Management Information

MIB, MO, & Management Protocol

Management Infromation - Concept

- Management applicaitons (managers) and managed devices (represented by agents) communicate
- Management Information
  - Anything managers need to know about managed devices
  - Carried in managemnet messages exchanged between managers and agesnt
  - Used by management functions.
- Important Questions:
  - *Define management information*
  - *establish common terminology* between manager and agent

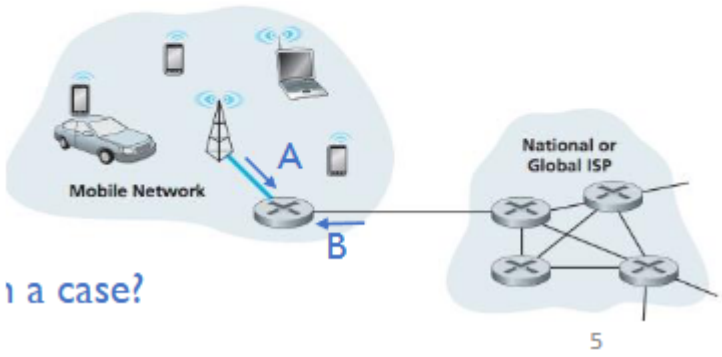
Common Terminology

A central aspect of management infromation which refers to a mutually understood way in which agents and managers can refer to various aspects of managed devices to prevent problems from arising.

Example Scenario:

- Manager queries an edge router for the incoming (direction A) traffic volume
- Agent has a different definition for "incoming" and returns the outgoing (direction B) traffic volume to manager

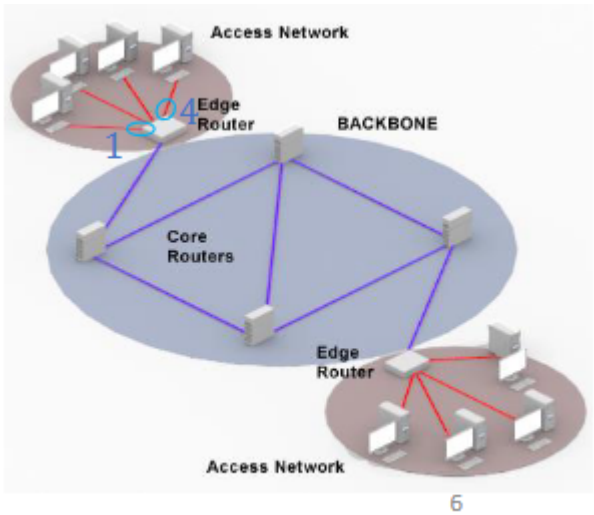
- Manager finds unusually high traffic --> Suspects an ongoing attack --> might switch off corresponding port to cut off the suspected attacker.



> Q: Why would the manager find it unusual in such a case Download vs upload speed (Down will always be higher than upload)

Example Scenario 2:

- Manager queries agent for information about port 1
- Agent uses different indexes for ports and refers to port 4 as port 1
- Manager confused what and who connected to the two ports
- Subsequent management decisions building on wrong facts



Misunderstandings:

- Type of information (incoming vs outgoing traffic in) scenario 1
- Particular instance of information (one of several ports) in scenario 2

Difference between MIB and Database

Why would we be using MIB rather than a database and database management syste (DBMS)

A1: Footprint

- DBMS: heavier weight as it requires more processing resources
- MIB: Lighter weight which enables more focus on management interfaces
- Network devices have limited processing capabilities making it difficult to run a DBMS
- Much of the genera-purpose processing provided by DBMS aren't needed by a manager or an agent.

A2: Management Requirements

- A lot of management information that is hierarchical in nature
- Some management information maintained by the agent(monitoring data for example), others by managers (Configuration settings)

A3: Real effects

- MIB: Not a "passive" database but *a view on an "active" real-world system*
- Information in MIB is accessed through and affected by: management operations, control protocols, the very functioning of the device, users loggin on and reconfiguring the device etc. --> MIB cannot be managed through a DBMS.

A4: Characteristics of contained data

- Database: large volumes of data, more or less of the same structure.
- MIB: many different types of information, each with relatively few instances --> more heterogeneous (Q:why?)

MIB and Management Protocol

- MIB and management protocol relationship
    - MIB: information aspect - content of communication
    - Management protocol: communication aspect - rules and procedures of communication
- Conceptually: MIB independent of management protocol
- Practically: management protocols specify the way MIBs are implemented
    - How management information is represented in the MIB
    - How MOs in the MIB are named and accessed by management applications
    - How the MIB can be structured as a whole
    - *A management protocol mandates a specific "flavor" of MIBs*

Categories of Management Information

- Distinction of management information importance
    - management applications treat different categories differently

Four main categories:

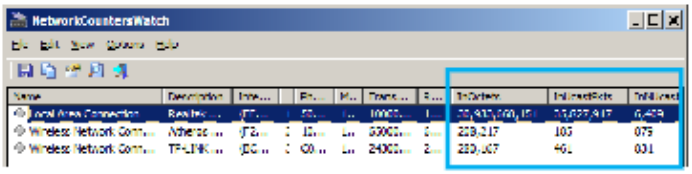
1. State information - current state of resources
2. Physical configuration information - how the managed device is physically configured
3. Logical configuration information - parameter settings and configured logical resources
4. Historical infromation - historical snapshots of performance-related state information

State Information

- State information - current state of resources
  - Information on the current performance/activities/alarm status of device
  - The most relevant management information for monitoring a network
  - Management applications can retrieve but cannot *directly* modify the state information (why?)
- Usually subject to frequent and rapid changes
  - Management applications may not cache this info but request from device whenever needed

State Information – Examples

- Current performance/activities of the device
  - Packet and connection counts for various protocols
  - Current CPU load, and utilization of bandwidth and memory, etc.
- Whether the device is currently functioning properly or not
  - Current alarm conditions
  - Highest alarm severity
  - Device up and running time since last reboot, etc.



Traffic counters

Physical Configuration Information

- Physical configuration information – how the managed device is physically configured, such as
  - Device type
  - Physical configuration in terms of cards and available ports
  - Serial numbers
  - MAC addresses
  - Management applications can retrieve but cannot modify this information

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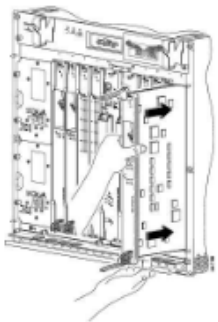
Physical Configuration Information

- Physical configuration information changes only rarely, if ever
  - Usually requires a "physical action" to affect physical configuration information, e.g., inserting a new line card into a networking equipment for a capacity upgrade
  - Management applications usually store this information in their database, for efficiency, instead of asking the agent repeatedly for it



Inserting a line card (Cisco)

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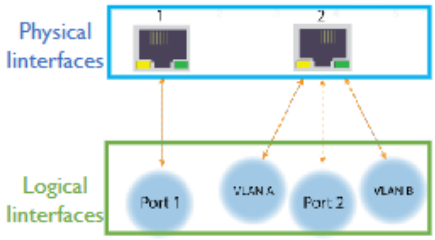
Logical Configuration Information

- Logical configuration information – parameter settings and configured logical resources, such as
  - IP addresses
  - Telephone numbers
  - Logical interfaces
- Two subcategories
  - Startup configuration information (persist after reboots)
  - Transient configuration information (the "running" configuration)



- Provide "knobs" for managers to control a device
  - Typically controlled (can be modified) by management applications with authorization
  - Management applications usually cache logical configuration important to them (knowing the information will not change unless they change it – Q: any conflict?)

Historical Information

- Historical information – historical snapshots of performance-related state information, such as
  - Packet counts for each 15-minute interval over the past 24 hours
  - Logs of various types of events (e.g., firewall log of recent remote connection attempts)
- Purpose
  - Management applications can retrieve this information in bulk from the device
  - No need to frequently collect state information unless necessary
- Q: can you give examples when historical information is useful for network management?

MIB Schemas and Metaschemas

Strictly speaking:

- MIB Schema: refers to a model
- MIB: refers to an instance of the model

MIB vs MIB Schema

Example of MIB Schema for the endpoint of a TCP connection

- Data items: e.g. TCP port number, IP address and port number of the remote endpoint of the connection, number of packets sent/received over the connection.
- May also incude semantic constraints: e.g the conditions under which the information about a TCP connection endpoint is removed from the MIB; whether a notice will be sent if such removal occurs

Example MIB for a particular endpoint at a particular time:

- TCP port 189, the remote endpoint's IP address 247.168.3.17, the remote end point's port number 188, and 452,895 packets sent, and 38,657 packets received.

Domain and Metaschema

MIB schema and MIB model are used synonymously

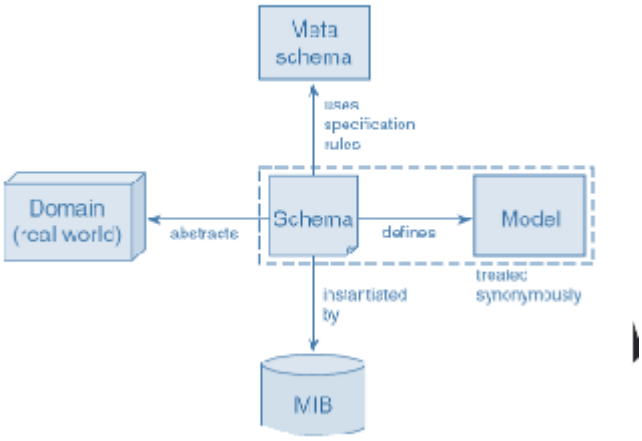
- Both referring to definitions of MIB
- Remains constant over time

Domain:

- The underlying "real world" abstracted by the model
- The "subject domain" that the model is all about

How is a MIB schema defined:

- Metaschema - "a schema of a schema"
- Specification language that specifies the MIB schema
- A definition of how to write and interpret model definitions



Metaschema - MIB Specification Language

A few MIB specification languages exist

- Generally, each defines MIBs used in conjunction with a particular management protocol or information model standard

Examples:

- Structure of Management Information version 1 and 2(SMI and SMIv2) - used in conjuction with Simple Network Management Protocol (SNMP)
- Managed Object Format (MOF) - Used in conjunction with Common Information Model (CIM)
- Guidelines for the Definitio nof Managed Objects (GDMO), used in conjunction with the Common Management Information Protocol (CMIP)

Impact of the Metaschema of the Schema

MIB model depends on what metaschema is being used

Object Oriented vs Table-based Metaschema

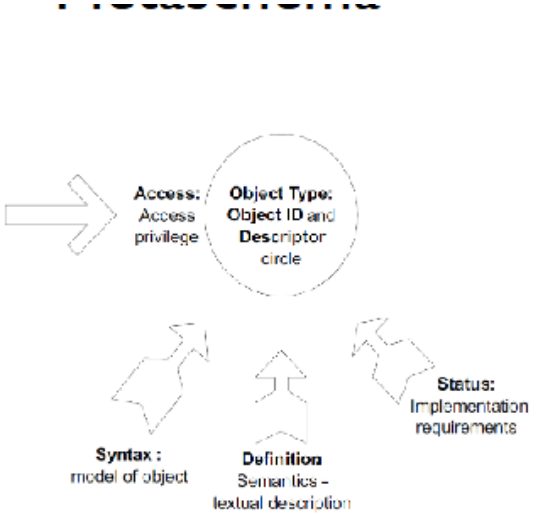
Some metaschema (MOF and GDMO) are object-oriented

- Represents different aspects of device as managed object (MO) classes
- Supports inheritance - reusing and refining MO classes
- More flexible and powerful

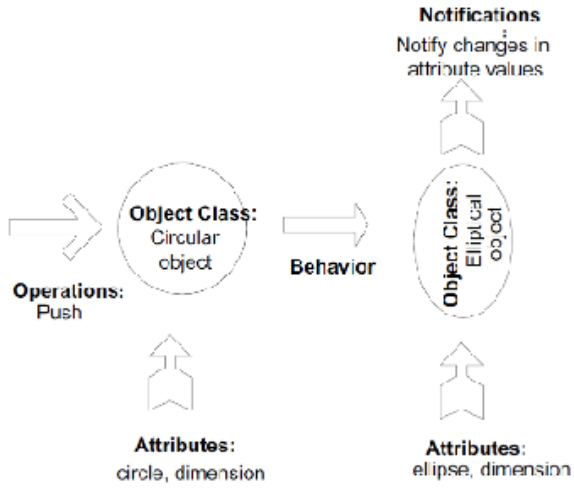
Others (SMI and SMIv2) are table-based

- Specify MIB models in the form of tables and variables grouped in vertain ways
- Table refers to one particular aspect of the devices
- Easy to understand and implement
- Focusing on this

MO in Object Oriented vs Table-based Metaschema



Characteristics of an MO (non-object-oriented)



Characteristics of an MO (object-oriented)

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Characteristics	Example
Object type	PktCounter
Syntax	Counter
Access	Read-only
Status	Mandatory
Description	Counts number of packets

Example characteristics of a packet counter MO (non-object-oriented)

Characteristics	Example
Object class	Packet Counter
Attributes	Single-valued
Operations	get, set
Behavior	Retrieves or resets values
Notifications	Generates notifications on new value

Example ccharacteristics of a packet counter MO (object-oriented)

Coexistence of MIB Schemas and MIBs

- Each metaschema has its advantages and drawbacks
- In practice, equipment vendors decide MIB schemas for their devices
  - Often several schemas corresponding to different metaschemas are provided simultaneously
- Users choose MIB schemas and assoicated management protocols
  - Possible different schemas and protocols for different management information/purpose
- Agents representing network equipment
  - Usually use simple metaschema
  - Limit of processing resources, simplicity of implementation
- An agent higher-up in the management hierarchy
  - May support object-oriented metaschema
  - Agent representing a computer system or a management application
  - Less constrained by computing resource, in favor of powerful metaschemas.

MIB is a view of a managed device:

- Possible to have multiple simultaneous views of the same device

With multiple MIBs of the same devices, each MIB can

- Be supported by its own management agent
- Interact with management applications through a different management protocol
- Cover a different scope/aspect of the same managed device.