

# Gestão/Management

Management of Local and Global  
Networks  
Concepts and Protocols

## Learning outcomes

- **Understand the need for professional automated management**
- **Understand the concept of policy-based management**
- **Realize the challenges of management in telecommunications, and the CMIS and TMN models.**



universidade  
de aveiro

## Why Networks and Systems Management?

4

- **Lower Cost** – Manual management is costly
- **More efficient** – Automatic systems allow an efficient planning, and mechanisms to predict the utilization trends: lower errors and faster actuation
- **Better service** – The manager is informed at the same time the (client) is, and can make an automatic check of the situation
- **Greater knowledge** – more information exists about the network, allowing better decisions and planning
- Why not human intervention?
  - **Difficult to describe responsibilities**
  - **Technology rapidly evolves**
  - **Management systems rapidly evolve**
  - **Lack of technical resources**



universidade  
de aveiro

## Commercial perspective

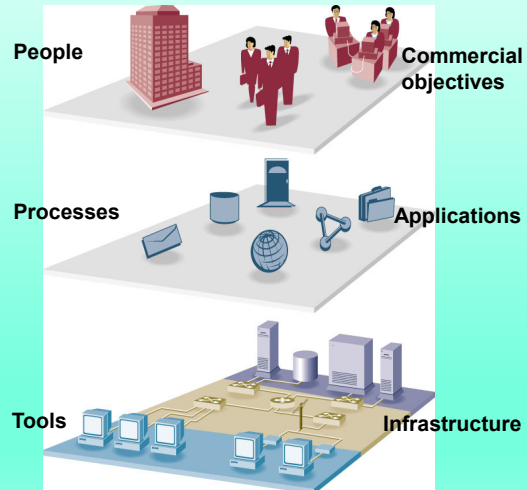
5

- **Problems need to be quickly solved**
- **Management systems simplify the work of multi-functional networks (e.g. VoIP in multiple networks)**
- **Persons better used – they do not need to perform repetitive tasks**
- **Companies need to optimize their structures, and network management allow resources optimization**

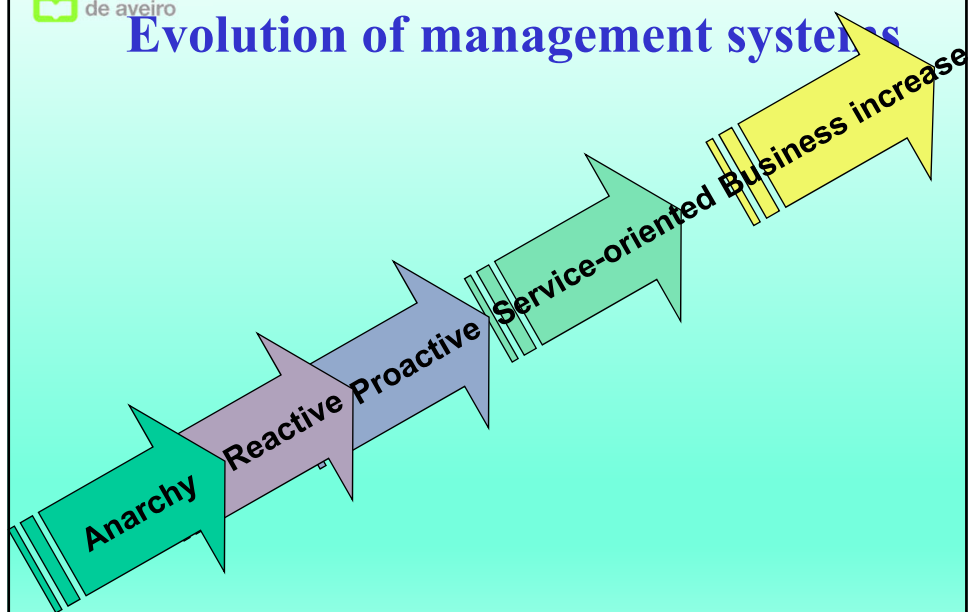


## Network management is:

Implement, integrate and coordinate resources (HW, SW and people) to plan, operate, manage, analyze, test, evaluate, design and expand the system to guarantee the service objectives (temporal, performance), with a reasonable cost and capacity.



## Evolution of management systems

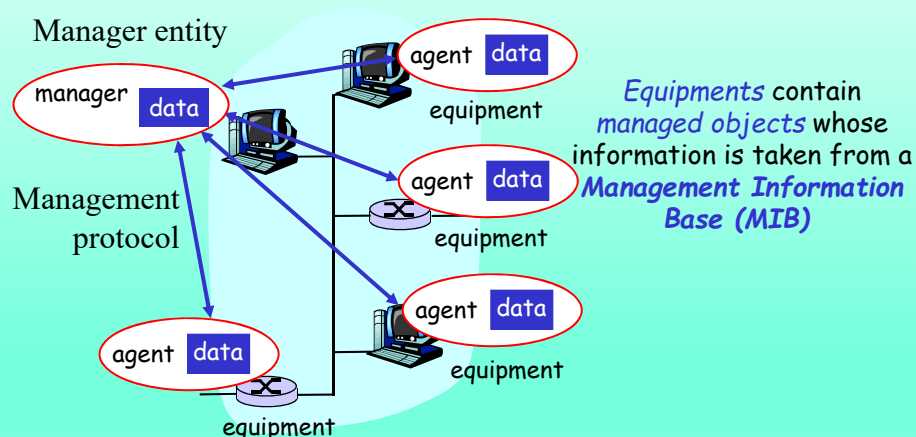


## Management alternatives

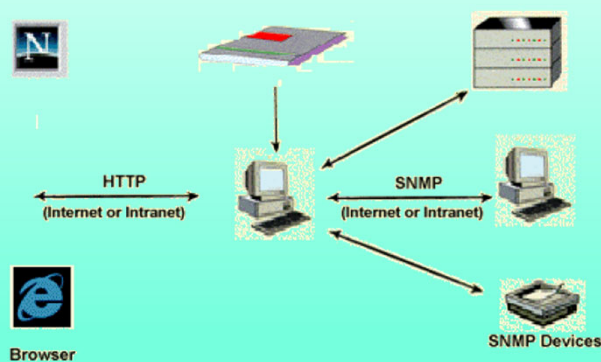
- |  |   |
|--|---|
| scope<br>communication<br>protocol<br>Decision model | <ul style="list-style-type: none"> <li>• <b>Systems management</b> – Covers all company aspects</li> <li>• <b>Networks management</b> – Covers mainly network aspects and communications systems and equipment</li> </ul>   |
|  | <ul style="list-style-type: none"> <li>• <b>Dedicated protocols</b> – dedicated for networks</li> <li>• <b>Web based systems</b> – resort to HTTP models, recently common</li> </ul>  |
|  | <ul style="list-style-type: none"> <li>• <b>Centralized models</b> – Agent-manager model</li> <li>• <b>Distributed models</b> – Share of the management responsibilities</li> <li>• <b>Hierarchical models</b> – Hierarchic structure with centralized information in the root</li> </ul> |

Current real management structures very complex, with several operational models simultaneously

## Basic Model for Network Management

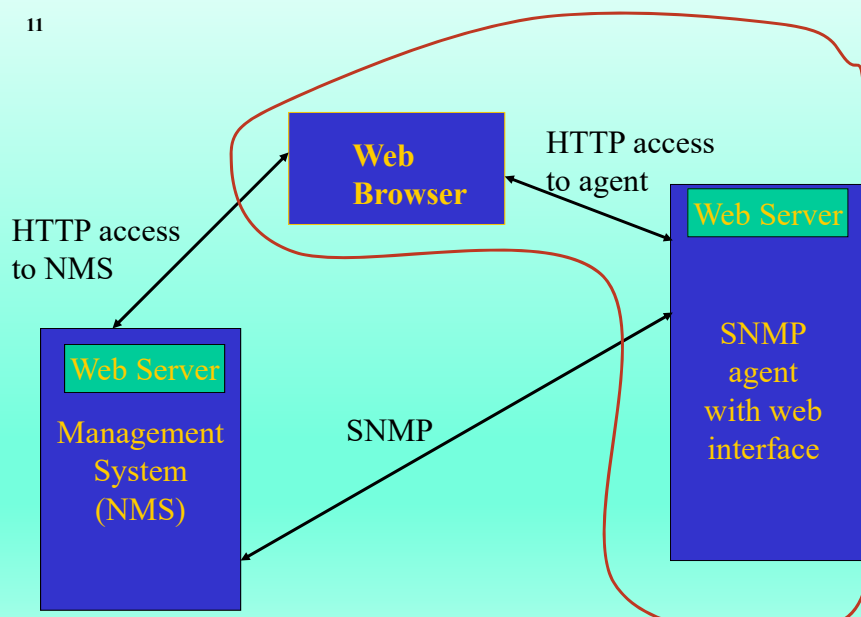


## WEB-based management



**Very common:**  
**Network and device management via web interfaces**

## Web-based management concept



## Network management

- ISO defined five areas for network management
  - **Fault management** – detection, isolation, and correction of anomaly behaviors

**F**ault

- **Configuration management** – control data for the network elements / collect data from network elements

**C**onfiguration

- **Accounting management** – measure network utilization and determine network costs and user accountings

**A**ccounting

- **Performance management** – evaluate/report network equipment behavior/efficiency

**P**erformance

- **Security management** – support communications network secure management

**S**ecurity

## Network management

- ISO defined five areas for network management
  - **Fault management** – detection, isolation, and correction of anomaly behaviors

**F**ault

- **Configuration management** – control data for the network elements / collect data from network elements

**C**onfiguration

- **Accounting management** – measure network utilization and determine network costs and user accountings

**A**ccounting

- **Performance management** – evaluate/report network equipment behavior/efficiency

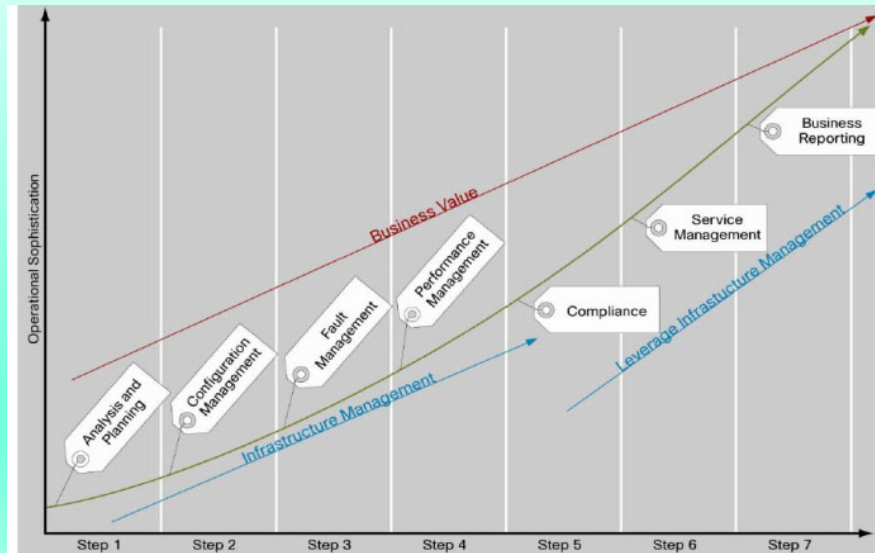
**P**erformance

- **Security management** – support communications network secure management

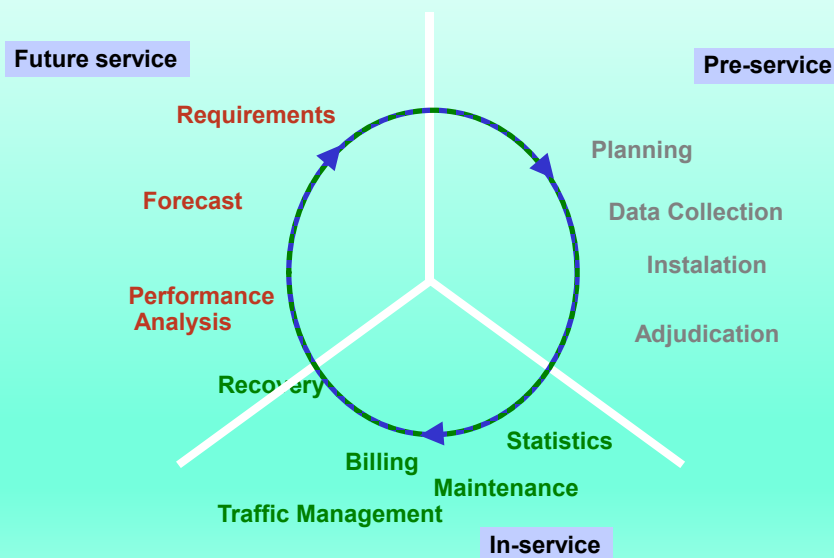
**S**ecurity

Isolating the management problems in distinct areas, ISO model allows conceptual solutions optimized to specific problems in each functional area

## Implementation plans



## Management Life Cycle



## Aspects of Network Management

- **What to manage?**
  - Network, equipment, systems, users, services, applications
- **How to manage?**
  - Interfaces, actions, abstractions
- **What protocol(s) format(s)?**
  - Protocol abstraction, formats, messages
- **What information format(s)?**
  - Information type

**Standards for all this – including global frameworks**

## Management protocols

- Methods to monitor and configure network equipments
- Do not describe how to achieve management objectives

Simple protocols ⇒ common data and parameters formats allowing easy information transfer

Complex protocols ⇒ add flexibility and security capacity

Advanced protocols ⇒ remotely execute network management tasks, without depending on specific protocol layers



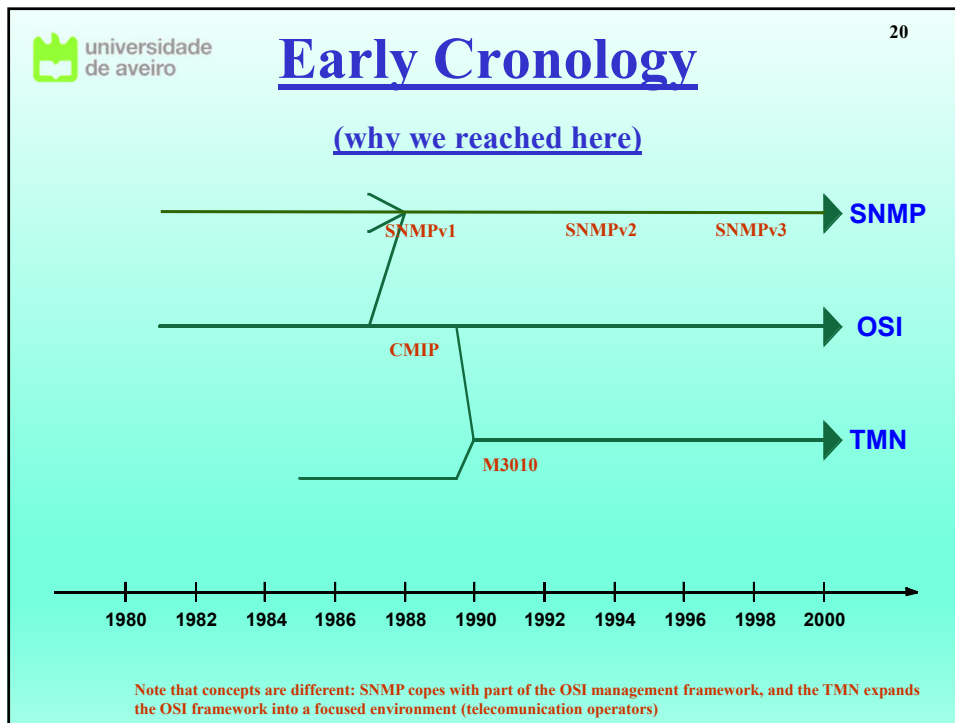
## Tools for network management

- WAN/LAN monitoring and analyzers
- Software monitors
- Security managers
- Documents, presentations and administrative instruments
- Tools for cross-analysis
- Databases, tools for information management
- Console emulator
- Tools for systems modelling
- Toolkits for development

## Network management standardization global models

- Internet Engineering Task Force (IETF)
  - **Simple Network Management Protocol**
    - SNMP, disman
    - *Operations and Management Area*
- International Telecommunications Union (ITU-T)
  - **Telecommunications Management Network**
    - *SG IV*
- International Standard Organization (ISO)
  - **OSI, CMIP-CSIS**
    - *ISO-IEC/JTC 1/WG 4*
- Others
  - **DMTF, TM FORUM, OMG, IEEE, ...**

**Early discussions across bodies. Now cooperation is the normal across bodies.**



universidade de aveiro

## PBM and COPS

**Concept: Policy Based Management**  
**Protocol: Common Open Policy Service**

## Policies - Example

- **Network with multiple services support**
  - **Differentiated QoS**
  - **Additional requirements in AAA functions**
    - Different levels
      - User
      - Service
      - QoS
- **Service authorized**
  - **only to some users**
  - **between authorized network points**
  - **with specific QoS requirements**
  - **between specific time intervals**
- **User also needs to be charged according to the service characteristics being received**

## Management based on Policies

- **Objective**: globally manage the network and not its elements.
- **Mechanism**:
  - **Define policies (rules) to inform the network of what to do – e.g:**
    - Operation center should have access to all routers
    - Charging department has priority in the last 3 months of each year
    - In the maximum, only 10% of each link can transport video.
  - **The policy rules are translated in equipment configuration changes**



universidade  
de aveiro

38

## Elements of systems based on policies

### Conceptual parts:

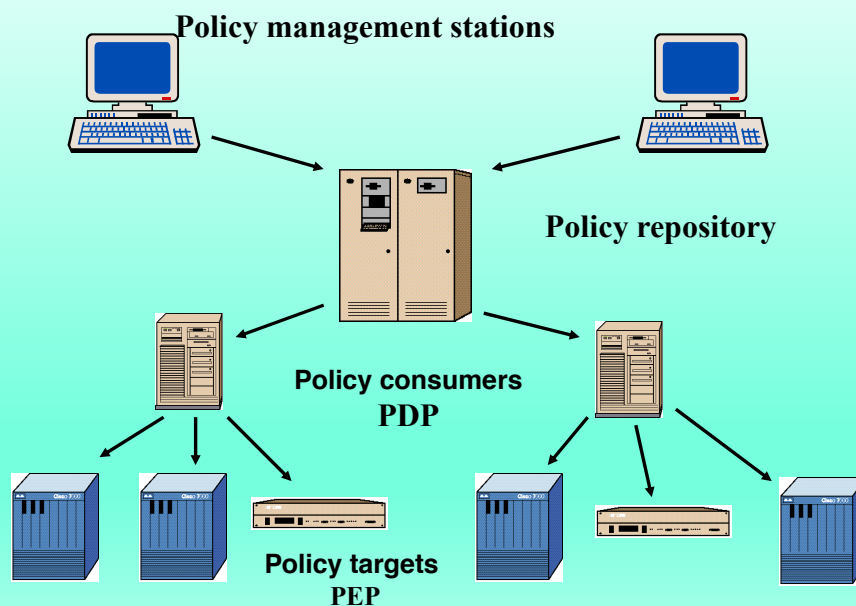
- **Management policy tools:**
  - Used to create the policy rules
- **Policies repository**
  - Store the policy rules
- **Policy consumers – *policy decision points, PDP***
  - Make decisions and transfer the policy rules (eventually translated) to the policy targets.
- **Policy targets, *policy enforcement points, PEP***
  - Functional elements affected by the policy rules.



universidade  
de aveiro

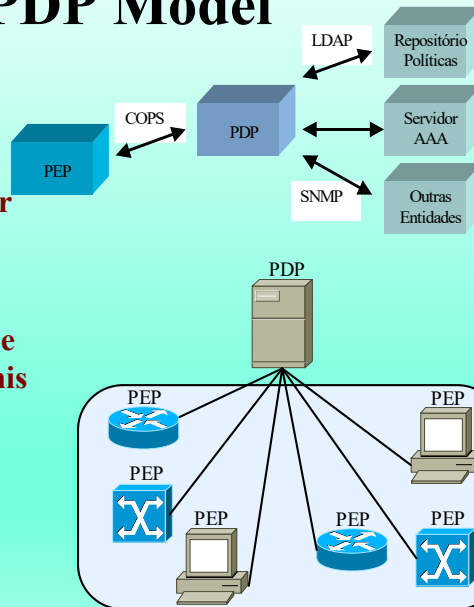
39

## Policy management system - example



## PEP-PDP Model

- **Model uses (may use) different protocols**
    - **Abstraction levels differ**
  - **Increasing trend**
    - **Software defined networking (SDN) can be seen as a variation of this concept**
- (OpenFlow is a protocol for SDN)



## Processing rules - sequence

- **Rules definition**
  - **Verify internal conflicts**
  - **Include in a repository (e.g. with LDAP)**
- **Get policies from policy consumers**
  - **Take decisions based on policies**
  - **Processed to create configurations in policy targets**
  - **May use temporal restrictions**
- **Send policies to policy targets**
  - **Can be “pushed” or “pulled” (e.g. by COPS or SNMP)**
- **Policy targets**
  - **Instal configurations**

universidade  
de aveiro

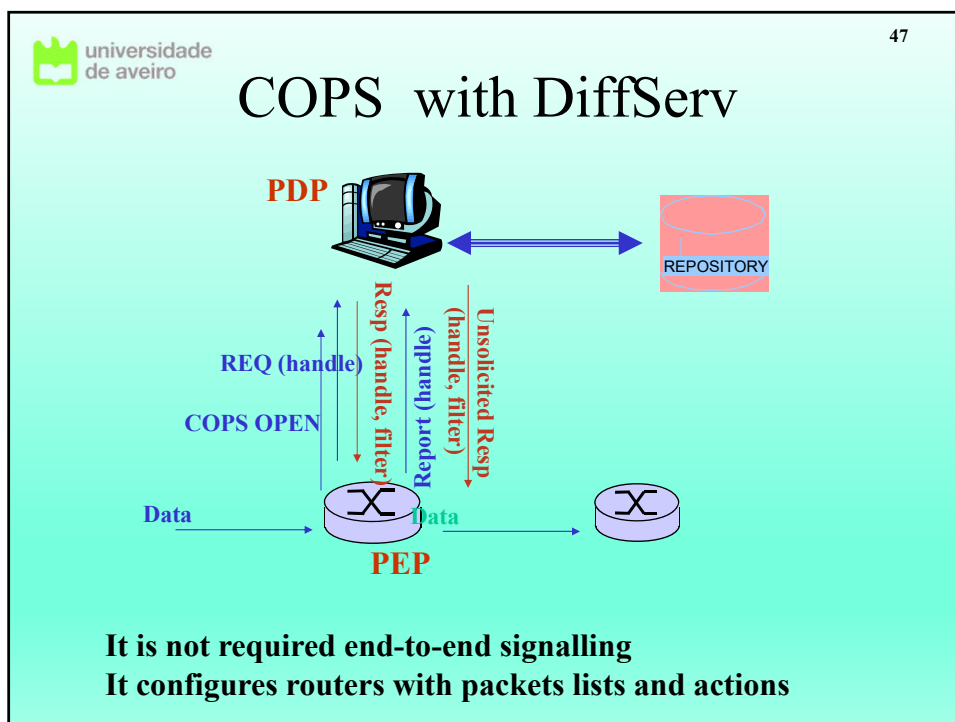
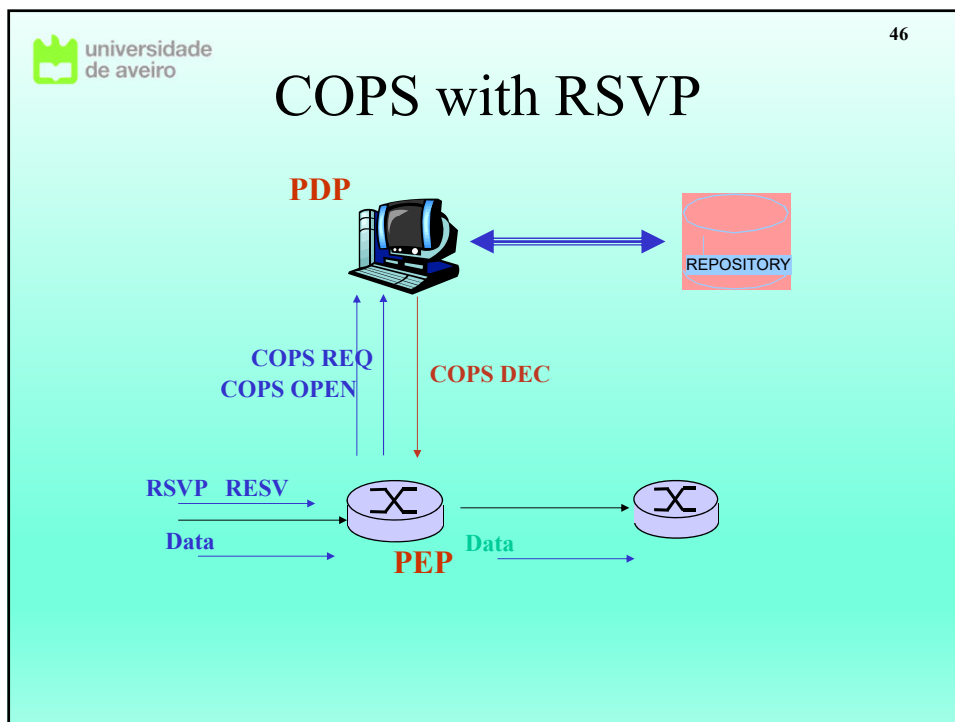
## COPS – Common Open Policy Service <sup>42</sup>

- Question/answer protocol to PDP-PEP interaction
- Based on TCP
- Maintains state synchronization
  - Recovers from fault
  - State maintenance with keep-alive
- PDP can send notifications to PEP
  - Default concept was for QoS support/control
- PDP can receive policies through LDAP and SNMP
- Supports two types of clients
  - RSVP, outsourcing model
  - Diff-serv, configuration model

universidade  
de aveiro

## PDP-PEP Interactions <sup>43</sup>

- Outsourcing (RSVP)
  - PEP contacts PDP when a decision is needed
  - Request contains relevant elements for the policy, and admission control information (e.g. flowspec)
  - Best match for RSVP-based QoS systems
- Configuration requests (Diffserv)
  - PDP configures PEP with specific equipment information
  - Considers a PIB (policy information base) that maintains provisioning information
  - Best match for DiffServ-based QoS systems



## CMIS/CMIP

**Common Management Information  
Services/Protocol**

## Management protocols (LAN-oriented)

49

### OSI CMIP

- Common Management Information Protocol
- Designed in 1980's: *the* unifying protocol (“**advanced**”) to network management
- Implemented very slowly

### SNMP: Simple Network Management Protocol

- Internet based (SGMP)
- Very simple in the beginning
- Rapidly spreaded
- It grew in largeness and complexity
- actual: SNMPv3
- Management protocol *de facto*



## OSI Management architecture

| ITU-T | Acronym   | Title   |
|-------|-----------|---|
| X.701 |           | <i>System Management Overview</i>   |
| X.710 | CMIS      | <i>Common Management Information Service</i>  |
| X.711 | CMIP      | <i>Common Management Information Protocol</i>   |
| X.712 | CMIP-PICS | <i>CMIP Protocol Implementation Conformance State Proforma</i>                                  |
| X.720 | MIM       | <i>Management Information Model (defines fundamental concepts of the objects)</i>               |
| X.721 | DMI       | <i>Definition of Management Information</i>   |
| X.722 | GDMO      | <i>Guideline for Definition of Management Objects (techniques for specification of objects)</i> |

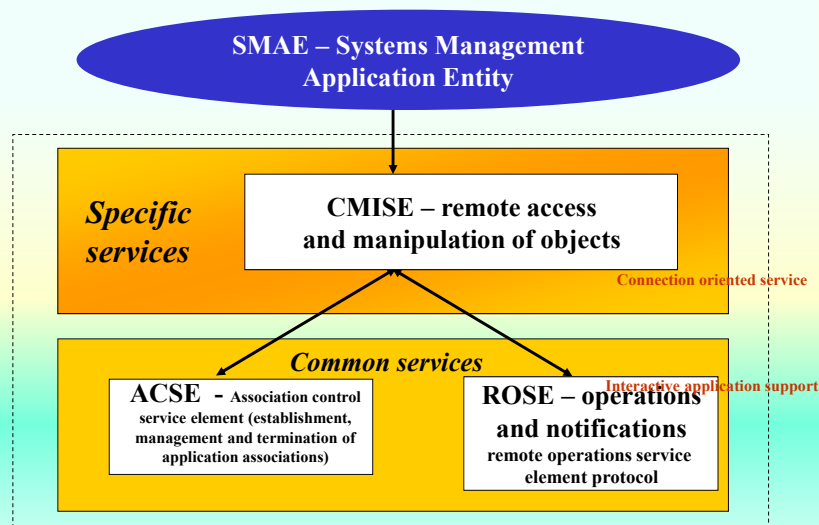
## CMIS/CMIP

- **Approach object-oriented - objects**
  - **Have attributes**
  - **Generate events/notifications (reliably)**
  - **Execute operations**
- **Objects with same attributes, notifications and operations belong to the same class**
- **Objects inserted in multiples hierarchies, with different inherits and containers**
- **Intelligent agents**
  - **Can use rules or policies defined by the manager**
  - **Can be changed on-line**
- **Actions (verbs)**  
**GET, SET, CREATE, DELETE, ACTION, NOTIFICATION, CANCEL\_GET**
- **Capacity of CMIP actions is related to scoping and filtering capacities - through **GDMOs****

## CMIP - GDMOs

- **Guideline for the Definition of Managed Objects**
  - **The equipment through which the agent operates**
- **Model objects inside the equipment**
  - **Instantiation of GDMOs is called MIB**
- **Do not have well-defined behaviors, with large implementation freedom**
  - **Flexibility**
  - **Problem (complexity)**
- **CMIP is not polling oriented**
  - **Better scalability is achieved**
- **There are not so many defined GDMOs as MIBs**

## Common Management Information Service (CMIS)



## CMIP: pros and cons

- **CMIP advantages**
  - Object-oriented approach is flexible and extensible
  - Support from telecommunications industry and international vendors
  - Support of manager-manager interaction
  - Support of automation environments
  - Imposed in some industrial areas
- **CMIP disadvantages**
  - Complex and multi-layer
  - Large management overhead
  - Few management systems based on CMIP
  - Few CMIP agents in use
  - Generally rejected in the Internet.

## Frameworks: SNMP and CMIS

### SNMP

- Static MIBs
- Concepts of limited models
- Non-connection oriented protocol
- Polling model
- Implementation-oriented
- Light
- Limited functionalities
- Bulk capacity only in new versions
- Completely dominating the market
- Many SNMP-based products

### CMIS

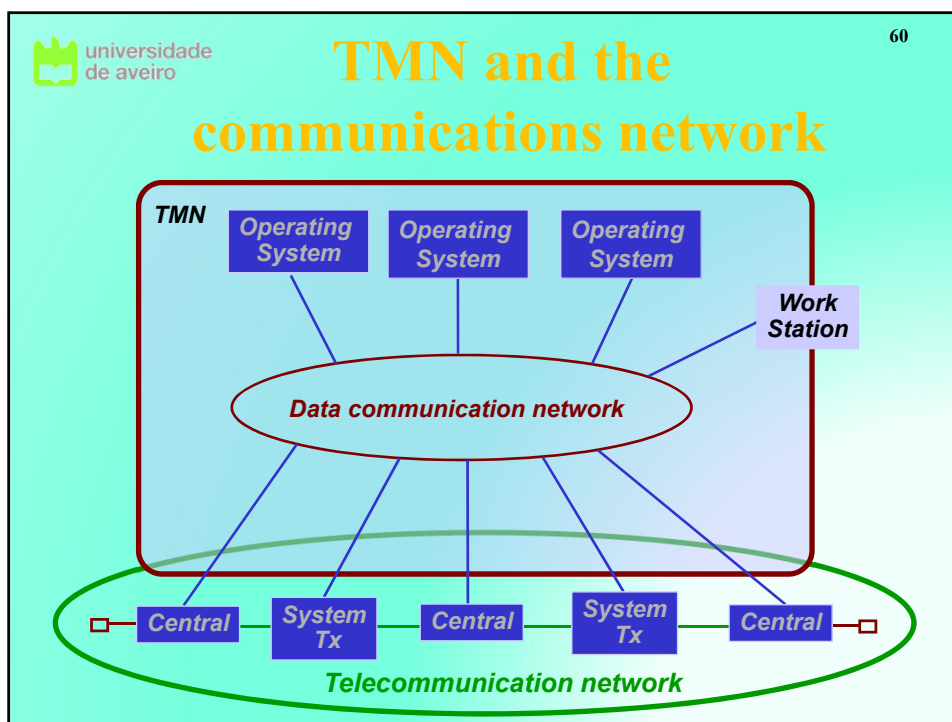
- Dynamic MIBs
- Object-oriented models
- Connection-oriented protocol
- Event-oriented model
- Specification-oriented
- Heavy
- Functionalities until the system management level
- Bulk capacity with scope and filtering
- Some relevance in the telecommunications market
- Some CMIP-based products in the market

# TMN

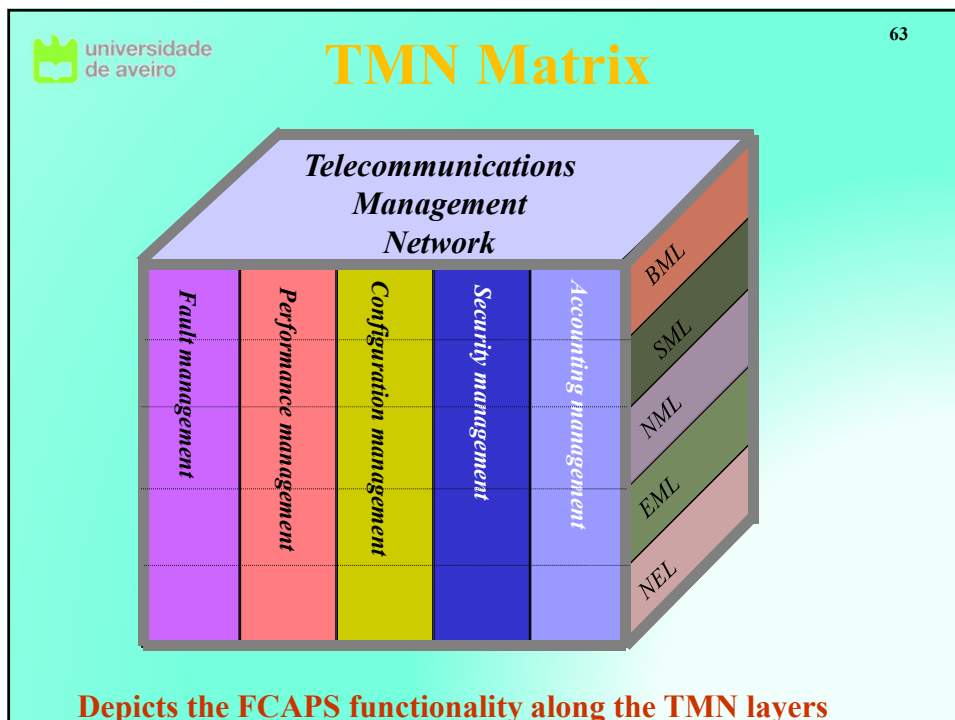
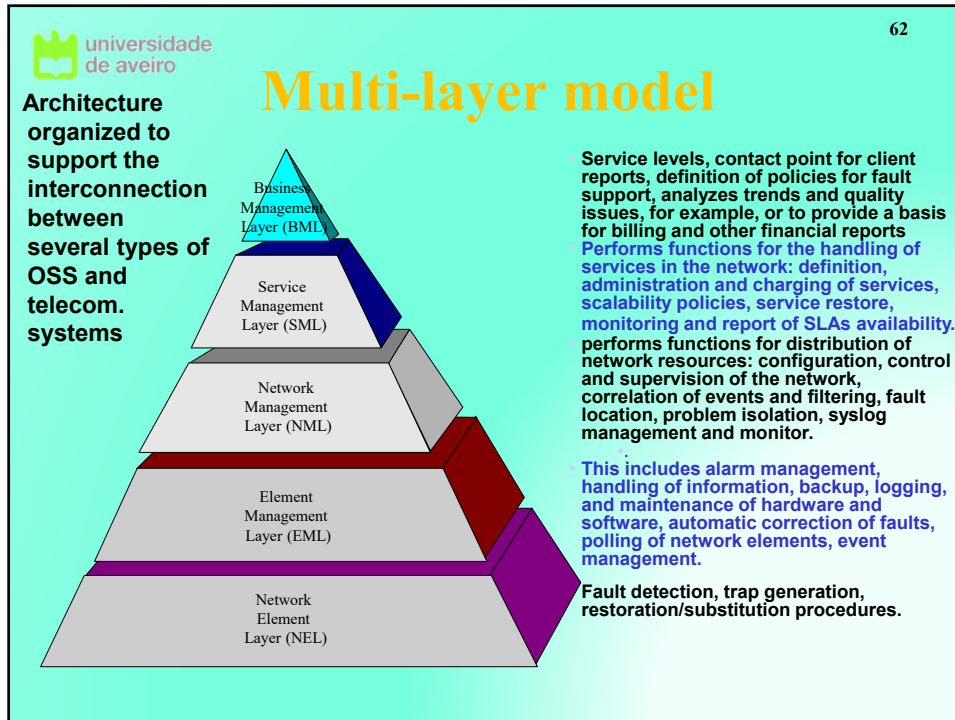
## Telecommunications Management Network

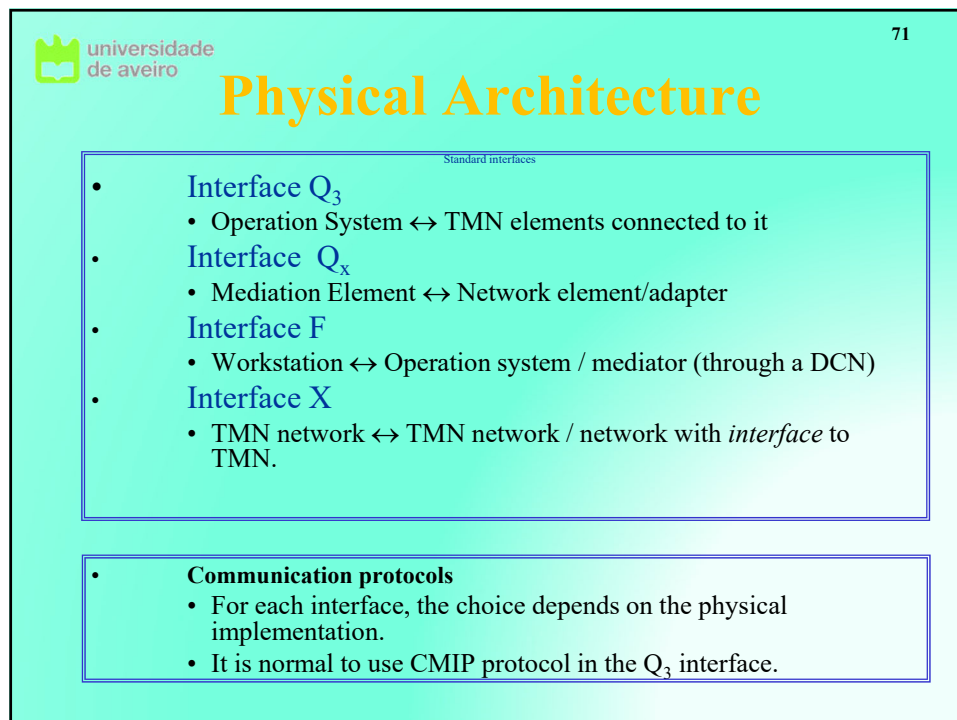
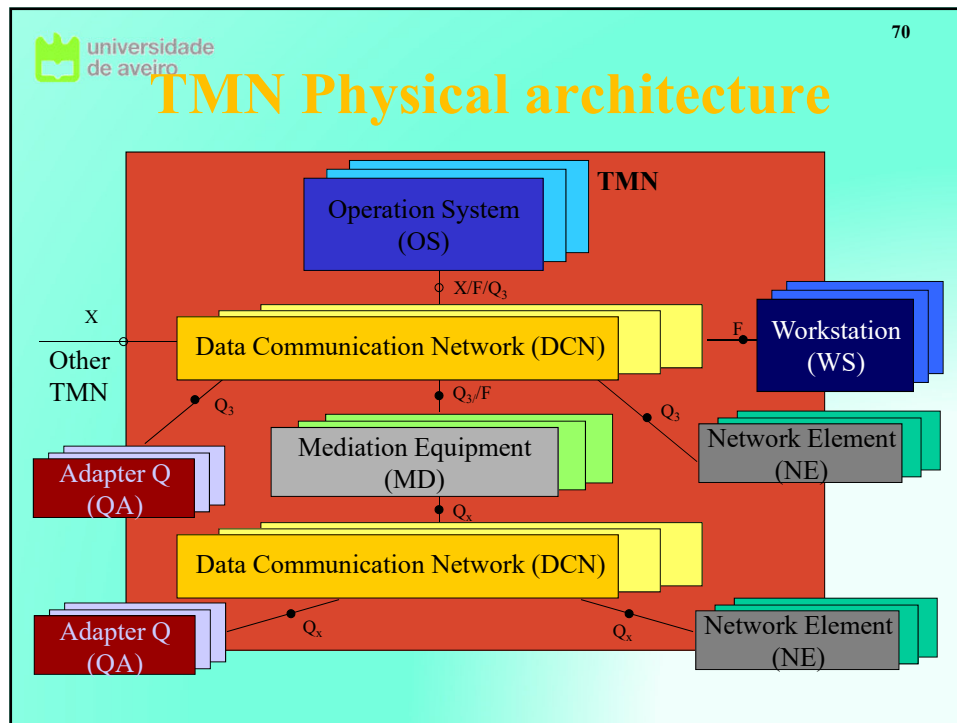
## What is TMN ?

- ***Objective***
  - Support the management of the telecommunication networks and services
- ***Concept***
  - Create an organized structure to allow the interconnection of several operating systems and telecommunications equipments, using a well-defined architecture, with normalized protocols and interfaces



- universidade de aveiro
- 61
- ## TMN
- **TMN is the telecommunications management network.**
    - **Relies on other management protocols and concepts.**
    - **Operations systems are where the main management functionality resides**
      - Now also known as OSS operational support systems
    - **The data communications network is where the management information flows**
    - **The TMN boundary intersects NEs (network elements) as they include some CM functionality.**
    - **Workstations provides user access to management functionality.**
      - The workstation glass interface is outside the bounds of standardisation.







## TMN and OSI

74

- TMN adds-on to OSI management
  - **Information model – new network**
  - **Organization model – extension through the concept of functional block**
  - **Communication model – Correspondence between interface - protocol**
  - **Functional model – new management functions (network)**
- Interworking TMN with other OSI systems
  - **Atenuate differences between protocols**
  - **Services functionalities and complementaring functions**
  - **Increase the OSI management potentialities or restrict the TMN management potentialities**