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Information technology — Open systems interconnection —

Part 5: The Directory: Protocol specifications

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see http://patents.iec.ch).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by ITU-T as ITU-T X.519 (10/2019) and drafted in accordance with its editorial rules, in collaboration with Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

This ninth edition cancels and replaces the eighth edition (ISO/IEC 9594-5:2017), which has been technically revised.

A list of all parts in the ISO/IEC 9594 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This Recommendation | International Standard, together with other Recommendations | International Standards, has been produced to facilitate the interconnection of information processing systems to provide directory services. A set of such systems, together with the directory information that they hold, can be viewed as an integrated whole, called the *Directory*. The information held by the Directory, collectively known as the Directory Information Base (DIB), is typically used to facilitate communication between, with or about objects such as application entities, people, terminals and distribution lists.

The Directory plays a significant role in Open Systems Interconnection, whose aim is to allow, with a minimum of technical agreement outside of the interconnection standards themselves, the interconnection of information processing systems:

- from different manufacturers;
- under different managements;
- of different levels of complexity; and
- of different ages.

This Recommendation | International Standard specifies the application service elements and application contexts for two protocols – the Directory Access Protocol (DAP) and the Directory System Protocol (DSP). The DAP provides for access to the Directory to retrieve or modify Directory information. The DSP provides for the chaining of requests to retrieve or modify Directory information to other parts of the distributed Directory System where the information may be held.

In addition, this Recommendation | International Standard specifies the application service elements and application contexts for the Directory Information Shadowing Protocol (DISP) and the Directory Operational Binding Management Protocol (DOP). The DISP provides for the shadowing of information held in one DSA to another DSA. The DOP provides for the establishment, modification and termination of bindings between pairs of DSAs for the administration of relationships between the DSAs (such as for shadowing or hierarchical relationships).

This Recommendation | International Standard provides the foundation frameworks upon which industry profiles can be defined by other standards groups and industry forums. Many of the features defined as optional in these frameworks may be mandated for use in certain environments through profiles. This ninth edition technically revises and enhances the eighth edition of this Recommendation | International Standard.

This ninth edition specifies versions 1 and 2 of the Directory protocols.

Rec. ITU-T X.511 (1993) | ISO/IEC 9594-3 (1995), Rec. ITU-T X.518 (1993) | ISO/IEC 9594-4 (1995) and Rec. ITU-T X.519 (1993) | ISO/IEC 9594-5 (1995) and their previous edition specified only version 1. Most of the services and protocols specified in this edition are designed to function under version 1. However some enhanced services and protocols, e.g., signed errors, will not function unless all Directory entities involved in the operation have negotiated version 2. Whichever version has been negotiated, differences between the services and between the protocols defined in the nine editions, except for those specifically assigned to version 2, are accommodated using the rules of extensibility defined in this edition of Rec. ITU-T X.519 | ISO/IEC 9594-5.

Annex A, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the common specifications for the Directory protocols.

Annex B, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the OSI protocol specification.

Annex C, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the Directory OSI protocols.

Annex D, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the IDM protocol specification.

Annex E, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the Directory IDM protocols.

Annex F, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module which contains all the ASN.1 object identifiers assigned to identify operational binding types in this series of Recommendations | International Standards.

Annex G, which is not an integral part of this Recommendation | International Standard, lists the amendments and defect reports that have been incorporated to form this edition of this Recommendation | International Standard.

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INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – Open Systems Interconnection – The Directory: Protocol specifications

1 Scope

This Recommendation | International Standard specifies the Directory Access Protocol, the Directory System Protocol, the Directory Information Shadowing Protocol, and the Directory Operational Binding Management Protocol which fulfil the abstract services specified in Rec. ITU-T X.511 | ISO/IEC 9594-3, Rec. ITU-T X.518 | ISO/IEC 9594-4, Rec. ITU-T X.525 | ISO/IEC 9594-9, and Rec. ITU-T X.501 | ISO/IEC 9594-2.

2 References

2.1 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 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 currently valid International Standards. The Telecommunication Standardization Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

2.1.1 Identical Recommendations | International Standards

- Recommendation ITU-T X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The basic model*.
- Recommendation ITU-T X.213 (2001) | ISO/IEC 8348:2002, *Information technology – Open Systems Interconnection – Network service definition*.
- Recommendation ITU-T X.214 (1995) | ISO/IEC 8072:1996, *Information technology – Open Systems Interconnection – Transport service definition*.
- Recommendation ITU-T X.500 (2019) | ISO/IEC 9594-1:2020, *Information technology – Open Systems Interconnection – The Directory: Overview of concepts, models and services*.
- Recommendation ITU-T X.501 (2019) | ISO/IEC 9594-2:2020, *Information technology – Open Systems Interconnection – The Directory: Models*.
- Recommendation ITU-T X.509 (2019) | ISO/IEC 9594-8:2020, *Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks*.
- Recommendation ITU-T X.511 (2019) | ISO/IEC 9594-3:2020, *Information technology – Open Systems Interconnection – The Directory: Abstract service definition*.
- Recommendation ITU-T X.518 (2019) | ISO/IEC 9594-4:2020, *Information technology – Open Systems Interconnection – The Directory: Procedures for distributed operation*.
- Recommendation ITU-T X.520 (2019) | ISO/IEC 9594-6:2020, *Information technology – Open Systems Interconnection – The Directory: Selected attribute types*.
- Recommendation ITU-T X.521 (2019) | ISO/IEC 9594-7:2020, *Information technology – Open Systems Interconnection – The Directory: Selected object classes*.
- Recommendation ITU-T X.525 (2019) | ISO/IEC 9594-9:2020, *Information technology – Open Systems Interconnection – The Directory: Replication*.
- Recommendation ITU-T X.680 (2015) | ISO/IEC 8824-1:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.
- Recommendation ITU-T X.681 (2015) | ISO/IEC 8824-2:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.
- Recommendation ITU-T X.682 (2015) | ISO/IEC 8824-3:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification*.

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– Recommendation ITU-T X.683 (2015) | ISO/IEC 8824-4:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications*.

– Recommendation ITU-T X.690 (2015) | ISO/IEC 8825-1:2015, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*.

2.1.2 ISO/IEC Standards

– ISO/IEC 10646:2017, *Information technology – Universal Coded Character Set (UCS)*.

2.1.3 Other references

– Recommendation ITU-T E.164 (2010), *The international public telecommunication numbering plan*.

– Recommendation ITU-T X.121 (2000), *International numbering plan for public data networks*.

– Recommendation ITU-T X.680 (2015) | ISO/IEC 8824-1:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*.

– Recommendation ITU-T X.681 (2015) | ISO/IEC 8824-2:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification*.

– Recommendation ITU-T X.682 (2015) | ISO/IEC 8824-3:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification*.

– Recommendation ITU-T X.683 (2015) | ISO/IEC 8824-4:2015, *Information technology – Abstract Syntax Notation One (ASN.1): Parameterization of ASN.1 specifications*.

– IETF RFC 793 (1981), *Transmission Control Protocol – DARPA Internet Program – Protocol Specification*.

– IETF RFC 1738 (1994), *Uniform Resource Locators (URL)*.

– IETF RFC 2246 (1999), *The TLS Protocol: Version 1.0*.

– IETF RFC 3546 (2003), *Transport Layer Security (TLS) Extensions*.

– IETF RFC 3986 (2005), *Uniform Resource Identifier (URI): Generic Syntax*.

2.2 Non-normative references

– Recommendation ITU-T X.217 (1995) | ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Association Control Service Element*.

– Recommendation ITU-T X.224 (1995) | ISO/IEC 8073:1997, *Information technology – Open Systems Interconnection – Protocol for providing the connection-mode transport service*.

– Recommendation ITU-T X.225 (1995) | ISO/IEC 8327-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented Session protocol: Protocol specification*.

– Recommendation ITU-T X.226 (1994) | ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented Presentation protocol: Protocol specification*.

– Recommendation ITU-T X.227 (1995) | ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*.

– Recommendation ITU-T X.650 (1996) | ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*.

– Recommendation ITU-T X.881 (1994) | ISO/IEC 13712-2:1995, *Information technology – Remote Operations: OSI realizations – Remote Operations Service Element (ROSE) service definition*.

– IETF RFC 896 (1984), *Congestion Control in IP/TCP Internetworks*.

– IETF RFC 1006 (1987), *ISO Transport Service on top of the TCP Version: 3*.

– IETF RFC 1277 (1991), *Encoding Network Addresses to Support Operation over Non-OSI Lower Layers*.

– IETF RFC 2126 (1997), *ISO Transport Service on top of TCP (ITOT)*.

– IETF RFC 4511 (2006), *Lightweight Directory Access Protocol (LDAP): The Protocol*.

3 Definitions

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

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3.1 Basic Directory definitions

The following terms are defined in Rec. ITU-T X.501 | ISO/IEC 9594-2:

a) *the Directory*;

b) *(Directory) user*;

c) *Directory System Agent (DSA)*;

d) *Directory User Agent (DUA)*.

3.2 Distributed Operation Definitions

The following terms are defined in Rec. ITU-T X.518 | ISO/IEC 9594-4:

a) *chaining*;

b) *performer*;

c) *referral*.

3.3 Protocol specification definitions

The following terms are defined in this Recommendation | International Standard.

NOTE – The terms defined in this clause are generalized definitions to cover both the OSI and the TCP/IP case, except where exceptions are indicated.

3.3.1 abstract syntax: The specification of data types and/or data values by using notation rules which are independent of the encoding technique used to represent them.

3.3.2 application-association: A cooperative relationship between two application-entities established by the Bind operation.

3.3.3 application-context: (OSI only definition); a set of rules commonly shared by two application-entities in order to support an application-association.

3.3.4 application-context-name: An ASN.1 object identifier that identifies (names) an application-context.

3.3.5 application layer: The top layer of the OSI seven layer model representing the semantics of the communication.

3.3.6 application-entity: A representation of the external behaviour of an application process in the form of its communication capabilities.

3.3.7 application-entity title: The Directory distinguished name of an application-entity, and in particular, an application-entity representing a Directory application process.

3.3.8 application process: A process within a system which performs information processing for a particular purpose, in particular processing Directory operations.

3.3.9 Bind operation: An operation type used for establishing an application-association.

3.3.10 Directory operation: An operation type for the exchange of Directory information.

3.3.11 directory protocol-data-unit: A unit of data for a Directory protocol consisting of control information and in general, also application data as specified by Directory operations.

NOTE 1 – A Directory PDU in the OSI environment includes all the protocol elements of the OSI Presentation Layer and if relevant, protocol elements of ACSE in addition to the Directory-specific protocol elements.

NOTE 2 – The term "application-protocol-data-unit (APDU)" is a unit of data defined by an OSI application protocol. This term is not used by Rec. ITU-T X.519 (2005) | ISO/IEC 9594-5:2005 and subsequent editions of these Directory Specifications. However, the abbreviation may appear in certain ASN.1 elements.

3.3.12 initiator: The application process that initiates an application-association by issuing a Bind request.

3.3.13 local matter: A decision made by a system concerning its behaviour that is not subject to the requirements of these Directory Specifications.

3.3.14 operation: An exchange between two application processes to perform a particular task. It consists of a request from one application-process to the other one and the return of zero or more responses (result and/or errors). An operation implies a certain process to be performed by the application process receiving the request.

3.3.15 protocol-data-unit: Comprised of the presentation protocol elements or the ACSE protocol elements of a Directory protocol-data-unit.

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3.3.16 **presentation layer**: The sixth layer of the OSI Reference Model.

3.3.17 **protocol error**: An unrecognized or unexpected protocol-data-unit or a protocol-data-unit with an unexpected or invalid parameter is received.

3.3.18 **responder**: The application-process that receives a Bind request and either accepts or refuses the application-association.

NOTE – Initiator and responder are defined with respect to a single transport-connection. The initiator is also the application process that initiated the transport-connection (see clause 8.4). A DSA can be both an initiator and responder simultaneously.

3.3.19 **session layer**: The fifth layer of the OSI Reference Model.

3.3.20 **session-protocol-data-unit**: (OSI only definition); a unit of data at the OSI Session Layer consisting of control information and in general, it also carries a Directory protocol-data-unit.

4 Abbreviations

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

AC	Application Context
ACSE	Association Control Service Element
AE	Application-Entity
AFI	Authority and Format Identifier
APDU	Application-Protocol-Data-Unit
DAP	Directory Access Protocol
DISP	Directory Information Shadowing Protocol
DOP	Directory Operational Binding Management Protocol
DSA	Directory System Agent
DSP	Directory System Protocol
DSP	Domain Specific Part
DUA	Directory User Agent
EOT	End of TSDU
IDI	Initial Domain Identifier
IDM	Internet Directly Mapped
IPv4	Internet Protocol, Version 4
IPv6	Internet Protocol, Version 6
ITOT	ISO Transport Service on top of TCP
LDAP	Lightweight Directory Access Protocol
LI	Length Indicator
NSAP	Network-Service-Access-Point
PDU	Protocol-Data-Unit
PGI	Parameter Group Identifier
PI	Parameter Identifier
PPDU	Presentation-Protocol-Data-Unit
PV	Parameter Value
SI	SPDU Identifier
SPDU	Session-Protocol-Data-Unit
TCP/IP	Transmission Control Protocol/Internet Protocol
TPDU	Transport-Protocol-Data-Unit
TPKT	Transport Packet
TSDU	Transport-Service-Data-Unit
URI	Uniform Resource Identifier

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5 Conventions

The term "Directory Specification" (as in "this Directory Specification") shall be taken to mean Rec. ITU-T X.519 | ISO/IEC 9594-5. The term "Directory Specifications" shall be taken to mean the Rec. ITU-T X.500 | ISO/IEC 9594-1, Rec. ITU-T X.501 | ISO/IEC 9594-2, Rec. ITU-T X.511 | ISO/IEC 9594-3, Rec. ITU-T X.518 | ISO/IEC 9594-4, Rec. ITU-T X.519 | ISO/IEC 9594-5, Rec. ITU-T X.520 | ISO/IEC 9594-6, Rec ITU-T X.521 | ISO/IEC 9594-7 and Rec. ITU-T X.525 | ISO/IEC 9594-9.

If an International Standard or ITU-T Recommendation is referenced within normal text without an indication of the edition, the edition shall be taken to be the latest one as specified in the normative references clause.

Prior to year 2020, the parts making up the Directory Specifications progressed together and can therefore collectively be identified as the Directory Specifications of a specific edition using the format: Rec. ITU-T X.5** (yyyy) | ISO/IEC 9594-*:yyyy (e.g.; Rec ITU-T X.5** (1993) | ISO/IEC 9594-*:1995).

This Directory Specification makes extensive use of Abstract Syntax Notation One (ASN.1) for the formal specification of data types and values, as it is specified in Rec. ITU-T X.680 | ISO/IEC 8824-1, ITU-T X.681 | ISO/IEC 8824-2, ITU-T X.682 | ISO/IEC 8824-3, ITU-T X.683 | ISO/IEC 8824-4 and Rec. ITU-T X.690 | ISO/IEC 8825-1.

This Directory Specification presents ASN.1 notation in the bold Courier New typeface. When ASN.1 types and values are referenced in normal text, they are differentiated from normal text by presenting them in the bold Courier New typeface. The names of procedures, typically referenced when specifying the semantics of processing, are differentiated from normal text by displaying them in bold Times New Roman. Access control permissions are presented in italicized Times New Roman.

If the items in a list are numbered (as opposed to using "–" or letters), then the items shall be considered steps in a procedure.

The syntax of Open Systems Interconnection (OSI) addressing related terms follow the rules established by Rec. ITU-T X.650 | ISO/IEC 7498-3. This syntax has been established to make a distinction between a term for a specific purpose and a more general term. As an example, transport-address is hyphenated to signal it is a specific term used in an OSI context, while transport address without a hyphen has a more general meaning.

6 Common protocol specification

6.1 Directory associations and operations

The protocols for these Directory Specifications are described as a set of *operations*. An operation is defined in terms of a request sent from one system to another system expecting this other system to process the request, and if applicable, it returns one or more replies constituting the result. An operation can either be a *Bind operation* or an operation invoked to access Directory information (a *Directory operation*).

If exception conditions are encountered, one or more errors may be returned instead of or in addition to possible results.

NOTE 1 – The currently defined operations will return either one or more results or a single error.

Directory protocols defined by these Directory Specifications may use an OSI protocol stack, a TCP/IP protocol stack or both. The specification provided by this clause is independent of the particular protocol stack. The OSI specific specification is given in clauses 7 and 8, while the TCP/IP specific specification is given in clauses 9 and 10.

A process within a system that processes Directory operations is called an *application process*. An *application-entity* is the reflection of the external behaviour of an application process.

Before Directory operations can be invoked between two Directory application processes, an *application-association* has to be established between the corresponding application-entities. An application-association is a cooperative relationship between two application-entities formed by the exchange of control information within the request and result of a Bind operation and by the use of a common underlying service.

NOTE 2 – This is a modified definition of application-association as given by Rec. ITU-T X.217 | ISO/IEC 8649, and is intended to cover both the use of an underlying OSI protocol stack and an underlying TCP/IP stack.

An application-association is terminated using an unbind exchange. The unbinding of an application-association is not defined as an operation.

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6.2 Specification for Directory operations

These Directory Specifications specify several operation types. An operation type is specified by the **OPERATION** ASN.1 information object class. Possible errors associated with an operation type are defined by the **ERRORS** ASN.1 information object class.

```
OPERATION ::= CLASS {
  &ArgumentType   OPTIONAL,
  &ResultType     OPTIONAL,
  &Errors         ERROR OPTIONAL,
  &operationCode  Code UNIQUE OPTIONAL }
WITH SYNTAX {
  [ARGUMENT &ArgumentType]
  [RESULT &ResultType]
  [ERRORS &Errors]
  [CODE &operationCode] }

ERROR ::= CLASS {
  &ParameterType,
  &errorCode      Code UNIQUE OPTIONAL }
WITH SYNTAX {
  PARAMETER       &ParameterType
  [CODE           &errorCode] }

Code ::= CHOICE {
  local   INTEGER,
  global  OBJECT IDENTIFIER,
  ... }
```

The **OPERATION** information object class is a convenient way to express the syntax of Directory requests, results and errors for a particular operation type.

This ASN.1 information object class has the following fields:

a) The **&ArgumentType** field specifies an open data type for the request part of an operation.

b) The **&ResultType** field specifies an open data type for one or more replies constituting the result of the request. If this field is absent, there is no result associated with the operation.

c) The **&Errors** field specifies one or more errors that can occur as the result of processing the request. If this field is absent, there is no error associated with the operation.

d) The **&operationCode** field specifies the type of Directory operation to be performed. This field is absent for the Bind operation. See clause 6.4 for currently defined operation codes.

Directory operations may in principle be performed in two different modes:

a) if a Directory operation shall be completed before a new Directory operation may be invoked, the mode of operation is *synchronous*; or

b) if several operations may be in progress at the same time, the mode of operation is a*synchronous*.

If all Directory operations defined for a particular type of application-association:

a) consist of both a request and one or more results and/or errors; and

b) are allowed only to be invoked by a designated system,

such operation may be executed in either synchronous or asynchronous mode. Otherwise, the mode of operation is always asynchronous.

The **OPERATION** information object class does not in itself imply any sequencing. A Directory request may have no result and/or error, or a request may have several results and/or errors. However, it does tie together a request with possible responses (results and errors) by carrying the same operation code and the same invoke id (see below). However, specification of a particular operation type may dictate sequencing restrictions.

An error is a report of the unsuccessful performance of an operation. An error is represented by the **ERROR** ASN.1 Information Object Class. The different fields are described below:

a) the **&ParameterType** field specifies the data type of the parameter of the error specifying the nature of the error; and

b) the **&errorCode** field specifies the code that identifies the error (see clause 6.5 for the defined error codes).

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Although not reflected by the **OPERATION** or the **ERRORS** information object classes, each invocation of a Directory operation is assigned an **InvokeId**, which is carried in the protocol. This makes it possible to indicate to what Directory operation a particular request, result or error belongs. The definition of the **InvokeId** is as follows:

```
InvokeId ::= CHOICE {
  present  INTEGER,
  absent   NULL,
  ... }
```

If an operation type does not specify an **&operationCode**, operations of this type cannot have **InvokeId** assigned.

6.3 Directory protocol overview

6.3.1 Use of underlying services

When two application processes from different open systems interact, the application-association is realized as an Application Layer protocol using either an OSI or a TCP/IP underlying service.

Details on the use of the OSI service are given in clause 8, while the details on the use of the TCP/IP service are given in clause 10.

The OSI Transport Layer may either be supported using the service as defined in Rec. ITU-T X.214 | ISO/IEC 8072 or by using the specification in clause 8.5. In this latter case, the OSI upper layer protocols stack are placed on top of a TCP/IP protocol stack.

6.3.2 The Directory Access Protocol (DAP)

Before a DUA and a DSA from different open systems can interact, a Bind operation has to be invoked between them to establish an application-association supporting a Directory protocol called the Directory Access Protocol (DAP).

The Bind operation (**directoryBind**) for establishing a DAP application-association is defined in clause 8 of Rec. ITU-T X.511 | ISO/IEC 9594-3.

The Directory Specifications allow a DUA to invoke a Bind operation and to initiate subsequent Directory operations. If the OSI underlying stack is used, Directory operations may be invoked either in synchronous mode or in asynchronous mode. If the TCP/IP underlying stack is used, Directory operations are always invoked in asynchronous mode.

All Directory operations require either a single reply or a single error to be returned.

6.3.3 The Directory System Protocol (DSP)

Before a pair of DSAs from different open systems can interact, a Bind operation has to be invoked between them to establish an application-association supporting a Directory protocol called the Directory System Protocol (DSP).

The Bind operation (**dSABind**) for establishing a DSP application-association is defined in clause 11 of Rec. ITU-T X.518 | ISO/IEC 9594-4.

Either DSA may invoke a Bind operation. Both the initiating and responding DSA may invoke subsequent Directory operations. Directory operations are always invoked in asynchronous mode on the DSP.

All Directory operations require either a single reply or a single error to be returned.

6.3.4 The Directory Information Shadowing Protocol (DISP)

Before a pair of DSAs from different open systems can interact for the purpose of exchanging shadowing information, a Bind operation has to be invoked between them to establish an application-association supporting a Directory protocol called the Directory Information Shadowing Protocol (DISP).

The Bind operation (**dSAShadowBind**) for establishing a DISP application-association is defined in clause 7.4.1 of Rec. ITU-T X.525 | ISO/IEC 9594-9.

If the OSI underlying stack is used, the mode of operation is synchronous or asynchronous depending on the application-context selected for the Bind operation. If the TCP/IP underlying stack is used, Directory operations are always invoked in asynchronous mode.

All Directory operations require either a single reply or a single error to be returned.

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6.3.5 The Directory Operational Binding Management Protocol (DOP)

Before a pair of DSAs from different open systems can interact for the purpose of maintaining operational bindings, a Bind operation has to be invoked to establish an application-association supporting a Directory protocol called the Directory Operational Binding Management Protocol (DOP).

The DSA that may assume the role of initiator of the Bind operation depends on the DSA roles assigned for the operational binding(s) to be managed using the Directory operations on the application-association. Only the initiator may invoke Directory operations. More than one operational binding type may only be managed within this application-association if the DSA roles for the distinct types are compatible (e.g., a DSA assumes Role A for each binding type).

All Directory operations require either a single reply or a single error to be returned.

6.4 Operation codes

6.4.1 Operation codes for DAP and DSP

The following operation codes are used in the DAP and the DSP:

```
id-opcode-read                    Code ::= local:1
id-opcode-compare                 Code ::= local:2
id-opcode-abandon                 Code ::= local:3
id-opcode-list                    Code ::= local:4
id-opcode-search                  Code ::= local:5
id-opcode-addEntry                Code ::= local:6
id-opcode-removeEntry             Code ::= local:7
id-opcode-modifyEntry             Code ::= local:8
id-opcode-modifyDN                Code ::= local:9
id-opcode-changePassword          Code ::= local:10
id-opcode-administerPassword      Code ::= local:11
id-opcode-ldapTransport           Code ::= local:12
id-opcode-linkedLDAP              Code ::= local:13
```

The use of these operation codes is specified in Rec. ITU-T X.511 | ISO/IEC 9594-3.

6.4.2 Operation codes for DISP

The following operation codes are used in the DISP.

```
id-opcode-requestShadowUpdate     Code ::= local:1
id-opcode-updateShadow            Code ::= local:2
id-opcode-coordinateShadowUpdate  Code ::= local:3
```

The use of these operation codes is specified in Rec. ITU-T X.525 | ISO/IEC 9594-9.

6.4.3 Operation codes for DOP

The following operation codes are used in the DOP.

```
id-op-establishOperationalBinding Code ::= local:100
id-op-modifyOperationalBinding    Code ::= local:102
id-op-terminateOperationalBinding Code ::= local:101
```

The use of these operation codes is specified in Rec. ITU-T X.501 | ISO/IEC 9594-2.

6.5 Error codes

6.5.1 Error codes for DAP and DSP

The following error codes are used in the DAP and the DSP. The code **id-errcode-referral** is only used in the DAP. The code **id-opcode-dsaReferral** is only used in the DSP:

```
id-errcode-attributeError         Code ::= local:1
id-errcode-nameError              Code ::= local:2
id-errcode-serviceError           Code ::= local:3
id-errcode-referral               Code ::= local:4
id-errcode-abandoned              Code ::= local:5
```


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```
id-errcode-securityError          Code ::= local:6
id-errcode-abandonFailed          Code ::= local:7
id-errcode-updateError            Code ::= local:8
id-errcode-dsaReferral            Code ::= local:9
```

6.5.2 Error codes for DISP

The following error code is used in the DISP:

```
id-errcode-shadowError            Code ::= local:1
```

6.5.3 Error codes for DOP

The following error code is used in the DOP:

```
id-err-operationalBindingError    Code ::= local:100
```

6.6 Abstract syntaxes

A protocol specification includes a specification of the data types that may be transferred as part of the protocol exchanges. The data types are defined using an abstract notation like the ASN.1 notation and constitute the abstract syntax for the protocol. The abstract syntaxes are quite similar for OSI communication and for TCP/IP communication, although there are differences. Four abstract syntaxes are defined for each of these types of communication corresponding to the four different Directory protocols. Only for the OSI communication are the abstract syntaxes assigned object identifiers. When establishing an OSI application-association the relevant object identifier for the abstract syntax is signalled in the Bind (see clause 7.6.1).

7 Directory protocols using the OSI stack

This clause defines the Directory protocols and their mapping onto the OSI Session Protocol. It incorporates the relevant elements of the OSI Presentation Protocol as defined by Rec. ITU-T X.226 | ISO/IEC 8823-1 and the Association Control Service Element (ACSE) as defined by Rec. ITU-T X.227 | ISO/IEC 8650-1.

The relevant part of the OSI session protocol is defined in clause 8.3.

7.1 OSI-PDUs

The messages of OSI-based protocols are conveyed over an OSI application-association as Directory protocol-data-units represented by the **OSI-PDU** data type as follows:

```
OSI-PDU{APPLICATION-CONTEXT:protocol} ::= TYPE-IDENTIFIER.&Type (
  OsiBind{{protocol}} |
  OsiBindResult{{protocol}} |
  OsiBindError{{protocol}} |
  OsiOperation{{protocol.&Operations}} |
  OsiUnbind |
  PresentationAbort )
```

7.2 Directory PDU structure

A Directory PDU in the OSI environment consists of protocol elements from the OSI Presentation Layer as defined by Rec. ITU-T X.226 | ISO/IEC 8823-1, of ACSE protocol elements as defined by Rec. ITU-T X.227 | ISO/IEC 8650-1, if relevant, and Directory specific protocol elements for the protocol in question.

The **OsiBind**, the **OsiBindResult** and the **OsiBindError** have presentation protocol elements and ACSE protocol elements in addition to the Directory specific protocol elements, while the **OsiOperation** only has presentation protocol elements in addition to the Directory specific protocol elements. The **PresentationAbort** has only presentation protocol elements.

The Presentation Layer protocol elements included within a specific Directory PDU comprise a PPDU.

NOTE 1 – The term PPDU (presentation-protocol-data-unit) is introduced here, as it is referenced when discussing presentation protocol errors and by the **Abort-reason** data type. The term is otherwise not relevant for these Directory Specifications.

The ACSE protocol elements included within a specific Directory PDU comprise an ACSE PDU.

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NOTE 2 – Rec. ITU-T X.227 | ISO/IEC 8650-1 uses the term APDU (application-protocol-data-unit) for an ACSE PDU. As the Directory specific protocol elements of a specific Directory PDU in principle also comprise an APDU, the term ACSE PDU is used here to avoid confusion.

The following PPDUs are used by this Directory Specification:

a) CP PPDU, which is reflected by the **CP-type** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It is part of the **OsiBind** data type;

b) CPA PPDU, which is reflected by the **CPA-PPDU** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It is part of the **OsiBindResult** data type;

c) CPR PPDU, which is reflected by the **CPR-PPDU** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It is part of the **OsiBindError** data type;

d) TD PPDU, which is reflected by the **User-data** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It is part of the **OsiOperation** data type;

e) ARU PPDU, which is reflected by the **ARU-PPDU** defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It is part of the **ARU-PPDU** data type as defined by this Directory specification; and

f) ARP PPDU, which is reflected by the **ARP-PPDU** defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. It constitutes the **ARP-PPDU** data type as defined by this Directory specification.

There is no PPDU defined for the release of an application-association (**OsiUnbind** and **OsiUnbindResult**). However, the **User-data** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1 is used to carry the **OsiUnbind** and **OsiUnbindResult**.

The following ACSE PDUs are used by this Directory Specification:

a) **AARQ-apdu** is a part of the **OsiBind** data type;

b) **AARE-apdu** is part of the **OsiBindResult** data type and the **OsiBindError** data type;

c) **RLRQ-apdu** is part of the **OsiUnbind** data type;

d) **RLRE-apdu** is part of the **OsiUnbindResult** data type; and

e) **ABRT-apdu** is part of the **ARU-PPDU** data type.

7.3 Session PDUs

In addition to the Directory PDUs, this Directory Specification also defines session-protocol-data-units (SPDUs). All the Directory PDUs are carried within an SPDU.

The following SPDUs are used by this Directory Specification:

a) CONNECT SPDU used to carry the **OsiBind**;

b) ACCEPT SPDU used to carry the **OsiBindResult**;

NOTE – The AARE ACSE PDU (as represented by **AARE-apdu** and **AAREerr-apdu**) is according to clause 8.1.3 of Rec. ITU-T X.227 | ISO/IEC 8650-1 mapped onto the P-CONNECT response/confirm, where result is set as 'user rejection'. According to clause 6.2.5.6 of Rec. ITU-T X.226 | ISO/IEC 8823-1, a CPR PPDU shall be issued at the Presentation Layer. Also, according to clause 7.1.3 of Rec. ITU-T X.226 | ISO/IEC 8823-1, the CPR PPDU is conveyed in the S-CONNECT response and confirm session primitives.

c) REFUSE SPDU is used to carry **OsiBindError** and it is used for rejecting an application-association due to Session Layer conditions;

d) FINISH SPDU is used to carry the **OsiUnbind** to initiate termination of an application-association;

e) DISCONNECT SPDU is used to carry the **OsiUnbindResult** to complete termination of an application-association;

f) ABORT SPDU is used to carry the **ARU-PPDU** and **ARP-PPDU** in addition to be used on its own when aborting due to a Session Layer problem;

g) ABORT ACCEPT SPDU carries no upper layer information, but it does indicate that an abort has been received by the peer system; and

h) DATA TRANSFER SPDU is used to carry **OsiOperation**.

Details of SPDUs are given in clause 8.3.

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7.4 OSI addressing

OSI defines addresses for the Network Layer and up to and including the Presentation Layer. The Address on the top of the Network Layer is called the network-service-access-point (NSAP) address. The structure of an NSAP address is defined in Rec. ITU-T X.213 | ISO/IEC 8348. A transport-address on top of the Transport Layer is defined as the NSAP address plus an optional transport-selector. A session-address on top of the Session Layer is defined as the transport-address plus an optional session-selector. A presentation-address is defined as a session-address plus an optional presentation-selector. Only session-selector and presentation-selector are referenced by this Directory Specification.

7.5 Procedure and sequencing

An application-association between two application processes is initiated by one of the application processes issuing an **OsiBind** as defined in clause 7.6.1. The initiating application process shall then wait for an **OsiBindResult** to confirm the application-association establishment before sending any Directory PDU on that application-association.

Independent of any sequencing rule, the initiating application process may at any time issue an **ARU-PPDU** or **ARP-PPDU** (see clause 7.6.7) after having issued an **OsiBind**. Likewise, the responding application may at any time issue an **ARU-PPDU** or **ARP-PPDU** after having received an **OsiBind**.

If an **OsiBindResult** is received, the initiating application process may send **OsiOperation** containing **OsiReq**, **OsiRes**, **OsiErr** and **OsiRej** as governed by the protocol in question.

An application-association is not established if an **OsiBindError** (see clause 7.6.3) is received in response to the **OsiBind**, or if the application-association is refused at the session level (see clause 8.3.5).

Two application processes may almost simultaneously issue **OsiBind** to each other. This shall be considered as two independent application-association establishment attempts. If they both succeed, the result will be two application-associations.

Protocol errors can occur within the session protocol, within the presentation protocol elements, within the ACSE protocol elements and within the Directory-specific protocol elements.

A protocol error can be caused by:

a) an unrecognized or unexpected PDU received; or

b) one or more parameters on a received PDU are invalid or unexpected.

NOTE 1 – According to the rules of extensibility specified in clause 12, unknown parameters shall be ignored. Clauses 8.5 of Rec. ITU-T X.226 | ISO/IEC 8823-1 and 7.4 of Rec. ITU-T X.227 | ISO/IEC 8650-1 specify similar rules.

NOTE 2 – Clauses 6.4.4.2 and 6.4.4.3 of Rec. ITU-T X.226 | ISO/IEC 8823-1 make a distinction between a protocol error and an invalid PPDU. As the two cases cause the same type of abort, this Directory Specification does not make that distinction. Clause 7.3.3.4 of Rec. ITU-T X.227 | ISO/IEC 8650-1 does not make that distinction either.

In both cases, the application-association or an application-association under establishment/termination shall be aborted.

If the problem is detected within the session protocol, an ABORT SPDU shall be issued (see clause 8.3.8) with no User Data.

If the problem is detected within the presentation protocol, an **ARP-PPDU** (see clause 7.6.7.2) shall be issued.

If the problem is detected within the ACSE protocol, an **ARU-PPDU** with **abort-source** set to **acse-service-provider** (see clause 7.6.7.1) shall be issued.

If the problem is detected within a Directory protocol, an **ARU-PPDU** with **abort-source** set to **acse-service-user** shall be issued.

7.6 Directory PDU specifications

7.6.1 OSI Bind request

```
OsiBind{APPLICATION-CONTEXT:Protocols} ::= SET {
  mode-selector                  [0]  IMPLICIT SET {
    mode-value                     [0]  IMPLICIT INTEGER(1)},
  normal-mode-parameters         [2]  IMPLICIT SEQUENCE {
    protocol-version               [0]  IMPLICIT BIT STRING {version-1(0)}
                                          DEFAULT {version-1},
    calling-presentation-selector  [1]  IMPLICIT Presentation-selector OPTIONAL,
    called-presentation-selector   [2]  IMPLICIT Presentation-selector OPTIONAL,
    presentation-context-definition-list
```

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```
                                  [4]  IMPLICIT Context-list,
    user-data                          CHOICE {
      fully-encoded-data  [APPLICATION 1] IMPLICIT SEQUENCE SIZE (1) OF SEQUENCE {
        transfer-syntax-name              Transfer-syntax-name OPTIONAL,
        presentation-context-identifier   Presentation-context-identifier,
        presentation-data-values          CHOICE {
          single-ASN1-type             [0]  ABSTRACT-SYNTAX.&Type
                                              (AARQ-apdu{{Protocols}})}}}}}


Presentation-selector ::= OCTET STRING(SIZE (1..4, ..., 5..MAX))

Context-list ::= SEQUENCE SIZE (2) OF SEQUENCE {
  presentation-context-identifier  Presentation-context-identifier,
  abstract-syntax-name             Abstract-syntax-name,
  transfer-syntax-name-list        SEQUENCE OF Transfer-syntax-name }

Presentation-context-identifier ::= INTEGER(1..127, ..., 128..MAX)

Abstract-syntax-name ::= OBJECT IDENTIFIER

Transfer-syntax-name ::= OBJECT IDENTIFIER

AARQ-apdu{APPLICATION-CONTEXT:Protocols} ::= [APPLICATION 0] IMPLICIT SEQUENCE {
  protocol-version                  [0] IMPLICIT BIT STRING {version1(0)}
                                            DEFAULT {version1},
  application-context-name          [1]  Application-context-name,
  called-AP-title                   [2]  Name OPTIONAL,
  called-AE-qualifier               [3]  RelativeDistinguishedName    OPTIONAL,
  called-AP-invocation-identifier   [4]  AP-invocation-identifier     OPTIONAL,
  called-AE-invocation-identifier   [5]  AE-invocation-identifier     OPTIONAL,
  calling-AP-title                  [6]  Name                         OPTIONAL,
  calling-AE-qualifier              [7]  RelativeDistinguishedName    OPTIONAL,
  calling-AP-invocation-identifier  [8]  AP-invocation-identifier     OPTIONAL,
  calling-AE-invocation-identifier  [9]  AE-invocation-identifier     OPTIONAL,
  implementation-information        [29] IMPLICIT Implementation-data OPTIONAL,
  user-information                  [30] IMPLICIT
                                           Association-informationBind{{Protocols}}}

Association-informationBind{APPLICATION-CONTEXT:Protocols} ::=
  SEQUENCE SIZE (1..MAX) OF
    EXTERNAL
      (WITH COMPONENTS {
         identification         (WITH COMPONENTS {..., syntax ABSENT}),
         data-value-descriptor  ABSENT,
         data-value             (CONTAINING TheOsiBind{{Protocols}})})

Application-context-name ::= OBJECT IDENTIFIER

AP-invocation-identifier ::= INTEGER

AE-invocation-identifier ::= INTEGER

Implementation-data ::= GraphicString

TheOsiBind{APPLICATION-CONTEXT:Protocols} ::=
  [16]  APPLICATION-CONTEXT.&bind-operation.&ArgumentType({Protocols})
```

The **OsiBind** is used for initiating an application-association. The **OsiBind** includes presentation protocol elements (see clause 7.6.1.1), ACSE protocol elements (see clause 7.6.1.2) and the Directory Bind protocol elements (see clause 7.6.1.3). The Bind request shall be formatted according to the specification given in the relevant clauses that are mentioned.

The **OsiBind** is carried in the User Data parameter or the Extended User Data parameter of the session CONNECT SPDU (see clause 8.3.3).

The responder of the application-association shall check the protocol elements in the following sequence:

1) The session protocol elements shall be checked. If one or more of these protocol elements are unacceptable, a REFUSE SPDU (see clause 8.3.5) shall be returned. Otherwise, continue.

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2) The presentation protocol elements shall be checked. If one or more of these protocol elements are unacceptable, an **OsiBindError** including a **provider-reason** component and excluding a **user-data** component (see clause 7.6.3.1) shall be returned. Otherwise, continue.

3) The ACSE protocol elements shall be checked. If one or more of these protocol elements are unacceptable, an **OsiBindError** shall be returned with **result** and **result-source-diagnostic** components of the **AAREerr-apdu** present and with the **user-information** component absent as specified in clause 7.6.3.2. Otherwise, continue.

4) The Directory Bind shall be checked according to rules for the Directory protocol in question. An **OsiBindResult** (see clause 7.6.2) shall be returned if the responder is able to accept the Directory Bind. Otherwise, an **OsiBindError** shall be returned with the **user-information** component of the **AAREerr-apdu** present.

If a protocol error is detected at any time during that sequence, the appropriate abort shall be issued as specified in clause 7.5.

7.6.1.1 Presentation protocol elements

The presentation protocol elements constituting a CP PPDU are those defined by the **OsiBind** data type above except for the embedded **AARQ-apdu**.

The **mode-selector** component shall always be set to 1.

NOTE 1 – Rec. ITU-T X.226 | ISO/IEC 8823-1 defines two modes of presentation-connection. These Directory Specifications always use the **normal-mode**.

The **normal-mode-parameters** component has the following subcomponents:

a) The **protocol-version** subcomponent shall be omitted or set to **version-1**. If specified differently, the responder shall return an **OsiBindError** with **provider-reason** set to **protocol-version-not-supported**.

b) The value of the **calling-presentation-selector** subcomponent, if supplied, shall be obtained from locally held information.

For a definition of presentation-selector, see clause 7.4.

c) The value of the **called-presentation-selector** subcomponent, if supplied, shall be obtained from:

– information obtained from the **AccessPoint** value of a **ContinuationReference** as the result of a previous Directory operation (see Rec. ITU-T X.518 | ISO/IEC 9594-4); or

– locally held information.

If the responder does not use presentation-selector addressing or if the supplied presentation-selector is not one for a Directory application-process, then the responder shall return an **OsiBindError** with **provider-reason** set to **called-presentation-address-unknown**.

d) The **presentation-context-definition-list** subcomponent shall have two elements, each being a sequence type with:

– a **presentation-context-identifier** that is selected by the initiator. It shall be an uneven integer and shall be different for the two elements;

– an **abstract-syntax-name**, which

i) for one of the elements shall be an object identifier identifying the ACSE abstract syntax (**id-acseAS**); and

ii) for the other element shall be an object identifier for a Directory abstract syntax corresponding to the type of application-association to be established (**id-as-directoryAccessAS**, **id-as-directorySystemAS**, **id-as-directoryShadowAS** or **id-as-directoryOperationalBindingManagementAS**, as appropriate);

– a **transfer-syntax-name-list**, which shall consist of one or more elements being the object identifier for ASN.1 encoding rules as listed below:

i) {joint-iso-itu-t asn1(1) basic-encoding(1)}, which is the object identifier for the basic encoding rules (BER).

ii) {joint-iso-itu-t asn1(1) ber-derived(2) distinguished-encoding(1)}, which is the object identifier for the distinguished encoding rules (DER).

iii) {joint-iso-itu-t asn1(1) packed-encoding(3) aligned(0)}, which is the object identifier for the packed encoding rules (PER), basic aligned variant.

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iv) {joint-iso-itu-t asn1(1) packed-encoding(3) unaligned(1)},which is the object identifier for the packed encoding rules (PER), basic unaligned variant.

v) {joint-iso-itu-t asn1(1) xml-encoding(5) basic(0)}, which is the object identifier for the basic XML encoding rules (XER).

See clause 8.1 for details on abstract syntaxes and transfer syntaxes.

e) The **user-data** subcomponent has the following elements:

NOTE 3 – The **user-data** subcomponent reflects the **fully-encoded-data** choice of the **user-data** of the CP PPDU defined by Rec. ITU-T X.226 | ISO/IEC 8823-1. The **fully-encoded-data** consists of a sequence of **PVD-list**. This Directory Specification requires exactly one **PVD-list**. Therefore, the sequence-of type specifies exactly one value.

– the **transfer-syntax-name** subcomponent, if present, shall be the object identifier for the basic encoding rules (BER);

NOTE 4 – According to clause 8.4.2.7 of Rec. ITU-T X.226 | ISO/IEC 8823-1: "The transfer syntax name shall be present when more than one transfer syntax name was proposed for the presentation context of the presentation data values".

– the **presentation-context-identifier** subcomponent shall be given the same value as the **presentation-context-identifier** of the element of the **presentation-context-definition-list** that specifies the ACSE abstract syntax;

– the **presentation-data-values** subcomponent shall hold the ACSE protocol elements as specified in clause 7.6.1.2.

7.6.1.2 ACSE protocol elements

The ACSE protocol elements are those defined by the **AARQ-apdu** data type above, except for the embedded **TheOsiBind**.

NOTE 1 – The ACSE protocol elements are the relevant components of the **AARQ-apdu** as defined by Rec. ITU-T X.227 | ISO/IEC 8650-1. Only the kernel functional unit of ACSE is used by these Directory Specifications. According to clause 9.1 of Rec. ITU-T X.227 | ISO/IEC 8650-1, the **sender-acse-requirements**, the **mechanism-name**, the **calling-authentication-value** and the **application-context-name-list** components are not relevant.

The **protocol-version** component shall be omitted or set to **version1**, i.e., bit 0 set. If the component is present, the initiator shall not include any bit after bit 0. If the responder receives a Bind request with this component present and bit 0 is set and one or more other bits are set, those bits shall be ignored. If bit 0 is not set, but some other bit is set, the responding application process shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **no-common-acse-version**.

The **application-context-name** component shall:

a) for the DAP, be set to **id-ac-directoryAccessAC**;

b) for the DSP, be set to **id-as-directorySystemAC**;

c) for the DISP, be set to either:

– **id-ac-shadowConsumerInitiatedAC**;

– **id-ac-shadowSupplierInitiatedAC**;

– **id-ac-shadowSupplierInitiatedAsynchronousAC**; or

– **id-ac-shadowConsumerInitiatedAsynchronousAC**;

d) for the DOP, be set to **id-ac-directoryOperationalBindingManagementAC**.

If the responder does not support the specified **application-context-name**, it shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **application-context-name-not-supported**.

The **called-AP-title** component, if present, shall be obtained from:

– information returned in a **ContinuationReference** as the result of a previous Directory operation; or

– locally held information.

If the responder does not recognize the **called-AP-title**, it shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **called-AP-title-not-recognized**.

The **called-AE-qualifier** component, if present, shall be obtained from:

– information returned in a **ContinuationReference** as the result of a previous Directory operation; or

– locally held information.

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If the responder does not recognize the **called-AE-qualifier**, it shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **called-AE-qualifier-not-recognized**.

The **called-AP-invocation-identifier** component may optionally be supplied if information about its value is retained from a previous application-association. If the responder does not recognize the **called-AP-invocation-identifier**, it shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **called-AP-invocation-identifier-not-recognized**.

The **called-AE-invocation-identifier** component may optionally be supplied if information about its value is retained from a previous application-association. If the responder does not recognize the **called-AE-invocation-identifier**, it shall reply with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **called-AE-invocation-identifier-not-recognized**.

The **calling-AP-title** component, if supplied, shall be obtained from locally held information. If the responder wants to ensure the identity of the initiator, but does not recognize the **calling-AP-title**, it may reject the application-association with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **calling-AP-title-not-recognized**.

The **calling-AE-qualifier** component, if supplied, shall be obtained from locally held information. If the responder wants to ensure the identity of the initiator, but does not recognize the **calling-AE-qualifier**, it may reject the application-association with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **calling-AE-qualifier-not-recognized**.

The **calling-AP-invocation-identifier** component may optionally be supplied. A receiving system may ignore this value, if present. If the responder wants to ensure the identity of the initiator, but does not recognize the **calling-AP-invocation-identifier**, it may reject the application-association with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **calling-AP-invocation-identifier-not-recognized**.

The **calling-AE-invocation-identifier** component may optionally be supplied. A responding system may ignore this value, if present. If the responder wants to ensure the identity of the initiator, but does not recognize the **calling-AE-invocation-identifier**, it may reject the application-association with an **OsiBindError** (see clause 7.6.3) with **Associate-source-diagnostic** set to **calling-AE-invocation-identifier-not-recognized**.

The **implementation-information** component may hold implementation-specific information. This information does not affect the application-association establishment procedure.

The **user-information** component has the following subcomponents:

a) **direct-reference**, if present, shall hold the object identifier for the basic encoding rules (BER);

b) **indirect-reference** shall identify the Directory abstract syntax within the **presentation-context-definition-list** as defined in clause 7.6.1.1 d); and

c) the **single-ASN1-type** shall hold the Bind protocol elements as specified in clause 7.6.1.3.

NOTE 2 – The **user-information** component corresponds to the **user-information** component of **AARQ-apdu** as defined by Rec. ITU-T X.227 | ISO/IEC 8650-1. This component is a **SEQUENCE OF EXTERNAL**. These Directory Specifications require exactly one occurrence of **EXTERNAL** (see NOTE in clause 7.6.1).

7.6.1.3 The Bind protocol elements

The **TheOsiBind** shall be the Bind request argument as defined for the Directory protocol in question.

NOTE – The Bind argument starts with the [16] tag as defined in Rec. ITU-T X.880 | ISO/IEC 13712-1.

7.6.2 OSI Bind result

An **OsiBindResult** is returned by the responder if the **OsiBind** is acceptable and the responder decides to engage in the application-association.

```
OsiBindResult{APPLICATION-CONTEXT:Protocols} ::= SET {
  mode-selector                    [0] IMPLICIT SET {mode-value  [0] IMPLICIT
INTEGER(1)},
  normal-mode-parameters           [2] IMPLICIT SEQUENCE {
    protocol-version                 [0] IMPLICIT BIT STRING {version-1(0)}
                                           DEFAULT {version-1},
    responding-presentation-selector [3] IMPLICIT Presentation-selector OPTIONAL,
    presentation-context-definition-result-list
                                     [5] IMPLICIT SEQUENCE SIZE (2) OF SEQUENCE {
      result                           [0] IMPLICIT Result(acceptance),
      transfer-syntax-name             [1] IMPLICIT Transfer-syntax-name },
```

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```
    user-data                              CHOICE {
      fully-encoded-data [APPLICATION 1] IMPLICIT SEQUENCE SIZE(1) OF SEQUENCE {
        transfer-syntax-name               Transfer-syntax-name OPTIONAL,
        presentation-context-identifier    Presentation-context-identifier,
        presentation-data-values           CHOICE {
          single-ASN1-type              [0]  ABSTRACT-SYNTAX.&Type(AARE-apdu{{Protocols}}
  )}}}}}}

OsiBindResult{APPLICATION-CONTEXT:Protocols} ::= SET {
  mode-selector                     [0] IMPLICIT SET {mode-value  [0] IMPLICIT
INTEGER(1)},
  normal-mode-parameters            [2] IMPLICIT SEQUENCE {
    protocol-version                  [0] IMPLICIT BIT STRING {version-1(0)}
                                          DEFAULT {version-1},
    responding-presentation-selector [3] IMPLICIT Presentation-selector OPTIONAL,
    presentation-context-definition-result-list
                                      [5] IMPLICIT SEQUENCE SIZE (2) OF SEQUENCE {
      result                            [0] IMPLICIT Result(acceptance),
      transfer-syntax-name              [1] IMPLICIT Transfer-syntax-name },
    user-data                             CHOICE {
      fully-encoded-data [APPLICATION 1] IMPLICIT SEQUENCE SIZE(1) OF SEQUENCE {
        transfer-syntax-name               Transfer-syntax-name OPTIONAL,
        presentation-context-identifier    Presentation-context-identifier,
        presentation-data-values           CHOICE {
          single-ASN1-type              [0]  ABSTRACT-SYNTAX.&Type(AARE-apdu{{Protocols}}
  )}}}}}}

Result ::= INTEGER {
  acceptance         (0),
  user-rejection     (1),
  provider-rejection (2)}

AARE-apdu{APPLICATION-CONTEXT:Protocols} ::= [APPLICATION 1] IMPLICIT SEQUENCE {
  protocol-version                     [0] IMPLICIT BIT STRING {version1(0)}
                                             DEFAULT {version1},
  application-context-name             [1]  Application-context-name,
  result                               [2]  Associate-result(accepted),
  result-source-diagnostic             [3]  Associate-source-diagnostic,
  responding-AP-title                  [4]  Name                          OPTIONAL,
  responding-AE-qualifier              [5]  RelativeDistinguishedName     OPTIONAL,
  responding-AP-invocation-identifier  [6]  AP-invocation-identifier      OPTIONAL,
  responding-AE-invocation-identifier  [7]  AE-invocation-identifier      OPTIONAL,
  implementation-information           [29] IMPLICIT Implementation-data  OPTIONAL,
  user-information                     [30] IMPLICIT
                                     Association-informationBindRes{{Protocols}}}

Association-informationBindRes{APPLICATION-CONTEXT:Protocols} ::=
  SEQUENCE SIZE (1) OF
    EXTERNAL (
      WITH COMPONENTS {
        identification         (WITH COMPONENTS {..., syntax ABSENT}),
        data-value-descriptor  ABSENT,
        data-value             (CONTAINING TheOsiBindRes{{Protocols}})})

Associate-result ::= INTEGER {
  accepted           (0),
  rejected-permanent (1),
  rejected-transient (2)}(0..2, ...)

Associate-source-diagnostic ::= CHOICE {
  acse-service-user     [1]  INTEGER {
    null                                          (0),
    no-reason-given                                (1),
    application-context-name-not-supported        (2),
    calling-AP-title-not-recognized               (3),
    calling-AP-invocation-identifier-not-recognized (4),
    calling-AE-qualifier-not-recognized           (5),
    calling-AE-invocation-identifier-not-recognized (6),
    called-AP-title-not-recognized                (7),
    called-AP-invocation-identifier-not-recognized  (8),
    called-AE-qualifier-not-recognized            (9),
```


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```
    called-AE-invocation-identifier-not-recognized  (10)}(0..10, ...),
  acse-service-provider [2]  INTEGER {
    null                                            (0),
    no-reason-given                                 (1),
    no-common-acse-version                          (2)}(0..2, ...)}

TheOsiBindRes{APPLICATION-CONTEXT:Protocols} ::=
  [17]  APPLICATION-CONTEXT.&bind-operation.&ResultType({Protocols})
```

The **OsiBindResult** is carried in the User Data parameter of the session ACCEPT SPDU (see clause 8.3.4).

7.6.2.1 Presentation protocol elements

The presentation protocol elements constituting a CPA PPDU are those defined by the **OsiBindResult** data type above, except for the embedded **AARE-apdu**.

The **mode-selector** component shall always be set to 1.

The **normal-mode-parameters** component has the following subcomponents:

a) The **protocol-version** subcomponent shall be omitted or set to **version-1**.

b) The **responding-presentation-selector** subcomponent, if supplied, shall be obtained from locally held information.

c) The **presentation-context-definition-result-list** subcomponent shall have two elements in a sequence corresponding to the sequence of elements provided in the **presentation-context-definition-list** of the Bind request, each providing the result of the context negotiation for the corresponding element as follows:

   – The **result** shall be present and set to **acceptance**.

   – The **transfer-syntax-name** shall be present and specify the object identifier for the basic encoding rules (BER).

d) The **user-data** subcomponent has the following elements:

   – The **transfer-syntax-name** subcomponent, if present, shall be the object identifier for the encoding rules elected by the responder.

   – The **presentation-context-identifier** subcomponent shall be given the same value as the **presentation-context-identifier** of the element of the **presentation-context-definition-list** of the Bind request that specified the ACSE abstract syntax name.

   – The **presentation-data-values** subcomponent shall hold the ACSE protocol elements as specified in clause 7.6.2.2.

7.6.2.2 ACSE protocol elements

The **protocol-version** component shall be omitted or set to **version1**, i.e., bit 0 set. If the component is present, the responder shall not include any bit after bit 0.

The **result** component shall be set to **accepted** by the responder.

The **result-source-diagnostic** component shall take the **acse-service-user** choice and take the value **null** or **no-reason-given**.

The **application-context-name** component shall be present and set to the value of the corresponding component of the Bind request.

The **responding-AP-title** component, if supplied, shall be obtained from locally held information.

The **responding-AE-qualifier** component, if supplied, shall be obtained from locally held information.

The **responding-AP-invocation-identifier** component may optionally be supplied. The initiator may ignore this component, if present.

The **responding-AE-invocation-identifier** component may optionally be supplied. The initiator may ignore this component, if present.

The **implementation-information** component may hold implementation-specific information. This information does not affect the application-association establishment procedure.

The **user-information** component has the following subcomponents:

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a) **direct-reference**, if present, shall hold the object identifier for the ASN.1 basic encoding rules (BER).

b) **indirect-reference** shall identify the Directory abstract syntax within the **presentation-context-definition-list** as defined in clause 7.6.1.1 d).

c) The **single-ASN1-type** shall hold the Bind result protocol elements as specified in clause 7.6.2.3.

7.6.2.3 The Bind result protocol elements

The **TheOsiBindRes** shall be the Bind result type as defined for the Directory protocol in question.

NOTE – The Bind result starts with the [17] tag as defined in Rec. ITU-T X.880 | ISO/IEC 13712-1.

7.6.3 OSI Bind error

```
OsiBindError{APPLICATION-CONTEXT:Protocols} ::= CHOICE {
  normal-mode-parameters  SEQUENCE {
    protocol-version                [0]  IMPLICIT BIT STRING {version-1(0)}
                                           DEFAULT {version-1},
    responding-presentation-selector
                                    [3]  IMPLICIT Presentation-selector OPTIONAL,
    presentation-context-definition-result-list
                                    [5]  IMPLICIT Result-list OPTIONAL,
    provider-reason                 [10] IMPLICIT Provider-reason OPTIONAL,
    user-data                            CHOICE {
      fully-encoded-data  [APPLICATION 1] IMPLICIT SEQUENCE SIZE (1) OF SEQUENCE {
        transfer-syntax-name                Transfer-syntax-name   OPTIONAL,
        presentation-context-identifier     Presentation-context-identifier,
        presentation-data-values            CHOICE {
          single-ASN1-type                 [0]
                    ABSTRACT-SYNTAX.&Type(AAREerr-apdu{{Protocols}})}}} OPTIONAL}}

Result-list ::=
  SEQUENCE SIZE (2) OF SEQUENCE {
    result                [0] IMPLICIT Result,
    transfer-syntax-name  [1] IMPLICIT Transfer-syntax-name   OPTIONAL,
    provider-reason       [2] IMPLICIT INTEGER {
      reason-not-specified                     (0),
      abstract-syntax-not-supported            (1),
      proposed-transfer-syntaxes-not-supported (2)} OPTIONAL}

Provider-reason ::= INTEGER {
  reason-not-specified                (0),
  temporary-congestion                (1),
  local-limit-exceeded                (2),
  called-presentation-address-unknown (3),
  protocol-version-not-supported      (4),
  default-context-not-supported       (5),
  user-data-not-readable              (6),
  no-PSAP-available                   (7)}

AAREerr-apdu{APPLICATION-CONTEXT:Protocols} ::=  [APPLICATION 1] IMPLICIT SEQUENCE {
  protocol-version                    [0]  IMPLICIT BIT STRING {version1(0)}
                                             DEFAULT {version1},
  application-context-name            [1]  Application-context-name,
  result                              [2]  Associate-result
                                             (rejected-permanent..rejected-transient),
  result-source-diagnostic            [3]  Associate-source-diagnostic,
  responding-AP-title                 [4]  Name OPTIONAL,
  responding-AE-qualifier             [5]  RelativeDistinguishedName OPTIONAL,
  responding-AP-invocation-identifier [6]  AP-invocation-identifier  OPTIONAL,
  responding-AE-invocation-identifier [7]  AE-invocation-identifier  OPTIONAL,
  implementation-information          [29] IMPLICIT Implementation-data OPTIONAL,
  user-information                    [30] IMPLICIT
                                 Association-informationBindErr{{Protocols}} OPTIONAL }

Association-informationBindErr{APPLICATION-CONTEXT:Protocols} ::=
  SEQUENCE SIZE (1) OF
    EXTERNAL (
      WITH COMPONENTS {
        identification         (WITH COMPONENTS {..., syntax ABSENT}),
        data-value-descriptor  ABSENT,
```


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```
        data-value              (CONTAINING TheOsiBindErr{{Protocols}})})

TheOsiBindErr{APPLICATION-CONTEXT:Protocols} ::=
  [18]  APPLICATION-CONTEXT.&bind-operation.&Errors.&ParameterType ({Protocols})
```

The **OsiBindError** is carried in the Reason Code field of the session REFUSE SPDU (see clause 8.3.5).

7.6.3.1 Presentation protocol elements

The presentation protocol elements constituting a CPR PPDU are those defined by the **OsiBindError** data type above except for the embedded **AAREerr-apdu**.

The **normal-mode-parameters** component has the following subcomponents:

NOTE 1 – The CPR-PPDU is a choice between X.410 mode and normal mode. These Directory Specifications only use the normal mode. The CHOICE statement is retained to ensure bitwise backward compatibility when using other than BER or similar encoding.

a) The **protocol-version** subcomponent shall be as specified in clause 7.6.2.1.

b) The **responding-presentation-selector** subcomponent, if supplied, shall be as specified in clause 7.6.2.1.

c) The **presentation-context-definition-result-list** subcomponent shall be specified as follows:

   – if the rejection is not related to presentation context negotiation, the **result** element shall be set to **acceptance**, **transfer-syntax-name** shall be present specifying the object identifier for the encoding rules by the responder, and **provider-reason** element shall be absent;

   – if the abstract syntax in question is not supported by any of the proposed transfer syntaxes, the **result** element shall set to **provider-rejection** and the **provider-reason** element shall be present with the appropriate value; or

   – if the abstract syntax in question is not supported at all and the previous bullet does not apply, the **result** element shall set to **user-rejection** and the **provider-reason** element shall be present with the appropriate value.

d) The **provider-reason** subcomponent shall be present if the application-association is rejected due to problems detected within the presentation protocol elements of the Bind request. Otherwise it shall be absent.

NOTE 2 – Clause 6.2.4.9 of Rec. ITU-T X.226 | ISO/IEC 8823-1 states for **provider-reason**: "If present, this shall indicate that the rejection is by the responding presentation-service-provider; if absent this shall indicate that the rejection is by the responding PS-user."

e) The **user-data** subcomponent shall be absent if **provider-reason** subcomponent is present. Otherwise, it shall be present with the following elements:

   – The **transfer-syntax-name** subcomponent, if present, shall be the object identifier for the ASN.1 basic encoding rules (BER).

   – The **presentation-context-identifier** subcomponent shall be given the same value as the **presentation-context-identifier** of the element of the **presentation-context-definition-list** of the Bind request that specified the ACSE abstract syntax name.

   – The **presentation-data-values** subcomponent shall hold the ACSE protocol elements as specified in clause 7.6.3.2.

7.6.3.2 ACSE protocol elements

The **protocol-version** component shall be as specified in clause 7.6.2.2.

The **application-context-name** component shall be present and set to the value of the corresponding component of the Bind request.

The **result** component shall be set to **rejected-permanent** or **rejected-transient** based on local considerations.

NOTE – According to clause 11.1.1 of Rec. ITU-T X.881 | ISO/IEC 13712-2, a Bind Error is carried in the A-ASSOCIATE response/confirm with the Result parameter value of the A-ASSOCIATE service primitives set to "rejected (permanent)" or "rejected (transient)", and the error value of the Bind operation is mapped on the User Information parameter of these service primitives. At the protocol level, that translates to the **result** component being set to either **rejected-permanent** or **rejected-transient**. Most of the Bind errors reflect a permanent condition. However, the **serviceError** with problem **unavailable** might be considered as being transient.

The **result-source-diagnostic** component shall take values as follows depending on the condition:

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a) if the rejection is within a directory protocol, the **acse-service-user** choice shall be taken with the value **null** or **no-reason-given**; or

b) if the rejection is ACSE related or due to errors in a specified application process title, application-entity title or application-context, the **acse-service-user** choice shall be taken with the appropriate value.

The value of the **responding-AP-title** component, if present, shall be obtained from locally held information.

The **responding-AE-qualifier** component, if present, shall be obtained from locally held information.

The **responding-AP-invocation-identifier** component, if present, may be ignored or retained for a future association with that DSA.

The **responding-AE-invocation-identifier** component, if present, may be ignored or retained for a future association with that DSA.

The **implementation-information** component may hold implementation-specific information.

The **user-information** component has the following subcomponents:

a) **direct-reference**, if present, shall hold the object identifier for the ASN.1 basic encoding rules (BER);

b) **indirect-reference** shall identify the Directory abstract syntax within the **presentation-context-definition-list** as defined in clause 7.6.1.1 d);

c) the **single-ASN1-type** shall hold the Bind error protocol elements as specified in clause 7.6.3.3.

7.6.3.3 The Bind error protocol elements

The **TheOsiBindErr** shall be the Bind error type as relevant for the type of error.

NOTE – The Bind error starts with the [18] tag as defined in Rec. ITU-T X.880 | ISO/IEC 13712-1.

7.6.4 OSI unbind request

```
TheOsiBindErr{APPLICATION-CONTEXT:Protocols} ::=
  [18]  APPLICATION-CONTEXT.&bind-operation.&Errors.&ParameterType ({Protocols})

OsiUnbind ::= CHOICE {
  fully-encoded-data
    [APPLICATION 1] IMPLICIT SEQUENCE SIZE (1) OF SEQUENCE {
       presentation-context-identifier  Presentation-context-identifier,
       presentation-data-values     CHOICE {
         single-ASN1-type        [0]  ABSTRACT-SYNTAX.&Type(TheOsiUnbind)}}}

TheOsiUnbind ::= [APPLICATION 2] IMPLICIT SEQUENCE {
  reason  [0] IMPLICIT Release-request-reason OPTIONAL}

Release-request-reason ::= INTEGER {normal(0)}
```

The **OsiUnbind** is carried in the User Data of the session FINISH SPDU (see clause 8.3.6).

Only the initiator of an application-association may invoke an unbind request.

NOTE 1 – Clause 8.5 of Rec. ITU-T X.880 | ISO/IEC 13712-1 defines a **CONNECTION-PACKAGE** information object class, where the field **&responderCanUnbind** specifies whether the responder may issue an unbind or not. It defaults to **FALSE**. Rec. ITU-T X.519 (2001) | ISO/IEC 9594-5:2001 did not add the **&responderCanUnbind** for any of the protocols. The IDM protocol allows the responder to issue an unbind, except for the DAP protocol (see clause 9.2.2).

NOTE 2 – Clause 8.5 of Rec. ITU-T X.880 | ISO/IEC 13712-1 also defines an **&unbindCanFail** field of the **CONNECTION-PACKAGE** information object class with default equal **FALSE**. Rec. ITU-T X.519 (2001) | ISO/IEC 9594-5:2001 did not add the **&unbindCanFail** for any of the protocols.

7.6.4.1 Presentation protocol elements

The presentation protocol elements are only those defined by the **User-data** data type defined by Rec. ITU-T X.226 | ISO/IEC 8823-1.

The **presentation-context-identifier** component shall be given the same value as the **presentation-context-identifier** of the element of the **presentation-context-definition-list** of the Bind request that specified the ACSE abstract syntax.

The **presentation-data-values** component shall hold the ACSE protocol elements as specified in clause 7.6.4.2.

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