INTERNATIONAL STANDARD

ISO/IEC 10040

Second edition
1998-10-15

Information technology — Open Systems Interconnection — Systems management overview

Technologies de l'information — Interconnexion de systèmes ouverts (OSI) — Aperçu général de la gestion-système

Reference number
ISO/IEC 10040:1998(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 10040 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 33, *Distributed application services*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.701.

This second edition cancels and replaces the first edition (ISO/IEC 10040:1992), which has been technically revised. It also incorporates Amendment 1:1995, Technical Corrigendum 1:1994 and Technical Corrigendum 2:1996.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – SYSTEMS MANAGEMENT OVERVIEW

1 Scope

This Recommendation | International Standard:

- provides an overview to the family of systems management standards;
- establishes the basis for partitioning the systems management standards into separate groups, specifying the scope of each group and identifying the principal components within each group;
- gives guidance on the development of systems management standards and identifies the way they relate to each other;
- defines terms for use by other systems management standards;
- is applicable to the definition of all systems management standards and to all aspects of systems management of whatever scale;
- is applicable to situations in which the responsibility for systems management is centralized and those where it is decentralized;
- establishes a model for systems management, identifies several aspects of systems management (i.e. information, functional, communications, and organizational), and further refines the model to clarify these aspects;
- identifies the principles governing conformance requirements and conformance claims to systems management standards.

There are no conformance requirements on the main body of this Recommendation | International Standard, however it does specify requirements on standards claiming compliance to systems management.

Annex A defines an application context for systems management and specifies the rules for negotiating systems management functional units. There are conformance requirements associated with these rules.

2 Normative references

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreement based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1 Identical ITU-T Recommendations | International Standards

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*
- ITU-T Recommendation X.207 (1993) | ISO/IEC 9545:1994, *Information technology – Open Systems Interconnection – Application layer structure.*
- ITU-T Recommendation X.217 (1995) | ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the association control service element.*
- ITU-T Recommendation X.227 (1995) | ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the association control service element: Protocol specification.*

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- ITU-T Recommendation X.680 (1994) | ISO/IEC 8824-1:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- ITU-T Recommendation X.681 (1994) | ISO/IEC 8824-2:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- ITU-T Recommendation X.682 (1994) | ISO/IEC 8824-3:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- ITU-T Recommendation X.683 (1994) | ISO/IEC 8824-4:1995, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications.*
- ITU-T Recommendation X.690 (1994) | ISO/IEC 8825-1:1995, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).*
- ITU-T Recommendation X.691 (1995) | ISO/IEC 8825-2:1995, *Information technology – ASN.1 encoding rules: Specification of Packed Encoding Rules (PER).*
- ITU-T Recommendation X.702 (1995) | ISO/IEC 11587:1996, *Information technology – Open Systems Interconnection – Application context for systems management with transaction processing.*
- CCITT Recommendation X.712 (1992) | ISO/IEC 9596-2:1993, *Information technology – Open Systems Interconnection – Common management information protocol: Protocol Implementation Conformance Statement (PICS) proforma* plus Technical Corrigenda 1 and 2 (1996).
- 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 (1993) | ISO/IEC 10165-6:1994, *Information technology – Open Systems Interconnection – Structure of management information: Requirements and guidelines for implementation conformance statement proformas associated with OSI management.*
- ITU-T Recommendation X.725 (1995) | ISO/IEC 10165-7:1996, *Information technology – Open Systems Interconnection – Structure of management information: General relationship model.*
- 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 10164-2:1992, *Information technology – Open Systems Interconnection – Systems Management: State management function.*
- CCITT Recommendation X.732 (1992) | ISO/IEC 10164-3:1993, *Information technology – Open Systems Interconnection – Systems Management: Attributes for representing relationships.*
- CCITT Recommendation X.733 (1992) | ISO/IEC 10164-4:1992, *Information technology – Open Systems Interconnection – Systems Management: Alarm reporting function.*
- CCITT Recommendation X.734 (1992) | ISO/IEC 10164-5:1993, *Information technology – Open Systems Interconnection – Systems Management: Event report management function.*
- CCITT Recommendation X.735 (1992) | ISO/IEC 10164-6:1993, *Information technology – Open Systems Interconnection – Systems Management: Log control function.*
- CCITT Recommendation X.736 (1992) | ISO/IEC 10164-7:1992, *Information technology – Open Systems Interconnection – Systems Management: Security alarm reporting function.*
- ITU-T Recommendation X.737 (1995) | ISO/IEC 10164-14:1996, *Information technology – Open Systems Interconnection – Systems Management: Confidence and diagnostic test categories.*
- ITU-T Recommendation X.738 (1993) | ISO/IEC 10164-13:1995, *Information technology – Open Systems Interconnection – Systems Management: Summarization function.*
- ITU-T Recommendation X.739 (1993) | ISO/IEC 10164-11:1994, *Information technology – Open Systems Interconnection – Systems Management: Metric objects and attributes.*

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- CCITT Recommendation X.740 (1992) | ISO/IEC 10164-8:1993, *Information technology – Open Systems Interconnection – Systems Management: Security audit trail functions.*
- ITU-T Recommendation X.741 (1995) | ISO/IEC 10164-9:1995, *Information technology – Open Systems Interconnection – Systems Management: Objects and attributes for access control.*
- ITU-T Recommendation X.742 (1995) | ISO/IEC 10164-10:1995, *Information technology – Open Systems Interconnection – Systems Management: Usage metering function for accounting purposes.*
- ITU-T Recommendation X.745 (1993) | ISO/IEC 10164-12:1994, *Information technology – Open Systems Interconnection – Systems Management: Test management function.*
- ITU-T Recommendation X.746 (1995) | ISO/IEC 10164-15:1995, *Information technology – Open Systems Interconnection – Systems Management: Scheduling function.*
- ITU-T Recommendation X.751 (1995) | ISO/IEC 10164-17:1996, *Information technology – Open Systems Interconnection – Systems Management: Change over function.*

2.2 Paired Recommendations | International Standards equivalent in technical content

- CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation 1 (ASN.1).*

  ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1).*
- CCITT Recommendation X.209 (1988), *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1).*

  ISO/IEC 8825:1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*
- CCITT Recommendation X.219 (1988), *Remote operations: Model, notation and service definition.*

  ISO/IEC 9072-1:1989, *Information processing systems – Text communication – Remote Operations – Part 1: Model, notation and service definition.*
- CCITT Recommendation X.229 (1988), *Remote operations: Protocol specification.*

  ISO/IEC 9072-2:1989 *Information processing systems – Text communication – Remote Operations – Part 2: Protocol specification.*
- ITU-T Recommendation X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts.*

  ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*
- ITU-T Recommendation X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications – Implementation conformance statements.*

  ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements.*
- 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.*
- CCITT Recommendation X.710 (1991), *Common management information service definition for CCITT applications.*

  ISO/IEC 9595:1991, *Information technology – Open Systems Interconnection – Common management information service definition.*
- CCITT Recommendation X.711 (1991), *Common management information protocol specification for CCITT applications.*

  ISO/IEC 9596-1:1991, *Information technology – Open Systems Interconnection – Common management information protocol – Part 1: Specification.*
- CCITT Recommendation X.860 (1992), *Open Systems Interconnection – Distributed transaction processing – Model.*

  ISO/IEC 10026-1:1992, *Information technology – Open Systems Interconnection – Distributed Transaction Processing – Part 1: OSI TP Model.*

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– CCITT Recommendation X.861 (1992), *Open Systems Interconnection – Distributed transaction processing: Service definition.*

  ISO/IEC 10026-2:1992, *Information technology – Open Systems Interconnection – Distributed Transaction Processing – Part 2: OSI TP Service.*

– CCITT Recommendation X.862 (1993), *Open Systems Interconnection – Distributed transaction processing: Protocol specification.*

  ISO/IEC 10026-3:1992, *Information technology – Open Systems Interconnection – Distributed Transaction Processing – Part 3: Protocol specification.*

2.3 Additional references

– ISO 8571:1988, *Information processing systems – Open Systems Interconnection – File Transfer, Access and Management.*

– ISO/IEC 9545:1994, *Information technology – Open Systems Interconnection – Application Layer structure.*

3 Definitions

3.1 Basic reference model definitions

This Recommendation | International Standard is based on the concepts in the Basic Reference Model for Open Systems Interconnection and makes use of the following terms defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

a) application service element;

b) systems management.

3.2 Management framework definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.700 | ISO/IEC 7498-4:

a) managed object;

b) management information base;

c) systems management application entity.

3.3 CMISE definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.710 | ISO/IEC 9595:

a) attribute (of managed object);

b) common management information service element;

c) common management information services.

3.4 Management information model definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.720 | ISO/IEC 10165-1:

a) attribute type;

b) naming tree;

c) managed object boundary.

This Recommendation | International Standard makes use of the following term defined in ITU-T Rec X.725 | ISO/IEC 10165-7:

d) managed relationship.

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3.5 OSI conformance testing methodology and framework definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.290 | ISO/IEC 9646-1 and ITU-T Rec. X.296 | ISO/IEC 9646-7:

a) Protocol Implementation Conformance Statement (PICS);

a) PICS proforma;

b) system conformance statement;

c) implementation conformance statement (ICS);

d) ICS proforma.

3.6 Systems management overview definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.6.1 agent: An MIS-User, which for a particular systems management interaction, has taken an agent role.

3.6.2 agent role: A role taken by an MIS-User in which it is capable of performing management operations on managed objects and of emitting notifications on behalf of managed objects.

3.6.3 generic definitions: Definitions of managed object classes, attribute types, notification types or management operation types, made available for general use.

3.6.4 (management) interaction: A single management operation or a single notification or an identified set of logically related management operations and notifications during which the manager and agent role do not change.

3.6.5 managed object class: A named set of managed objects sharing the same (named) sets of attributes, notifications, management operations (packages), and which share the same conditions for presence of those packages.

NOTE – The following two definitions are aligned with the corresponding definitions in OSI Conformance Testing Methodology and Framework ITU-T Rec. X.290 | ISO/IEC 9646-1 for PICS and PICS proforma.

3.6.6 managed object conformance statement (MOCS): A statement made by a supplier of a managed object implementation, stating the capabilities and options which have been implemented, and any features which have been omitted.

3.6.7 management information conformance statement (MICS): A statement from a supplier about an implementation's manager role capabilities and options relating to management information which have been implemented and any features which have been omitted.

3.6.8 MICS proforma: A document, in the form of a questionnaire, which when completed by the supplier of an implementation having manager role capability becomes a MICS.

3.6.9 MOCS proforma: A document, in the form of a questionnaire, designed by the managed object definer or conformance test suite specifier, which when completed for a managed object implementation becomes the MOCS.

3.6.10 managed (open) system: A real open system containing an MIS-User which can take the agent role.

3.6.11 management domain: A specification of a collection of managed objects of interest.

3.6.12 management information: The information within an open system which may be transferred by OSI management protocols.

3.6.13 management jurisdiction: A representation of the relationship between a management policy and a management domain.

3.6.14 management policy: An identifiable specification that can be evaluated with respect to managed objects.

3.6.15 management policy violation: The condition existing when managed objects fail to comply with the semantics of a policy.

3.6.16 management support object: A systems managed object defined specifically to support a systems management function (e.g. log, discriminator).

3.6.17 manager: An MIS-User, which for a particular systems management interaction, has taken a manager role.

3.6.18 manager role: A role taken by an MIS-User in which it is capable of issuing management operations and of receiving notifications.

3.6.19 managing (open) system: A real open system containing an MIS-User which can take the manager role.

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3.6.20 MIS-User: An application making use of systems management services.

3.6.21 notification: Information emitted by a managed object relating to an event that has occurred within the managed object.

3.6.22 notification type: A named data-type defining a specific kind of notification.

3.6.23 (N)-layer managed object: A managed object specific to the (N)-layer.

3.6.24 (N)-layer management protocol: An (N)-layer protocol for the exchange of (N)-layer management information supported solely by protocols of the layers (N-1) and below.

NOTE – This Recommendation | International Standard neither specifies nor requires the use of (N)-layer management protocols. The definition is included here for the sake of completeness.

3.6.25 (systems management) operation: An operation on a managed object to effect systems management.

3.6.26 systems managed object: A managed object relevant to more than one layer, to the system as a whole, or to specific management functions.

3.6.27 systems management application process: An application process participating in systems management.

3.6.28 systems management application service element: An application service element providing systems management services.

3.6.29 systems management function: A part of systems management activities which satisfy a set of logically related user requirements.

3.6.30 systems management functional area: A category of systems management user requirements.

3.6.31 systems management functional unit: A named non-empty set of systems management services defined for the purpose of identifying specific sets of functionality where there is a requirement to establish or negotiate the use of such functionality between end systems or for reference purposes in other standards.

3.6.32 systems management functional unit package: A named non-empty set of systems management functional units, defined for the purposes of negotiation of functional units on an association.

3.6.33 systems management (application) protocol: An application layer protocol supporting systems management services.

3.6.34 systems management service: A named set of service primitives that provide a service for use in systems management.

4 Abbreviations

For the purposes of this Recommendation | International Standard, the following abbreviations apply:

ACSE	Association Control Service Element
ASE	Application Service Element
ASN.1	Abstract Syntax Notation One
B-ISDN	Broadband Integrated Services Digital Network
CMIP	Common Management Information Protocol
CMIPDU	Common Management Information Protocol Data Unit
CMIS	Common Management Information Service
CMISE	Common Management Information Service Element
CSPDN	Circuit Switched Public Data Network
DMI	Definitions of Management Information
FTAM	File Transfer, Access and Management
GDMO	Guidelines for the Definition of Managed Objects
GMI	Generic Management Information
GMOCS	Guidelines for Managed Object Conformance Statements
GRM	General Relationship Model
ICS	Implementation Conformance Statement
Id	Identifier

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ISDN	Integrated Services Digital Network
LAN	Local Area Network
MAPDU	Management Application Protocol Data Unit
MCS	Management Conformance Summary
MHS	Message Handling System
MIB	Management Information Base
MICS	Management Information Conformance Statement
MIDS	Management Information Definition Statement
MIS	Management Information Service
MOCS	Managed Object Conformance Statement
MOTIS	Message Oriented Text Interchange System
MRCS	Managed Relationship Conformance Statement
OSI	Open Systems Interconnection
PICS	Protocol Implementation Conformance Statement
PSPDN	Packet Switched Public Data Network
ROSE	Remote Operations Service Element
SACF	Single Association Control Function
SMAE	Systems Management Application Entity
SMAPM	Systems Management Application Protocol Machine
SMASE	Systems Management Application Service Element
SMF	Systems Management Function
SMFA	Systems Management Functional Area
SMFU	Systems Management Functional Unit
SMI	Structure of Management Information
TMN	Telecommunications Management Network
TP	Transaction Processing
VT	Virtual Terminal
WAN	Wide Area Network

5 Systems management

Systems management provides mechanisms for the monitoring, control and coordination of resources and OSI protocol standards for communicating information pertinent to those resources. In order to describe management operations on resources, the resources are viewed as managed objects with defined properties. Information required for systems management purposes in any open system may be provided through local input, may result from input from other open systems through systems management (application layer) communication or may be a result of lower layer protocol exchanges.

In particular, systems management applies to but is not limited to (e.g. use of ITU-T M.3000-Series, TMN, is also considered a valid application of systems management):

- OSI Layer 1 (Dedicated lines/leased lines, satellite connections);
- OSI Layer 2 (LAN, WAN, etc.);
- OSI Layer 3 (CSPDN, PSPDN, ISDN, B-ISDN, ITU-T Rec. X.300 subnetwork, etc.);
- OSI Layer 4 (Transport Layer Entities);
- OSI Layer 5 (Session Layer Entities);
- OSI Layer 6 (Presentation Layer Entities);
- OSI Layer 7 (MHS | MOTIS, FTAM, VT, TP, Directory).

NOTE – While the principal impetus for the development of these standards has been the need to manage OSI resources, they also have broader applicability. Furthermore, it is possible that in the future, standards development may be undertaken to specifically address additional areas.

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Systems management is applicable to a wide range of distributed processing and communications environments. These environments range from local area networks interconnecting small systems, to interconnected corporate and national networks on a global scale. Small scale environments may be managed by appropriate small scale management systems, consisting of a single manager capable of controlling and coordinating the open communication environment through a number of agents. The standards and concepts are also applicable to large scale environments supporting multiple managers.

There are three main groupings within the set of systems management standards. They are:

a) a set of standards specifying systems management functions;

b) a set of standards relating to the specification of managed objects;

c) a set of application layer service and protocol standards for communicating information relating to management functions.

The requirements to be satisfied by systems management activities can conveniently be grouped into five areas, each of which gives rise to one or more standards covering one or more functions. These areas as defined by the OSI Management Framework (see CCITT Rec. X.700 | ISO/IEC 7498-4) are:

– fault management;

– configuration management;

– accounting management;

– performance management;

– security management.

However, many items of information, their associated management operations and the communication protocols are known to be common to more than one area. And, in performing management activities, sets of management functions may be combined to effect a particular management policy.

For these reasons, systems management standards form a closely interrelated set of standards.

6 Systems management model

6.1 Introduction

This clause identifies a number of concepts of systems management and provides a model to clarify these concepts and their relationships.

The following subclauses describe the various aspects of the systems management model:

– information aspects;

– functional aspects;

– OSI communications aspects;

– organizational aspects.

Management of a communications environment is an information processing application. Because the environment being managed is distributed, the individual components of the management activities are themselves distributed. Management applications perform the management activities in a distributed manner, by establishing associations between systems management application entities.

As shown in Figure 1 the interactions which take place between systems management application entities are abstracted in terms of management operations and notifications issued by one entity to the other; these are communicated using systems management services and protocols.

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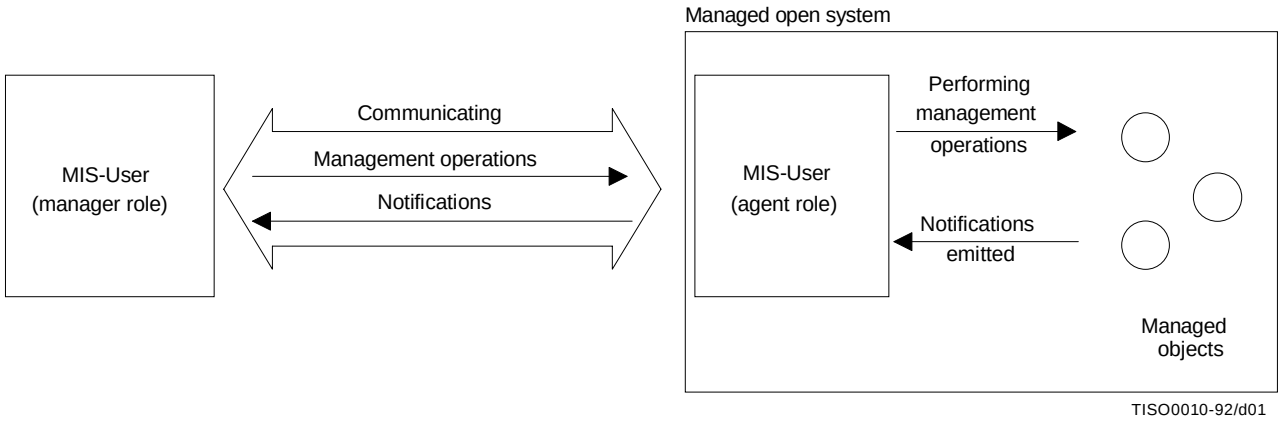


Figure 1 – Systems management interactions

Management activities are effected through the manipulation of managed objects. For the purposes of systems management, management applications are categorized as MIS-Users. Each interaction takes place between two MIS-Users, one taking the manager role, the other the agent role.

An MIS-User taking the role of an agent is that part of a distributed application that manages the managed objects within its local system environment. An agent performs management operations on managed objects as a consequence of management operations communicated from a manager. An agent may also forward notifications emitted by managed objects to a manager.

An MIS-User taking the role of a manager is that part of a distributed application which has responsibility for one or more management activities, by issuing management operations and receiving notifications.

The concept of a manager is not limited to applications participating solely in systems management; other applications needing access to management information may use management information services.

Roles are not permanently assigned to MIS-Users. Some MIS-Users can be restricted to only taking an agent role, some to only taking a manager role while other MIS-Users are allowed to take an agent role in one interaction and to take a manager role in a separate interaction.

NOTE 1 – When a management interaction between open systems pertains to more than one managed object, the specification of how the agent distributes the management operation amongst its managed objects is not subject to standardization.

NOTE 2 – A managed object can itself represent a resource outside of the managed system. The relationship between the managed system and the outside resource may also be one of manager/agent. If the communication between these systems follows OSI Management standards, then management operations on a managed object in the original managed system might result in further manager/agent exchanges, operating on a “remote” managed object. No limits are imposed upon the number of such cascaded management operations that are permitted.

It is important to recognize that this Recommendation | International Standard only establishes a conceptual model that describes the structure and contents of the information actually communicated by the use of standardized management information services. Whenever management information is communicated, it is done in terms of this model.

Whether, where and how systems represent and store the real data from which the management information is derived is a local matter, and therefore not subject to standardization.

NOTE 3 – Figure 2 represents a particular way of viewing certain aspects of the system management model and is given for information only. The figure has been of value during the development of this Specification. In particular, it differentiates the mapping to standardized communication (following the rules introduced in 6.2) from local mapping, which illustrates that a method of viewing the real management information in terms of the model must exist within the systems management application process. Furthermore, the method exists in the local environment and is therefore an implementation matter not subject to standardization.

Figure 2 does not show the complete model, nor does it show all the details in full. In particular it does not imply that there is necessarily only one subtree of the naming tree related to a specific layer, nor does it imply that the term “systems management information model space” is a defined term.

6.2 Information aspects

This subclause introduces the information aspects of the systems management model. The definitive specification of the information model is given in CCITT Rec. X.720 | ISO/IEC 10165-1. It refines the concept of Managed Objects defined in CCITT Rec. X.700 | ISO/IEC 7498-4. It deals with their attributes, the management operations that may be performed upon them, and the notifications that they may emit. The set of managed objects in a system, together with their attributes, constitutes that system's Management Information Base (MIB).

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Standardized managed objects are expected to be specified by the standardization organizations responsible for standardizing the resources represented by the managed objects (e.g. the group responsible for standardizing an (N)-layer protocol entity is also responsible for standardizing the managed object that represents the management view of that protocol entity). Guidelines and tools to support the definition of managed objects are provided, as are a collection of definitions of management information to support the definitions of managed objects and the definition of systems management functions.

6.2.1 Managed objects

A managed object is the OSI Management view of a resource that is subject to management, such as a layer entity, a connection, a Directory Service Agent, or an item of physical communications equipment. Thus, a managed object is the abstraction of such a resource that represents its properties as seen by (and for the purpose of) management. An essential part of the definition of a managed object is the relationship between these properties and the operational behaviour of the resource. This relationship is not modelled in a general way.

Managed objects can be specific to an individual layer, in which case they are known as (N)-layer managed objects. Those managed objects that are relevant to more than one layer, to a specific systems management function (management support object) or to the system as a whole are known as systems managed objects.

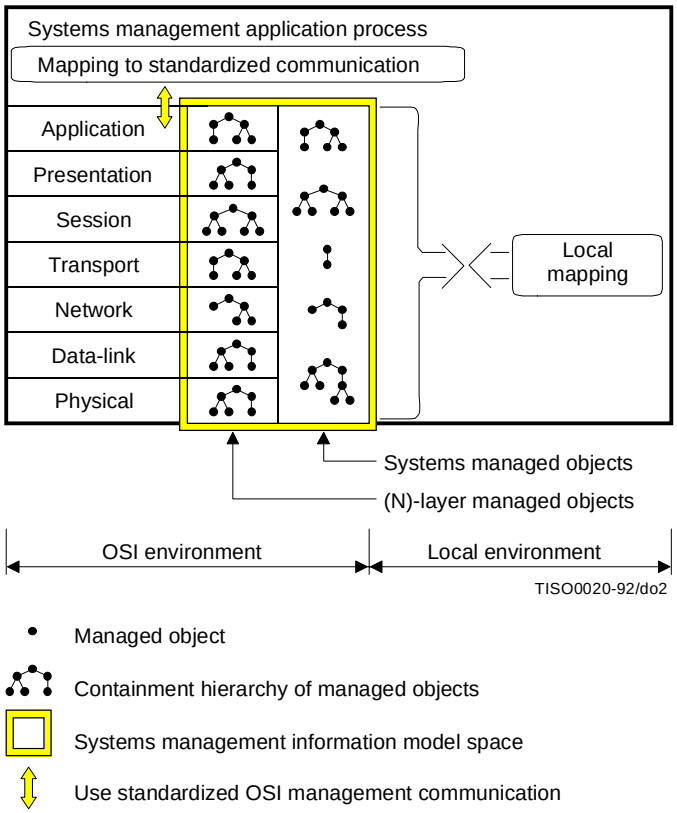


Figure 2 – Relationship between information and communication aspects of the systems management model

6.2.2 Attributes

Attributes are properties of managed objects. An attribute has an associated value, which may have a simple or a complex structure.

6.2.3 Management operations and notifications

Part of the definition of a managed object is the specification of the set of management operations that can be performed upon it and the effect that these management operations have upon the managed object and its attributes. The definition may also specify the effect, if any, on related managed objects. The execution of a management operation may also be conditional upon the state of the managed object or its attributes. An essential part of the definition of a management operation is the set of possible ways in which it can fail.

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Managed objects may also emit notifications, which contain information concerning the occurrence of an event associated with the managed object.

Whereas the mechanisms for communicating management operations and notifications are subject to OSI management standardization, the mechanisms for performing management operations and notifications are not. No corresponding internal systems interface is subject to standardization. The relationship between management operations at the managed object boundary and what is communicated in protocol between open systems is described in 6.4.

6.3 Functional aspects

This subclause describes functional aspects of the systems management model.

A systems management function may satisfy more than one requirement and to satisfy some requirements, more than one function may be applicable. Therefore, a many-to-many relationship between functions and requirements exists.

The specification of a systems management function defines the management activities and information that are necessary to meet the requirements.

Management functions may be combined to accomplish a specific management activity.

Since not all services are always required on a given association, a systems management function's services may be subgrouped into one or more functional units, which are basic units of negotiation between MIS-Users. In addition, functional units spanning services from more than one function may be defined.

Functional units that cross function boundaries are provided to support the following sets of capabilities:

a) notifications only;

b) management operations only;

c) notifications and management operations.

NOTE – Other functional units are defined that allow negotiation of subsets of these capabilities (e.g. monitor, control).

The agent cannot in general determine the purpose of the management operations it receives or the notifications it emits. For example, an open system cannot in general determine whether its responses to requests to read error counters will be used for the purpose of fault management or performance management. The agent responds to requests from a manager individually, without needing any wider context within which to carry out the request.

6.4 OSI communications aspects

The interactions between MIS-Users acting in the role of manager and agent respectively are realized through the exchange of management information. This communication is accomplished using OSI protocols.

The general OSI communication service for systems management is CMIS. Subclause 6.4.1 describes how CMIS is used to support communications concerning the management operations and notifications applicable to managed objects in a managed system. Subclauses 6.4.2 through 6.4.5 explain how communications support fits into the application layer structure.

MIS-Users may make use of other OSI services (such as TP or FTAM) which may or may not support the manager/agent role distinction, however the MIS-Users shall still support the manager/agent role distinction.

NOTE – MIS-Users may make use of other services.

6.4.1 Support for management operations and notifications

There are two aspects to communications support for management operations and notifications:

a) support for the transfer of requests for management operations and notifications between MIS-Users;

b) support for the control of access to managed objects and the external dissemination of notification information.

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The major components are shown in Figure 3.

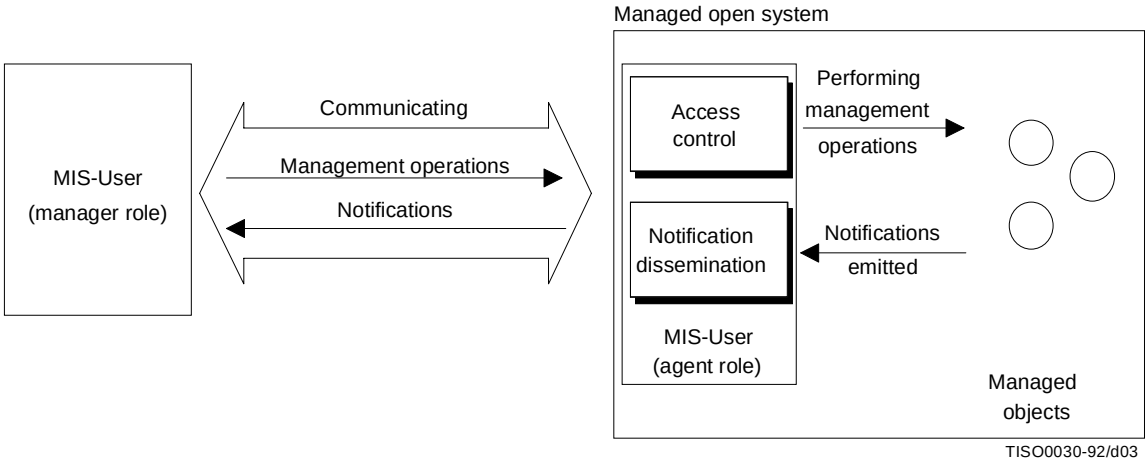


Figure 3 – Communication support for notifications and managements operations

The systems management services have primitives for the communication of requests for the various types of management operations defined in CCITT Rec. X.720 | ISO/IEC 10165-1, and primitives for the transfer of notification information. In this way, the systems management services mirror the exchange defined at the managed object boundary. The systems management services provide additional support for the selection of appropriate managed objects by scoping and filtering.

CCITT Rec. X.730 | ISO/IEC 10164-1 defines how the systems management services are mapped onto CMIS services.

There is a strict correspondence between the types of exchange defined (in the information model) at the managed object boundary and communications support in systems management services; however, in individual exchanges (or potential exchanges) of information, these mechanisms may intervene to control information flow.

Access control mechanisms may deny management operation requests from specified managers on selected managed objects.

For the external communication of a management notification emitted by a managed object, a mechanism is defined to identify destinations for external communications and matching criteria that the notification information shall satisfy. Independently of this, another mechanism is defined that can cause the information to be logged for subsequent retrieval.

6.4.2 Systems management application entity

The Systems Management Application Entity (SMAE) consists of the Systems Management Application Service Element (SMASE) and the Association Control Service Element (ACSE, ITU-T Rec. X.217 | ISO/IEC 8649). Other OSI application service elements required within the SMAE are described below.

Figure 4 shows how systems management components fit into the application layer structure.

The SMASE defines the semantics and abstract syntaxes of the information transferred as relevant to OSI management in Management Application Protocol Data Units (MAPDUs). The MAPDU is the OSI protocol realization of the abstract notion of management operations and notifications exchanged between systems management application entities (see 6.1). For each MAPDU defined, the mapping to supporting services is also specified.

The services provided by the SMASE may be grouped for the purpose of negotiation using functional units. The SMASE specifies management information to be exchanged between the systems management application entities. The communications service used by the SMASE may be provided by the Common Management Information Service Element (CMISE) ASE or other ASEs such as File Transfer, Access and Management (FTAM, ISO 8571) or Transaction Processing (TP, CCITT Rec. X.860 | ISO/IEC 10026-1). The use of CMISE also implies the presence of the Remote Operation Service Element (ROSE, CCITT Rec. X.219 | ISO/IEC 9072-1). CMISE specifies the service and procedures for transfer of Common Management Information Protocol Data Units (CMIPDUs). CMISE provides a means for the exchange of information in management operations and notifications for management purposes in a common manner. Other ASEs can be used to communicate management information.

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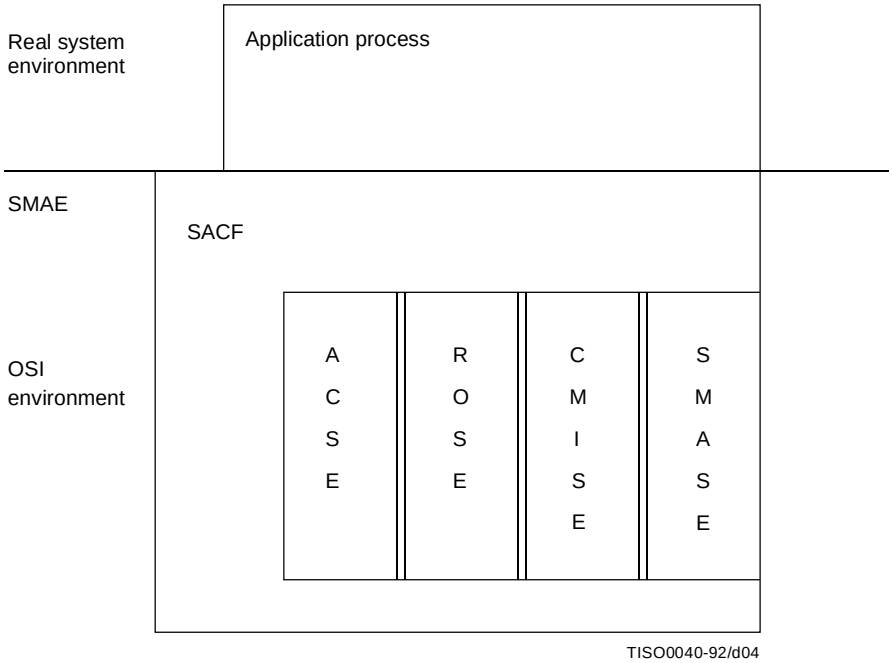


Figure 4 – Management and the application layer

6.4.3 Application context

Two systems management application entities establish an association by agreeing on an application context, which identifies the initial shared management knowledge for that association, including the various application service elements used.

For the purpose of systems management, a name has been allocated to a systems management application context in Annex A. This application context is for use in cases where only systems management is used. Other names may be allocated in the future, implying the use of a different set of ASEs.

An application context for use of TP with CMIS is specified in ITU-T Rec. X.702 | ISO/IEC 11587.

6.4.4 Shared management knowledge

In order to perform systems management, shared management knowledge must exist between the manager and the agent.

Management knowledge for systems management communication includes (but is not limited to):

- Protocol knowledge (e.g. application context).
- Function knowledge (e.g. functions and functional units).
- Managed object knowledge (e.g. classes and instances and identification of managed objects and their attributes).
- Constraints on functions supported and relationships between those functions and managed objects. In particular, constraints on the relevant managed objects in an open system that shall be present in order for specific functions to be supported.
- Definition knowledge (e.g. definitions of managed object classes).
- Repertoire knowledge (e.g. knowledge of classes of managed objects supported by a given managed system.

Shared management knowledge manifests itself in terms of distributed management applications, and hence the respective views of each end system may be different if managed objects contained within the associated open systems are dissimilar (see Figure 5). The shared management knowledge refers to the common knowledge between the two systems, i.e. the shared management schema.

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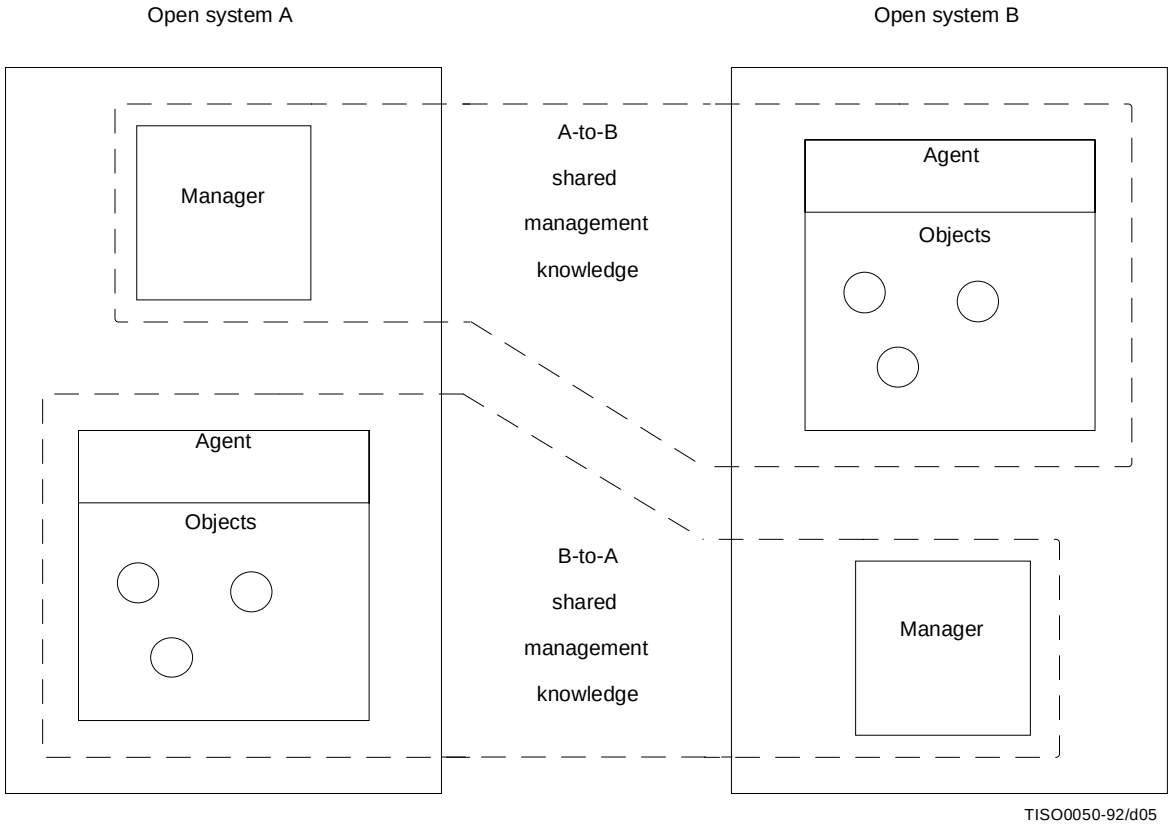


Figure 5 – Views of shared management knowledge

As specified in 6.1 there is a need to be able to establish and modify the shared management knowledge that exists between two systems engaging in management information exchange.

Management knowledge can be established at any time, specifically:

- prior to any communication taking place (e.g. established at system design or build time, or "remembered" from a previous association);
- during the association establishment phase;
- subsequently, during the lifetime of the association.

A priori knowledge to enable management communication is an example of the establishment of management knowledge.

At association establishment time it should be possible to either establish or modify the management knowledge.

Having set up an association for the purposes of systems management, a mechanism may be used to modify the management knowledge. For example, a knowledge discovery mechanism may be supported by systems supporting the agent role, to enable the capabilities of a system to be examined. (The use of such a mechanism by managers should be left optional.)

Any modifications to the shared management knowledge after association time might be made by means of a knowledge update mechanism.

Standardized management knowledge shall be made available as managed objects.

In addition, some aspects of standardized management knowledge may be made available by other mechanisms, such as Directory objects.

6.4.5 Use of supporting services

Different functions require different communication services, for example, certain functions may require file-oriented management operations, while others may only require a simple request/reply protocol.

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6.5 Organizational aspects

The organizational aspects of the model describe the distributed nature of OSI management. Many of the concepts pertinent to systems management organizational aspects (e.g. manager, agent) have been introduced earlier (see 6.1). This subclause identifies further organizational aspects.

6.5.1 Requirements

The organizational requirements for management policies are:

- to be able to manage management policies;
- to share the responsibility for setting a policy between multiple authorities and to delegate a policy from one authority to another.

The organizational requirements for management domains are:

- to be able to manage management domains;
- to permit managed objects to be associated in a group;
- to allow managed objects to belong to more than one group.

The organizational requirements for management jurisdiction are:

- to be able to manage management jurisdictions;
- to be able to apply policy to a group of managed objects;
- to support multiple policies applying to a specific managed object.

6.5.2 Architectural model

Figure 6 illustrates how a management jurisdiction relates a management policy and a management domain, and, consequently provides a means of applying policy semantics to the domain membership. The dashed arrows illustrate that the representation of policy semantics and domain membership are not prescribed by the architecture.

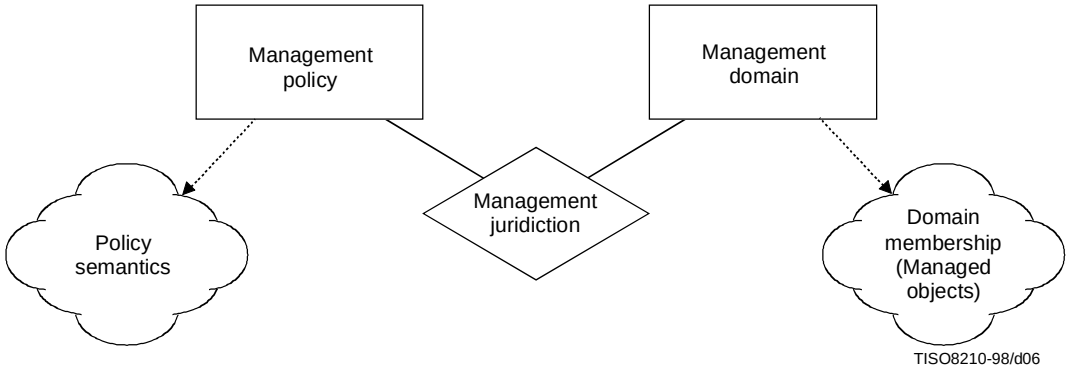


Figure 6 – Organizational aspects of the architectural model

The requirements expressed in 6.5.1 for policy are addressed by identifying semantics of a management policy:

a) The application of management policy cannot extend the defined behaviour of a managed object.

b) A management policy is subject to change.

c) A management policy is dynamic in that it may come into and go out of existence over time.

d) A management policy can be evaluated for managed objects.

e) Management policy include, but are not limited to, the following types: Management policy of authorization and management policy of obligation. Management policies of authorization state what may be done. Management policies of obligation state what shall be done.

The requirements expressed in 6.5.1 for domains are addressed by identifying specification for a grouping of managed objects as a management domain:

a) A management domain is a specification of a grouping of zero or more managed objects; these managed objects are referred to as members of the management domain.

b) A managed object can be a member of zero or more management domains.

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c) Membership of a management domain can be dynamic.

d) A managed object is neither required to possess, nor is it precluded from possessing, knowledge of the management domains of which it may be a member.

e) The membership of a management domain need not be enumerable.

The requirements expressed in 6.5.1 for jurisdiction are addressed by identifying a relationship between a management policy and a management domain:

a) Management domains and management policies referenced by a management jurisdiction are independently dynamic.

b) A management policy applies to managed objects when a management jurisdiction relates the management policy to a management domain.

c) If a managed object is a member of more than one management jurisdiction, it may consequently be subject to more than one management policy.

d) As a result of a managed object being subject to a management policy, a policy violation may occur. It can occur that two or more management policies, when applied to a managed object, will generate an unavoidable policy violation.

e) A managed object is neither required to possess, nor is it precluded from possessing, knowledge of the management policies that can apply to it.

7 Systems management standards

The model introducing the concepts of systems management is given in clause 6. This clause describes the various standards documents, and their relationships to each other and to the model in clause 6. Figure 7 illustrates these relationships. It also indicates other standards that contain specific management information and how they relate to the systems management standards. The arrows in Figure 7 are the suggested order for reading systems management standards.

The standards relevant to systems management can be categorized as:

– standards specifying the structure;

– standards for communication of management information;

– standards relating to management information;

– standards for systems management functions.

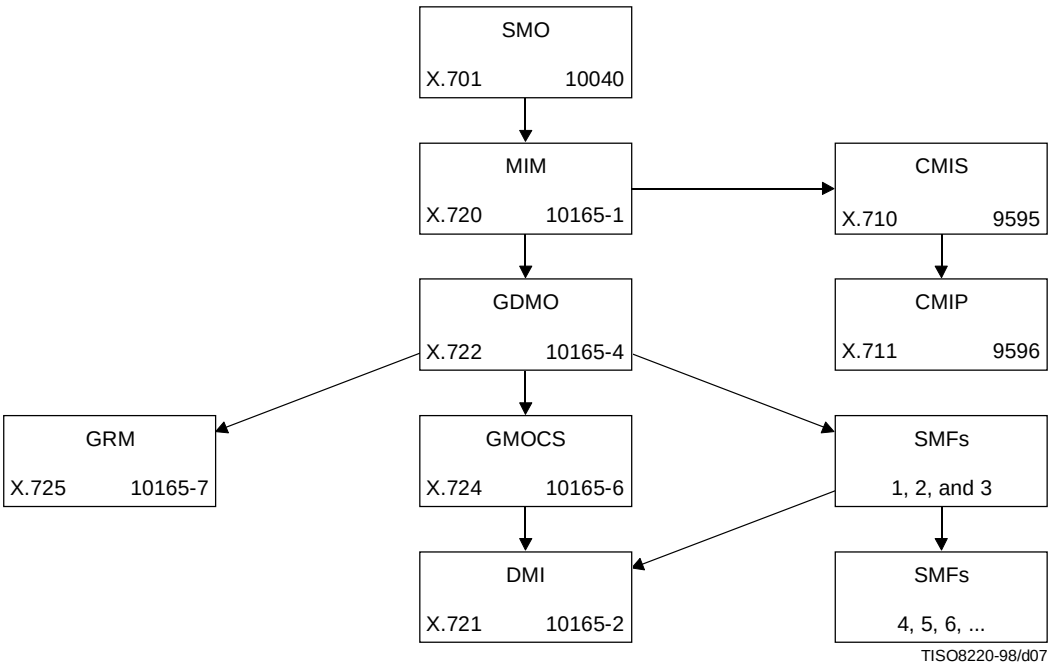


Figure 7 – Relationship between standards

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7.1 Architecture and structure

CCITT Rec. X.700 | ISO/IEC 7498-4 provides a framework for the coordinated development of standards for OSI Management, by defining terminology, providing a structure and describing OSI Management activities.

This Recommendation | International Standard provides an overview to OSI Systems Management, as described in clause 1.

7.2 Communication of management information

CCITT Rec. X.710 | ISO/IEC 9595 defines an Application Service Element (The Common Management Information Service Element), which may be used by an application process (in a centralized or decentralized management environment) to exchange information in management operations and notifications for the purpose of systems management.

CCITT Rec. X.710 | ISO/IEC 9595 defines a set of service primitives (that constitute the application service element), the related parameters and any necessary information for the semantic description of each service primitive. The CMIS service primitives convey requests for management operations, results of management operations and event reports, corresponding to the operations and notifications defined in the Management Information Model, between open systems.

CCITT Rec. X.711 | ISO/IEC 9596-1 specifies the protocol that provides the Common Management Information Service. It is used by application layer entities to exchange management information.

CCITT Rec. X.711 | ISO/IEC 9596-1 specifies procedures for the transmission of management information between application entities, the abstract syntax of the CMIP, procedures for the correct interpretation of protocol control information, and the conformance requirements for implementations.

In case of specific needs, other ASEs (such as TP or FTAM) may be used in addition for the communication of management information. An application context for use of TP with CMISE is specified in ITU-T Rec. X.702 | ISO/IEC 11587.

7.3 Structure of management information

The standards relating to management information fall into two groups: definitions of managed object classes, and standards which support the definition of managed object classes. Most managed object class definitions will be defined by layer groups and liaison organisations; but some managed objects are required to support OSI Management itself. Specific examples are the managed objects representing event forwarding discriminators and management logs. Standards for these form part of the set of systems management standards.

The standards that present guidelines on how to define managed object classes include:

- CCITT Rec. X.720 | ISO/IEC 10165-1 (MIM), which defines the model for managed objects covering their attributes, the management operations that can be performed on them, the notifications they may emit and the appropriate naming schemes so that managed objects and attributes can be identified in protocol;
- CCITT Rec. X.721 | ISO/IEC 10165-2 (DMI), which defines system managed objects, and templates that can be imported into a variety of managed object class definitions, to support the consistent definition of attributes, notifications, and management operations including their parameters;
- CCITT Rec. X.722 | ISO/IEC 10165-4 (GDMO), which provides guidance, methods and notational techniques for specifying managed object classes and other management information;
- ITU-T Rec. X.723 | ISO/IEC 10165-5 (GMI), which defines generic management information pertinent to managed objects for OSI layer protocols;
- ITU-T Rec. X.724 | ISO/IEC 10165-6 (GMOCS), which provides guidance, methods and notational techniques for specifying ICS for management systems; and
- ITU-T Rec. X.725 | ISO/IEC 10165-7 (GRM), which defines the model for general relationships and notational tools for defining general relationships.

NOTE – Other management information documents (e.g. standards, technical reports or registers containing registration of information objects, generic managed objects or classification of managed objects) may be required.

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7.4 Systems management functions

The standards related to systems management functions include one or more of the following components:

a) Definition of a set of systems management services that address particular requirements. In standards which include this component, functionality that represents added value beyond that available from CMISE (or other ASEs used to support management activity) is documented as a service. Added value services are defined whenever restrictions are placed on the information content of a supporting ASE service primitive (e.g. restricting the parameter types that may occur in the primitive, or restricting the primitive to operate on a particular support object class). Added value services are also defined whenever a particular ordering or procedural use of supporting services is required.

   This component consists of one or more of:

   1) user requirements;
   2) models that relate the systems management services to user requirements;
   3) a service definition that lists systems management services that are required and their semantics;
   4) a protocol specification that specifies the mapping of systems management services and their parameters onto underlying services;
   5) definitions of the relationship between systems management services and SMI management operations and notifications;
   6) relationships with other systems management functions;
   7) conformance requirements.

   Standards which include this component may contain or call for the use of particular generic definitions, and may also define systems management functional units.

b) Requirements and models for generic definitions. Such components of systems management function standards are concerned solely with the provision of generic definitions of managed objects, attributes, management operations and notifications that address particular functional requirements.

   The managed objects, attributes, management operations and notifications required by standards which include this component are available for use on the Pass-through service defined in CCITT Rec. X.730 | ISO/IEC 10164-1. These services map the operations that can be performed on and by a managed object directly onto the CMIS services.

   This component consists of:

   1) user requirements;
   2) models that relate the generic definitions to user requirements;
   3) statements of the compliance requirements placed on other standards that make use of the generic definitions.

      NOTE – The generic definitions required by these functions are documented in accordance with the guidelines for the definition of managed objects. The first seven parts of the systems management functions refer to DMI, while the other systems management functions refer to annexes which contain the generic definitions.

c) Definition of systems management functional units. Standards which include this component identify specific sets of systems management services where there is a requirement to establish knowledge of the use of such functionality on an association as part of the establishment of management knowledge. A single functional unit may include services defined in more than one standard, and may define the use of services in conjunction with managed object classes.

   This component consists of:

   1) user requirements;
   2) models that relate the systems management functional units to the user requirements;
   3) lists of systems management services that are required by the functional unit, along with any managed object class restrictions associated with any of these services as they pertain to a functional unit;
   4) definitions of functional units;
   5) the abstract syntax necessary to identify the functional unit in protocol;
   6) descriptions of any relationships between functional units;

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7) descriptions of any relationships between functional units and systems management functions;

8) conformance requirements.

Each of these components can appear alone in a systems management function standard. They can also be combined in any manner except that a generic definition component and a functional unit component cannot be combined without reference to or inclusion of a service definition component.

8 Conformance and compliance

This clause specifies:

- compliance requirements placed by this Recommendation | International Standard on other standards;
- compliance requirements for systems claiming conformance to systems management;
- conformance requirements for systems claiming conformance to this Recommendation | International Standard.

8.1 Compliance to this Recommendation | International Standard

8.1.1 Introduction

Three categories of systems management standards are identified in clause 7:

- standards for communication of management information;
- standards relating to management information;
- standards related to systems management functions.

Standards claiming compliance with this Recommendation | International Standard shall identify the category of standard for which compliance is claimed and shall comply with any requirements defined in clauses 7 and 8 that apply to the category identified.

Standards for communication and standards relating to systems management functions shall require, for conformance, the minimum required to maintain the integrity of the protocol specified by the standards. Collections of useful functionality can be defined in profiles.

NOTE – some standards may define a profile.

It is also a requirement that each standard should express its dependencies on non-mandatory aspects of underlying standards by identifying what elements of a given underlying service are required to support the given protocol. This also requires that each protocol standard should specify the conditional requirements that express, for each element of the service provided by that protocol, which protocol units are required to enable that element of service to be supported.

8.1.2 Requirements for communication standards

Standards that specify protocols to be used for the communication of management information shall state the requirements for static and dynamic conformance to the protocol and shall provide a PICS proforma that identifies all the information that shall be provided in claims of conformance. These standards shall state that as a minimum requirement for conformance to systems management, the support of the ASN.1 Basic Encoding Rules (see CCITT Rec. X.209 | ISO/IEC 8825) is required for abstract syntaxes defined for systems management.

Standards for communication shall require, for conformance, only the minimum required to maintain the integrity of the protocol specified by the standards. Such standards may also define a profile within the base standard.

Standards for communications shall also identify which protocol units are required for each element of service that can be provided by the communications standard so that any other standard using the communications service can unambiguously define its requirements.

A system claiming conformance to communications standards shall support the set of elements of protocol that are required for each of the services claimed to be supported.

8.1.3 Requirements for management information standards

Standards that define management information shall state the requirements for static and dynamic conformance in the agent role to the management information definitions and shall provide a MOCS proforma, in accordance with ITU-T Rec. X.724 | ISO/IEC 10165-6, that identifies all the information that shall be provided in claims of conformance to the managed object class definition. It may also provide a MRCS proforma that identifies all the information about managed relationships, including name bindings, that shall be provided in claims of conformance.

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The requirements for conformance to a managed object class shall be specified in terms of the behaviour definitions associated with the class, its attributes, management operations and notifications. A claim of conformance to a managed object class requires that a managed object instance identified as being a member of that class conforms to the managed object class definition; i.e. to have the structure defined for the class, to be able to perform the operations and emit the notifications defined for the class, and to have the attributes defined for the class with their expected type and operations.

There can be a relationship between the behaviour of a resource visible at the managed object boundary and the behaviour of the resource visible at any other boundary defined by OSI standards. If, and only if, such a relationship is specified, then the nature of that relationship shall be stated as part of the definition of the managed object class. Such specified relationships are subject to a claim from the supplier describing how the relationship appears in a particular implementation, with a statement of implementation restrictions (for example, the maximum delay between a management interaction and its effect on other externally visible behaviour, or vice versa). This claim may be specified in the MOCS, or in a document referenced by the MOCS.

NOTE – Such a relationship may be part of the conformance requirement to the managed object as specified in the relevant standard. It is not always feasible to express such a relationship in a deterministic way which is subject to conformance testing without at the same time over-constraining implementations. For example, internal synchronization delays within a system could cause indefinite delays between interactions. Should it be feasible in some particular case, these relationships would be part of the conformance requirements of the managed object definition. In doing so, it is especially important not to over-constrain implementations nor create undesirable over-specification of their operation.

The existence of a conformance requirement in a standard does not necessarily imply testability of the requirement.

Where a standard provides a generic definition of a managed object, it shall provide a MIDS proforma that identifies all of the information that is required for construction of a MOCS proforma for a managed object using the generic definition.

Where a standard claims to provide support for a function or makes use of a generic definition within a managed object definition, the standard shall satisfy the compliance requirement stated in the function or generic definition standard.

Standards that define management information shall also state the requirements for static and dynamic conformance in the manager role to the operations and notifications specified in the management information definitions, and shall provide or reference a MICS proforma that identifies all the information that shall be provided in claims of conformance. Conformance in the manager role to operations means that the implementation has the ability to generate the specified operations; where relevant, operations can be limited to specified attributes. Conformance in the manager role to notifications means that the implementation has the ability to receive the specified notifications.

8.1.4 Requirements for standards related to management functions

Standards that define systems management functions shall state the static and dynamic conformance requirements associated with the protocol defined in the function standard and shall provide a PICS proforma that identifies all the information that shall be provided in claims of conformance. Where support of a function requires the use of particular generic definitions, the function standard shall identify the set of generic definitions that it requires.

Standards that contain generic definitions shall state the compliance requirements that are placed upon managed object standards or other standards that make use of the definitions it contains.

Conformance may be claimed to the generic definitions in Systems Management Function standards, in accordance with ITU-T Rec. X.724 | ISO/IEC 10165-6.

Standards that define systems management functional units shall state the conformance requirements associated with the support of each functional unit and shall provide a PICS proforma that identifies all the information that shall be provided in claims of conformance.

Where a function standard defines the use of a management support object, that standard shall specify the conformance requirements for that managed object in a MOCS proforma.

Standards that define system management functions shall include a statement advising the supplier of an implementation how to complete the ICS proforma.

A systems management function standard shall specify the mapping to the supporting services.

NOTE – A Systems Management Application Protocol Machine (SMAPM) is an abstraction within a systems management function that maps the parameters of request and response primitives into MAPDUs and maps the information received in MAPDUs into parameters of indication and confirmation primitives.

Standards relating to systems management functions shall require, for conformance, the minimum required to maintain the integrity of the specification in the standards. The minimum required may vary according to the scope and purpose of the function standard.

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For example, in the case of a systems management function standard, such as the State management function, that defines generic attributes, a generic attribute group and notifications to be used in many managed object definitions, the minimum conformance requirement might be simply to any one of the state attributes, the state attribute group or notifications. In other cases, such as Usage metering, minimum conformance might be to one of the objects or packages defined in the systems management function. In yet other cases, such as Test management, the minimum conformance required might include several managed objects as well as sequences of exchanges.

The minimum requirement for a manager role implementation may also differ from the minimum requirement for an agent role implementation. For example, in a manager role implementation, the minimum conformance requirement to a generic attribute (such as a state attribute) might be limited to at least one operation (e.g. Get) on the attribute, whereas in an agent role implementation, the minimum requirement could be support for all operations defined for the attribute.

8.1.5 Guidelines for claims to conform to OSI management

The supplier of an implementation which is claimed to conform to systems management standards shall follow the instructions for completion of ICS proforma given in that standard. Such instructions can include:

a) the set of systems management application contexts supported;

b) the relevant standards to which conformance is claimed. A MCS shall be completed, in accordance with ITU-T Rec. X.724 | ISO/IEC 10165-6;

c) the set of management information protocols (e.g. CMIP) that the supplier of an implementation claims to support, in the form of a PICS for each management information protocol, in the format required by the protocol standard. Support for this set of protocols shall include the ability to support ASN.1 Basic Encoding Rules (see CCITT Rec. X.208 | ISO/IEC 8824) for abstract syntaxes defined for systems management. This set of protocols shall include:

   1) all protocols required for the support of any systems management functional unit for which support is claimed;

   2) all protocols required for the support of the application context(s) for which support is claimed;

   3) all protocols required for the support of the management operations and notifications specified by the set of managed object classes for which support is claimed;

a) the set of systems management functions (which may be expressed in terms of systems management functional units) that the supplier of an implementation claims to support, in the form of a PICS for each function, in the format required by the function standard;

b) the managed relationships, including name bindings, that the supplier of an implementation taking the agent role claims to support, in the form of a MRCS, in the format required by the management information standard; and

c) the set of managed object classes that the supplier of an implementation taking the agent role claims to support, in the form of a MOCS for each managed object class, in the format required by the managed object class standard. This set of managed objects classes shall include any managed object classes that are required for the support of the systems management functional units for which support is claimed.

8.2 Conformance to this Recommendation | International Standard

The only conformance requirements specified by this Recommendation | International Standard are those related to the application context for systems management specified in Annex A.

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Annex A

Application context for systems management

(This annex forms an integral part of this Recommendation | International Standard)

A.1 Background

This annex describes an application context that is available for an association in the systems management environment.

This annex defines an application context to be used within systems management. The support of this application context is required to guarantee successful establishment of an association for systems management. Additional application contexts for systems managment are specified in ITU-T Rec. X.702 | ISO/IEC 11587.

The rules for the Systems management application context, defined within this annex, enable the part of the application context used on the association to be modified by addition of CMISE and SMASE functional unit definition and negotiation, without a change in the application context name.

A.2 Systems management application context

A.2.1 ASEs

This application context consists of the following ASEs and referential relationships:

- ACSE;
- ROSE;
- CMISE;
- SMASE.

The SMASE provides service to the user of the Systems Management Application Entity (SMAE). The SMASE uses the CMISE which, in turn, uses the ROSE. The SACF provides the management association services to the SMAE and uses ACSE.

The SMASE, CMISE and ROSE share a single abstract syntax. This abstract syntax is defined in CCITT Rec. X.711 | ISO/IEC 9596-1.

A.2.2 Elements of procedure

In the Systems management application context both the initiator of the association and responder can take both the agent role and the manager role. When the association is successfully established with the Systems management application context, manager and agent roles may be switched between each interaction taking place on that association, and the assignment of roles for a particular interaction is decided by the invoker of that interaction.

In this application context any interaction can be attempted, but an attempt to use an interaction not supported by both management systems shall result in an error. If an unsupported interaction is attempted, the following error values, as defined in CCITT Rec. X.710 | ISO/IEC 9595, shall be used to report the failure of the interaction:

- “unrecognized operation: the operation is not one of those agreed between the CMISE-service-users”, if the attempted interaction was an operation;
- “no such event type: the event type specified was not recognized”, if the attempted interaction was a notification.

Further elements of procedure are defined in A.3.

A.2.3 Application context name

The Application Context Name of this application context shall have the following object identifier value:

{joint-iso-itu-t ms(9) smo(0) application-context(0) systems-management(2)}

and the following object descriptor value:

"Systems management application context"

A.2.4 Use of ACSE

The association-information parameter defined in ITU-T Rec. X.227 | ISO 8650-1 shall be the sequence of the EXTERNAL data supplied for CMISE, as defined in CCITT Rec. X.711 | ISO/IEC 9596-1, optionally followed by the EXTERNAL data supplied for SMASE.

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The EXTERNAL data supplied for SMASE is an ASN.1 data type “SMASEUserData” as defined in A.3.4.

The mode parameter defined in ITU-T Rec. X.217 | ISO 8649 shall have the value “normal”.

The abstract syntax name specified in A.3.4, shall be included in the Presentation Context Definition List.

A.3 Rules for establishing associations

The association rules for CMISE, specified in Annex A of CCITT Rec. X.711 | ISO/IEC 9596-1, apply for the application context defined within this Recommendation | International Standard.

A.3.1 Application context negotiation

The initiator of the association uses the Systems management application context name to propose the establishment of an association with the Systems management application context.

If the responder accepts the association and responds with the same application context name, then the association is established with the Systems management application context.

If the responder accepts the association but responds with a different application context name, then an association with a different application context is established. The rules for its use and for negotiation of its functionality are out of scope of the Systems management application context.

If the responder rejects the association request, then no application association is established, in accordance with the rules defined in ITU-T Rec. X.227 | ISO 8650-1.

A.3.2 Functional unit negotiation

The negotiation rules defined in CCITT Rec. X.711 | ISO/IEC 9596-1 are followed for negotiating CMISE functional units.

Negotiation of Systems Management Functional Units (SMFUs) is optional. An agreed initial set of SMFUs can be determined at association establishment time by use of the smfuPackages parameter defined in A.3.3 and A.3.4. When a set of SMFUs has been agreed, the association is constrained by the agreed set of functional units until a new agreement has been reached. Only operations and notifications in the agreed set are allowed to be used on the association.

NOTE 1 – Provision of a mechanism to modify the agreed set of SMFUs during the association is the subject of ongoing work.

A set of SMFUs is identified by specifying the smfuPackages parameter with all bits corresponding to elements of the set of SMFUs set to one. Missing trailing bits in a BITSTRING shall be interpreted as set to zero.

To negotiate a set of SMFUs, the initiator of the association shall propose a valid non-empty set of SMFUs. To accept SMFU negotiation, the responder shall respond with a valid set of SMFUs, which is either identical to or a subset of the proposed set. To refuse SMFU negotiation, the responder shall respond with the smfuPackages parameter absent.

If no set of SMFU is proposed by the initiator (the smfuPackages parameter not present on the request), the responder shall respond with the smfuPackages parameter absent, or reject the association.

If SMFU negotiation is accepted, the set of SMFUs specified in the response constitutes the agreed initial set of SMFUs on that association. If the association is successfully established but SMFU negotiation is not accepted, then the rules for the association are governed only by the agreed application context as specified in A.2.2.

NOTE 2 – If two functional units proposed by an initiator provide overlapping management capabilities, and one functional unit is specified in the response and the other functional unit is not specified in the response, then those management capabilities common to both functional units are within the agreed initial set for that association.

The managerRoleFunctionalUnit and the agentRoleFunctionalUnit subparameters of the smfuPackages parameter are used to distinguish between the support of a particular SMFU in either the manager role, the agent role or both. This allows for the use of functional unit negotiation to negotiate down to a manager-only or an agent-only management system.

Once an agreed set of SMFU has been negotiated, the management systems are responsible for supporting any requirements and/or constraints agreed for the association. If specific SMFUs have been negotiated, any attempt to carry out interactions outside the bounds of the negotiated SMFUs shall result in an error.

A.3.3 Guidelines for the definition of functional unit packages

A functional unit package is a non-empty set of functional units, defined for the purposes of negotiation of functional units on an association.

Functional unit package definitions require allocation of an object identifier value. The value of this object identifier is used to identify the functional unit package during association negotiation, using the abstract syntax specified in A.3.4.

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Furthermore a functional unit package definition shall assign one unique bit position to each of the functional units defined within the functional unit package. These bit positions are used to identify which bits to set in either the managerRoleFunctionalUnit BIT STRING or the agentRoleFunctionalUnit BIT STRING or both to indicate which functional units are proposed for negotiation.

EXAMPLE

"This Recommendation | International Standard assigns the following object identifier value

{joint-iso-itu-t ms(9) function(2) partX(X) functionalUnitPackage(1)}

as a value of the ASN.1 type FunctionalUnitPackageId defined in ITU-T Rec. X.701 | ISO/IEC 10040 to use for negotiating the following functional unit(s)

0 functional unit A
1 functional unit B
.
.
.
n functional unit Z

where the numbers identifies the bit position assigned to the functional unit, and the name references the functional units as defined in clause X of this Recommendation | International Standard."

A.3.4 Definition of abstract syntax for SMASE

This Recommendation | International Standard assigns the ASN.1 object identifier value:

{joint-iso-itu-t ms(9) smo(0) negotiationAbstractSyntax(1) version1(1)}

as an abstract syntax name for the set of all presentation data values each of which is a value of the ASN.1 type

SMASE-A-ASSOCIATE-Information.SMASEUserData

The ACSE protocol (see ITU-T Rec. X.227 | ISO 8650-1) is described using ASN.1. The “user information” is defined using the EXTERNAL data type. The SMASE user information to be passed in the A-ASSOCIATE in a separate EXTERNAL in the “user information” parameter is defined as follows:

```
SMASE-A-ASSOCIATE-Information {joint-iso-itu-t ms(9) smo(0) asn1Modules(2) negotiationDefinitions(0)
version1(1)}
DEFINITIONS ::= BEGIN
  SMASEUserData ::= SEQUENCE{
      smfuPackages SET OF FunctionalUnitPackage OPTIONAL,
      -- shall be present on request/indication if SMFU
      -- negotiation is proposed and on response/confirm
      -- if SMFU negotiation is accepted, otherwise this
      -- parameter shall be omitted.
      reason Reason OPTIONAL,
      -- may only be present on A-ASSOCIATE response/confirm.
      -- When SMFU negotiation fails, when SMFU negotiation
      -- results in a reduction of the proposed set of SMFUs
      -- or when the association request is rejected, it may
      -- carry a specific reason for this.
      systemsManagementUserInformation GraphicString OPTIONAL
      -- this parameter is provided solely for the convenience
      -- of implementations needing to distinguish between
      -- different implementation environments, it shall not
      -- be the subject of conformance test
  }

  Reason ::= INTEGER {
      smfusNotSupported                (0),
        -- one or more of the requested SMFUs are not supported
      smfuCombinationNotSupported      (1),
        -- the individual SMFUs are supported, but not
        -- in this proposed combination on a single association
      smfusRequiredNotAvailable        (2),
        -- one or more required SMFUs have been negotiated away
```


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```
        smfuNegotiationRefused                (3)
          -- responder refuses to negotiate SMFUs
          -- without explicitly stating why
    }

    FunctionalUnitPackage ::= SEQUENCE {
        functionalUnitPackageId FunctionalUnitPackageId,
        managerRoleFunctionalUnit [0] IMPLICIT BIT STRING DEFAULT {},
            -- If not present implies role not supported for this functionalUnitPackage.
        agentRoleFunctionalUnit [1] IMPLICIT BIT STRING DEFAULT {}
            -- If not present implies role not supported for this functionalUnitPackage.
        }

    FunctionalUnitPackageId ::= OBJECT IDENTIFIER

    END
```

A.3.5 Minimum communications support

Where systems management communications uses connection oriented services, the minimum requirements of systems management for supporting services are:

- a Presentation connection only using the kernel functional unit without any context management service elements;
- a two-way simultaneous Session connection without expedited or synchronization service element.

A.4 Conformance

An open system claiming conformance to the Systems management application context shall comply with the static and dynamic requirements stated in A.4.1 and A.4.2.

A.4.1 Static conformance

The system shall support the transfer syntax derived from the encoding rules specified in CCITT Rec. X.209 | ISO/IEC 8825 and the named {joint-iso-itu-t asn1(1) basic-encoding(1)} set of encoding rules for the purpose of interpreting the user-information parameter in the ACSE-apdu as defined by the abstract syntax {joint-iso-itu-t ms(9) smo(0) negotiationAbstractSyntax(1) version1(1)} defined in A.3.4.

A.4.2 Dynamic conformance

The open system shall support the elements of procedure defined in this annex as either association initiator, association responder or both.

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Annex B

Scope statement for systems management functions

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

This boilerplate for scope clauses defines the elements that are required to be present (or absent) in scope clauses as a consequence of the definitions that appear in clause 7; it does not disallow the addition of other material in the scope clause that may be required for other reasons.

B.1 The rules

The rules that applies to filling in the scope boilerplate are:

- {} surround elements in the boilerplate that require context specific modification;
- [] surround optional elements of the boilerplate;
- ***comment*** is used to qualify {} and [] where necessary to further describe the nature of the optionality or replacement text required.

B.2 The boilerplate

The boilerplate for writing scope clauses in systems management standards is:

1 Scope

This part of this Recommendation | International Standard

SERVICE DEFINITION PART:[

- establishes user requirements for the service definition needed to support the {function name} function;
- establishes models that relate the service provided by the function to the user requirements;
- defines the service provided by the function;
- specifies the protocol that is necessary in order to provide the service;
- defines the relationship between the service and SMI management operations and notifications;
- defines relationships with other systems management functions;
- specifies conformance requirements.

]***Present only in standards that define systems management services***

GENERIC DEFINITION PART:[

- establishes user requirements for the generic definitions needed to support the {function name} function;
- establishes models that relate the generic definitions to user requirements;
- defines generic [managed object classes,] [attribute types,] [management operation types,] [notification types,]***delete as appropriate*** documented in accordance with the guidelines for the definition of managed objects;
- specifies compliance requirements placed on other standards that make use of these generic definitions.

]***May exist IN ISOLATION in a single standard but shall not exist in a standard that contains a FUNCTIONAL UNIT PART unless the standard also contains a SERVICE DEFINITION PART.***

FUNCTIONAL UNIT PART:[

- establishes user requirements for the {name[s] of functional unit[s]} functional unit[s];
- establishes models that relate the functional unit[s] to the user requirements;
- defines the functional unit[s] and the list[s] of systems management services that are required by the functional unit[s];

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- specifies the abstract syntax necessary to identify the functional unit[s] in protocol;
- [establishes the relationship[s] between {functional unit name[s]} functional unit[s];]
- [establishes the relationships between the {functional unit name[s]} functional unit[s] and the function name[s]} systems management function[s];]
- specifies conformance requirements.

]***May exist IN ISOLATION in a single standard but shall not exist in a standard that contains a GENERIC DEFINITION PART unless the standard also contains a SERVICE DEFINITION PART.***

This Recommendation | International Standard is applicable to {field of application, user requirements, e.g. "managing states..."}.

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