INTERNATIONAL STANDARD

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2000-11-01

Information technology — Open Systems Interconnection — Structure of management information: Managed objects for supporting upper layers

Technologies de l'information — Interconnexion de systèmes ouverts (OSI) — Structure de l'information de gestion: Objets gérés pour supporter les couches supérieures

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO/IEC 10165 may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 10165-8 was prepared by ITU-T (as ITU-T Recommendation X.287) and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

ISO/IEC 10165 consists of the following parts, under the general title *Information technology — Open Systems Interconnection — Structure of management information*:

— *Part 1: Management Information Model*

— *Part 2: Definition of management information*

— *Part 4: Guidelines for the definition of managed objects*

— *Part 5: Generic management information*

— *Part 6: Requirements and guidelines for implementation conformance statement proformas associated with OSI management*

— *Part 7: General relationship model*

— *Part 8: Managed objects for supporting upper layers*

— *Part 9: Systems management application layer managed objects*

Annexes A and B form a normative part of this part of ISO/IEC 10165.

INTERNATIONAL STANDARD

ITU-T RECOMMENDATION

INFORMATION TECHNOLOGY – OPEN SYSTEMS INTERCONNECTION – STRUCTURE OF MANAGEMENT INFORMATION: MANAGED OBJECTS FOR SUPPORTING UPPER LAYERS

1 Scope

This Recommendation | International Standard defines generic upper-layer managed objects.

This Recommendation | International Standard:

- establishes a model for common supporting upper layer objects;
- provides generic and formal definitions for common supporting upper layer information (managed objects).

This Recommendation | International Standard does not:

- define new management functions;
- specify a framework or methodology for conformance tests.

In the context of this Recommendation | International Standard, the term *Supporting Upper Layers* is used to refer to ACSE, Presentation, and Session layers.

2 Normative references

The following ITU-T 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 agreements 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 current valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of the 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.226 (1994) | ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification.*
- 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.*
- ITU-T Recommendation X.283 (1997) | ISO/IEC 10733:1998, *Information technology – Elements of management information related to the OSI Network layer.*
- ITU-T Recommendation X.284 (1997) | ISO/IEC 10737:1998, *Information technology – Elements of management information related to the OSI Transport layer.*

- ITU-T Recommendation X.501 (1997) | ISO/IEC 9594-2:1998 *Information technology – Open Systems Interconnection – The Directory: Models.*
- ITU-T Recommendation X.650 (1996) | ISO/IEC 7498-3:1997, *Information techology – Open Systems Interconnection – Basic reference model: Naming and addressing.*
- ITU-T Recommendation X.701 (1997) | ISO/IEC 10040:1998, *Information technology – Open Systems Interconnection – Systems management overview.*
- ITU-T Recommendation X.710 (1997) | ISO/IEC 9595:1998, *Information technology – Open Systems Interconnection – Common management information service.*
- ITU-T Recommendation X.711 (1997) | ISO/IEC 9596-1:1998, *Information technology – Open Systems Interconnection – Common management information protocol: Specification.*
- CCITT Recommendation X.720 (1992) | ISO/IEC 10165-1:1993, *Information technology – Open Systems Interconnection – Structure of management information: Management information model.*
- CCITT Recommendation X.721 (1992) | ISO/IEC 10165-2:1992, *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information.*
- CCITT Recommendation X.722 (1992) | ISO/IEC 10165-4:1992, *Information technology – Open Systems Interconnection – Structure of management information: Guidelines for the definition of managed objects.*
- ITU-T Recommendation X.723 (1993) | ISO/IEC 10165-5:1994, *Information technology – Open Systems Interconnection – Structure of management information: Generic management information.*
- ITU-T Recommendation X.727 (1999) | ISO/IEC 10165-9:2000 *Information technology – Open Systems Interconnection – Structure of management information: Systems management application layer managed objects.*

2.2 Paired ITU-T Recommendations | International Standards equivalent in technical content

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

  ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1).*

- CCITT Recommendation X.290 (1995), OSI *conformance testing methodology and framework for protocol Recommendations for ITU-T applications – General concepts.*

  ISO 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts.*

- CCITT Recommendation X.700 (1992), *Management framework for Open Systems Interconnection (OSI) for CCITT Applications.*

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

2.3 Additional references

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

3 Definitions

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

3.1 Basic reference model definitions

This Recommendation | International Standard makes use of the following terms defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

a) open system;

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) systems management application-entity.

3.3 CMIS definitions

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

a) attribute;

b) Common Management Information Service Element;

c) Common Management Information Service.

3.4 Remote Operations definitions

This Recommendation | International Standard makes use of the following terms defined in CCITT Rec. X.219 | ISO/IEC 13712-1:

a) invoker;

b) performer.

3.5 Systems management overview definitions

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

a) agent;

b) agent role;

c) generic definitions;

d) managed object class;

e) managed (open) system;

f) manager;

g) manager role;

h) MIS-User;

i) notification;

j) notification type;

k) systems management application protocol;

l) systems management functional unit.

3.6 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) containment hierarchy.

3.7 Guidelines for the definition of managed objects definitions

This Recommendation | International Standard makes use of the following term defined in CCITT Rec. X.722 | ISO/IEC 10165-4:

– template.

4 Symbols and abbreviations

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

ACSE Association Control Service Element
AE Application Entity
AEI Application Entity Invocation
ALS Application Layer Structure
AP Application Process
API Application Process Invocation
ASE Application Service Element
ASO Application Service Object
CL Connectionless
CMISE Common Management Information Service Element
CO Connection Oriented
DN Distinguished Name
FU Functional Unit
GMI Generic Management Information
OSI Open Systems Interconnection
PDU Protocol Data Unit
PM Protocol Machine
PPDU Presentation Layer PDU
PSA Presentation Layer SAP
RDN Relative Distinguished Name
ROSE Remote Operations Service Element
SAP Service Access Point
SMASE Systems Management Application Service Element
SSAP Session Layer SAP
TSAP Transport Layer SAP
TSDU Transport Service Data Unit
UL Upper Layer

5 Conventions

This Recommendation | International Standard makes use of the template notation defined in CCITT Rec. X.722 | ISO/IEC 10165-4 as the notation for defining managed object classes and the abstract syntax notation defined in CCITT Rec. X.208 | ISO/IEC 8824 as the means of defining ASN.1 data types associated with the use of template notation.

6 Overview

This Recommendation | International Standard defines Managed Objects that represent OSI Management's view of those elements of an Open System which support the OSI Session, Presentation and Application Layer services subject to OSI management operations.

The defined objects are of four different kinds:

- Communication Entities representing active functional elements which perform communication processing functions within a system.
- Protocol Machines performing communications functions within an entity.
- Service AccessPoints at which services are provided by an entity to the user entity.
- Connections and Associations established between entities for the transfer of service or protocol data.

The first three kinds of objects are of a static nature, and the last kind is of a more dynamic nature.

6.1 Upper Layer Model

The relationship between the Upper Layer object at each layer follows the structure as defined in the lower layers. This structure of objects in the lower layers, as defined by ITU-T Rec. X.283 | ISO/IEC 10733, Elements of management information related to the OSI Network layer and ITU-T X.284 | ISO/IEC 10737, Elements of management information related to the OSI Transport layer, is as illustrated in Figure 1.

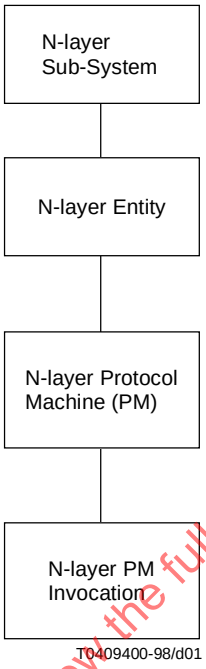


Figure 1 – Generic OSI Layer Containment Hierarchy

N-Layer subsystems are subclasses of the managed object class "Rec. X.723 | ISO/IEC 10165-5:1994":subsystem. This managed object class is used as a common containment point for managed objects in a system that relates to the operation on the N-layer.

N-layer entities are subclasses of the managed object class "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntity. This managed object class is used to represent the active functional elements which perform communications processing functions within a system, e.g. Network Entity, Transport Entity, etc. The localSapNames attribute contains a set of distinguished names of layer (N – 1) SAPs or ports at which services are provided to the entity.

N-layer protocol machines are subclasses of either "Rec. X.723 | ISO/IEC 10165-5:1994":clProtocolMachine or "Rec. X.723 | ISO/IEC 10165-5:1994":coProtocolMachine. These represent the protocol machine performing communications (connectionless-mode or connection-mode, respectively) within an entity. The information represented may include the information across all invocations initiated by this protocol machine. A protocol machine includes the mechanism for both the establishment and data-transfer phases of the communications.

N-layer invocations are subclasses of "Rec. X.723 | ISO/IEC 10165-5:1994":singlePeerConnection and represent an association or a connection established between N-layer entities for the transfer of service or protocol data (using an N-layer protocol of the N-layer protocol machine). The underlyingconnectionNames attribute contains the distinguished names of the managed objects that represent the underlying connections or physical media used by the connection (i.e. supporting service invocation).

This same model essentially applies to all the layers in the OSI model. However, at the application layer, the protocol machine is actually composed of different protocol modules or components called Application Service Objects (ASOs). These components represent the different establishment (and termination) and data transfer phases of communication.

Generally, ACSE (a subclass of ASO) will be the ASO that provides the establishment phase with one or more other ASOs composing the data transfer phase. Although the ASOs are often referred to as protocol machines themselves, they actually represent only a component. While it is true that certain ASOs may have a state machine (e.g. CMISE PM, SMASE PM, ACSE PM), it is only the combination of ASOs and ACSE that constitutes a protocol machine in the same sense as the lower layers, i.e. containing both the establishment and data transfer phases.

As a result, in this Application Layer Model, it may be necessary to show the "structure" of the "constructed" PM in terms of its ASOs. This same "structure" is also reflected in the PM's invocations of the ASOs. The relationship between a PM and its ASOs (i.e. its "structure") is represented by naming. Naming may also be used to show the relationship between the invocation of an application layer PM and its component ASO. If naming is used to represent the components of a PM and its invocation, the naming structures of an application layer PM and that of its invocation should be isomorphic. (See Figures 7 and 8.)

Because the Application Layer PM is a composition, it is not modelled as a separate object from its entity, the Application Entity. Rather, only the component PMs, the ASOs, are represented as managed objects. Therefore, in the application layer, the application layer entity and its PM are modelled as one object, called the Application Entity (AE). This object then contains or is related to the objects that represent the modules or components of the PM; these objects are ASOs or subclasses of ASO. Also in order to represent the structure of the component invocations in the same configuration as the components themselves the invocation of this application Layer PM, called Application Entity Invocation, is modelled as a separate object in order to represent the structure of the component invocations (e.g. it can be used as the "container" of the component invocations).

In the lower layers as seen above, the PM invocations are contained in their respective PMs. Unlike the lower layers, however, the Application Layer models the components of the protocol machine and its invocations. Therefore, in the application layer model, an invocation has a relationship to both its corresponding PM component and its superior invocation. The relationship between a component invocation and its containing invocation object is represented by naming, in which the component invocations are named with respect to the application layer invocation object and represent the structure of the invocation. Each component invocation has a pointer to its corresponding PM component. This relationship is represented by the attribute invocationOfPointer. If the structure of the PM is simple enough, this relationship may be represented by naming. See Figure 4 for possible name bindings.

For the Application Layer Structure (ALS) defined in ITU-T Rec. X.227 | ISO/IEC 8650-1, the concept of an Application Service Object (ASO) and its recursive structure also needs to be modelled. An ASO is an element within an AE representing a set of capabilities: it contains two or more ASOs combined with a Control Function (CF) that controls the interactions among its components.

The term ASE is used to refer to specialized ASOs that cannot be decomposed, that is, they cannot be composed of other ASOs.

Specific ASEs are modelled as subclasses of ASO.

An ASO that contains an Establishment ASE (e.g. ACSE) and at least one data transfer ASE is called an ASO Entity. An AE is a specialized ASO Entity that includes an Establishment ASE (e.g. ACSE) among its ASO(s) and/or ASE(s); it is always the outermost ASO Entity in an Application Layer which refers to a PSAP. An AE can also contain the following: ASO Entities which include ACSE (ASOEs); ASOs which do not contain ACSE; and ASEs.

With respect to specialized ASEs, only the management of ACSE is standardized in this Recommendation | International Standard. Management of other ASEs, like CMISE, ROSE, SMASE etc. might be specified in other standards.

6.2 Managed Object Hierarchy

6.2.1 Session Layer Managed Object Classes

The following managed object classes are defined for the session layer:

a) Session Entity;

b) Session Connection-oriented Protocol Machine;

c) S (Session) SAP;

d) Session Connection;

e) Session Subsystem.

The session layer containment hierarchy is illustrated in Figure 2.

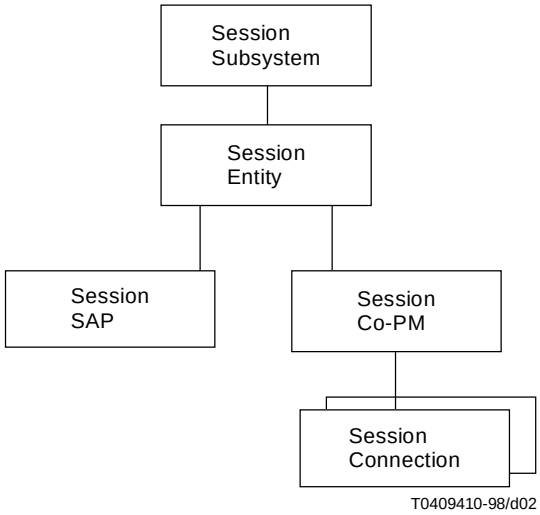


Figure 2 – Session Layer Containment Hierarchy

6.2.2 Presentation Layer Managed Object Classes

The following managed object classes are defined for the presentation layer:

f) Presentation Entity;

g) Presentation Connection-oriented Protocol Machine;

h) P (Presentation) SAP;

i) Presentation Connection;

j) Presentation Subsystem.

The presentation layer containment hierarchy is illustrated in Figure 3.

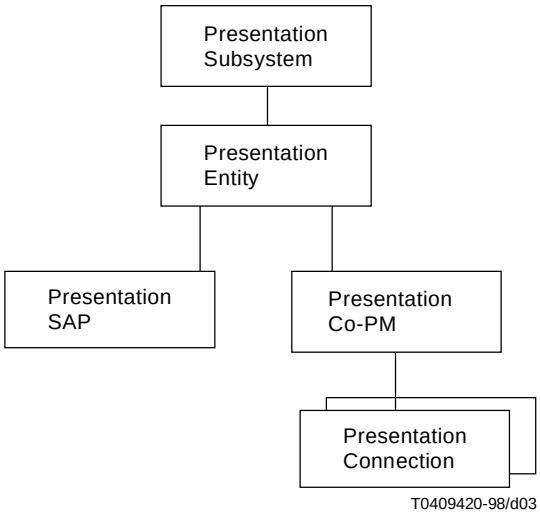


Figure 3 – Presentation Layer Containment Hierarchy

6.2.3 Application Layer Managed Object Classes

The following managed objects are defined for the application layer:

k) Application Entity;

l) Application Entity Invocation;

m) ACSE;

n) ACSE Association;

o) Application Subsystem;

p) AP (Application Process) Invocation;

q) ASO Entity;

r) ASO;

s) ASO Invocation.

A generic application layer containment hierarchy is illustrated in Figure 4.

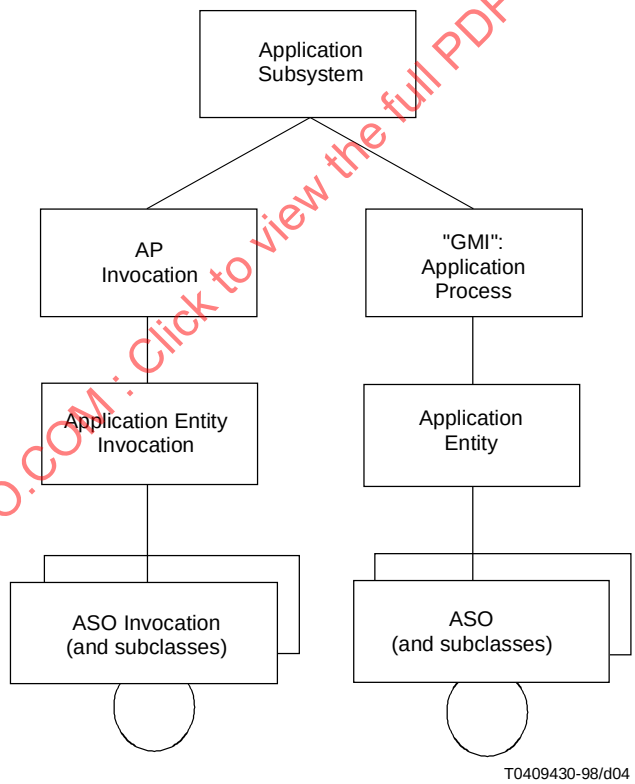
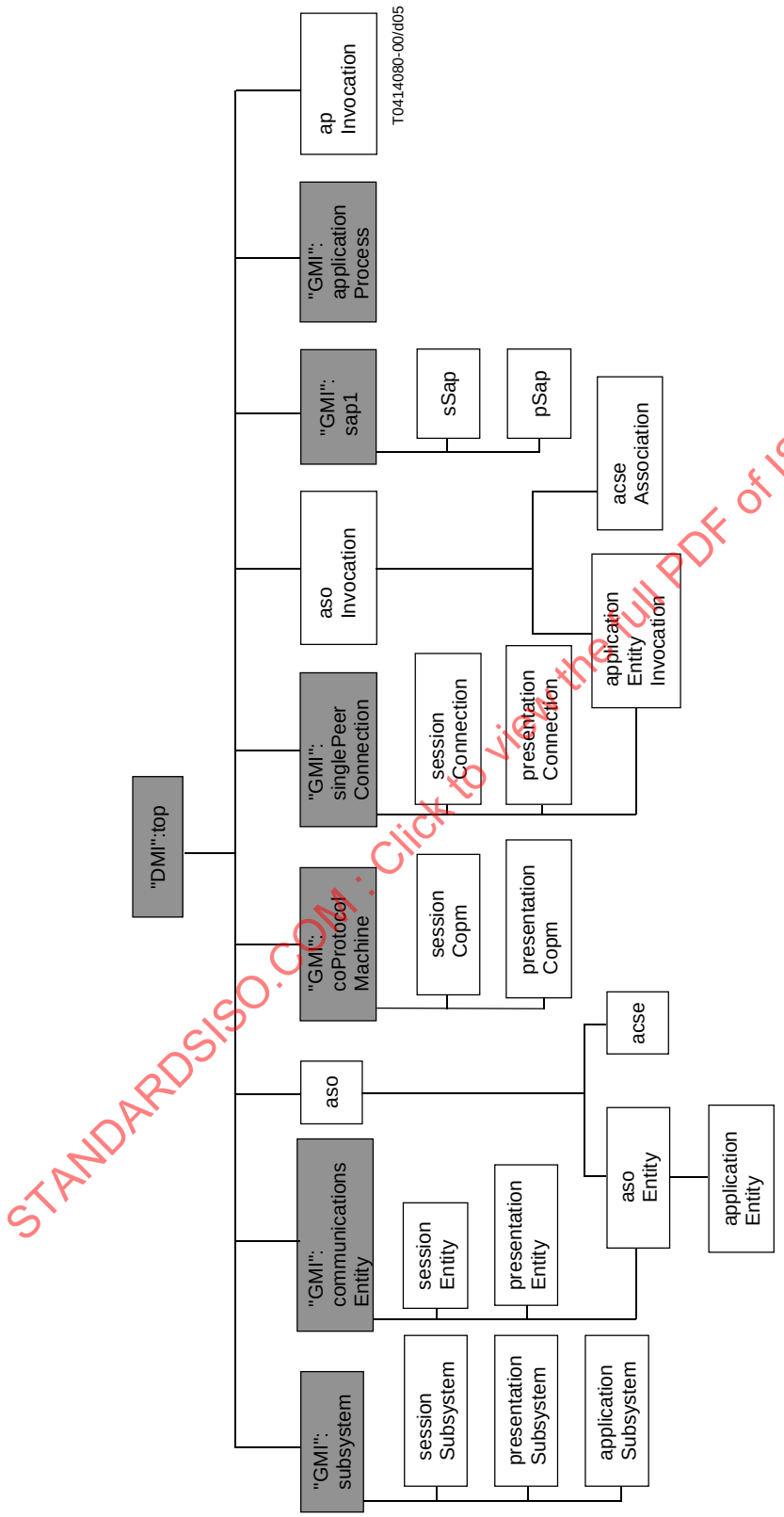


Figure 4 – Generic Application Layer Containment Hierarchy

6.3 Inheritance

The inheritance hierarchy for the managed object classes defined for the session, presentation and application layers is illustrated below in Figure 5.



Shaded object classes are defined in other Recommendations | International Standards:
"DMI"="Rec. X.721 | ISO/IEC 10165-2 : 1992"
"GMI"="Rec. X.723 | ISO/IEC 10165-5 : 1995"

Figure 5 – Inheritance Hierarchy of Upper Layer Objects

6.4 Relationships

6.4.1 Layer N-1 Services

Each entity has a relation to the SAP managed object of its underlying layer.

6.4.2 Connections

There is a relationship between a connection/association and its underlying connection managed objects. At the presentation and session layers, and for entities at the application layer (i.e. ASO Entities, Application Entity), there is a relationship between a connection/association and its underlying connection managed object. The underlyingConnectionNames attribute pointer is used to represent this relationship. For example, the presentation connection is related to the session connection via the underlyingConnectionNames attribute pointer. An Application Entity Invocation points to its presentation Connection using the same attribute pointer.

6.5 Session and presentation layer invocations

Figure 6 illustrates the various relationships among managed objects at the session and presentation layers. These relationships are represented either via containment (illustrated as straight lines) or via pointer attributes (illustrated as arrowed lines).

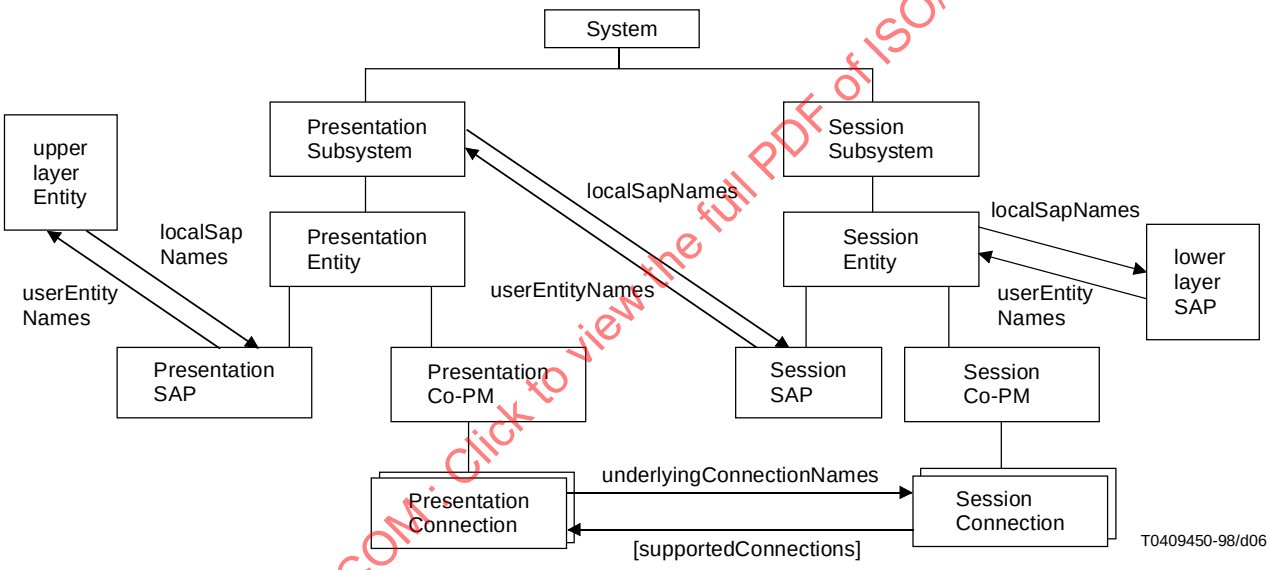


Figure 6 – Presentation and Session Layer Relationships

6.6 Application entity and application entity invocations

An example of a containment hierarchy for a typical application layer using ACSE and other ASEs appears in Figure 7. This figure also identifies the other relationships between object instances represented by pointer attributes (illustrated as arrowed lines). Figure 8 shows an example for a generic application layer using ASO Entities, ASOs and ASEs.

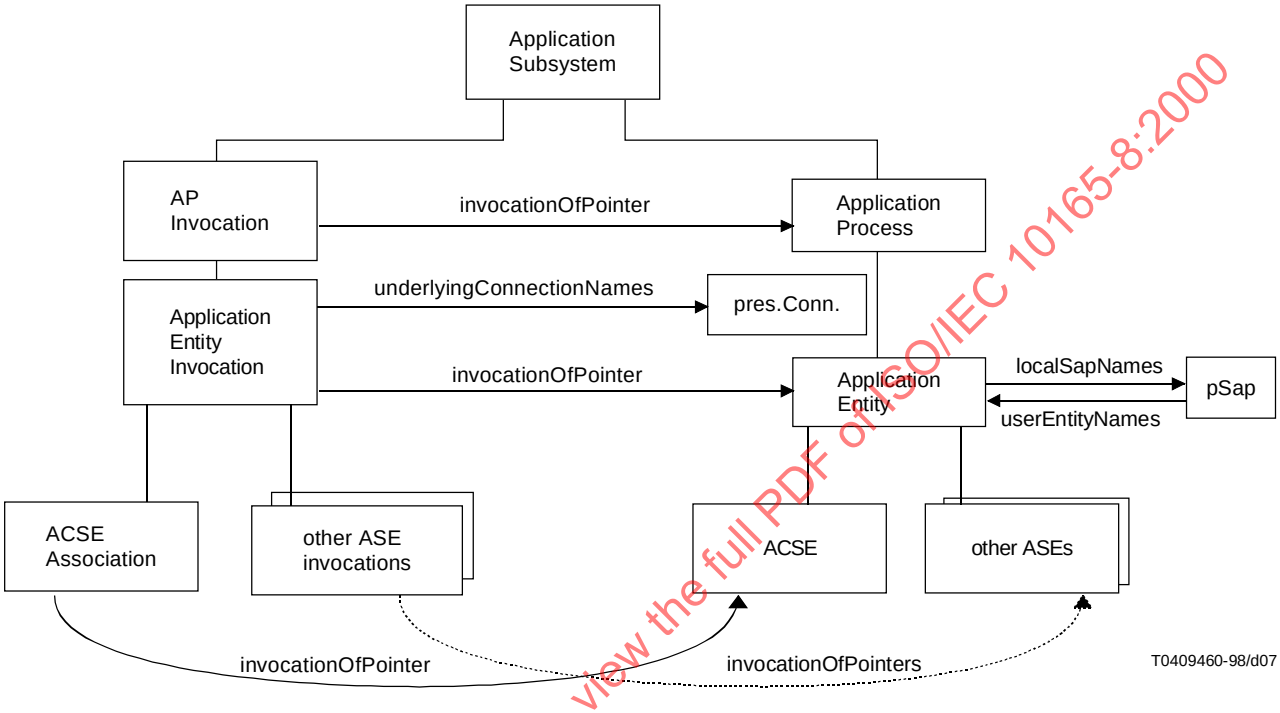


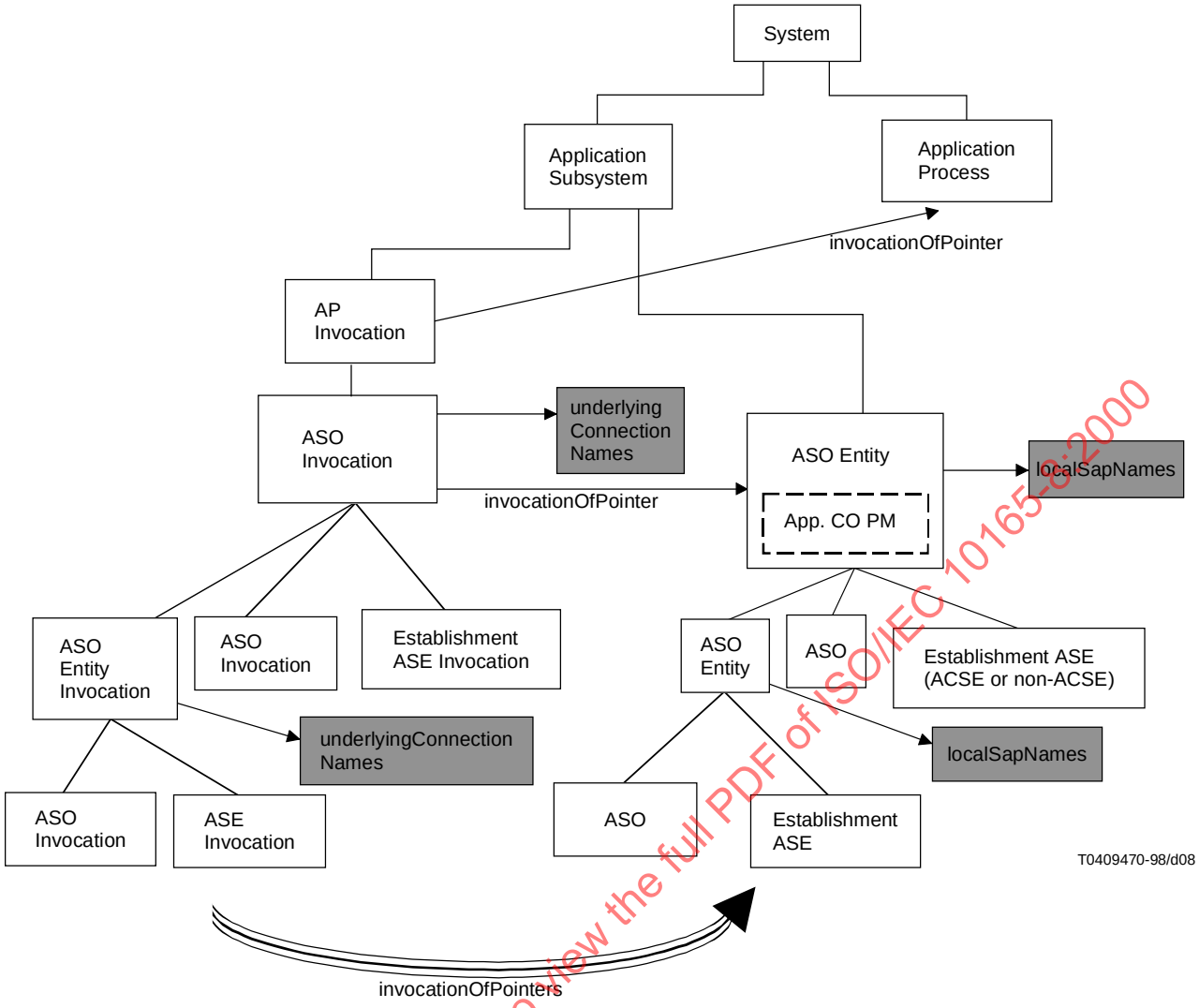
Figure 7 – Application Layer Containment Hierarchy with ACSE

The solid lines represent containment relationships between managed object instances. Containment relationships are used to determine the Distinguished names for managed object instances (i.e. the contained managed object instance is named within the scope of the containing managed object instance). An arrowed line represents a relationship attribute (i.e. pointer from one managed object instance to another).

An Application process is part of an open system. A managed open system (represented by a managed object such as system managed object defined in CCITT Rec. X.721 | ISO/IEC 10165-2 or managedElement managed object defined in ITU-T Rec. M.3100) may contain zero or more Application processes in its application subsystem. An Application process may also be contained in the system object directly. In this case, the Application Entity is contained in the Application Subsystem rather than the Application Process.

The name of the application entity is its application entity title, and the name of the application process is its application process title. It is possible, with the proper name bindings and choice of naming attributes, to have the name of the managed objects representing an Application entity and its Application process to be the same as the Distinguished Names of their form 1 Application entity title and Application process title, respectively.

To enable naming harmony between the AE-title and the name of the AE managed object, the naming attribute (Relative Distinguished Name / RDN) of the Application entity managed object instance must be the form 1 Application entity qualifier.



NOTE 1 – Each component of the uppermost ASO Invocation points to its corresponding component under the ASO Entity.

NOTE 2 – An ASO Entity must contain an Establishment ASE (may be ACSE or non-ACSE).

NOTE 3 – In this figure, the ASO Invocation structure is isomorphic to its corresponding ASO Entity structure.

NOTE 4 – Entities that are shaded are outside the scope of this Application Layer.

NOTE 5 – Solid lines indicate containment relationships, arrowed lines indicate attribute pointer relationships.

Figure 8 – Generic Application Layer Containment Hierarchy

7 Generic definitions

7.1 Imported definitions

7.1.1 Imported managed object classes

The following managed object classes and their associated attributes are imported from ITU-T Rec. X.723 | ISO/IEC 10165-5 and CCITT Rec. X.721 | ISO/IEC 10165-2:

– "Rec. X.723 | ISO/IEC 10165-5:1994":applicationProcess

– "Rec. X.723 | ISO/IEC 10165-5:1994":applicationProcessId

– "Rec. X.723 | ISO/IEC 10165-5:1994":applicationProcessTitle

– "Rec. X.723 | ISO/IEC 10165-5:1994":supportEntityNames

– "Rec. X.721 | ISO/IEC 10165-2:1992":operationalState

- "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntity
  - "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntityId
  - "Rec. X.723 | ISO/IEC 10165-5:1994":localSapNames
  - "Rec. X.721 | ISO/IEC 10165-2:1992":operationalState
- "Rec. X.723 | ISO/IEC 10165-5:1994":coProtocolMachine
  - "Rec. X.723 | ISO/IEC 10165-5:1994":coProtocolMachineId
  - "Rec. X.721 | ISO/IEC 10165-2:1992":operationalState
- "Rec. X.723 | ISO/IEC 10165-5:1994":Sap1
  - "Rec. X.723 | ISO/IEC 10165-5:1994":sapId
  - "Rec. X.723 | ISO/IEC 10165-5:1994":sap1Address
  - "Rec. X.723 | ISO/IEC 10165-5:1994":userEntityNames
- "Rec. X.723 | ISO/IEC 10165-5:1994":Single peer connection
  - "Rec. X.723 | ISO/IEC 10165-5:1994":connectionId
  - "Rec. X.723 | ISO/IEC 10165-5:1994":underlyingConnectionNames
  - "Rec. X.723 | ISO/IEC 10165-5:1994":supportedConnectionNames (conditional)
- "Rec. X.723 | ISO/IEC 10165-5:1994":subsystem
  - "Rec. X.723 | ISO/IEC 10165-5:1994":subsystemId

7.1.2 Imported name bindings

The following name bindings are imported from ITU-T Rec. X.723 | ISO/IEC 10165-5:

- applicationProcess-system;
- communicationsEntity-subsystem;
- coProtocolMachine-communicationsEntity;
- sap1-communicationsEntity;
- singlePeerConnection-coProtocolMachine;
- subsystem-system.

The communicationsEntity-subsystem namebinding is used for naming instances of sessionEntity with respect to sessionSubsystem and for naming instances of presentationEntity to presentationSubsystem.

The coProtocolMachine-communicationsEntity namebinding is used for naming instances of sessionCopm with respect to sessionEntity and for naming instances of presentationCopm with respect to presentationEntity.

The sap1-communicationEntity namebinding is used for naming instances of sSap to sessionEntity and for naming instances of pSap to presentationEntity.

The singlePeerConnection-coProtocolMachine namebinding is used for naming instances of sessionConnection to sessionCopm and for naming instances of presentationConnection to presentationCopm.

7.2 Session layer managed object classes

7.2.1 Session Subsystem

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":subsystem holds reference information about Session subsystem.

It specializes by adding only behaviour.

7.2.2 Session Entity

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntity holds reference information about Session entity.

It specializes by adding only behaviour.

7.2.3 Session COPM

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":coProtocolMachine holds reference information pertaining to the capabilities of a Session protocol machine.

It specializes by adding the following attributes:

- Session protocol versions supported (bitstring);
- Session functional units supported (bitstring);
- Session optional support requirements (i.e. segmenting).

7.2.4 SSAP

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":sap1 has the S-selector and the binding between the Presentation Entity and the sap.

It specializes by adding only behaviour.

7.2.5 Session Connection

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":singlePeerConnection holds reference information pertaining to the single session connection for the association. The underlying connections attribute is used to point to the transport connection used.

It specializes by adding the following attributes:

- Session protocol version in use;
- Session functional units negotiated in use;
- it may have an attribute for the negotiated maximum TSDU size if segmenting is in use.

NOTE – Subclasses of this object class may be defined to include statistics on PPDU transfers which take place over the connection.

7.3 Presentation layer managed object classes

7.3.1 Presentation Subsystem

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":subsystem holds reference information about Presentation Subsystem.

It specializes by adding only behaviour.

7.3.2 Presentation Entity

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntity holds reference information about Presentation Entity.

It specializes by adding only behaviour.

7.3.3 Presentation COPM

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":coProtocolMachine holds reference information pertaining to the capabilities of a Presentation protocol machine.

It specializes by adding the following attributes:

- Presentation functional units supported (bitstring);
- Abstract syntaxes supported (set of OBJECT IDENTIFIER);
- Transfer syntaxes supported (set of OBJECT IDENTIFIER).

7.3.4 PSAP

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":sap1 has the P-selector and the binding between the AE and the sap.

It specializes by adding only behaviour.

7.3.5 Presentation Connection

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":singlePeerConnection holds reference information pertaining to the single presentation connection for the association. The underlying connections attribute is used to point to the session connection endpoint used.

It specializes by adding the following attributes:

- presentation functional units negotiated in use;
- presentation contexts in use.

NOTE – Subclasses of this object class may be defined to include statistics on PPDU transfers which take place over the connection.

7.4 Application layer managed object classes

7.4.1 Application entity

This subclass of asoEntity holds reference information about an Application entity and its associated ACSE protocol machine.

It specializes by adding behaviour which restricts the values of its asoEntity attributes.

7.4.2 Application subsystem

This subclass of "Rec. X.723 | ISO/IEC 10165-5:1994":subsystem holds reference information about an Application subsystem.

It specializes by adding only behaviour.

7.4.3 ASO

This subclass of "Rec. X.721 | ISO/IEC 10165-2:1992":top holds reference information about an ASO.

It specializes by adding the following attributes:

- "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntityId;
- asoTitle;
- asoQualifier;
- "Rec X.721 | ISO/IEC 10165-2 : 1992":operationalState.

7.4.4 ASO entity

This subclass of aso and "Rec. X.723 | ISO/IEC 10165-5:1994":communicationsEntity holds reference information about an ASO entity.

It specializes by adding the following attribute:

- application context names supported.

7.4.5 ACSE

This subclass of aso holds reference information about ACSE application service element.

It specializes by adding the following attributes:

- ACSE functional units supported as initiator;
- ACSE functional units supported as responder;
- ACSE editions supported.

7.4.6 ASO Invocation

This subclass of "Rec. X.721 | ISO/IEC 10165-2:1992":top holds reference information about an invocation of an ASO or of an ASO entity.

It specializes by adding the following attributes:

- "Rec. X.723 | ISO/IEC 10165-5:1994":connectionId;
- invocationOfPointer.

7.4.7 Application entity invocation

This subclass of asoInvocation and "Rec. X.723 | ISO/IEC 10165-5:1994":singlePeerConnection holds reference information about an application entity invocation.

It specializes by adding only behaviour.

7.4.8 ACSE association

This subclass of asoInvocation holds reference information about an ACSE association.

It specializes by adding the following attributes:

- calling AE title;
- ACSE functional units negotiated in use;
- Application context in use;
- parent ASO invocation (relationship pointer to parent ASO invocation. It could be the AEI);
- it may also have an attribute for the called AE Title, if the AE Title is known.

7.4.9 AP invocation

This subclass of "Rec. X.721 | ISO/IEC 10165-2:1992":top holds reference information about an application process (AP) invocation.

It specializes by adding the following attributes:

- apInvocationId;
- invocationOfPointer, to identify the specific AP it is an invocation of.

7.5 Name bindings

The following name bindings are defined in this Recommendation | International Standard for support of the model:

- apInvocation-applicationSubsystem;
- applicationProcess-applicationSubsystem;
- asoInvocation-apInvocation;
- asoInvocation-asoInvocation;
- asoEntity-applicationProcess;
- aso-asoEntity;
- aso-aso.

Annex A

Monolithic Upper Layer

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

Given that a separate layer managed object design is defined, the characteristics of the separate managed objects can be included in defining a merged or monolithic upper layer objects (e.g. a monolithic upper layer entity managed object, a monolithic upper layer connection protocol machine managed object, and a monolithic upper layer connection managed object, as shown in Figure A.1). Monolithic upper layer implementations are not adequately modelled by separate managed objects for each protocol layer. The monolithic upper layer object classes define essentially merge the functionality of the separate session layer, presentation layer and application entity object classes into one object class for an entity, a connection protocol machine and a connection. Note that the behaviour at the application layer for the application entity's constituent ASO Entities, ASOs, and ASEs does not change.

The management information in the monolithic managed object design is essentially the same as the management information in the separable upper layer managed object design previously defined.

The information being kept is the same for the monolithic managed object case as for the separate managed object case, except for the lack of need for the one-to-one relationship pointers.

The monolithic upper layer entity managed objects are appropriate when the implementation has combined the upper layer protocols into a single entity.

For the monolithic UL entity managed object class, multiple inheritance is used from the application entity, presentation entity, session entity, presentation COPM, and session COPM managed object classes. The PSAP and SSAP do not need to be represented because null selectors are appropriate in the monolithic case. Specific implementations which use non-null selectors could subclass. The local SAP names attribute is used to point to the TSAP managed object.

Similarly, for the monolithic UL Connection managed object class, multiple inheritance is used from the Application Entity Invocation, Presentation Connection, and Session Connection managed object classes.

It would not be easy to merge the ASO/ASE specific association information objects, due to the one-to-many containment relationship. Having a different monolithic ASO/ASE-association endpoint subclass defined for each ASO/ASE-type is not practical due to the combinatorial complexity involved.

There is benefit in retaining separate managed object instances to maintain each ASO/ASE invocation's view of the association.

A.1 Monolithic Upper Layer Subsystem

This subclass of applicationSubsystem, presentationSubsystem, and sessionSubsystem holds reference information about an application subsystem which has monolithic connection of all three upper layers.

It specializes by adding only behaviour.

A.2 Monolithic Upper Layer Entity

This subclass of applicationEntity, presentationEntity, sessionEntity, presentationCopm and sessionCopm holds reference information about an application entity which has monolithic implementation of all three upper layers.

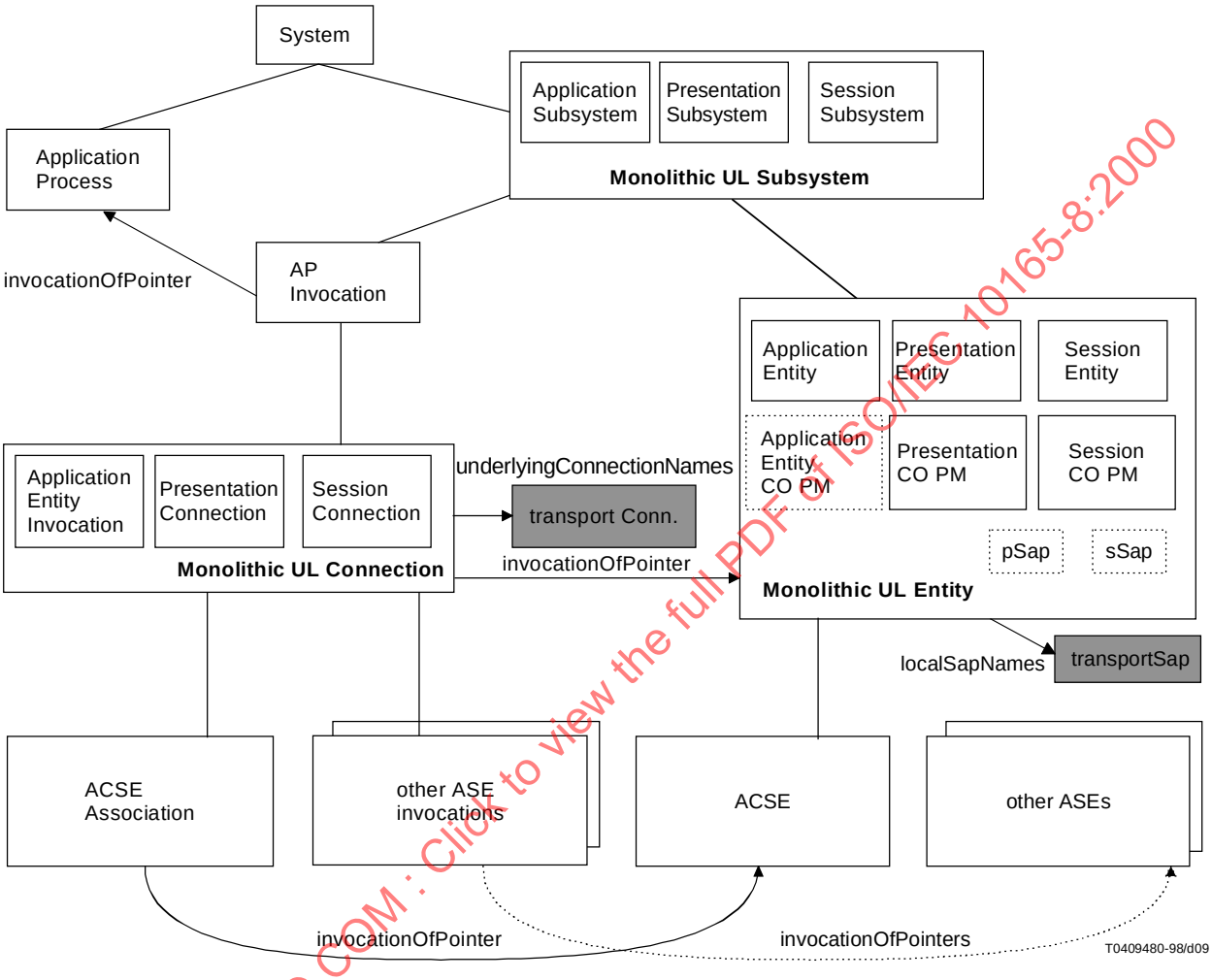
It specializes by adding the following attributes:

- presentation selector value;
- session selector value.

A.3 Monolithic Upper Layer Connection

This subclass of applicationEntityInvocation, presentationConnection, and sessionConnection holds reference information about an application connection which has monolithic connection of all three upper layers.

It specializes by adding only behaviour.



NOTE 1 – Transport entities are shaded because they are outside the scope of this Recommendation | International Standard.

NOTE 2 – Solid lines indicate containment relationships, arrowed lines indicate attribute pointer relationships.

Figure A.1 – Monolithic Upper Layer Managed Object Classes and their Relationships

Annex B

Management Information Definitions

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

```
--<GDMO.Document "ITU-T Rec. X.287 | ISO/IEC 10165-8 : 2000"
--  {joint-iso-ccitt ms(9) smi(3) part8(8) }>--
--<GDMO.Version 1.3 "ITU-T Rec. X.287 | ISO/IEC 10165-8 : 2000" >--

aCSE MANAGED OBJECT CLASS
  DERIVED FROM aso;
  CHARACTERIZED BY
    aCSEPackage PACKAGE
      BEHAVIOUR
        aCSEBehaviour BEHAVIOUR
          DEFINED AS
              !  This subclass of ase is a specialized application
              service object holds reference information about an ACSE
              application service element. It specializes by adding the
              following attributes:
              - acseFUinitiator, the ACSE functional units supported as
              initiator;
              - acseFUresponder, the ACSE functional units supported as
              responder;
              - acseEditionsSupported, the ACSE editions supported;

              An application service element does not qualify as an
              asoEntity or as a "Rec. X.723 | ISO/IEC 10165-5 :
              1994":communicationsEntity because it does not have both
              the association phase and the transfer phase of
              communication. ACSE provides only the association phase of
              communication.
              !;;
      ATTRIBUTES
        acseFUinitiator GET,
        acseEditionsSupported GET,
        acseFUresponder GET;;;

REGISTERED AS {UL-AttributeModule.acseMOCId};

acseAssociation MANAGED OBJECT CLASS
  DERIVED FROM asoInvocation;
  CHARACTERIZED BY
    acseAssociationPackage PACKAGE
      BEHAVIOUR
        acseAssociationBehaviour BEHAVIOUR
          DEFINED AS
              !This subclass of aseInvocation holds reference information
              for an ACSE association. It specializes by adding the
              following attributes:
              - calling AE title,
              - ACSE functional units negotiated in use,
              - Application context in use,
              - parent ASO invocation (relationship pointer to parent ASO
              invocation, which could be the AEI).

              It may also have an attribute for the called AE title, if
              known.!;;
      ATTRIBUTES
        callingAEtitle GET,
        acseFUinUse GET,
        applContextInUse GET,
        parentASOinvoc GET;;;
  CONDITIONAL PACKAGES
    calledAEtitlePackage PACKAGE
      ATTRIBUTES
        calledAEtitle GET;
    REGISTERED AS {UL-AttributeModule.calledAEtitlePId};
```

```
    PRESENT IF  !Present only if the called AE Title is known. !;
REGISTERED AS {UL-AttributeModule.acseAssociationMOCId};

apInvocation MANAGED OBJECT CLASS
  DERIVED FROM        "Rec. X.721 | ISO/IEC 10165-2 : 1992":top;
  CHARACTERIZED BY
    apInvocationPackage PACKAGE
      BEHAVIOUR
        apInvocationBehaviour BEHAVIOUR
          DEFINED AS
              ! This subclass of "Rec. X.721 | ISO/IEC 10165-2 :
              1992":top holds reference information about an Application
              Process Invocation. It specializes by adding the following
              attributes:
              - apInvocationId;
              - invocationOfPointer.

              The apInvocationId attribute serves as the naming attribute
              for instances of this class. The invocationOfPointer
              attribute identifies the specific Application Process
              (using the distinguished name, DN, of an instance of the
              "Rec. X.723 | ISO/IEC 10165-5 : 1994":applicationProcess
              managed object class) of which the instance of this class
              is an invocation. !;;
      ATTRIBUTES
        apInvocationId GET,
        invocationOfPointer GET;;;
REGISTERED AS {UL-AttributeModule.apInvocationMOCId};

applicationEntity MANAGED OBJECT CLASS
  DERIVED FROM        asoEntity;
  CHARACTERIZED BY
    applicationEntityPackage PACKAGE
      BEHAVIOUR
        applicationEntityBehaviour BEHAVIOUR
          DEFINED AS
              !This subclass of asoEntity holds reference information
              about an application entity. For an instance of the
              applicationEntity object class, the asoQualifier attribute
              contains the value of the local application entity (AE)
              qualifier. The asoTitle attribute contains the value of the
              associated application process (AP) title. The
              communicationsEntityId attribute holds the instance's
              Application Entity (AE) Id. The localSapNames attribute
              identifies a pSAP object instance.

              An applicationEntity object is always the outermost ASO
              Entity in an AP and serves as the supporting service for
              all of its contained ASOs (including ASO Entities and
              ASEs). !;;;;
REGISTERED AS {UL-AttributeModule.applicationEntityMOCId};

applicationEntityInvocation MANAGED OBJECT CLASS
  DERIVED FROM
    "Rec. X.723 | ISO/IEC 10165-5 : 1994":singlePeerConnection,
    asoInvocation;
  CHARACTERIZED BY
    applicationEntityInvocationPackage PACKAGE
      BEHAVIOUR
        aEInvocationBehaviour BEHAVIOUR
          DEFINED AS
              ! This subclass of "Rec. X.723 | ISO/IEC 10165-5 :
              1994":singlePeerConnection and asoInvocation represents an
              invocation of an application entity.  It adds no additional
              attributes.

              The inherited "Rec. X.723 | ISO/IEC 10165-5 :
              1994":connectionId attribute serves as the naming attribute
              for instances of this class, and represents the application
              entity (AE) invocation id. The inherited attribute "Rec.
              X.723 | ISO/IEC 10165-5 : 1994":underlyingConnectionNames
```

```
            identifies the supporting services or connections, which
            for instances of this class is a presentation address (the
            distinguished name of an object instance representing a
            presentation invocation). The inherited invocationOfPointer
            attribute identifies the application entity of which an
            instance of this class is an invocation. !;;;;
REGISTERED AS {UL-AttributeModule.applicationEntityInvocationMOCId};

applicationSubsystem MANAGED OBJECT CLASS
  DERIVED FROM      "Rec. X.723 | ISO/IEC 10165-5 : 1994":subsystem;
  CHARACTERIZED BY
    applicationSubsystemPackage PACKAGE
      BEHAVIOUR
        applicationSubsystemBehaviour BEHAVIOUR
          DEFINED AS
            ! This subclass of "Rec. X.723 | ISO/IEC 10165-5 :
            1994":subsystem is used as a common containment point for
            managed objects in a system that relate to the application
            layer (i.e., application entity Mos). It can use the "Rec.
            X.723 | ISO/IEC 10165-5 : 1994":subsystem-system Name
            Binding. !;;;;
REGISTERED AS {UL-AttributeModule.applicationSubsystemMOCId};

aso MANAGED OBJECT CLASS
  DERIVED FROM      "Rec. X.721 | ISO/IEC 10165-2 : 1992":top;
  CHARACTERIZED BY
    asoPackage PACKAGE
      BEHAVIOUR
        asoBehaviour BEHAVIOUR
          DEFINED AS
            ! This subclass of "Rec. X.721 | ISO/IEC 10165-2 :
            1992":top holds reference information about an ASO, which is
            a collection of two or more ASOs (including specialized
            ASOs, e.g., ASEs) together with a Control Function that
            moderates the interactions of the component ASEs and ASOs
            with the service provided and the supporting service. An
            ASO contains one or more ASEs/ASOs that provide for data
            transfer phase of communication. An ASO may also contain an
            ASE that provides for the establishment phase of
            communication. An ASO association can only be established
            to an ASO that provides for both the establishment and data
            transfer phases.

            This managed object class is non-instantiable. Subclasses
            of this class provide information about specific ASOs
            including the information about the Controlling Function.
            The information about the Control Function may only be
            specified via the behaviour definitions of subclasses of
            this class, but can be made visible via attributes of the
            subclass if needed.

            It specializes by adding the following attributes:
            - "Rec. X.723 | ISO/IEC 10165-5 :
            1994":communicationsEntityId;
            - asoTitle;
            - asoQualifier;
            - "Rec. X.721 | ISO/IEC 10165-2 : 1992":operationalState.

            The attribute "Rec. X.723 | ISO/IEC 10165-5 :
            1994":communicationsEntityId serves as the naming attribute
            for instances of this class. The ASO Name is formed by
            concatenating the asoTitle and the asoQualifier. The
            operationalState is used to indicate whether instances of
            this class are enabled or disabled, the syntax and
            semantics of which are defined in Rec. X.721 | ISO/IEC
            10165-2 and Rec. X.731 | ISO/IEC 10164-2. !;;
      ATTRIBUTES
        "Rec. X.723 | ISO/IEC 10165-5 : 1994":communicationsEntityId GET,
        asoTitle GET,
        asoQualifier GET,
        "Rec. X.721 | ISO/IEC 10165-2 : 1992":operationalState GET;;;
```

```
REGISTERED AS {UL-AttributeModule.asoMOCId};

asoEntity MANAGED OBJECT CLASS
  DERIVED FROM
    "Rec. X.723 | ISO/IEC 10165-5 : 1994":communicationsEntity,
    aso;
  CHARACTERIZED BY
    asoEntityPackage PACKAGE
      BEHAVIOUR
        asoEntityBehaviour BEHAVIOUR
          DEFINED AS
              ! This subclass of aso and "Rec. X.723 | ISO/IEC 10165-5 :
              1994":communicationsEntity holds reference information
              about an ASO entity, which is an ASO that contains ACSE for
              the establishment phase of communication. Thus, it
              represents an ASO with which communications may be
              established.

              An instance of an asoEntity serves as the supporting
              service for its contained objects, which can include ASOs
              (i.e., subclasses of the ASO managed object class: this
              includes ASEs, e.g., ACSE, CMISE, SMASE, and also other
              ASO Entities).

              It specializes by adding the following attribute:
              - applContextNameSupport.

              The applContextNameSupport attribute identifies the
              specific application contexts that are supported by an
              instance of this class. These are identified using the
              given application contexts' object identifier values. !;;
      ATTRIBUTES
        applContextNameSupport GET;;;
REGISTERED AS {UL-AttributeModule.asoEntityMOCId};

asoInvocation MANAGED OBJECT CLASS
  DERIVED FROM     "Rec. X.721 | ISO/IEC 10165-2 : 1992":top;
  CHARACTERIZED BY
    asoInvocationPackage PACKAGE
      BEHAVIOUR
        asoInvocationBehaviour BEHAVIOUR
          DEFINED AS
              ! This subclass of "Rec. X.721 | ISO/IEC 10165-2 :
              1992":top holds reference information about an ASO
              Invocation. This managed object class is non-instantiable.
              Subclasses of this class provide information about
              invocations of specific ASOs.

              An instance of a subclass of ASO Invocation serves as the
              supporting service for its * contained *  object instances,
              which are in turn also subclasses of ASO Invocation (e.g.,
              AE Invocation, ACSE Invocation, CMISE Invocation, SMASE
              Invocation).

              It specializes by adding the following attributes:
              - connectionId;
              - invocationOfPointer.

              The connectionId attribute serves as the naming attribute
              for instances of this class. The invocationOfPointer
              attribute identifies a specific ASO of which the instance
              of this class is an invocation. !;;
      ATTRIBUTES
        "Rec. X.723 | ISO/IEC 10165-5 : 1994":connectionId GET,
        invocationOfPointer GET;;;
REGISTERED AS {UL-AttributeModule.asoInvocationMOCId};

monoULConnection MANAGED OBJECT CLASS
  DERIVED FROM
    applicationEntityInvocation,
    presentationConnection,
    sessionConnection;
```

```
  CHARACTERIZED BY
    monoULConnectionPackage PACKAGE
      BEHAVIOUR
        monoULConnectionBehaviour BEHAVIOUR
          DEFINED AS
              ! The monoULConnection managed object class is a subclass
              of three object classes:  applicationEntityInvocation,
              presentationConnection and sessionConnection. It holds
              reference information about an application connection which
              has monolithic connection of all three upper layers. It
              adds no additional attributes. !;;;;
REGISTERED AS {UL-AttributeModule.monoULConnectionMOCId};

monoULEntity MANAGED OBJECT CLASS
  DERIVED FROM
    applicationEntity,
    presentationEntity,
    sessionEntity,
    presentationCopm,
    sessionCopm;
  CHARACTERIZED BY
    monoULEntityP1 PACKAGE
      BEHAVIOUR
        monoULEntityBehaviour BEHAVIOUR
          DEFINED AS
              ! The monoULEntity managed object class is a subclass of
              applicationEntity, presentationEntity, sessionEntity,
              presentationCopm and sessionCopm object classes. It holds
              reference information about an application entity which has
              monolithic implementation of all three upper layers.

              The communicationsEntityId attribute is multiply inherited
              from all three "Entity" superclasses and serves as the
              naming attribute for instances of this class. It should
              have the exact value as the coProtocolMachineId attribute,
              multiply inherited from "Copm" superclasses.

              The operationalState attribute has the semantics and syntax
              defined in "Rec. X.731 | ISO/IEC 10164-2" State Management
              Function. The value of the localSAPName attribute
              (inherited) should contain the address of the SAP that the
              virtual sessionEntity points to. The value of the
              asoQualifier attribute (inherited from aso) is the local AE
              Qualifier. The value of the asoTitle attribute (inherited
              from aso) is the AP Title. The value of the application
              context names supported (inherited from applicationEntity)
              contains the values supported by the virtual application
              layer.

              Since this is a subclass of presentationCopm and
              sessionCopm, it also holds reference information pertaining
              to the capabilities of a protocol machine which has
              monolithic implementation of all three upper layers.

              The following attributes are inherited from
              presentationCopm:
              - Presentation functional units supported (bitstring);
              - Abstract syntaxes supported (set of OBJECT IDENTIFIER);
              - Transfer syntaxes supported (set of OBJECT IDENTIFIER).

              The following attributes are inherited from sessionCopm:
              - Session functional units supported (bitstring);
              - Optional session support requirements (i.e., segmenting);
              - Session protocol versions supported.

              This object class specializes by adding the following
              attributes:
              - presentation selector value;
              - session selector value.
              These two attributes are needed because in the monolithic
              implementation the functionality of the PSAP and SSAP object
```

```
            classes are "absorbed" into this object class along with
            their containers (presentationEntity and sessionEntity). !;;
      ATTRIBUTES
        presSelectorValue GET,
        sessionSelectorValue GET;;;
REGISTERED AS {UL-AttributeModule.monoULEntityMOCId};

monolithicUpperLayerSubsytem MANAGED OBJECT CLASS
  DERIVED FROM
    sessionSubsystem,
    presentationSubsystem,
    applicationSubsystem;
  CHARACTERIZED BY
    monolithicUpperLayerSubsystemPackage PACKAGE
      BEHAVIOUR
        monolithicUpperLayerSubsystemBehaviour BEHAVIOUR
          DEFINED AS
            ! This subclass of sessionSubsystem, presentationSubsystem,
            applicationSubsystem is used as a common containment point
            for managed objects in a system that relate to the a
            monolithic upper layer. It can use the "Rec. X.723 |
            ISO/IEC 10165-5 : 1994":subsystem-system Name Binding. !;;;;
REGISTERED AS {UL-AttributeModule.monolithicUpperLayerSubsystemMOCId};

pSap MANAGED OBJECT CLASS
  DERIVED FROM      "Rec. X.723 | ISO/IEC 10165-5 : 1994":sap1;
  CHARACTERIZED BY
    pSapP1 PACKAGE
      BEHAVIOUR
        pSapB1 BEHAVIOUR
          DEFINED AS
            !This subclass of "Rec. X.723 | ISO/IEC 10165-5 :
            1994":sap1 has the P-selector and the binding between the
            AE and the sap.!;;;;
REGISTERED AS {UL-AttributeModule.pSapMOCId};

presentationConnection MANAGED OBJECT CLASS
  DERIVED FROM      "Rec. X.723 | ISO/IEC 10165-5 : 1994":singlePeerConnection;
  CHARACTERIZED BY
    presConnEndpointP1 PACKAGE
      BEHAVIOUR
        presConnectionBehaviour BEHAVIOUR
          DEFINED AS
            !This subclass of "Rec. X.723 | ISO/IEC 10165-5 :
            1994":singlePeerConnection holds reference information
            pertaining to the single presentation connection for the
            association. The underlying connections attribute is used
            to point to the session connection endpoint used.

            It specializes by adding the following attributes:
            - presentation functional units negotiated in use;
            - presentation contexts in use.  !;;
      ATTRIBUTES
        presFUinUse GET,
        presContextInUse GET;;;
REGISTERED AS {UL-AttributeModule.presentationConnectionMOCId};

presentationCopm MANAGED OBJECT CLASS
  DERIVED FROM      "Rec. X.723 | ISO/IEC 10165-5 : 1994":coProtocolMachine;
  CHARACTERIZED BY
    presentationCopmP1 PACKAGE
      BEHAVIOUR
        presentationCopmBehaviour BEHAVIOUR
          DEFINED AS
            !This subclass of "Rec. X.723 | ISO/IEC 10165-5 :
            1994":coProtocolMachine holds reference information
            pertaining to the capabilities of a Presentation protocol
            machine.

            It specializes by adding the following attributes:
            - Presentation functional units supported (bitstring);
```