Telecommunication
Network Management

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Overview

- Why we need management in telecommunication?
- TMN architecture
- TMN Interfaces
- TMN Planes
- TMN Management Functions
- Application layer for Interactive class
- Application Entities: ACSE, SMASE, ROSE, CMISE
- Application layer for File transfer class: FTAM
- CMISE, CMIP
- TMN Information Model
- Comparing TMN and SNMP
Need for TMN

- Telecommunication is growing very fast
  - New infrastructure
  - New services
  - More competition
  - Several networks and service providers for one service
  - Increased request for QoS
- More need for network management
- Today trend: network management features is one of the criteria for product decisions
TMN history

- Network management has been vendor dependent
- ITU defined an architecture for TMN in 1988
- In 1992 several important recommendations for TMN
- In the last few years the awareness of TMN is increased two extreme positions:
  - TMN is the solution for network management
  - TMN is too complex, difficult and cost too much
- TMN standards provide definitions for the information in support of management and how they are exchanged across different interfaces
- Many implementations details are left opened
TMN Architecture

- Recommendation M.3010 defines the framework in terms of three basic architectures: functional, information, and physical.
- TMN uses concepts from OSI System Management architectures and applies them in the context of telecommunication management.
- The OSI management architecture two roles:
  - Manager to monitor and control resources
  - Agent
  - The roles can be reversed
TMN Architecture (cont.)

Management network

Signaling network

Communication network
Functional Architecture

OSF → DCF → MF → DCF → NEF
OSF → DCF → QAF → DCF → MF
OSF → DCF → MF → DCF → WSF

TMN
Functional Architecture

- **OSF**: Operating system function
  - Obtaining management information such as alarms
  - Processing the retrieved information, for example, correlating alarms to find out their cause
  - Direct the managed entities to take the needed actions
- **MF**: Mediation function
  - Mediate the exchange of information, store filter, adapt and correlate the data
- **NEF**: Network element function
Functional Architecture

- **QAF**: Q adapter function:
  - Bridge between the non-TMN and TMN systems
- **WSF**: Workstation function:
  - Bridge between the user and TMN systems
- **DCF**: Data communication function
Information architecture: How to structure the management information between managers and agents

The resources are used either to provide telecommunication service or to aid in management
Physical Architecture: example
Physical Architecture

- OS: Operating System
- NE: Network element
- DCN: Data communication network
- QA: Interface adapter
- WS: Workstation
- MD: Mediation device
- I: Interface
Physical Architecture: Interfaces

- Q3 interface specifies the information exchanged between: OS - NE, OS - MD, MD-NE, OS -OS
- X interface specifies the information exchanged between different TMN (administrations)
- Qx interface specifies the information exchanged between: MD - NE
- QA provides adaptation to interface TMN with other systems
- F interface specifies the information exchanged between an OS and a workstation
- Communication protocols and management information are standardized for Q3 and X
TMN Cube

- Communication Plane
- Management functional plane
- Logical Plane
TMN Logical Plane

- Management Application Functions (MAF)
- Information Conversion Function (ICF)
- Message Communication Function (MCF)
- Workstation Support Function (WSSF)
- User Interface Support Function (UISF)
- Directory System Function (DSF)
- Directory Access Function (DAF)
- Security Function (SF)
<table>
<thead>
<tr>
<th>Level of Abstraction</th>
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</thead>
<tbody>
<tr>
<td>Business management level information (BML)</td>
</tr>
<tr>
<td>Service management level information (SML)</td>
</tr>
<tr>
<td>Network management level information (NML)</td>
</tr>
<tr>
<td>Elemental management level information (EML)</td>
</tr>
<tr>
<td>Elemental level information (EL)</td>
</tr>
</tbody>
</table>
TMN Management Functions

- Defined in M.3400 following the OSI
- **Fault:** Alarm surveillance, fault isolation, fault correction and testing
- **Configuration:** Network planning and engineering, Service planning and negotiations, provisioning, status and control, and installation
- **Performance:** Performance monitoring, traffic management, and quality of services
- **Security:** Security of management and management of security, prevention, detection, containment and recovery
- **Accounting:** Usage measurements, billing, contracts, service profiles, tariffs/pricing
Communications Plane

- Infrastructure components: end-to-end integrity, segmenting, retransmission
- Two classes of applications:
  - Interactive: request/reply alarm status
  - File transfer: example software download, traffic files
- Contents of exchange depends on the application
TMN Support Environment

- Directory Services: Facilitate reaching the destinations, X.500

- Security Services:
  - Authentication
  - Access control
  - Data confidentiality
  - Data integrity
  - Nonrepudiation
Initially TMN communication interfaces between different components adopted OSI standards

For example ISO protocol for File Transfer and Access Management (FTAM) is required for file transfer class

Recently enhancements include TCP/IP (RFC 1006)
Application layer for Interactive class

- Application layer two types of activities:
  - Information processing
  - Communicating the application information to remote systems

- Application Service Elements (ASE) – building blocks for specific functions:
  - Association Control Service Element (ACSE)
  - Remote Operation Service Element (ROSE)
  - Common Management Information Service Element (CMISE)
  - System Management Service Element (SMASE)
Application Entity

Coordination functions

ACSE

SMASE

CMISE

ROSE
Application Entity

- ACSE is used by a connection-oriented application to set up and release an association (with an application)
- ROSE is a generic framework to issue request to a remote system and receive responses, correlates requests and responses
- CMISE refines the structure offered by request/reply framework of ROSE
- SMASE is used as a generic term to cover all management functions
The first step: establish a virtual connection using ACSE

The message uses the structure defined by ROSE (request/reply)

CMISE defines fields common to all management functions
File-Oriented Class

- Use of ACSE to setup an association
- FTAM for file transfer (ISO 8571)
CMISE

- CMISE: an application service element that defines a common structure for exchanging management information

- CMISE is composed of two parts:
  - Service Definitions (X.710|ISO 9595) used by the service user in requesting and responding to requests.
    - The definitions are applicable to different functional areas
  - Protocol Specification (X.711|ISO 9596-1)
The managed objects and their properties form a repository:
Management Information Base MIB
CMISE Services

- M-EVENT-REPORT: Report an event
- M-GET: Retrieve attributes and their values
- M-SET: Modify attribute values
- M-ACTION: Request an action to be performed
- M-CREATE: Request to create a new managed object
- M-DELETE: Request to delete a managed object
- M-CANCEL-GET: Request to cancel a previously invoked M-GET service

- Two type of services: confirmed and unconfirmed
- When a service is confirmed a response is send to indicate the success of failure
Scoping Feature

Start here

Network Element
Id = “Acme”

Network Unit
Id = “CSU1”

Element
Id = “Slot1A”

TTP
Id = 11

Equipment
id = “Controller”

Modem
Id = “Sri”

Port
Id = “4”

Processor
Id = 1

Scope down to second level

M-GET, M-SET, MACTION, M-DELETE

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Filtering Features

Network Element
Id = “Acme”

Element
Id = “Slot1A”

TTP
Id = 11

Equipment
Id = “Controller”

Modem
Id = “Sri”

Port
Id = “4”

Processor
Id = 1

Vendor name = “ADC”
Administrative Status = locked

Administrative Status = unlocked
Operation state = disabled

\{(object class = equipment AND vendor name = “ADC”) OR (object class = processor AND operational state = disabled)\}
CMIP

- The Common Management Information Protocol is designed for exchanging the management information of CMISE services
- Defined in terms of request/reply paradigm offered by ROSE
- Both ROSE and CMIP are specified using ASN.1

<table>
<thead>
<tr>
<th>Invoke Id</th>
<th>Operation value</th>
<th>Managed/ Base object class</th>
<th>Managed/ Base object Instance</th>
<th>Operation Specific information</th>
</tr>
</thead>
</table>

Structure of CMIP request
<table>
<thead>
<tr>
<th>Service</th>
<th>Operation value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event report</td>
<td>0</td>
</tr>
<tr>
<td>Confirmed event report</td>
<td>1</td>
</tr>
<tr>
<td>Get</td>
<td>2</td>
</tr>
<tr>
<td>Set</td>
<td>3</td>
</tr>
<tr>
<td>Confirmed set</td>
<td>4</td>
</tr>
<tr>
<td>Action</td>
<td>5</td>
</tr>
<tr>
<td>Confirmed action</td>
<td>6</td>
</tr>
<tr>
<td>Create</td>
<td>7</td>
</tr>
<tr>
<td>Delete</td>
<td>9</td>
</tr>
<tr>
<td>Cancel get</td>
<td>10</td>
</tr>
</tbody>
</table>
The repository in case of management is called: Management Information Base MIB

Object-oriented modeling paradigm: provides an abstraction that combines data and functions that use the data and operate into an object

- Encapsulation
- Modularity
- Extensibility and reusability
- Relationship
Managed objects are created in a system to represent the resources to be managed.

The repository of managed objects is called the Management Information Base (MIB).

Even though the instances are objects, the databases used to store the MIB may vary with the implementation, for example, a relational or an object-oriented database may be used.

A MIB includes all the management information, which is a collection of managed objects and the information contained in them.
TMN vs. SNMP

- SNMP: the managed nodes are considered simple entities and the management functions are kept to minimum; the intelligence is in the manager
- TMN is intended to address managing complex entities

Architecture

- TMN uses peer-to-peer model, roles assumed by a system: manager or agent
- TMN includes sophisticated methods to negotiate capabilities
- SNMP assumes a simple agent-manager paradigm, SNMP v2 includes manager-to-manager communication
- SNMP no concept of negotiation capabilities
**TMN vs. SNMP**

- **Communication Infrastructure**
  - SNMP uses UDP, reliability not a requirement
  - CMIP is designed as a connection oriented protocol, reliability is required in many applications
- **SNMP uses polling, CMIP is event driven**
- **Services**
  - TMN separates services and protocols
  - TMN more powerful services such filtering, scoping etc
- **MIB: O-O is used only in TMN**
  - SNMP only attributes, TMN behaviours, attributes and operations
  - O-O properties: reuse, inheritance, polymorphism
  - TMN more complex data, SNMP only four types
Summary

- Management is key factor in telecommunication
- TMN architecture
- TMN Interfaces
- TMN Planes
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