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.
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
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.

```
<table>
<thead>
<tr>
<th>Historical performance data storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNMP polling</td>
</tr>
<tr>
<td>polling engine</td>
</tr>
<tr>
<td>NMS</td>
</tr>
<tr>
<td>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 spreadsheet for professional quality presentation.</td>
</tr>
<tr>
<td>The NMS plots gauge values directly.</td>
</tr>
<tr>
<td>For counters it plots this_counter - last_counter</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>this_time - last_time</td>
</tr>
</tbody>
</table>
```
Useful MIB variables

**Good information like**
- data throughput (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**
babyPer
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
- 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
    rtcpXrVoipNetworkLossRate
    rtcpXrVoipAverageDiscardRate
    ……
    rtcpXrVoipJitterBufferSize
}
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

<table>
<thead>
<tr>
<th>RMON Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistics</strong></td>
<td>Measures real time LAN statistics such as utilization, bytes, packets, collisions, SMT frames, broadcasts, runts, jabbers, CRC errors</td>
</tr>
<tr>
<td><strong>History</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Alarm</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Hosts</strong></td>
<td>Measures host specific LAN statistics such as bytes sent, bytes received, frames sent, frames received</td>
</tr>
<tr>
<td><strong>Hosts top N</strong></td>
<td>The probe observes all conversations for, say, 10 minutes and reports on the top 50 talkers by bytes received.</td>
</tr>
<tr>
<td><strong>Traffic matrix</strong></td>
<td>Measures the traffic matrix between systems based on their MAC address. Routers show up as a big talker and listener</td>
</tr>
<tr>
<td><strong>Filter</strong></td>
<td>Defines packet data patterns of interest. The NMS provides a GUI to allow filtering by MAC, IP, TCP and other byte patterns of interest</td>
</tr>
<tr>
<td><strong>Packet Capture</strong></td>
<td>Collect &amp; forward packets matching the Filter to the NMS, where a GUI decodes and displays the packet trace</td>
</tr>
<tr>
<td><strong>Notification</strong></td>
<td>Send an alert SNMP trap for the Alarm group</td>
</tr>
</tbody>
</table>
The RMON MIB tree

1 etherStatsTable (RFC 1271)
   1 etherStatsEntry
      1 etherStatsIndex
      2 etherStatsDataSource
      3 etherStatsDropEvents
      4 etherStatsOctets
      5 etherStatsPkts
      6 etherStatsBroadcastPkts
      7 etherStatsMulticastPkts
      8 etherStatsCRCAlignErrors
      9 etherStatsUndersizePkts
     10 etherStatsOversizePkts
     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.

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
    ```
CLI \textit{(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

Agent: 192.168.1.66

SNMP v1 / SNMP v2c

Community String:
- GET: public
- SET: ******

SNMP v3

User Name: johnb
Password: ******
Privacy Password: *******
MIB Browser

 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

<table>
<thead>
<tr>
<th>Status</th>
<th>Host</th>
<th>Address</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>LinkSys</td>
<td>192.168.1.1</td>
<td></td>
</tr>
<tr>
<td>Offline</td>
<td>BeigeG3</td>
<td>192.168.1.2</td>
<td>Mac OS X Server 10.2.3</td>
</tr>
<tr>
<td>Active</td>
<td>QuickSilver</td>
<td>192.168.1.66</td>
<td>Mac OS X 10.2.4</td>
</tr>
<tr>
<td>Active</td>
<td>nameserver1</td>
<td>204.127.198.4</td>
<td></td>
</tr>
<tr>
<td>Active</td>
<td>nameserver2</td>
<td>63.240.76.4</td>
<td></td>
</tr>
<tr>
<td>Offline</td>
<td>PowerBookAirport</td>
<td>192.168.2.2</td>
<td>HTTP</td>
</tr>
<tr>
<td>Offline</td>
<td>OmniBookAirport</td>
<td>192.168.2.5</td>
<td>Apache on Red Hat Linux 8</td>
</tr>
<tr>
<td>Offline</td>
<td>Windows2000</td>
<td>192.168.1.72</td>
<td></td>
</tr>
</tbody>
</table>

Created: Sun, 08 Feb 2004 04:57:03 GMT
Viewed: 1/7/04 20:57:22
- **Open Source** tool
- [http://www.mrtg.org](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
# Multi Router Traffic Grapher -- Example Configuration File
# Global Configuration

WorkDir: /Users/johnb/Sites/mrtg
Refresh: 300

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 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%)
OpenNMS

- Open source project, so it's free
- PostgreSQL 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
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple Computer//DTD PLIST 1.0//EN" "http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<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>
        </array>
      </dict>
    </array>
  </dict>
</plist>
```
HP OpenView Network Node Manager 6.4 Demo Pack

- Full featured version of Node Manager
- [openview.hp.com/products/nnm/download.html](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 & downloads

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

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 & presents performance 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

management area with local discovery & discovery filtering, polling, local data collection, and map exporting to MS
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

Windows Firewall is blocking incoming network connections, except for the programs and services selected below. Adding exceptions allows some programs to work better but might increase your security risk.

 Programs and Services:
- Name
  - AOL Instant Messenger
  - Boson NetSim
  - File and Printer Sharing
  - iTunes
  - javaw
  - Peer Name Resolution Protocol (PNRP)
  - Remote Assistance
  - Remote Desktop
  - Server
  - SNMP
  - UPnP Framework

- Display a notification when Windows Firewall blocks a program

Edit a Port

Use these settings to open a port through Windows Firewall. To find the port number and protocol, consult the documentation for the program or service you want to use.

- Name: SNMP
- Port number: 161
- Protocol: TCP

What are the risks of opening a port?

Change scope...
Firewall Issue 2

Windows Firewall

General

Network Connection Settings
Windows Firewall is enabled for the connections selected below. To add exceptions for an individual connection, select it, and then click Settings:

- Kepler
- Local Area Connection

Exceptions

Security Logging
You can create a log file for troubleshooting purposes.

Advanced

ICMP

Internet Control Message Protocol (ICMP) allows the computers on a network to share error and status information. Select the requests for information from the Internet that this computer will respond to:

- Allow incoming echo request
- Allow incoming timestamp request
- Allow incoming mask request
- Allow incoming router request
- Allow outgoing destination unreachable
- Allow outgoing source quench
- Allow outgoing parameter problem
- Allow outgoing time exceeded
- Allow redirect
- Allow outgoing packet too big

Description
Messages sent to this computer will be repeated back to the sender. This is commonly used for troubleshooting—for example, to ping a machine. Requests of this type are automatically allowed if TCP port 445 is enabled.

OK Cancel

Default Settings
To restore all Windows Firewall settings to a default state, click Restore Defaults.
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%)
MRTG Configuration

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
## References

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>ISBN</th>
<th>Publisher</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>practical planning for network growth</td>
<td>John Blommers</td>
<td>0-13-206111-2</td>
<td>Prentice Hall PTR</td>
<td>1996</td>
</tr>
<tr>
<td>Essential SNMP</td>
<td>Douglas R. Mauro</td>
<td>0596000200</td>
<td>O'Reilly &amp; Associates</td>
<td>2001</td>
</tr>
<tr>
<td>PGP Pretty Good Privacy</td>
<td>Simson Garfinkel</td>
<td>1565920988</td>
<td>O'Reilly &amp; Associates</td>
<td>1994</td>
</tr>
<tr>
<td>UNIX &amp; Windows Interoperability Guide</td>
<td>Alan R. Roberts</td>
<td>013026332X</td>
<td>Prentice Hall</td>
<td>2001</td>
</tr>
<tr>
<td>Voice-Enabling the Data Network</td>
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