, test, poll, configure, analyze, evaluate, and control the network and element resources to meet the real-time, operational performance, and Quality of Service (QoS) requirements at a reasonable cost. Network management is the sum of all activities related to configure, control and monitor network and systems (William, 1993).

Simple Network Management Protocol (SNMP) is governs networks management and monitoring the network devices and their functions. SNMP defines a client-server relationship (Stalling, 1999). The client program (called the network manager) makes virtual connection to a server program (called the SNMP agent), which executes on a remote network device and serves information to the manager regarding the device's status.

The database controlled by the SNMP agent, is referred to as the SNMP Management Information Base (MIB), and is a standard set of statistical and control values. Management Information Bases are a collection of definitions, which define the properties of the managed object within the device to be managed. Every managed device keeps a database of values for each of definitions written in the MIB. The latest Internet MIB is given in RFC 1213 sometime called the MIB-II. It can be thought of a MIB as an information warehouse (David, 1999).

Web technology is very rapidly penetrating many business areas. Systems and network management is no exception. The technology is based on the Internet and offers a number of benefits in terms of openness and ubiquity of its standards and tools. The ability to use a universal browser to access management functions, device status and statistics, and to configure remote managed objects from anywhere at anytime gives many advantages to a network administrator.

The Java language was developed at Sun Microsystems in 1991 as part of a research project to develop software for consumer electronics devices, television sets, VCRs, toasters, and others sorts of machine. Java's goals at that time were to be small, fast, efficient and easily portable to a wide range of hardware devices. Those goals made Java an ideal language for distributing executable programs via the World Wide Web and also a general purpose programming language for developing programs that are easily usable and portable across different platforms. Java programs (Applets, Applications) can run on any machine that has the Java Virtual Machine and Web browser installed. Java Applet is a small application, which is run on the Web browser and provides an interesting graphical display.

Web-Based Management is the application of Internet and Java programming technologies for network and device management. Those technologies are the latest; little research has been made on them so far. This research includes the comparisons of Web-Based Management with conventional SNMP Management. In this comparison emphasis is put on several characteristics, such as security, cost, and user friendliness.

In this study, a method is presented as evidence that the Web-Based Management is one of the latest application for network device monitoring that can be used to solve existing problems.

1.2 Justification of the Study

One of the latest emerging technologies is the use of Internet technology and Java for network and SNMP for network device monitoring purposes. This application is called Web-Based Network Device Monitoring (WBNDM). WBNDM is latest and it is time to judge the value of this new technology by conducting proper research. Therefore, the aims of this study are:

a) To study on Web-Based Management and its application to the network device monitoring.
b) To compare between the developed tool and the conventional SNMP monitoring tool. In this comparison the emphasis is put on speed of packets or octets transfer from clients to computer agents and vice versa.

1.3 Problem Statement

Conventional network management systems that have been studied and developed until now tend to incline to the analysis of equipment itself or traffic. They have some drawbacks. They are difficult to use and do not furnish integrated environment. Also, they have several limitations that include being operated on specific operating system and having no standard graphical user interface (Hong, et al., 1999) as well as other limitations such as those concerning standardization (Stalling, 1999). As a result, it is not easy to monitor and configure the network device statistical data from remote place in a standard Graphical User Interface manner.

1.4 Scope of the Thesis

In this research, the study is concentrated on three main parts. They are SNMP, Web-Based management, and Java programming. Apache Tomcat Web server, and SNMP Applet Server (SAS) are used in this study. The goal of this tool is to monitor and configure functions to be performed on a communication network. The development of this prototype serves to investigate the extent to which the applications offer a monitoring of network device statistical data from remote place in an efficient mode.

1.5 Objective

The main goal of this study is to develop a sophisticated Web-Based Network Device Monitoring Tool by exploiting the advantages provided by Java programming language and its mobile agent characteristics. The objectives are as follows:

a) To develop a client program using Java programming language and runs on the standard Web browser. The Java Applet (client program) is interfaced to the network agent/device via SNMP Applet Server (SAS) using Apache Tomcat Web server.

b) To monitor the configured statistical data of the network agents/devices from remote place using existing Simple Network Management Protocol (SNMP).

c) To compare between the developed tool and the conventional SNMP management tool that evaluates the speed on the basis of MIB variables.

1.6 Structure of the Dissertation

Firstly, Chapter 1 of this dissertation introduces the subject matter as well as discussing the problem, scope and objectives of concern. Chapter 2 is devoted to network management, SNMP and Java tutorials, previous work, and work related with the project, and presents the current state of Web-based management tools and their pros and cons. Chapter 3 focuses on the solution methods and highlights the contributions, model, submodel proposed for Web-Based Network Device Monitoring Tool. Chapter 4 presents the result and discussion on implementation and validation of proposed solution. Finally, the conclusion and some directions for future work are delivered in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

This chapter offers discussions about the applicability of network, tutorials of SNMP and Java programming, and criticisms of different SNMP tools, and server programs. Finally, basic Web documents, Web technologies, and various types of Web- based management architecture from academia and institution are discussed.

2.1 Network Management

The evolution of network management has been in close systems and communication network with the way in which systems and network themselves have evolved - from a limited interconnected homogenous set of systems under one domain to a large heterogeneous distributed communication environment spanning across multiple domains. It is evident that the complexity of network management has accumulated over the years to cater to the heterogeneous and ubiquitous communication networks that we have today. The complexity has been a direct consequence of variety of network components, geographic distribution of components, multiple operating domains, integrated service environment and heterogeneity of systems.

Five major functional areas of network management are defined by ISO including configuration management, accounting management, fault management, performance management, and security management. Based on the functionality of configuration management defined by the Open System Intcerconnect (OSI) (OMAP, 1998)