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Part 5: The Directory: Protocol specifications

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Foreword

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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.

CONTENTS

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.

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*.

- 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:

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.

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 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.

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).

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.