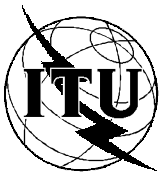

INTERNATIONAL TELECOMMUNICATION UNION

CCITT X.700

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

(09/92)

DATA COMMUNICATION NETWORKS

MANAGEMENT FRAMEWORK FOR OPEN SYSTEMS INTERCONNECTION (OSI) FOR CCITT APPLICATIONS

Recommendation X.700

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT 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 Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation X.700 was prepared by Study Group VII and was approved under the Resolution No. 2 procedure on the 10th of September 1992.

CCITT NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized private operating agency.

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CONTENTS

Page

1 Scope 1

2 References 1

3 Definitions 1

4 Symbols and abbreviations 2

5 Concepts in OSI management 2

6 Model of OSI management 5

7 OSI management specifics 7

Annex A – Comments relating to the OSI management framework 9

INTRODUCTION

The basic reference model of Open Systems Interconnection (OSI), Recommendation X.200 [1], provides a description of the activities necessary for systems to interwork using communication media. This Recommendation provides a description of the framework and structure of OSI management in a way that supplements and clarifies the description of management contained in Recommendation X.200 [1].

The purpose of this Recommendation is to provide a common basis for the coordinated development of management standards.

It is also the purpose of this Recommendation to identify areas for developing or improving standards, and to provide a common reference for maintaining consistency of all related standards. It is not the intent of this Recommendation either to serve as an implementation specification, or to be a basis for appraising the conformance of actual implementations, or to provide a sufficient level of detail to define precisely the services and protocols of the management architecture. Rather, this Recommendation provides a conceptual and functional framework which allows independent teams of experts to work productively on the development of management standards.

This Recommendation provides an extension to Recommendation X.200 [1] and therefore assumes as a basis the concepts and terminology included therein. The objective of this document is to describe a framework for those management activities pertinent to OSI, and to identify the management services which are supported by OSI management protocols.

The description of the management framework given in this Recommendation is developed in stages:

- Clause 1 defines the scope of this Recommendation.
- Clause 2 lists related OSI standards.
- Clause 3 defines terms used in this Recommendation.
- Clause 4 defines abbreviations used in this Recommendation.
- Clause 5 provides the description of general concepts relating to management.
- Clause 6 defines a model for OSI management.
- Clause 7 introduces the areas of OSI management standardization, specifies how each of the component parts of OSI management operate and defines the form of management information exchanges.

Management is manifest in a number of ways. Management is related to activities which control or monitor the use of resources. Within open systems the resources can be those which provide data storage or processing capabilities, or they can be those which provide interconnection capabilities. It is only the latter and the communications concerning their management which fall within the scope of OSI management standardization.

Human beings are ultimately responsible for managing the OSI environment, although responsibilities may be delegated to automated processes.

Recommendation X.700

MANAGEMENT FRAMEWORK FOR OPEN SYSTEMS INTERCONNECTION (OSI) FOR CCITT APPLICATIONS[1)]

(1992)

1 Scope

This Recommendation establishes a framework for coordinating the development of existing and future standards for OSI management, and is provided for reference by those Recommendations.

This Recommendation

- defines terminology of and describes concepts for OSI management;
- provides a structure for OSI management together with an overview of the objectives of, and facilities provided by, OSI management; and
- describes OSI management activities.

This Recommendation does not specify services or protocols for OSI management. It is neither an implementation specification for systems, nor a basis for appraising the conformance of implementations.

2 References

[1] CCITT Recommendation X.200 (1988), *Reference model for Open Systems Interconnection for CCITT applications.*

[2] CCITT Recommendation X.800 (1991), *Security architecture for Open Systems Interconnection for CCITT applications.*

3 Definitions

3.1 This Recommendation makes use of the OSI terminology defined in Recommendation X.200 [1] specifically:

a) (N)-entity;

b) (N)-layer;

c) (N)-protocol;

d) (N)-protocol-data-unit;

e) open system;

f) systems management.

3.2 Terms defined in Recommendation X.200 [1] which are redefined for the purposes of this Recommendation:

3.2.1 **systems management application-entity**

An application-entity for the purpose of systems management communication.

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1) Recommendation X.700 and ISO/IEC 7498-4: Information technology – Open Systems Interconnection – Management framework were developed in close collaboration and are technically identical.

3.3 Additional definitions

3.3.1 **OSI management**

The facilities to control, coordinate and monitor the resources which allow communications to take place in the OSI environment;

3.3.2 **(N)-layer operation**

The monitoring and control of a single instance of communication;

3.3.3 **managed object**

The OSI management view of a resource that may be managed through the use of OSI management protocol(s);

3.3.4 **management information base**

The conceptual repository of management information within an open system.

4 Abbreviations

MIB	Management information base
OSI	Open systems interconnection
OSIE	OSI environment
PDU	Protocol-data-unit
QOS	Quality of service
SMAE	Systems management application-entity

5 Concepts in OSI management

5.1 *Users' requirements of OSI management*

Recognizing the need for interconnection services which will carry information in a reliable and economic manner, OSI management supports the users' needs for

a) activities which enable managers to plan, organize, supervise, control and account for the use of interconnection services;

b) the ability to respond to changing requirements;

c) facilities to ensure predictable communications behaviour; and

d) facilities which provide for information protection and for the authentication of sources of, and destinations for, transmitted data.

The management tools which provide this support may vary in complexity depending upon the users' requirements. Such tools may operate locally or cooperate across a number of open systems. OSI management does not constrain the user interface.

5.2 *The OSI management environment*

The OSI management environment is that subset of the total OSI environment (OSIE), which is concerned with the tools and services needed to monitor, control and coordinate interconnection activities. The OSI management environment includes both the capability for managers to gather information and to exercise control, and the capability to maintain an awareness of, and report on, the status of resources in the OSIE.

The individual open systems within the OSIE may have aspects of management responsibility delegated to them. The responsibility may be manifest in terms of

a) autonomous management of the open system; and

b) cooperation with other open systems, through the exchange of information, to perform coordinated management activities.

This management responsibility is directed at individual resources, each of which may operate with a degree of independence from other resources. This management responsibility may be further extended to coordinate and control sets of resources to increase functionality and performance.

5.3 *Managed objects, their attributes and operations*

A managed object is the OSI management view of a resource that is subject to management, such as a layer entity, a connection or an item of physical communications equipment. Thus, a managed object is the abstracted view of such a resource that represents its properties as seen by (and for the purposes of) management.

A managed object is defined in terms of attributes it possesses, operations that may be performed upon it, notifications that it may issue and its relationships with other managed objects. This is distinct from, but related to, any definitions or specification of the resource represented by the managed object as an element of the OSIE.

The set of managed objects within a system, together with their attributes, constitutes that system's management information base (MIB).

5.4 *Management relationships between open systems*

The users' requirements for OSI management may be met either by local operations or by the communication of information between open systems, or by both. OSI management is achieved between open systems through cooperation between one or more components of the management activity taking a managing role and others taking a managed role. The role played by a particular system may be static or may change over time, and may depend upon the particular management communication.

OSI management information flow between open systems is defined in terms of operations and notifications.

5.5 *OSI management functional areas*

5.5.1 *Introduction*

OSI management is required for a number of purposes. These requirements are categorized into a number of functional areas:

a) fault management (see § 5.5.2);

b) accounting management (see § 5.5.3);

c) configuration management (see § 5.5.4);

d) performance management (see § 5.5.5); and

e) security management (see § 5.5.6).

Specific management functions, within these functional areas, are provided by OSI management mechanisms. Many of the mechanisms are general in the sense that they are used to fulfil requirements in more than one functional area. Similarly, managed objects are general in the sense that they may be common to more than one functional area.

Each of these functional areas is described briefly below. The lists of functions are not necessarily exhaustive.

5.5.2 *Fault management*

Fault management encompasses fault detection, isolation and the correction of abnormal operation of the OSI environment. Faults cause open systems to fail to meet their operational objectives and they may be persistent or transient. Faults manifest themselves as particular events (e.g. errors) in the operation of an open system. Error detection provides a capability to recognize faults. Fault management includes functions to

a) maintain and examine error logs;

b) accept and act upon error detection notifications;

c) trace and identify faults;

d) carry out sequences of diagnostic tests; and

e) correct faults.

5.5.3 *Accounting management*

Accounting management enables charges to be established for the use of resources in the OSIE, and for costs to be identified for the use of those resources. Accounting management includes functions to

a) inform users of costs incurred or resources consumed;

b) enable accounting limits to be set and tariff schedules to be associated with the use of resources; and

c) enable costs to be combined where multiple resources are invoked to achieve a given communication objective.

5.5.4 *Configuration management*

Configuration management identifies, exercises control over, collects data from and provides data to open systems for the purpose of preparing for, initializing, starting, providing for the continuous operation of, and terminating interconnection services. Configuration management includes functions to

a) set the parameters that control the routine operation of the open system;

b) associate names with managed objects and sets of managed objects;

c) initialize and close down managed objects;

d) collect information on demand about the current condition of the open system;

e) obtain announcements of significant changes in the condition of the open system; and

f) change the configuration of the open system.

5.5.5 *Performance management*

Performance management enables the behaviour of resources in the OSIE and the effectiveness of communication activities to be evaluated. Performance management includes functions to

a) gather statistical information;

b) maintain and examine logs of system state histories;

c) determine system performance under natural and artificial conditions; and

d) alter system modes of operation for the purpose of conducting performance management activities.

5.5.6 *Security management*

The purpose of security management is to support the application of security policies by means of functions which include

a) the creation, deletion and control of security services and mechanisms;

b) the distribution of security-relevant information; and

c) the reporting of security-relevant events.

Note – Recommendation X.800 [2] provides further information on the placement of OSI management functions within the overall security architecture.

6 Model for OSI management

6.1 *Overview*

OSI management encompasses those activities needed to control, coordinate and monitor the resources which allow communications to take place in the OSI environment. Activities relate to the means by which

a) a real open system obtains information to enable the supervision and control of its communications resources; and

b) real open systems cooperate to supervise and control the OSI environment.

The model of OSI management is defined in terms of

c) OSI management structure (see § 6.2);

d) supporting functionality required by OSI management (see § 6.3);

e) management information base (see § 6.4);

f) flow of control amongst processes (see § 6.5); and

g) flow of information between entities (see § 6.6).

6.2 *OSI management structure*

Management is effected through a set of management processes. These processes are not necessarily located at one local system but may be distributed in many ways over a number of systems. Where management processes which are not co-resident need to communicate with one another in the OSI environment, they communicate using OSI management protocols. OSI management is accomplished through

a) systems management;

b) (N)-layer management; and

c) (N)-layer operation.

Systems management provides mechanisms for the monitoring, control and coordination of managed objects through the use of application-layer systems management protocols. OSI communications concerning systems management functions are realized through a systems management application-entity (SMAE). Systems management may be used to manage any objects within or associated with an open system.

(N)-layer management provides mechanisms for the monitoring, control and coordination of managed objects which relate to communications activities within the (N)-layer, through the use of special-purpose management protocols within the (N)-layer. (N)-layer management can affect multiple instances of communication. The (N)-layer may therefore be managed through the use of systems management protocols or through the use of (N)-layer management protocols.

(N)-layer operation provides mechanisms for the monitoring and control of a single instance of communication.

This Recommendation does not imply any particular relationship among management mechanisms.

6.3 *Supporting functionality required by OSI management*

An open system must have sufficient functionality at all seven layers to support an SMAE before the systems management functionality provided by that SMAE can be accessed by another open system.

When the functionality to support any SMAEs does not exist, the greatest OSI management functionality that can be available on such an open system is the set of separate individual functionalities provided by the layer managements of the (N)-layers within that open system. In order to support (N)-layer management, sufficient communication functionality must exist at layers 1 to (N – 1).

When neither systems management nor (N)-layer management can be provided, then the greatest OSI management functionality that can be available is the set of separate individual management functionalities provided by (N)-layer operation.

An SMAE can exist on an open system independently of the existence of (N)-layer management entities at any of the layers.

6.4 *Management information base*

A management information base (MIB) is that information within an open system which may be transferred or affected through the use of OSI management protocols. The MIB is the set of managed objects within an open system; however, only the managed objects relating to the OSI environment are subject to standardization. In addition, the logical structure of management information is standardized. This does not imply any form of physical or logical storage for the information and its implementation is a matter of local concern and outside the scope of OSI standards.

Management information may be shared between management processes and structured according to the requirements of those processes. The MIB neither restricts the interpretation of management data to a pre-defined set, nor to whether the data is stored in a processed or unprocessed form. However, both the abstract syntax and the semantics of information which is part of the MIB are defined so that they can be represented in OSI protocol exchanges.

6.5 *Flow of management control*

Management processes, which support OSI management, receive control information

a) from people and/or software acting as administrative agents local to a management process; and

b) from remote systems through their

- SMAEs;
- (N)-layer management entities;
- (N)-entities.

The management process exerts control

c) directly upon managed objects in the same open system; and

d) upon managed objects in other open systems by protocol exchanges through their

- SMAEs;
- (N)-layer management entities;
- (N)-entities.

The flow of control from administrative agents to local management processes occurs entirely within the local system environment, and as such is outside the scope of OSI management standardization. Such local control may result in OSI management communications. The abstract syntax and semantics of control flow within the OSI environment are defined so that they can be represented in OSI protocol exchanges.

6.6 *Flow of management information*

The OSI management information within a management information base may be provided by, and made available to

a) local administrative agents; and

b) remote open systems, through

- systems management protocols;
- (N)-layer management protocols;
- (N)-protocols.

Information exchanges may provide monitoring information or may result in the exercise of control. Information exchanges between administrative agents and the MIB occur entirely within the local system and are outside the scope of OSI management standardization.

7 OSI management specifics

7.1 *OSI management standardization*

Areas of OSI management standardization include

a) the services and protocols used to transfer management information between open systems; and

b) the abstract syntax and semantics of the information transferred in management protocols.

These areas of standardization apply to systems management, (N)-layer management and normal (N)-layer operation.

The actual specification of the syntax, semantics, services and protocols, and the concepts applicable to managed objects are provided in specific OSI Recommendations. The physical representation of managed objects and their physical storage are local matters and are not subject to standardization.

Systems management Recommendations specify the systems management services and protocols, plus the abstract syntax and semantics of the information transferred in such protocols.

The (N)-layer management protocols and the management aspects of (N)-protocols are defined by Recommendations specifying those protocols in order to cover layer related aspects of the above management facilities. (N)-layer Recommendations may specify (N)-layer management protocols and their use.

This Recommendation does not imply that any systems management protocols or layer management protocols are mandatory, neither does it constrain the use of management information in any (N)-protocol exchanges.

7.2 *OSI management operation*

7.2.1 *Systems management*

Systems management communications provide the normal method for exchanging OSI management information. These communications take place between systems management applications entities. Systems management protocols are application layer protocols. Any application-process which communicates according to systems management protocol standards does so through an SMAE. The service elements used to support systems management are application service elements.

Not all open systems provide the full functionality of the seven layers specified in Recommendation X.200. Where such open systems are not the initial source of, nor the ultimate destination for the transfer of data, they act for such instances of communication as relay open systems. Where such systems are required to act as sources of system management information or are subject to systems management control, information is communicated using systems management protocols.

7.2.2 *(N)-layer management*

(N)-layer management supports the monitoring, control and coordination of (N)-layer managed objects. (N)-layer management protocols are supported by protocols of the layers (N – 1) and below. They do not provide communication capability offered by the (N + 1) and higher layers. (N)-layer management protocols can only convey management information between peer (N)-layer management entities pertinent to the (N)-sub-systems in which these entities reside.

(N)-layer management protocols should only be used when special requirements dictate that systems management protocols are inappropriate or when systems management protocols are not available.

(N)-layer management protocols provide functions such as:

a) communicating parameter values associated with managed objects which relate to the operation of the (N)-layer;

b) testing the functionality provided by the (N – 1)-layer; and

c) conveying error information describing faults or diagnostic information related to the operation of the (N)-layer.

Each (N)-layer management protocol is independent of other layer management protocols. This Recommendation does not require the development of (N)-layer management protocols for each of the seven layers.

7.2.3 *(N)-layer operation*

Management functions may exist within the (N)-protocols in all seven layers of OSI. The management information that is carried within an (N)-protocol must be distinguishable from information which the protocol carries for other purposes. It is the responsibility of the (N)-protocol to provide this distinction.

Management information carried by (N)-protocol exists for the purpose of controlling and monitoring a single instance of communication. Examples of management information carried within an (N)-protocol are

a) parameters carried in connection establishment PDUs that apply to the specific instance of communication which is being established;

b) parameters carried in particular PDUs which can modify the environment in which this instance of communication operates;

c) error information describing faults encountered during the operation of that specific instance of communication; and

d) parameters carried in connection release PDUs which report information pertaining to that specific instance of communication which is being released.

7.2.4 *Relationships between systems management, (N)-layer management and (N)-layer operation*

Whereas the specification of (N)-layer management and (N)-layer operation Recommendations is not the concern of systems management, the semantics of (N)-layer management information and the operations permitted thereon must be consistent with such information and operations defined by systems management.

(N)-layer management entities are of different types from those (N)-entities which operate (N)-protocols as defined in Recommendation X.200 [1]. (N)-layer management protocols are distinguished from normal (N)-protocols by the use of (N – 1)-layer addressing mechanisms or by discrimination mechanisms within the (N)-layer.

(N)-layer management entities and (N)-entities operate, independently of each other, upon managed objects which relate to the operation of the (N)-layer.

7.3 *The form of management information exchanges*

Management information exchanges are effected by the use of application layer or (N)-layer services; these may be normal (N)-services, or services provided specifically for management purposes. The information exchanges may be either 2-party or N-party in nature, depending upon the requirements of the initiator of the exchange and the nature of the services available to carry out the exchange.

Any party may take the role of initiator in a management exchange; the remaining parties to the exchange take the role of responder. The exchange may be initiated for the purposes of performing management operations of notifications.

7.4 *OSI management conformance*

This Recommendation does not imply any conformance requirements for systems management, (N)-layer management or (N)-layer operation.

ANNEX A

(to Recommendation X.700)

Comments relating to the OSI management framework

(This annex does not form an integral part of this Recommendation)

A.1 *Introduction*

The OSI management framework provides the concepts and an abstract model of OSI management for use by those developing OSI standards.

The purpose of this annex is to provide additional explanatory material as an aid to understanding the concepts in the body of this Recommendation and to explain their application.

A.2 *Brief overview of OSI management scope and concepts*

Three forms of management information exchange are defined within the OSI management architecture for which standards are expected:

a) systems management;

b) (N)-layer management; and

c) (N)-layer operation.

Systems management is the preferred form of management information exchange and provides mechanisms for the exchange of information relating to the monitoring, control and coordination of communications resources of concern to open systems. The framework uses the term "managed objects" to describe the management view of these resources. Systems management acts upon managed objects in order to manage the resources to which these objects relate. Such managed objects can relate to one or more OSI layers.

It is perceived that the majority of management information exchanges between open systems will require context negotiation, the establishment of a management session, a reliable end-to-end transport service etc., in exactly the same way as other application layer exchanges. Therefore systems management communication is effected through application layer protocols (see Figure A-1/X.700).

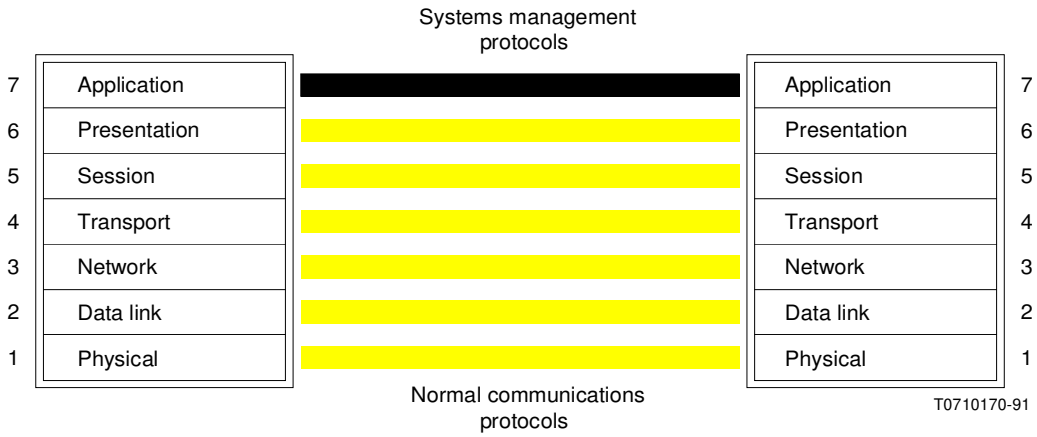

FIGURE A-1/X.700

Systems management information exchange

Systems management services and protocols are being developed collaboratively between CCITT and JTC 1, to provide a common base for all applicable CCITT applications (notably the Telecommunication Management Network Recommendations) and JTC 1 Standards.

(N)-layer management is used in special circumstances to carry information relating specifically to the operation of an (N)-layer. An example of layer management is the transport layer network connection management sub-protocol (NCMS). It is important to note that layer management at one layer should not replicate any of the functionality of the layers above it, as this would be at variance with the basic reference model. Figure A-2/X.700 shows an example of such an exchange in the transport layer. (N)-layer management exchanges can occur in any layer, although layers 2, 3 and 4 are those for which Recommendations are most likely to occur.

Layer management standards are the responsibility of the relevant layer standards group, within CCITT/JTC 1.

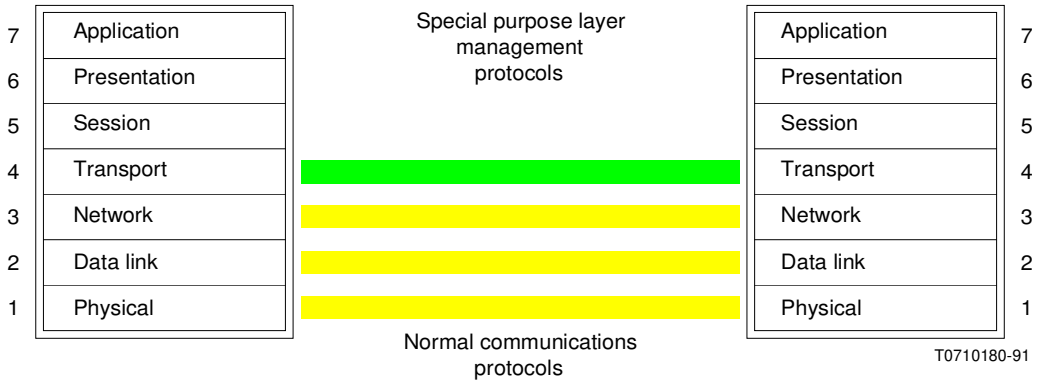

FIGURE A-2/X.700

(N)-Layer management exchange

(N)-layer operation is the set of facilities which control and manage a single instance of communication. These facilities can be embedded within an existing "normal" (N)-protocol exchange (see Figure A-3/X.700), for example the passing of charging information in an X.25 Clear packet, or they may be a special element of protocol, such as an X.25 Reset.

Recommendation | Standards for (N)-layer operation are the responsibility of the relevant layer standards group with CCITT/JTC 1.

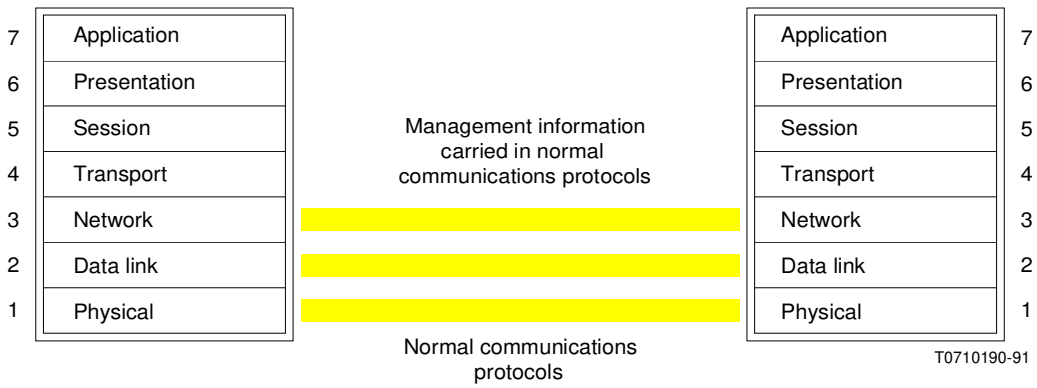

FIGURE A-3/X.700

(N)-layer operation

A.3 *Systems management Recommendations*

There are requirements for standardized application services and protocols for the exchange of management information covering a number of functions. A set of application layer Recommendations for systems management are being developed to give users a "toolkit" of services and protocols to allow the exchange of management information between open systems.

A.4 *Management information and the management information base*

It is important to recognize that the real information being carried in OSI management protocols is in fact information generated by (and defined by) the individual layer Recommendations. Thus the specification and identification of these "real" elements of management information needs to be carried out by the layer standards groups, in liaison with the OSI management Working Group, as part of the standardization activity.

A common approach is needed across the layers if a consistent definition is to be produced without omissions or duplications. There is also the problem that not all elements are layer-related. Furthermore, the top-level statements of allocation of functions to the set of OSI management protocols are not complete. This makes it difficult for those who have identified particular users needs for management activities (e.g. for access control or QOS) to express them constructively and to direct contributions to the appropriate groups.

Consequently, the MIB can be viewed as that information within an open system which can be transferred or affected by the use of OSI management protocols.

The MIB can also be visualized as the set of managed objects within an open system, which relate to the OSI environment. In addition, the logical structure of management information must be standardized. However, this does not imply any form of physical or logical storage for the information and its implementation is a matter of local concern and outside the scope of OSI Recommendations.

Management information may be shared between management processes and structured according to the requirements of those processes. The MIB neither restricts the interpretation of management data to a pre-defined set, nor to whether the data is stored as received or processed. However, both the abstract syntax and the semantics of information which are part of the MIB are defined so that they can be represented in OSI protocol exchanges.