
**Information technology — Open
Systems Interconnection — The
Directory —**

**Part 5:
Protocol specifications**

*Technologies de l'information — Interconnexion de systèmes ouverts
(OSI) — L'annuaire —*

Partie 5: Spécifications du protocole

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (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).

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For an explanation on 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 the following URL: www.iso.org/iso/foreword.html.

This eighth edition cancels and replaces the seventh edition (ISO/IEC 9594-5:2014), which has been technically revised.

This document was prepared by ISO/IEC JTC 1, *Information technology*, SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T X.519 (10/2016).

A list of all parts in the ISO/IEC 9594 series, published under the general title *Information technology — Open Systems Interconnection — The Directory*, can be found on the ISO website.

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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 eighth edition technically revises and enhances the seventh edition of this Recommendation | International Standard.

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

The first and second editions 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 eight 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.

**INTERNATIONAL STANDARD
RECOMMENDATION ITU-T**

**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 (2016) | ISO/IEC 9594-1:2017, *Information technology – Open Systems Interconnection – The Directory: Overview of concepts, models and services.*
- Recommendation ITU-T X.501 (2016) | ISO/IEC 9594-2:2017, *Information technology – Open Systems Interconnection – The Directory: Models.*
- Recommendation ITU-T X.509 (2016) | ISO/IEC 9594-8:2017, *Information technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks.*
- Recommendation ITU-T X.511 (2016) | ISO/IEC 9594-3:2017, *Information technology – Open Systems Interconnection – The Directory: Abstract service definition.*
- Recommendation ITU-T X.518 (2016) | ISO/IEC 9594-4:2017, *Information technology – Open Systems Interconnection – The Directory: Procedures for distributed operation.*
- Recommendation ITU-T X.520 (2016) | ISO/IEC 9594-6:2017, *Information technology – Open Systems Interconnection – The Directory: Selected attribute types.*
- Recommendation ITU-T X.521 (2016) | ISO/IEC 9594-7:2017, *Information technology – Open Systems Interconnection – The Directory: Selected object classes.*
- Recommendation ITU-T X.525 (2016) | ISO/IEC 9594-9:2017, *Information technology – Open Systems Interconnection – The Directory: Replication.*
- 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 10646:2014, *Information technology – Universal Multiple-Octet Coded Character Set (UCS).*

2.1.3 Other references

- Recommendation ITU-T E.164 (2010), *International operation – Numbering plan of the international telephone service*.
- 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:

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 for edition 5 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.

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

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 X.500-series Recommendations and all parts of ISO/IEC 9594.

This Directory Specification uses the term *first edition systems* to refer to systems conforming to the first edition of the Directory Specifications, i.e., the 1988 edition of the series of CCITT X.500 Recommendations and the ISO/IEC 9594:1990 edition.

This Directory Specification uses the term *second edition systems* to refer to systems conforming to the second edition of the Directory Specifications, i.e., the 1993 edition of the series of ITU-T X.500 Recommendations and the ISO/IEC 9594:1995 edition.

This Directory Specification uses the term *third edition systems* to refer to systems conforming to the third edition of the Directory Specifications, i.e., the 1997 edition of the series of ITU-T X.500 Recommendations and the ISO/IEC 9594:1998 edition.

This Directory Specification uses the term *fourth edition systems* to refer to systems conforming to the fourth edition of the Directory Specifications, i.e., the 2001 editions of Recs ITU-T X.500, X.501, X.511, X.518, X.519, X.520, X.521, X.525 and X.530, the 2000 edition of Rec. ITU-T X.509, and parts 1-10 of the ISO/IEC 9594:2001 edition.

This Directory Specification uses the term *fifth edition systems* to refer to systems conforming to the fifth edition of the Directory Specifications, i.e., the 2005 edition of the series of ITU-T X.500 Recommendations and the ISO/IEC 9594:2005 edition.

This Directory Specification uses the term *sixth edition systems* to refer to systems conforming to the sixth edition of the Directory Specifications, i.e., the 2008 edition of the series of ITU-T X.500 Recommendations and the ISO/IEC 9594:2008 edition.

This Directory Specification uses the term *seventh edition systems* to refer to systems conforming to the seventh edition of the Directory Specifications, i.e., the 2012 edition of the ITU-T X.500-series Recommendations and the ISO/IEC 9594:2014 edition.

This Directory Specification uses the term *eighth edition systems* to refer to systems conforming to the eighth edition of the Directory Specifications, i.e., the 2016 edition of the ITU-T X.500-series Recommendations and the ISO/IEC 9594:2017 edition.

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.

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:

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

- if a Directory operation shall be completed before a new Directory operation may be invoked, the mode of operation is *synchronous*; or
- if several operations may be in progress at the same time, the mode of operation is *asynchronous*.

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

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