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**Information technology — Open Systems  
Interconnection — The Directory: Protocol  
specifications**

*Technologies de l'information — Interconnexion de systèmes ouverts  
(OSI) — L'Annuaire: 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.

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

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

Attention is drawn to the possibility that some of the elements of this part of ISO/IEC 9594 may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 9594-5 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*, in collaboration with ITU-T. The identical text is published as ITU-T Recommendation X.519.

This third edition cancels and replaces the second edition (ISO/IEC 9594-5:1995), of which it constitutes a minor revision.

ISO/IEC 9594 consists of the following parts, under the general title *Information technology — Open Systems Interconnection — The Directory*:

- *Part 1: Overview of concepts, models and services*
- *Part 2: Models*
- *Part 3: Abstract service definition*
- *Part 4: Procedures for distributed operation*
- *Part 5: Protocol specifications*
- *Part 6: Selected attribute types*
- *Part 7: Selected object classes*
- *Part 8: Authentication framework*
- *Part 9: Replication*
- *Part 10: Use of systems management for administration of the Directory*

Annexes A to G form a normative part of this part of ISO/IEC 9594. Annex H is for information only.

## Introduction

This Recommendation | International Standard, together with the 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 which 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 third edition technically revises and enhances, but does not replace, the second edition of this Recommendation | International Standard. Implementations may still claim conformance to the second edition. However, at some point, the second edition will not be supported (i.e. reported defects will no longer be resolved). It is recommended that implementations conform to this third edition as soon as possible.

This third edition specifies version 1 and version 2 of the Directory protocols.

The first and second editions also specified version 1. Most of the services and protocols specified in this edition are designed to function under version 1. When version 1 has been negotiated differences between the services and between the protocols defined in the three editions are accommodated using the rules of extensibility defined in this edition of ITU-T Rec. X.519 | ISO/IEC 9594-5. 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.

Implementors should note that a defect resolution process exists and that corrections may be applied to this part of this International Standard in the form of technical corrigenda. The identical corrections will be applied to this Recommendation in the form of Corrigenda and/or an Implementor's Guide. A list of approved technical corrigenda for this part of this International Standard can be obtained from the subcommittee secretariat. Published technical corrigenda are available from your national standards organization. The ITU-T Corrigenda and Implementor's Guides may be obtained from the ITU Web site.

Annex A, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the directory access protocol.

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

Annex C, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the directory information shadowing protocol.

Annex D, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module for the directory operational binding management protocol.

## ISO/IEC 9594-5:1998(E)

Annex E, which is an integral part of this Recommendation | International Standard, provides the ASN.1 module which contains all the ASN.1 object identifiers assigned in this Recommendation | International Standard.

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 an integral part of this Recommendation | International Standard, provides the ASN.1 module for the security exchanges.

Annex H, 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 fulfilling the abstract services specified in ITU-T Rec. X.511 | ISO/IEC 9594-3, ITU-T Rec. X.518 | ISO/IEC 9594-4, and ITU-T Rec. X.525 | ISO/IEC 9594-9.

**2 Normative references**

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to 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 Identical Recommendations | International Standards**

- ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model.*
- ITU-T Recommendation X.213 (1995) | ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network service definition.*
- ITU-T Recommendation X.214 (1995) | ISO/IEC 8072:1996, *Information technology – Open Systems Interconnection – Transport service definition.*
- ITU-T Recommendation X.215 (1995) | ISO/IEC 8326:1996, *Information technology – Open Systems Interconnection – Session service definition.*
- ITU-T Recommendation X.216 (1994) | ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition.*
- ITU-T Recommendation X.217 (1995) | ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Association Control Service Element.*
- ITU-T Recommendation X.227 (1995) | ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification.*
- ITU-T Recommendation X.500 (1997) | ISO/IEC 9594-1:1998, *Information technology – Open Systems Interconnection – The Directory: Overview of concepts, models and services.*
- ITU-T Recommendation X.501 (1997) | ISO/IEC 9594-2:1998, *Information technology – Open Systems Interconnection – The Directory: Models.*
- ITU-T Recommendation X.509 (1997) | ISO/IEC 9594-8:1998, *Information technology – Open Systems Interconnection – The Directory: Authentication framework.*
- ITU-T Recommendation X.511 (1997) | ISO/IEC 9594-3:1998, *Information technology – Open Systems Interconnection – The Directory: Abstract service definition.*

- ITU-T Recommendation X.518 (1997) | ISO/IEC 9594-4:1998, *Information technology – Open Systems Interconnection – The Directory: Procedures for distributed operation.*
- ITU-T Recommendation X.520 (1997) | ISO/IEC 9594-6:1998, *Information technology – Open Systems Interconnection – The Directory: Selected attribute types.*
- ITU-T Recommendation X.521 (1997) | ISO/IEC 9594-7:1998, *Information technology – Open Systems Interconnection – The Directory: Selected object classes.*
- ITU-T Recommendation X.525 (1997) | ISO/IEC 9594-9:1998, *Information technology – Open Systems Interconnection – The Directory: Replication.*
- ITU-T Recommendation X.530 (1997) | ISO/IEC 9594-10:1998, *Information technology – Open Systems Interconnection – The Directory: Use of systems management for administration of the Directory.*
- ITU-T Recommendation X.680 (1997) | ISO/IEC 8824-1:1998, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation.*
- ITU-T Recommendation X.681 (1997) | ISO/IEC 8824-2:1998, *Information technology – Abstract Syntax Notation One (ASN.1): Information object specification.*
- ITU-T Recommendation X.682 (1997) | ISO/IEC 8824-3:1998, *Information technology – Abstract Syntax Notation One (ASN.1): Constraint specification.*
- ITU-T Recommendation X.683 (1997) | ISO/IEC 8824-4:1998, *Information technology – Abstract Syntax Notation One (ASN.1): Parametrization of ASN.1 specifications.*
- ITU-T Recommendation X.690 (1997) | ISO/IEC 8825-1:1998, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).*
- ITU Recommendation X.803 (1994) | ISO/IEC 10745:1995, *Information technology – Open Systems Interconnection – Upper layers security model.*
- ITU Recommendation X.830 (1995) | ISO/IEC 11586-1:1996, *Information technology – Open Systems Interconnection – Generic upper layers security: Overview, models and notation.*
- ITU Recommendation X.831 (1995) | ISO/IEC 11586-2:1996, *Information technology – Open Systems Interconnection – Generic upper layers security: Security Exchange Service Element (SESE) service definition.*
- ITU Recommendation X.832 (1995) | ISO/IEC 11586-3:1996, *Information technology – Open Systems Interconnection – Generic upper layers security: Security Exchange Service Element (SESE) protocol specification.*
- ITU Recommendation X.833 (1995) | ISO/IEC 11586-4:1996, *Information technology – Open Systems Interconnection – Generic upper layers security: Protecting transfer syntax specification.*
- ITU-T Recommendation X.880 (1994) | ISO/IEC 13712-1:1995, *Information technology – Remote Operations: Concepts, model and notation plus Technical Corrigendum 1 (1996).*
- ITU-T Recommendation X.880 (1994)/Amd.1 (1995) | ISO/IEC 13712-1:1995/Amd.1:1996, *Information technology – Remote Operations: Concepts, model and notation – Amendment 1: Built-in operations.*
- ITU-T Recommendation X.881 (1994) | ISO/IEC 13712-2:1995, *Information technology – Remote Operations: OSI realizations – Remote Operations Service Element (ROSE) service definition.*
- ITU-T Recommendation X.881 (1994)/Amd.1 (1995) | ISO/IEC 13712-2:1995/Amd.1:1996, *Information technology – Remote Operations: OSI realizations – Remote Operations Service Element (ROSE) service definition – Amendment 1: Mapping to A-UNIT-DATA and built-in operations.*
- ITU-T Recommendation X.882 (1994) | ISO/IEC 13712-3:1995, *Information technology – Remote Operations: OSI realizations – Remote Operations Service Element (ROSE) protocol specification plus Technical Corrigendum 1 (1996).*
- ITU-T Recommendation X.882 (1994)/Amd.1 (1995) | ISO/IEC 13712-3:1995/Amd.1:1996, *Information technology – Remote Operations: OSI realizations – Remote Operations Service Element (ROSE) protocol specification – Amendment 1: Mapping to A-UNIT-DATA and built-in operations.*

## 2.2 Paired Recommendations | International Standards equivalent in technical content

- ITU-T Recommendation X.218 (1993) *Reliable Transfer: Model and Service Definition.*  
ISO/IEC 9066-1:1989, *Information processing systems – Text communication – Reliable Transfer – Part 1: Model and service definition.*



### 2.3 Other references

- ITU-T Recommendation E.164 (1997), *The international public telecommunication numbering plan*.
- ITU-T Recommendation X.121 (1996), *International numbering plan for public data networks*.
- RFC 2025 (1996), *The Simple Public-Key GSS-API Mechanism (SPKM)*.

## 3 Definitions

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

### 3.1 OSI Reference Model Definitions

The following terms are defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

- a) *abstract-syntax*;
- b) *application-context*;
- c) *application-entity*;
- d) *application process*;
- e) *application-protocol-control-information*;
- f) *application-protocol-data-unit*;
- g) *application-service-element*.

### 3.2 Remote Operations Definitions

The following terms are defined in ITU-T Rec. X.880 | ISO/IEC 13712-1:

- a) *connection package*;
- b) *contract, association contract*;
- c) *error*;
- d) *operation*; <https://standards.iteh.ai/catalog/standards/sist/52c3948d-c273-4988-b7d3-2c089e654638/iso-iec-9594-5-1998>
- e) *operation package*;
- f) *ROS-object*.

### 3.3 Basic Directory Definitions

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

- a) *the Directory*;
- b) *(Directory) user*;
- c) *Directory System Agent (DSA)*;
- d) *Directory User Agent (DUA)*.

### 3.4 Distributed Operation Definitions

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

- a) *chaining*;
- b) *referral*.

### 3.5 Upper layer security definitions

The following terms are used as defined in ITU-T Rec. X.803 | ISO/IEC 10745:

- a) *security association*;
- b) *security transformation*;
- c) *security exchange*;
- d) *security exchange item*.

The following terms are used as defined in ITU-T Rec. X.830 | ISO/IEC 11586-1:

- a) *protecting transfer syntax*;
- b) *protection mapping*.

## 4 Abbreviations

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

AC	Application Context[COMP/RM1]
ACSE	Association Control Service Element[COMP/RM2]
AE	Application Entity
APCI	Application Protocol Control Information
APDU	Application Protocol Data Unit
ASE	Application Service Element
DAP	Directory Access Protocol
DISP	Directory Information Shadowing Protocol
DOP	Directory Operational Binding Management Protocol
DSA	Directory System Agent
DSP	Directory System Protocol
DUA	Directory User Agent
GULS	Generic Upper Layers Security
ROS	Remote Operations Service
ROSE	Remote Operations Service Element
RTSE	Reliable Transfer Service Element
SESE	Security Exchange Service Element

## 5 Conventions

With minor exceptions this Directory Specification has been prepared according to the "Presentation of ITU-T | ISO/IEC common text" guidelines in the Guide for ITU-T and ISO/IEC JTC 1 Cooperation.

The term "Directory Specification" (as in "this Directory Specification") shall be taken to mean ITU-T Rec. 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 "1988 edition systems" to refer to systems conforming to the first (1988) 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 "1993 edition systems" to refer to systems conforming to the second (1993) 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. Systems conforming to this third edition of the Directory Specifications are referred to as "1997 edition systems".

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

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

This Directory Specification defines directory operations using the Remote Operation notation defined in ITU-T Rec. X.880 | ISO/IEC 13712-1.

## 6 Protocol overview

### 6.1 Remote Operations – Specification and OSI Realization

ITU-T Rec. X.880 | ISO/IEC 13712-1 defines several information object classes that are useful in the specification of ROS-based application protocols such as the various Directory protocols defined in this Directory Specification. A number of these classes are used in this and subsequent clauses. The specification techniques provided in ITU-T Rec. X.880 | ISO/IEC 13712-1 are used to define a generic protocol between objects. When realized as an OSI application layer protocol, the concepts of ITU-T Rec. X.880 | ISO/IEC 13712-1 are mapped to OSI concepts in ITU-T Rec. X.881 | ISO/IEC 13712-2 and ITU-T Rec. X.882 | ISO/IEC 13712-3.

The **ROS-OBJECT-CLASS** class is used to define a set of common capabilities of a set of ROS-objects in terms of the (association) contracts they support as initiators and/or responders. When realized using the communication services of OSI, a ROS-object maps to an application process and a contract to an application context. In these Directory Specifications the term abstract service is used to refer to a ROS association contract and OSI application layer protocol to refer to the realization of a contract between two open systems using OSI communication services.

The **OPERATION-PACKAGE** class is used to define a set of operations which may be invoked by a ROS-object assuming the role of "consumer", the operations which may be invoked by a ROS-object assuming the role of "supplier", and the operations which may be invoked by both ROS-objects. When using the communication services of OSI, an operation package is realized as an application service element (ASE).

The **CONNECTION-PACKAGE** class is used to define the bind and unbind operations used to establish and release an association. When realized using the communication services of OSI, a connection package is realized as the procedures that use the services of the Association Control Service Element.

The **CONTRACT** class is used to define an association contract in terms of a connection package and one or more operation packages. When specifying the contract, the packages in which the association initiator assumes the role of consumer, the association responder assumes the role of consumer, and either may assume the role of consumer are identified. When using the communication services of OSI, a contract is realized as an application context.

The **APPLICATION-CONTEXT** class is used to define the static aspects of an application context. These include the contract that is realized via the application context, the OSI service that establishes and releases the association, the OSI service that provides information transfer for the interactions of the contract, and the abstract syntaxes used.

The **ABSTRACT-SYNTAX** class, which is built in to ASN.1, is used to define and assign an object identifier to an ASN.1 type whose values comprise an abstract syntax.

The OSI application layer protocols defined in the Directory Specifications, the DAP, DSP, DISP and DOP, are protocols to provide communication between a pair of application processes. In the OSI environment this is represented as communication between a pair of Application-Entities (AEs) using the presentation service. The function of an AE is provided by a set of Application-Service-Elements (ASEs). The interaction between AEs is described in terms of their use of the services provided by the ASEs. All the services provided by the Directory ASEs are contained in a single AE.

The Remote Operations Service Element (ROSE) supports the request/reply paradigm of the operation. The Directory ASEs provide the mapping function of the abstract-syntax notation of the directory operation packages onto the services provided by the ROSE.

The Association Control Service Element (ACSE) supports the establishment and release of an application-association between a pair of AEs. Associations between a DUA and a DSA may be established only by the DUA. Only the initiator of an established association can release it.

Optionally, the Reliable Transfer Service Element (RTSE) may be used to reliably transfer the Application Protocol Data Units (APDUs) of the DISP.

Optionally, the Security Exchange Service Element (SESE) may be used to convey credentials for authentication and to establish a security association.

### 6.2 Directory ROS-Objects and Contracts

ITU-T Rec. X.511 | ISO/IEC 9594-3 defines the abstract service between a DUA and the Directory which provides an access point to support a user accessing Directory services.

The **dua** class of ROS-object describes a DUA, being an instance of this class, as the initiator of the contract **dapContract**. This contract is referred to in these Directory Specifications as the Directory Abstract Service. It is specified as a ROS-based information object in 6.3.

```
dua ROS-OBJECT-CLASS ::= {
    INITIATES    { dapContract }
    ID           id-rosObject-dua }
```

The **directory** class of ROS-object describes the provider of the Directory Abstract Service. This provider is the responder of the **dapContract**.

```
directory ROS-OBJECT-CLASS ::= {
    RESPONDS    { dapContract }
    ID         id-rosObject-directory }
```

The Directory is further modelled, as depicted in Figure 1, as being represented to a DUA by a DSA which supports the particular access point concerned. ITU-T Rec. X.518 | ISO/IEC 9594-4 defines the interactions between a pair of DSAs within the Directory to support user requests which are chained.

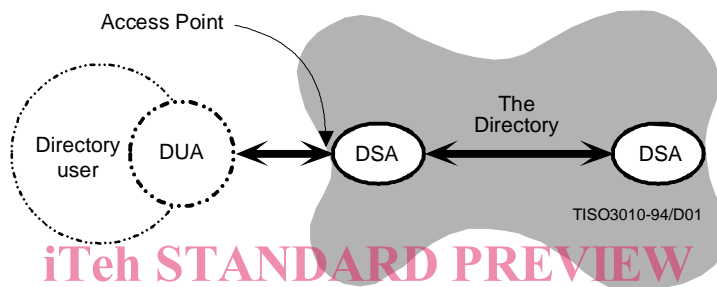


Figure 1 – Directory Interactions  
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The **directory** object is therefore manifested as a set interacting DSAs. Each DSA comprising the **directory** is an instance of the **dap-dsa** class. A **dap-dsa** object assumes the role of responder in the **dapContract**.

```
dap-dsa ROS-OBJECT-CLASS ::= {
    RESPONDS    { dapContract }
    ID         id-rosObject-dapDSA }
```

In addition to interacting with DUAs, DSAs interact with one another to achieve various objectives. In what follows, a number of contracts and ROS-objects expressing how DSAs participate in these contracts are defined. Any real DSA may instantiate one or more of these DSA ROS-objects.

The interactions between DSAs generally required to provide the Directory Abstract Service in the presence of a distributed DIB are defined as a **dspContract**. A DSA that participates in this contract is defined as a ROS-object of class **dsp-dsa**. The contract is referred to in these Directory Specifications as the DSA Abstract Service. It is specified as a ROS-based information object in 6.4.

```
dsp-dsa ROS-OBJECT-CLASS ::= {
    BOTH        { dspContract }
    ID         id-rosObject-dspDSA }
```

The Shadow Abstract Service specifies the shadowing of information between a shadow supplier and a shadow consumer DSA. This service is manifested in two forms and therefore is defined as two distinct contracts. They are specified as a ROS-based information objects in 6.5.

The **shadowConsumerContract** expresses the form of the service in which the shadow consumer, a ROS-object of class **initiating-consumer-dsa**, initiates the contract. A ROS-object of class **responding-supplier-dsa**, responds in this contract.

```
initiating-consumer-dsa ROS-OBJECT-CLASS ::= {
    INITIATES    { shadowConsumerContract }
    ID         id-rosObject-initiatingConsumerDSA }
```

```

responding-supplier-dsa ROS-OBJECT-CLASS ::= {
  RESPONDS      { shadowConsumerContract }
  ID            id-rosObject-respondingSupplierDSA }

```

The **shadowSupplierContract** expresses the form of the service in which the shadow supplier, a ROS-object of class **initiating-supplier-dsa**, initiates the contract. A ROS-object of class **responding-consumer-dsa**, responds in this contract.

```

initiating-supplier-dsa ROS-OBJECT-CLASS ::= {
  INITIATES     { shadowSupplierContract }
  ID            id-rosObject-initiatingSupplierDSA }

```

```

responding-consumer-dsa ROS-OBJECT-CLASS ::= {
  RESPONDS     { shadowSupplierContract }
  ID            id-rosObject-respondingConsumerDSA }

```

The interactions between two DSAs to manage a set of operational bindings are defined as a **dopContract**.

```

dop-dsa ROS-OBJECT-CLASS ::= {
  BOTH         { dopContract }
  ID            id-rosObject-dopDSA }

```

A DSA that participates in this contract is defined as a ROS-object of class **dop-dsa**. This contract is specified as a ROS-based information object in 6.6.

### 6.3 DAP Contract and Packages

The **dapContract** is defined as an information object of class **CONTRACT**.

```

dapContract CONTRACT ::= {
  CONNECTION    dapConnectionPackage
  INITIATOR CONSUMER OF { readPackage | searchPackage | modifyPackage }
  ID            id-contract-dap }

```

When a DUA and DSA from different open systems interact, this association contract may be realized as an OSI application layer protocol, referred to in these Directory Specifications as the Directory Access Protocol (DAP). The definition of this protocol in terms of an OSI application context is provided in 7.2 of this Directory Specification.

The **dapContract** is composed of a connection package, **dapConnectionPackage**, and three operation packages, **readPackage**, **searchPackage** and **modifyPackage**.

The connection package, **dapConnectionPackage**, is defined as an information object of class **CONNECTION-PACKAGE**. The bind and unbind operations of this connection package, **directoryBind** and **directoryUnbind**, are defined in ITU-T Rec. X.511 | ISO/IEC 9594-3.

```

dapConnectionPackage CONNECTION-PACKAGE ::= {
  BIND          directoryBind
  UNBIND        directoryUnbind
  ID            id-package-dapConnection }

```

The operation packages, **readPackage**, **searchPackage** and **modifyPackage**, are defined as information objects of class **OPERATION-PACKAGE**. The operations of these operation packages are defined in ITU-T Rec. X.511 | ISO/IEC 9594-3.

```

readPackage OPERATION-PACKAGE ::= {
  CONSUMER INVOKES { read | compare | abandon }
  ID                id-package-read }

```

```

searchPackage OPERATION-PACKAGE ::= {
  CONSUMER INVOKES { list | search }
  ID                id-package-search }

```

```

modifyPackage OPERATION-PACKAGE ::= {
  CONSUMER INVOKES { addEntry | removeEntry | modifyEntry | modifyDN }
  ID                id-package-modify }

```

NOTE – These packages, when realized as ASEs, are used for the construction of application contexts defined in this Specification. They are not intended to allow for claims of conformance to individual, or other combinations of, ASEs.

Since the DUA is the initiator of the **dapContract**, it assumes the role of consumer of the operation packages of the contract. This means that only the DUA can invoke operations in this contract and its OSI realization.

## 6.4 DSP Contract and Packages

The **dspContract** is defined as an information object of class **CONTRACT**.

```
dspContract CONTRACT ::= {
    CONNECTION          dspConnectionPackage
    OPERATIONS OF      { chainedReadPackage | chainedSearchPackage | chainedModifyPackage }
    ID                  id-contract-dsp }
```

When a pair of DSAs from different open systems interact, this association contract is realized as an OSI application layer protocol, referred to in these Directory Specifications as the Directory System Protocol (DSP). The definition of this protocol in terms of an OSI application context is provided in 7.2.

The **dspContract** is composed of a connection package, **dspConnectionPackage**, and three operation packages, **chainedReadPackage**, **chainedSearchPackage** and **chainedModifyPackage**.

The connection package, **dspConnectionPackage**, is defined as an information object of class **CONNECTION-PACKAGE**. It is identical to the connection package, **dapConnectionPackage**.

```
dspConnectionPackage CONNECTION-PACKAGE ::= {
    BIND                dSABind
    UNBIND              dSAUnbind
    ID                  id-package-dspConnection }
```

The operation packages, **chainedReadPackage**, **chainedSearchPackage** and **chainedModifyPackage**, are defined as information objects of class **OPERATION-PACKAGE**. The operations of these operation packages are defined in ITU-T Rec. X.518 | ISO/IEC 9594-4.

```
chainedReadPackage OPERATION-PACKAGE ::= {
    OPERATIONS         { chainedRead | chainedCompare | chainedAbandon }
    ID                  id-package-chainedRead }
```

```
chainedSearchPackage OPERATION-PACKAGE ::= {
    OPERATIONS         { chainedList | chainedSearch }
    ID                  id-package-chainedSearch }
```

```
chainedModifyPackage OPERATION-PACKAGE ::= {
    OPERATIONS         { chainedAddEntry | chainedRemoveEntry |
                        chainedModifyEntry | chainedModifyDN }
    ID                  id-package-chainedModify }
```

NOTE – These packages, when realized as ASEs, are used for the construction of application contexts defined in this Specification. They are not intended to allow for claims of conformance to individual, or other combinations of, ASEs.

In the **dspContract** either DSA may assume the role of initiator and either the initiating or responding DSA may invoke the operations of the contract.

## 6.5 DISP Contracts and Packages

The **shadowConsumerContract** and **shadowSupplierContract** are defined as information objects of class **CONTRACT**.

```
shadowConsumerContract CONTRACT ::= {
    CONNECTION          dispConnectionPackage
    INITIATOR CONSUMER OF { shadowConsumerPackage }
    ID                  id-contract-shadowConsumer }
```

```
shadowSupplierContract CONTRACT ::= {
    CONNECTION          dispConnectionPackage
    RESPONDER CONSUMER OF { shadowSupplierPackage }
    ID                  id-contract-shadowSupplier }
```

NOTE – The term consumer and supplier are employed in the notation for the **CONTRACT** and **OPERATION-PACKAGE** classes are used to designate two roles. These roles correspond to the two terms shadow consumer and shadow supplier, respectively, used in ITU-T Rec. X.525 | ISO/IEC 9594-9.

The OSI realizations of the two forms of the Shadow Abstract Service, referred to collectively as the Directory Information Shadowing Protocol (DISP), are defined in terms of several OSI application contexts, provided in 7.2.

The **shadowConsumerContract** and **shadowSupplierContract** are composed of a common connection package, **dispConnectionPackage**, and one operation package, either **shadowConsumerPackage** in the first case or **shadowSupplierPackage** in the second.

The connection package, **dispConnectionPackage**, is defined as an information object of class **CONNECTION-PACKAGE**. It is identical to the connection package, **dapConnectionPackage**.

```
dispConnectionPackage CONNECTION-PACKAGE ::= {
    BIND          dSAShadowBind
    UNBIND        dSAShadowUnbind
    ID            id-package-dispConnection }
```

The operation packages, **shadowConsumerPackage** and **shadowSupplierPackage**, are defined as information objects of class **OPERATION-PACKAGE**. The operations of these operation packages are defined in ITU-T Rec. X.525 | ISO/IEC 9594-9.

```
shadowConsumerPackage OPERATION-PACKAGE ::= {
    CONSUMER INVOKES { requestShadowUpdate }
    SUPPLIER INVOKES { updateShadow }
    ID                id-package-shadowConsumer }
```

```
shadowSupplierPackage OPERATION-PACKAGE ::= {
    SUPPLIER INVOKES { coordinateShadowUpdate |
                    updateShadow }
    ID                id-package-shadowSupplier }
```

Since the shadow consumer is the initiator of the **shadowConsumerContract**, it assumes the role of consumer of the **shadowConsumerPackage**. This means that the shadow consumer invokes the **requestShadowUpdate** operation and that the shadow supplier invokes the **updateShadow** operation.

Since the shadow supplier is the initiator of the **shadowSupplierContract**, it assumes the role of supplier of the **shadowSupplierPackage**. This means that the shadow supplier invokes the operations of the contract.

## 6.6 DOP Contract and Packages

The **dopContract** is defined as an information object of class **CONTRACT**.

```
dopContract CONTRACT ::= {
    CONNECTION          dopConnectionPackage
    OPERATIONS OF      { dopPackage }
    ID                  id-contract-dop }
```

When a pair of DSAs from different open systems interact, this association contract is realized as an OSI application layer protocol, referred to in these Directory Specifications as the Directory Operational Binding Management Protocol (DOP). The definition of this protocol in terms of an OSI application context is provided in 7.2.

The connection package, **dopConnectionPackage**, is defined as an information object of class **CONNECTION-PACKAGE**. It is identical to the connection package, **dapConnectionPackage**.

```
dopConnectionPackage CONNECTION-PACKAGE ::= {
    BIND          dSAOperationalBindingManagementBind
    UNBIND        dSAOperationalBindingManagementUnbind
    ID            id-package-dopConnection }
```

The operation package, **dopPackage**, is defined as information objects of class **OPERATION-PACKAGE**. The operations of these operation packages are defined in ITU-T Rec. X.501 | ISO/IEC 9594-2.

```
dopPackage OPERATION-PACKAGE ::= {
    CONSUMER INVOKES { establishOperationalBinding |
                    modifyOperationalBinding |
                    terminateOperationalBinding }
    ID                id-package-operationalBindingManagement }
```

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

## 6.7 Use of underlying services

The DAP, DSP, DOP and DISP protocols make use of underlying services as described below.