



HP OpenView Extensible SNMP Agent Administrator's Reference

HP 9000 Series



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Introduction and Operational Concepts

This manual is for the person who installs configures, administers, and troubleshoots the HP OpenView Extensible SNMP Agent. The HP OpenViewExtensible SNMPAgent is provided with the HP-UX version 8.0 or later software.

This manual assumes that you are a knowledgeable HP-UX system and network administrator and troubleshooter. You should know how to do the following:

- Update your system with new software.
- Kill processes.
- Write shell scripts.
- View, search, and edit files.

In addition, you also need to understand SNMP MIBs and traps.





Documentation Guide and References

HP-UX System Administration Manuals

- *HP-UX Reference*

Networking Manuals

- *Installing and Administering LAN/9000 Software*
- *Administering ARPA Services*
- *Using ARPA Services*

Network Management Manuals

Refer to the Administrator's Reference manual that was shipped with your HP OpenView product.

TCP/IP and SNMP Concepts

Comer, Douglas. *Internetworking With TCP/IP: Principles, Protocols, and Architecture*. Englewood Cliffs, New Jersey: Prentice-Hall, 1988. To order, reference ISBN 0-13-470154-2.

Rose, Marshall T. *The Simple Book: An Introduction to Management of TCP/IP-based internets*. Englewood Cliffs, New Jersey: Prentice-Hall, 1989. To order, reference ISBN 0-13-812611-9.

Stallings, William *SNMP, SNMPv2, and CMIP: The Practical Guide to Network-Management Standards*. Addison-Wesley Publishing Company Inc, 1993. To order, reference ISBN 0-201-63331-0.





Internet Request for Comments Documents

Copies of these documents are shipped on the HP OpenView Extensible SNMP Agent product installation media. They are in the **EAGENT-MAN** fileset and are installed in the **/usr/ov/doc** directory.

To find out about...	See...	Filename
how MIB objects are defined	RFC1155: Structure and Identification of Management Information for TCP/IP-based Internets	rfc1155.txt
the protocol used to manage the MIB objects	RFC1157: A Simple Network Management Protocol (SNMP)	rfc1157.txt
the format for creating MIB object files	RFC1212: Concise MIB Definitions	rfc1212.txt
the objects contained in the Internet-standard MIB	RFC1213: Management Information Base for Network Management of TCP/IP-based Internets: MIB-II	rfc1213.txt





Definitions and Concepts

This section describes the definitions and the concepts that you need to successfully configure and manage your HP OpenView Extensible SNMP Agents.

A manageable network consists of one or more manager systems, or network management stations, and a collection of agent systems, or network elements.

- A **manager system** executes network and system management operations which monitor and control agent systems. The implementation of these network and system management operations is called the **manager**.
- An **agent system** is a device, such as a host, gateway, terminal server, hub, or bridge, that has an **agent** responsible for performing the network and system management operations requested by the manager.

A manager and agent may exist on the same system.

The Simple Network Management Protocol (**SNMP**) communicates management information between a manager and an agent. SNMP allows

- A manager to retrieve (**get**) management information from an agent. The manager sends requests for information to the agent, and the agent sends back replies containing the information requested.
- A manager to alter (**set**) management information on an agent.
- An agent to send information to the manager without an explicit request from the manager. Such an operation is called a **trap**. Traps alert the manager of changes that occur on the agent system, such as a reboot. The agent knows which manager system to send traps to through a configurable trap destination.

Requests for information on an agent are accompanied by a **community name**, which is a password that allows the manager access to that information.





MIBs

Conceptually, the information on the agent is known as the Management Information Base (**MIB**). The MIB is not a physically distinct database, but rather, a concept that encompasses configuration and status values normally available on the agent system. MIB values conform to an Internet-standard structure of management information and compose a virtual data store on the agent system. This structure is defined by *RFC 1155: Structure and Identification of Management Information for TCP/IP-based Internets*. Agents contain the “intelligence” required to access MIB values.

The MIB objects are defined using the Internet-standard structure of management information (SMI) and compose a virtual data store on the agent system. This structure is defined by *RFC 1155: Structure and Identification of Management Information for TCP/IP-based Internets* and amended by *RFC 1212: Concise MIB Definitions*. Together RFCs 1155 and 1212 define the structure of management information for SNMP-based management. SNMP agents contain the “intelligence” required to access MIB values.

MIBs are organized into **MIB modules**. A MIB module is a file defining all the MIB objects under a subtree. The foundation module is the standards-based MIB-II module defined by *RFC 1213: Management Information Base of Network Management of TCP/IP internets: MIB-II*. In addition to the Internet-standard MIB-II objects defined in RFC 1213, many hardware vendors, such as Hewlett-Packard, Cisco Systems, Wellfleet, and Novell (Excelan), have developed MIB extensions for their own products. The MIBs defined by these various hardware vendors are referred to as enterprise-specific MIBs in this manual.

How to Access the MIB

The manager accesses the agent's MIB using SNMP's get and set operations.

Figure 1-1 shows a simplified diagram of the manager-agent interactions just described.

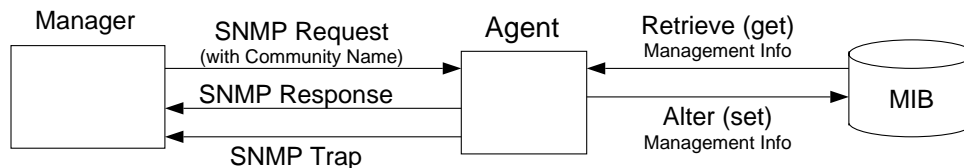


Figure 1-1. Manager-Agent Communication through SNMP





How MIBs are Organized

Conceptually the **MIB objects** are organized in a hierarchical tree structure. Figure 1-2 illustrates the tree structure. The numbers in parenthesis are the numerical representation of the nodes.

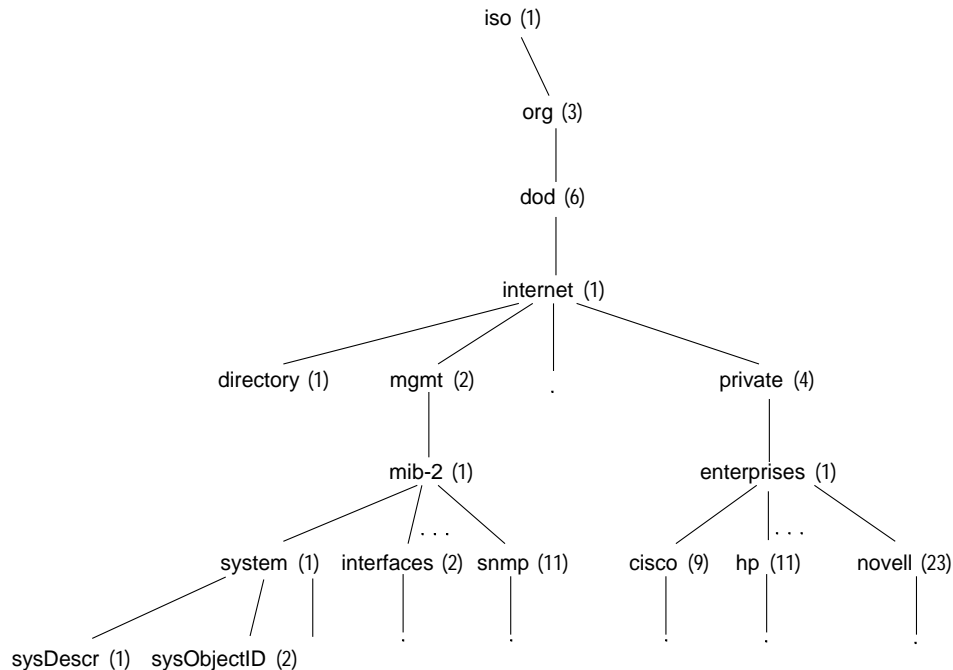


Figure 1-2. MIB Organization

Each branch of the tree consists of logical groupings used to generate unique object IDs. The branch is referred to as a **node**. A node can have both “parents” and “children.” A node that does not have “children” is referred to as a **leaf node**. The leaf node is the actual object. Only leaf nodes return MIB values from agents or have their MIB values altered. A **subtree** is used to refer to all nodes and children under a branch of the tree.

A MIB object is named by its place in the tree. A full object ID name contains all the nodes, including the leaf nodes. The nodes are concatenated and separated by periods. For example, the **mib** subtree is **iso.org.dod.internet.mgmt.mib** which is concisely written as **1.3.6.1.2.1**. This MIB object notation follows the standard notation defined in Abstract Syntax Notation One (ASN.1).

1-6 Definitions and Concepts





To avoid conflicts of object IDs, each branch of the tree must be “registered,” that is, defined, through a designated organization. Enterprise-specific MIBs are registered under the **enterprises** subtree. The Internet-standard MIB-II is registered under the **mib** subtree. The **mib** subtree is primarily used to manage TCP/IP-based networks through SNMP.

Traps

A trap is a message sent from a remote system (an agent) to a manager without an explicit request from the manager. Agents send traps to the manager to indicate that a particular condition exists on the agent system such as an error has occurred or an event has happened.

The traps are defined in *RFC 1157: A Simple Network Management Protocol (SNMP)*. Each SNMP trap contains a generic trap number and a specific trap number. The generic trap numbers range from 0 to 6.

- ColdStart(0)
- WarmStart(1)
- LinkDown(2)
- LinkUp(3)
- AuthenticationFailure(4)
- EgpNeighborLoss(5)
- EnterpriseSpecific(6)

The generic traps 0 through 5 are defined by SNMP. You can define your own trap by combining the generic enterprise-specific trap 6 with your own specific trap number.

Information the Manager Can Receive

Typically, the information the manager can receive from the agent is limited to the set of MIB objects defined on the agent. Using the HP OpenView SNMP Agent provided with the HP-UX networking software you can get information about Internet-standard MIB-II objects defined in RFC 1213 and HP enterprise-specific MIB objects. However, sometimes you have information on a device that you cannot get through these predefined MIB objects. For example, you may want to know if

- An LP spooler is up or down.
- A certain piece of software is still running or not.

The HP OpenView Extensible SNMP Agent enables you to retrieve this type of information.





The HP OpenView Extensible SNMP Agent

The **HP OpenView Extensible SNMP Agent** is a superset of the HP OpenView SNMP Agent. The HP OpenView Extensible SNMP Agent still supports MIB-II and HP enterprise-specific objects *plus* it supports any MIB objects you add to the agent -- you are no longer limited to just retrieve management information about a given set of objects defined by the various hardware vendors and standards organizations. Using the HP OpenView Extensible SNMP agent, you can

- Add your own objects to the agent.
- Configure the agent to notify the manager when something is wrong on the agent.

You add your own objects by defining the objects in a new MIB subtree. This MIB subtree is contained in a new MIB module that extends the MIB that already exists on the agent. You can add MIB objects using either a command or a file.

For each object you define, you must either specify a command that you want the agent to execute or a file that you want the agent to read when the agent receives an SNMP request. It is by executing the specified command that the **extensible agent** can respond to the SNMP request. When a manager sends an SNMP GetRequest or SetRequest, the agent executes the command associated with that object and returns the results of the command in the SNMP reply.

Applying this concept, you can, for example, create a new MIB module that defines objects that will help you

- Retrieve client data not available from your current standard agent through an SNMP GetRequest. For example, you can
 - List the users logged into a remote system.
 - List the size of mail queues on a remote system.
 - Check the status of the printers on your network.
 - Monitor critical processes on a remote system.
- Execute an application or script on a remote system through an SNMP SetRequest. For example, in a manufacturing environment you can change the number of parts produced per hour.

You configure the agent to notify the manager when something is wrong by executing the **snmptrap** command. The **snmptrap** command is included with the HP OpenView Extensible SNMP Agent. You can use the **snmptrap** command to define your own enterprise-specific trap and notify the manager of events or conditions detected by applications. For example, you can configure the agent to notify the manager when a process on a remote system stops running.

By adding your own objects and configuring traps on the agent, the HP OpenView Extensible SNMP Agent becomes a tool that you can use to do system management, peripheral management, and application management. It is a tool that enables you, through SNMP, to extend your agent to essentially get or set any MIB objects associated with a system, device, or application. The objects you manage do not have to be TCP/IP devices running SNMP as long as the agent system can communicate with the device.

1-8 Definitions and Concepts





Figure 1-3 illustrates the extensible agent concepts just described. For example, if a critical software process goes down, the agent can send a trap to the manager indicating the process went down. You can then use the set capability from the manager to re-start the process.

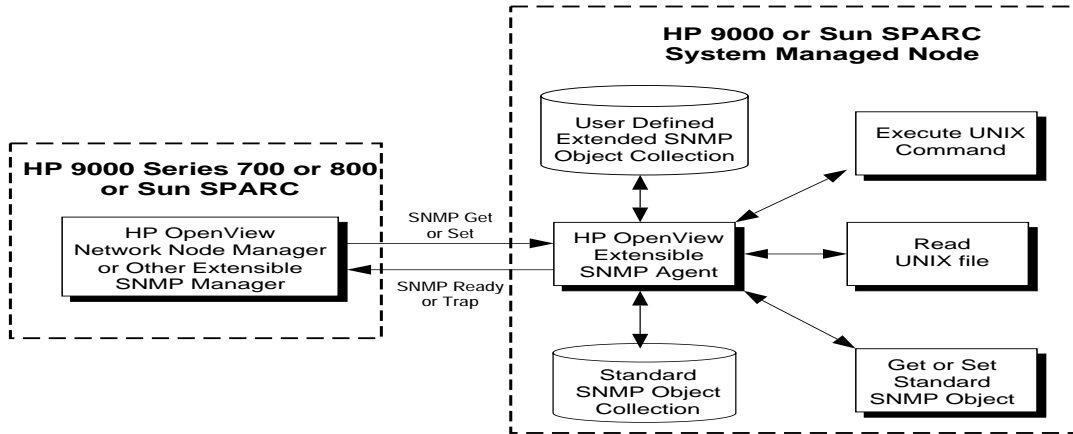


Figure 1-3. Extensible SNMP Agent Concepts





The HP OpenView Network Node Manager

This section gives examples of how the HP OpenView Extensible SNMP Agent can help you manage your network more proactively than before. The examples use the **HP OpenView Network Node Manager** software as the management station.

Note

While this manual uses the HP OpenView Network Node Manager to illustrate examples of how to apply the functionality of the HP OpenView Extensible SNMP Agent, you can use *any* SNMP management station to manage your HP OpenView Extensible SNMP Agents.

After adding objects to the agent, you can

- Load the new MIB module, that is, the file defining the new objects, into the HP OpenView Network Node Manager MIB. Once you have loaded the new MIB module on the management station you can manage any of the MIB objects you have defined on the network.
- Get and set values of your new objects using a point-and-click MIB Browser.
- Without programming, build new MIB applications in a matter of minutes for your new objects. Once you have built your MIB applications, you can monitor the objects through the HP OpenView Network Node Manager menu bar.
- Collect historical MIB information about your new object and display collected data.
- Define event thresholds for the new objects. This helps you, for example, to find out when a printer goes down.
- Define actions to be taken upon receipt of an SNMP trap coming from a system running the extensible agent.
- Manage critical software processes that are running on unattended systems in dispersed locations.





Processes and Files

This section defines the processes and files that are key to the operation of the HP OpenView Extensible SNMP Agent. Included are explanations of the interactions and relationships among these processes and files. The interactions among processes and files at invocation time and during regular operation are different.

Invocation Behavior

The process that runs as the HP OpenView Extensible SNMP Agent is `/etc/snmpd.ea`, the extensible SNMP daemon. The `/etc/netnmrc` script automatically starts the `snmpd.ea` background process. This process should run on the agent system at all times to respond to requests from the manager system. To ensure that this process is invoked, the

`/etc/netlinkrc` script starts the `netnmrc` script during system reboot.

- On invocation, `snmpd.ea` reads the following files to obtain its configuration: `/etc/snmpd.conf`

The `/etc/snmpd.conf` file contains the agent's trap destinations, community names, and certain MIB values.

- `/etc/snmpd.extend`

The `/etc/snmpd.extend` file defines the extended agent MIB objects.





Operational Behavior

Once the HP OpenView Extensible SNMP Agent is operational, the `snmpd.ea` background process continues to run. When the manager sends an SNMP request to the agent, `snmpd.ea` processes the request, takes the appropriate action, such as executing a command or reading a file, and sends an SNMP reply to the manager.

Agents such as `snmpd.ea` send standard SNMP traps such as cold start, warm start, link down, link up, and authentication failure traps to the manager. Optionally, you can configure the HP OpenView Extensible SNMP Agent to execute `snmptrap` commands. The `snmptrap` command also sends traps to the manager.

`snmpd.ea` (agent) errors are logged to the `/usr/adm/snmpd.log` file.

Figure 1-4 shows the operational interactions and relationships among these processes and files.

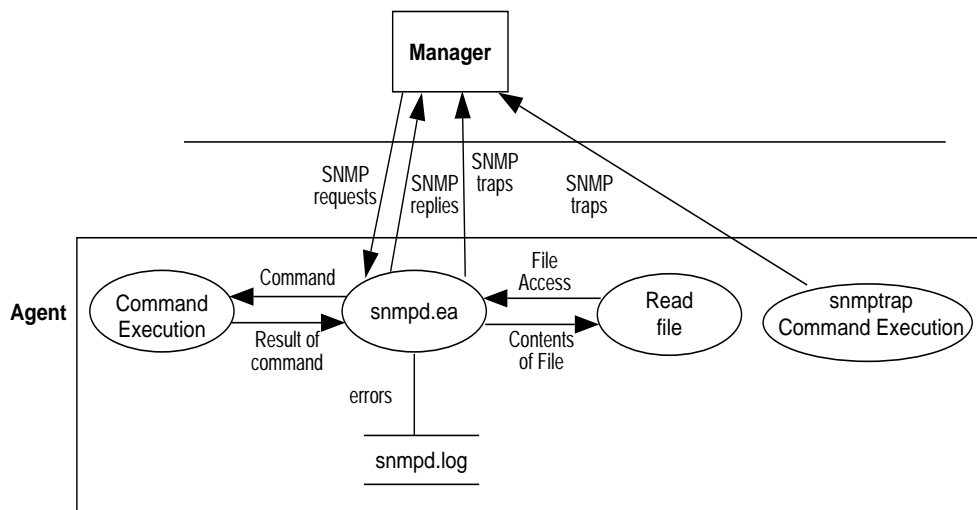


Figure 1-4. Agent Processes and Files During Operation

1-12 Processes and Files







2

Installing Verifying, Stopping, and Restarting the Agent Software

This chapter gives hardware and software requirements for the HP OpenView Extensible SNMP Agent and tells how to install, verify, stop, and restart the product.

Prerequisite Agent Hardware and Software

The HP OpenView Extensible SNMP Agent runs on HP 9000 Series 700, and 600/800 computers.

The following software must be installed, configured, and running properly prior to installing the HP OpenView Extensible SNMP Agent:

- HP-UX Series 700 version 8.05 or later, or
HP-UX Series 600/800 version 8.0 or later
- the **NETINET** fileset



Installing the Extensible SNMP Agent Software

Your first task is to install the HP OpenView Extensible SNMP Agent software on each HP-UX agent system for which you have a license. This section describes the following:

- How to install the agent software from a netdist server.
- How to install the agent software in an HP-UX cluster.

Caution

The agent software consists of two versions:

- one for Series 600, 700, or 800 HP-UX version 8.0
- one for Series 600, 700, or 800 HP-UX version 9.0

Be sure to load the agent tape whose version matches the HP-UX system version on which you are installing the agent software. Otherwise, the system may load an incorrect version of the agent software, and the agent software will not run when started.

Note

You must be super-user to perform the installation. You do not need to shut down HP-UX on the agent system to single user mode to install the software.





Installing the Agent Software from a Netdist Server

HP-UX provides netdist server capability, which allows you to install the HP-UX software onto your networked systems by “pulling” the software from a central software distribution server. This method allows fast and efficient installation of the agent software on many HP-UX systems.

If you do not have a netdist server or if you want to install the agent software directly from tape, skip this section and go to the section on “Installing the Agent Software from Tape” later in this chapter.

Installing the agent software from a netdist server involves the following steps:

1. Put the agent software on a netdist server.
2. Install the agent software.

Each step is described below.

Putting the Agent Software on a Netdist Server

You need to perform the task of putting the HP OpenView Extensible SNMP Agent software on a netdist server only once.

If you have not already set up a netdist server for software installation and you want to, do so first. Follow these instructions to set up a netdist server.

1. Log on as root and make sure you are in the root directory.
2. Create the directory `/netdist` if it does not already exist on the server.
3. Check to see that the `/etc/services` file contains an entry for the netdist server. The entry looks something like this:

```
netdist      2106/tcp      #update(1m) network distribution service
```

If this entry does not exist, add it to the file.

4. Insert tape into the tape drive.
5. Run `/etc/updist` by typing `/etc/updist`. The `updist` program, a variant of `update`, transfers filesets from tape (or another server) to a hierarchical structure beneath the `/netdist` directory. These filesets are the ones the netdist server delivers to other systems on request: the filesets you select using `updist` are the only ones the netdist server can provide.

Installing Verifying, Stopping, and Restarting the Agent Software 2-3





6. Add the HP OpenView Extensible SNMP Agent software filesets, which are in the **EXTAGENT** partition, to the netdist server. Filesets in the **EXTAGENT** partition are **EAGENT-RUN** and **EAGENT-MAN**. To do add the filesets, run the **updist** program. For more information on **updist**, see **update(1M)** in the *HP-UX Reference*.
7. Verify that necessary lines in the file `/usr/adm/inetd.sec` (for example, **exec** and **install**) have their permissions set to **allow**. If these files are not listed, edit `/usr/adm/inetd.sec` to include them. Also verify that the range of ip addresses of the systems that will have this service available have the permission set to **allow**. For example,

```
exec          allow          15.15.64.* 15.1.43.*
```

8. Type `/etc/netdistd -l` (lowercase **L**) to bring up the server. The **netdistd** program is the daemon that monitors the network for netdist requests; the `-l` argument causes the netdist daemon to log activity and error information to `/usr/adm/netdist.log`. The **netdist.log** file is described later in this section. For other options to **netdistd**, see **netdistd(1M)** in the *HP-UX Reference*.

Verifying the Netdist Server

To verify that the server system is now ready for use by the `/etc/update` program, run **update** interactively and specify the server system's hostname as the update source. Verify that the available filesets correspond to those loaded on the server system. Another verification method is to run the following command on the server system and look for the desired filesets in the output.

```
update -c -s hostname
```

Where *hostname* is the name of your host.

Note

If the source is a netdist server system, **update -c** lists only those available filesets that match the client system's architecture type. Use the **update -s** option to list the other type. For example, on a Series 800 system:

```
update -c -s hostname -s800
```

Where *hostname* is the name of your host.

2-4 Installing the Extensible SNMP Agent Software





Installing the Agent Software From the Netdist Server

To install the HP OpenView Extensible SNMP Agent software, perform the following activities:

1. Type `/etc/update` to use the `update` program to install the product.
2. Once inside the `update` program, change the source to be the netdist server.
3. Use `/` (forward slash) as the destination directory.
4. Load the `EXTAGENT` partition from your netdist server.

Filesets in the `EXTAGENT` partition are `EAGENT-RUN` and `EAGENT-MAN`.

The installation automatically starts the agent software.

Repeat the installation on all of your HP OpenView Extensible SNMP Agent systems licensed to use the HP OpenView Extensible SNMP Agent.

Checking the netdist.log File

The `netdistd` records events in `/usr/adm/netdist.log` if you specify the `-l` argument when you started the daemon (`/etc/netdistd -l`).

The `netdist.log` file contains the following information:

- The process ID of the parent `netdistd` daemon.
- The number of remote, incoming requests for the `update` program.
- The number of `update` program requests currently being serviced. By default, a netdist server can service twenty remote update sessions simultaneously. To change the default, use the `-c` option, as described in `netdist(1M)` in the *HP-UX Reference*.





Here is an example of a `netdist.log` file:

```
Version @(#) $Revision: 69.2 $           Startup
Building database 14:56:42
Database ready 14:59:46
netdistd.560 14:59:46 ... Started on port 2106           Parent daemon
netdistd.560 14:59:46 ... Connection limit is 2
1.562 15:09:22 ... Begin service for hptest on port 2106       First child daemon
1.562 15:09:22 update @(#) $Revision: 69.208 $
2.570 15:10:36 ... Begin service for hpclient on port 2106     Second child daemon
2.570 15:10:36 update @(@) $Revision: 69.208 $
2.570 15:10:36 HP-UX hpclient 9.0 A9000/800
1.562 15:13:02 ... End service for hptest
2.570 15:27:17 ... End service for hpclient
```

Startup The first three lines print when you start the `netdistd` program. The first line shows the version of the `netdistd` program; the second and third lines indicate that the database was initialized successfully.

Parent daemon Entries beginning with `netdist` indicate a “parent” daemon. The parent daemon's process ID (PID) is the number immediately following `netdist` (in the example, this number is `560`). When shutting down the netdist server, use this PID to kill the parent daemon process.

Child daemons Entries beginning with a digit indicate “child” daemons. The first number (for example, the `1` in `1.562`) is a counter that increments by one each time a child daemon is spawned. This counter lets you determine the number of update sessions that have used this netdist server since the server was started. In the example, two child daemons (`1.562` and `2.570`) have been spawned from the parent daemon (`560`).

The number following the counter (for example, the `562` in `1.562`) is the child daemon's process ID (PID). *Do not kill the child process*—if you do, you will interrupt an update in progress.

Starting Up the Netdist Server

When `updist` completes, type `/etc/netdistd -l` (lowercase `L`) to bring up the server. The `netdistd` program is the daemon that monitors the network for netdist requests; the `-l` argument causes the netdist daemon to log activity and error information to `/usr/adm/netdist.log`. The `netdist.log` file is described later in this section. For other options to `netdistd`, see `netdistd(1M)` in the *HP-UX Reference*.

2-6 Installing the Extensible SNMP Agent Software





Shutting Down the Netdist Server

The `netdistd` daemon spawns a child process to handle each incoming update request. Thus, if three update requests are being serviced, four copies of the `netdistd` daemon are running. *Do not kill the child process*—if you do, you will interrupt an update in progress.

To shut down the netdist server, do the following:

1. Determine which process is the parent process by viewing the file in `/usr/adm/netdist.log`. Entries beginning with `netdist` indicate a “parent” daemon. (See “Checking the netdist.log File” for additional information on the `netdist.log` file.)
2. Kill the original parent daemon (see `kill(1)` in the *HP-UX Reference*), and wait for any child daemons to terminate normally. Killing the parent daemon prevents any new connections from being established.

The parent daemon's process ID (PID) is the number immediately following `netdist` (in the example, this number is `560`). When shutting down the netdist server, use this PID to kill the parent daemon process. For example, using the sample `netdist.log` file, the command to kill the original parent daemon would be `kill 560`.

Installing the Agent software from Tape

Perform the tasks in this section if you want to install the HP OpenView Extensible SNMP Agent software directly from tape instead of from a netdist server.

To install the HP OpenView Extensible SNMP Agent software from tape, perform the following activities.

- Use the `/etc/update` program to install the product from the agent tape that matches your HP-UX system version. See your HP-UX system administration manual for prerequisites and instructions on using the `update` program.
- Load the `EXTAGENT` partition.

Filesets in the `EXTAGENT` partition are `EAGENT-RUN` and `EAGENT-MAN`.

The installation automatically starts the agent software.

Repeat the installation on all of your HP OpenView Extensible SNMP Agent systems licensed to use the HP OpenView Extensible SNMP Agent.

Installing the Agent Software in an HP-UX Cluster

By default, each cluster node in an HP-UX cluster shares the same `snmpd.extend` file, that is, each agent reads the same file when it comes up. (The `snmpd.extend` file is the MIB module that extends the agent's MIB.) If you want a different configuration file for each cluster node, do one of the following:

- Make the `snmpd.extend` file a Context Dependent File (CDF).
- Create multiple versions of the `snmpd.extend` file.

Installing Verifying, Stopping, and Restarting the Agent Software 2-7





Making snmpd.extend a CDF

To make `snmpd.extend` a CDF, as root execute the command

```
makecdf /etc/snmpd.extend
```

For information about the `makecdf` command, see your *HP-UX Reference* manual.

Creating Multiple Versions of snmpd.extend

After creating a separate copy of the `snmpd.extend` file for each cluster node, use the following command:

```
snmpd.ea -e extendfilename
```

where *extendfilename* is any name that is meaningful to you.

You can execute the `snmpd.ea -e extendfilename` command at the command line. However, a preferred way is to edit the `/etc/netnmrc` file. See the following example.

EXAMPLE:

Assume you have three cluster nodes and one cluster server as shown in figure 2-1. You have four different `snmpd.extend` files

```
/tmp/s.ext1
/tmp/s.ext2
/tmp/s.ext3
/tmp/s.ext4
```

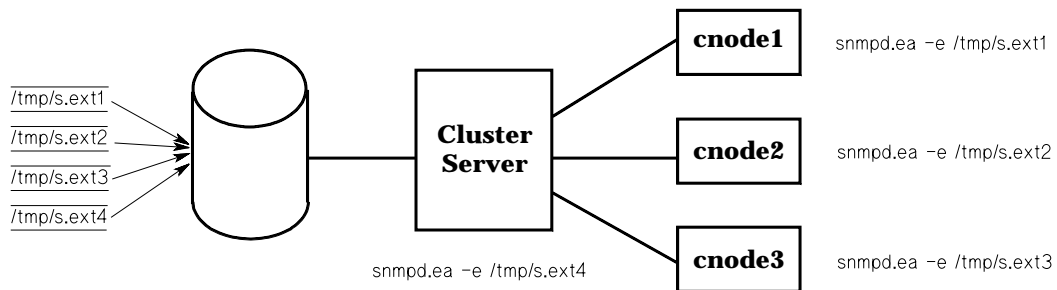


Figure 2-1. Example HP-UX Cluster

2-8 Installing the Extensible SNMP Agent Software





To edit the `/etc/netnmrc` script to specify a unique `snmpd.extend` file for each cluster client, follow these steps:

1. Find the entry

```
case $NODENAME in
    $ROOTSERVER
```

2. Add a line for each cluster node specifying the `snmpd.extend` file to execute. Using the example, here is the entry for each cluster client.

```
case $NODENAME in
    $ROOTSERVER) if [ -f /etc/snmpd.ea ]
                  then
                  /etc/snmpd.ea -e /tmp/s.ext4 && /bin/echo "snmpd.ea \c"
                  fi
                  ;;
    cnode1)      if [ -f /etc/snmpd.ea ]
                  then
                  /etc/snmpd.ea -e /tmp/s.ext1 && /bin/echo "snmpd.ea \c"
                  fi
                  ;;
    cnode2)      if [ -f /etc/snmpd.ea ]
                  then
                  /etc/snmpd.ea -e /tmp/s.ext2 && /bin/echo "snmpd.ea \c"
                  fi
                  ;;

    cnode3)      if [ -f /etc/snmpd.ea ]
                  then
                  /etc/snmpd.ea -e /tmp/s.ext3 && /bin/echo "snmpd.ea \c"
                  fi
                  ;;
esac
```





Verifying Agent Software Operation

To verify that the agent software is running correctly, enter the command

```
/etc/chksnmpd
```

If you run **chksnmpd** as root, and the agent software is running correctly, the results look similar to the following.

```
chksnmpd: hostname, Fri Dec 13 12:43:06 1993
          SU privileges
          Reading file   : /etc/snmpd.conf
          Sending request :
          Success: snmpd responded to request
```

If you receive errors during your verification refer to the "Troubleshooting" chapter.

Stopping and Restarting the Agent Software

If you want to stop the agent software, you must kill the **snmpd.ea** process using the **kill** command.

To restart the HP OpenView Extensible SNMP Agent software, you must be root. Execute the startup script with the command

```
/etc/netnmrc
```







2-12 Stopping and Restarting the Agent Software







2-14 Stopping and Restarting the Agent Software







2-16 Stopping and Restarting the Agent Software















2-22 Stopping and Restarting the Agent Software











Configuration

This chapter discusses how to

- Configure the HP OpenView Extensible SNMP Agent to support new objects.
- Configure HP OpenView Extensible SNMP Agents to execute the `snmptrap` command.
- Optionally configure system contact and location, community name, and trap destinations on the HP OpenView Extensible SNMP Agent.

Configuring Extensible SNMP Agents

Configuring the HP OpenView Extensible SNMP Agent so the management station can manage the new objects you add to the extensible agent, is a three step process.

1. Write a MIB module, `snmpd.extend`, that extends the HP OpenView Extensible SNMP Agent to support new MIB objects. See “Step 1. Write MIB Module.”
2. Copy the MIB module to the manager system. See “Step 2. Copy New MIB to the Manager System.”
3. Integrate the new MIB objects into the manager's MIB. See “Step 3. Integrate New MIB into the Manager's MIB.”

Figure 3-1 illustrates the configuration process.

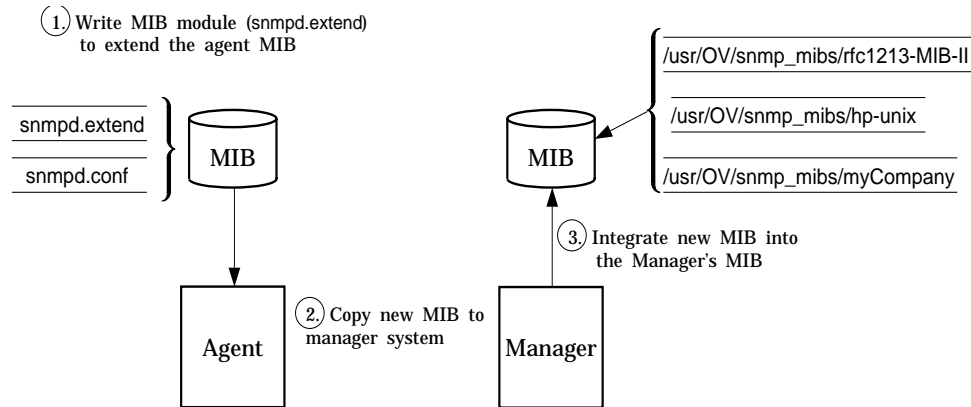


Figure 3-1. Extensible SNMP Agent Configuration

Before You Begin

To write a MIB module, you need to understand what a MIB is and how MIBs are organized. For the manager to access the MIB objects you define on an agent, the MIB module you write must follow the conventions specified by *RFC 1155: Structure and Identification of Management Information for TCP/IP-based Internets* and *RFC 1212: Concise MIB Definitions*. If you are not familiar with these concepts, see

- The Request for Comments (RFC) documents. For a listing, see chapter 1, “Introduction and Operational Concepts.”
- The sections “MIBs” and “How MIBs are Organized” in chapter 1 “Introduction and Operational Concepts.”
- The “Sample MIB Solution” section in chapter 4, “Creating Your MIB Module.”

3-2 Configuring Extensible SNMP Agents



Step 1. Write MIB Module

To write a MIB module that extends the MIB on the HP OpenView Extensible SNMP Agent to support new objects, follow these steps:

1. Define your MIB objects.

You can define one or more MIB objects, and you can group and define the MIB objects in one or more subtrees. The size of a subtree is limited to 200 nodes.

To define your MIB objects, follow these steps:

a. List all the objects that you want to add to the agent.

b. Determine if objects can be grouped together into subtrees.

Organize your MIB objects into logical groups. For example, the following MIB-II objects are all members of the **systems** group: **sysDescr**, **sysObjectID**, **sysUpTime**, **sysContact**, **sysName**, **sysLocation**, and **sysServices**. For a list of supported MIB objects, see appendix A or the MIB modules in the `/usr/OV/snmp_mibs` directory.

c. Define all the nodes in each subtree.

Keep in mind that nodes can be children of other nodes.

When defining the node, follow these rules defined by ASN.1:

- use an arbitrary number of letters, digits, and hyphens
- begin with a lowercase letter
- do not end with a hyphen
- do not follow a hyphen with another hyphen
- do not use underscores

You may also want to follow these conventions

- end counters with the letters
- give each node a unique name, although the name is not required to be unique

d. Define the actual objects, that is, the leaf nodes in the subtree.

When you define the actual object, determine a unique name for the MIB objects.

Common conventions when defining the object names are to

- Start all object names in a group with a prefix that can be derived from the group name. For example, the objects in the **systems** group all begin with the prefix '**sys.**' See the listing in step b. above.
- Capitalize the word after the prefix. For example, **Contact** is capitalized in the object name **sysContact**.





- e. Determine where to place the object in the MIB tree.

To ensure that your object IDs are unique, add your MIBs under your own company (enterprise) name in the **enterprises** subtree. See figure 1-2 in chapter 1 for an illustration of the MIB tree.

If you do not have an enterprise ID assignment, you can get one by registering your enterprise with

Internet Assigned Numbers Authority
 USC/Information Sciences Institute
 4676 Admiralty Way
 Marina del Rey, CA 90292-6695 USA

Telephone: (213) 822-1511
 iana@isi.edu

The benefit of registering your enterprise with the Internet Assigned Numbers Authority (IANA) is that you can control your own MIB subtree and avoid conflict with other MIBs.

2. Log on as root user to the agent system.

3. Create the MIB module, `snmpd.extend`.

Note that an example `snmpd.extend` file is provided with the HP OpenView Extensible SNMP Agent product in the `/usr/OV/prg_samples/eagent` directory.

The `snmpd.extend` file is the MIB module that extends the MIB on the agent to include the objects you define. The `snmpd.extend` file is designed to use the macro template defined in *RFC 1212: Concise MIB Definitions*. Therefore, when you create the `snmpd.extend` file, follow the Abstract Syntax Notation One (ASN.1) format described in RFC 1212. Use the Hewlett-Packard enterprise-specific MIB or the Internet-standard MIB-II as a model. The Hewlett-Packard MIB is documented in the "Objects Definition" section in appendix A. MIB-II is documented in RFC 1213. You can also access these MIBs online. The respective files are `/usr/OV/snmp_mibs/hp-unix` and `/usr/OV/snmp_mibs/rfc1213-MIB-II`.

Refer to the "Creating Your MIB Module" chapter for detailed information about defining MIB objects for the MIB module.

4. Reconfigure the HP OpenView Extensible SNMP Agent (`snmpd.ea`) using the `/etc/snmpd.ea -c` command.

When you reconfigure the agent, the system checks the syntax and the structure of the `snmpd.extend` file and logs any errors or success to `/usr/adm/snmpd.log` (for SunOS). For Solaris (`/var/adm/snmpd.log`). To see the errors on standard error, kill `/etc/snmpd.ea` and restart it.

3-4 Configuring Extensible SNMP Agents





5. From the manager, verify that the agent responds to the objects you have added.

To verify that the agent responds, use any of the SNMP commands provided with your SNMP manager product.

If you use the HP OpenView Network Node Manager, the SNMP commands are `snmpget`, `snmpnext`, `snmpnext`, and `snmpwalk`. For information about the SNMP commands, see the `snmpget(1)`, `snmpnext(1)`, `snmpset(1)`, and `snmpwalk(1)` man pages. After loading the MIB (`snmpd.extend`), you can also use MIB operations such as the MIB Browser. As an example of how to use an SNMP command, here is the syntax of the `snmpget` command

```
snmpget hostname .objectID
```

Note that when you specify the object ID in an SNMP command, the object ID must start with a dot (.).

To troubleshoot any problems, see chapter 5 “Troubleshooting.”

6. Configure all of your HP OpenView Extensible SNMP Agent systems.

To configure additional HP OpenView Extensible SNMP Agent systems, do one of the following:

- Copy the `snmpd.extend` file to all of your HP OpenView Extensible SNMP Agent systems.

When you copy the `snmpd.extend` file to all your agents, all your agents are the same.

After you copy the `snmpd.extend` file, you must reconfigure the agent using the `/etc/snmpd.ea -c` command.

- Create separate `snmpd.extend` files for each agent.

If you want to manage different objects on the different agents, you can create separate `snmpd.extend` files for each agent. If you do this, make sure that the object IDs you use are unique. That is, each object ID should have the same description associated with it across all agents. To create separate `snmpd.extend` files for each agent, repeat steps 1 through 5 on each agent.

Once you have configured all of your HP OpenView Extensible SNMP Agent systems, you are ready to configure the manager. See the next section “Step 2. Copy New MIB to the Manager System.”





Step 2. Copy New MIB to the Manager System

Before the manager can access the new MIB objects you add to the agent, you need to copy the MIB module, `snmpd.extend`, to the manager system.

You can copy the `snmpd.extend` file into any directory on the manager system. However, to make it easier to keep track of the MIB module files, you may want to copy your MIB module file to the default MIB module directory. If you use the HP OpenView Network Node Manager, the default directory is `/usr/OV/snmp_mibs`.

Copy the `snmpd.extend` file from the agent to `/usr/OV/snmp_mibs/myCompany` where *myCompany* is a name that uniquely identifies your MIB.

If you create separate MIB object files for different agents, name your MIB module files *myCompanyAgent1*, *myCompanyAgent2*, and so forth.

Step 3. Integrate New MIB into the Manager's MIB

Once you have copied the MIB module to the manager system, integrate the new objects into the manager's MIB.

If you use the HP OpenView Network Node Manager to manage the agent, the steps to integrate the new MIB into the manager's MIB are as follows:

1. Run the HP OpenView Network Node Manager.
2. Load the new MIB, *myCompany*, into the manager's MIB.

For HP OpenView Network Node Manager to access your new MIB objects, the MIB module defining those objects must be loaded into the manager's MIB. Use the **Load/Unload MIBs** operation to do so.

You are now ready to manage your HP OpenView Extensible SNMP Agents. For example, if you use the HP OpenView Network Node Manager you can use the **Browse MIB**, **MIB Data Collection**, **MIB Application Builder**, and the applications built by the **MIB Application Builder** to manage the new objects.

3-6 Configuring Extensible SNMP Agents





Configuring Traps

This section explains how to use the `snmptrap` command to send SNMP traps from agents to managers. It discusses

- how to define traps
- how traps are sent
- when to use `snmptrap`
- how to use the `snmptrap` command
- sample solution

Before You Begin

To configure your agent to send traps, you need to understand what traps are. If you are not familiar with traps, see

- the “Traps” section in chapter 1, “Introduction and Operational Concepts”
- *RFC 1157: A Simple Network Management Protocol (SNMP)*
- the `snmptrap(1)` man page

How to Define Traps

To define your own trap, you need to uniquely identify your trap. You do so by combining the generic EnterpriseSpecific trap 6 with your own specific trap number. The maximum specific trap number is $2^{32}-1$. This combination tells the manager what kind of trap it is. For example, in the sample trap solution shown at the end of this section, the trap is a combination of 6 and the specific trap 2.

Optionally, you can pass along data.

How Traps Are Sent

The agent sends the traps using the `snmptrap` command. For example, you can configure your agent to send traps by executing the `snmptrap` command from a shell script.





When to Use snmptrap

As a manager, you have two alternatives when monitoring the status of an agent. You can

- Continuously poll the agent from the manager to get information.
- Send a trap from the agent to the manager.

Polling creates a lot of traffic on the network and, if an event occurs shortly after polling has taken place, the manager may not find out about an event for an extended period of time. The key benefits of using the **snmptrap** command are that you can decrease the amount of SNMP traffic on the network and that you can find out about an event sooner.

If you have HP OpenView Network Node Manager, you can customize your environment by using the **snmptrap** command in conjunction with the **Event Configuration** operation. For example, assume that you have written a script on an agent that executes the **snmptrap** command when a particular process on the agent goes down. You can then use the **Event Configuration** operation from the HP OpenView Network Node Manager station to take an action when the manager receives that particular trap from the agent.

Using snmptrap

The **snmptrap** command is documented in the **snmptrap(1)** man page. See appendix B “Reference.”



Sample Trap Solution

Assume that you are responsible for managing the printers on your network. Your goal is to write a script that executes the `snmptrap` command when the printer scheduler goes down. Here is an example script.

```
#!/bin/sh
#
#
# This script checks to see if the printer scheduler (lpsched) is
# running. This check is performed every hour. If the scheduler is not
# running, the agent sends an SNMP trap to the management station.
#
# If a management station receives a trap from a system with enterprise
# equal to .1.3.6.1.4.1.4242, generic-trap equal to 6, and the specific
# trap equal to 2, the management station knows that the printer
# scheduler for that agent-addr is down.
#
# The agent sends how many hours the lp scheduler has been down with
# the trap.
#
AGENT_ADDRESS=15.6.71.223

MGMT_STATION=flcndmak

hours=0
while true
do
    sleep 3600
    pid=`ps -ef | grep lpsched| grep -v grep | wc -l`
    if [ $pid -eq 0 ]
    then
        hours=`expr $hours + 1`
        snmptrap $MGMT_STATION .1.3.6.1.4.1.4242 $AGENT_ADDRESS 6 2 0 \
            .1.3.6.1.4.1.4242.4.2.0 integer $hours
    else
        hours=0
    fi
done
```



Optional Agent Software Configuration

This section defines and covers the following HP OpenView Extensible SNMP configuration values:

- system contact and location
- community name
- trap destinations

This section explains how these configuration values are implemented on the HP OpenView Extensible SNMP and tells how to optionally set them.

System Contact and Location

The agent software operates correctly without any configuration. Optionally, you may want to set the agent's system contact and system location so that the manager can request these values remotely.

The **system contact** is the name of the system's administrative contact, plus information on how to contact this person. The **system location** is a description of the physical location of the system.





Configuring System Contact and Location

You can set the system contact and system location for the HP OpenView Extensible SNMP Agent software in one of two ways:

- Edit the `/etc/snmpd.conf` file.
- Execute the following command:

```
/etc/snmpd.ea -C "contact" -L "location"
```

If an agent system is not an HP-UX cluster client, you may use either method. The recommended method is to set the system contact and system location by editing the `/etc/snmpd.conf` file.

Note

The system contact and system location values set through the command `/etc/snmpd.ea -C "contact" -L "location"` take precedence over the system contact and system location values in the `/etc/snmp.conf` file. That is, if the values are set both ways, the system uses the values specified in the command-line invocation instead of those specified in the `/etc/snmpd.conf` file.

If an agent system is an HP-UX cluster client, you must set the system contact and system location through the `/etc/netnmrc` script on the cluster root server. The command

```
/etc/snmpd.ea -C "contact" -L "location"
```

is provided for use in the script.





Setting System Contact and Location on Non HP-UX Cluster Clients

For systems that are not HP-UX cluster clients, follow these instructions to set the system contact and system location by editing the `/etc/snmpd.conf` file.

1. At the end of the `snmpd.conf` file, find these two lines.

```
location:          # enter location of agent
contact:           # enter contact person and how to contact this person
```

2. Delete the comments (preceded by the # sign).
3. After the `location:` label, add the system's physical location. The maximum length of the ASCII system location string is 256 characters.
4. After the `contact:` label, add the name of the system's administrative contact and information on how to contact that person. The maximum length of the ASCII system contact string is 256 characters.

EXAMPLE:

```
location: 1st floor, south of post P2
contact: Bob Jones (Phone: Ext. 2815, Mail: jones@host2)
```

5. Reconfigure `snmpd.ea` using the `snmpd.ea -c` command.

3-12 Optional Agent Software Configuration





Setting the System Contact and Location in an HP-UX Cluster

First, set the cluster root server's system contact and system location by editing the `/etc/snmpd.conf` file as described in the previous section.

Next, edit the `/etc/netnmrc` script to specify a unique system contact and system location for each cluster client. The maximum length of the ASCII system contact and system location strings is 256 characters each.

1. Find the comment

```
#
# Start network management agent
#
```

2. Edit the script that starts `snmpd.ea` to include an `/etc/snmpd.ea` command case with a unique system contact and system location for each cluster client.

EXAMPLE:

```
case $NODENAME in
  $ROOTSERVER) if [ -f /etc/snmpd.ea ]
                then
                  /etc/snmpd.ea && /bin/echo "snmpd.ea \c"
                fi
                ;;
  client1)     if [ -f /etc/snmpd.ea ]
                then
                  /etc/snmpd.ea -L "1st floor, west of post J2" -C "Steve Smith \
(Phone: Ext. 3921, Mail: sjs@rserver1)" && /bin/echo "snmpd.ea \c"
                fi
                ;;
  client2)     if [ -f etc/snmpd.ea ]
                then
                  /etc/snmpd.ea -L "1st floor, west of post J3" -C "Nancy White \
(Phone: Ext. 5876, Mail: ncw@rserver1)" && /bin/echo "snmpd.ea \c"
                fi
                ;;
.
. (Continue with cases for each cluster client)
.
  *) if [ -f /etc/snmpd.ea ]
      then
        /etc/snmpd.ea && /bin/echo "snmpd.ea \c"
      fi
      ;;
esac
```





Community Name

A **community name** is a password that enables SNMP access to MIB values on an agent. Community names are not highly secure; they go unencrypted across the network. Also, currently accessible MIB values are not normally considered sensitive information.

The HP OpenView Extensible SNMP Agent's community name implementation has the following characteristics.

- You configure the community name in the agent's `snmpd.conf` file.
- The community name is associated with all of the agent's MIB values, not with subsets of MIB values.
- You can enter multiple community names for GetRequests and SetRequests.

GetRequests

By default, HP OpenView Extensible SNMP Agent (`snmpd.ea`) responds to GetRequests with any community name. No community name is initially configured for the agent in the `snmpd.conf` file. You can configure the agent to respond to more than one get-community-name. The associated lines from the file are

```
get-community-name:          #enter community name
get-community-name:          #enter community name
```

SetRequests

By default, the agent does not respond to SetRequests. To enable managers to set MIB values you must configure the agent to respond to SNMP SetRequests. To do so, enter a community name in the `snmpd.conf` file. You can configure the agent to respond to more than one set-community-name. The associated line from the file are

```
set-community-name:          #enter community name
set-community-name:          #enter community name
```

Managers can only set MIB values using the set-community-name entered.

Manager-Agent Community Name Relationship

To learn about how the manager interacts with the agent, see your manager documentation.

3-14 Optional Agent Software Configuration





Authentication Failure

An **authentication failure** results when a manager system sends an incorrect or an invalid community name to an agent. When an agent receives an invalid community name, it can send an authentication failure trap to the manager system.

By default, the HP OpenView Extensible SNMP Agent does not send authentication failure traps because it responds to any community name. If you want HP OpenView Extensible SNMP Agents to send authentication failure traps, you need to configure a community name in the agent's `/etc/snmpd.conf` file.

Configuring Community Name

Caution HP does not recommend that you change the HP OpenView Extensible SNMP Agent default community name configuration. Changing the default community name configuration results in the likelihood of inadvertently making agents inaccessible to the manager and its operations.

You may want to configure a community name on your HP OpenView Extensible SNMP Agents for the following reasons:

- To cause the agents to send **Incorrect Community Name (authenticationFailure trap)** events to their manager systems.
- To allow the agents to respond to a non-HP manager that sends a different community name with its SNMP requests.
- To restrict managers from accessing object values.





Entering an Agent's Community Name

If you change the default community name configuration, HP recommends that you use the same community name on all agents.

To enter an HP OpenView Extensible SNMP Agent's community name, edit the `snmpd.conf` file on the agent system.

1. Near the end of the file, find the line:

```
get-community-name:                #enter community name
```

2. Delete the comment (preceded by the # sign).
3. After the `get-community-name:` label, add the agent's community name.

EXAMPLE:

```
get-community-name: private
get-community-name: mark
```

4. Reconfigure the HP OpenView Extensible SNMP Agent software with the `snmpd.ea -c` command.

Note

Once an HP OpenView Extensible SNMP Agent is configured with a community name, if you want to stop the agent from sending authentication failure traps, kill `snmpd.ea` and restart it with the `-a` option: `/etc/snmpd.ea -a`. For more information about options, see the `snmpd.ea(1M)` man page.





Trap Destinations

Trap destinations exist on agents to tell the agents where to send their SNMP traps. A **trap destination** identifies a manager system that is to receive the agent's traps. An agent may have multiple trap destinations if multiple managers are managing the agent.

If you are using the HP OpenView Network Node Manager to manage your network, you do not need to set HP OpenView Extensible SNMP Agents' trap destinations manually. When an HP OpenView Network Node Manager “discovers” an HP OpenView Extensible SNMP Agent within its management region, the manager tells the agent to send SNMP traps to the manager's system. In other words, the manager's **netmon** process automatically sets the agent's trap destination in the `/etc/snmpd.conf` file. Trap destinations set in this manner are followed by the comment

```
# automatically added by network manager
```

When you unmanage a node, or delete a node from the map, the manager's **netmon** process automatically removes the agent's trap destination in the `/etc/snmpd.conf` file.

Configuring Trap Destinations

If you want an HP OpenView Extensible SNMP Agent to send traps to a manager system other than one running the HP OpenView Network Node Manager, you must manually set the agent's trap destination. To set an HP OpenView Extensible SNMP Agent's trap destination, edit the `/etc/snmpd.conf` file on the agent system.

1. Near the end of the file, find the line:

```
trap-dest:      #enter name of management system where traps will be sent
```

2. Delete the comment (preceded by the # sign).
3. After the **trap-dest:** label, add the host name or IP address of the management system that you want the agent to send its traps to.

EXAMPLE:

```
trap-dest: 15.2.113.223
```

4. If you want to specify additional trap destinations, add more **trap-dest:** lines to the file.
5. Reconfigure the HP OpenView Extensible SNMP Agent software with the `snmpd.ea -c` command.





3-18 Optional Agent Software Configuration





Configuration 3-19







Configuration 3-21





3-22 Optional Agent Software Configuration





Creating your MIB Module

This chapter discusses how to

- Determine what type of MIB object you want to define.
- Define MIB objects using commands.
- Define MIB objects using files. This includes simple objects and table objects.

Determining the Type of MIB Object to Define

The MIB objects that you define may be of two types. The objects may be associated with commands or they may be associated with a file. If the object is associated with a command and the agent receives an SNMP request for that object, the command is executed and the output of the command is returned in the SNMP reply. If the object is associated with a file and the agent receives an SNMP request for that object, the file is read and the contents of the file are returned in the SNMP reply.

When choosing whether to define objects as command objects or file objects you may want to ask the following questions:

Is a command required to obtain the object's value? If so, you may want to define the object associated with a command. If the value of the object does not require a command to be executed every time the object's value is retrieved, you may want to define the object associated with a file.

Are the objects arranged in a table (that is, do the objects have rows and columns)? If so, you must define the objects associated with a file.

Are you concerned with the performance of executing a command each time the object is retrieved? If so, you may want to avoid executing a command and define the objects associated with a file.

Once you have determined how to define your MIB object, use the macro template described in the next section to help you define the MIB object.





Using the Macro Template

Here is an illustration of the macro template you will use. You will use this template for defining both command and file MIB objects. You need to fill in the fields shown in italics.

Note that the `snmpd.extend` file differs from the RFCs in the following areas:

- The `IMPORTS` and `EXPORTS` clauses are not required in the `snmpd.extend` file and will be ignored if added.
- The `DESCRIPTION` clause is required. Use this field to define the commands you want to execute.

```

1 → moduleName DEFINITIONS ::= BEGIN

2 → -- dashes indicate a comment

3 → [enterpriseName OBJECT IDENTIFIER ::= { objectID }
   nodeName OBJECT IDENTIFIER ::= { objectID }

4 → Object OBJECT-TYPE
5 →     SYNTAX Value
6 →     ACCESS Value
7 →     STATUS Value
   DESCRIPTION
8 →     "Add a textual description of your object here along with:
       READ-COMMAND: read_command
       READ-COMMAND-TIMEOUT: timeout_in_seconds
       WRITE-COMMAND: write_command
       WRITE-COMMAND-TIMEOUT: timeout_in_seconds
       FILE-COMMAND: file_command"
       FILE-COMMAND-FREQUENCY: file_command_seconds
       PIPE-IN-NAME: pipe_in_name
       PIPE-OUT-NAME: pipe_out_name
       PIPE-FREQUENCY: pipe_seconds
       APPEND-COMMUNITY-NAME: true | false
       FILE-NAME: file_name"
9 →     ::= { parent_node subidentifier }
   END

```

4-2 Determining the Type of MIB Object to Define





Here is an explanation of each callout number in the `snmpd.extend` file. For an example, see the section “Sample MIB Solution” later in this chapter.

- 1 - *moduleName* The name of your MIB module.
- 2 - insert two dashes (--) Adds documentation in front of your comments.
- 3 - *enterpriseName* The enterprise ID you have registered with the Internet Assigned Numbers Authority. For example, Hewlett-Packard's enterprise ID is `hp` and the corresponding *objectID* is `{ enterprises 11 }`.

nodeName The name of the node under which you want to organize your MIB objects. You can have multiple node name entries and a node can be a child of another node.

- 4 - *Object* The textual label of your object.
- 5 - **SYNTAX** Defines the data structure corresponding to the object type. The HP OpenView Extensible SNMP Agent supports the following values:

INTEGER A simple type consisting of positive and negative whole numbers, including zero. Do not use the value zero as an enumerated type.

OCTET STRING A simple type taking zero or more octets, each octet being an ordered sequence of eight bits.

OBJECT IDENTIFIER A type denoting an authoritatively named object. An example is `1.3.6.1.2.1.1`.

NULL A simple type consisting of a single value, also called null. This type can only be used with defining an object associated with a command.

NetworkAddress A type representing an IP address.

IpAddress A type representing an IP address.

Counter A type representing a non-negative integer which calculates change and increases until it reaches a maximum value. When it reaches the maximum value, it wraps around and starts increasing again from zero.

Gauge A type representing a non-negative integer which may increase or decrease, but which latches at a maximum value.

TimeTicks A type representing a numeric value which counts the time since an event.





Opaque	A type representing an arbitrary encoding.
DisplayString	A type representing textual information taken from the NVT ASCII character set.
PhysAddress	A type representing a media address. For many types of media, this will be a binary representation. For example, an ethernet address is represented as a string of six octets.
SEQUENCE OF	A type representing a table. This type represents objects that have rows and columns. This type can only be used when defining objects associated with a file.
SEQUENCE	A type representing the entry of a table. This type is a child of an object with type SEQUENCE OF . This type may optionally have an INDEX clause. The INDEX clause identifies the column that uniquely defines the row. The default INDEX clause is the first column of the table. This type can only be used when defining objects associated with a file.

The maximum value for **INTEGER**, **Counter**, **Gauge**, and **TimeTicks** is 2^{32-1} (4294967295 decimal).

- 6 - **ACCESS** Defines the level of access allowed. Valid values are
- | | |
|-------------------|--|
| read-only | Means you can perform GetRequests but not SetRequests on the object |
| read-write | Means you can perform both GetRequests and SetRequests on the object |
- 7 - **STATUS** Defines the implementation support required. Valid values for **STATUS** are **mandatory**, **optional**, **obsolete**, and **deprecated**. It is recommended that you use **mandatory**.
- 8 - Use the **DESCRIPTION** clause to describe your object. This is also where you define the commands or files associated with the object.

If your object is associated with a command, enter the following fields after the textual description:

READ-COMMAND	If your ACCESS Value is read-only or read-write , you must enter the READ-COMMAND . When the agent receives an SNMP GetRequest or a GetNextRequest, the agent executes the read_command and returns the results of that command in the SNMP reply. The output can be either standard out or standard error.
---------------------	--

4-4 Determining the Type of MIB Object to Define





- READ-COMMAND-TIMEOUT** Specifies the time in seconds you want the agent to wait for the *read_command* to finish. The maximum value is 90 seconds. The **READ-COMMAND-TIMEOUT** is optional. If you do not specify a *timeout_in_seconds* value, the agent will wait three seconds.
- WRITE-COMMAND** If your **ACCESS Value** is **read-write**, you must enter the **WRITE-COMMAND**. The agent executes the *write_command* when it receives an SNMP SetRequest. The *write_command* should not generate output to standard out or standard error.
- WRITE-COMMAND-TIMEOUT** Specifies the time in seconds you want the agent to wait for the *write_command* to finish. The maximum value is 90 seconds. The **WRITE-COMMAND-TIMEOUT** is optional. If you do not specify a *timeout_in_seconds* value, the agent will wait three seconds. If you specify a *timeout_in_seconds* value of -1, the *write_command* is executed and the agent responds without waiting for the command to finish.

If the commands do not finish before the *timeout_in_seconds*, the agent kills the commands and returns a general error.

snmpd.ea processes one command at a time and waits for an answer before processing the next command.

The **DESCRIPTION** clause may contain the **READ-COMMAND**, **READ-TIMEOUT**, **WRITE-COMMAND**, and **WRITE-TIMEOUT** fields if the **SYNTAX** is one of the following: **INTEGER**, **OCTET STRING**, **OBJECT IDENTIFIER**, **NULL**, **NetworkAddress**, **IpAddress**, **Counter**, **Gauge**, **TimeTicks**, **Opaque**, **DisplayString**, or **PhysAddress**. Refer to the next section for the syntax of the **DESCRIPTION** clause.

If your object is associated with a file, enter the following fields after the textual description:

- FILE-COMMAND** When the agent receives an SNMP GetRequest, GetNextRequest, or SetRequest, the agent executes the *file_command* before either reading or creating the *file_name*. When the agent receives an SNMP SetRequest, the agent also executes the *file_command* after the *file_name* has been created. The *file_command* must complete within 10 seconds.





- FILE-COMMAND-FREQUENCY** When the agent receives an SNMP GetRequest or GetNextRequest, the agent executes the *file_command* if the agent last executed the *file_command* more than *file_command_seconds* ago. By default, the *file_command* will get executed at most every 10 seconds. The agent executes the *file_command* both before and after the file has been created for every SNMP SetRequest regardless of when it was last executed.
- PIPE-IN-NAME** After the agent writes to the *pipe_out_name*, the agent reads the *pipe_in_name* waiting for a message. If the agent reads a 0, the agent continues processing and either reads or creates a *file_name*. If the agent reads something other than 0, or if the agent does not receive a message within 10 seconds, the agent returns a *genErr*. The **PIPE-IN-NAME** is required if the **PIPE-OUT-NAME** is present. Both the *pipe_in_name* and *pipe_out_name* can be created using the `mkfifo(1)` command.
- PIPE-OUT-NAME** When the agent receives an SNMP GetRequest, GetNextRequest, or SetRequest, the agent writes to the *pipe_out_name*. The *pipe_out_name* must be a FIFO (named pipe). The management station's IP address, the community name used in the request, the **OBJECT IDENTIFIER** used in the request, the **SYNTAX** of the object, the request issued by the management station, and the instance are written to the pipe. Each value is separated by white space and the message ends with the '\0' character. When the agent receives an SNMP SetRequest, the agent also writes to *pipe_out_name* after the *file_name* has been created.
- PIPE-FREQUENCY** When the agent receives an SNMP GetRequest or GetNextRequest, the agent writes to the *pipe_out_name* if the agent last wrote to the *pipe_out_name* more than *pipe_seconds* ago. By default, the *pipe_out_name* will get written to at most every 10 seconds. The agent writes to the *pipe_out_name* both before and after the file has been created for every SNMP SetRequest, regardless of when it was last written to.
- APPEND-COMMUNITY-NAME** If **APPEND-COMMUNITY-NAME** is *true*, the agent reads or creates *file_name.comm*, where *comm* is the community name sent in the request. If *file_name.comm* is not present, the agent returns an error. The value for **APPEND-COMMUNITY-NAME** must be either *true* or *false*.

4-6 Determining the Type of MIB Object to Define



**FILE-NAME**

When the agent receives an SNMP GetRequest or GetNextRequest, the agent reads the *file_name* and returns the contents of that file in the SNMP Reply. When the agent receives an SNMP SetRequest, the agent creates *file_name* containing the value that the object is set to. The *file_name* will no longer contain comments after the agent creates it.

`snmpd.ea` processes one command at a time and waits for an answer before processing the next command.

Note that the read and write access values do not have anything to do with the read and write file permissions.

The **FILE-COMMAND**, **FILE-COMMAND-FREQUENCY**, **PIPE-IN-NAME**, **PIPE-OUT-NAME**, **PIPE-FREQUENCY**, and **APPEND-COMMUNITY-NAME** clauses are optional.

The **DESCRIPTION** clause may contain the **FILE-NAME** field if the **SYNTAX** is one of the following: **INTEGER**, **OCTET STRING**, **OBJECT IDENTIFIER**, **NetworkAddress**, **IpAddress**, **Counter**, **Gauge**, **TimeTicks**, **Opaque**, **DisplayString**, **PhysAddress**, **SEQUENCE**, or **SEQUENCE OF**. Refer to the next section for the syntax of the **DESCRIPTION** clause.

- 9 - *parent_node* is the name of the node you have already identified. *subidentifier* is the number that is appended to the parent node to make the object unique.

The DESCRIPTION Clause

Valid syntax and ordering for Extensible SNMP Agent commands in **DESCRIPTION** clause are:

Simple Objects

```

READ-COMMAND: command-line
[ READ-COMMAND-TIMEOUT: seconds-to-timeout ]
WRITE-COMMAND: command-line
[ WRITE-COMMAND-TIMEOUT: seconds-to-timeout ]

```

EXAMPLE:

```

READ-COMMAND: /usr/bin/users
READ-COMMAND-TIMEOUT: 10

```





Simple Objects and Table Objects

```
[ FILE-COMMAND: command-line [ FILE-COMMAND-FREQUENCY: seconds ] ]
[ PIPE-IN-NAME: pipe-name
PIPE-OUT-NAME: pipe-name
[ PIPE-FREQUENCY: seconds ] ]
[ APPEND-COMMUNITY-NAME: true | false ]
FILE-NAME: filename
```

EXAMPLE:

```
FILE-COMMAND: /usr/bin/filecmd
FILE-COMMAND-FREQUENCY: 30
APPEND-COMMUNITY-NAME: false
FILE-NAME: /tmp/myfile
```

Ordering is important. For example, **FILE-COMMAND** must be before **FILE-NAME**.

Using Commands to Define your MIB Object

If you use commands to define your MIB object, the command can be either an existing UNIX command, or a command that you have written. If you write your own commands, see “Writing Shell Commands” later in this section.

- You specify these commands in the **DESCRIPTION** clause in the **snmpd.extend** file.
- The maximum command size is 5120 characters.
- A command can span multiple lines. Optionally, end each line with a backslash (\).

Sample MIB Solution

To illustrate how you can configure your HP OpenView Extensible SNMP Agent to support any object you define, this section has a step-by-step sample solution.

Assume you work for the Flintstones Company. Your goal is to write MIB objects to

- list users who are using a system
- manage mail queues
- manage the number of widgets produced per hour on an unattended system
- keep track of the LP scheduler

Your agent system is **flintagent** with the default community name **public**. The set community name is **secret**.

The manager system is running the HP OpenView Network Node Manager software.

4-8 Determining the Type of MIB Object to Define





Here are the steps.

1. Define your MIB objects.

To ensure that your object IDs are unique, you decide to define your MIB objects in the **flintstones (4242)** subtree. The MIB tree hierarchy is

```

internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private (4) 1 }

flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
fsys          OBJECT IDENTIFIER ::= { flintstones 1 }
fmail         OBJECT IDENTIFIER ::= { flintstones 2 }
fwidgets     OBJECT IDENTIFIER ::= { flintstones 3 }
fprinters     OBJECT IDENTIFIER ::= { flintstones 4 }
fdisk        OBJECT IDENTIFIER ::= { flintstones 5 }
fprocess     OBJECT IDENTIFIER ::= { flintstones 6 }
fconfig      OBJECT IDENTIFIER ::= { flintstones 7 }
    
```

The MIB objects are defined and organized into the logical groups shown in figure 4-1.

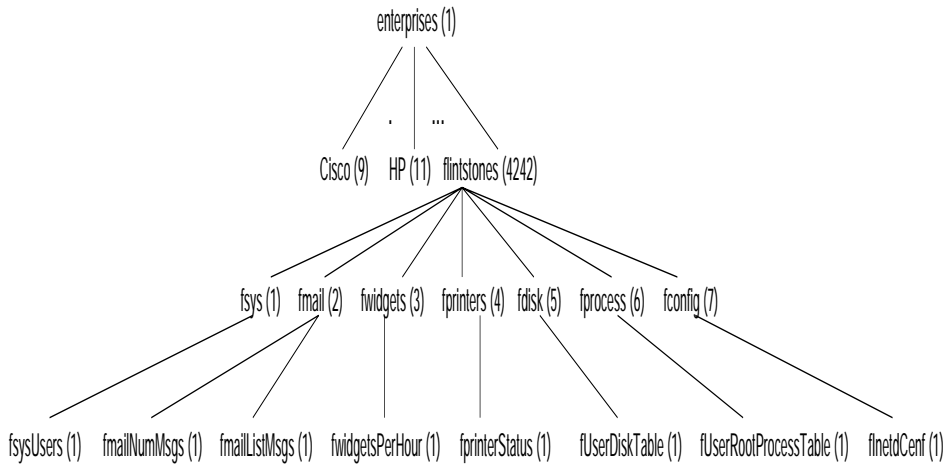


Figure 4-1. MIB Tree Structure for Sample MIB Solution





The object identifiers for the leaf nodes, that is, the MIB objects, are:

Leaf Node	Object Identifier
<code>fsysUsers</code>	<code>1.3.6.1.4.1.4242.1.1.0</code>
<code>fmailNumMsgs</code>	<code>1.3.6.1.4.1.4242.2.1.0</code>
<code>fmailListMsgs</code>	<code>1.3.6.1.4.1.4242.2.2.0</code>
<code>fwidgetsPerHour</code>	<code>1.3.6.1.4.1.4242.3.1.0</code>
<code>fprintersStatus</code>	<code>1.3.6.1.4.1.4242.4.1.0</code>

Note that the suffix 0 indicates that this is a leaf node (instance 0).

2. Log on as root user to the `flintagent` system.
3. Create the MIB module, `snmpd.extend`.

You may decide to use the example `snmpd.extend` file provided with the HP OpenView Extensible SNMP Agent as a model. To do so, copy `/usr/OV/prg_samples/eagent/snmpd.extend` to `/etc/snmpd.extend`. This is the example `snmpd.extend` file.

```

FLINTSTONES DEFINITIONS ::= BEGIN

-- This MIB module, snmpd.extend, defines the MIB objects for the
-- Flintstones Company.

internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private(4) 1 }

flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
fsys          OBJECT IDENTIFIER ::= { flintstones 1 }
fmail         OBJECT IDENTIFIER ::= { flintstones 2 }
fwidgets      OBJECT IDENTIFIER ::= { flintstones 3 }
fprinters     OBJECT IDENTIFIER ::= { flintstones 4 }
fdisk         OBJECT IDENTIFIER ::= { flintstones 5 }
fprocess      OBJECT IDENTIFIER ::= { flintstones 6 }
fconfig       OBJECT IDENTIFIER ::= { flintstones 7 }

-- The fsys Group

```

4-10 Determining the Type of MIB Object to Define



```

fsysUsers      OBJECT-TYPE
    SYNTAX      DisplayString
    ACCESS      read-only
    STATUS      mandatory
    DESCRIPTION
        "List of users on the flintstones machine.
        READ-COMMAND: /usr/bin/users; exit 0
        READ-COMMAND-TIMEOUT: 5"
    ::= { fsys 1 }

-- The fmail Group

fmailNumMsgs   OBJECT-TYPE
    SYNTAX      Gauge
    ACCESS      read-only
    STATUS      mandatory
    DESCRIPTION
        "Message count on the mail queue.
        READ-COMMAND: /usr/bin/mailq -bp | fgrep -v Mail | wc -l"
    ::= { fmail 1 }

fmailListMsgs  OBJECT-TYPE
    SYNTAX      DisplayString
    ACCESS      read-only
    STATUS      mandatory
    DESCRIPTION
        "List of mail messages on the mail queue.
        READ-COMMAND: /usr/bin/mailq
        READ-COMMAND-TIMEOUT: 10"
    ::= { fmail 2 }

-- The fwidgets Group

fwidgetsPerHour OBJECT-TYPE
    SYNTAX      Gauge
    ACCESS      read-write
    STATUS      mandatory
    DESCRIPTION
        "Number of widgets produced per hour.
        READ-COMMAND: /usr/OV/prg_samples/eagent/num_widgets $i $c $o $$s
        READ-COMMAND-TIMEOUT: 2
        WRITE-COMMAND: /usr/OV/prg_samples/eagent/change_num_widgets $*
        WRITE-COMMAND-TIMEOUT: 10"
    ::= { fwidgets 1 }

-- The fprinters Group

```

```

fprintersStatus OBJECT-TYPE
    SYNTAX Integer {
        up(1),
        down(2)
    }
    ACCESS read-only
    STATUS mandatory
    DESCRIPTION
        "Status of the printer scheduler.
        READ-COMMAND: ps -ef | grep lpsched | grep -v grep | wc |
        awk '{ if ($1 == 0) print 2; else print 1 }' "
    ::= { fprinters 1 }

```

END

Note the following:

- The commands you are executing are defined in the **DESCRIPTION** clause in the **snmpd.extend** file. One benefit of adding the commands to the **DESCRIPTION** clause is that you can see what commands you are executing when you ask for description from the manager.
- The **READ-COMMAND-TIMEOUT** and the **WRITE-COMMAND-TIMEOUT** lines are optional. It indicates the time in seconds the agent will wait for a response. If a timeout is not specified, the agent by default will wait three seconds for a response. If the command does not finish before the timeout, the agent kills the command and returns a general error.

4. Reconfigure the HP OpenView Extensible SNMP Agent (**snmpd.ea**) using the **/etc/snmpd.ea -c** command.

When you reconfigure the agent, the system checks the syntax and the structure of the **snmpd.extend** file and logs any errors or success to **/usr/adm/snmpd.log**. To see the errors on standard error, kill **/etc/snmpd.ea** and restart it.

5. From the manager, verify that **flintagent** responds to the objects you have added.

Use any of the SNMP commands or use the MIB operations in HP OpenView Network Node Manger such as the MIB Browser. For information about the SNMP commands, see the **snmpget(1)**, **snmpnext(1)**, **snmpset(1)**, and **snmpwalk(1)** man pages.

For example, to verify that the **fsysUsers** object returns a list of users with the **snmpget** command, type:

```
snmpget flintagent .1.3.6.1.4.1.4242.1.1.0
```

Note that when you specify the object ID in an SNMP command, the object ID must start with a dot (.).

4-12 Determining the Type of MIB Object to Define



The `snmpget` command executes the `/usr/bin/users` command and returns a list of users logged into the `flintagent` system.

To change the `fwidgetsPerHour` object to produce 15 widgets per hour with the `snmpset` command, type:

```
snmpset -c secret flintagent .1.3.6.1.4.1.4242.3.1.0 Gauge 15
```

Your sample configuration is done.

Refer to the "Writing Shell Commands" section later in this chapter if you need information on writing shell commands.

Using Files to Define Your MIB Object

Both simple objects and tables can be added to the MIB module. The file based method requires a new set of keywords in the `DESCRIPTION` clause of the `OBJECT-TYPE` macro definition. The agent recognizes the `FILE-NAME:` field in the `DESCRIPTION` clause. The file associated with the `FILE-NAME:` field is read to retrieve the values of the object and created to modify the values associated with the object.

The following objects can be added using the file based technique: `INTEGER`, `OCTET STRING`, `OBJECT IDENTIFIER`, `NetworkAddress`, `IpAddress`, `Counter`, `Gauge`, `TimeTicks`, `Opaque`, `DisplayString`, `PhysAddress`, `SEQUENCE`, or `SEQUENCE OF`. These objects can have `ACCESS` of `read-only` or `read-write`.

Simple objects. These are objects that have one value. For example, most systems have only one CPU model number. This object would be a simple object. If a system had several CPUs, a table of CPU model numbers would be required. Tables are discussed later.

If the `SYNTAX` of the object is `OCTET STRING`, `Opaque`, or `DisplayString`, the agent reads the entire file for the value. The maximum size of the file contents is 4096 (4K). If the string is prefixed with '0x', the value of the string is converted to hexadecimal. For example, if the file contained `0x0800093519D0`, the agent would return the hexadecimal representation of this value rather than the ASCII representation.

Other objects defined are read from the file looking for the first value separated by white space. You can use the '#' character in the first column for comments.

EXAMPLE:

You want the agent to respond with the system's default printer. The default printer is stored in `/usr/spool/lp/default`. You also want to modify the default printer, so you want to update `/usr/spool/lp/default` remotely using SNMP.





The following entries are entered into `snmpd.extend(4)` to add this object to the agent.

```
internet    OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones OBJECT IDENTIFIER ::= { enterprises 4242 }
fprinters   OBJECT IDENTIFIER ::= { flintstones 4 }
```

```
fdefaultPrinter OBJECT-TYPE
    SYNTAX      DisplayString
    ACCESS      read-write
    STATUS      mandatory
    DESCRIPTION
        "Default printer
        FILE-NAME: /usr/spool/lp/default"
    ::= { fprinters 2 }
```

Note that this object is a string and has `read-write` access.

If the file `/usr/spool/lp/default` contains

```
ljetp4
```

and the agent receives an SNMP GetRequest for `flintstones.fprinters.fdefaultPrinter.0`, the `snmpd.ea` reads `/usr/spool/lp/default` and returns "ljetp4" to the management station.

The agent caches this value in memory for future possible requests. If the file contents do not change (the modification time of the file does not change) and the agent receives another SNMP GetRequest for `flintstones.fprinters.fdefaultPrinter.0`, the agent returns "ljetp4" from its cache rather than re-read the file contents.

The same procedures are used for GetNextRequests. If the agent receives an SNMP GetNextRequest for `flintstones.fprinters.fdefaultPrinter` the agent reads `/usr/spool/lp/default` and returns "ljetp4" for the object `flintstones.fprinters.fdefaultPrinter.0` to the management station.

4-14 Determining the Type of MIB Object to Define





If the agent receives a SNMP SetRequest for `flintstones.fprinters.fdefaultPrinter.0` with value `"laserjet-14"` the agent will create `/usr/spool/lp/default` with the contents `"laserjet-14."` The contents of the file before the SetRequest are gone. If the agent cannot write the file, a `genError` is returned and the error is logged to `/usr/adm/snmpd.log`.

Table Objects. Table objects are useful for objects that have several values. An example of table objects found in MIB-II are the tcp connection table and the interface table.

EXAMPLE:

You want to retrieve the list of users on a remote machine, their user id, the disk space associated with the user, and the email address of the user. The data on the remote machine is located in a file `/usr/OV/prg_samples/eagent/user_disk_space`. The contents of the file look like this.

#	User ID	User Name	Disk Space	Email Address
	100	zach	120	zach@server1
	201	alice	65	alice@server2
	320	john	2	john@server3
	119	craig	500	root@server1
	217	steve	75	steve@server1
	83	bob	111	bob@bobby

This table has four columns and six rows. Every table defined using the Extensible SNMP Agent must have a column or a set of columns that uniquely define the row. In some models, this column would be called a key. In this example, the first column is unique. The `User ID` is unique on this system. If the `User Names` are unique, the second column could be used as the 'key.'



To configure the agent to respond to these objects, you need to make the following entries into the agent configuration file `snmpd.extend(4)`.

```

internet          OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises       OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones       OBJECT IDENTIFIER ::= { enterprises 4242 }
fdisk             OBJECT IDENTIFIER ::= { flintstones 5 }

fUserDiskTable    OBJECT-TYPE
    SYNTAX          SEQUENCE OF FUserDiskEntry
    ACCESS          not-accessible
    STATUS          mandatory
    DESCRIPTION     "List of users and the number of kilobytes in their home
                    directory.
                    FILE-NAME: /usr/OV/prg_samples/eagent/user_disk_space"
    ::= { fdisk 1 }

fUserDiskEntry    OBJECT-TYPE
    SYNTAX          FUserDiskEntry
    ACCESS          not-accessible
    STATUS          mandatory
    DESCRIPTION     "This macro documents the column that uniquely describes
                    each row."
    INDEX { FUID }
    ::= { fUserDiskTable 1 }

FUserDiskEntry ::=
    SEQUENCE {
        FUID INTEGER,
        fUserName DisplayString,
        fUserDiskSpace INTEGER,
        fUserEmailAddress DisplayString
    }

FUID              OBJECT-TYPE
    SYNTAX          INTEGER
    ACCESS          read-only
    STATUS          mandatory
    DESCRIPTION     "User's unique ID"
    ::= { fUserDiskEntry 1 }

```

4-16 Determining the Type of MIB Object to Define


```

fUserName          OBJECT-TYPE
    SYNTAX          isplayString
    ACCESS          read-only
    STATUS          mandatory
    DESCRIPTION    "User login name"
    ::= { fUserDiskEntry 2 }

fUserDiskSpace     OBJECT-TYPE
    SYNTAX          INTEGER
    ACCESS          read-only
    STATUS          mandatory
    DESCRIPTION    "Amount of disk space (in kilobytes) used by the
                    user."
    ::= { fUserDiskEntry 3 }

fUserEmailAddress  OBJECT-TYPE
    SYNTAX          DisplayString
    ACCESS          read-write
    STATUS          mandatory
    DESCRIPTION    "Email address for the user."
    ::= { fUserDiskEntry 4 }

```

The first **OBJECT-TYPE** macro, **fUserDiskTable**, describes the file name associated with the object. The second **OBJECT-TYPE** macro, **fUserDiskEntry**, describes the column that uniquely identifies a row. The next entry, **FUserDiskEntry**, is for documentation purposes. This entry lists the columns in the table. This entry is optional. The last four **OBJECT-TYPE** macros, **fUID**, **fUserName**, **fUserDiskSpace**, and **fUserEmailAddress** define the columns in the table.

If the agent receives a **GetNextRequest** for **fUserDiskTable.fUserDiskEntry.fUID**, the agent will read the entire file **/usr/OV/prg_samples/eagent/user_disk_space**. The agent then sorts the table based on the object specified in the **INDEX** clause. The sorted table will then look like this:

83	bob	111	bob@bobby
100	zach	120	zach@server1
119	craig	500	root@server1
201	alice	65	alice@server2
217	steve	75	steve@server1
320	john	2	john@server3

The file contents have not been changed, the cached values in the agent are sorted.

The agent would then return the first value in the table. This value would be the first column of the first row. The management station would receive the value **83** for the MIB object **flintstones.fdisk.fUserDiskTable.fUserDiskEntry.fUID.83**. The **fUID** has **83** appended to the object identifier.

The user ID **83** uniquely identifies the value in the row.



If the agent receives an SNMP GetNextRequest for `flintstones.fdisk.fUserDiskTable.fUserDiskEntry.fUID.83`, the agent would check to see if the file has been modified. If the file has been modified, the agent would re-read `/usr/OV/prg_samples/eagent/user_disk_space`. It would then return the next user ID after the user ID for "bob." It would return the value 100 for `flintstones.fdisk.fUserDiskTable.fUserDiskEntry.fUID.100`.

If the agent receives an SNMP GetNextRequest for `flintstones.fdisk.fUserDiskTable.fUID.320`, which is the user ID for "john," the agent would then notice that there are not any more user names and it would return the first value in the second column. It would return the value "bob" for MIB object `fUserDiskEntry.fUserName.83`.

If the agent receives an SNMP GetRequest for `fUserDiskEntry.fUserEmailAddress.217` the agent would look for an email address associated with the row 217. 217 is the key for "steve", so the agent would return the value "steve@server1" for the MIB object `fUserDiskEntry.fUserEmailAddress.217`.

If the user would like to print the entire table, the user would issue an SNMP GetNextRequest for `fUserDiskTable.fUserDiskEntry.fUID`, `fUserDiskTable.fUserDiskEntry.fUserName`, `fUserDiskTable.fUserDiskEntry.fUserDiskSpace`, and `fUserDiskTable.fUserDiskEntry.fUserEmailAddress`.

The agent would return the first row back to you. The agent would return the following MIB objects value pairs:

```
fUserDiskTable.fUserDiskEntry.fUID.83, 83
fUserDiskTable.fUserDiskEntry.fUserName.83, "bob"
fUserDiskTable.fUserDiskEntry.fUserDiskSpace.83, 111
fUserDiskTable.fUserDiskEntry.fUserEmailAddress.83, "bob@bobby"
```

The user would then issue another SNMP GetNextRequest for

```
fUserDiskTable.fUserDiskEntry.fUID.83
fUserDiskTable.fUserDiskEntry.fUserName.83
fUserDiskTable.fUserDiskEntry.fUserDiskSpace.83
fUserDiskTable.fUserDiskEntry.fUserEmailAddress.83
```

The agent would reply with the next row in the table. The following MIB object, value pairs would be returned.

```
fUserDiskTable.fUserDiskEntry.fUID.100, 100
fUserDiskTable.fUserDiskEntry.fUserName.100, "zach"
fUserDiskTable.fUserDiskEntry.fUserDiskSpace.100, 120
fUserDiskTable.fUserDiskEntry.fUserEmailAddress.100, "zach@server1"
```

This would continue until the last row was retrieved.

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If you would want to modify the email address for "alice", the user would issue an SNMP SetRequest for MIB object `fUserDiskTable.fUserDiskEntry.fUserEmailAddress.201` with value "alice@mailer." The agent would write this value, along with all the other entries in the table to `/usr/OV/prg_samples/eagent/user_disk_space`. The file would then contain:

```
100    "zach"    120    "zach@server1"
201    "alice"   65     "alice@mailer"
320    "john"    2      "john@server3"
119    "craig"   500    "root@server1"
217    "steve"   75     "steve@server1"
83     "bob"     111    "bob@bobby"
```

The following rules apply to creating the file that contains a table:

- Each row of the table ends in a new-line. A row can continue over a new-line by adding the character '\ ' at the end of the line. For example, if the file contains

```
Column1 "Column # 2" \
"Column 3" Column4 Column5
```

The agent would consider this as one row with five columns.

- Each column is separated by white space. A column may be enclosed in double quotes. The second column of the above example is enclosed in double quotes and is equal to "Column # 2." The agent converts \ " to ", and \\ " to \ ".

For example, if the file contains

```
"This is an \"example\" of a column with \\\" style quotes"
```

The agent would return the following to the management station.

```
This is an "example" of a column with \" style quotes
```

- A column's value may not extend over a new-line.





Filling the File with Values

The file contents can be updated using the usual conventions available with UNIX. For example, you can enter static configuration information using an editor. For information that changes every five minutes, you can execute a **cron(1M)** command to update the file's contents. For example, a UNIX script could be run every night that creates `/usr/OV/prg_samples/eagent/user_disk_space` containing the disk space for every user.

A UNIX process may elect to update the file with up-to-date data. If you want a UNIX command to be executed before the file is read, you can optionally enter the field "**FILE-COMMAND**" in the description clause found in `snmpd.extend`.

If you want a UNIX process to receive a message before the file is read, you can optionally enter the field "**PIPE-IN-NAME**" and "**PIPE-OUT-NAME**" in the **DESCRIPTION** clause found in `snmpd.extend`.



The FILE-COMMAND

The *file_command* specified after the **FILE-COMMAND** field is executed before the agent reads the **snmpd.extend** file. The command may update the contents of the file.

For example, if you want to remotely retrieve the list of processes that are owned by 'root,' you would define the following MIB:

```

internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
fprocess      OBJECT IDENTIFIER ::= { flintstones 6 }

fUserRootProcessTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF FUserRootProcessEntry
    ACCESS      not-accessible
    STATUS      mandatory
    DESCRIPTION
        "List of root processes.
         FILE-COMMAND: /usr/OV/prg_samples/eagent/get_processes
         FILE-NAME: /usr/OV/prg_samples/eagent/root_processes"
    ::= { fprocess 1 }

fUserRootProcessEntry OBJECT-TYPE
    SYNTAX      FUserRootProcessEntry
    ACCESS      not-accessible
    STATUS      mandatory
    DESCRIPTION
        "This macro documents the column that uniquely describes
         each row."
    INDEX { fProcessID }
    ::= { fUserRootProcessTable 1 }

FUserRootProcessEntry ::=
    SEQUENCE {
        fProcessID INTEGER,
        fProcessName DisplayString
    }

fProcessID    OBJECT-TYPE
    SYNTAX     INTEGER
    ACCESS     read-only
    STATUS     mandatory
    DESCRIPTION
        "Process ID"
    ::= { fUserRootProcessEntry 1 }

```

```

fProcessName          OBJECT-TYPE
    SYNTAX             DisplayString
    ACCESS              read-write
    STATUS              mandatory
    DESCRIPTION
        "Name of process"
    ::= { fUserRootProcessEntry 2 }

```

If the agent receives an SNMP GetNextRequest for

```

fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessID
fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessName

```

the agent would execute the following command

```
/usr/OV/prg_samples/eagent/get_processes
```

This command creates the file

```
/usr/OV/prg_samples/eagent/root_processes
```

which contains the process ids and process names run by root.

The agent then reads `/usr/OV/prg_samples/eagent/root_processes`, sorts the contents, and returns the first row to the management station.

By default, the command is run at most once every 10 seconds. For example, if the agent receives another SNMP GetNextRequest for

```

fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessID
fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessName

```

the agent would only execute the following command if it had been more than 10 seconds since the agent last executed the command.

```
/usr/OV/prg_samples/eagent/get_processes
```

If you only want the command to be run at most every hour, you can change the default frequency by entering the following in the `DESCRIPTION` clause:

```
FILE-COMMAND-FREQUENCY: 3600
```

The command must exit with value 0, or a `genErr` is returned to the management station. The agent will kill the command if it does not return in 10 seconds.

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Using the FILE-COMMAND with Set Requests

The *file_command* is executed before and after a set request happens. This occurs every time a set operation is requested regardless of when the command was last executed.

For example, if you want to be able to update the configuration file for **inetd(1M)**, the following object would be defined.

```

internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private(4) 1 }

flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
fconfig       OBJECT IDENTIFIER ::= { flintstones 7 }

fInetdConf    OBJECT-TYPE
    SYNTAX     DisplayString
    ACCESS     read-write
    STATUS     mandatory
    DESCRIPTION
        "The configuration file for inetd
        FILE-COMMAND: /usr/OV/prg_samples/eagent/update_inetd $r
        FILE-COMMAND-FREQUENCY: 7200
        FILE-NAME: /etc/inetd.conf"
    ::= { fconfig 1 }

```

If the agent receives a SNMP SetRequest for **flintstones.fconfig.fInetdConf.0** with the contents of a **inetd.conf(4)** configuration file, the agent would execute the command

```
/usr/OV/prg_samples/eagent/update_inetd SetRequest
```

The agent would then write the contents to **/etc/inetd.conf**. The agent then executes

```
/usr/OV/prg_samples/eagent/update_inetd PostSetRequest
```

The command checks the value of the first argument. If the value is "**PostSetRequest**," the command executes **/etc/inetd -c** to tell **inetd** to re-read its configuration file.

Using the PIPE-IN-NAME and PIPE-OUT-NAME Clauses

The **PIPE-IN-NAME** and **PIPE-OUT-NAME** clauses are used for interprocess communication between the agent and another UNIX process.

The *pipe_out_name* file name specified after the **PIPE-OUT-NAME** receives data before the agent reads the file. After a process reads the data, the process may update the contents of the file. After the process is finished updating the file, it must notify the agent that it is done by writing to the *pipe_in_name* file specified after **PIPE-IN-NAME**.



Lets use the same example for **FILE-COMMAND**. Rather than execute a command to fill the contents of the file, a process will be running in the background waiting to fill the contents of the file.

```
internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises  OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones  OBJECT IDENTIFIER ::= { enterprises 4242 }
fprocess     OBJECT IDENTIFIER ::= { flintstones 6 }
```

```
fUserRootProcessTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF FUserRootProcessEntry
    ACCESS      not-accessible
    STATUS      mandatory
    DESCRIPTION
        "List of root processes.
        PIPE-IN-NAME: /tmp/fifo_in
        PIPE-OUT-NAME: /tmp/fifo_out
        FILE-NAME: /usr/OV/prg_samples/eagent/root_processes"
    ::= { fprocess 1 }
```

```
fUserRootProcessEntry OBJECT-TYPE
    SYNTAX      FUserRootProcessEntry
    ACCESS      not-accessible
    STATUS      mandatory
    DESCRIPTION
        "This macro documents the column that uniquely
        describes each row."
    INDEX { fProcessID }
    ::= { fUserRootProcessTable 1 }
```

```
FUserRootProcessEntry ::=
    SEQUENCE {
        fProcessID      INTEGER,
        fProcessName    DisplayString
    }
```

```
fProcessID      OBJECT-TYPE
    SYNTAX      INTEGER
    ACCESS      read-only
    STATUS      mandatory
    DESCRIPTION
        "Process ID"
    ::= { fUserRootProcessEntry 1 }
```

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```

fProcessName      OBJECT-TYPE
    SYNTAX         DisplayString
    ACCESS         read-write
    STATUS         mandatory
    DESCRIPTION   "Name of process"
    ::= { fUserRootProcessEntry 2 }

```

If the agent receives an SNMP GetNextRequest for

```

fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessID
fprocess.fUserRootProcessTable.fUserRootProcessEntry.fProcessName

```

the agent would send a message to `/tmp/fifo_out`.

The message contents include:

```

the manager's IP address
community name
object id
object type
pdu type
instance

```

The end of the message is denoted by a '\0' character.

The background process would then receive this message, create the file

```

/usr/OV/prg_samples/eagent/root_processes

```

containing the process ids and process names run by root.

The background process then writes a 0 to `/tmp/fifo_in` to indicate that the file creation was successful. If the agent receives data other than a 0, a `genErr` is returned to the management station and a message is logged to `snmpd.log`.

The agent then reads `/usr/OV/prg_samples/eagent/root_processes`, sorts the contents, and returns the first row to the management station.



An example background process could look like this:

```

#! /bin/sh
if [ ! -p /tmp/fifo_out ] ;then
    mkfifo /tmp/fifo_out
fi
if [ ! -p /tmp/fifo_in ] ;then
    mkfifo /tmp/fifo_in
fi
while [ 1 ]; do
    read addr cname oid oid_type pdu instance < /tmp/fifo_out
    ps -u root | grep -v PID | awk '{print $1 " " " $4}' \
        > /usr/OV/prg_samples/eagent/root_processes
    echo "\00" >>/tmp/fifo_in
done
exit 0

```

The files `/tmp/fifo_out` and `/tmp/fifo_in` can be created using the `mkfifo(1)` command.

By default, data is written to the *pipe_out_name* pipe no more often than every 10 seconds. To change this frequency, you can specify a new value using the `PIPE-FREQUENCY` clause.

Set operations using the `PIPE` clauses work similarly as the `FILE-COMMAND`. Data is written to the *pipe_out_name* pipe before and after the pipe is read. After the process receives data from the *pipe_out_name* pipe the process must write data to the *pipe_in_name* pipe.

The agent will wait at the most 10 seconds for data from the *pipe_in_name* pipe.





Creating Proxies Using the Extensible SNMP Agent

You can use the Extensible SNMP Agent to create a proxy. The agent can respond to objects on behalf of another system, device, or application.

For example, if you want the agent to respond with the amount of memory for three systems that do not support SNMP, the agent can act as a proxy for those other systems. The three systems that do not support SNMP are named **larry**, **curly**, and **moe**. The following three files contain the amount of memory on each system:

```
/usr/OV/prg_samples/eagent/memory.larry
/usr/OV/prg_samples/eagent/memory.curly
/usr/OV/prg_samples/eagent/memory.moe
```

`/usr/OV/prg_samples/eagent/memory.larry` contains the value **32** for 32 megabytes.

`/usr/OV/prg_samples/eagent/memory.curly` contains **128** and

`/usr/OV/prg_samples/eagent/memory.moe` contains **64**.

Larry has IP address 15.2.112.244, **curly** has IP address 15.2.114.237, and **moe** has IP address 15.2.113.223.

To implement this proxy, you would define the following object:

```
internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
fsys          OBJECT IDENTIFIER ::= { flintstones 1 }

fmemory       OBJECT-TYPE
  SYNTAX      INTEGER
  ACCESS      read-only
  STATUS      mandatory
  DESCRIPTION
    "Amount of memory (in megabytes) on system
    APPEND-COMMUNITY-NAME:true
    FILE-NAME: /usr/OV/prg_samples/eagent/memory"
  ::= { fsys 2 }
```

The agent will respond on behalf of **larry**, **curly**, and **moe** for the object **flintstones.fsys.fmemory**. The community name in the request indicates the system of interest. If the community name is **'larry'**, the amount of memory for 15.2.112.244 will be returned. If the community name is **"curly"**, the amount of memory for 15.2.114.237 will be returned, and if the community name is **"moe"**, the amount of memory for 15.2.113.223 will be returned.

The new field, **APPEND-COMMUNITY-NAME**, tells the agent to read the file named

```
/usr/OV/prg_samples/eagent/memory.communityName.
```





If the agent receives an SNMP GetRequest for `flintstones.fsys.fmemory.0` with community name "moe," the agent reads `/usr/OV/prg_samples/eagent/memory.moe` and returns 64 to the management station.

If the agent receives an SNMP GetRequest for `flintstones.fsys.fmemory.0` with community name "larry," the agent reads `/usr/OV/prg_samples/eagent/memory.larry` and returns 32 to the management station.

Using Proxy for Objects that are Built into the Agent

This proxy can be used to proxy for MIB-II objects or HP-UNIX objects.

For example, if you want to return different `sysDescr` values for the proxied systems `larry`, `curly` and `moe`, the following files would contain a value for `sysDescr`:

```
/usr/OV/prg_samples/eagent/sysDescr.larry
/usr/OV/prg_samples/eagent/sysDescr.curly
/usr/OV/prg_samples/eagent/sysDescr.moe
```

To implement this proxy, you would define the following object:

```
internet      OBJECT IDENTIFIER ::= { iso(1) org(3) dod(6) internet(1) }
enterprises   OBJECT IDENTIFIER ::= { internet private(4) 1 }
flintstones   OBJECT IDENTIFIER ::= { enterprises 4242 }
mgmt          OBJECT IDENTIFIER ::= { internet 2 }
mib-2         OBJECT IDENTIFIER ::= { mgmt 1 }
system        OBJECT IDENTIFIER ::= { mib-2 1 }
```

```
sysDescr      OBJECT-TYPE
    SYNTAX     DisplayString (SIZE (0..255))
    ACCESS     read-only
    STATUS     mandatory
    DESCRIPTION
        "A textual description of the entity. This value
        should include the full name and version
        identification of the system's hardware type,
        software operating-system, and networking
        software. It is mandatory that this only contain
        printable ASCII characters.
        APPEND-COMMUNITY-NAME: true
        FILE-NAME: /usr/OV/prg_samples/eagent/sysDescr"
    ::= { system 1 }
```

If the agent receives an SNMP GetRequest for `system.sysDescr.0` with community name "moe," the agent reads `/usr/OV/prg_samples/eagent/sysDescr.moe` and returns the string contained in the file to the management station.

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If the agent receives an SNMP GetRequest for `system.sysDescr.0` with community name "public," the agent returns its internal value for `sysDescr`.

Writing Shell Commands

This section discusses the steps for writing your own shell commands and the conventions that you need to follow for the commands to work with SNMP. The shell commands can be either UNIX shell scripts or programs.

Here are the steps.

1. Log on to the agent system where you want the command to execute.
2. Write the script or the program.

For an example, see the example script at the end of these steps, or
`/usr/OV/prg_samples/eagent/num_widgets` or
`/usr/OV/prg_samples/eagent/change_num_widgets`.

Arguments

By default, `snmpd.ea` does not pass any arguments to the `read_command` or `file_command`. If you want `snmpd.ea` to pass arguments, use the arguments listed below.

By default, `snmpd.ea` passes an argument to the `write_command` -- the value you want to set the object to. For example, if you want to set the object value to 2, the agent passes that value to the command.

Optionally, if you want `snmpd.ea` to pass arguments to the `read_command`, `write_command` and `file_command`, use the following arguments. You can specify the arguments in any order.

Argument	Value passed in
<code>\$i</code>	The management station's IP address. The address is in internet dot notation.
<code>\$c</code>	The community name used in the request.
<code>\$o</code>	The OBJECT IDENTIFIER used in the request. The OBJECT IDENTIFIER is in dot notation.
<code>\$r</code>	The request issued by the management station. One of the following values will be passed: GetRequest, GetNextRequest, SetRequest, or PostSetRequest. The PostSetRequest will be passed to the <code>file_command</code> after the <code>file_name</code> has been created.
<code>\$I</code>	The instance used in the request.



- \$s** The **SYNTAX** of the object. One of the following values will be passed:
INTEGER, OCTET STRING, OBJECT IDENTIFIER, NULL, NetworkAddress, IpAddress, Counter, Gauge, TimeTicks, Opaque, DisplayString, or PhysAddress.
- \$*** This is the same as specifying **\$i \$c \$o \$s**.
- \$\$** Substitute **\$**.

You add these arguments when you specify the command in the **snmpd.extend** file. For example, if you want **snmpd.ea** to pass in the IP address of the management station, the community name, and the object ID when executing the **/usr/OV/prg_samples/eagent/change_num_widgets** command, specify the following in the **DESCRIPTION** clause in the **snmpd.extend** file:

```
READ-COMMAND: /usr/OV/prg_samples/eagent/change_num_widgets $i $c $o
```

When the command executes, **snmpd.ea** substitutes the **\$** arguments with the real IP address of the management station, the community name, and the object ID.

Search path

HP recommends that you use the full path when specifying the command. However, this is not a requirement. You inherit the path of the calling process.

Return values

The return values for the **read_command** should be printed to standard out or standard error.

Execution

The **read_command**, **write_command**, and **file_command** are executed as if executed by **/bin/sh**.

Shell commands are supported. You can specify shell commands such as **exit**, **read**, **if**, and **for** in the **read_command**, **write_command**, and **file_command**. For a description of the shell commands, see the **sh(1)** man page. Shell commands do not have a path. See the **snmpd.extend(4)** man page for examples.

Exit codes

Make sure that the shell command exits with the correct exit code. An invalid exit code results in an error returned to the management station. The command must exit with the following exit codes (These exit codes are defined by RFC 1157.):



read_command exit codes are:

Exit Code	What the code means
0	No error, that is, your command is successful. The data echoed to standard out or standard error will be returned to the management station in the SNMP reply. Only data necessary for the reply should be echoed to standard out or standard error. Too much data will return a general error. The data echoed must be of the same SYNTAX as specified in the snmpd.extend file. If the data is not the same SYNTAX , a general error will be returned to the management station.
5	General error, that is, the command is unsuccessful.

write_command exit codes are:

Exit Code	What the code means
0	No error, that is, your command is successful. No data should be echoed to standard out or standard error.
3	Bad value, that is, the value passed into the command is invalid. For example, if the command accepts values from 1 to 9, and a user tries to pass in a value of 132, the shell command exits with 3.
5	General error, that is, the command is unsuccessful. If anything is echoed to standard out or standard error on the <i>write_command</i> , a general error is returned.

file_command should exit with 0, if not, a general error is returned to the management station.

Any errors the system encounters while trying to execute your shell command, are returned as general errors. For example, if your program does not exist, the system returns a general error. If the agent returns a general error, an error message is logged to `/usr/adm/snmpd.log`.

3. Verify that the shell command executes successfully.

To verify that your shell command executes successfully, execute the command. For example, to verify that the command associated with **fmailListMsgs** in the example **snmpd.extend** file executes successfully, type

```
/usr/bin/mailq
```

The command should return a list of mail messages on the mail queue.





4. Check the exit code by typing:

```
echo $?
```

If the value is 0, the shell command is successful.

5. If your shell command has arguments, verify the arguments.

For example, assume you want to verify the `num_widgets` command shown in the “Sample Shell Command” section below. The `num_widgets` command is defined in the example `snmpd.extend` file as

```
DESCRIPTION "
    READ-COMMAND: /usr/OV/prg_samples/eagent/num_widgets $i $c $o $s"
```

To verify the arguments, the command you type may look something like

```
num_widgets 15.2.3.149 public 1.3.6.1.4.4242.3.1 Gauge
```

The steps for writing your own shell commands are done.

Sample Shell Command

```
#!/bin/sh
#
# @(#) HP OpenView Extensible SNMP Agent Release 3.0
# num_widgets $Date: 94/01/19 15:35:33 $ $Revision: 3.3 $
#
# This shell script is an example for the SNMP extensible agent
# (snmpd.ea(1M|8)).
#
# This script is called by the agent when a management station requests
# the object
#
# iso.org.dod.internet.private.enterprises.flintstones.fwidgets.
# fwidgetsPerHour.
#
# This script is registered in the snmpd.extend(4) file.
#
# This program will return the number of fwidgetsPerHour. The number of
# widgets per hour is stored in /tmp/widgets_per_hour.
#
# A general error will be returned if
# a) the request is made for an object identifier other than the one
# listed above.
# b) the request is made with the community string not equal to "public"
# c) the request is made for an object with SYNTAX not equal to "Gauge"
#
```

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```
WIDGETS_FILE=/tmp/widgets_per_hour

echo $* >$0.out 2> $0.err

case $2 in
    public) break;;
    secret) break;;
    *) echo "Invalid Community Name"; exit 5;
esac

case $3 in
    1.3.6.1.4.1.4242.3.1) break;;
    *) echo "Invalid Object Identifier"; exit 5;
esac

case $4 in
    Gauge) break;;
    *) echo "Invalid syntax"; exit 5;;
esac

if [ -r $WIDGETS_FILE ]
then
    cat $WIDGETS_FILE
else
    echo 3 >$WIDGETS_FILE
    cat $WIDGETS_FILE
fi

exit 0
```



4-34 Determining the Type of MIB Object to Define





5

Troubleshooting

This chapter focuses on troubleshooting the HP OpenView Extensible SNMP Agent product itself and the `snmpd.extend` file. It does not cover how to do network troubleshooting.

This chapter discusses the following topics:

- recommended practices for problem prevention, isolation, and recovery
- characterizing the problem
- general product troubleshooting considerations
- troubleshooting by component





Recommended Practices

Following these recommended practices helps you to prevent problems, isolate problems, and recover from problems.

- Ensure that the agent system meets the hardware, software and configuration prerequisites, and recommendations discussed in previous chapters.
- Do not modify HP OpenView Extensible SNMP Agent product files, such as `snmpd.conf` and `snmpd.extend`, without retaining the original files. The original files provide a way of restoring a known good operational configuration. If you correct a problem by restoring the original files, you can isolate the problem to the changes you made to these files.
- Use logging of the agent background processes to help isolate problems, but be sure to clean up log files regularly. For information about logging, see the `snmpd(1M)` man page.

The next table describes the logging options for the HP OpenView Extensible SNMP Agent background process.

Caution Logging is normally used only by support personnel. Logging can cause the log file to grow extremely large (multiple megabytes in size) fairly quickly. If you use logging, remember to frequently monitor the size of the log file and turn logging off as soon as you are finished.





The following information explains the variable *logmask* in the next table. Log masks specify the type of output listed in `/usr/adm/snmpd.log` or in *logfile*. To select multiple output types, add the individual *logmask* values together and enter that number.

0	Turn off logging.
1	Log authentication failure traps.
2	Log errors.
4	Log configuration requests.
8	Log requests and replies.
16	Log requests and replies for objects that have been added.
32	Log hexdumps of packets received and sent by the <code>snmpd.ea</code> .
64	Log trace messages.

The default log mask is 3, that is, `snmpd.ea` logs authentication failure traps and errors.

EXAMPLES:

To turn logging off when the agent is running, enter the following command:

```
snmpd.e -M 0
```

To log errors and requests and replies, add their *logmask* value (2 + 8) to determine the *logmask* value to enter.

```
snmpd.ea -M 10
```

The default log file is `/usr/adm/snmpd.log` and logging is automatically set to ON (log mask 3). See the following table if you want to make changes to the logging defaults.





Logging of the Agent Process <i>/etc/snmpd.ea</i>	
To...	Use...
Set initial logging mask	-m <i>logmask</i>
Change default log file	-l <i>logfile</i>
Change logging mask	-M <i>logmask</i>
Turn off logging	-M 0

When the object you are trying to get returns an error, look in the **snmpd.log** to find out what the error is. Also, if you have just defined new objects, look in the **snmpd.log** for syntax errors.

5-4 Recommended Practices





Characterizing the Problem

Symptoms are visible circumstances that indicate a problem. Whenever you encounter a symptom, collect the basic information that follows.

Scope: What is Affected?

Distinguish Agent vs. Manager Problem

A problem with the agent often shows up as a symptom of a problem on the manager system. When a manager depends on SNMP for data, the problem is usually with the agent. For example, if your manager provides information about a particular node on the network and that information is incorrect, the problem may be that the agent sends incorrect information. To isolate the problem, see the “Troubleshooting by Component” section.

Distinguish Agent vs. `snmpd.extend` File Problem

See the “Troubleshooting by Component” section.

Affected Parts of the HP OpenView Extensible SNMP Agent

What part of the HP OpenView Extensible SNMP Agent is affected? All operations, or just some?

Context: What Changed?

Determine what may have changed on your network or product configuration: hardware, software, files, security, utilization, and so forth.

Duration: How Long or How Often?

Is the problem consistent (fails every time) or intermittent (fails sometimes)?

Context: What Action Was Performed?

When the problem occurred, what was happening? For instance,

- What operation was selected?
- What command was executed?
- What data was requested or sent?





General Product Troubleshooting Considerations

When troubleshooting the HP OpenView Extensible SNMP Agent product, consider the fact that SNMP is based on User Datagram Protocol, or UDP, which is an unreliable protocol (no error checking and no guarantee of message receipt). This may cause occasional failures of manager-agent communication.

When You Need More Information

Other information that may assist your troubleshooting of the HP OpenView Extensible SNMP Agent product is available in

- the operational overview in the “Introduction and Operational Concepts” chapter
- the “Supported MIB Objects” appendix
- the “Reference” appendix
- the Request for Comment (RFC) documents referenced in the “Introduction and Operational Concepts” chapter

If a problem does not appear to be with the HP OpenView Extensible SNMP Agent itself or with the `snmpd.extend` file, see to your

- networking documentation for network troubleshooting procedures
- system documentation for system troubleshooting procedures





Troubleshooting by Component

This section suggests actions to take if you suspect a problem with a component of the agent system. This section also discusses the sequence of interactions and/or the flow of data associated with a component's operation when such information may help you to isolate the problem. This section covers the following components of the network management system:

- runtime components
- SNMP subsystem
- agent MIB
- `snmpd.extend` file

For detailed information on a command or process mentioned in this section, see its associated man page in the “Reference” appendix.

Runtime Components

If you are having problems running the HP OpenView Extensible SNMP Agent, check software versions, file permissions, and startup scripts.

Agent File Permissions

By default, the HP OpenView Extensible SNMP Agent (`snmpd.ea`) is executable only by root; however, the `/etc/chksnmpd` command is executable by anyone. For Solaris, the command is `/usr/sbin/chksnmpd`.





Startup Scripts

Check to see if some component in the execution sequence is “broken,” such as a syntax error in one of the product's startup scripts. The startup execution sequence for the HP OpenView Extensible SNMP Agent is shown below.

```
/etc/netlinkrc --> /etc/netnmrc --> /hp-ux/etc/snmpd
```

SNMP Subsystem

Use the following methods to troubleshoot the SNMP subsystem.

- Verify that community names are correctly configured on both the manager and agent system. See the “Configuration” chapter for detailed information on this topic.
- Use the **chksnmpd** command to verify operation of the **snmpd.ea** (agent) on an HP OpenView Extensible SNMP Agent system. See the **chksnmpd(1)** man page.
- Check the **snmpd.log** file on an HP OpenView Extensible SNMP Agent for **snmpd.ea** errors (if you have logging turned on).
- Verify that the agent system's trap destination is set properly. See the “Configuration” chapter for more information on this topic.
- If you use the HP OpenView Network Node Manager, you can also use the **Diagnose: Network Connectivity -> IP / TCP / SNMP** operation to verify SNMP operation on a remote SNMP node.





Agent MIB

Use the following methods to troubleshoot the agent MIB.

- Make sure that the agent and the manager can communicate. The problem may be with the network configuration on the agent system. To test network connectivity, execute the **ping** command.
- Use an SNMP get command from the manager system to inspect an individual agent MIB value. If you use the HP OpenView Network Node Manager, the command is **snmpget**.
- Use an SNMP walk command from the manager system to dump part or all of the agent's MIB for inspection. If you use the HP OpenView Network Node Manager, the command is **snmpwalk**.
- Check that the object ID configured on the agent system is the same as the object ID configured on the manager system.
- If you are trying to do an SNMP SetRequest, verify that the agent is configured to respond to SNMP SetRequests. (By default, the agent does not allow managers to alter MIB values.) To configure the agent to respond to SNMP SetRequests, add a set-community-name to the agent's **/etc/snmpd.conf** file.
- If you use the HP OpenView Network Node Manager or the HP OpenView SNMP Platform Management product, you can also use the **Browse MIB** operation to verify that the information retrieved is accurate.

snmpd.extend File

To troubleshoot the **snmpd.extend** file, first troubleshoot locally, then troubleshoot over the network.

Use the following methods to troubleshoot the **snmpd.extend** file.

Locally

- Execute each command in the **snmpd.extend** file by itself from the operating system command line to see if the command returns the expected response.
- Verify that the command executed correctly by typing:

```
echo $?
```
- If the command has arguments, verify the arguments. To do so, execute the commands independently supplying all necessary parameters.
- Check the **snmpd.log** for syntax errors.





- If the agent finds an error when reading in the `snmpd.extend` file, the agent will display the line where the error occurred and the correct syntax.
- Check that the command defined in the `snmpd.extend` file is executable.
- Verify that execute permission is set on the command.
- Check that the object ID on which you are trying to get information executes the proper command. To find out what commands are executed with each object, set the following logging mask

```
snmpd.ea -M 19
```

- Check that the output for the command you are executing corresponds to the proper data type.
- Check that the command in the `snmpd.extend` file is spelled correctly. For example, a common error is to type `/usr` as `/user`.

From the Manager

If, after troubleshooting the problem on the agent system you still have a problem, check the following:

- Do an SNMP request to each object in the `snmpd.extend` file from the management station to make sure the file works correctly.
- After you have done an SNMP SetRequest, do an SNMP GetRequest to verify that the value was set correctly.



A

Supported MIB Objects

This appendix lists the MIB objects supported by the HP OpenView Extensible SNMP Agent.

Included in the list are

- standard MIB-II objects supported by HP OpenView Extensible SNMP Agents for HP-UX 8.0 or later agents
- non-standard HP extended MIB objects, that is, Hewlett-Packard's enterprise-specific MIB module
These are located in `/usr/ov/snmp_mibs/hp-unix`



Standard MIB-II Objects Supported by Extensible SNMP Agents

The HP OpenView Extensible SNMP Agent running on your HP OpenView network management system supports all standard MIB-II objects, except for the EGP group. Refer to *RFC 1213: Management Information Base for Network Management of TCP/IP-based internets: MIB-II* for details.

Objects That Agents Allow You to Change

The following list shows the objects that the HP OpenView Extensible SNMP Agent allows you to change through an SNMP SetRequest.

Note Before you can change agent MIB values, you must configure the agent to respond to SNMP SetRequests. To do so, enter a **set-community-name** to the `/etc/snmpd.conf` file on the agent.

```
sysContact
sysName
sysLocation
ifAdminStatus
atPhysAddress
ipRouteNextHop
ipRouteType
ipRouteAge
ipNetToMediaPhysAddress
ipNetToMediaType
snmpEnableAuthTraps
```





Non-Standard HP Extended MIB Objects

This section defines HP OpenView Extensible SNMP Agent-specific MIB objects. The HP OpenView SNMP Agent MIB is consistent with the Internet Activity Board's (IAB's) network management strategy defined in RFC1109, RFC1155, RFC1157, and RFC1212. For a listing of the non-standard HP extended MIB objects, see the `/usr/ov/snmp_mibs/hp-unix` file on the HP OpenView network management system.

Format of Definitions

The next section contains the specification of all HP object types contained in the MIB. Following the conventions of the RFC 1212, the object types are defined using the following fields:

OBJECT-TYPE	A textual name, termed the OBJECT DESCRIPTOR, for the object type.
SYNTAX	The abstract syntax for the object type, presented using ASN.1. This must resolve to an instance of the ASN.1 type ObjectSyntax defined in the Structure of Management Information (SMI). SMI identifies the rules used to define the objects that can be accessed through a network management protocol.
ACCESS	A keyword, one of read-only, read-write, write-only, or not-accessible.
STATUS	A field describing the status of the object type.
DESCRIPTION	textual description of the semantics of the object type. Implementations should ensure that their interpretation of the object type fulfills this definition since this MIB is intended for use in multi-vendor environments. As such it is vital that object types have consistent meaning across all machines.
::=	The OBJECT IDENTIFIER corresponding to the object type.









A-6 Non-Standard HP Extended MIB Objects





B

Reference

This appendix contains the Reference Pages (man pages) for the HP OpenView Extensible SNMP Agent product.







Glossary

A

Agent

1 - A process running on a device that responds to SNMP requests and sends SNMP traps.

2 - A device that responds to SNMP requests and sends SNMP traps.

Agent system

A device, such as a host, gateway, terminal server, hub, or bridge, that has an agent responsible for performing the network management operations requested by the manager.

C

Community name

A password that allows a manager to access MIB values on an agent.

E

Enterprise-specific MIB

MIBs developed by individual vendors for their specific product lines. Vendors register their private MIBs under the enterprises object identifier subtree.

Extensible agent

An agent that has been configured to support any MIB object defined on the agent.





G

get

An action that enables the manager to retrieve management information from an agent.

H

HP OpenView Extensible SNMP Agent

A superset of the HP OpenView TCP/IP Agent that extends an agent's existing Management Information Base (MIB) to support new objects.

HP OpenView Network Node Manager

An application that provides fault, configuration, and performance management of multivendor TCP/IP networks.

HP OpenView TCP/IP Agent

HP's TCP/IP agent that provides the capabilities necessary to manage HP 9000 and Sun SPARCstation computers through SNMP.

L

Leaf node

A node in the MIB tree that does not have "children." The leaf node is the actual object.

M

Manager

A system that is executing network management software.

Manager system

A system that executes network management operations and control agent systems.





MIB

Management Information Base. A collection of objects (management information) that can be accessed through a network management protocol.

MIB module

A file defining all the MIB objects under a subtree. For example, the Internet-standard MIB-II and the HP enterprise-specific MIB are MIB modules.

MIB object

Managed object defined according to the *RFC 1155: Structure and Identification of Management Information for TCP/IP-based Internets* or *RFC 1212: Concise MIB Definitions*.

MIB tree

A concept used to illustrate the organization of MIB objects.

MIB variable

A pairing of a MIB object and associated MIB value or values.

N

Node

A branch of the MIB tree.

Network

A group of data communication objects, with varying degrees of intelligence, that are interconnected through a common transmission medium. A network has both logical and physical characteristics.





O

Object ID

The name used to uniquely identify a MIB object. The object ID is based on an object's place in the MIB tree.

S

set

An action that enables the manager to alter management information on an agent.

Simple Network Management Protocol

The protocol used to retrieve network information from nodes; defined by *RFC 1157: A Simple Network Management Protocol (SNMP)*.

SNMP

See the Simple Network Management Protocol.

snmpd.ea

The background process on the extensible agent system that processes requests from the manager.

snmpd.extend

The default MIB module that extends the MIB on the agent to include new user-defined objects.

SNMP table

A table defined using the **SYNTAX SEQUENCE OF** and the **INDEX** clause.

Subtree

All nodes and children under a branch of the MIB tree.





T

Trap

Information sent from a node that supports SNMP (an agent) to the manager without an explicit request from the manager. Traps inform the manager of changes that occur on these nodes (for example, reboot).







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We Welcome Your Comments

HP OpenView

Extensible SNMP Agent Administrator's Reference

Please circle the number that best describes your opinion about the following items

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
The information you need is:					
Easy to find	1	2	3	4	5
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Accurate	1	2	3	4	5
The illustrations are:					
Useful	1	2	3	4	5
Easy to understand	1	2	3	4	5
The examples are:					
Useful	1	2	3	4	5
Easy to understand	1	2	3	4	5
Comments: _____					

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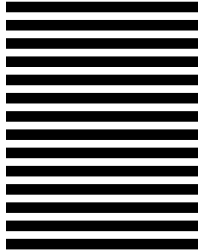




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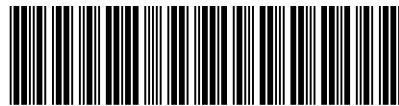






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