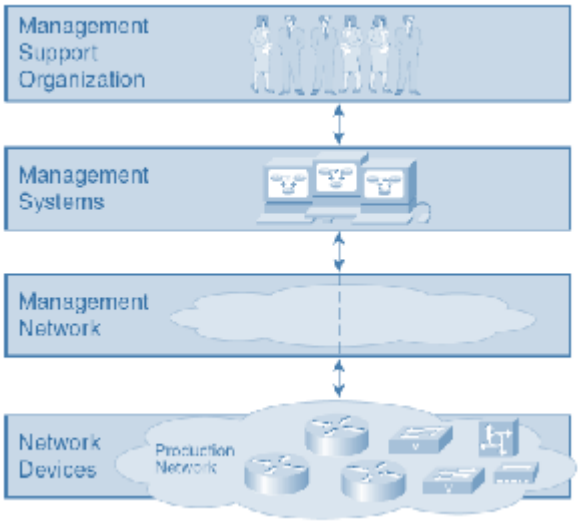
Lecture 4

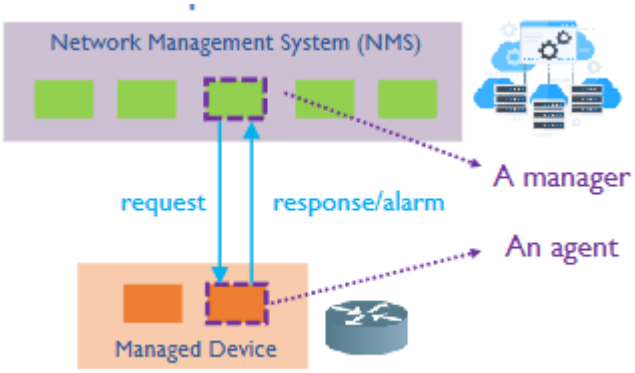
Network Management Components

- Network devices
  - Managed devices/network elements
- Network management system (NMS)
  - An integrated set of tools for management
- Management network
  - Interconnecting managing and managed entities
- Management support organization
  - Running the network using the management technologies



Key Concept - "Manager" & "Agent"

- Network management system (NMS) includes *management applications*
  - Each management application is a manager
  - An NMS can involve multiple managers
- Network devices come with software component that implements a management interface.
  - These components would be knowwn as an *agent*
  - Network devices can have multiple agents for different management functions (i.e reading data, configuring, etc.)
- Manager - agent communication
  - Manager is in charge
  - Agent plays a support role



Network Devices

- Also called network elements that includes the following:

    1. Switches
    2. Routers
    3. Gateways
    4. Can potentially include network operated servers.

- MUST HAVE a *management interface*

    - Allowing the management system to send messages to a device (request to configure, retrieve status data)
    - Allowing a device to send messages to the management system (response to request, unexpected event alarm, etc.)

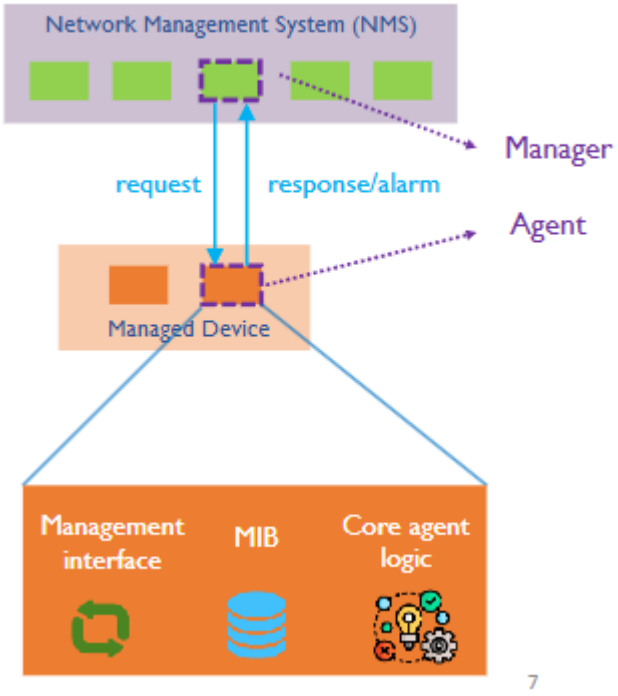
Components of Agent

Agent

The software that implements the management interface for that device. This device *IS NOT* a network device, However, it represents the device when communicating with a management application (manager)

Conceptually an agent consists of three main parts:

1. Management interface
2. Management Information Base (MIB)
3. Core agent logic.

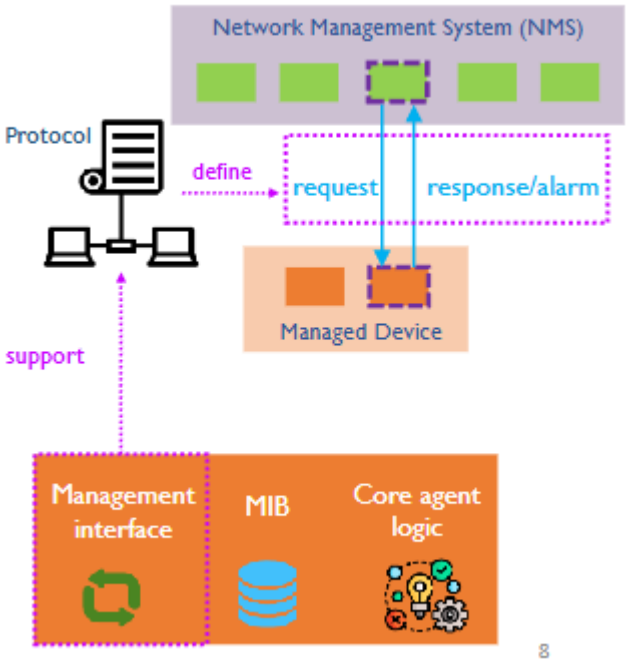


Agent Part 1 - Management interface

The management interface handles management communications by *supporting a management protocol* (Rules of communication) for manager-agent communication.

With the management interface:

- Management application (manager) can *open or terminate a management session* with the Agent
- Manager can make *management requests* to the agent (requests for data, change configuration, etc.)
- The *agent can send messages* to the manager (alert of loss of communication with another device for example.)



Management Information

An agent has a management information base (MIB)

Management information provides an *abstraction of real-world aspects of devices* for management purposes such as:

1. Version of installed software
2. Utilization of ports
3. Device temperature, voltage
4. Protocol timeout parameters
5. Firewall rules

Agent Part 2 - MIB

MIB is a *conceptual data store* that contains a management view of the device being managed.

- Conceptual data stored in MIB - management information
- Agent MIB - information local to the device
- Manager MIB - information of all managed devices

THE MIB IS NOT A REAL DATABASE

- An agent MIB is a "virtual" database containing management infromation - just a way to view nad organize information.

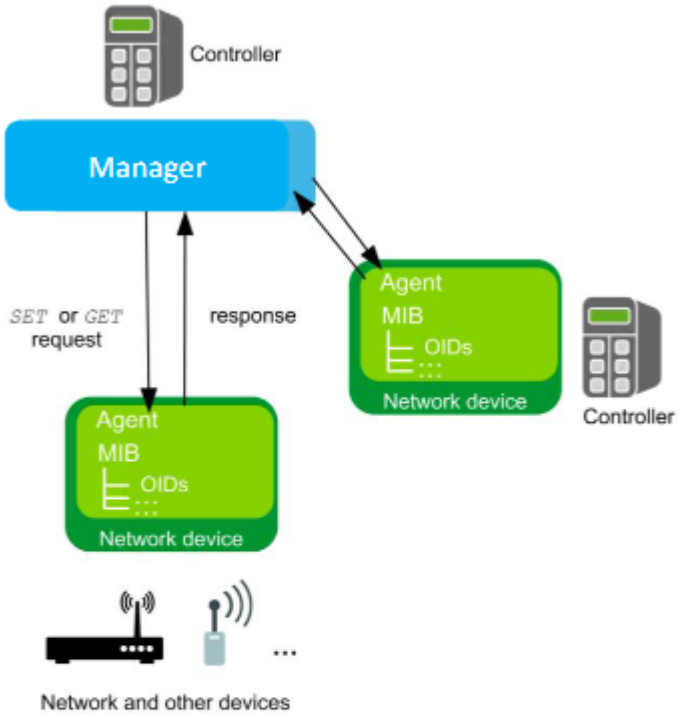
EXAMPLE OF MIB:

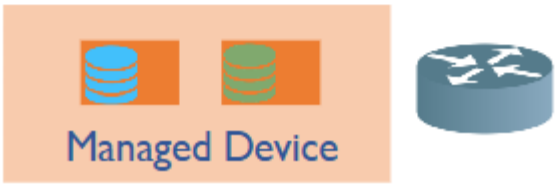
- Ports of a router represented as a table in an imaginary database
- Each port having a corresponding entry in the table
- Columns contain conceptual attributes corresponding to actual porperties of the port.

If a device has multiple agents, each agent could have a different MIB - different views and abstraction of information

MIB provides a foundation for network management operations

- Management operations are based on management communications
- Management communications are about exchaning information



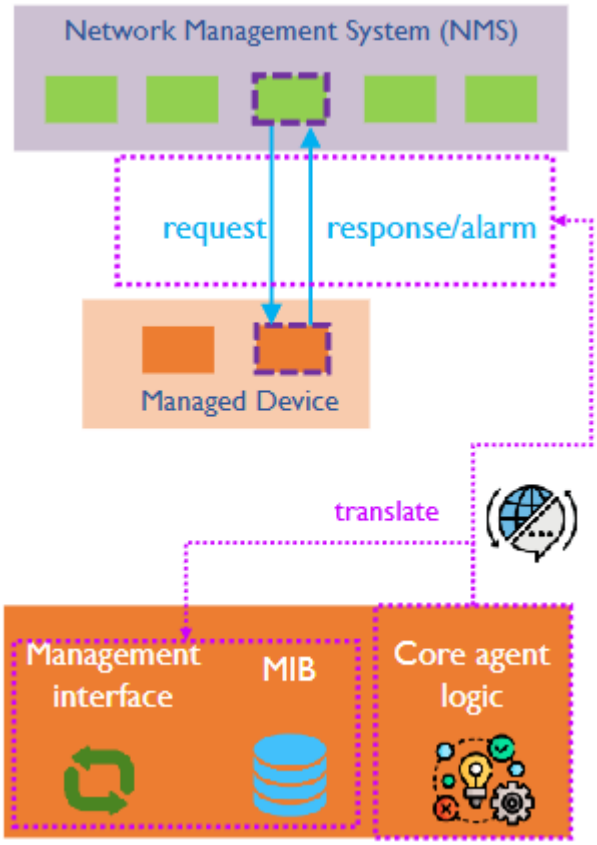


Agent Part 3 - Core Agent logic

The core agent logic *translates* between the operation of the management interface, the MIB, and the actual device.

EXAMPLE:

1. Manager sends a request to "retrieve a counter" into an Agent
2. The core agent logic *receives the request through the management interface*
3. Core agent logic *checks MIB* for the referred counter.
4. Core agent logic translates the request into an operation that reads out the corresponding hardware register of the device.



Managed Object vs. Real Resource

A managed object (MO) is a chunk of management infromation that represents one of the real-world aspects of a network device.

An MO could represent:

1. Device fan along with its operational state
2. Port along with a set of statistical data
3. Firewall rule

The *real-world object* that an MO represents is generally referred to as the "real resource"

- Same real resource can be abstracted in different ways corresponding to different and possibly coexisting MOs

> Q: can you give an analogy of different abstractions of the same object?
>
> A person's title will change depending on who you ask with each title representing a different abstraction of the same object

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Network Management System (NMS)

- NMS provides the tools to manage a network including the following:
  - Network monitoring application & network analyzers
  - Service Provisioning systems
  - Device management applications

- Intrusion Detection systems

Distributed Network Management

An NMS is not always on one host

Distributed network management: - NMS runs on and is distributed across several hosts.

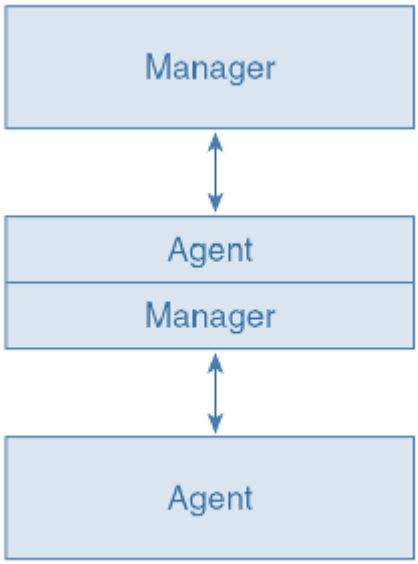
- Benefits of distributed management:
  1. Scalable: more hosts = greater processing, I/O and storage capacity.
  2. Robust: if one fails, NMS can still be running
  3. Delay and overhead: managing from location close to a local network (similar to cloud vs. edge computing.)

Management Proxy and Hierarchy

Proxy: Node acting on behalf of other nodes

A network device may act as a management proxy to another. - Plays the agent role in interacting with the management system. - Plays the manager role in interacting with another device.

This eventually forms a *management hierarchy* and the entity in the middle does not have to be a device. - possible a sub- or local management system.



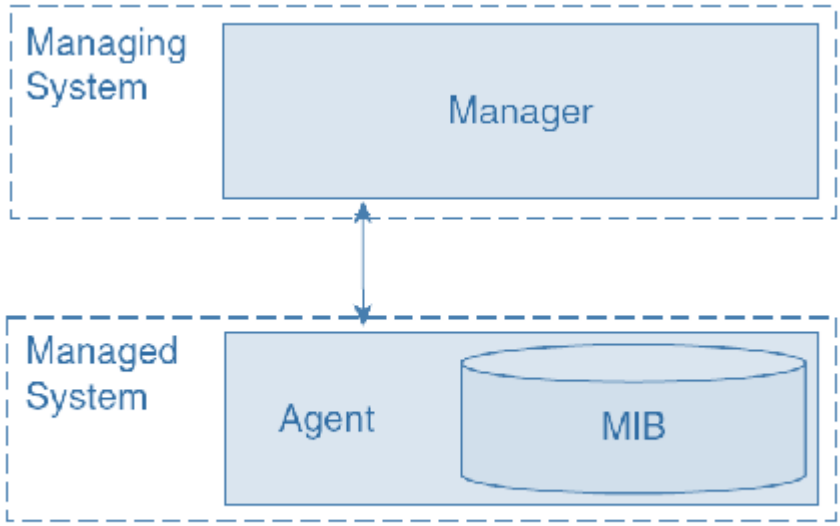
Management Hierarchy

Manager - Agent - MIB Relationship

- Fundamental relationship among manager, agent, and MIB
- The manager operates on the abstraction of the agent provided through the agent's MIB:
  - Sends requests to the Agent
  - Receives responses from the Agent

- Asks the agent to be notified of events

Agent: proxy for managed device NMS: proxy for the real-world organization responsible for managing the network.

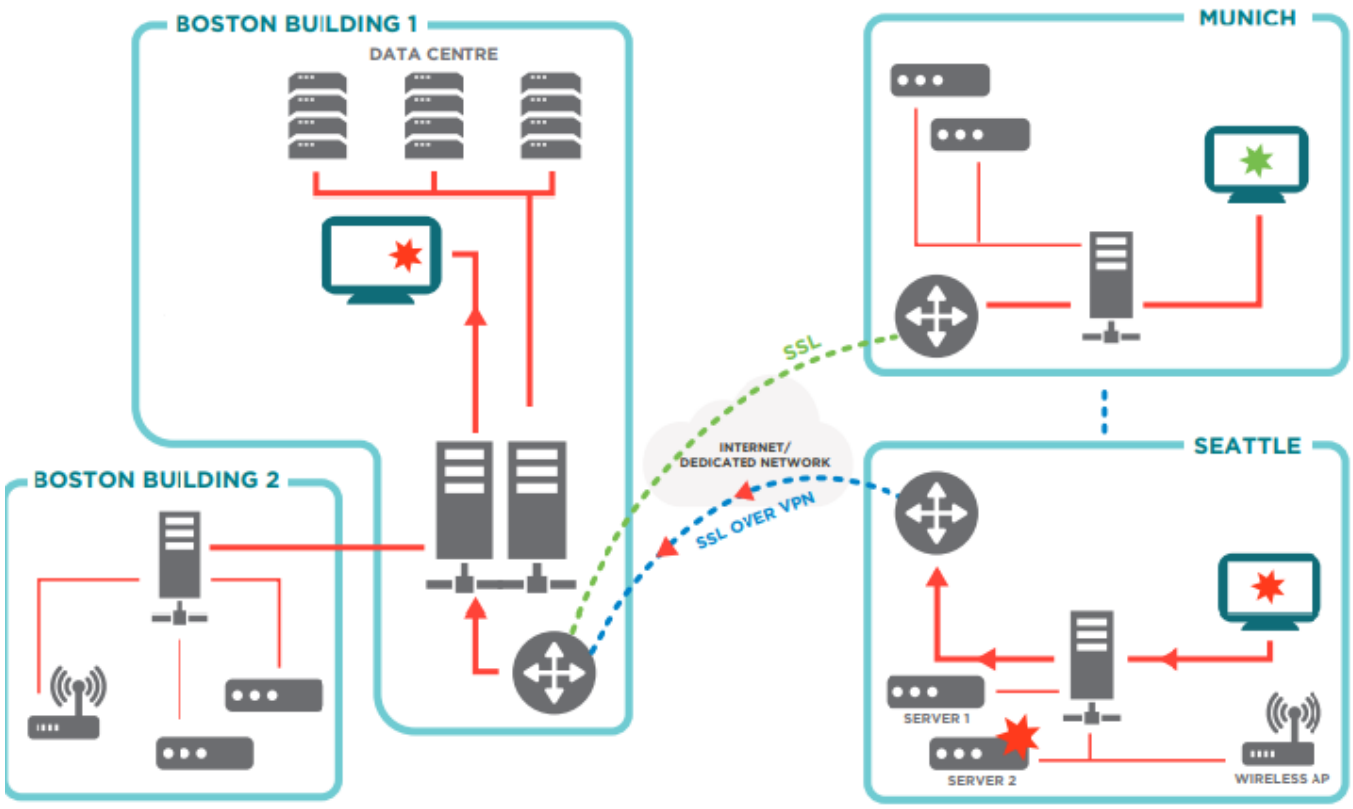


Manager/Agent Reference Diagram

Concept of Management Network

Managers and agents need to communicate and NMS on different hosts need to be able to communicate with each other.

- Management network: the network interconnecting NMS and managed devices
- Production networks: the network providing services to the end user.
- Management and production networks can be physically separate networks or the same physical network.



Connecting NMS to Network Devices

Network devices can be connected with/without a management Network and here are the following methods to do so:

1. Direct connections
    - Network devices have a management/console port (typically a serial interface)
    - A technician can directly connect a craft terminal to a device.

Issues: - Needs on-site physical access to the device - Impractical to go from device to device in a large scale network.

2. Connecting through a terminal servers
    - Terminal server will have a set of serial interface ports, each connecting with one network device and a port for the craft terminal to connect to.

Issues: - Still needs on-site physical access to the terminal server - Would also still need to go between terminal servers

3. Terminal server with Ethernet port and IP address
    - On-site connection to teh terminal server no longer needed
    - preliminary management Network

Issues: - Keeping track of which devices are connected to what terminal server and their respective ports.

4. Connecting to network devices through regular Ethernet ports(In-band Management Network)

    - Skips the need for terminal servers
    - Connects to network devices using regular Ethernet ports and IP address.

> In-band management network
>
> Same network infrastructure and port for management and production networks (mixing network management data traffic and production data traffic

5. Connecting to network devices through management Ethernet ports (out-of-band Management Network)
    - Also skips terminal servers
    - Connects to network device using Ethernet ports and IP addresses dedicated to network management purposes.

> Out-of-band Management network
>
> Different ports for management and production networks (separating management data traffic from production data traffic.

In-band vs Out-of-band Management Network

- In-band: *same network* shared by production and management traffic
- Out-of-band: *dedicated* management network

Dedicated Management Network: Pros & Cons

To determine whether management networks are beneficial, we would need to look at the trade offs.

Which (dedicated or shared management network is better in:

- Reliability:
    - Out-of-band because it removes the possibility of having a highly congested production traffic flow from losing management traffic which is necessary to manage production traffic in the first place.
- Quality of service (QoS) for production traffic:
    - Out-of-band works especially considering that management traffic is quite unpredictable since sometimes it will have a higher traffic rate than normal which would potentially interrupst production traffic flow.
- Ease of network planning:
    - Out-of-band: It enables us to separate the planning for how management and production traffic would go around.
    - However it is also fair to consider in-band management because it simplifies the entire process because you would have less factors to consider overall.
- Security:
    - Out-of-band: prevents unauthorized access from making changes on the management side which can potentially cause the entire network to go down.
- Cost:

- In-band would be cheaper to implement as less time and effort would be needed in setting up the entire network infrastructure since it will all be bundled together.

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the Non-Technical aspects

Network Management Fundamentals - Pages 93-97

Organizational aspect of network management: - Management support organization - Important to telecommunications service providers and large enterprises - Smaller businesses may not have a management support organization (but just one network administrator.

For large networks: *network operation center (NOC)*

Management Support Organization - Tasks

- Overall task: managing the network Manager
  - Montoring the network for failures
  - Diagnosing failures and carrying out repairs
  - Provisioning new services
  - Adding and removing users to and from the network
  - Tracking network performance, taking preventative measures
  - Planning network upgrades
  - Planning network topology and network buildout

Management Support Organization - Structure

- Management support organization divided into different units
  - Each performing a distinct function
  - Minimizing interactions between different units and dependencies causing finger-pointing situations

Example structure:

- Network planning: Analyzing network usage and traffic patterns, planning network buildout and service rollout.
- Network operations: Keeping the network running and monitoring the Network
- Network administration: Physically deploying the network and services on it, may include field technicians (combining A and M in OAMP)
- Customer management: Interacting with customers