INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

X.170

(06/99)

SERIES X: DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

Public data networks – Maintenance

Network-network management architecture for data networks

ITU-T Recommendation X.170

(Previously CCITT Recommendation)

ITU-T X-SERIES RECOMMENDATIONS

DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

PUBLIC DATA NETWORKS	
Services and facilities	X.1–X.19
Interfaces	X.20–X.49
Transmission, signalling and switching	X.50–X.89
Network aspects	X.90–X.149
Maintenance	**X.150–X.179**
Administrative arrangements	X.180–X.199
OPEN SYSTEMS INTERCONNECTION	
Model and notation	X.200–X.209
Service definitions	X.210–X.219
Connection-mode protocol specifications	X.220–X.229
Connectionless-mode protocol specifications	X.230–X.239
PICS proformas	X.240–X.259
Protocol Identification	X.260–X.269
Security Protocols	X.270–X.279
Layer Managed Objects	X.280–X.289
Conformance testing	X.290–X.299
INTERWORKING BETWEEN NETWORKS	
General	X.300–X.349
Satellite data transmission systems	X.350–X.399
MESSAGE HANDLING SYSTEMS	X.400–X.499
DIRECTORY	X.500–X.599
OSI NETWORKING AND SYSTEM ASPECTS	
Networking	X.600–X.629
Efficiency	X.630–X.639
Quality of service	X.640–X.649
Naming, Addressing and Registration	X.650–X.679
Abstract Syntax Notation One (ASN.1)	X.680–X.699
OSI MANAGEMENT	
Systems Management framework and architecture	X.700–X.709
Management Communication Service and Protocol	X.710–X.719
Structure of Management Information	X.720–X.729
Management functions and ODMA functions	X.730–X.799
SECURITY	X.800–X.849
OSI APPLICATIONS	
Commitment, Concurrency and Recovery	X.850–X.859
Transaction processing	X.860–X.879
Remote operations	X.880–X.899
OPEN DISTRIBUTED PROCESSING	X.900–X.999

For further details, please refer to ITU-T List of Recommendations.

ITU-T RECOMMENDATION X.170

NETWORK-NETWORK MANAGEMENT ARCHITECTURE FOR DATA NETWORKS

Summary

The rapid evolution of data transmission service has increased internetwork traffic between several types of data networks (e.g. packet switched networks, frame relay networks, ISDN networks and ATM networks), or between public and private data networks. Accordingly, the variety and the volume of management information (e.g. charging or traffic information) of each network have also increased, and there may be a demand to exchange such management information in a uniform way so that all networks can have access to each other by using a unique protocol or mechanism.

In view of these circumstances, this Recommendation describes the general principles and the framework, for exchanging management information and management operations between data networks.

Source

ITU-T Recommendation X.170 was prepared by ITU-T Study Group 7 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 18th of June 1999.

FOREWORD

ITU (International Telecommunication Union) is the United Nations Specialized Agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the ITU. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation the term *recognized operating agency (ROA)* includes any individual, company, corporation or governmental organization that operates a public correspondence service. The terms *Administration*, *ROA* and *public correspondence* are defined in the *Constitution of the ITU (Geneva, 1992)*.

INTELLECTUAL PROPERTY RIGHTS

The ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. The ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, the ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Recommendation X.170

NETWORK-NETWORK MANAGEMENT ARCHITECTURE FOR DATA NETWORKS

(Geneva, 1999)

1 Scope

This Recommendation is one of a set of Recommendations dealing with Network-Network Management Interface for data networks, which include:

– the definition of the architectural framework to exchange management information for the provision of total Customer Network Management (CNM) services by the carrier accommodating its subscribers;

– the description of services between two networks;

– the definition of management information elements, such as the managed object (MO);

– classes, attribute types, action types, notification types;

– compliance requirements placed on other ITU-T Recommendations definitions; and

– conformance requirements.

When a carrier provides CNM services defined in Recommendation X.160, there may be requirements to exchange management information or operations with its adjacent network related to its customers' internetwork communication. This Recommendation resolves such requirements for the provision of total CNM services for its customers. It defines the architectural framework for Network-Network Management to exchange management information necessary for a carrier to provide its customers with CNM services related to internetwork communication with another network.

This Recommendation makes use of the principles of the CNM and the TMN X-interface. Within these overall frameworks, it meets requirements specific to data networks and the provision of CNM services.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

2.1 Identical Recommendations | International Standards

– ITU-T Recommendation X.283 (1997) | ISO/IEC 10733:1998, *Information technology – Elements of management information related to the OSI Network layer.*

– ITU-T Recommendation X.701 (1997) | ISO/IEC 10040:1998, *Information technology – Open Systems Interconnection – System management Overview.*

– ITU-T Recommendation X.703 (1997) | ISO/IEC 13244:1998, *Information technology – Open Distributed Management Architecture.*

– ITU-T Recommendation X.710 (1997) | ISO/IEC 9595:1998, *Information technology – Open Systems Interconnection – Common management information service.*

– ITU-T Recommendation X.711 (1997) | ISO/IEC 9596-1:1998, *Information technology – Open Systems Interconnection – Common management information protocol: Specification.*

– CCITT Recommendation X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management information model.*

– CCITT Recommendation X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information.*

– CCITT Recommendation X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects.*

– ITU-T Recommendation X.723 (1993) | ISO/IEC 10165-5:1994, *Information technology – Open Systems Interconnection – Structure of management information: Generic management information.*

– ITU-T Recommendation X.724 (1996) | ISO/IEC 10165-6:1997, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management.*

– CCITT Recommendation X.730 (1992) | ISO/IEC 10164-1:1993, *Information technology – Open Systems Interconnection – Systems Management: Object Management Function.*

– CCITT Recommendation X.731 (1992) | ISO/IEC 10164-2:1993, *Information technology – Open Systems Interconnection – Systems Management: State Management Function.*

2.2 Paired Recommendations | International Standards equivalent in technical content

– CCITT Recommendation X.700 (1992), *Management Framework for Open Systems Interconnection (OSI) for CCITT applications.*

ISO/IEC 7498-4:1989, *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework.*

2.3 Additional references

– ITU-T Recommendation M.3010 (1996), *Principles for a telecommunications management network.*

– ITU-T Recommendation M.3020 (1995), *TMN interface specification methodology.*

– ITU-T Recommendation M.3100 (1995), *Generic network information model.*

– ITU-T Recommendation M.3320 (1997), *Management requirements framework for the TMN X-interface.*

– ITU-T Recommendation X.160 (1996), *Architecture for customer network management service for public data networks.*

– ITU-T Recommendation X.161 (1997), *Definition of customer network management services for public data networks.*

– ITU-T Recommendation X.162 (1997), *Definition of management information for customer network management service for public data networks to be used with the CNMc interface.*

– ITU-T Recommendation X.163 (1995), *Definition of management information for customer network management service for public data networks to be used with the CNMe interface.*

– ITU-T Recommendation X.790 (1995), *Trouble management function for ITU-T applications.*

– ISO 9735:1988, *Electronic data interchange for administration, commerce and transport (EDIFACT) – Application level syntax rules.*

3 Definitions

For the purposes of this Recommendation, the following definitions apply.

3.1 X.160 definitions

This Recommendation makes use of the following terms defined in Recommendation X.160:

– Customer Network Management (CNM);

– CNM service;

– CNM interface;

– CNM provider;

– CNM Reference Point;

– Customer's Management Function;

– Customer's Management System;

– Service Provider's CNM Function.

3.2 X.701 management framework definitions

This Recommendation makes use of the following terms defined in ITU-T Rec. X.701 | ISO/IEC 10040:

– managed object;

– managed object class;

– agent;

– manager;

– notification.

3.3 X.710 CMIS definitions

This Recommendation makes use of the following terms defined in ITU-T Rec. X.710 | ISO/IEC 9595:

– attribute;

– M_REPORT operation;

– M_GET operation;

– M_SET operation;

– M_ACTION operation;

– M_CREATE operation;

– M_DELETE operation;

– M_CANCEL_GET operation.

3.4 M.3010 definitions

This Recommendation makes use of the following terms defined in Recommendation M.3010:

– OS;

– OS function.

3.5 Network-Network Management (NNM) definitions

This Recommendation defines the following terms:

3.5.1 network-network management (NNM): NNM facilitates the exchange of management information between a network accommodating customers and another network involved in those customer's internetwork communication. Currently, NNM is intended to be used for providing CNM services. That is, the network providing the CNM service collects related management information necessary for the CNM service from another network, and in some cases management action is performed, such as line testing. Internetwork communication may range more than two networks.

3.5.2 NNM interface: This is an interface between the network of the carrier providing its customers with CNM services and another carrier's network involving the customer's internetwork communications.

3.5.3 NNM service user: This means the manager that retrieves CNM related information or uses functions from another network for the purpose of CNM service provision.

3.5.4 NNM service provider: This means the agent within another carrier's network that provides the NNM service user with management information or functions required for CNM activities.

3.5.5 NNM reference point: This is a functional boundary between the NNM service user and the NNM service provider where management information is transferred.

4 Abbreviations

This Recommendation uses the following abbreviations:

CMIP Common Management Information Protocol

CMISE Common Management Information Service Element

CNM Customer Network Management

CNMc CNM interface using CMIP

CNMe CNM interface using EDI/MHS

CORBA Common Object Request Broker Architecture

DCN Data Communication Network

DTE Data Terminal Equipment

EDI Electronic Data Interchange

GDMO Guidelines for the Definition of Managed Objects

HTTP Hyper Text Transfer Protocol

ICS Implementation Conformance Statement

MO Managed Object

NNM Network-Network Management

ODMA Open Distributed Management Architecture

PDU Protocol Data Unit

SNMP Simple Network Management Protocol

SVC Switched Virtual Connection

TINA Telecommunication Information Networking Architecture

5 Conventions

This Recommendation does not use any specific conventions.

6 Model for Network-Network Management

6.1 Relationship between the Architecture, the Services and the Management Information documents

This Recommendation is one of a proposed set of Recommendations, which directly specify the NNM:

– the architecture for NNM (X.170, present Recommendation);

– management services for NNM (X.171, future Recommendation);

– management information elements for NNM (X.172, future Recommendation).

Since this Recommendation is used for the transfer of CNM services and information between networks, Recommendations X.160-X.163 are related.

6.2 Overview of NNM

The NNM provides a carrier operating a data network with management information owned by another carrier relating to its customer's internetwork communication. As shown in Figure 1, the carrier operating Data Network 1 has customers and provides CNM services through the CNM interface. This customer's DTE may set a connection with a DTE subscribing to another carrier (Data Network 2). In this case, Data Network 1 must manage information about internetwork communication of that customer, e.g. traffic information and usage information of Data Network 2.

NNM supports the exchange of management information between networks in such circumstances. NNM specifies the principle of such exchange between the OS functions of two networks based on the TMN X-interface. A bilateral agreement is necessary for two carriers to exchange management information through the NNM interface. To have access to the other carrier's OS function, some authentication steps may be taken to ensure that an agreed level of security is maintained.

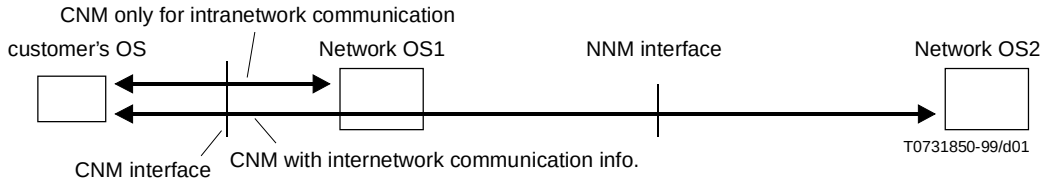


Figure 1/X.170 – Information flow for NNM

6.3 NNM model involving more than two networks

There may be multiple networks involved in the provision of CNM services. From the management viewpoint, the customer's OS and OSs of each network are interacted with each other. The OS of the network accommodating the customer controls all the CNM activities of all the network OSs for providing the customer with CNM services in a uniform way. The following three cases can be considered for the NNM modelling as shown in Figure 2.

a) *one-to-one relationship*

The OS of the CNM provider's network, i.e. Data Network 1 in this example, has relationship with all the related OSs of the networks involved in the customer's internetwork communication. The relationship between Data Networks 1 and i is identical to that between Data Networks 1 and 2 in the simplest model of NNM physical architecture.

b) *cascade relationship*

In this case, the agent and the manager are coupled in each OS. OS i shall provide OS i–1 with management information (MOs) of OS i+1. However, the management associations is only one in the CNM provider's OS (Data Network 1).

c) *distributed client/server relationship*

In this case, the managers and agents are distributed in several OSs. The manager of customer's OS or CNM provider's OS requests management information to one or more agents that are distributed in several OSs. The agent in each OS shall provide management information to customer's or CNM provider's OS.

Which case is implemented is based on the bilateral agreement among the networks involved in the NNM activities.

Each manager-agent relationship described above is subject to the rule of this Recommendation. If some networks exist between the manager and agent but they are used only for management data communication (i.e. the DCN role), they have nothing to do with NNM activities.

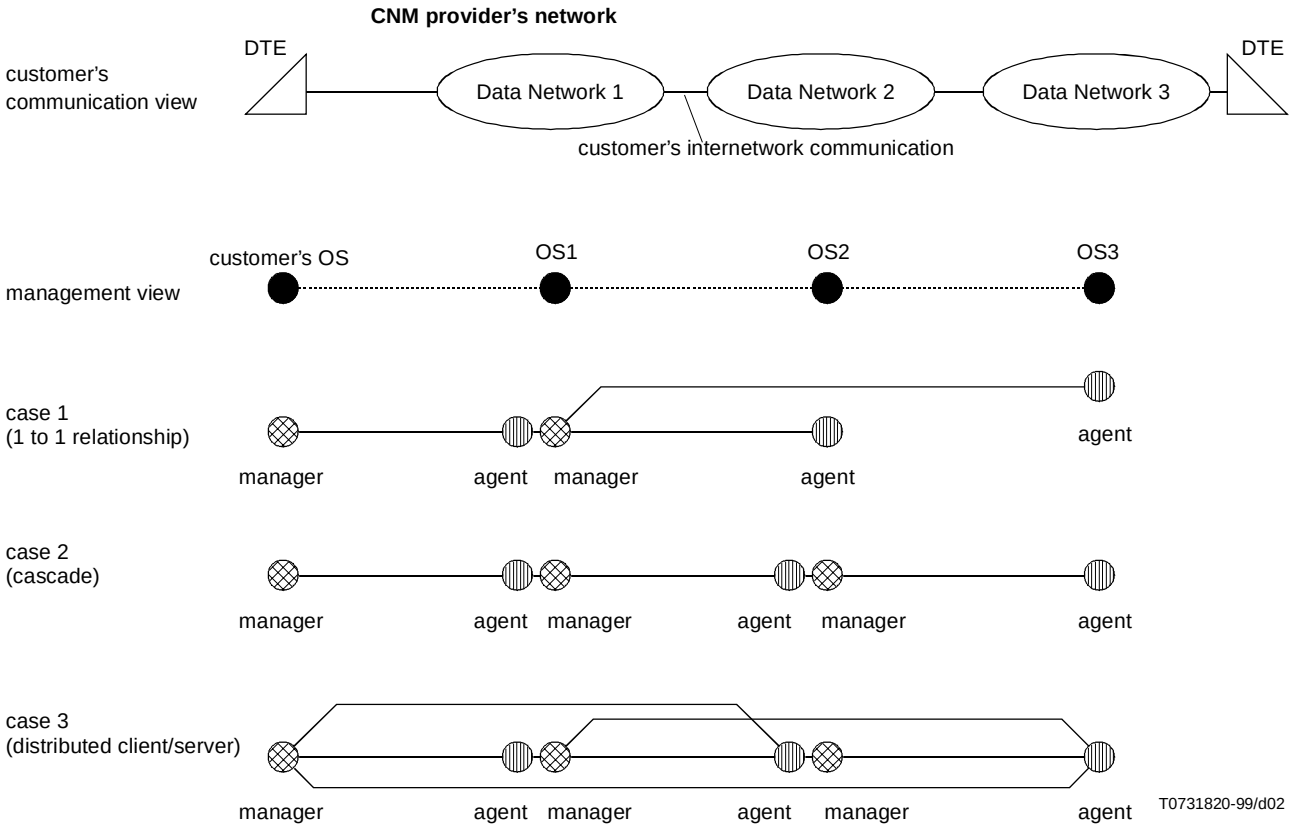


Figure 2/X.170 – Modelling for the case involving multiple networks

7 NNM Architecture

7.1 NNM Physical architecture

A single NNM service user's OS communicates across a NNM interface to one or more NNM service provider's OSs located in the other data network using at least one association for each of the NNM OSs. A single NNM service provider's OS may support simultaneous associations with several NNM service user's OS in the user network.

The NNM physical architecture consists of the following physical elements.

Customer's OS: This function block is a customer's operation system. It has the manager role. It is identical to the customer's management system defined in Recommendation X.160.

CNM interface: See also 3.4/X.160.

The proper protocols for CNM interface uses the SNMP and CMIP protocols recommended in Recommendation X.160 (CNMc), ATM-Forum M3, and HTTP.

NNM interface: See 3.5.2.

CNM provider's network: This means the network of the carrier (Data Network 1) providing its customers with CNM services.

NNM is used for Data Network 1 (CNM provider) to provide its customer with CNM services for the internetwork communication in addition to the normal CNM services defined in Recommendation X.161. As shown in Figure 3, management information necessary for providing CNM services of internetwork communications from Data Network 1 is received and processed through the NNM interface from Data Network 2.

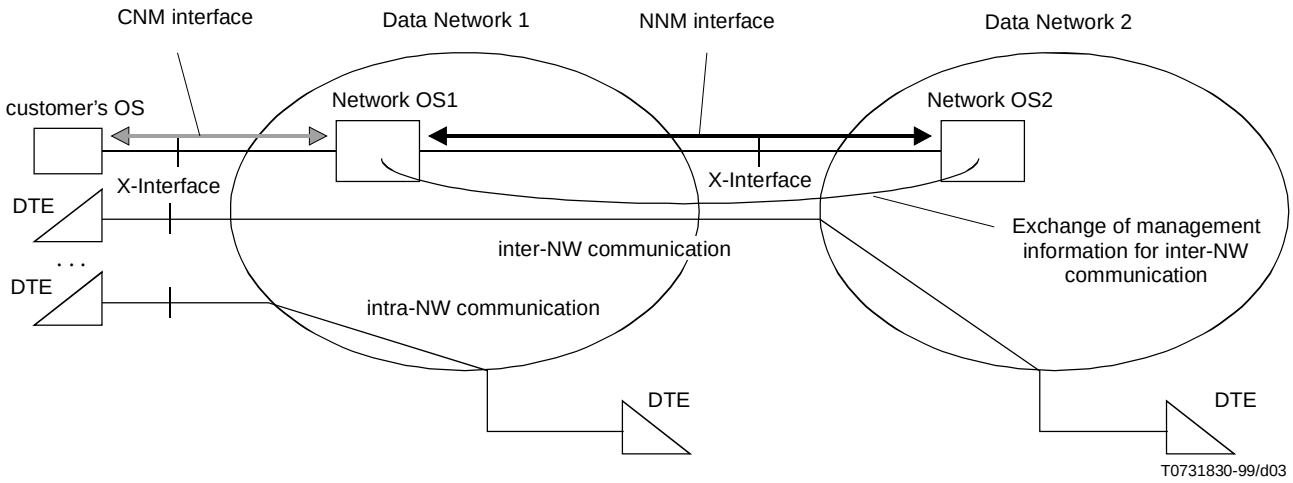


Figure 3/X.170 – Physical architecture of NNM

7.2 NNM Functional architecture

NNM functional architecture is based on several function blocks of the three OS functions of carriers and a customer involved for the provision of CNM services as shown in Figure 4.

Access Management Function: The Access Management Function is the function that processes capabilities related to the access such as user authentication, user interface and the usage for CNM.

CNM agent: This function block provides customers with CNM services in the CNM provider's network. Services related to both intranetwork communications and internetwork communications are provided. It is identical to the service provider's CNM function defined in Recommendation X.160.

CNM Management information: This function block provides necessary management information to be used for the provision of CNM. In particular, it means the management information related to its customer's intranetwork communications.

CNM manager: This function block processes CNM activities with the service provider. It is identical to a customer's management function defined in Recommendation X.160.

CNM reference point: This is a functional boundary between CNM user and the network of the carrier providing its customers with CNM services through the intranetwork communication.

mapped CNM Management information: This function block provides necessary management information for the provision of CNM for its customers. The management information transferred from the other carrier's network is processed by the mapping function, and accumulated in the form of CNM management information.

mapping function: This function block converts management information transferred from the other carrier's network to be used for the provision of CNM services for its customers.

NNM agent: This function block, which is located in the NNM service provider's OS (Data Network 2), provides necessary management information and management functions required by the NNM manager (Data Network 1). It controls the transfer of NNM management information and provides some authentication mechanisms.

NNM Management information: This function block provides necessary management information to be transferred to its NNM manager.

NNM manager: This function block, which is located in the NNM service user's OS, retrieves necessary management information from the other carrier's network and processes it for the provision of CNM for the customers. For transferring management information, and in some cases using management functions, of the other carrier's network, standardized protocols, protocol profiles and procedures are used, such as the OSI systems management. Management information is defined in the X.170-series Recommendations.

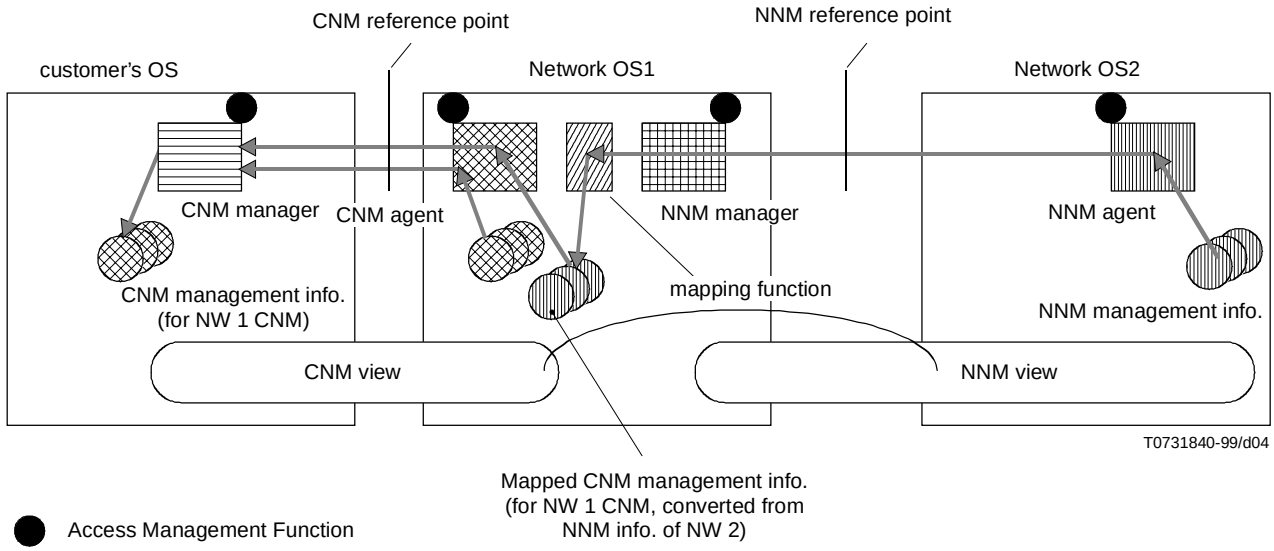


Figure 4/X.170 – Functional architecture of NNM

7.3 NNM Informational architecture

The NNM accesses to management applications are divided into two groups:

1) access between NNM interfaces over the networks; and

2) access by NNM service users.

Two kinds of information can be exchanged between the network and the accesser:

– management information related to a specific interface or a specific link;

– management information which concerns events on the different links and services available to the accesser.

In the latter case, the management information will be exchanged in a centralized way at an NNM reference point supported at the connection between two networks or a network and NNM service user or customer's internetwork communication for one to one relationship model involving more than two networks.

For the NNM model involving more than two networks, NNM information architecture should reflect the following:

– NNM information architecture, in order to guarantee interoperability, is based on standardized open management paradigms that support the standardized modelling of the information to be communicated.

– NNM management information models:

  A management information model presents an abstraction of the management aspects of network resources to be transferred to its NNM manager and the related support management activities.

– NNM interaction model:

  An NNM interaction model should be defined in NNM information architecture to provide the rules and patterns that govern the flow of information between NNM function blocks at the reference point. The proper interaction models include manager/agent, client/server, and invoker/responder, and are associated with a specific management paradigm. This means that the proper distributed-processing principles can be considered and included in the text to allow for distributed processing in an NNM within multiple networks.

– NNM manager/agent:

  An NNM manager is defined to be a management process acting in managing role, while an NNM agent is defined to be a process acting in a managed role. The interaction model relevant to a manager/agent pair is determined by the management paradigm selected.

7.4 NNM services and information definition at the NNM interface

To transfer management information at the NNM interface, management services, i.e. NNM services, are intended to be defined in a future Recommendation of this series, i.e. Recommendation X.171. Also, NNM management information is intended to be defined in future Recommendation X.172.

Service and information definitions may be different from those specified for CNM services. For example, the billing control service defined in Recommendations X.161 and X.162 allows the customer to start and stop the periodical report of usage information. In NNM, this capability is unnecessary, but only the usage meter logs transfer capability is required. Only necessary capabilities are defined as NNM services and NNM information elements.

7.5 NNM interaction model

7.5.1 Overview

Management information necessary for providing CNM services may be used when the customer requires it. According to this condition, management information is exchanged at the NNM interface in several manners.

7.5.1.1 Event occurrence basis

When an event related to the customer's internetwork communication occurs, the OS detecting it may immediately notify the CNM provider's OS of the occurrence of an abnormality, or charging information at the end of a call.

7.5.1.2 On demand basis

The CNM provider's OS starts the action of management information retrieval to the other networks when a request is received from its customer. The OS has access to an MO related to the request through a CMIP operation. This type of interaction is especially used for the retrieval of real-time information or the latest data value related to the internetwork communication.

7.5.1.3 Periodic basis

Management information is periodically transferred from related network OS to the CNM provider's OS. How to transfer the information depends on the service and information type. Periodic invocation of GET operation from the CNM provider's OS and periodic notification from the other network (NNM service provider's network) may be supported by the OSs involved in the NNM activities. This may cause the delay of data transfer/retrieval by the periodic interval from the event occurrence.

Which types of data transfer method is used depends on the service and information type. Multiple types of data transfer methods may be supported at an NNM interface.

NOTE – Data transfer technologies other than CMIP, e.g. CORBA, SNMP, etc., may be used for the interaction of NNM information.

7.5.2 Interaction of NNM information

7.5.2.1 A notification from the NNM Agent to the NNM Manager

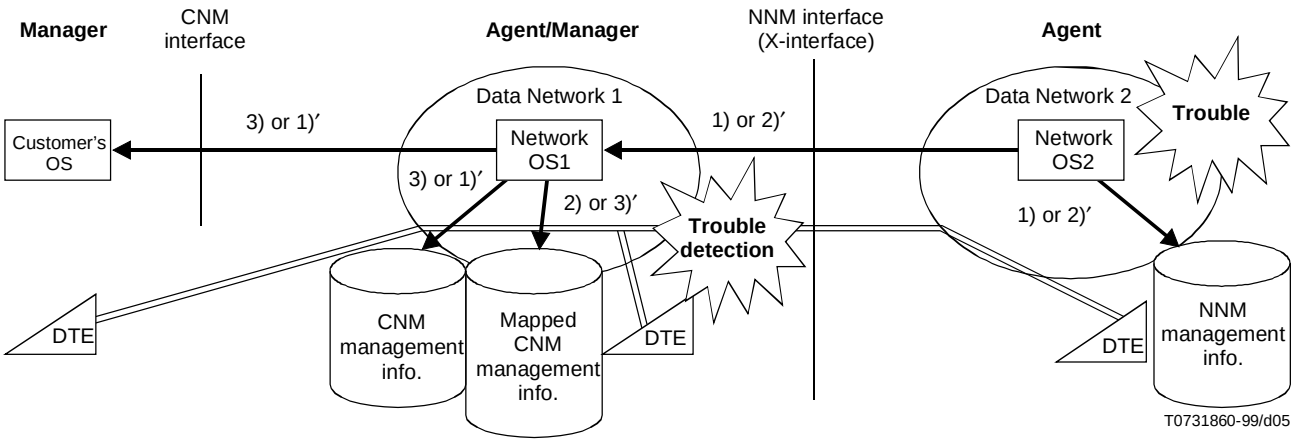
Figure 5 shows the interaction of notifications between the NNM manager and agent when a trouble occurs in Data Network 2.

If the trouble is first detected by Network 2, the following steps are taken for the interaction between two Network OSs.

1) An Alarm is sent from Network OS2 to Network OS1 and also the alarm information is stored in Network OS2.

2) This information is once stored in the mapped CNM management information base of Network OS1. This information is stored for a limited period of time.

3) Then, Network OS1 converts this information into CNM information and sends a CNM Alarm to the CNM customer's OS.



NOTE – 1) ... 3)′: step numbers (refer to 7.5.2.1).

Figure 5/X.170 – Interaction of notifications between the NNM manager and agent

If the trouble is first detected by Network 1 by the internetwork connection call processing, the following steps are taken.

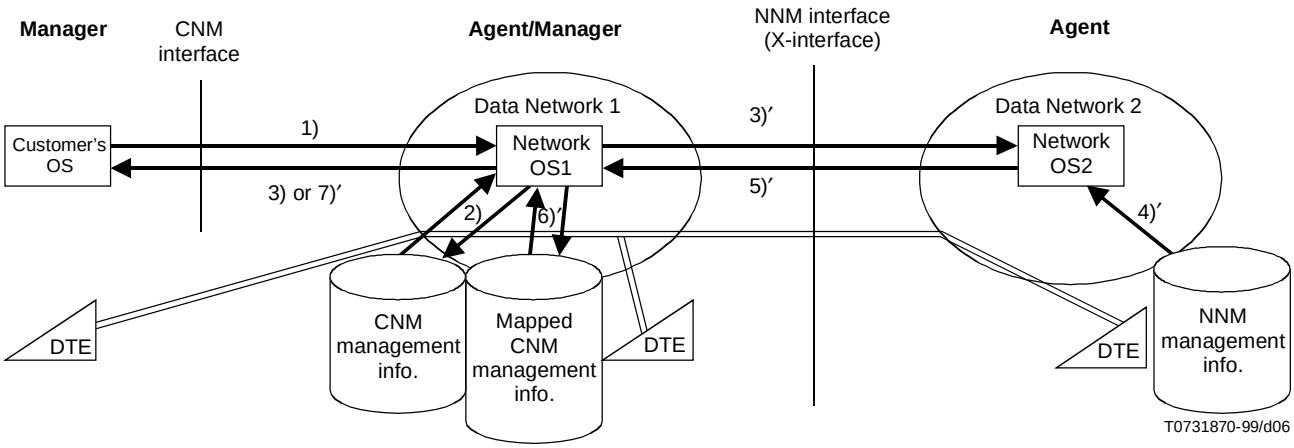
1)′ An Alarm is sent from Network OS1 to the CNM customer's OS and the information about the Alarm is stored in Network OS1 (the CNM management information base).

2)′ An Alarm is sent from Network OS2 to Network OS1 after the processing of 1)′.

3)′ The Alarm information is temporarily stored in the mapped CNM management information base, and because the alarm information has already existed in Data Network 1, Network OS1 will not send it to the customer.

7.5.2.2 Access from the NNM Manager to the NNM Agent

Figure 6 shows the interaction of requests/responses between the NNM manager when a customer requests some activity related to an internetwork communication.



NOTE – 1) ... 7)′: step numbers (refer to 7.5.2.2).

Figure 6/X.170 – Interaction of requests/responses between the NNM manager and agent

1) A CNM customer's OS requests a CNM Service.

2) On receipt of this request, if there exists its related information in Data Network 1, Network OS1 retrieves necessary data from the element that contains the information, modifies the current value of the necessary data, or performs some action, in accordance with the request.

3) Network OS1 sends a response to the CNM customer's OS as a CNM Service.

3)′ If there is no information in Data Network 1, Network OS1 sends an NNM service request (converted from the CNM request) through the NNM interface to Network OS2.

4)′ On receipt of this NNM service request, Network OS2 processes it by retrieving or modifying necessary information, and performing some action.

5)′ Network OS2 sends a response to Network OS1(in the mapped CNM management information base).

6)′ Network OS1 converts NNM information into CNM information and stores this information (in the CNM management information base).

7)′ Network OS1 sends a response to a CNM customer's OS as a CNM service.

7.5.2.3 Interaction including periodic actions

When notifications are periodically emitted by Network OS2, the same interaction as described in 1) – 3) of 7.5.2.1 applies.

When requests are periodically emitted by a customer's OS, the same interaction as described in 1) – 7)′ of 7.5.2.2 applies.

7.6 NNM interface conditions

This Recommendation does not itself define the protocol suite to be used for the exchange of information at the NNM interface. It uses the manager and agent concept for the description of management interaction, where the manager is the user of management information and the agent is the provider of management information. However, since this concept is defined in CMISE but is very general, it shall be used when other protocols or procedures are used.

Currently, only CMISE-based procedure is defined. Other types of interfaces, e.g. EDI-based procedure, may be defined in the future as a new Recommendation, including protocol stacks.

The main part of this Recommendation does not describe protocol dependent procedures to transfer management information at the NNM interface. In Appendix I, procedural descriptions using the basic protocol as the underlying transfer capability are described.

7.7 Authentication Control for the Service

The NNM service provider may authenticate the identity of the requesting network for the purpose of security. Access of the manager to the management information/functions is allowed when conditions of authentication and qualification defined by the NNM service provider (agent) are satisfied. If access is not permitted, the agent provider may notify the manager that the access has been refused. Details of security mechanisms are for further study.

7.8 Relationship to other Recommendations

The NNM is based on the TMN framework and the X-interface concept defined in Recommendations M.3010 and M.3320. Also, it is closely related to the CNM framework, services, and management information definitions, defined in the X.160-series Recommendations. CMISE-based operations and management information definitions are based on or imported from the X.700-series Recommendations. Management information related to layers 1, 2, and 3 is imported from the X.280-series Recommendations. If EDI-based procedure is incorporated, ISO 9735 will be referenced.

7.9 Distributed Processing Environment

For the interaction of NNM information, CORBA, TINA, ODMA and other standardized technologies may be used.

Appendix I

NNM procedural description based on CMISE

I.1 Procedure

Each instance of management communications is modelled using the OSI Systems Management model specified in Recommendation X.701. It models the mechanism by which managed-object notifications and operations are communicated between open systems.

Management information is transferred between the manager in the NNM service user's system and the agent in the NNM service provider's system through the NNM interface.

First, the NNM manager sets up an association with the NNM agent that provides NNM services. The association may be permanently set based on the agreement of both networks, or, when required on a demand basis. The application context to be used and the functional unit negotiation rules are to be specified in another Recommendation.

When the on-demand basis data transfer method is used for performing a specific CNM service (to be defined in future Recommendation X.171), from the CNM provider, the manager sends a CMIP PDU in accordance with the service. The corresponding management operation type of the CMIP (i.e. M_GET, M_SET, M_ACTION, M_CREATE, M_DELETE, M_CANCEL_GET) is determined by the managed information definition specified in future Recommendation X.172. Having received the CMIP PDU, the agent interprets what kind of requirement it has received and performs a management operation such as retrieval of charging information or a line test. The manager, i.e. the CNM provider, obtains the result and processes it in accordance with the service type the customer requested. This processed information is returned to the customer's OS in the form of a CMIP PDU result.

The periodic basis data transfer method may also be used. The manager, i.e. the CNM provider, invokes a CMIP operation (i.e. M_GET, M_SET, M_ACTION, M_CREATE, M_DELETE, M_CANCEL_GET) in a predetermined interval. The cycle is determined so that CNM service can be appropriately provided to the customer, and to be defined in future Recommendations X.171 and X.172. In some services, the agent may send periodically management information by M_EVENT_REPORT to the manager (the CNM provider). When the CNM provider receives a request from the customer, it provides the customer with the latest management information it can provide at that moment. Some delay may occur.

When the event occurrence basis data transfer method is implemented, the agent sends M_EVENT_REPORT including event occurrence information. The manager, after having received this notification, converts the format as specified in the CNM service definition, and sends it to the customer's OS in the format of an M_EVENT_REPORT.

I.2 Connectivities between NNM service user and service provider systems by CMIP

A single NNM service user's OS communicates across a NNM interface to one or more NNM service provider's OSs located in the other data network using at least one association for each of the NNM OSs.

A single NNM service provider's OS may support simultaneous associations with several NNM service user's OS in the user network.

Appendix II

NNM Service Requirements

II.1 Overview

The service corresponding to each CNM service shall be defined at the NNM interface. However, service description and data type are not identical to those defined in Recommendations X.161 and X.162.

II.2 Service list

The following CNM services are defined in Recommendation X.161.

a) Fault Management:
   - CNM Alarm Notification Service.
   - CNM Fault History Service.
   - CNM Trouble Report Service.

b) CNM Loop set up Service:
   - CNM Test host Service.
   - CNM Protocol Monitoring Service.

c) Configuration Management:
   - CNM Configuration Inquiry Service.
   - CNM Reconfiguration Service.
   - CNM Ordering Service, CNM Service Request service.
   - CNM Systematic Call Redirection Service.

d) CNM Inventory inquiry service.

e) Accounting Management:
   - CNM Periodic billing Service.
   - CNM Detailed accounting service.
   - CNM Quota Control Service.
   - CNM Real-time Charging Information Service.

f) Performance Management:
   - CNM Traffic Information Service.
   - CNM Quality of Service Information Service.
   - CNM Network statistics service.

g) Security Management.

h) CNM Password Change Service:
   - CNM Access Rights Definition Service.

Some of the following services may be provided as NNM services.

a) Fault Management:
   - Alarm Notification Service.
   - Fault History Service.
   - Trouble Report Service.
   - Loop set up Service.
   - Test host Service.

b) Protocol Monitoring Service.

c) Configuration Management:

- Configuration Inquiry Service.
- Reconfiguration Service.
- Ordering Service, CNM Service Request service.
- The Systematic Call Redirection Service (for internetwork call redirection).
- Inventory inquiry service.

d) Accounting Management:

- Periodic billing Service.
- Detailed accounting service.
- Quota Control Service.
- Real-time Charging Information Service.

e) Performance Management:

- Traffic Information Service.
- Quality of Service Information Service.
- Network statistics service.

f) Security Management.

NOTE – The Password Change Service and the Access Rights Definition Service corresponding to the CNM services will not be provided because they are related only to the CNM interface. This service is not ranged up to the NNM interface. However, other security related services may be required.

II.3 Requirements for each NNM service

For each service listed in II.2, the following requirements shall be considered. Note that in the following context the CNM service provider (CNM agent) is identical to the NNM service user (NNM manager).

a) *Fault Management*

- Alarm Notification Service:

  Alarms related to the customer's intercommunication may be notified to the CNM service provider from the NNM agent in anther network involved in it. The event occurrence basis data transfer shall be applied.

- Fault History Service:

  Fault history logs related to the customer's intercommunication may be accumulated in the NNM agent and may be accessed from the CNM service provider. This service may be provided if the network of the NNM agent has registration information or service ordering data for internetwork communication. In that case, the service is provided on demand basis.

- Trouble Report Service:

  Trouble Report may be exchanged to resolve the customer's abnormality in its internetwork communication. The management information is transferred on demand basis.

- Loop set up Service:

  At both ends of the internode trunks and the remote DTE subscriber line, a loopback point may be set. This operation is performed on demand basis.

- Test host Service:

  The internode trunks and the remote DTE subscriber line may be tested by loop setting. Also, internetwork communication's normality may be checked by protocol integrity testing. This operation is performed on demand basis.

- Protocol Monitoring Service:

  At the internode trunks and the remote DTE subscriber line, protocol sequences may be monitored. This operation is performed on demand basis.

b) *Configuration Management*

– Configuration Inquiry Service:

Configuration information about at least the internode trunks and the remote DTE subscriber line shall be retrieved by the CNM service provider. The management information is transferred on demand basis.

– Reconfiguration Service:

The administrative state of the internode trunks and the remote DTE subscriber line may be controlled by the CNM service provider. This operation is performed on demand basis.

– Ordering Service, CNM Service Request service:

Some of service profile items may be modified by the CNM service provider. This operation is performed on demand basis.

– Inventory inquiry service:

Some of the inventory items may be retrieved by the CNM service provider. The management information is transferred on demand basis.

c) *Accounting Management*

– Periodic billing Service:

Billing information related to the internetwork communication may be transferred periodically. The condition of data transfer may be changed by the CNM service provider. The management information is transferred either on demand basis or periodic basis.

– Detailed accounting service:

Usage information related to the internetwork communication may be retrieved on demand basis by the CNM service provider.

– Quota Control Service:

This service may be used to share the bill related to internetwork communication between multiple networks. How to transfer the management information is for further study.

– Real-time Charging Information Service:

The charging information related to the internetwork communication may be notified immediately just after the release of a SVC. This management information is transferred on event occurrence basis.

d) *Performance Management*

– Traffic Information Service:

Some of traffic information items may be retrieved by the CNM service provider. The management information is transferred either on demand basis or periodic basis.

– Quality of Service Information Service:

Some of traffic information items may be retrieved by the CNM service provider. The management information is transferred either on demand basis or periodic basis.

– Network Statistics service.

– Some processed traffic information items may be retrieved by the CNM service provider. The management information is transferred either on demand basis or periodic basis.

e) *Security Management*

NNM security related services are for further study.

Appendix III

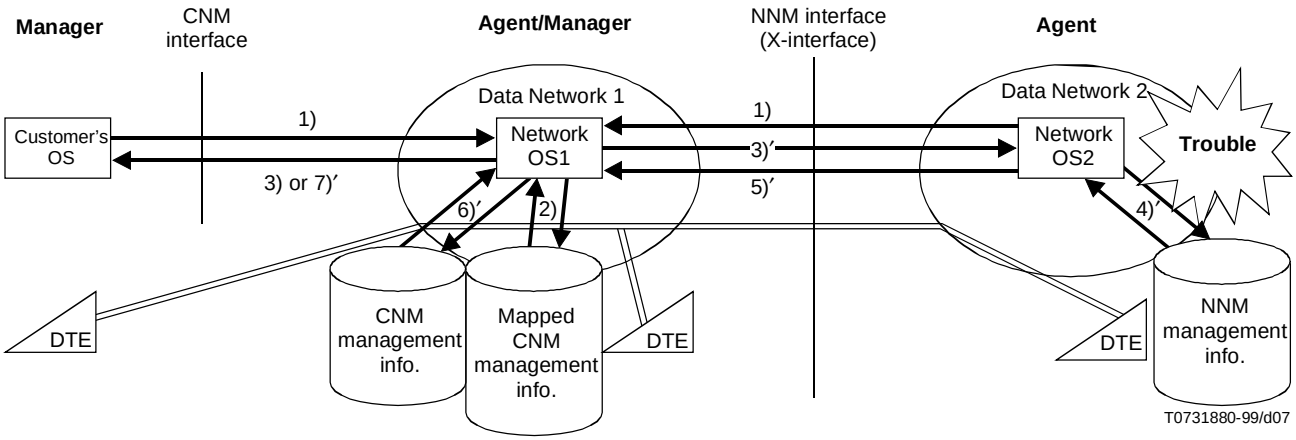
NNM Interaction Model

III.1 Overview

This appendix gives a more complicated example of the interaction framework between the NNM manager and agent described in 7.5. A combination of 7.5.2.1 and 7.5.2.2 is described.

III.2 Combined interaction

Figure III.1 shows the interaction of notifications and requests/responses between the NNM manager.



NOTE – 1) ... 7)′: step numbers (refer to III.2).

Figure III.1/X.170 – Interaction of notifications and requests/responses between the NNM manager and agent

1) An Alarm is sent from Network OS2 to Network OS1 and also the alarm information is stored in Network OS2. At the same time, a CNM customer's OS requests a CNM Service.

2) This alarm is stored by Network OS1 (temporarily in the mapped CNM management information base, or for a longer period in the CNM management base). If the information concerning the request exists in Data Network 1, Network OS1 retrieves necessary data from the element that contains the information, modifies the current value of the necessary data, or performs some action, in accordance with the request.

3) Network OS1 sends a response to the CNM customer's OS as a CNM Service.

3)′ If there is no information in Data Network 1 at the time of the receipt of the request, Network OS1 sends a NNM service request to Network OS2. This request is sent through NNM interface in a converted format (from CNM format to NNM format).

4)′ Network OS2 processes the request from Network OS1.

5)′ Network OS2 sends a response to Network OS1.

6)′ Network OS1 converts NNM information into CNM information and stores the information in the CNM format.

7)′ Network OS1 sends a response to a CNM customer's OS as a CNM Service.

NOTE – This case explains the processing performed when a trouble is first detected by Network 2. However, even if the trouble is first detected by Network 1 through the internetwork call processing, the basic sequence of Case 3 remains the same. Only, Network 1 ignores the NNM notification.

ITU-T RECOMMENDATIONS SERIES

Series A	Organization of the work of the ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	**Data networks and open system communications**
Series Y	Global information infrastructure
Series Z	Languages and general software aspects for telecommunication systems