Network Management & Monitoring

Introduction to SNMP

Overview

- What is SNMP?
- OIDs
- MIBs
- Polling and querying
- Traps
- SNMPv3 (Optional)

What is SNMP?

SNMP – Simple Network Management Protocol

- Industry standard, hundreds of tools exist to exploit it
- Present on any decent network equipment

Query – response based: **GET / SET**

- GET is mostly used for monitoring

Tree hierarchy

- Query for ”Object Identifiers” (OIDs)

Concept of MIBs (Management Information Base)

- Standard and vendor-specific (Enterprise)

What is SNMP?

UDP protocol, port 161

Different versions

- V1 (1988) – RFC1155, RFC1156, RFC1157
  - Original specification
- v2 – RFC1901 ... RFC1908 + RFC2578
  - Extends v1, new data types, better retrieval methods (GETBULK)
  - Used is version v2c (without security model)
- v3 – RFC3411 ... RFC3418 (w/security)

Typically we use SNMPv2 (v2c)

What is SNMP?

Terminology:

- Manager (the monitoring ”client”)
- Agent (running on the equipment/server)

What is SNMP?

Typical queries

- Bytes In/Out on an interface, errors
- CPU load
- Uptime
- Temperature or other vendor specific OIDs

For hosts (servers or workstations)

- Disk space
- Installed software
- Running processes
- ...

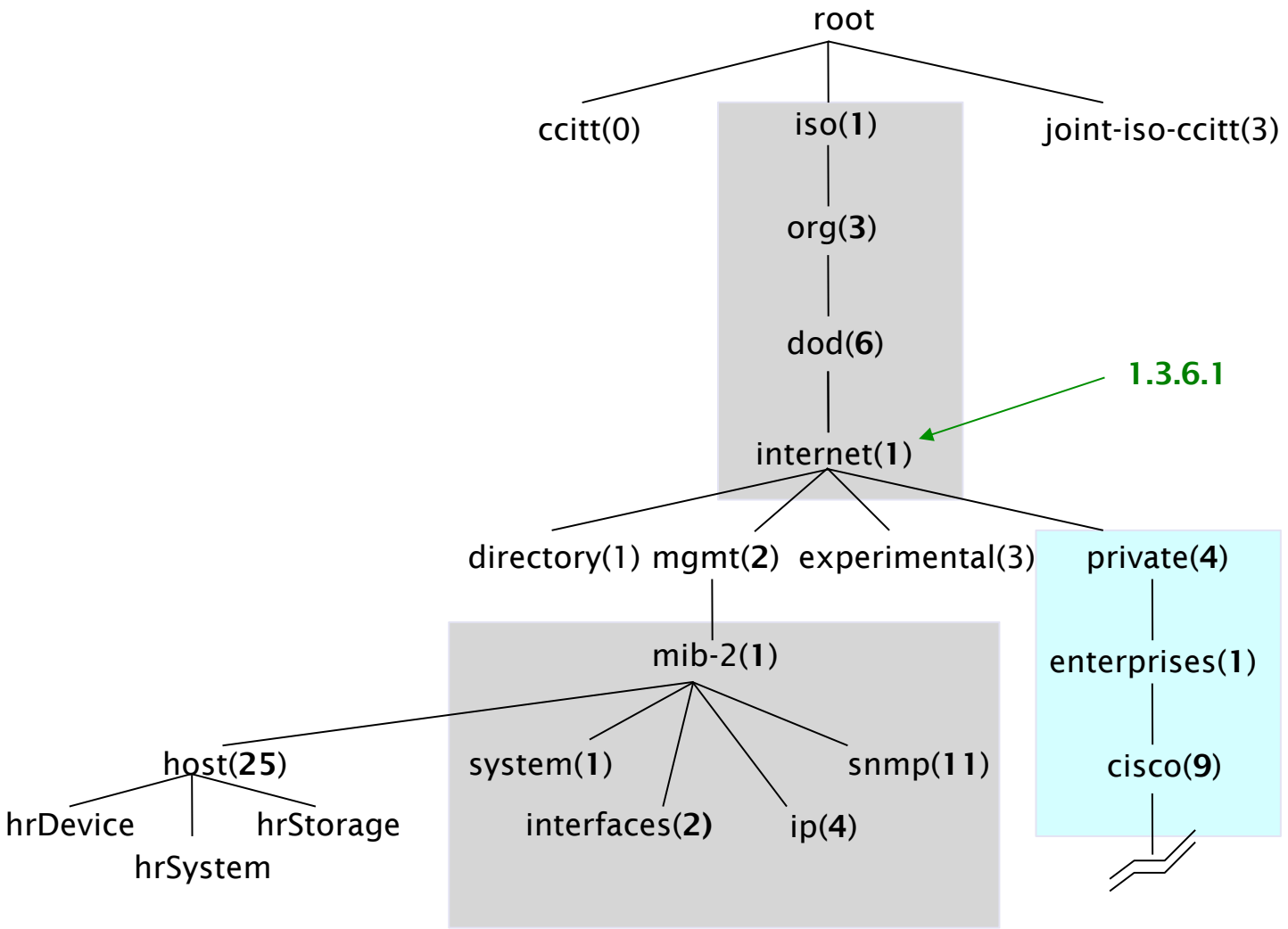
Windows and UNIX have SNMP agents

How does it work?

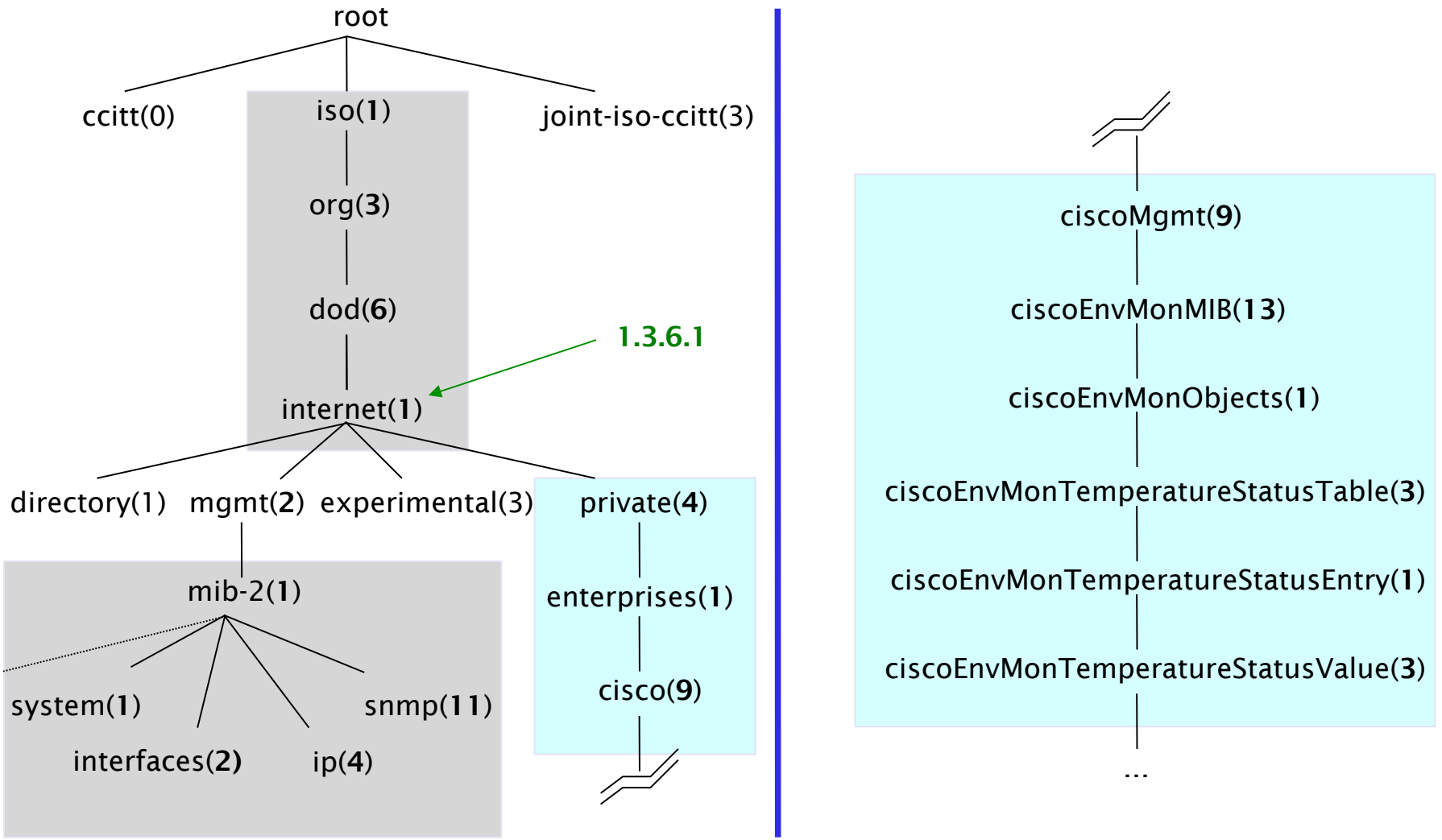
Basic commands

- GET (manager -> agent)
  - Query for a value
- GET-NEXT (manager -> agent)
  - Get next value (list of values for a table)
- GET-RESPONSE (agent -> manager)
  - Response to GET/SET, or error
- SET (manager -> agent)
  - Set a value, or perform action
- TRAP (agent -> manager)
  - Spontaneous notification from equipment (line down, temperature above threshold, ...)

The MIB Tree


root
ccitt(0)
iso(1)
joint-iso-ccitt(3)
org(3)
dod(6)
1.3.6.1
internet(1)
directory(1)
mgmt(2)
experimental(3)
private(4)
mib-2(1)
enterprises(1)
host(25)
system(1)
snmp(11)
cisco(9)
hrDevice
hrStorage
interfaces(2)
ip(4)
hrSystem

The MIB Tree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mgmt(2)
experimental(3)
private(4)
mib-2(1)
enterprises(1)
system(1)
snmp(11)
cisco(9)
interfaces(2)
ip(4)
ciscoMgmt(9)
ciscoEnvMonMIB(13)
ciscoEnvMonObjects(1)
ciscoEnvMonTemperatureStatusTable(3)
ciscoEnvMonTemperatureStatusEntry(1)
ciscoEnvMonTemperatureStatusValue(3)
...

If Email Adresses were OIDs

user@nsrc.org

would have been something like:

user@nsrc.enterprises.private.internet.dod.org.iso

user@99999.1.4.1.6.3.1

except that we write the top-most part at the left:

1.3.6.1.4.1.99999.117.115.101.114

An OID is just a unique key (within one managed device) for one piece of information

Ensures vendors don't have conflicting OIDs

The Internet MIB

- **directory**(1) OSI directory
- **mgmt**(2) RFC standard objects
- **experimental**(3) Internet experiments
- **private**(4) Vendor-specific
- **security**(5) Security
- **snmpV2**(6) SNMP internal

OIDs and MIBs

- Navigate tree downwards
- OIDs separated by '.'
  - `1.3.6.1.4.1.9. ...`
- OID corresponds to a label
  - `.1.3.6.1.2.1.1.5 => sysName`
- The complete path:
  - `.iso.org.dod.internet.mgmt.mib-2.system.sysName`
- How do we convert from OIDs to Labels (and vice versa ?)
  - Use of MIBs files!

MIBs

- MIBs are files defining the objects that can be queried, including:
  - Object name
  - Object description
  - Data type (integer, text, list)
- MIBS are structured text, using ASN.1
- Standard MIBs include:
  - MIB-II – (RFC1213) – a group of sub-MIBs
  - HOST-RESOURCES-MIB (RFC2790)

MIBs - 2

MIBs also make it possible to interpret a returned value from an agent

- For example, the status for a fan could be 1,2,3,4,5,6 – what does it mean ?

MIBs - SAMPLE

```
sysUpTime OBJECT-TYPE
              SYNTAX  TimeTicks
              ACCESS  read-only
              STATUS  mandatory
              DESCRIPTION
                      "The time (in hundredths of a second) since the
                      network management portion of the system was last
                      re-initialized."
              ::= { system 3 }
```

`sysUpTime OBJECT-TYPE`
This defines the object called `sysUpTime`.

`SYNTAX TimeTicks`
This object is of the type `TimeTicks`. Object types are specified in the SMI we mentioned a moment ago.

`ACCESS read-only`
This object can only be read via SNMP (i.e., `get-request`); it cannot be changed (i.e., `set-request`).

`STATUS mandatory`
`This object must be implemented in any SNMP agent.`

`DESCRIPTION`
`A description of the object`

`::= { system 3 }`
The `sysUpTime` object is the third branch off of the system object group tree.

MIBs - SAMPLE

```
CiscoEnvMonState ::= TEXTUAL-CONVENTION
        STATUS  current
        DESCRIPTION
                "Represents the state of a device being monitored.
                 Valid values are:

                 normal(1):          the environment is good, such as low
                                     temperature.

                 warning(2):         the environment is bad, such as temperature
                                     above normal operation range but not too
                                     high.

                 critical(3):        the environment is very bad, such as
                                     temperature much higher than normal
                                     operation limit.

                 shutdown(4):        the environment is the worst, the system
                                     should be shutdown immediately.

                 notPresent(5):      the environmental monitor is not present,
                                     such as temperature sensors do not exist.

                 notFunctioning(6): the environmental monitor does not
                                     function properly, such as a temperature
                                     sensor generates a abnormal data like
                                     1000 C.
```

Querying SNMP agent

Some typical commands for querying:

- `snmpget`
- `snmpwalk`
- `snmpstatus`
- `snmptable`

Syntax:

```
snmpXXX -c community -v1 host [oid]
snmpXXX -c community -v2c host [oid]
```

Querying SNMP agent

Let's take an example

- `snmpstatus -c NetManage -v2c 10.10.0.254`
- `snmpget -c NetManage -v2c 10.10.0.254 .iso.org.dod.internet.mgmt.mib-2.interfaces.ifNumber.0`
- `snmpwalk -c NetManage -v2c 10.10.0.254 ifDescr`

Querying SNMP agent

Community:

- A ”security” string (password) to define whether the querying manager will have RO (read only) or RW (read write) access
- This is the simplest form of authentication in SNMP

OID

- A value, for example, .1.3.6.1.2.1.1.5.0, or it's name equivalent
- .iso.org.dod.internet.mgmt.mib-2.system.sysName.0

Let's ask for the system's name (using the OID above)

- Why the .0? What do you notice?

Coming up in our exercises...

- Using snmpwalk, snmpget
- Configuring SNMPD
- Loading MIBs
- Configuring SNMPv3 (optional)

References

- *Essential SNMP* (O'Reilly Books) Douglas Mauro, Kevin Schmi
- *Basic SNMP at Cisco*
  http://www.cisco.com/warp/public/535/3.html
  http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/snmp.htm
- Wikipedia:
  http://en.wikipedia.org/wiki/Simple_Network_Management_Protocol
- IP Monitor MIB Browser
  http://support.ipmonitor.com/mibs_byoidtree.aspx
  Cisco MIB browser: http://tools.cisco.com/Support/SNMP/do/BrowseOID.do
- Open Source Java MIB Browser
  http://www.kill-9.org/mbrowse
  http://www.dwipal.com/mibbrowser.htm (Java)
- SNMP Link – collection of SNMP resources
  http://www.snmplink.org/
- Net-SNMP Open Source SNMP tools
  http://net-snmp.sourceforge.net/
- Integration with Nagios http://www.cisl.ucar.edu/nets/tools/nagios/SNMP-traps.html

Optional Materials

SNMP Version 3

SNMP and Security

- SNMP versions 1 and 2c are insecure
- SNMP version 3 created to fix this

- Components
  - Dispatcher
  - Message processing subsystem
  - Security subsystem
  - Access control subsystem

SNMP version 3 (SNMPv3)

The most common module is based in user, or a “User-based Security Model”

- **Authenticity and integrity:** Keys are used for users and messages have digital signatures generated with a hash function (MD5 or SHA)
- **Privacy:** Messages can be encrypted with secret-key (private) algorithms (DES)
- **Temporary validity:** Utilizes a synchronized clock with a 150 second window with sequence checking.

Security Levels

noAuthPriv

– No authentication, no privacy

authNoPriv

– Authentication with no privacy

authPriv

– Authentication with privacy

Cisco SNMPv3 configuration

```
snmp-server view  vista-ro   internet  included
snmp-server group ReadGroup  v3 auth read vista-ro
snmp-server user  admin ReadGroup v3 auth md5  xk122r56
```

Or alternatively:

```
snmp-server user  admin  ReadGroup v3 auth md5 xk122r56
    priv des56 D4sd#rr56
```

Net-SNMP SNMPv3 configuration

```
# apt-get install snmp snmpd
# net-snmp-config --create-snmpv3-user -a "xk122r56" admin
  /usr/sbin/snmpd
# snmpwalk -v3 -u admin -l authNoPriv -a MD5 -A "xk122r56"
    127.0.0.1
```