

Network Management

- introduction to network management
 - motivation
 - major components
- Internet network management framework
 - MIB: management information base
 - SMI: data definition language
 - SNMP: protocol for network management
 - security and administration
- presentation services: ASN.1

Network Management 4-1

Outline

- **What is network management?**
- Internet-standard management framework
 - Structure of Management Information: SMI
 - Management Information Base: MIB
 - SNMP Protocol Operations and Transport Mappings
 - Security and Administration
- ASN.1

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What is network management?

- **autonomous systems (aka "network")**: 100s or 1000s of interacting hardware/software components
- other complex systems requiring monitoring, control:
 - jet airplane
 - nuclear power plant
 - others?

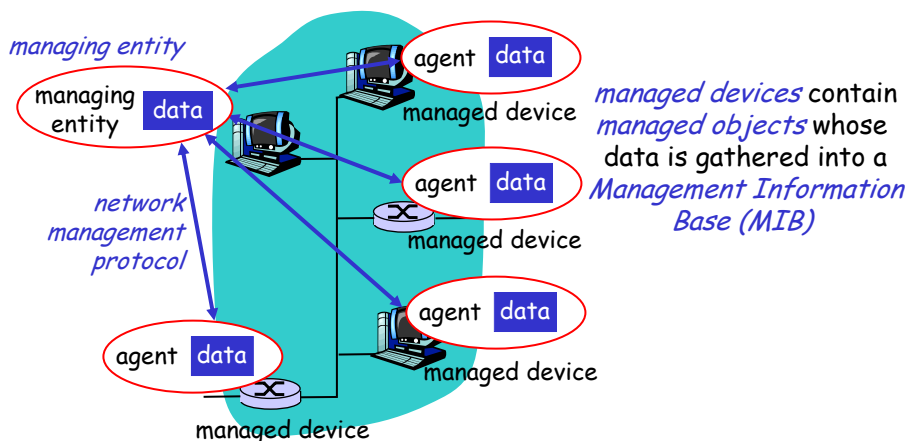


"Network management includes the deployment, integration and coordination of the hardware, software, and human elements to monitor, test, poll, configure, analyze, evaluate, and control the network and element resources to meet the real-time, operational performance, and Quality of Service requirements at a reasonable cost."

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Infrastructure for network management

definitions:



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Network Management standards

OSI CMIP

- ❑ Common Management Information Protocol
- ❑ designed 1980's: *the* unifying net management standard
- ❑ too slowly standardized

SNMP: Simple Network Management Protocol

- ❑ Internet roots (SGMP)
- ❑ started simple
- ❑ deployed, adopted rapidly
- ❑ growth: size, complexity
- ❑ currently: SNMP V3
- ❑ *de facto* network management standard

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- ❑ ASN.1

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SNMP overview: 4 key parts

- ❑ **Management information base (MIB):**
 - distributed information store of network management data
- ❑ **Structure of Management Information (SMI):**
 - data definition language for MIB objects
- ❑ **SNMP protocol**
 - convey manager<->managed object info, commands
- ❑ **security, administration capabilities**
 - major addition in SNMPv3

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SMI: data definition language

Purpose: syntax, semantics of management data well-defined, unambiguous

- ❑ base data types:
 - straightforward, boring
- ❑ OBJECT-TYPE
 - data type, status, semantics of managed object
- ❑ MODULE-IDENTITY
 - groups related objects into MIB module

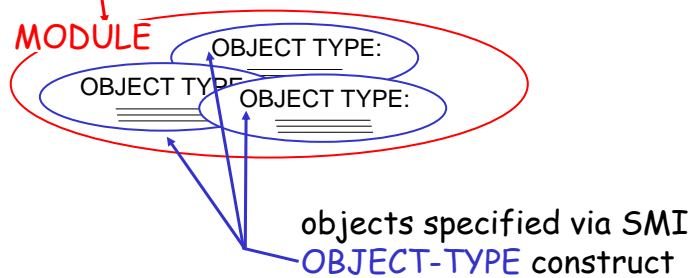
Basic Data Types

INTEGER
Integer32
Unsigned32
OCTET STRING
OBJECT IDENTIFIED
IPAddress
Counter32
Counter64
Gauge32
Time Ticks
Opaque

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SNMP MIB

MIB module specified via SMI
MODULE-IDENTITY
 (100 standardized MIBs, more vendor-specific)



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SMI: Object, module examples

OBJECT-TYPE: ipInDelivers

```
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}
```

MODULE-IDENTITY: ipMIB

```
ipMIB MODULE-IDENTITY
LAST-UPDATED "941101000Z"
ORGANIZATION "IETF SNMPv2
  Working Group"
CONTACT-INFO
  " Keith McCloghrie
  ....."
DESCRIPTION
  "The MIB module for managing IP
  and ICMP implementations, but
  excluding their management of
  IP routes."
REVISION "019331000Z"
.....
 ::= {mib-2 48}
```

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MIB example: UDP module

<u>Object ID</u>	<u>Name</u>	<u>Type</u>	<u>Comments</u>
1.3.6.1.2.1.7.1	UDPInDatagrams	Counter32	total # datagrams delivered at this node
1.3.6.1.2.1.7.2	UDPNoPorts	Counter32	# undeliverable datagrams no app at port
1.3.6.1.2.1.7.3	UDInErrors	Counter32	# undeliverable datagrams all other reasons
1.3.6.1.2.1.7.4	UDPOutDatagrams	Counter32	# datagrams sent
1.3.6.1.2.1.7.5	udpTable	SEQUENCE	one entry for each port in use by app, gives port # and IP address

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SNMP Naming

question: how to name every possible standard object (protocol, data, more..) in every possible network standard??

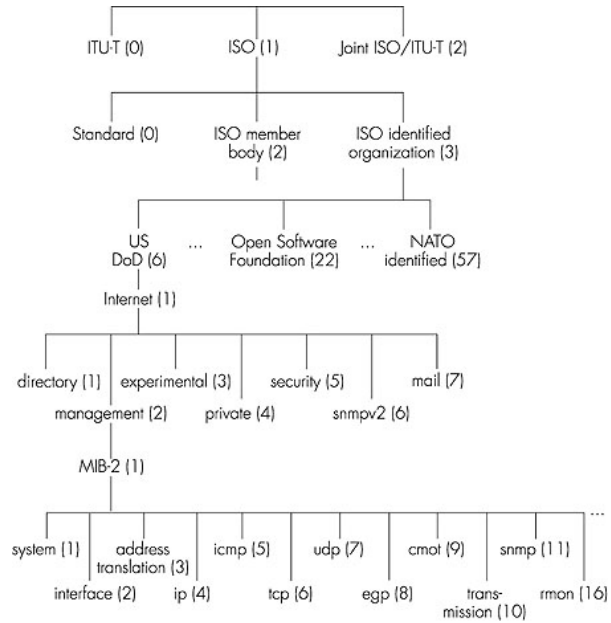
answer: ISO Object Identifier tree:

- hierarchical naming of all objects
- each branchpoint has name, number



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OSI Object Identifier Tree

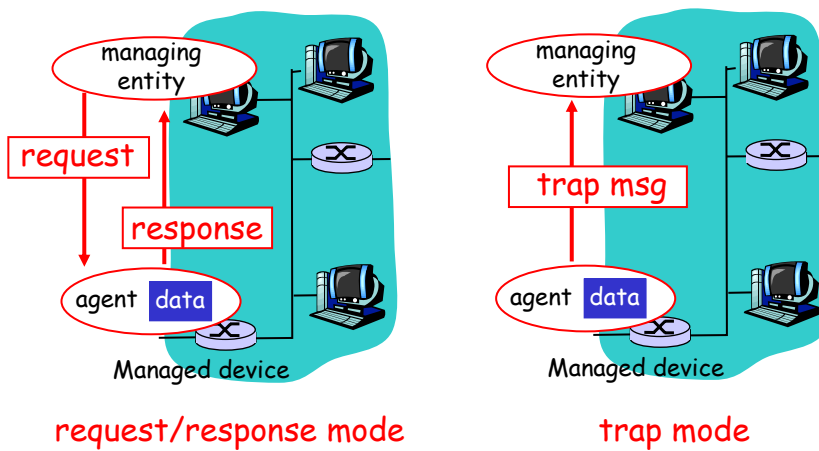


Check out www.alvestrand.no/harald/objectid/top.html

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SNMP protocol

Two ways to convey MIB info, commands:



request/response mode

trap mode

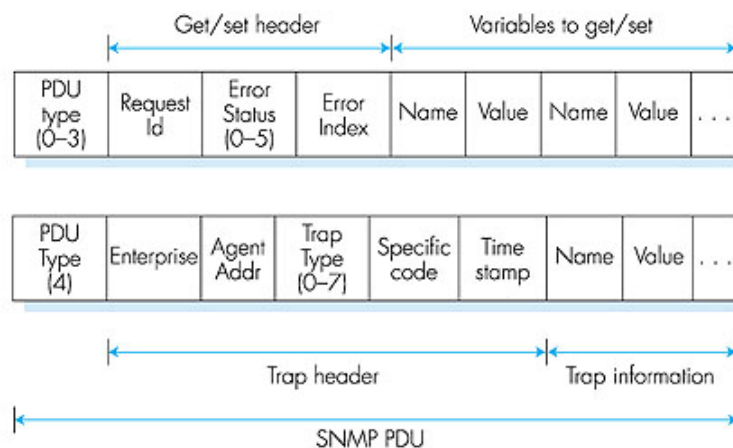
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SNMP protocol: message types

<u>Message type</u>	<u>Function</u>
GetRequest GetNextRequest GetBulkRequest	Mgr-to-agent: "get me data" (instance,next in list, block)
InformRequest	Mgr-to-Mgr: here's MIB value
SetRequest	Mgr-to-agent: set MIB value
Response	Agent-to-mgr: value, response to Request
Trap	Agent-to-mgr: inform manager of exceptional event

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SNMP protocol: message formats



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SNMP security and administration

- ❑ **encryption:** DES-encrypt SNMP message
- ❑ **authentication:** compute, send $MIC(m,k)$:
compute hash (MIC) over message (m),
secret shared key (k)
- ❑ **protection against playback:** use nonce
- ❑ **view-based access control**
 - SNMP entity maintains database of access rights, policies for various users
 - database itself accessible as managed object!

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Outline

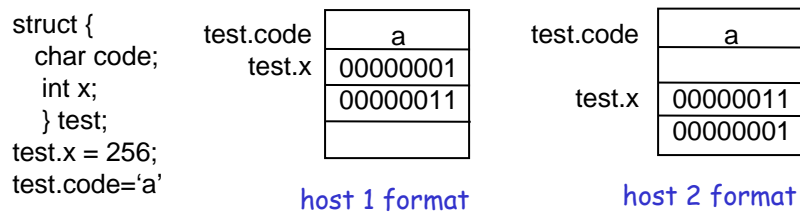
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- ❑ **The presentation problem: ASN.1**

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The presentation problem

Q: does perfect memory-to-memory copy solve "the communication problem"?

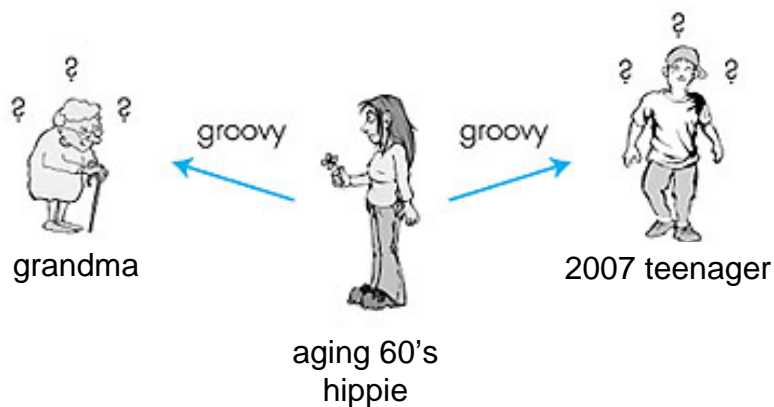
A: not always!



problem: different data format, storage conventions

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A real-life presentation problem:



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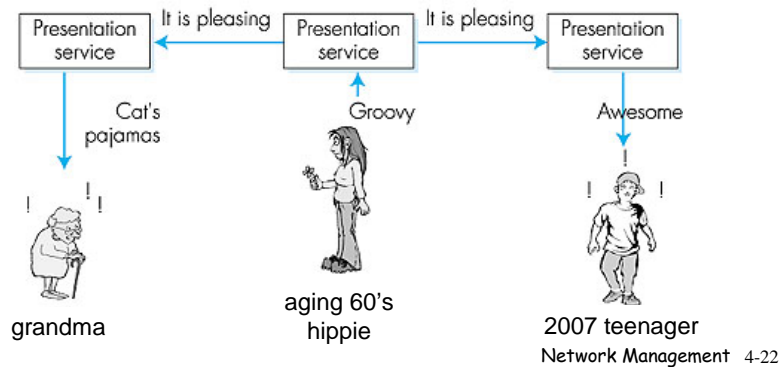
Presentation problem: potential solutions

1. Sender learns receiver's format. Sender translates into receiver's format. Sender sends.
 - real-world analogy?
 - pros and cons?
2. Sender sends. Receiver learns sender's format. Receiver translate into receiver-local format
 - real-world-analogy
 - pros and cons?
3. Sender translates host-independent format. Sends. Receiver translates to receiver-local format.
 - real-world analogy?
 - pros and cons?

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Solving the presentation problem

1. Translate local-host format to host-independent format
2. Transmit data in host-independent format
3. Translate host-independent format to remote-host format



ASN.1: Abstract Syntax Notation 1

- ❑ **ISO standard X.680**
 - used extensively in Internet
 - like eating vegetables, knowing this "good for you"!
- ❑ **defined data types**, object constructors
 - like SMI
- ❑ **BER: Basic Encoding Rules**
 - specify how ASN.1-defined data objects to be transmitted
 - each transmitted object has Type, Length, Value (TLV) encoding

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TLV Encoding

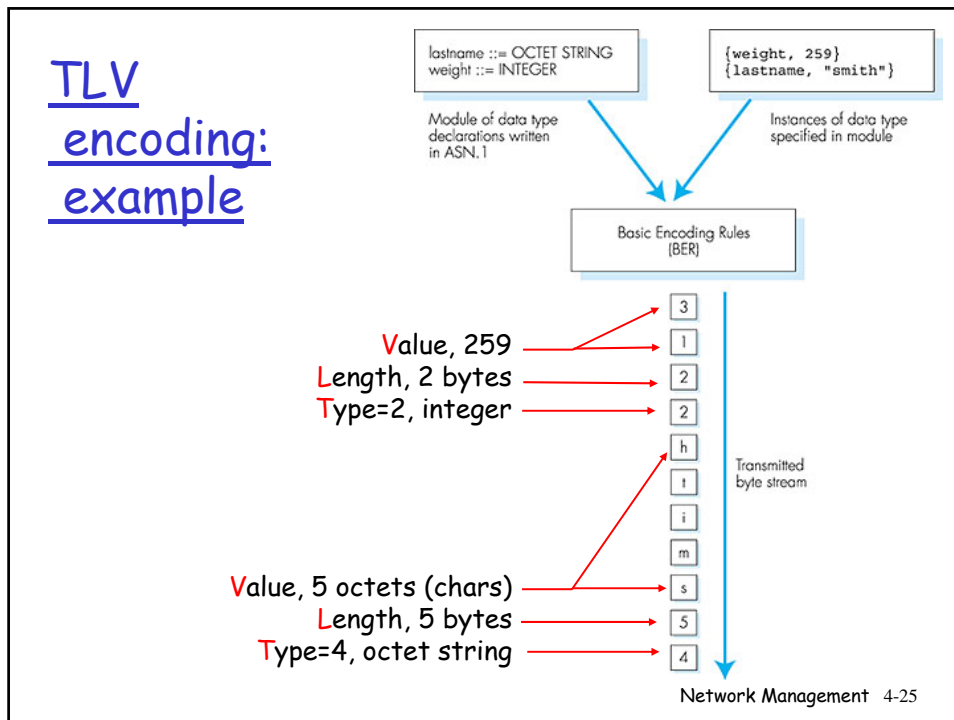
Idea: transmitted data is self-identifying

- **T**: data type, one of ASN.1-defined types
- **L**: length of data in bytes
- **V**: value of data, encoded according to ASN.1 standard

<u>Tag Value</u>	<u>Type</u>
1	Boolean
2	Integer
3	Bitstring
4	Octet string
5	Null
6	Object Identifier
9	Real

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TLV encoding: example



Network Management: summary

- network management
 - extremely important: 80% of network "cost"
 - ASN.1 for data description
 - SNMP protocol as a tool for conveying information
- Network management: more art than science
 - what to measure/monitor
 - how to respond to failures?
 - alarm correlation/filtering?