Network Management

Things a network manager needs to be able to do

- Remotely:
  - Detect problems in network devices (NICs, routers, links)
  - Monitor traffic for resource allocation
  - Monitoring performance vs. Service Level Agreements (SLAs)
  - Detect intrusions

ISO's areas of network management

- Performance management
- Fault management
- Configuration management
- Accounting management
- Security management

Performance management

- Objective: monitor and control performance of network devices and channels
- Ensure that the network provides acceptable performance for the long-term
- Utilization
- Throughput
- Congestion
- ...
Fault management

- Objective: detect and respond to faults in the network
  - Detection / Isolation / Resolution
  - Router hardware failures
  - Router software errors
  - Link failures
  - Host failures (?)

Configuration management

- Objective: Allow the manager to track the devices in the network and their configurations
  - Hardware
  - Software

Accounting management

- Objective: Allows manager to control and track usage of network resources
  - Usage quotas
  - Charging
  - Privileges

Security management

- Objective: Control access to network resources
  - Security policy
  - Key distribution
  - Certification authorities
  - Firewalls
  - ...
Components of a network management infrastructure

- Managing entity – central control point
- Managed device – network hw/sw
  - Managed objects – individually-managed parts of a device
  - Management Information Base (MIB) – managed data (in a common db format)
  - Management agent – local management process
- Management protocol – defines the interaction between Managing Entity and Managed Devices

Simple Network Management Protocol (SNMP)

- Most widely used network management protocol (Internet)
- RFC 2570
- First released in early ’90s

Elements of the SNMP operational model

- Data definition language (SMI)
- Definitions of management information (MIB)
- Protocol definition (SNMP)
- Security and admin capabilities

SNMP operation

- Get – retrieve a value from a specified variable
- Get-Next – retrieve the next value
- Set – set a variable to a specified value
- Trap – Alert from Agent
SNMP transport

- SNMP messages normally carried by UDP
- SNMP does not specify a retransmission policy (although there is no prohibition on building one in)

Data definition language

- “Structure of Management Information” (SMI)
- Defines the management information residing in a managed entity

SMI data types

- Integer32 (32 bit integer)
- Unsigned32 (unsigned 23-bit integer)
- Octet String (byte string up to 64KB long)
- Object Identifier (structured name)
- IPAddress
- Counter32, Counter64 (wrapping counters)
- Gauge32 (non-wrapping counter)
- TimeTicks (1/100ths of a sec since some event)

The SMI OBJECT-TYPE construct

- OBJECT-TYPE
  - Objects that contain the management data
  - Specifies data type, status, and semantics of a managed object
  - Different OBJECT-TYPEs are standard, defined in RFCs
- Clauses of OBJECT-TYPE
  - SYNTAX – basic data type of the object
  - MAX-ACCESS – permissions
  - STATUS – validity of object definition
  - DESCRIPTION – plaintext describing the object
An example OBJECT-TYPE

```
ipInDelivers OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The total number of input datagrams successfully delivered to IP user protocols (including ICMP)"
::= {ip 9}
```

(from RFC 2011)

The SMI MODULE-IDENTITY construct

- Groups related objects together (e.g., all of the IP-related objects are in the "ipMIB" module – RFC 2011)
- Some module types:
  - IP (RFC 2011)
  - TCP (RFC 2012)
  - UDP (RFC 2013)

Management Information Base (MIB)

- A virtual database that holds the managed modules/objects at a managed device (collectively, for the entire network)

IDs for modules and objects

- Every module/object is assigned a hierarchical number
- Numbering defined by ISO Abstract Syntax Notation – One (ASN.1)
ASN.1

- An ISO framework intended to give a unique identifier to every object type in a network

ASN.1 hierarchy

Example MIB objects

- 1.3.6.1.2.1.1.3 (sysUpTime) -- system up time in 1/100th of a sec
- 1.3.6.1.2.1.1.6 (sysLocation) -- physical location of this node
- 1.3.6.1.2.1.7.4 (udpInErrors) -- number of received UDP datagrams that could not be delivered

Web-based management

- The idea: HTTP carries the management information, user interfaces through a web browser
- Not (yet) a replacement for the entire SNMP operational model
  - SNMP = instrumentation and control
  - HTTP+browser = universally-available transport and display mechanism
- Advantages:
  - Accessibility from any point
  - Needs less proprietary SW
  - Platform independence
  - Easier deployment, maintenance, training...
- Examples:
  - Internet Traffic Report (www.internettrafficreport.com)
  - DNS response time (www.caida.org/cgi-bin/dns_perform.pl)
  - Quest IP Statistics (http://stat.qwest.net/index_flash.html)