Lecture 1: Traditional Network Management Systems

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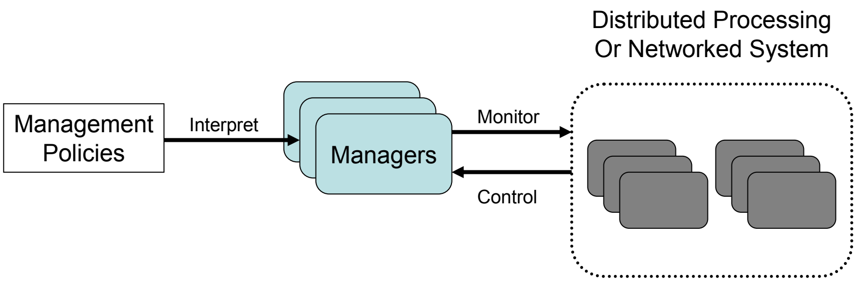
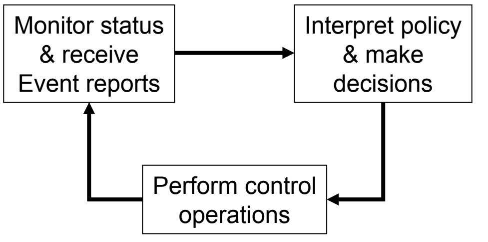
What is management?

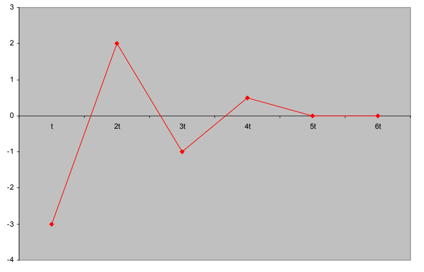
- Supervision and control of a system so that it fulfills the requirements of both owners and users of the system.



Closed-loop Management



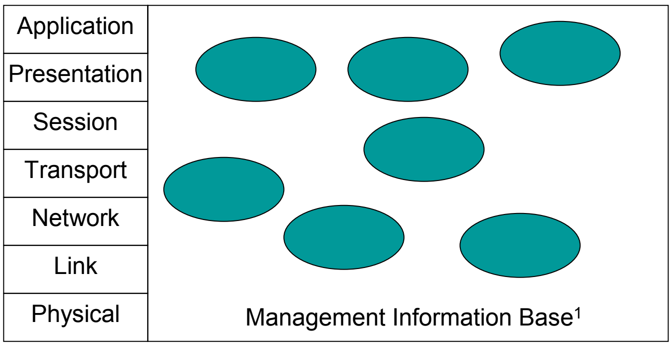
- Many aspects of system management require closed-loop control of the system – i.e. based upon measurements of current activity and indications of desired activity, control operations on the system are performed



Five Functional Areas of Mgmt

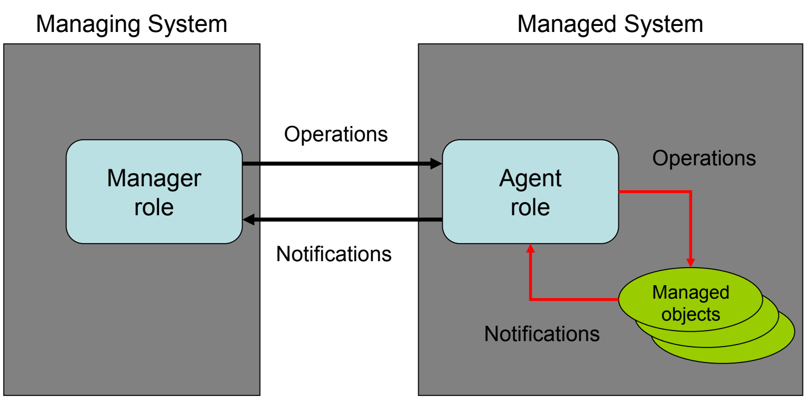
- Fault – identify the existence of a fault, diagnose its cause, and carry out confidence tests to ensure that faults have been rectified
- Configuration – monitor the state of resources and their interrelationships; change the state of and relationships between resources
- Accounting – gather data relating to the usage of resources and assign that usage to the appropriate subscriber
- Performance – gather resource usage data and combine the data to provide performance statistics
- Security – manage the security environment of a network including detection of security violations and maintaining security audits; perform the network management task in a secure manner

ISO Management Model



[1]Each MIB element represents a real resource in the network.

ISO System Mgmt Architecture



Defining Managed Objects

- One defines the characteristics of a managed object class, and each managed object is an instance of its class
- A managed object class definition defines:
  - The properties or characteristics visible at the managed object boundary – termed attributes, and each attribute has a value
  - The management operations that may be applied to an instance of the class
  - The behavior it exhibits in response to management operations
  - The notifications that it emits, and the circumstances in which it emits them
  - Its position in the inheritance hierarchy of managed object classes
- The Guidelines for the Definition of Managed Objects (GDMO) is the international standard that defines the notation used to specify managed object classes

Example GDMO Specification

```
pduCounterObject MANAGED OBJECT CLASS
    DERIVED FROM “CCITT REC.X.721(1992)|ISO/IEC 10165-2: 1992”: top ;
    CHARACTERIZED BY
           basePackage PACKAGE – in-line PACKAGE definition
                      ATTRIBUTES       pduCounterName
                                                 GET ;
                                       pduCounter
                                                 INITIAL VALUE syntax.initialZero
                                                 GET ;
           ; -- End of in-line PACKAGE definition
    ; -- End of CHARACTERIZED BY constyruct
REGISTERED AS (object-identifier 1) ;
```

Example GDMO Specification (2)

```
pduCounterName ATTRIBUTE
    WITH ATTRIBUTE SYNTAX syntax.CounterName ;
    MATCHES FOR EQUALITY;
    BEHAVIOUR
        counterNameBehavior BEHAVIOUR
            DEFINED AS
                *This attribute is the naming attribute for the
                pduCounterObject managed object class.  It has no
                function other than to provide a unique identifier for
                instances of the class contained within a given
                superior object class.*
        ; -- End of embedded BEHAVIOUR template
    ; -- End of BEHAVIOUR construct
REGISTERED AS (object-identifier 2) ;
```

Example GDMO Specification (…)

- And many more pages of impenetrable gobbledy-gook ☺.

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Management Operations

- ***Get*** the value of an attribute
- ***Replace*** the value of an attribute
- ***Replace with default*** the value of an attribute
- ***Add/Remove*** a value to/from a set-valued attribute
- ***Get*** and ***Replace with default*** may be used on attribute groups
- ***Create***, ***Delete***, and ***Action*** may be applied to a managed object as a whole

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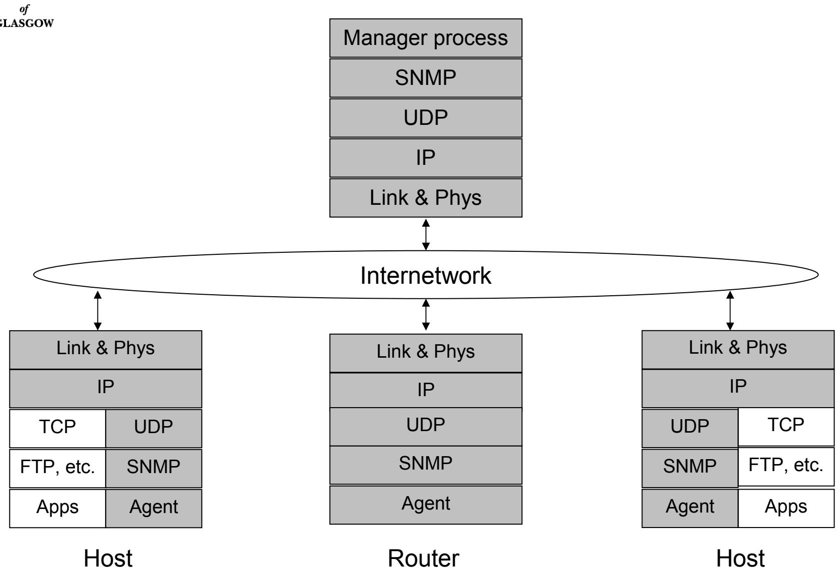
Management Protocols

- CMIP (Common Management Information Protocol) – protocol for accessing managed objects through OSI protocols
- SNMP (Simple Network Management Protocol) – protocol for accessing managed objects through UDP/IP protocols
- With the predominance of the TCP/IP suite of protocols in the Internet today, SNMP is the dominant protocol for accessing MIB data

SNMP Stack



Management Realities

- UDP basis of SNMP – unreliable data transfer, implies lack of reliance upon notifications
- Reticence of network element manufacturers to permit control ACTION's via managed objects, implies that control actions must be activated via CLI commands; these are distinctly non-standard, forcing most such actions to be taken by manual operators
- Polling nature of SNMP GET operations implies that systems based strictly on SNMP access to MIB's inherently suffer scalability problems

Control and Data Planes

- Control plane refers to the network and protocols over that network to support the creation, modification, and destruction of sessions that convey application data – i.e. the network used to control the data network
- Data plane refers to the network supporting these sessions, and that is controlled by the control plane traffic – i.e. the data network
- The physical networks underlying these two planes can be different (telephony) or the same (Internet Service Provider)

What's wrong with current OSSs?

- Measurement not designed into Internet protocols
- Management functionality is bolted onto network elements, not built in (MIBs)
- Centralized management model (doesn't scale)
- Management model is reactive (tools to track down a problem when detected) rather than proactive (prevent problems from occurring)
- Monitoring tools for manual use by the operator rather than automated management

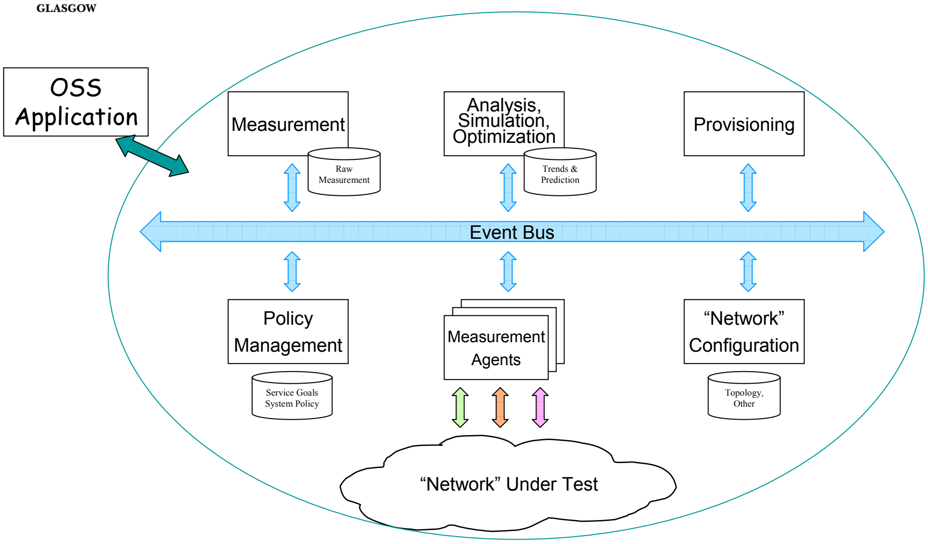
Automated management requires a paradigm shift

- Internet protocols must be modified to support measurement features
- Measurements should always be active, thus enabling proactive management
- Management functionality must be distributed around the network to address scale
- Suitably adapted closed-loop techniques should be used to automate management activities

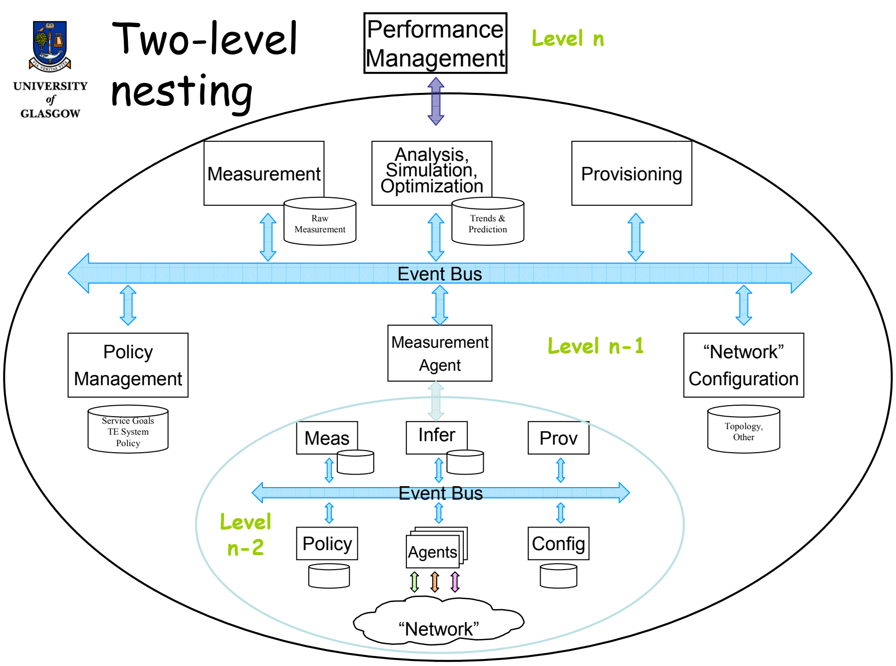
Intelligent Operational Support Systems

- Intelligent OSSs automate network management activities
- This automation requires innovation and integration of results in four main areas:
  1. Generation of triggers that reflect true deviation of delivered service from contracted service (intelligent measurement)
  2. Instantaneous access to topology, resource, routing, and other relevant contextual data that affect the interpretation of generated triggers
  3. Ability to capture preferences and constraints that an operator would apply to the interpretation of network data (policy)
  4. Powerful analysis components to interpret triggers, subject to the contextual and policy data, to rapidly yield appropriate automatic management actions to apply to the network

Closed-loop OSS architecture



Two-level nesting



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Why is this nested architecture useful?

- Successful automation of particular functions will require coordination of closed-loop activities at each of the abstraction levels
- Explicitly viewing the system as nested instantiations of the common pattern provides scope for leverage of solutions and technologies across levels of abstraction (e.g. Event Bus)
- The need for integrated approaches to common needs across the levels of abstraction (e.g. information storage and retrieval) becomes apparent and may guide the solutions