SNMP and RMON

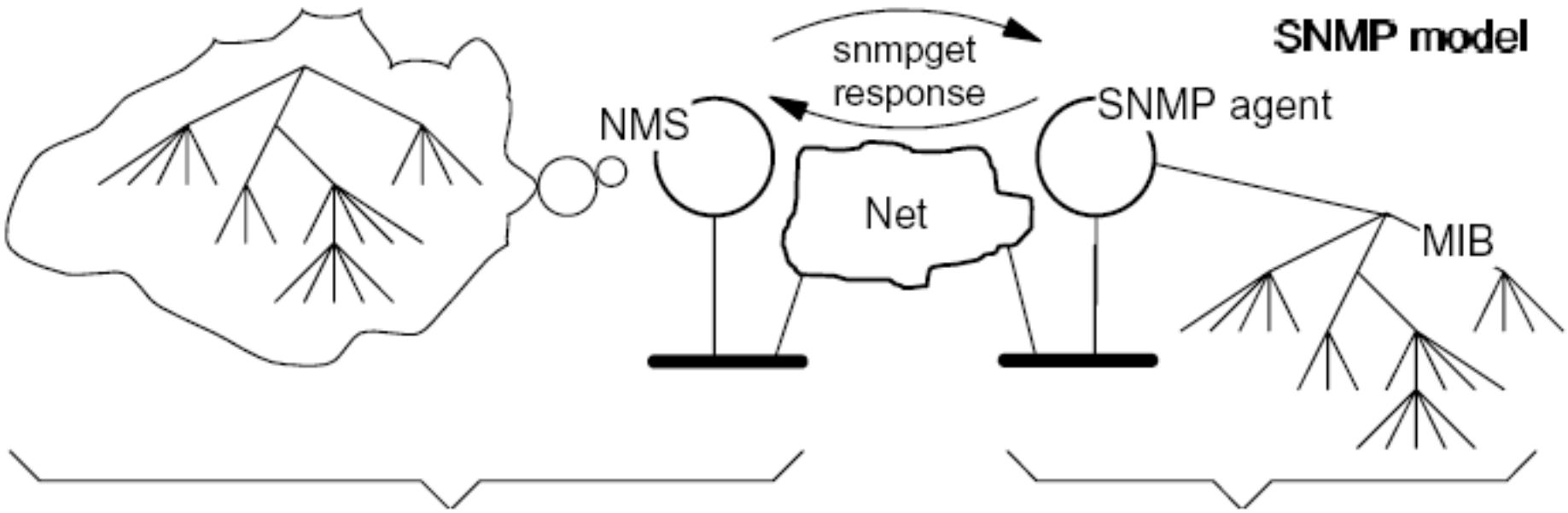
Outline

- 1.0 Introduction to SNMP
- 2.0 Beyond MIB-2
- 3.0 RMON MIB
- 4.0 Basic SNMP Tools
- 5.0 Usable SNMP Tools
- 6.0 SNMP Polling Architectures
- 7.0 SNMP Demo
- 8.0 References

1.0 Introduction to SNMP

DNS & DHCP

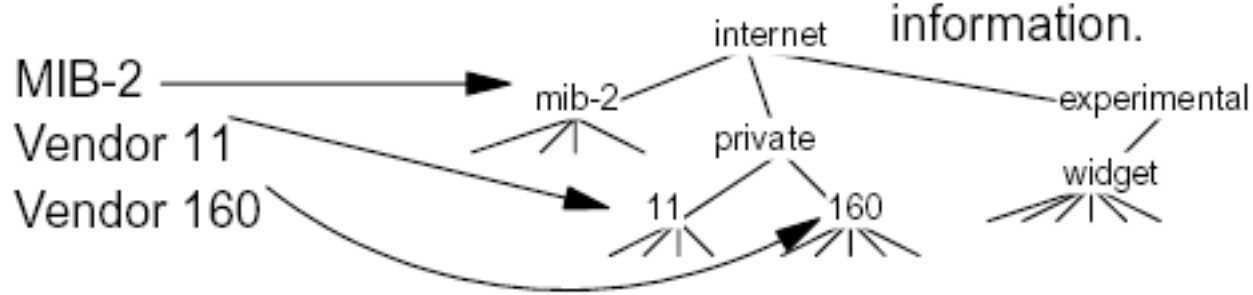
- These core services must work properly
- Network management tools will falter otherwise
- Routers and multi-homed hosts have one name and multiple IP addresses
- Network gear, servers, printers, DNS and DHCP servers have static IP addresses
- Ideally DHCP servers provide dynamic updates to the corporate DNS servers



The NMS needs to know exactly which MIB variables to request from the SNMP agent. The MIB compiler is used to load vendor MIBs (ASCII) into the compiled MIB file. The MIB-2 file is the default.

"database"

Each child node has a pointer to function code capable of going into the hardware and extracting the desired information.



ASCII ASN.1

MIB Compiler

Additional MIB branches grafted to the tree

SNMP is Simple

- GET is a read operation from the agent
- SET is a write operation to the agent
- TRAP is a single packet from agent to NMS
- SNMP operations require a community string which acts like a password
- SNMP version 1, 2c and 3 are out there
- SNMP v3 has security and bulk GETs

SNMP is a Simple Protocol

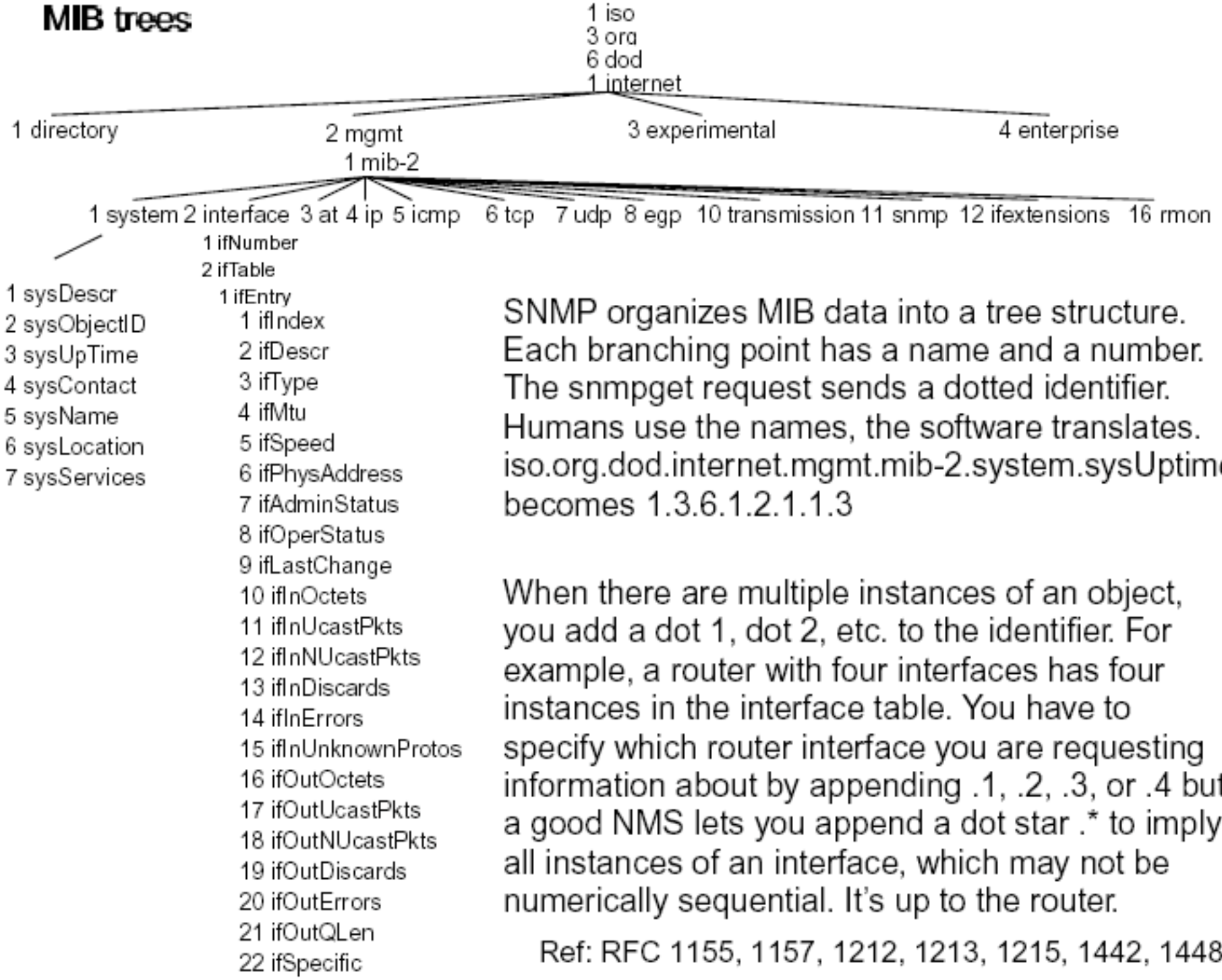
- request-reply oriented
- connectionless UDP transport
- applications handle timeouts:
  - timeout value
  - # retries
  - duplicate replies
  - multiple gets
- simple operators
  - snmpget
  - snmpgetnext
  - snmpset
- compound get is allowed
- "too big" reply may happen
- community name needed
  - one for gets
  - one for sets
  - 4 extras for HP RMON
- data structures defined by MIBs
- Management Information Base
- information in the MIB can be
  - configuration
  - performance
  - counters
  - status
  - tables
- custom MIB information

Some Aspects of SNMP

Poll SNMP variables to profile performance
Element manager GUI controls via SNMP
RMON MIB for segment monitoring
Private MIB used by manufacturers
MIB-2 is universally implemented
LAN analyzers can decode SNMP
Shell commands
- snmpget
- snmpgetnext
- snmpwalk
- snmpset

MIB browser
- GUI
- navigates the MIB tree
- shows numerical encoding
- allows snmpget of child nodes
- supports snmpgetnext to walk a MIB
- decodes snmp reply data
- lets you do snmpset command
- excellent educational tool
- use "show description" button
- check operation of an SNMP device

MIB trees



SNMP organizes MIB data into a tree structure. Each branching point has a name and a number. The snmpget request sends a dotted identifier. Humans use the names, the software translates. iso.org.dod.internet.mgmt.mib-2.system.sysUptime becomes 1.3.6.1.2.1.1.3

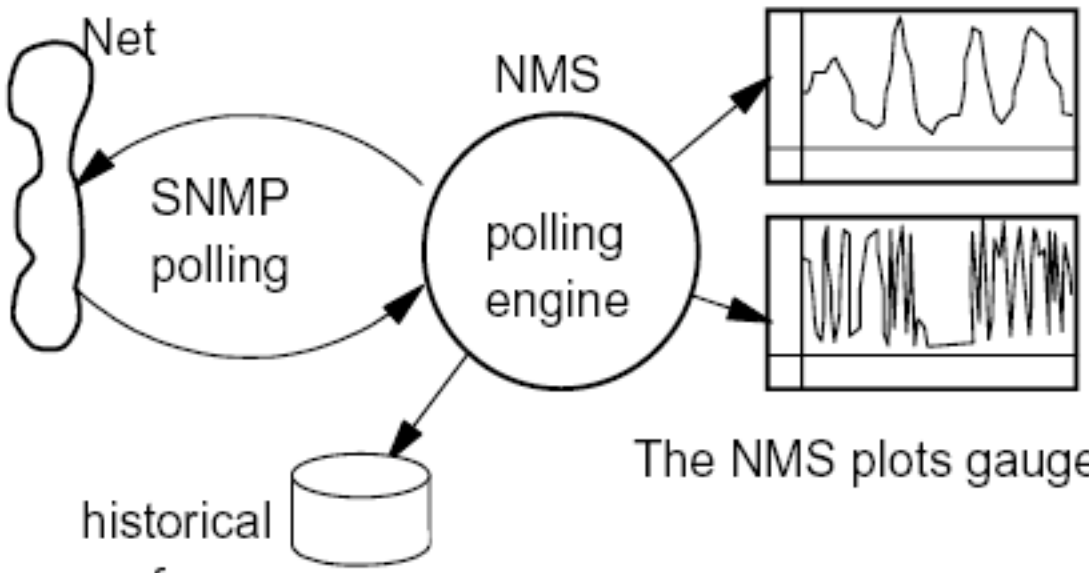
When there are multiple instances of an object, you add a dot 1, dot 2, etc. to the identifier. For example, a router with four interfaces has four instances in the interface table. You have to specify which router interface you are requesting information about by appending .1, .2, .3, or .4 but a good NMS lets you append a dot star .* to imply all instances of an interface, which may not be numerically sequential. It's up to the router.

Ref: RFC 1155, 1157, 1212, 1213, 1215, 1442, 1448

SNMP provides several basic data types

- **DisplayString** is a character string (e.g. system description and system contact)
- **Octet string** is also a string of characters (e.g. community name)
- **Integer** is typically an index used to access a table
- **Counter** is an integer that grows monotonically, usually 32 bits long, and wraps
- **Gauge** acts like your car speedometer, goes up and down, and may represent the length of a queue, the CPU utilization of a router (e.g. Cisco's busyPer), or an interface speed. It represents a rate variable (units/second)

SNMP performance polling requires the NMS to understand the different types of numerical data the user might ask it to poll for.



Custom graphs produced by the report generator on an X-terminal, on a web page in the form of a GIF image. Data may be exported in CSV format to a spreadhseet for professional quality presentation.

The NMS plots gauge values directly.

For counters it plots $\frac{\text{this\_counter - last\_counter}}{\text{this\_time - last\_time}}$

Useful MIB variables

Good information like
- data thoughput (bytes or octets)
- CPU utilization (servers, routers)
- CPU load averages (1, 5, 15 minutes)
- packets forwarded (routers)
- number of users logged on (servers)
- free memory (routers, servers)
- file system free space (servers)

Bad information like
- broadcasts and multicasts (all)
- collisions (not so bad really)
- TCP retransmissions (servers)

Ugly information like
- CRC errors (all interfaces)
- excess retries (Ethernet)
- interface disconnects (serial lines)
- packet discards (routers)
- SMT problems on FDDI (probe)

What we need are a few good MIBS

interface group
ifInNUcastPkts
ifInUcastPkts
ifInOctets
ifInDiscards
ifInErrors
ifOutErrors
ifOutQLen

ip group
ipForwDatagrams
ipOutDiscards

tcp group
tcpRetransSegs

Cisco enterprise MIB
busyPer

2.0 Beyond MIB-2

Special MIBs

- DNS Server MIB Extensions RFC 1611
- DNS Resolver MIB Extensions RFC 1612
- VPN Gateway MIB & Traps (ex Intel@NetStructure VPN Gateway)
- draft-ietf-l3vpn-mpls-vpn-mib-01.txt
- http://www.juniper.net/techpubs/software/junos/junos60/swconfig60-net-mgmt/html/vpn-mib.html
- RTP MIB
- VOIP MIB
- Directory Server Monitoring MIB RFC 2605
- RIP version 2 MIB Extension RFC 1724
- Printer MIB RFC 1759
- Mail Monitoring MIB RFC 2789
- RADIUS Authentication Client MIB RFC 1618
- RADIUS Authentication Server MIB RFC 1619
- IPv4 Multicast Routing MIB RFC 2932
- Power Ethernet MIB

Proposed RTP MIB V2

draft-clark-avt-rtpmibv2-00.txt

Alan Clark – alan@telchemy.com

Rationale

- RTP MIB exists, need to add support for new RTCP XR metrics
- Desirable to have MIB(s) that supports VoIP, conferencing, multicast……..
- Proposed RTP MIB V2 draft incorporates RTCP XR VoIP metrics into RTP MIB
- Applications
  - Collect IP Phone stats in Gateway
  - Conference bridge management
  - ……..

rtcpXrVoipTable

rtcpXrVoipEntry ::= SEQUENCE {

- rtcpXrVoipIndex
- rtcpXrVoipCallIdentifier
- rtcpXrVoipSourceIPaddress
- rtcpXrVoIPSourcePort
- rtcpXrVoipVocoderType
- rtcpXrVoipCallDuration

Basic call info

- rtcpXrVoipNetworkLossRate
- rtcpXrVoipAverageDiscardRate
- …….
- rtcpXrVoipJitterBufferSize

RTCP XR VoIP Metrics

}

What supports SNMP?

- "Support" = SNMP agent runs on it
- Managed Devices
  - Manageable hubs, switches, routers
  - VPN gateways, NAT routers
  - VOIP gateways, RTP servers
- O/S (Mac OS X, Windows, Linux, UNIX)

What can you measure with SNMP?

- Anything the SNMP agent can measure
- Any physical link (Frame Relay links, tunnels, fiber, ethernet, wireless, etc)
- Any logical link (VLAN, MPLS, VPN)
- Any server (OS, network links, service & processes, resources)

Situating SNMP Tools

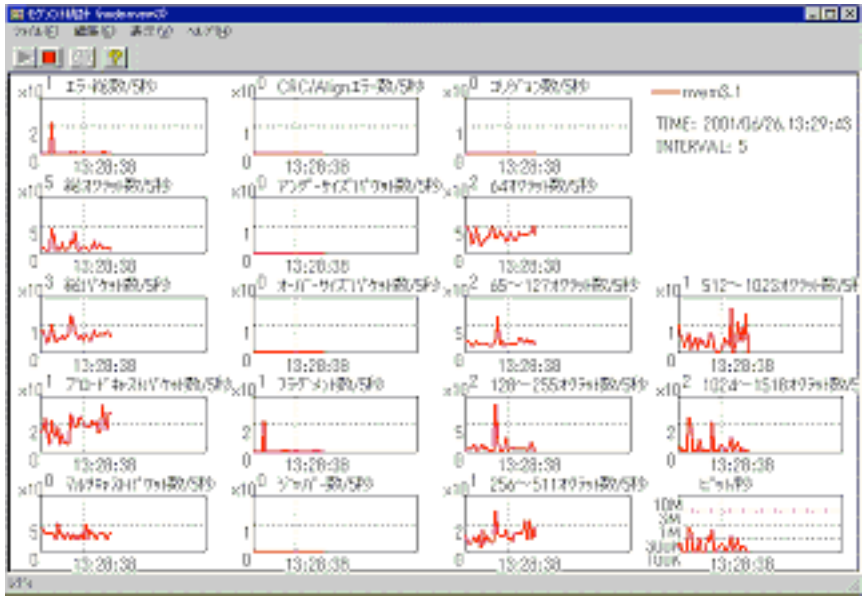
- Agents embedded in active network infrastructure (switches, routers, gateways, Wireless Access Points)
- Mail, web, FTP, NAT, DNS, DHCP, database, Windows domain controllers - servers
- Special locations such as security perimeters, dial-in VPN gateways
- NMS servers in the data center, consoles in the NOC

3.0 RMON MIB

Remote MONitoring

- RMON MIB - an extension to MIB-2
- Standard for measuring network traffic
- Stand-alone probes contain RMON agents
- Built into high end switches and routers
- Remotely configurable (often via SNMP)
- Real time statistics, packet capture, thresholds
- Central repository of archived data (by NMS)

RMON Instrumentation



http://www.sw.nec.co.jp/middle/WebSAM/products/Netvisor/image/rmon.gif

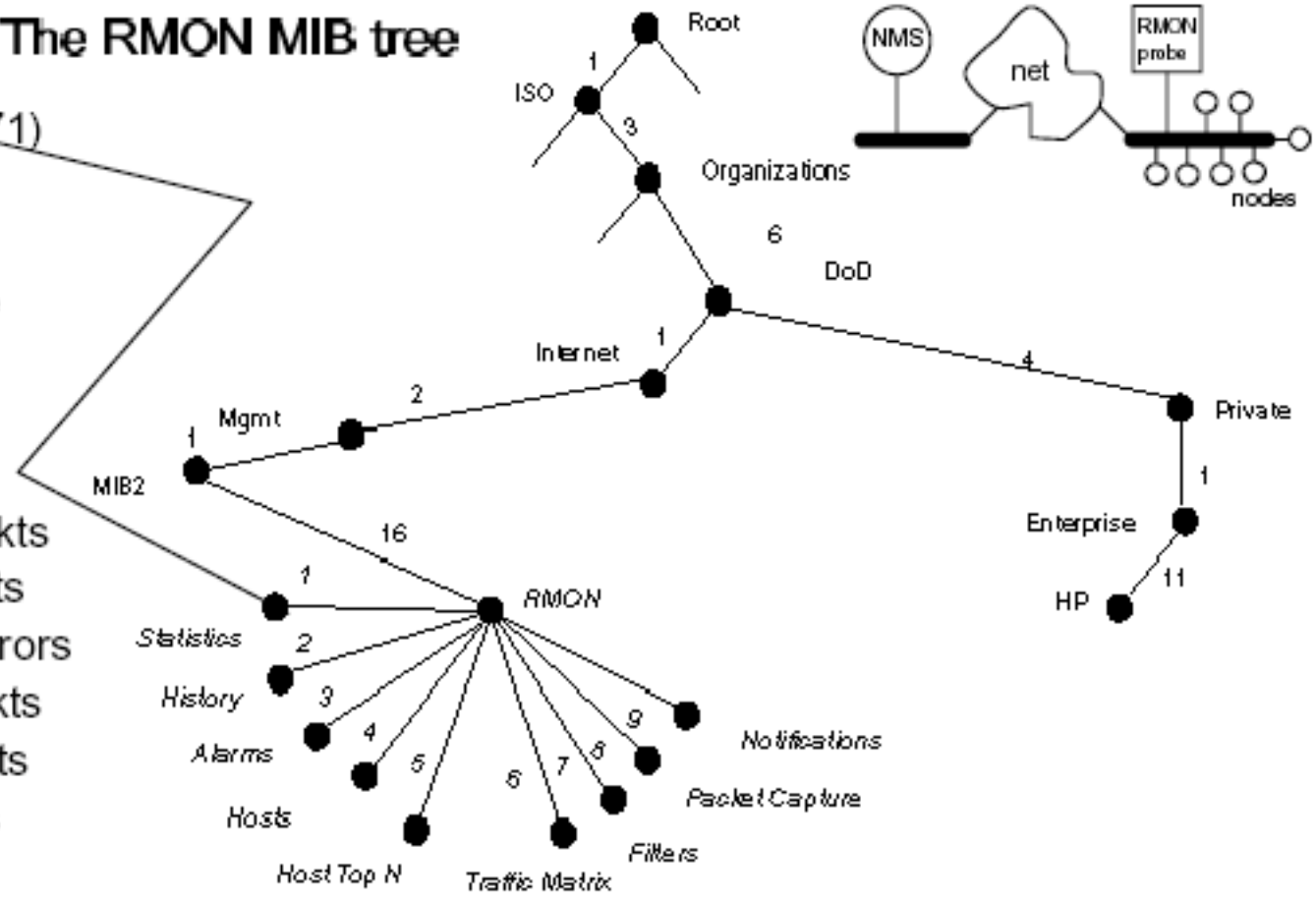
http://www.in-line.ru/news/img/160902_1.gif

RMON MIB Nine Groups

RMON Group	Description
Statistics	Measures real time LAN statistics such as utilization, bytes, packets, collisions, SMT frames, broadcasts, runts, jabbers, CRC errors
History	Collects selected statistics samples in memory, typically over a 30-second or 30-minute averaging interval. This local performance data collection offloads an NMS from remote SNMP polling.
Alarm	Defines thresholds for a specified statistic and sends an RMON SNMP trap to the network management station. This local performance event generation offloads the NMS and reduces SNMP polling traffic on the network
Hosts	Measures host specific LAN statistics such as bytes sent, bytes received, frames sent, frames received
Hosts top N	The probe observes all conversations for, say, 10 minutes and reports on the top 50 talkers by bytes received.
Traffic matrix	Measures the traffic matrix between systems based on their MAC address. Routers show up as a big talker and listener
Filter	Defines packet data patterns of interest. The NMS provides a GUI to allow filtering by MAC, IP, TCP and other byte patterns of interest
Packet Capture	Collect & forward packets matching the Filter to the NMS, where a GUI decodes and displays the packet trace
Notification	Send an alert SNMP trap for the Alarm group

The RMON MIB tree

1 etherStatsTable (RFC 1271)
- 1 etherStatsEntry
  - 1etherStatsIndex
  - 2 etherStatsDataSource
  - 3 etherStatsDropEvents
  - 4 etherStatsOctets
  - 5 etherStatsPkts
  - 6 etherStatsBroadcastPkts
  - 7 etherStatsMulticastPkts
  - 8 etherstatsCRCAlignErrors
  - 9 etherstatsUndersizePkts
  - 10 eterstats OversizePkts
  - 11 etherStatsFragments
  - 12 etherStatsJabbers
  - 13 etherStatsCollisions
  - 14 etherStatsPkts64Octets
  - 15 etherStatsPkts65to127Octets
  - 16 etherStatsPkts128to255Octets
  - 17 etherStatsPkts256to511Octets
  - 18 etherStatsPkts512to1023Octets
  - 19 etherStatsPkts1024to1518Octets
  - 20 etherStatsOwner
  - 21 etherStatsStatus



An SNMP request for 1.3.6.1.2.1.16.1.1.1.10 returns the number of Oversize packets the RMON Ethernet probe has counted since it was last initialized, boot, or reset.

RFC 1513 specifies Token-Ring RMON extensions. RFC1757 specifies FDDI RMON extensions. The HP LanProbe MIB is at: ftp://venera.isi.edu/mib/lanprobe-mib.

Completeness of RMON

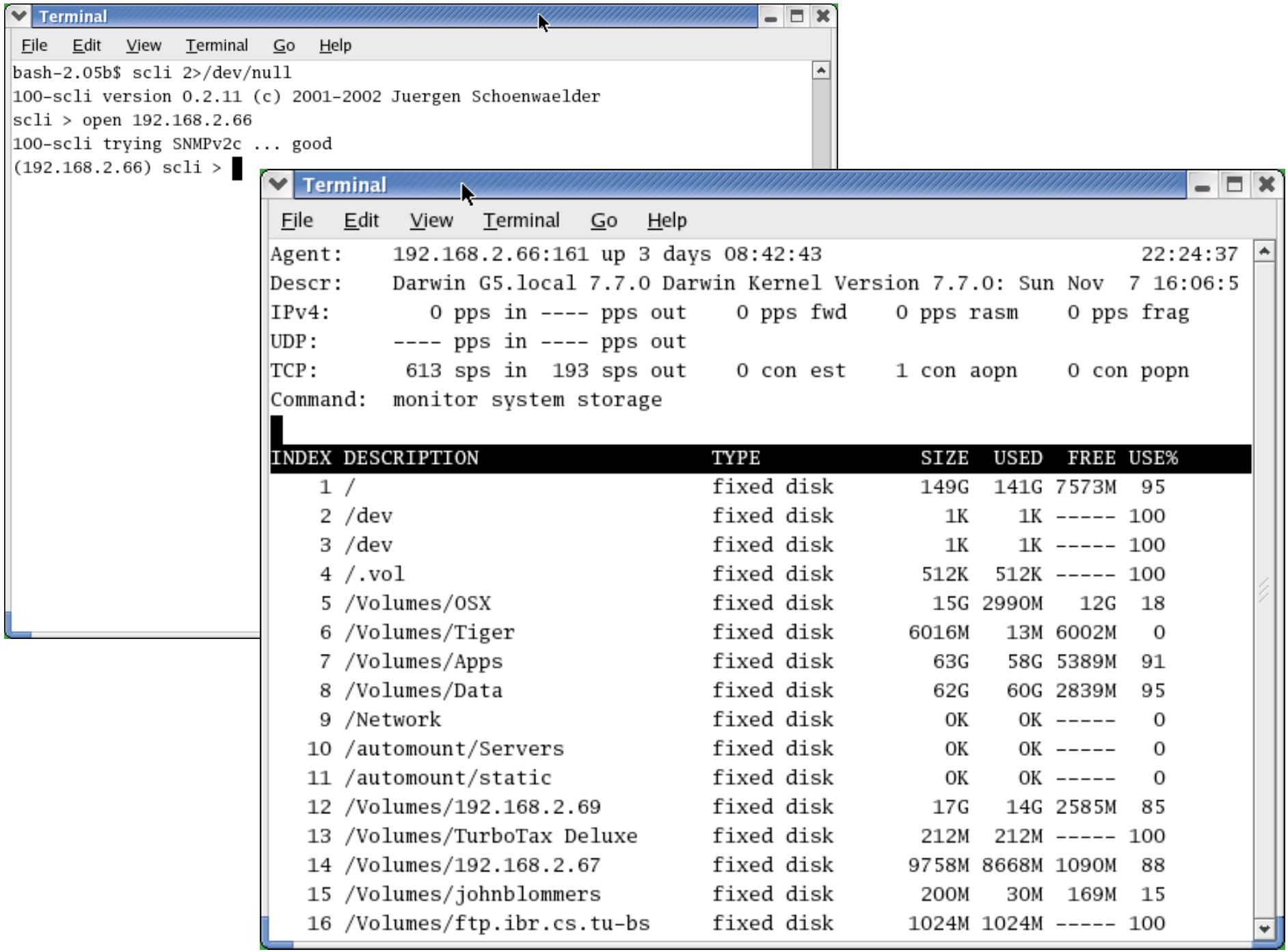
- Implementation of the full RMON MIB requires relatively expensive hardware because:
  - more CPU cycles are needed
  - more RAM is needed (data buffers)
  - more network bandwidth is needed
  - a bigger ROM is needed (RMON code)
- Statistics, History, and Alarm are minimum

4.0 Basic SNMP Tools

Simple SNMP Management Tools

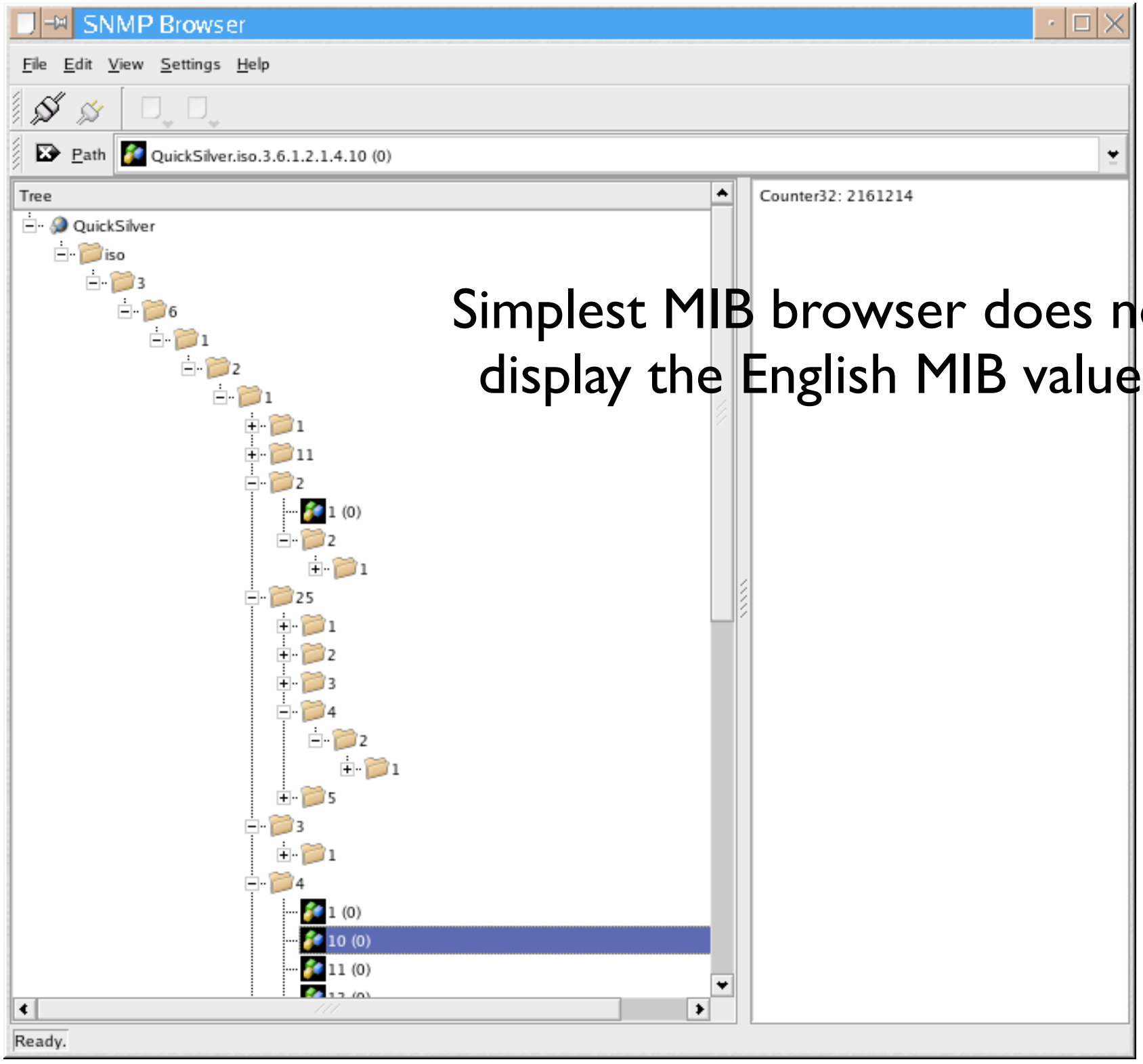
- Query the SNMP agent directly with CLI
- `snmpwalk -v 2c -c public localhost sysUpTime.0`
  `SNMPv2-MIB::sysUpTime.0 = Timeticks: (15774056) 1 day, 19:49:00.56`
- `snmpwalk -Of -v 2c -c public localhost .interfaces.ifTable.ifEntry.ifInOctets.4`
- `.iso.org.dod.internet.mgmt.mib-2.interfaces.ifTable.ifEntry.ifInOctets.4 = Counter32: 453958290`

scli (SNMP Command Line Interface)



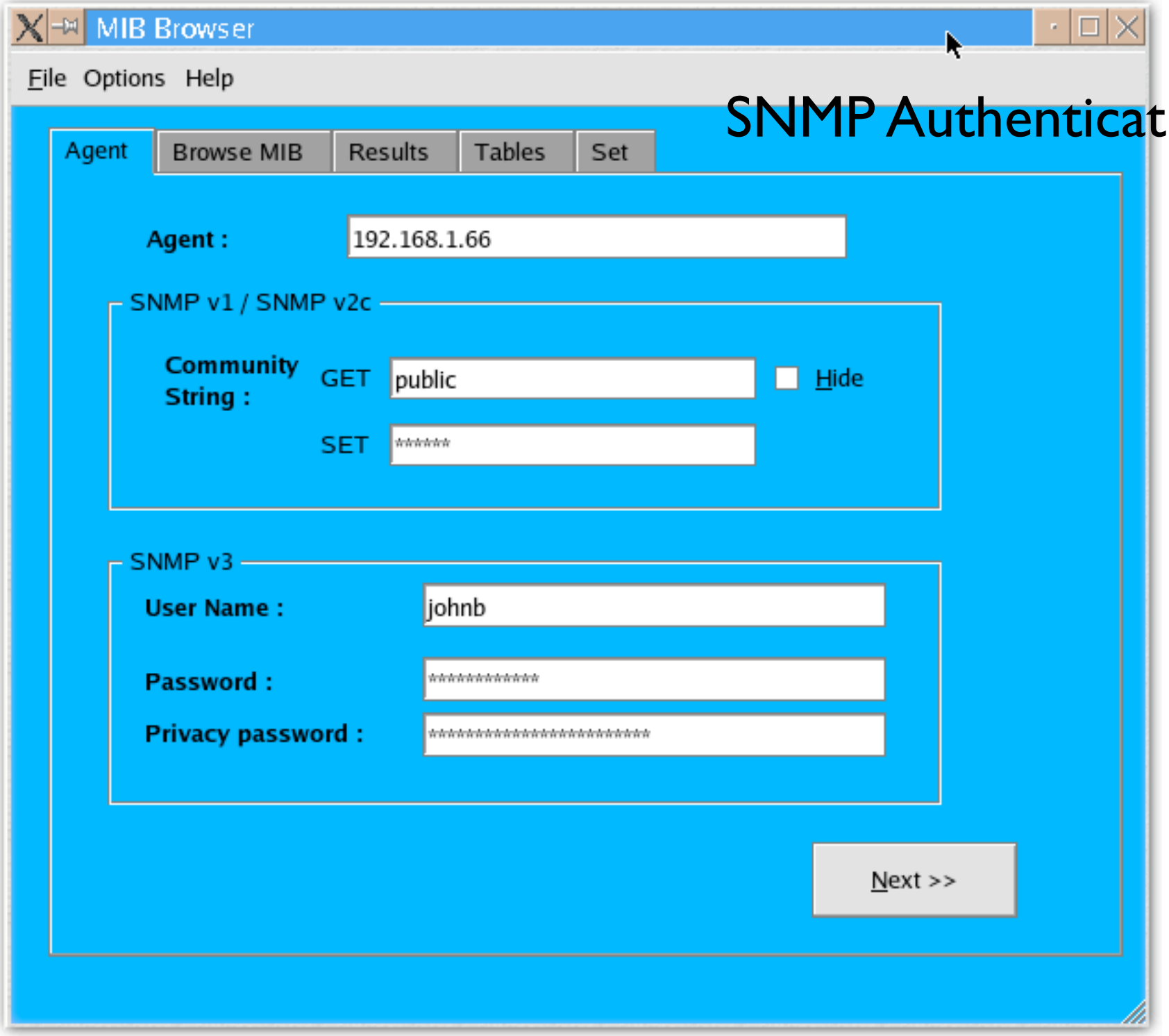
SNMP MIB Browser

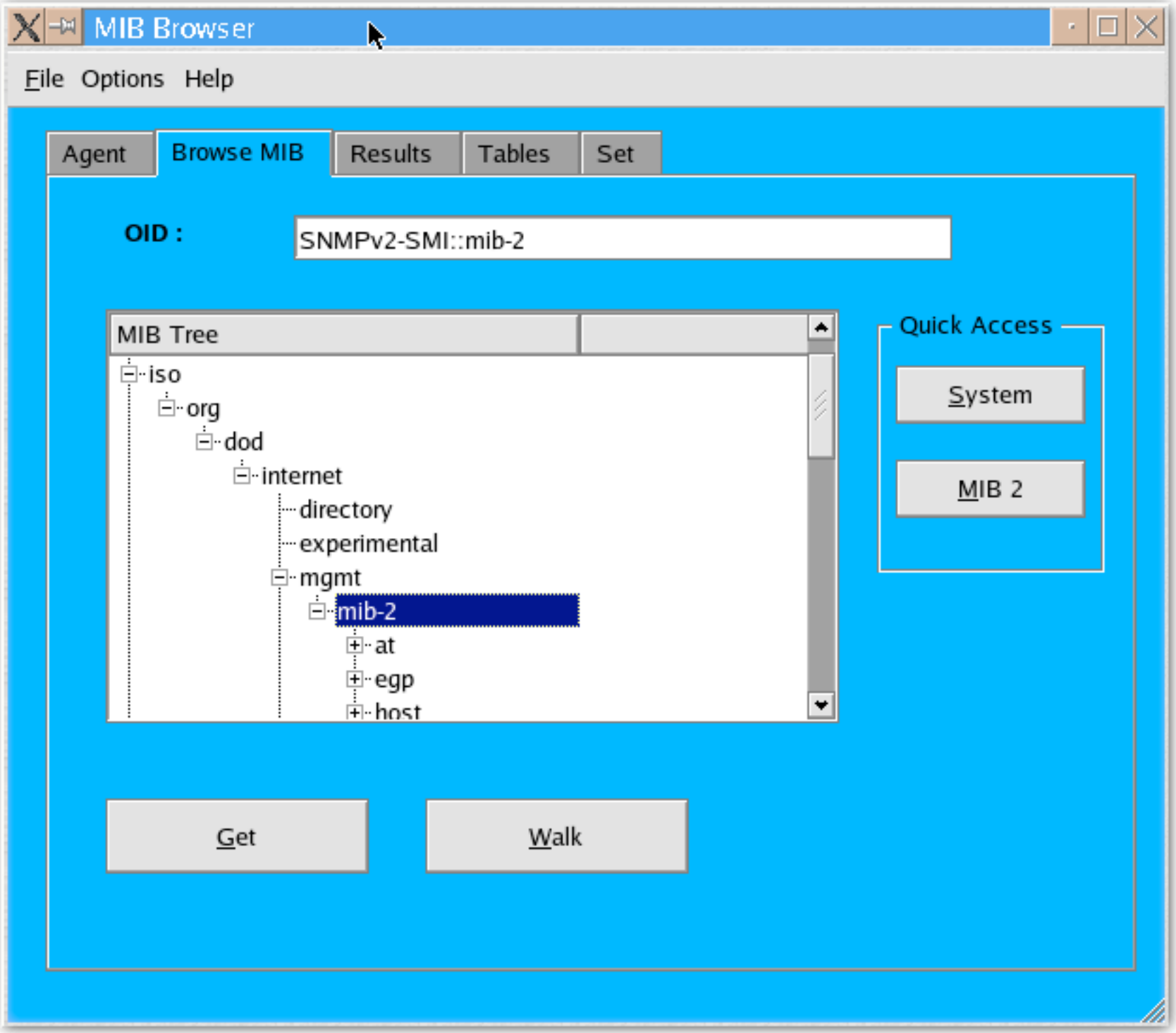
- MIB browsers are an excellent learning tool for SNMP
  - http://www.ibr.cs.tu-bs.de/cgi-bin/sbrowser.cgi
  - http://sourceforge.net/projects/mibrow/
  - http://sourceforge.net/projects/snmpbrowser/



Simplest MIB browser does not display the English MIB values

SNMP Authentication




MIB Browser
File Options Help
Agent
Browse MIB
Results
Tables
Set
OID :
SNMPv2-SMI::mib-2
MIB Tree
iso
org
dod
internet
directory
experimental
mgmt
mib-2
at
egp
host
Quick Access
System
MIB 2
Get
Walk

5.0 Usable SNMP Tools

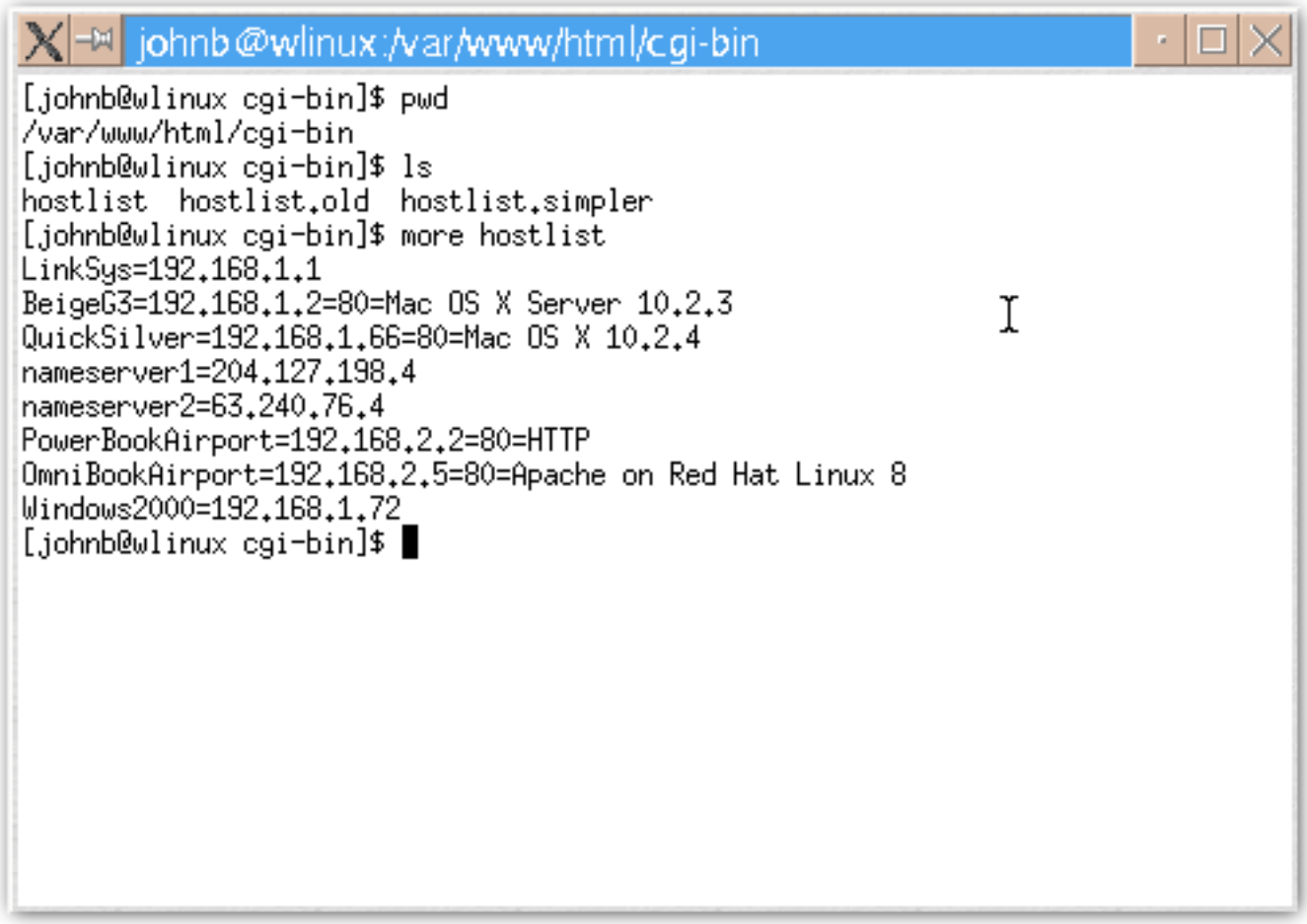
What Data do we want?

- Historical performance data for trending and troubleshooting
- Real time performance data for real time troubleshooting
- Error data (bad and ugly)
- SNMP Traps generated by agents (status change, threshold exceeded)
- Correct network topology map

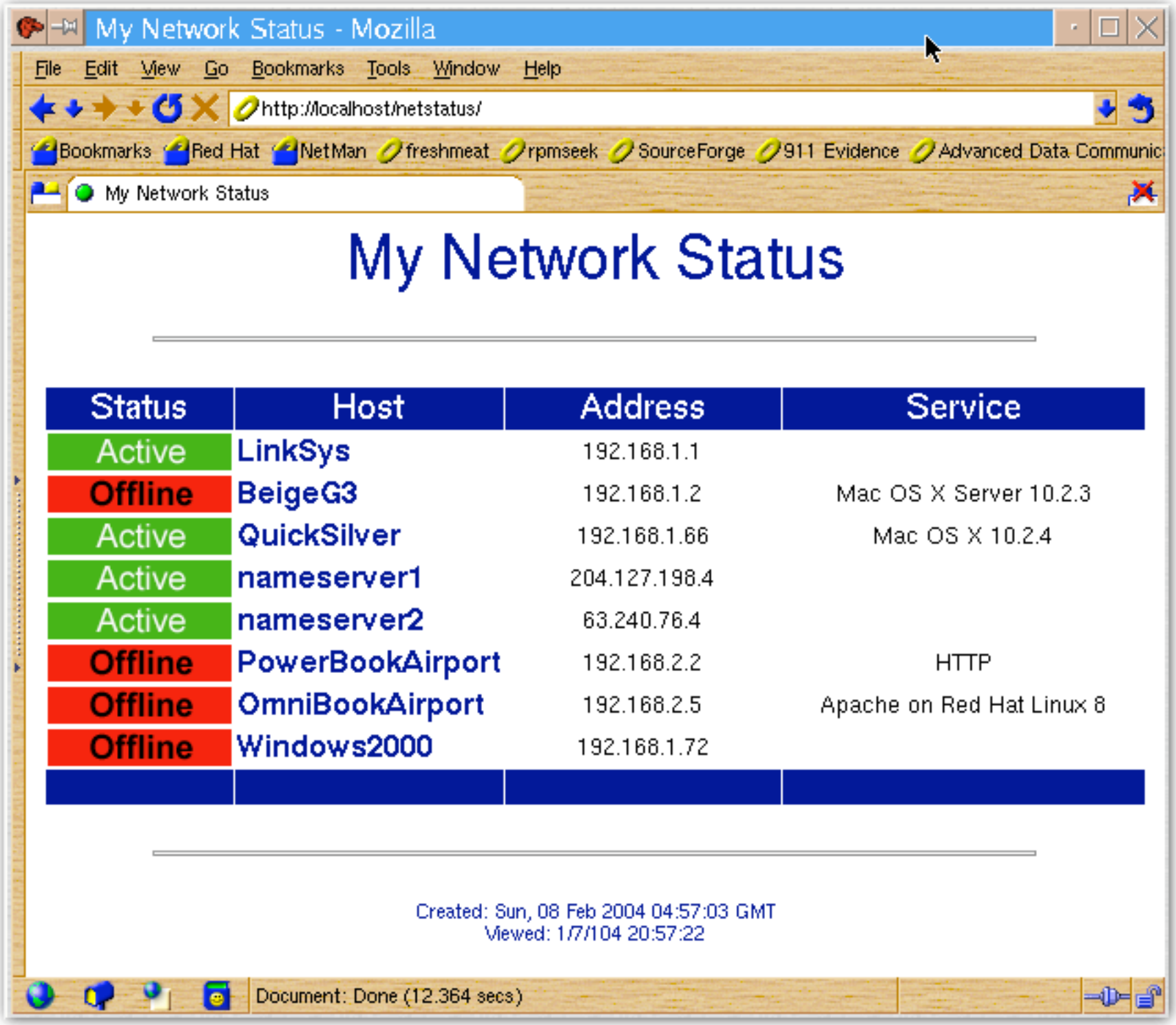
Real World Tools

- netstatus (http://sourceforge.net/projects/netstatus/)
- MRTG (http://people.ee.ethz.ch/~oetiker/webtools/mrtg/)
- opennms (http://www.opennms.org/)
- HP OpenView Network Node Manager
- HP OpenView Operations Windows (OVOW)

netstatus config. file



netstatus runs periodically via a crontab entry


My Network Status - Mozilla
File Edit View Go Bookmarks Tools Window Help
http://localhost/netstatus/
Bookmarks Red Hat NetMan freshmeat rpmseek SourceForge 911 Evidence Advanced Data Communic
My Network Status
My Network Status
Status Host Address Service
Active LinkSys 192.168.1.1
Offline BeigeG3 192.168.1.2 Mac OS X Server 10.2.3
Active QuickSilver 192.168.1.66 Mac OS X 10.2.4
Active nameserver1 204.127.198.4
Active nameserver2 63.240.76.4
Offline PowerBookAirport 192.168.2.2 HTTP
Offline OmniBookAirport 192.168.2.5 Apache on Red Hat Linux 8
Offline Windows2000 192.168.1.72
Created: Sun, 08 Feb 2004 04:57:03 GMT
Viewed: 1/7/104 20:57:22
Document: Done (12.364 secs)

- **Open Source** tool
- http://www.mrtg.org
- Time-scheduled Perl script
- Configuration file drives SNMP data collector
- Creates web pages of performance plots
- Requires a web server such as Apache
- Pre-compiled for Windows and Linux

mrtg.cfg

```
##################################################################
# Multi Router Traffic Grapher -- Example Configuration File
##################################################################
# * consider using ../run/cfgmaker to build your initial mrtg.cfg file
# ####################
# Global Configuration
# ####################
WorkDir: /Users/johnb/Sites/mrtg
Refresh: 300
##
## Target --------------------------------------
##
Target[beigeg3]: 5:public@192.168.1.2
MaxBytes[beigeg3]: 1250000
Title[beigeg3]: Beigeg3 MRTG statistics
PageTop[beigeg3]: <H1>Traffic Analysis for beigeg3</H1>
PageFoot[beigeg3]: <HR size=2 noshade>This page managed by JohnB.
Directory[beigeg3]: beigeg3
```

OmniBook Wireless - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://localhost/mrtg/omnibookw.html

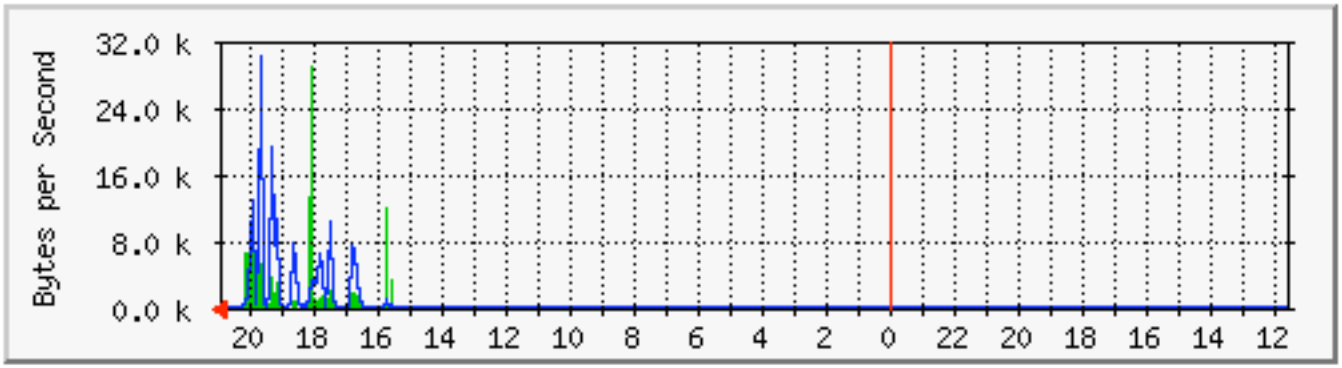
Bookmarks Red Hat NetMan freshmeat rpmseek SourceForge 911 Evidence Advanc

OmniBook Wireless

OmniBook Wireless LAN

The statistics were last updated **Saturday, 7 February 2004 at 20:55**

`Daily' Graph (5 Minute Average)

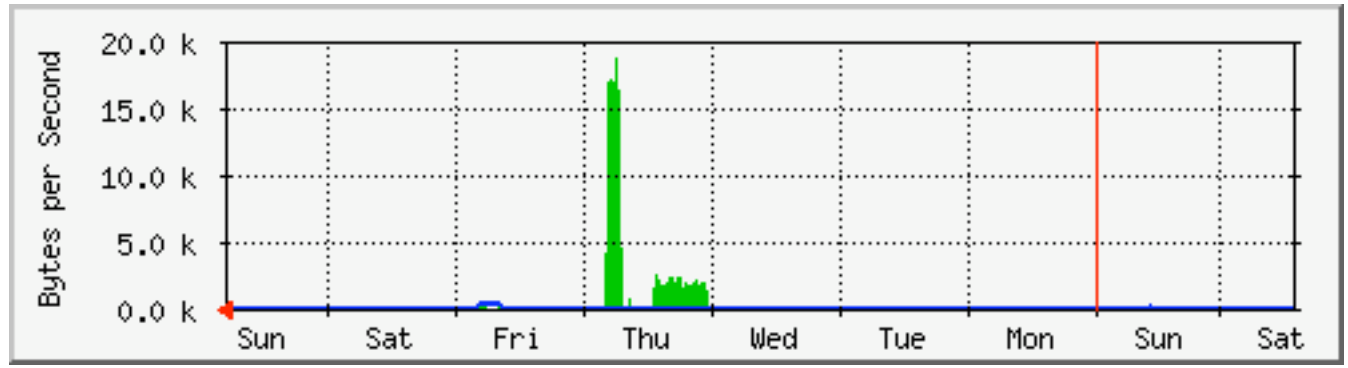


Max In:29.2 kB/s (0.3%) Average In:410.0 B/s (0.0%) Current In:0.0 B/s (0.0%)
Max Out:30.2 kB/s (0.3%) Average Out:503.0 B/s (0.0%) Current Out:0.0 B/s (0.0%)

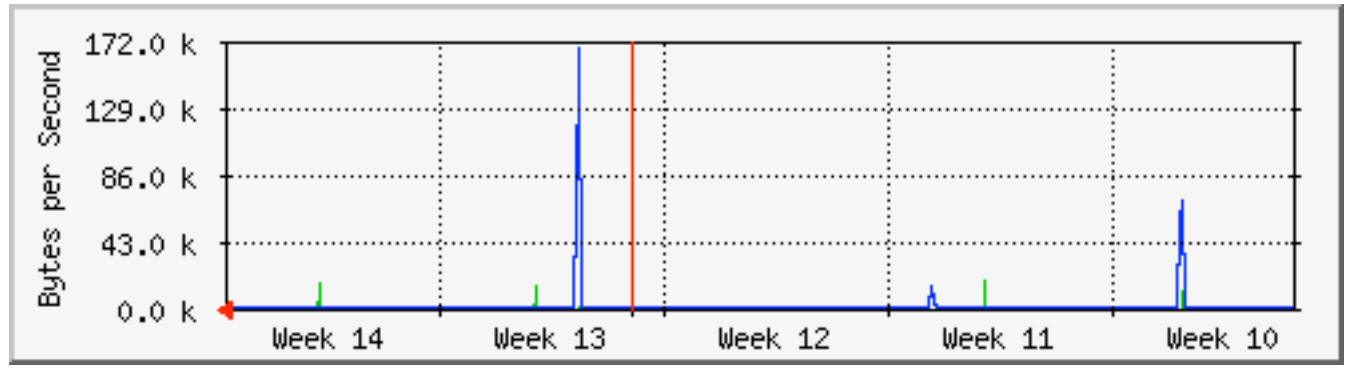
Document: Done (43.294 secs)

`Daily' Graph
(5 Minute Average)

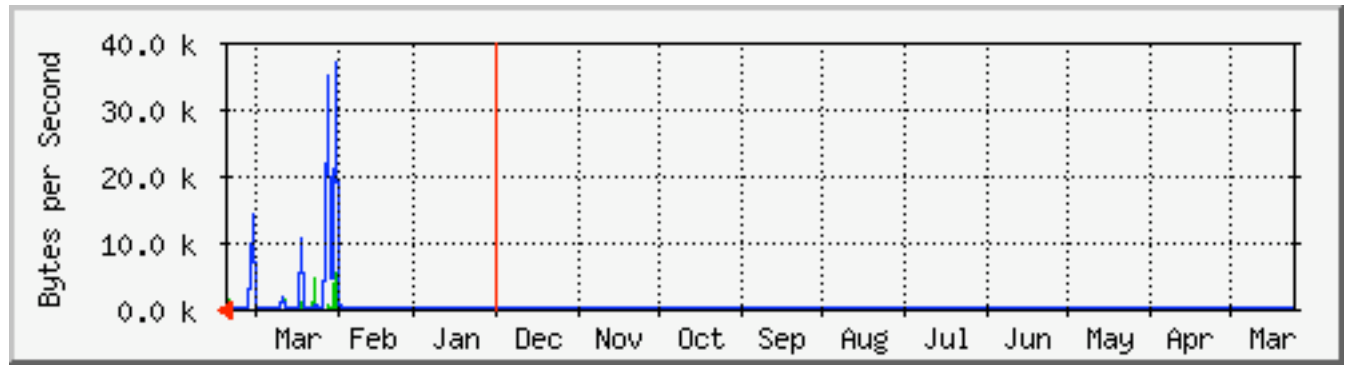
`Weekly' Graph
(30 Minute Average)



`Monthly' Graph
(2 Hour Average)



`Yearly' Graph
(1 Day Average)

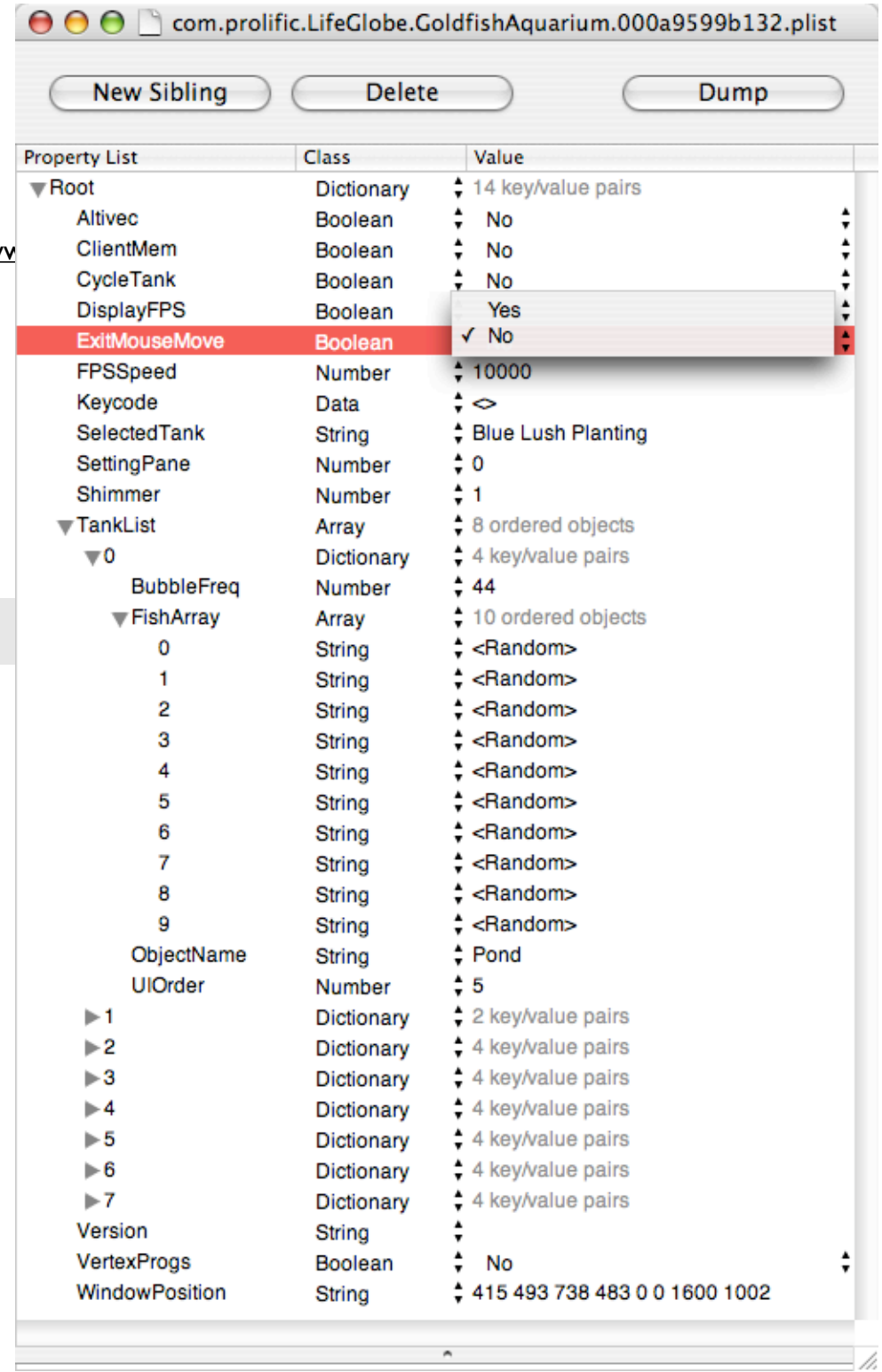


OpenNMS

- Open source project, so it's free
- PostgresSQL database for storing all data
- Web interface on port 8080
- Discovery (pings given range of IP addresses)
- SNMP data collection & display
- Notification services
- Event & trap logging
- Polling
- XML configuration files

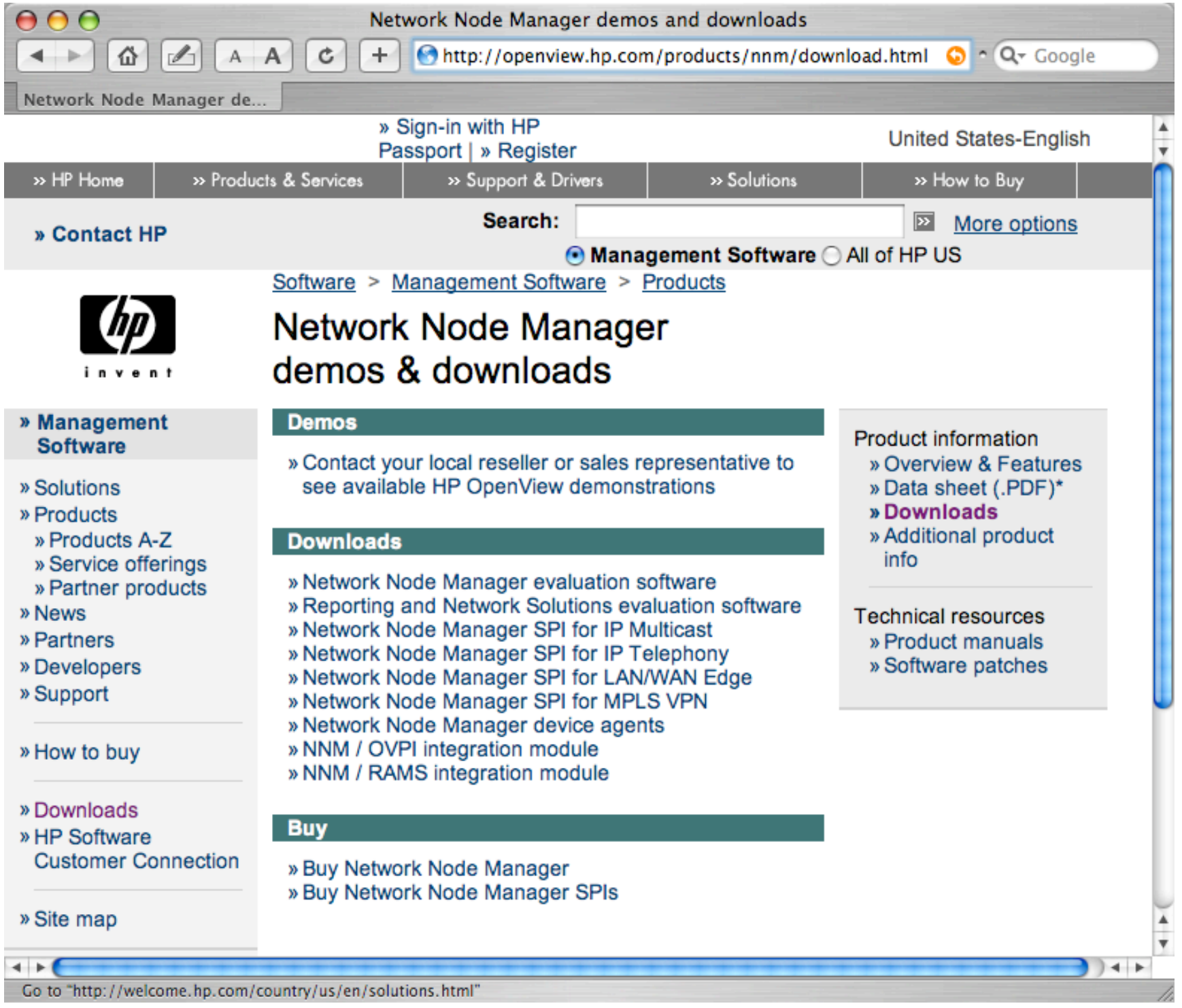
About XML

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Computer//DTD PLIST 1.0//EN" "http://www
<plist version="1.0">
<dict>
        <key>Altivec</key>
        <false/>
        <key>ClientMem</key>
        <false/>
        <key>CycleTank</key>
        <false/>
        <key>DisplayFPS</key>
        <true/>
        <key>ExitMouseMove</key>
        <false/>
        <key>FPSSpeed</key>
        <integer>10000</integer>
        <key>Keycode</key>
        <data>
        </data>
        <key>SelectedTank</key>
        <string>Blue Lush Planting</string>
        <key>SettingPane</key>
        <integer>0</integer>
        <key>Shimmer</key>
        <integer>1</integer>
        <key>TankList</key>
        <array>
                <dict>
                        <key>BubbleFreq</key>
                        <integer>44</integer>
                        <key>FishArray</key>
                        <array>
                                <string>&lt;Random&gt;</string>
                                <string>&lt;Random&gt;</string>
                                <string>&lt;Random&gt;</string>
```

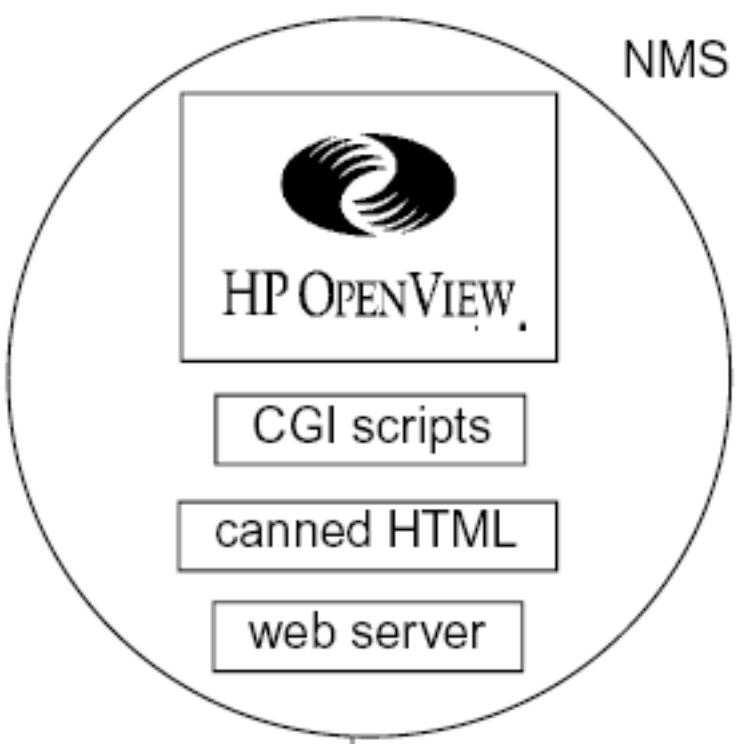


HP OpenView Network Node Manager 6.4 Demo Pack

- Full featured version of Node Manager
- openview.hp.com/products/nnm/download.html
- Time limited demo ~60 days
- W2K & XP, Solaris, HP-UX, Red Hat Enterprise
- Requires web server and DNS to work
- Do not test this at work without permission
- Native GUI or web-based interface


Network Node Manager demos and downloads
http://openview.hp.com/products/nnm/download.html
Google
Network Node Manager de...
» Sign-in with HP Passport | » Register
United States-English
» HP Home
» Products & Services
» Support & Drivers
» Solutions
» How to Buy
» Contact HP
Search:
More options
Management Software
All of HP US
Software > Management Software > Products
invent
Network Node Manager demos & downloads
» Management Software
» Solutions
» Products
» Products A-Z
» Service offerings
» Partner products
» News
» Partners
» Developers
» Support
» How to buy
» Downloads
» HP Software Customer Connection
» Site map
Demos
» Contact your local reseller or sales representative to see available HP OpenView demonstrations
Downloads
» Network Node Manager evaluation software
» Reporting and Network Solutions evaluation software
» Network Node Manager SPI for IP Multicast
» Network Node Manager SPI for IP Telephony
» Network Node Manager SPI for LAN/WAN Edge
» Network Node Manager SPI for MPLS VPN
» Network Node Manager device agents
» NNM / OVPI integration module
» NNM / RAMS integration module
Buy
» Buy Network Node Manager
» Buy Network Node Manager SPIs
Product information
» Overview & Features
» Data sheet (.PDF)*
» Downloads
» Additional product info
Technical resources
» Product manuals
» Software patches
Go to "http://welcome.hp.com/country/us/en/solutions.html"

HP OV NNM & The Web



standard web browser:

- Netscape for UNIX X-client
- Netscape for Windows
- Netscape for Macintosh

The web server provides the HTTP support necessary for this to work
The canned HTML lets the user select the information they want
The CGI scripts collect the desired information from OV
The OV system provides the requested information in the database
The degree of interaction is limited to read-only web pages (e.g. no interactive map)

Scalability of SNMP tools

- netstatus is a very manual tool, poor scaling, and offers only up/down information
- MRTG has some automation support but does not scale to multiple boxes, collects & a presents perfomance data
- OpenNMS does discover, event, performance collection but no network maps
- HP OpenView NNM supports a hierarchy of NMSs, scales to enterprise networks, collects perf data, builds maps, auto-discovers, does event correlation

6.0 SNMP Polling Architectures

SNMP and Polling

- Any IP device's status can be checked with ping
- SNMP device status checked with SNMPGET
  - read the system uptime variable
  - check interface status on all interfaces
  - how often should we check status?
  - what if we have 100,000 network interfaces?
  - what if we have a global Intranet?

SNMP and Polling

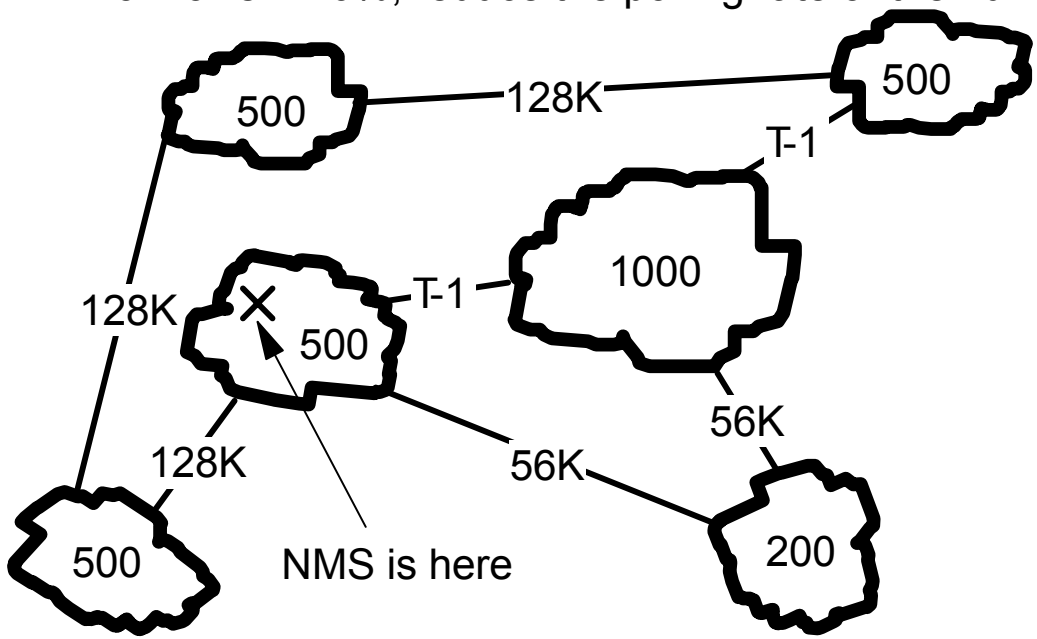
- Distributed polling benefits:
  - more NMSs = highly available NMS
  - localizes polling to the local site
  - improved response time to queries
  - increased polling rate feasible
  - can collect additional SNMP data
  - RMON complements SNMP polling

SNMP and Polling

How much SNMP polling traffic does my NMS create on my network?

You are going to implement SNMP performance monitoring of your network:

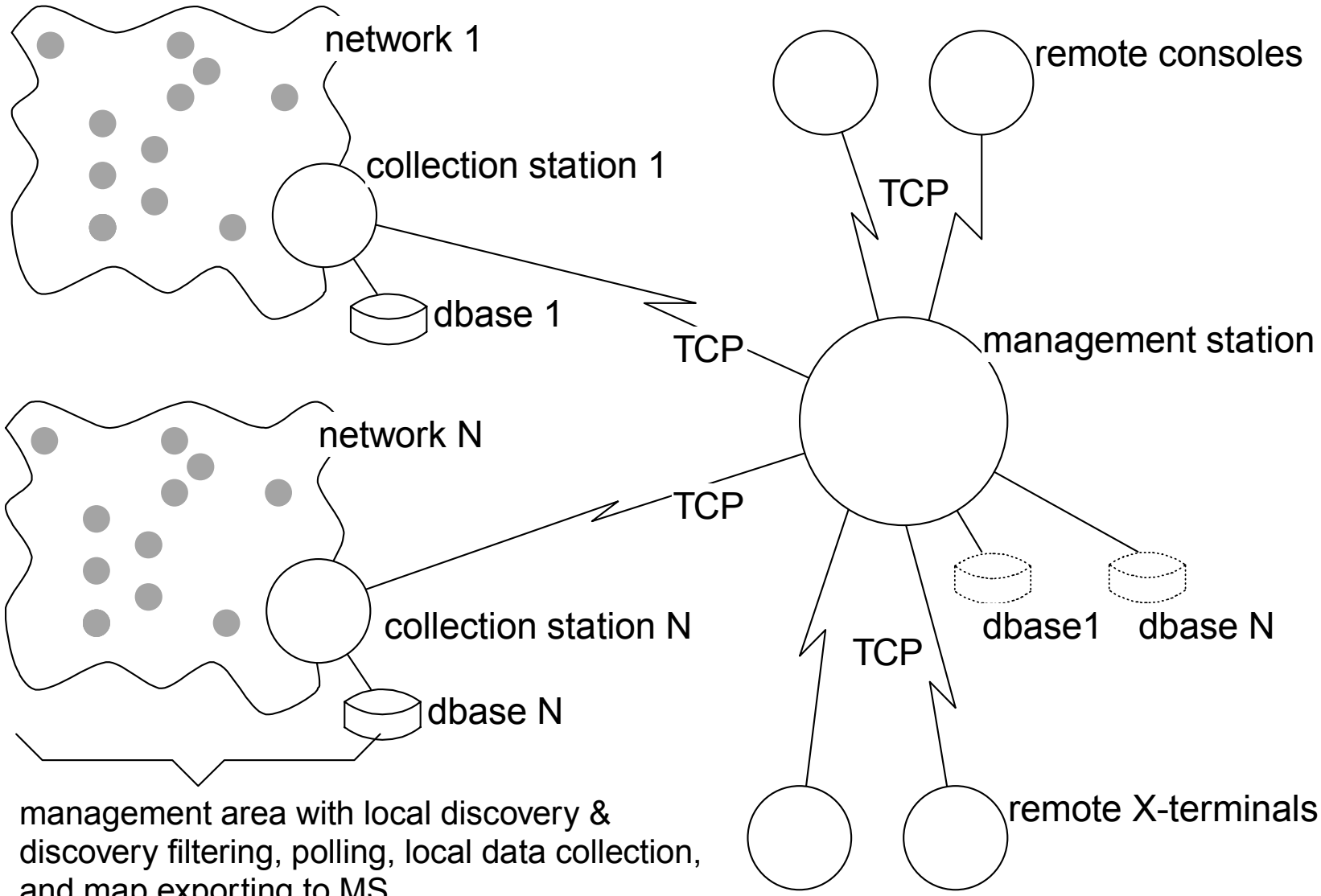
- measuring the size of the SNMP gets and replies gives 200 and 250 bytes
- 250 bytes is the larger number, so work with it
- you want to keep SNMP traffic in both directions <10% of the slowest WAN link
- for each network, count the number of measurements to be taken
- assume a 1-minute sampling interval as a starting point
- determine the path that SNMP traffic will take across the whole network
- add up flows that share the same path, for the larger 250-byte packets
- compare the total flows with the line speed at each point
- for flows > 10%, reduce the polling rate or the number of managed devices



Aside: Why do network managers worry so much about adding network management traffic to their WAN links when web servers and Email hubs are being installed at a record pace, and workers are surfing the net without any regard or appreciation whatsoever for the impact on the enterprise network?

SNMP and Polling

Distributed NMS Topology

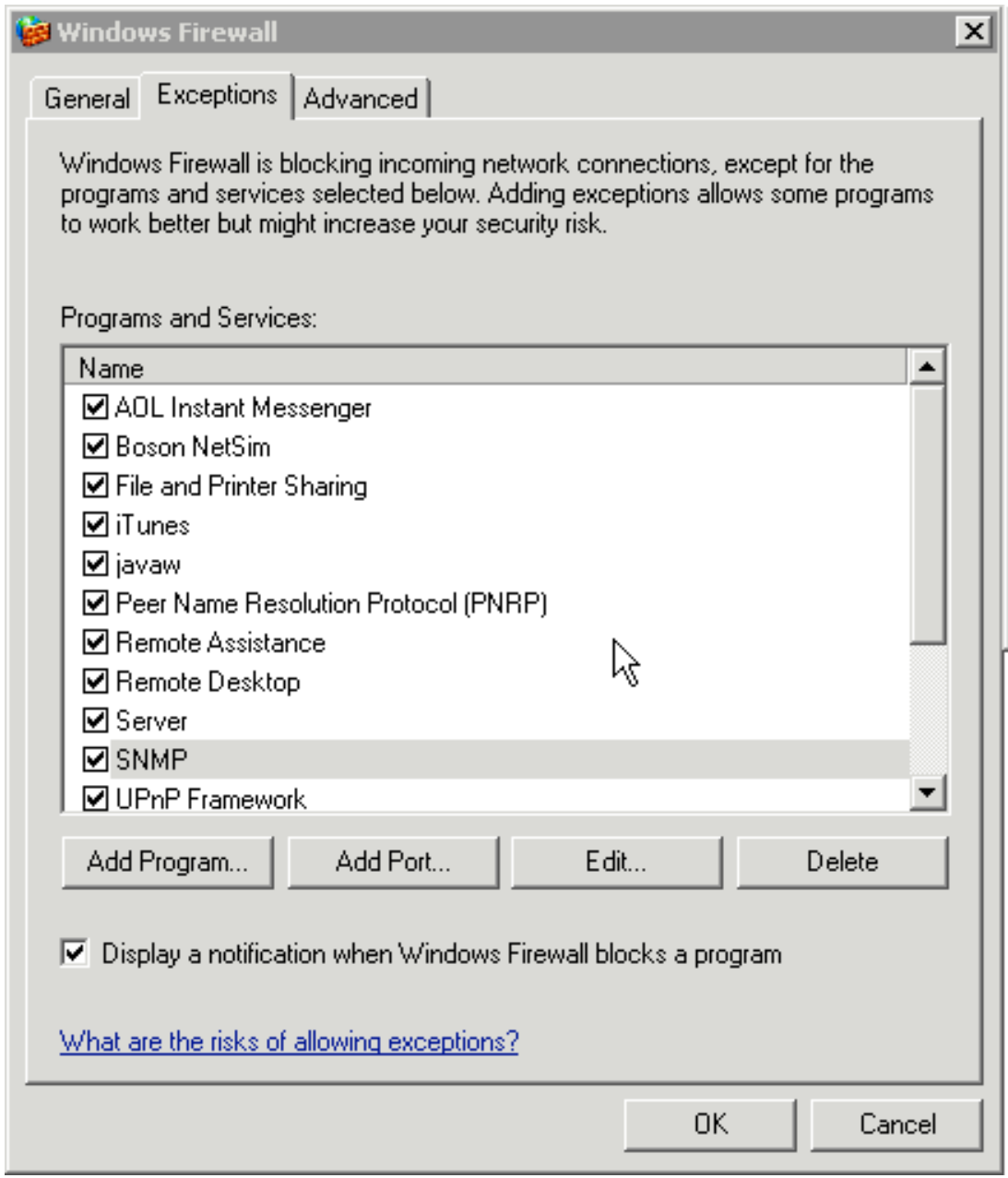


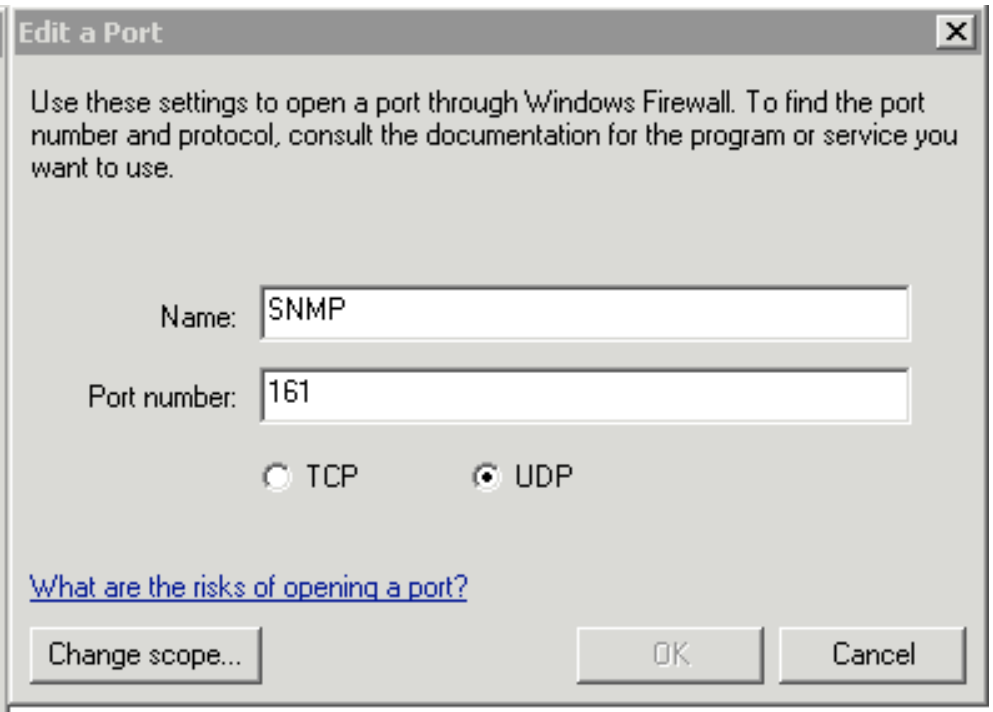
7.0 SNMP Demo

Demo Outline

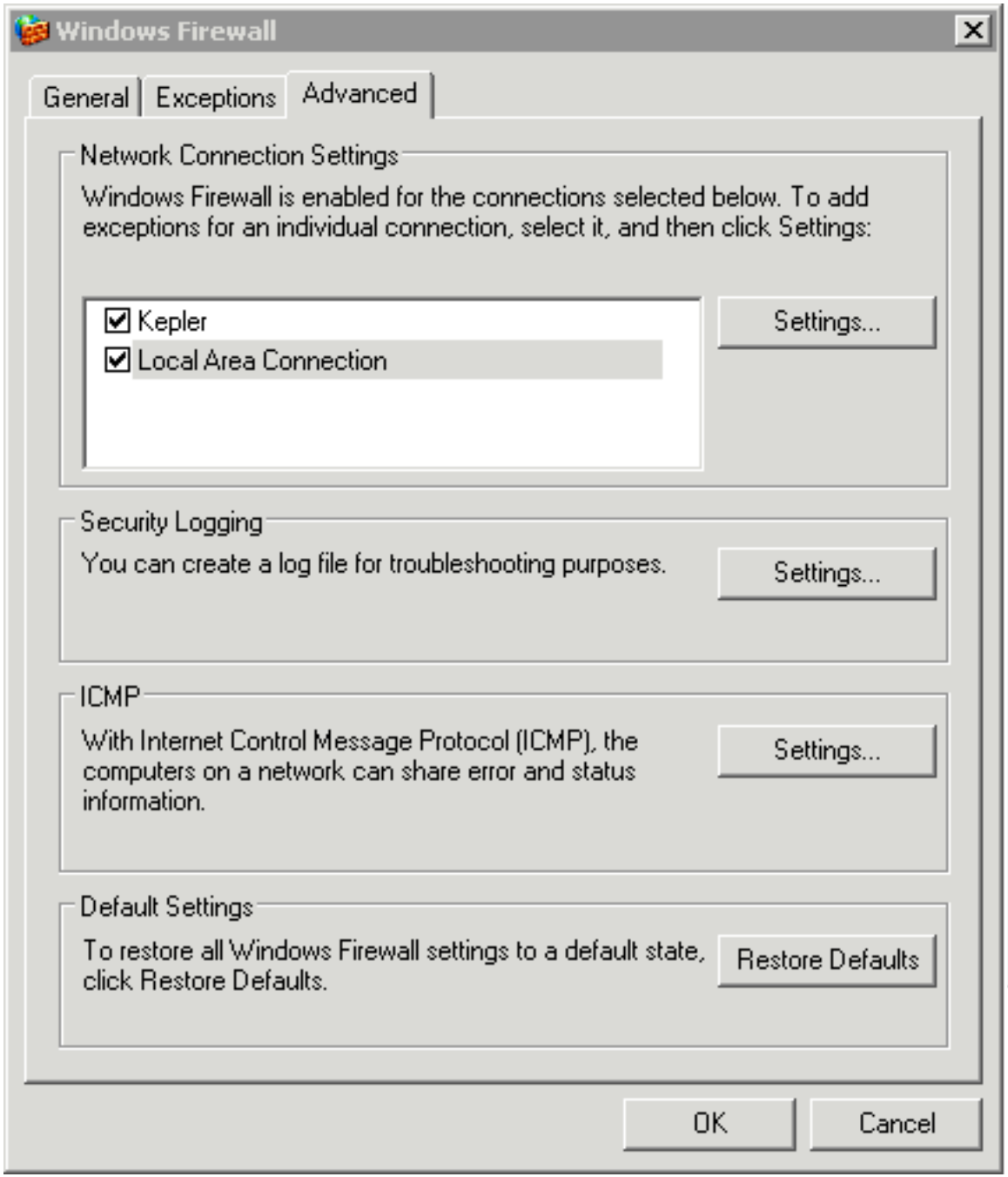
- Laptops with SNMP agents installed
- Configure GET community strings
- Confirm SNMP agent is running
- Study the MIB using snmpwalk
- Make a list of interesting variables

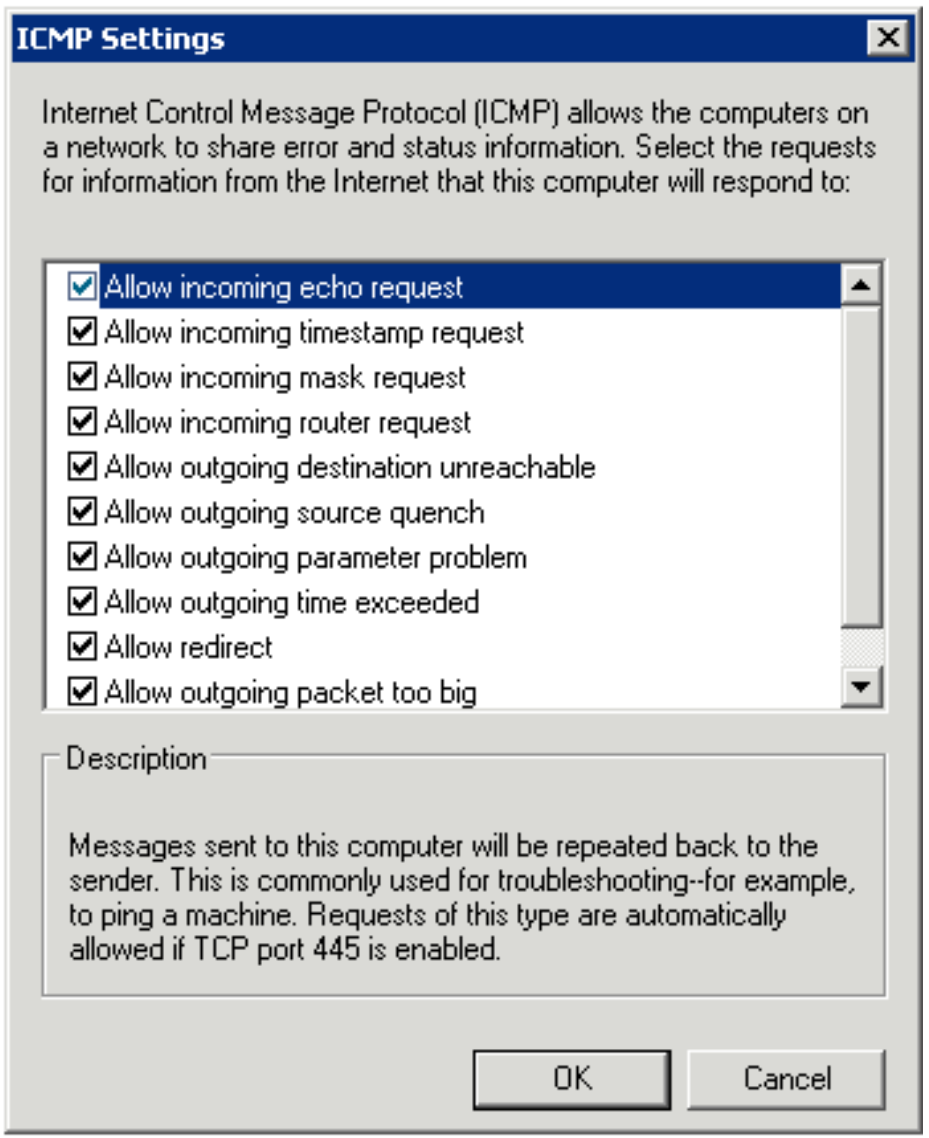
Firewall Issue 1





Firewall Issue 2





Powerbook LAN

http://192.168.2.76/mrtg/powerbook.html

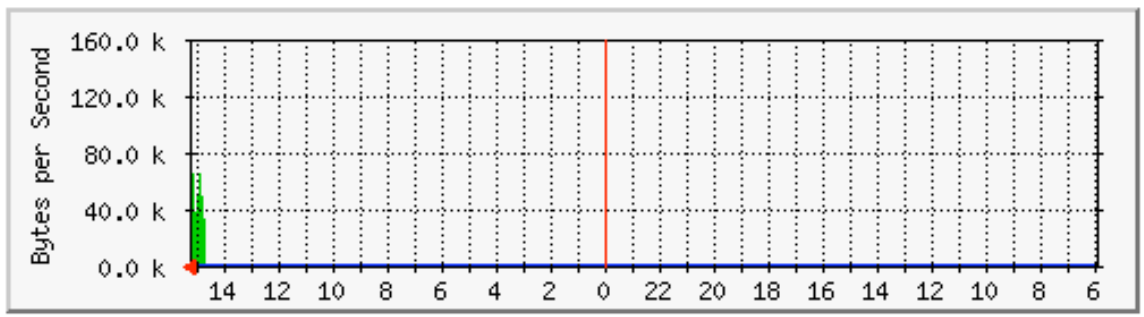
Powerbook LAN

Powerbook LAN

MRTG

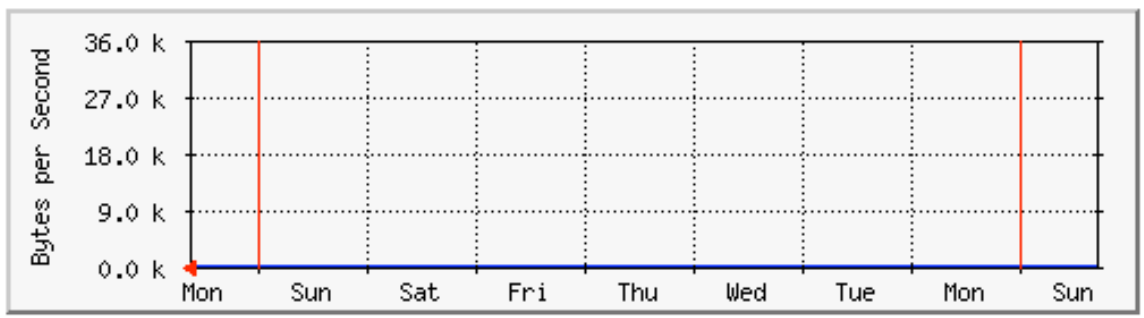
The statistics were last updated **Monday, 31 January 2005 at 15:15**,
at which time **'Powerbook.local'** had been up for **1:27:39**.

`Daily' Graph (5 Minute Average)



Max In:157.9 kB/s (1.6%) Average In: 58.2 kB/s (0.6%) Current In:157.9 kB/s (1.6%)
Max Out:2703.0 B/s (0.0%) Average Out:1102.0 B/s (0.0%) Current Out:2703.0 B/s (0.0%)

`Weekly' Graph (30 Minute Average)



Max In:33.8 kB/s (0.3%) Average In:33.8 kB/s (0.3%) Current In:33.8 kB/s (0.3%)
Max Out:684.0 B/s (0.0%) Average Out:684.0 B/s (0.0%) Current Out:684.0 B/s (0.0%)

Done

MRTG Configuruation

johnb@omnibook:/etc/mrtg

```
WorkDir: /var/www/html/mrtg
#Target[r1]: 2:public@myrouter.somplace.edu
#MaxBytes[r1]: 1250000
#Title[r1]: Traffic Analysis
#PageTop[r1]: <H1>Stats for our Ethernet</H1>

#Target[omnibook]: 2:public@127.0.0.1:::::2
#Target[omnibook]: 2:public@127.0.0.1
#Maxbytes[omnibook]: 10000000
#Title[omnibook]: OmniBook
#PageTop[omnibook]: <H1>OmniBook LAN</H1>


Target[powerbook]: 4:public@192.168.2.75
Maxbytes[powerbook]: 10000000
Title[powerbook]: Powerbook LAN
PageTop[powerbook]: <H1>Powerbook LAN</H1>

Target[omnibook]: 2:public@192.168.2.76
Maxbytes[omnibook]: 10000000
Title[omnibook]: OmniBook
PageTop[omnibook]: <H1>OmniBook</H1>
```

8.0 References

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The Simple Book - Revised second edition	Rose M.T.	0-13-451659-1	Prentice Hall	1999
practical planning for network growth	John Blommers	0-13-206111-2	Prentice Hall PTR	1996
Essential SNMP	Douglas R. Mauro Kevin J. Schmid	0596000200	O'Reilly & Associates	2001
Internetworking with TCP/IP Vol.1: Principles, Protocols, and Architecture (4th Edition)	Douglas Comer	0130183806	Prentice Hall	2000
PGP Pretty Good Privacy	Simson Garfinkel	1565920988	O'Reilly & Associates	1994
UNIX & Windows Interoperability Guide	Alan R. Roberts	013026332X	Prentice Hall	2001
Voice-Enabling the Data Network	James F. Durkin	1587050145	Cisco Press	2002
Building Internet Firewalls, 2nd Ed.	Zwicky, Cooper, Chapman	1565928717	O'Reilly & Associates	2000

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QuickTime for the Web, 2nd Ed.	Apple Developer Series	1-55860-780-3	Morgan Kaufmann	2002
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Virtual Private Networks	Yuan, Strayer	0201702096	Addison-Wesley	2001
IP Telephony	Bill Douskalis	0130141186	Prentice Hall	1999