Computer Networks

Lecture on

Network Management

Plan of This Lecture

- Network management tasks
- Management tools
- Management protocols

Network Management Tasks

Network devices – administrative functions

- Configuration
  - remote administration – access & constrains
  - provisioning – interface activation, bandwidth limits, flow filtering
  - VLANS
  - multicast support
  - QoS – queuing & scheduling
  - network services – VPNs, proxies, …
  - securing the device – hardening, Access Control Lists, firewall, …
- Monitoring
  - alarms & warnings
  - congestions
- Data gathering
  - accounting data
  - efficiency statistics
  - usage statistics & trends

Change management

Data centres – administrative duties

- control physical access
- control of power supplies and air conditioning
- equipment inventory

Network Management Reference Models

Telecommunications Management Network *– defined by ITU-T*	Open System Interconnection Management *– defined by ISO* aka. FCAPS model

Management layers
• Business
  ○ financial reports
  ○ trends and quality issues
• Services
  ○ administration and charging of services
• Networks
  ○ network planning
  ○ inventory
  ○ provisioning
• Network elements
  ○ configuration
  ○ statistics
  ○ power supply
	Management categories
	• Fault
	• Configuration
	• Accounting
	• Performance
	• Security

Management Tools

- Command Line Interface – from local console or via ssh
  - Each device family has own CLI dialect
  - Automating by scripts (Perl, Expect, Python)

- Proprietary management software
  - From device manufacturers
  - Designed by network providers

Based on:

- CORBA
- Java Management Extensions

- Management protocols
  - SNMP — IETF — 1990
  - CMIP — ITU-T & ISO — 1992
  - NETCONF — IETF — 2006
  - Web Services-Management — DMTF — 2010
  - Of-Config — ONF — 2014
  - RESTCONF — IETF — 2017

- Specifications of management data
  - Management Information Bases (MIB) in ASN.1 – *Abstract* Syntax Notation number 1
    - allows express structure of objects
    - widely used
  - Data models in YANG – *Yet Another Next Generation*
    - well suited for network management
    - MIBs can be translated to YANG
    - programmers friendly
  - Data models in CIM – *Common Information Model*
    - allows express structure & relations between objects
    - a bit complicated

SNMP – *Simple Network Management Protocol*

RFC 1157 SNMP v1 – password in open text (1988)

RFC 1155 ...

RFC 1441 SNMP v2 – encrypted passwords (1994)

RFC 1452

RFC 1448 ...

… SNMP v2p, v2c, v2u, v2*

RFC 2570 - 2575 SNMP v3 (1998)

CMIP – Common Management Information Protocol

- ISO equivalent of SNMP
- Complex and complicated
- Rarely used, e.g., in SDH equipment

SNMP Principles

Controlled nodes:

computer, router, switch, printer, …

- which has an SNMP agent
- which collect current state and history

Management station:

- set of processes
- process communicate with an SNMP agent

Proxy

- controls nodes using their native mechanisms
- communicates with a management station (MS)

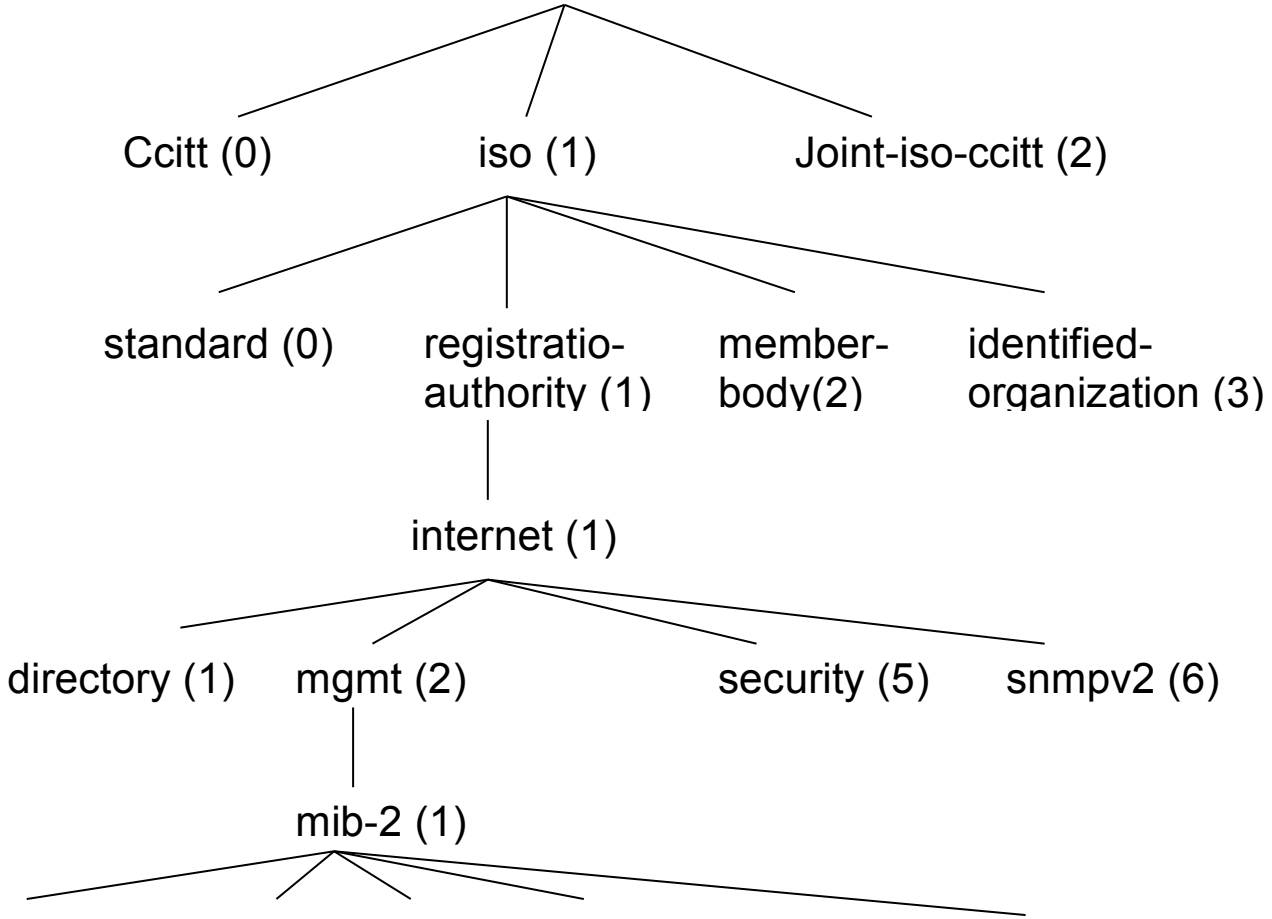
Communication

- UDP port 161 for agent
  port 162 for MS
- MS can read and modify node objects
- MSs can exchange their data bases
  – starting from v.2
- messages:
  - question – response
  - traps
  - binary coded

Objects

- defined in ASN.1

Object Identifier



Representation example of an OI group:

iso(1) identified-organization(3) dod(6) internet(1) mgmt(2) mib-2(1) ≡ {1, 3, 6, 1, 2, 1}

MIB – *Management Information Base*

RFC 1213 was the first one:

iso(1) identified-organization(3) dod(6) internet(1) mgmt(2) mib-2(1)
{1, 3, 6, 1, 2, 1}

Group	**# objects**	
System(1)	7	name, localization, hardware description, manufacturer
Interface(2)	23	transfer measures
AT(3)	3	address translation
IP(4)	42	IP statistic
ICMP(5)	26	ICMP statistic
TCP(6)	19	TCP statistic
UDP(7)	6	UDP statistic
EGP(8)	20	EGP statistic
Transmission(9)	0	media-specific
SNMP(10)	29	

175 objects + additional defined by manufacturer

There hundreds of MIBs defined by IETF, IEEE, ITU-T and manufacturers

Exemplary SNMP messages: Get-request({1, 3, 6, 1, 2, 1, 7, 1})
Set-request({1, 3, 6, 1, 2, 1, 10, 5}, 0)

SNMP Versions

- V1
  - no security
  - widely used via outbound management networks / links or via ssh
- V2
  - SNMP Community – identification for joint management by several admins
    agent + set of MSs
  - MIB View - data subset accessible for a Community
- V3
  - Complex mechanisms for identification, privacy and control access
  - Management structure – naming system for entities, communities, policies, users

Devices support V1 & V3

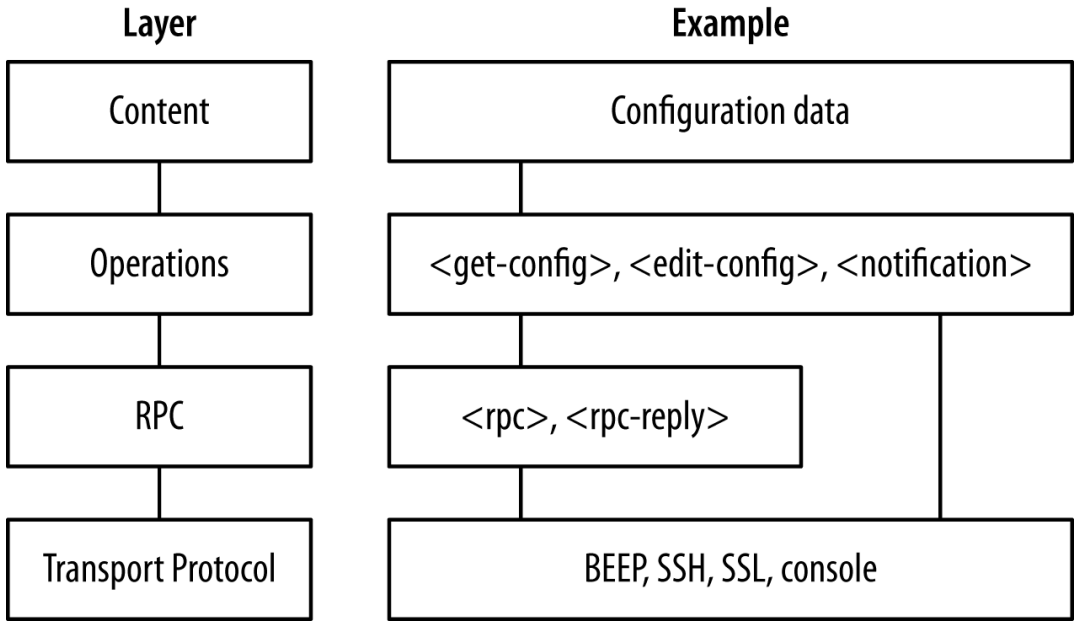
SNMP is widely used for monitoring Admins prefer CLI scripts for setting configurations

- It is not suitable to change tens of parameters in one step

NETCONF – Network Configuration Protocol

www.netconfcentral.org

- Aim – to install, modify and delete configurations



Operations: *get, get-config, edit-config, copy-config, delete-config, lock, unlock, close-session, kill- session*

- The device can
  - return its management data model
  - send asynchronous messages (notifications)
- Some extensions can be negotiated during session opening

The Other Protocols

Web Services-Management

- Management of: servers, applications, web services, terminals
- Works over SOAP
- XML codding
- Data models in Common Information Model (CIM)
  http://www.wbemsolutions.com/tutorials/CIM/index.html

Of-Config

- Management of OpenFlow switches
- Based on NETCONF
- Data models in YANG

RESTCONF

- Based on NETCONF
- XML & JSON codding
- Data models in YANG
- RESTful interface

Summary

- Network management tasks
  - Network management reference models
- Management tools
- Dominant management protocols
  - Simple Network Management Protocol
    - SNMP Principles
    - Object Identifier
    - Management Information Base
    - SNMP Versions
  - NETCONF – Network Configuration Protocol
- The other protocols
  - Web Services-Management
  - Of-Config
  - RESTCONF

Questions

1. What functions can be configured on a network switch?
2. What data can be gathered from a network device?
3. Mention at least 3 network management protocols.
4. Mention at least 2 data modeling languages.
5. Why do we need to specify management data of network devices?
6. What are important differences between the SNMP versions?
7. Why SNMP ver.1 is widely used, even thought it is unsecure?
8. What is a representation of an OBJECT IDENTIFIER (used by SNMP)?
9. What are the functions of an SNMP agent?
10. What operations can be performed by NETCONF?

Questions for curious minds

1. What are the meanings of SNMP community and SNMP view?
2. What are the Configuration Databases supported by NETCONF?