The Design of a Graphical User Interface for a Network Management Protocol

Xiaoan Hou, Youlu Zheng
Science Application International Corporation / University of Montana

INTRODUCTION

1.1 GUI and X-Window System

The graphical user interface (GUI) is one of the most revolutionary changes occurring in the evolution of modern computing systems. In the space of less than 15 years the expectation of what the interaction between human and computer should be like has changed from a terse, character-oriented exchange modeled on the teletypewriter to the familiar Windows, Icons, Menus and Pointing device (WIMP) interface. This revolution has increased the accessibility and usability of computer systems to the general public.

The X Window System (X for short) is widely recognized as the industry standard for network-based window systems. X provides a powerful platform that allows programmers to develop sophisticated graphic user interfaces portable to any system that supports the X protocol. Motif is a high-level user interface toolkit that makes it easier to write applications that use the X Window System. The Motif library builds on the Xt Intrinsics layer and provides visual components like buttons and scrollbars from which an application's user interface can be built. A educational network management software, named SNMPview, was newly developed using Motif/Xt. SNMPview possesses a high portability to the large body of existing different UNIX platforms.

1.2 Simple Network Management Protocol

In the IP world, simple network management protocol is synonymous with network management. The word simple can be deceptive. The simple in Simple Network Management Protocol (SNMP), for example, might lead you to think it is a protocol, or a set of rules, for simple network management. In fact, network management is never simple nor are the protocols that are used to implement it. The oxymoronic SNMP is "simple" only in comparison to the OSI (Open Systems Interconnection) management model. In fact, SNMP was originally designed and implemented as an interim specification for communicating with network devices while the OSI specification was being finalized and being implemented during the late 80s. SNMP was supposed to fade away once OSI came on-line. But things have not worked out that way. By 1993, when OSI finally matured, SNMP had a three years head start and had already been implemented in hundreds of products. SNMP is now the de facto standard in network management.

The SNMP model for managing networks is based on three pieces of software: agents, MIBs (management information bases), and management stations (or called manager). Figure 1 shows the schematic representation of SNMP model. Agents are pieces of software that run at each network device. They fetch
information from a database called management information base which is also stored at the device.

![SNMP Model Diagram](image)

**Figure 1 SNMP Model**

Management stations (manager) let you retrieve and display information gathered from a device's agent and MIB. Management station can also control (or Set in SNMP terms) those devices.

---

**DESIGN OVERVIEW OF SNMPVIEW**

New SNMP support software, called SNMPview, has been developed to provide an aid for network managers or those who take interest in rapidly understanding current and novel techniques for network management. SNMPview provides a graphic user interface to the command line interface of the MIT SNMP Development Kit. Figure 3 shows the SNMPview graphical user interface.

### 2.1 Network Map and Host Selection

SNMPview can perform an automated discovery of all the agents (computers, printers, etc) interconnected in a local network and then draw a map of the network in a two level tree. The root of the tree is the management station, which is the computer where the SNMPview software is installed. A SNMP command requires you to specify a remote host before you can query on the management information stored in that host. SNMPview provides two ways to specify a remote host on the SNMP command line. You can choose a host from either the network map or from the sorted host list. The host list is sorted by alphabetical order, which provides a fast way to identify a desired host to retrieve management information. Once a host is chosen, the status of the host is automatically tested using the ping command. If the host responds, the background of the host icon remains unchanged. If the chosen host is down at the time, the background of the host icon will be set to a dark color, which is an indication that the chosen host is not available for management information inquiry. In both cases, the IP address of the chosen host will be retrieved. There are two textfields on the GUI of SNMPview, one labeled Selected Host and the other IP Address. These two textfields are specially designed to display the chosen host at any time. Once a host is chosen, the Selected Host textfield shows the chosen host name and the IP Address textfield displays its IP address. Figure 3 shows the network map and sorted list of all the hosts interconnected in our Computer Science Department subnetwork. A network node is represented by an icon, which is an XmRowColumn widget managing two widgets: an XmLabel widget to display the host name and an XmPushButton widget to display a pixmap of an IBM RISC computer. The sorted host name list is displayed by an XmList widget. From the figure, you can see the
background of the host *gem* and *dalphi* is dark, indicating these two hosts are down at the time of testing and are not available for management information retrieval.

### 2.2 Toggle Button Implementation of SNMP commands

The four basic SNMP commands are implemented as a RadioBox. That is, an XmRowColumn widget is used to manage a set of four XmToggleButton widgets. A toggle button consists of an optional indicator and a label area. The labels for the toggle buttons are snmpget, snmpnext, snmpset and snmptrap, as shown in Figure 2. A diamond indicator means that the toggle button displays a "one-of-many" selection state. That is, only one XmToggleButton can be selected at one time. By default, the snmpget selection is set at the start of SNMPview. The center portion of the indicator is set to the specified color once the toggle button is selected.

**Figure 2  SNMPview Graphical User Interface**
If a second button is selected afterwards, the first selected button will be unset. This feature of radio box provides a simple graphic way to select a SNMP command.

### 2.3 Procedures for Retrieving Management Information

The SNMPview GUI also includes an XmList widget displaying the MIB variable list, named Management Information. To issue a SNMP command, as dictated by the syntax of SNMP commands, you need to first specify one SNMP command from the four available commands. This task is done by selecting one of the four toggle buttons as discussed in the above section. Second, you need to specify a remote host from which you are interested in retrieving management information. A remote host can be graphically chosen as discussed in the Section: Network Map and Host Selection. Third, you must specify the name or the OID of an MIB, which indicates what kind of information you want to retrieve. This job is accomplished by selecting an item from the Management Information list. Once you click an item in the Management Information list, the dot notation numeric name of the chosen MIB object is retrieved automatically through a search of the MIB-2 object database. Then a SNMP command is issued containing the specified host and the numeric name of the chosen MIB object. The dot notation numeric name of an MIB object is not shown in the Management Information list. This information is intentionally hidden from the user since the textual name of an MIB object is much more understandable and more likely to be useful when a user issues a SNMP command.

### 2.4 Network Mode and MIB Mode

If you choose the Network Map command from the Network pulldown menu or you open a network file, which stores a list of hosts, to draw a map of hosts in the underline subnetwork, the program automatically enters network mode. In network mode, the upper large scrolled window will show a map of hosts interconnected in the network; the lower left list widget will show a sorted list of hosts in the network. The lower right list widget will load the list of MIB-2 variables. You can perform the retrieval of network management information only in network mode. On the other hand, if you choose the MIB pulldown menu to display the MIB OID tree, the program automatically enters MIB mode. The upper large scrolled window now displays the MIB OID tree using a pushbutton labeled with MIB variable textual name representing each node in the tree. The lower left list widget will display the list of SNMP related MIB objects. The lower right list widget named Management Information remains unchanged. The dot notation numeric name of an MIB variable can be obtained by clicking the corresponding node in the tree or selecting the corresponding item in the MIB OID list. The textual name of the selected MIB variable is displayed in the Selected MIB Object textfield and the dot notation numeric name or OID in the Object Identifier textfield. Hence, SNMPview can also function as an MIB browser.

### 2.5 Network File Management

SNMPview can also assist in performing file management. It can open a network file, which stores a list of hosts, and draw a map of the hosts specified in that file. The host list is sorted first and then set into the

---

**Figure 3** Toggle Button Implementation of SNMP Commands

---

1996 ASEE Annual Conference Proceedings
Host List widget. It can also perform an automated search of all the hosts interconnected in the present local network and then draw a map of the network. The search algorithm is described in the next section. The Delete and Add commands under the Edit menu let you delete an unwanted host from the map, add a host into the network map, or save the modified host list as a new network file. This function provides the flexibility to remove those hosts that are always down and add those hosts that are new members of the network.

**COMPARISON AND SUMMARY**

SNMPview was developed as an educational tool for those who want to rapidly learn about current network management techniques. This software possesses many advantages as an education tool. SNMPview provides direct feel about how SNMP works. The user has a high flexibility in freely choosing what command to issue, what host to manage and what kind of management information to retrieve or set. To use this software requires little previous knowledge of SNMP. A user can play with the software using only a mouse and at the same time, gain a sense about how present networks are managed. In contrast, other available SNMP software packages are usually designed for efficient network management, not for education. They usually hide those details of SNMP command implementation from the user intentionally.

SNMP could be puzzling for a learner. Extensive knowledge of MIB is a prerequisite in understanding Simple Network Management Protocol. SNMPview can function both as a network manager and as an MIB browser. Combining these two functions into one software package makes a good educational tool for understanding of SNMP. Though separate products containing either an MIB browser or a network manager are widely available, software packages that combine both an MIB browser and a network manager into one are rare. For example, the popular software package HP OpenView, one of the major commercial network management systems, has an MIB browser. However, this package is expensive, its code is not in the public domain and thus cannot be modified by a potential user and is thus not ideal for educational use.

SNMPview provides two ways to select a host for the query of management information. The unique sorted list of hosts displayed by SNMPview enables a user to rapidly identify a desired host. The public domain SNMP software, NetGuardian developed by the University of Lisbon, provides a nice graphic user interface for SNMP. However, NetGuardian hides the implementation of SNMP commands and does not implement the snmpset operation. This kind of implementation restricts the software function to monitoring network. The software cannot be used to configure a network. Although NetGuardian draws nice map of a network to be managed, it does not provide the list of hosts in the network. It would be hard to find a desired host from the map when the number of hosts in the network becomes large.

As an educational tool, SNMPview is better than other available public domain packages, and more adaptable than commercial SNMP software. However, as a network management tool, SNMPview is insufficient. The SNMP command set is not efficiently implemented since only one piece of management information or one table of management information can be retrieved at one time. In order to make SNMPview a commercial product or even a more useful educational tool many network functions need to be implemented or enhanced. These include automated periodical device status polling, event (or problem) notification, hierarchical discovery of all the nodes in a wide area network, and many others.

**ACKNOWLEDGMENT**
This project was supported, in part, by the National Science Foundation via the Instrumentation and Laboratory Improvement (ILI) program. A Computer Graphics and Visualization Lab with clustered IBM RS/6000 workstations was established in 1993 with a grant from the program with matching fund from the University of Montana. The laboratory’s graphical environment supports both regular courses and special projects, and extends the level of training beyond what is possible with the PC-instructional clusters. With the laboratory, the students gain hands-on experience with state-of-the-art graphics and visualization technologies and better prepare themselves for careers in research, public service, and industry.

Many undergraduate and graduate students in the Department of Computer Science, University of Montana, have worked in and used the lab in various visualization projects. Numerous professionals from schools, government agencies attended tutorials, seminars utilizing this lab. The authors are indebted for the support from the National Science Foundation.

REFERENCE


5. James R. Davin, The SNMP Development Kit Release Notes, Laboratory of Computer Science, Massachusetts Institute of Technology, January 1994. (this reference is available in postscript file format from the ftp site: allspice.lcs.mit.edu)

About the Authors:

XIAOAN HOU is an programmer/analyst from Science Application International Corporation, Los Altos, California. His email address is xiaoan@inow.com.

YOULU ZHENG is a tenured professor in the Department of Computer Science, University of Montana. He is also consultant and adviser for several computer and network related companies. His email address is zheng@cs.umt.edu.