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Part 5:
ADI31 — DUA Support for Distributed Operations

Technologies de l'information — Profils normalisés internationaux ADInn — L'Annuaire OSI —

Partie 5: ADI31 — Support DUA d'opérations réparties

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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. In addition to developing International Standards, ISO/IEC JTC 1 has created a Special Group on Functional Standardization for the elaboration of International Standardized Profiles.

An International Standardized Profile is an internationally agreed, harmonized document which identifies a standard or group of standards, together with options and parameters, necessary to accomplish a function or a set of functions.

Draft International Standardized Profiles are circulated to national bodies for voting. Publication as an International Standardized Profile requires approval by at least 75 % of the national bodies casting a vote.

International Standardized Profile ISO/IEC ISP 10615-5 was prepared with the collaboration of

— Asia-Oceania Workshop (AOW);

— European Workshop for Open Systems (EWOS);

— Open Systems Environment Implementors' Workshop (OIW).

ISO/IEC ISP 10615 consists of the following parts, under the general title *Information technology — International Standardized Profiles ADInn — OSI Directory*:

— *Part 1: ADI11 — DUA Support of Directory Access*

— *Part 2: ADI12 — DSA Support of Directory Access*

— *Part 3: ADI21 — DSA Performer Role*

— *Part 4: ADI22 — DSA Invoker Role*

— *Part 5: ADI31 — DUA Support for Distributed Operations*

— *Part 6: ADI32 — DSA Support for Distributed Operations*

— *Part 7: ADI41 — Specific Digital Signature Schemes*

— *Part 8: ADI4X — Use of Strong Authentication*

Annexes A and B form an integral part of this part of ISO/IEC ISP 10615. Annex C is for information only.

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Introduction

The concept and structure of International Standardized Profiles for Information Systems are laid down in ISO/IEC TR 10000. The purpose of an International Standardized Profile is to recommend when and how certain information technology standards shall be used. This part of ISO/IEC ISP 10615 specifies application profile ADI31 as defined in the Technical Report ISO/IEC TR 10000-2.

This part of ISO/IEC ISP 10615 is one of a set of International Standardized Profiles relating to the Directory (see TR 10000-2).

This part of ISO/IEC ISP 10615 profiles the manner in which DUAs are to behave when they are autonomously initiating and continuing operations in which multiple DSAs are to be contacted (as a result of receiving back referrals or continuation-references in list or search results) in the course of accessing the Directory. This part of ISO/IEC ISP 10615 also clarifies certain elements of behaviour which are unclear or are insufficiently defined in the base standard.

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Information technology — International Standardized Profiles ADInn — OSI Directory —

Part 5:
ADI31 — DUA Support for Distributed Operations

1 Scope

1.1 General

Although ISO/IEC 9594-4 | CCITT X.518 describes the DSA procedures relating to referrals and Search Continuation References, this part of ISO/IEC ISP 10615 does not define the DUA's role in acting upon these procedures.

This part of ISO/IEC ISP 10615 specifies the behaviour of DUAs when they use DAP to access multiple DSAs in the course of making a single original enquiry without human intervention in the formulation of protocol. Multiple enquiries result from receiving continuation references embedded in referrals, list results or search results).

DUAs which do not have the capability of following referrals or Search Continuation References without human intervention in the formulation of protocol are not within the scope of this part of ISO/IEC ISP 10615 for the purposes of conformance, although its recommendations may be of value.

NOTE – The conformance requirements of this part of ISO/IEC ISP 10615 presume the scenario depicted in Figure 1: human intervention (if any) is restricted to the possibility of a "go/no-go" decision; in the case of conformance testing, each such decision is presumed to be "go".

The scope of this part of ISO/IEC ISP 10615 is limited to matters of procedure in exercising the DAP protocol, and does not cover enhancements of service. It does not cover any (DAP) protocol encoding issues.

NOTE – In the absence of this part of ISO/IEC ISP 10615, the implementor of a DUA with the capability of following continuation references automatically will need to make design decisions about the behaviour of the DUA when doing so. An aim of this part of ISO/IEC ISP 10615 is to minimise uncertainty and enhance consistency in making design solutions by means of functional standardisation. This part of ISO/IEC ISP 10615 adds no spurious complexity, given that the requirement pre-exists to follow continuation references automatically

1.2 Position within the taxonomy

This part of ISO/IEC ISP 10615 is identified in ISO/IEC TR 10000-2 as ADI31 "Directory—Distributed Operations—DUA Support of Distributed Operations".

1.3 Scenario

This part of ISO/IEC ISP 10615 profiles the autonomous behaviour of DUAs when Referrals or Search Continuation References are used by the Directory.

A DUA creates an association to a DSA of its choice, and invokes an operation. The DSA may return a referral instead of a result, or the result may contain continuation references. The latter occur in the case of List or Search operations in which the DSA is unwilling or unable to complete the search, but is able to advise which other DSAs may be able to assist.

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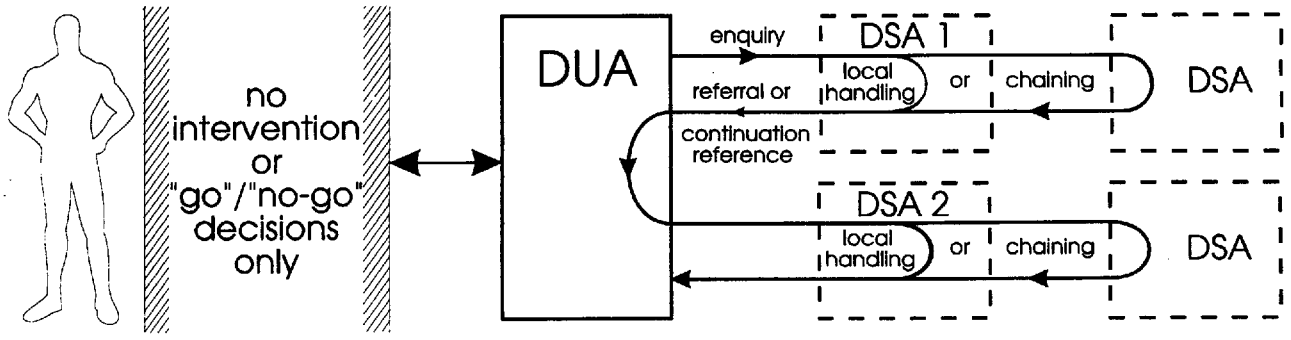


Figure 1: DUA Behaviour for Distributed Operations

The possible actions which may then be taken by a DUA, without human intervention except possibly the taking of a "go/no-go" decision, are specified in this part of ISO/IEC ISP 10615.

2 Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC ISP 10615. At the time of publication, the editions indicated were valid. All documents are subject to revision and parties to agreements based on this part of ISO/IEC ISP 10615 are warned against automatically applying any more recent editions of the documents listed below, since the nature of references made by ISPs to such documents is that they may be specific to a particular edition. Members of IEC and ISO maintain registers of currently valid International Standards and ISPs, and ITU-T maintains published editions of its current Recommendations.

2.1 Paired CCITT Recommendations | International Standards equivalent in technical content

- CCITT Recommendation X.208:1988, *Data Communications – Open Systems Interconnection (OSI) – Specification of Abstract Syntax Notation One (ASN.1).*

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

- CCITT Recommendation X.209:1988, *Data Communications – Open Systems Interconnection (OSI) – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*

  ISO/IEC 8825:1990, *Information technology – Open Systems Interconnection – Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*

- CCITT Recommendation X.219:1988, *Data Communications – Open Systems Interconnection (OSI) – Remote Operations: Model, notation and service definition.*

  ISO/IEC 9072 – 1:1989, *Information processing systems – Text communication – Remote Operations – Part 1: Model, notation and service definition.*

- CCITT Recommendation X.229:1988, *Data Communications – Open Systems Interconnection (OSI) – Remote Operations: Protocol Specification.*

  ISO/IEC 9072 – 2:1989, *Information processing systems – Text communication – Remote Operations – Part 2: Protocol specification.*

- CCITT Recommendation X.500:1988, *Data Communication Networks – The Directory – Overview of Concepts, Models and Services.*

  ISO/IEC 9594 – 1:1990, *Information technology – Open Systems Interconnection – The Directory – Part 1: Overview of concepts, models and services.*

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- CCITT Recommendation X.501:1988, *Data Communication Networks – The Directory – Models.*

  ISO/IEC 9594-2:1990, *Information technology – Open Systems Interconnection – The Directory – Part 2: Models.*

- CCITT Recommendation X.509:1988, *Data Communication Networks – The Directory – Authentication Framework.*

  ISO/IEC 9594-8:1990, *Information technology – Open Systems Interconnection – The Directory – Part 8: Authentication framework.*

- CCITT Recommendation X.511:1988, *Data Communication Networks – The Directory – Abstract Service Definition.*

  ISO/IEC 9594-3:1990, *Information technology – Open Systems Interconnection – The Directory – Part 3: Abstract service definition.*

- CCITT Recommendation X.518:1988, *Data Communication Networks – The Directory – Procedures for Distributed Operation.*

  ISO/IEC 9594-4:1990, *Information technology – Open Systems Interconnection – The Directory – Part 4: Procedures for distributed operation.*

- CCITT Recommendation X.519:1988, *Data Communication Networks – The Directory – Protocol Specification.*

  ISO/IEC 9594-5:1990, *Information technology – Open Systems Interconnection – The Directory – Part 5: Protocol specifications.*

- CCITT Recommendation X.520:1988, *Data Communication Networks – The Directory – Selected Attribute Types.*

  ISO/IEC 9594-6:1990, *Information technology – Open Systems Interconnection – The Directory – Part 6: Selected attribute types.*

2.2 Normative Amendments and Technical Corrigenda

In accordance with TR10000-1 clause 6.3.2 c), attention is drawn to normative Amendments and Technical Corrigenda affecting the Directory Standards documents IEC 9594:1990 and the CCITT X.500:1988 recommendations.

Annex B defines the references to the agreed amendments and corrigenda. Compliance with these amendments and corrigenda is necessary to achieve the interoperability requirements for this part of ISO/IEC ISP 10615. It also identifies those which appear to be relevant to this ISP.

The following subset of these have been identified as particularly relevant to this part of ISO/IEC ISP 10615:

ISO/IEC 9594-3:1988/Cor.3:1992

ISO/IEC 9594-4:1988/Cor.1:1991

ISO/IEC 9594-4:1988/Cor.2:1992

ISO/IEC 9594-4:1988/Cor.3:1993

ISO/IEC 9594-5:1988/Cor.1:1992

2.3 Additional normative references

- CCITT Recommendation X.581:1992, *Directory Access Protocol – Protocol Implementation Conformance Statement (PICS) Proforma.*

- ISO/IEC TR 10000-1:1995, *Information technology – Framework and taxonomy of International Standardized Profiles - Part 1: General principles and documentation framework.*

- ISO/IEC TR 10000-2:1995, *Information technology-Framework and taxonomy of International Standardized Profiles - Part 2: Principles and taxonomy for OSI profiles.*

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3 Definitions

3.1 General

Many of the definitions used may be found in the Standards. Since not all of the definitions are to be found in the Definitions clauses within the standards documents, references are listed in Table 1 below. The "Part" reference refers to the part number within ISO/IEC 9594 or its CCITT equivalent (see also Clause 2).

Table 1: Definitions and references

Term	Part	Reference
Continuation reference	4	12.9
List (I) Procedure	4	18.7.2.1.1
List (II) Procedure	4	18.7.2.1.2
Partial Outcome Qualifier	3	10.1.3.3
Presentation address	6	5.9.1
Referral	4	3.5.16
Search (I) Procedure	4	18.7.2.2.1
Search (II) Procedure	4	18.7.2.2.2

For the purposes of this part of ISO/IEC ISP 10615, the following definitions apply:

3.1.1 Search Continuation Reference: The use of one or more Continuation References, embedded in the Partial Outcome Qualifier of a list or search result, to indicate information within the scope of the list or search that may not previously have been accessed in preparing the result. Search Continuation References, if followed, give rise to further operations;

3.1.2 Operation Sequence: The series of operations (possibly just one) which are invoked by a DUA (possibly fully automatically, but not excluding the possibility of user intervention) in fulfilment of a single User enquiry or update. These operations can sometimes be considered nested-for example, a search operation can result in a number of Continuation-References which can be followed; these in turn can give rise to further Search Continuation References (or Referrals);

3.1.3 User: The human or application user which is concerned with obtaining entry information from the Directory;

NOTE – A DUA may provide additional functions to support the user, but the specification of these functions is outside the scope of this part of ISO/IEC ISP 10615.

3.1.4 Manager: The human or application user which is concerned with maintaining a useful communications relationship between the User and the Directory;

NOTES:

1. DUAs may embody facilities to support the Manager, such as:
   - Configuration facilities
   - Logs
   - Protocol relationships not using DAP
2. The Manager may be the same as or distinct from the User.

3.1.5 Protocol Action: Action taken by a DUA (possibly as a result of user action) which is expressed in terms of DAP or ROSE/ACSE protocol elements;

3.1.6 User Advice Action: Action taken by a DUA which is expressed in terms of information or advice to the user;

3.1.7 Manager Advice Action: Action taken by a DUA which is expressed in terms of information or advice to the Manager (for example, information which is subsequently logged for later examination by the Manager);

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NOTE – How User Advice Action or Manager Advice Action is actually taken is outside the scope of this part of ISO/IEC ISP10615;

3.1.8 User Intervention: Voluntary action by the user (e.g. following observation of results returned during an Operation Sequence), which causes the content of the Operation Sequence to be modified, or the Operation Sequence to be terminated or truncated.

3.2 Support Level

To specify the support level of protocol features for ISO/IEC ISP 10615-5, the following terminology is defined.

3.2.1 Mandatory: m: Mandatory requirement for support

A feature is supported by a DUA implementation if the DUA is able to process the feature in accordance with the base standard or as specified in ISO/IEC ISP 10615-5.

3.2.2 Optional: o: Optional requirement for support

The support of the feature is left to the implementor of the DUA.

3.2.3 Conditional: c: Conditional requirement for support

The requirement to support the item depends on a specified condition. The condition and the resulting support requirements are stated separately.

4 Abbreviations

The following abbreviations are used as defined in ISO/IEC 9594 | CCITT Rec. X.500 series or in ISO/IEC TR 10000-1 :

ACSE	Association Control Service Element
APDU	Application Protocol Data Unit
ASN.1	Abstract Syntax Notation One
AVA	Attribute Value Assertion
DAP	Directory Access Protocol
DIB	Directory Information Base
DIT	Directory Information Tree
DMD	Directory Management Domain
DSA	Directory System Agent
DSP	Directory System Protocol
DUA	Directory User Agent
ISP	International Standardized Profile
NSSR	Non-Specific Subordinate Reference
PDU	Protocol Data Unit
POQ	Partial outcome qualifier
PRL	Profile Requirements List
RDN	Relative Distinguished Name
ROSE	Remote Operations Service Element

5 Conformance

Primary DUA conformance requirements are stated in the Directory Standards. However, these documents contain no statements that cover conformance to Distributed Operations.

Conformance to this part of ISO/IEC ISP 10615 concerns the optional implementation of procedures which DUAs shall support when they follow referrals or Search Continuation Reference automatically. When conformance to these procedures is claimed, the conformance requirements apply to the case where no user intervention applies (i.e. the DUA applies a sequence of operations in the absence of any user action).

Conformance to these procedures is signified below by the phrase "*conformance to autonomous DUA procedures*".

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The compliance of a DUA with these procedures shall be capable of being tested by setting up suitable test suites, which, however, shall observe only the externally observable behaviour of the DUA. The conformance statements of this part of ISO/IEC ISP 10615 lay down the range of information for suitable DUA test suites.

DUAs claiming conformance to autonomous DUA procedures shall also satisfy the basic conformance requirements for defined in [ISO/IEC 9594-5 | CCITT X.519] in clause 9.1.

NOTE – There is no requirement that a DUA should be obliged always to act in this autonomous manner. DUAs may thus act under the complete or partial control of human users, making indirect use, as desired, of incoming continuation reference information.

Conformance requirements of autonomous DUA procedures which lie outside standards requirements are listed in clause A.7 of Annex A.

6 Static Conformance Requirements

6.1 General Requirements

DUAs conformant with autonomous DUA procedures shall be able to respond to referrals and Search Continuation References by the autonomous generation of new operations in accordance with the mandatory procedures of clause 7. This requirement calls for timely responses from the DUA, without requiring actions by human users or other parties that are not part of the DUA, other than possibly the making of "go/no-go" decisions.

6.2 New Invokes

DUAs conformant to autonomous DUA procedures shall be able to pursue each followable continuation reference by the creation of a new Invoke. A followable continuation reference is defined as one with correct syntax and for which the DSA identified can be directly accessed by the DUA (possibly as a result of suitable configuration).

6.3 Accessible DSAs

DUAs conformant to autonomous DUA procedures shall support access to multiple DSAs, although they are not required to support multiple simultaneous associations.

6.4 Loop Detection

DUAs claiming conformance to autonomous DUA procedures shall have the capability of detecting Loops encountered in referrals and Search Continuation References. As a minimum, this requires the detection of the situation when the combination of **targetObject**, **aliasedRDNs**, **nameResolutionPhase** and **nextRDNToBeResolved** is repeated.

NOTE – In order to support this requirement, it is necessary for a DUA to maintain a list of summary information for each Operation Sequence, as generated in support of referrals or Search Continuation References, sufficient to enable the detection of precise operation repetition. For example, the list must contain:

- DSA name
- target-object name
- Operation progress parameters

analogous to the TraceItem element defined within [ISO/IEC 9594-4 | CCITT X.518] of the Directory Specifications.

However, the presence of this list cannot be directly detected, and so is not in itself the subject of a conformance requirement.

NOTE – With a DUA acting under the control of a human user, the user may often be able to detect loops when supervising a series of operations, and may then make a "no-go" decision to terminate the series of operations. This is not within the scope of the present requirements.

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7 Procedures

7.1 Invocation of Operations

DUAs that are subject to the use of Referrals or Search Continuation References may carry out multiple operations (i.e. an Operation Sequence) in order to fulfil a single User enquiry or update.

NOTE – Unless otherwise noted, the term "operation" is taken in Clause 7 to mean the functional operations Read, Compare, List, Search, Add-Entry, Remove-Entry, Modify-Entry and Modify-RDN, and specifically to exclude the Abandon operation.

Following each DAP response back from the Directory to the DUA, further DAP operations may be required if the intent of the operation is to be pursued to the full. DUAs may be provided with facilities for controlling the interaction:

The proposed response may be reported by the DUA to the user, who may be able to decide to activate it or deactivate it or to abandon the remainder of the sequence of operations needed fully to complete the original enquiry, or to limit the number of DAP operations which may be initiated

The user may be able to adjust the service controls (e.g. to limit the value of **scopeOfReferral** to **dmd**).

7.2 Response from the DSA

7.2.1 Possible Responses

In the absence of an attempt to abandon an operation, the following are the possible protocol-conformant responses from the DSA to the original Invoke :

Table 2: Possible responses

DSA returns...	DUA action:
return-result not containing Continuation-References	Information is to be returned to the User as User Advice Action.
return-result containing Continuation-References	Any information supplied is returned to the User as User Advice Action; in this case, Continuation-Reference data shall be handled as clause 7.4 below.
return-error (not Referral) indicating a Directory problem (Annex C clause C.2)	Information may be returned to the Manager as Manager Advice Action.
return-error (not Referral) indicating a problem with the enquiry (other errors)	Information is returned to the User as User Advice Action
Referral	Handle as defined in clause 7.3 below.
Reject or A-ABORT is returned, or a time-out occurs	Advice of failure shall be returned to the User as User Advice Action; other relevant information may be returned to the Manager as Manager Advice Action (see Annex C clause C.2).

NOTE– ROSE specifications (as referenced in clause 2.1) require that other responses are handled by the DUA returning a ROSE reject with problem mistyped-argument or by terminating the association. This applies to all DUAs, whether or not they support automatic following of referrals and Search Continuation References

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7.2.2 Negative Outcomes

Some error situations represent normal negative outcomes to enquiries; they represent problems with the user-supplied enquiry, and are not normally subject to Manager Advice Action. These include:

Attribute-Errors:	attribute-or-value-already-exists
	no-such-attribute-or-value
Name-Errors:	alias problem
	no-such-object
Service-Errors:	not-allowed-on-non-leaf
	not-allowed-on-RDN
	out-of-scope
	unable-to-proceed
	unavailable-critical-extension

NOTES:

1. Clause C.2 identifies Manager Advice Actions.
2. The form, or even existence, of Manager Advice Actions, although desirable, is wholly optional.

7.3 Referrals Procedures

The procedures of subclauses 7.3.1 to 7.3.8 relate to following Referrals.

7.3.1 Referral With Name-Resolution-Phase Set To Completed

If a Referral is received following an Invoke which has **nameResolutionPhase** set to **completed**, it shall be considered to be invalid. There shall be no Protocol Action (there is no appropriate such action that can be taken). Appropriate Manager Advice Actions may be taken.

7.3.2 Other Referrals

Otherwise, on receiving a Referral, the PDU shall be analysed and validated as specified in clause 7.3.3.

7.3.2.1 If the PDU (even if syntactically correct) fails validation and cannot be acted upon. Suitable Manager Advice Action may take place, but there shall be no Protocol Action, except as directed below.

If a PDU is fully actionable (even though elements of the protocol may not be as expected). Information may be returned to the User as User Advice Action. The DUA, possibly in combination with the User, now has two choices when proceeding with the referral:

- Proceed with the Referral (see subclause 7.3.4 and subsequent steps)
- Abandon the Referral (with suitable User Advice Action)

7.3.3 Validation Of Continuation References

Validation of continuation references within referrals shall include making the checks defined in the subclauses below (see also subclause 7.4.1 for the corresponding checking within Search Continuation References).

NOTE – A failures of such a checks represents a Directory problem, and should therefore give rise to Manager Advice Action.

7.3.3.1 Target-Object Requirements

targetObject shall comply with requirements for Distinguished Names as specified in [ISO/IEC 9594-2 | CCITT X.501] (the precise extent of checking of attribute values within these names is a DUA option). **targetObject** shall not be accepted if it is the name of Root.

NOTE – The syntactic checking of names seems desirable to help protect the Directory service.

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7.3.3.2 Target-Object Different From Base-Object

If **targetObject** differs from the **object** (or **baseObject**) supplied to the DSA, **aliasedRDNs** shall be present and shall take a non-zero value.

7.3.3.3 Aliased-RDNs

aliasedRDNs (if present) shall have a value not greater than the number of RDNs in **targetObject**.

7.3.3.4 Name-Resolution-Phase

In the case of referrals, **nameResolutionPhase** shall be not be set to **completed**.

NOTE – This restriction does not apply to continuation references within Search Continuation References (see also clause 7.4.1).

7.3.3.5 Next-RDN-To-Be-Resolved

nextRDNToBeResolved shall be ignored unless **nameResolutionPhase** takes the value **proceeding**; and, if present, its value shall be no greater than the number of RDNs in Target-Object; if Target-Object is the same as for the previous Invoke in the Operation Sequence, **nextRDNToBeResolved** may not be less now than it was on the previous Referral.

7.3.3.6 RDNs-Resolved

rdnsResolved shall not be present unless **nameResolutionPhase** takes the value **proceeding**; it shall always be less than the number of RDNs in **targetObject** and the value of **nextRDNToBeResolved**.

7.3.3.7 Reference-Types

Values of **referenceType** other than those defined in the '88 Directory standards shall be accepted in accordance with the requirements for extensibility.

7.3.3.8 Access-Points

If **accessPoints** (a **SET OF AccessPoint**) contains at least one **accessPoint**, the internal structure of each such **accessPoint** element shall be validated as defined in the subclause below.

NOTE – ISO/IEC ISP 10615-6 (ADI32) permits **accessPoints** to be empty.

7.3.3.8.1 Valid Name

accessPoint shall check that **ae-title** complies with requirements for Distinguished Names as specified in [ISO/IEC 9594-2 | CCITT X.501] (the precise extent of checking of attribute values within these names is a DUA option). **ae-title** shall not be accepted if it is the name of Root, since Root is not a valid object.

7.3.3.8.2 Presentation Address

Address shall contain a valid Presentation Address. The precise extent of checking is a DUA option, but shall include ASN.1 syntax checking, while permitting extensions in accordance with the rules of extensibility applied to **PresentationAddress**.

7.3.4 DUA Invokes

The DUA shall then carry out one or more Invokes which shall use as Object Name the Target-Object Name of the Referral, except that the DUA may legitimately terminate the Operation Sequence under any of the following conditions:

- A loop is detected
- An upper-bound for the number of allowed requests has been reached for the Operation Sequence
- Time or size limits have been reached
- An unrecoverable error condition arises during the validation procedure described in clause 7.3.3
- User intervention causes the Operation Sequence to skip particular operations or to abandon the whole sequence

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7.3.5 Common-Arguments

If the Operation Sequence continues, the DUA shall set the **OperationProgress** elements of **CommonArguments** to correspond to those supplied by the Referral, with the following exception. **aliasedRDNs** need not be set to correspond to the value supplied in the referral

NOTE – However, using the supplied value of **aliasedRDNs** will make the final result of a sequence of distributed operations using referrals more closely match the final result if chaining had been used.

7.3.6 Omitting Aliased RDNs

If **aliasedRDNs** is absent in the Referral, it shall be omitted.

7.3.7 Responses

Following the issue of an Invoke as a consequence of the Referral, responses shall be handled as for 7.2, except in the case of multiple Access Points (this situation corresponds to NSSRs (Non-Specific Subordinate References), and shall be dealt with as defined in 7.3.8 below). A response of an **unableToProceed** service-error to an invoke following a single access-point referral shall be considered an acceptable outcome, and shall be treated as if the response had been a **noSuchObject** name-error.

7.3.8 Multiple Access Point Referral

In the case of a multiple Access Point referral, the following subclauses apply.

NOTE – If there is at any one time a requirement for several Invokes to be sent, a compliant DUA may send these out, sequentially or in parallel or in any combination of these.

7.3.8.1 Service-Error (unable-to-proceed)

Service-error **unableToProceed** implies that the DSA contacted was unable to continue Name Resolution. Another DSA may be contacted. When all DSAs have been contacted with the **unableToProceed** result, the net effect shall be considered equivalent to a **noSuchObject** Name Error.

7.3.8.2 Errors when Name Resolution has Continued

Certain errors only occur when Name Resolution has continued beyond the point reached by the Non-Specific Subordinate Reference being processed; the Non-Specific Subordinate Reference processing shall then be deemed to have been terminated.

More generally, the following can happen when actioning a Non-Specific Subordinate Reference:

A. The operation succeeds

B. It results in another referral

C. It results in an error which indicates that nevertheless name resolution has been successfully completed

D. It results in an error which indicates that the target entry definitely does not exist

E. It results in an error which indicates that the DSA has been able to resolve the next-RDN-to-be-resolved, but it has not been possible to determine whether the object entry does or does not exist

F. It results in an error which indicates that the DSA has been unable to resolve even the next-RDN-to-be-resolved

G. It results in an error for which it is indeterminate whether the DSA is or is not capable of resolving the next-RDN-to-be-resolved on the basis of information stored within it

The semantics of error returns, as clarified in ISO/IEC ISP 10615-6 can be exploited to identify the situations in which each outcome occurs.

- Situations A and B are self-explanatory.

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- Situation C is the case with the following errors:

  attribute-error: (any)

  update-error: (any)

- Situation D is the case with the following errors:

  name errors:

  no-such-object

  alias-problem

  alias-dereferencing-problem

  invalid-attribute-syntax

  With number of RDNs in matched name greater or equal to **nextRDNToBeResolved**

- Situation E is the case with the following errors:

  service-errors:

  chaining-required

  out-of-scope

- Situation F is the case with the following errors:

  name-error:

  invalid-attribute-syntax with number of RDNs in matched name shorter than nextRDNToBeResolved

  service-error:

  unable-to-proceed

- Situation G is the case for all remaining errors:

  reject

  operation-timeout

  security-problem: (any)

  service-errors:

  busy

  unavailable

  unwilling-to-perform

  loop-detected

  invalid-reference

  DIT-error

  time-limit-exceeded

  administrative-limit-exceeded

  unavailable-critical-extension

7.4 Search Continuation Reference Procedures

Search Continuation References are created as a result of a List or a Search operation, and are intended to be pursued by the DUA in accordance with the List (II) or Search (II) procedures of [ISO/IEC 9594-4 | CCITT X.518] clauses 18.7.2.1.2 or 18.7.2.2.2.

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7.4.1 Checking continuation references

Continuation references shall be checked as defined in clause 7.3.3 above, except that:

- If a particular continuation reference is faulty, it may be ignored and the other Continuation-References may be followed
- If a faulty continuation reference is still usable; it may be followed as if it were not faulty
- **nameResolutionPhase** may be **completed** (and would always be completed if an alias is not encountered)

7.4.2 Rejects

ASN.1 syntax errors, shall always be responded to by a Reject with problem **mistypedArgument**, or by terminating the association.

7.4.3 New Invokes

The DUA shall be able (possibly selectively) to pursue each followable Search Continuation Reference by the creation of a new Invoke (note also the static conformance requirement of Clause 6.2).

Each such Invoke shall be formulated as follows:

- Operation shall be List or Search, as appropriate
- **object** or **baseObject** shall be set to the **targetObject** returned in the continuation reference
- In Search, subset shall be set to **baseObject** if the invoking Search had subset set to **oneLevel**, or to **wholeSubtree** otherwise
- In **operationProgress**, **nameResolutionPhase** shall be set to the value supplied in the continuation reference
- **nextRDNToBeResolved** shall be omitted if **nameResolutionPhase** is set to **completed**

NOTE – Service controls may be adjusted. See also Annex C clause C.14.

The response to the Invoke may in turn be an error, a result with or without nested Search Continuation References, or a Referral. These shall be handled (recursively where appropriate) in accordance with 7.2 above.

7.5 Loop Detection

If a loop is detected in respect of a referral or Search Continuation Reference (see also Clause 6.4), the Invoke that would have otherwise been undertaken shall not be carried out.

NOTE – It is in general not possible to exclude the possibility of duplicate information being returned in following a Search Continuation Reference.

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Annex A
(normative)
Profiles Requirements List

NOTE – In the event of a discrepancy becoming apparent in the body of autonomous DUA procedures and the tables in this Annex, this Annex is to take precedence.

A.0 Introduction

This Annex specifies the constraints and characteristics of this part of ISO/IEC ISP 10615 on what shall or may appear in an Implementors' PICS for an implementation conformant to autonomous DUA procedures.

This Annex is based on the Directory Access Protocol PICS Proforma of Recommendations CCITT X.581 although the purpose of this PICS Proformas is somewhat different to that of this part of ISO/IEC ISP 10615, and the correspondence is patchy,

Most of the provisions of X.581 are marked as "void", meaning either "no new requirements" or "not currently relevant". Sub-requirements are omitted in the interests of compactness.

A new clause (A.7) is introduced to hold the specific requirements of conformance with autonomous DUA procedures.

The terminology of conformance requirements is used as defined in 3.2.

The abbreviations used in the heading of the tables in this Annex are:

D - conformance requirement as defined in the base standard

P - conformance requirement as defined in this part of ISO/IEC ISP 10615

Profile Requirements List

A.1 General

A.1.1 Identification of PICS

(void)

A.1.2 Identification of the implementation and/or system

Ref. No	Question	Response
1	Implementation Name	(void)
2	Version Number	(void)
3	Machine Name	(void)
4	Machine Version Number	(void)
5	Operating System Name	(void)
6	Operating System Version No.	(void)
7	Special Configuration (1)	DUA for connection to either standalone or co-operating DSAs (mandatory for conformance with autonomous DUA procedures)

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Ref. No	Question	Response
8	Other Information	DUA is conformant to autonomous DUA procedures and 1. Supports automatic following of referrals 2. Supports automatic following of continuation references

The following predicate is defined:

p_auto = A.1.2/8

A.1.3 Identification of the system supplier and/or test laboratory client

(void)

A.2 Identification Of The Protocol

Ref. No.	Question	Response
1	Title, Reference Number, publication date of the protocol standard	CCITT Recommendation X.500:1988, Data Communication Networks - The Directory - Overview of Concepts, Models and Services. ISO/IEC 9594-1:1990, Information technology-Open Systems Interconnection - The Directory-Part 1: Overview of Concepts, Models and Services. Directory Access Protocol
2	Protocol Version Number	v1988
3	Implemented Addenda	None
4	Implemented Defect Reports (Ref. No)	See Annex B

A.3 Global Statement Of Conformance

A.3.1 DSA implementation and/or system

(not applicable)

A.3.2 DUA implementation and/or system - General Capabilities

(void)

A.4 Capabilities And Options

A.4.1 Supported application context

The only application context supported by this PICS proforma is Directory Access application context.

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A.4.2 Operations

Ref. no.	Operation	D	P	Notes	Reference
1	DirectoryBind	m	m	See note below	
2	DirectoryUnbind	m	m	See note below	
3	Read	o	(void)	See note below	
4	Compare	o	(void)	See note below	
5	Abandon	o	(void)	See note below	
6	List	o	m	Implicitly required	6.1
7	Search	o	m	Implicitly required	6.1
8	AddEntry	o	(void)	See note below	
9	RemoveEntry	o	(void)	See note below	
10	ModifyEntry	o	(void)	See note below	
11	ModifyRDN	o	(void)	See note below	

NOTE – This part of ISO/IEC ISP 10615 defines no special requirements for these operations.

A.4.3 Protocol elements

A.4.3.1 DirectoryBind Protocol Elements

(void)

A.4.3.2 Read Elements

Ref. no.	Protocol Element	D (DUA)	P	Notes	Reference
1	ReadArgument	m	m		
4	CommonArguments	o	c Note 1	Also see note 2 below	
5	ReadResult	m	m		

NOTES:

1. If p_auto then m else o
2. Support of CommonArguments is a prerequisite for supporting continuation of Read operations following a referral.

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A.4.3.3 Compare Elements

Ref. no.	Protocol Element	D	P	Notes	Reference
1	CompareArgument	m	m		
4	CommonArguments	o	c Note 1	Also see note 2 below	
5	CompareResult	m	m		

NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of Compare operations following a referral.

A.4.3.4 Abandon Elements

(void)

A.4.3.5 List Elements

Ref. no.	Protocol Element	D	P	Notes	Reference
1	ListArgument	m	m		
3	CommonArguments	o	c Note 1	Also see note 2 below	
4	ListResult	m	m		
5	listInfo	m	m		
6	DistinguishedName	o	c Note 1	Also see note 2 below	
7	subordinates	m	m		
11	partialOutcomeQualifier	o	c Note 1	Also see note 2 below	
12	limitProblem	o	c Note 1	Also see note 2 below	
13	unexplored	o	c Note 1	Also see note 2 below	
14	unavailableCriticalExt	m	m	Also see note 2 below	
15	CommonResults	m	m		
16	uncorrelatedListInfo	o	(void)		

NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of list operations following a referral or Continuation Reference.

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A.4.3.6 Search Elements

Ref. no.	Protocol Element	D	P	Note	Reference
1	SearchArgument	m	m		
7	CommonArguments	o	c Note 1	Also see note 2 below	
8	SearchResult	m	m		
9	searchInfo	m	m		
10	DistinguishedName	o	c Note 1	Also see note 2 below	
11	entries	m	m		
12	partialOutcomeQualifier	o	c Note 1	Also see note 2 below	
13	CommonResults	m	m		
14	uncorrelatedSearchInfo	o	(void)		

NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of search operations following a referral or Continuation Reference.

A.4.3.7 AddEntry Elements

Ref. no.	Protocol Element	D	P	Notes	Reference
1	AddEntryArgument	m	m		
4	CommonArguments	o	c Note 1	Also see note 2 below	
5	AddEntryResult	m	m		

NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of AddEntry operations following a referral.

A.4.3.8 RemoveEntry Elements

Ref. no.	Protocol Element	D	P	Note	Reference
1	RemoveEntryArgument	m	m		
3	CommonArguments	o	c Note 1	Also see note 2 below	
4	RemoveEntryResult	m	m		

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NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of Read operations following a referral.Support of CommonArguments is a prerequisite for supporting continuation of RemoveEntry operations following a referral.

A.4.3.9 ModifyEntry Elements

Ref. no.	Protocol Element	D	P	Note	Reference
1	ModifyEntryArgument	m	m		
8	CommonArguments	o	c Note 1	Also see note 2 below	
9	ModifyEntryResult	m	m		

NOTES:

1. If p_auto then m else o

2. Support of CommonArguments is a prerequisite for supporting continuation of ModifyEntry operations following a referral.

A.4.3.10 ModifyRDN Elements

Ref. no.	Protocol Element	D	P	Note	Reference
1	ModifyRDNArgument	m	m		11.4 (X.511)
5	CommonArguments	o	c Note 1	Also see note 2 below	
6	ModifyRDNResult	m	m		

NOTES:

1. If p_auto then m else 0

2. Support of CommonArguments is a prerequisite for supporting continuation of ModifyRDN operations following a referral.

A.4.3.11 Errors and Parameters

Ref. no.	Protocol Element	D	P	Notes	Reference
1	Abandoned	c	(void)		
2	AbandonFailed	c	(void)		
5	AttributeError	c	(void)		
11	NameError	c	(void)		
14	Referral	c	c Notes 1 and 2		
16	SecurityError	c	(void)		
18	ServiceError	c	(void)		

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Ref. no.	Protocol Element	D	P	Notes	Reference
20	UpdateError	c	(void)		

NOTES:

1. If p_auto then m else o
2. Support of referrals is a prerequisite for conformance with autonomous DUA procedures.

A.4.3.12 Common Arguments Elements

Ref. no.	Protocol Element	D	P	Note	Reference
1	ServiceControls	o	(void)		
2	SecurityParameters	o	(void)		
8	requestor	o	(void)		
9	OperationProgress	o	c Note 1	See note below	
10	nameResolutionPhase	o	m		
11	nextRDNToBeResolved	o	m		
12	aliasedRDNs	o	m		
13	extensions	o	m		Revised form

NOTES:

1. If p_auto then m else o
2. Support of referrals is a prerequisite for conformance with autonomous DUA procedures.

A.4.3.13 CommonResults Elements

(void)

A.4.3.14 Service Controls

(void)

A.4.3.15 Entry Information Selection

(void)

A.4.3.16 Entry Information

(void)

A.4.3.17 Filter Elements

(void)

A.4.3.18 Filter item Elements

(void)

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A.4.3.19 Continuation Reference

Ref. no.	Protocol Element	D	P	Notes	Reference
1	targetObject	o	m	See note below	
2	aliasedRDNs	o	m	See note below	
3	OperationProgress	o	m	See note below	
4	nameResolutionPhase	o	m	See note below	
5	nextRDNToBeResolved	o	m	See note below	
6	rdnsResolved	o	m	See note below	
7	AccessPoint	o	m	See note below	
8	Name	o	m	See note below	
9	PresentationAddress	o	m	See note below	
10	pSelector	o	m	See note below	
11	Selector	o	m	See note below	
12	tSelector	o	m	See note below	
13	nSelector	o	m	See note below	

Note. Support of these elements is a prerequisite for conformance with autonomous DUA procedures.

A.4.4 Directory schema

(void)

A.5 Other information

(void)

A.6 Multi-Layer Dependencies

(void)

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A.7 Requirements particular to this part of ISO/IEC ISP 10615

A.7.1 Static Capabilities

Ref. no	Capability	Reference	Profile	Notes
1	Automatic following of referrals	6.1, 6.2	c Note 1	
2	Automatic following of Search Continuation References	6.1, 6.2	c Note 1	
3	Support of access to multiple DSAs	6.3	c Note 1	
4	Support of loop detection	6.4	c Note 1	

NOTES:

1. If p_auto then m else o

A.7.2 Procedures

Ref no	Procedure	Reference	Profile	Notes
1	Support of referrals procedures	7.1, 7.2, 7.3	c Note 1	
2	Support of Search Continuation Reference procedures	7.1, 7.2, 7.4	c Note 1	
3	Support of loop detection procedures	7.5	c Note 1	

NOTES:

1. If p_auto then m else o

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Annex B
(normative)
Amendments and corrigenda

International standards are subject to constant review and revision by the ISO/IEC Technical Committee concerned and by ITU-T. The following amendments and corrigenda are approved by ISO/IEC JTC1 and by ITU-T, but at the date of publication of this part of ISO/IEC ISP 10615 they were not yet incorporated in the text of the corresponding base standards as referenced in this part of ISO/IEC ISP 10615. The amendments and corrigenda as listed below are considered as normative references by this part of ISO/IEC ISP 10615.

ISO/IEC 9594-2:1988/Cor.1:1991	resolving defects 006, 021
ISO/IEC 9594-2:1988/Cor.2:1992	resolving defects 036, 037
ISO/IEC 9594-3:1988/Cor.1:1991	resolving defects 001, 007, 012, 014, 020, 032
ISO/IEC 9594-3:1988/Cor.2:1992	resolving defects 038, 042
ISO/IEC 9594-3:1988/Cor.3:1992	resolving defect 052
ISO/IEC 9594-3:1988/Cor.4:1993	resolving defects 041, 054, 060, 063, 068, 069
ISO/IEC 9594-4:1988/Cor.1:1991	resolving defects 004, 010, 011, 012, 013, 022, 023, 025, 026, 027, 029
ISO/IEC 9594-4:1988/Cor.2:1992	resolving defects 002, 034, 048, 050, 059
ISO/IEC 9594-4:1988/Cor.3:1993	resolving defects 024, 062, 065, 066
ISO/IEC 9594-5:1988/Cor.1:1992	resolving defect 052
ISO/IEC 9594-7:1988/Cor.1:1991	resolving defect 005
ISO/IEC 9594-7:1988/Cor.2:1992	resolving defect 055
ISO/IEC 9594-8:1988/Cor.1:1991	resolving defects 009, 015, 016, 019, 031

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Annex C
(informative)
Recommendations for Distributed Operations

C.1 Initial Invocation of Operations

The initial Invoke for a new operation should normally use **notStarted** as the value for **NameResolutionPhase** within **OperationProgress** in **CommonArguments**.

NOTE. Since this is the default value, the **OperationProgress** field may be omitted. The initial use of other values of **nameResolutionPhase** may be appropriate to fulfil objectives outside the scope of this profile.)

Subsequent Invokes within an Operation Sequence may use a new object-name and different values of **OperationProgress** within **CommonArguments**.

C.2 Manager Advice Actions

Information that may usefully be returned as Manager Advice Action indicates:

- Rejects, Aborts and other direct indications of Directory or DUA malfunction
- Situations that may indicate Schema or other errors within the DUA:

  Attribute-errors:

  invalid-attribute-syntax

  inappropriate-matching

  constraint-violation

  undefined-attribute-type

  Name-errors: invalid-attribute-syntax

  Update-errors:

  naming-violation

  object-class-violation
- Situations that indicate possible faults within the Directory:

  Name-errors: alias-dereferencing-problem)

  Service-errors:

  administrative-limit-exceeded

  busy

  chaining-required

  DIT-error

  invalid-reference

  loop-detected

  time-limit-exceeded

  unavailable

  unavailable-critical-extension

  unwilling-to-perform
- Attempts to carry out unauthorised operations:

  Security-errors: (any)

  Update-Errors:

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affects-multiple-DSAs

object-class-modification-prohibited

Information included as Manager Advice Actions is not restricted to this list of items.

C.3 Reference-Types

Within a continuation reference, **referenceType** may be checked for taking a reasonable value.

NOTES::

1. DR:066 in Approved Technical Corrigendum 3 to ISO/IEC 9594-4 (X.518) permits referenceType to be present even in the DAP.
2. DUAs must be able to accept new values of referenceType, as permitted by the Extensibility Rules (Approved Technical Corrigendum 1 to ISO/IEC 9594-5 (X.519).

C.4 Compatibility with Required Scope-of-Referral

Within a continuation references, DUAs may be able to check that accessPoints are be compatible with the required scope-of-referral if this service control element is present. However, the extent and method of such checking is a local matter, and may not always be possible without knowledge of DMD configuration.

C.5 Loop Detection

If a loop is detected, appropriate information may be supplied as Manager Advice Action. The DUA may continue with the Operation Sequence if further actions can usefully be taken. However, it is permitted to terminate the Operation Sequence.

NOTE – The precise circumstances under which this continuing action can take place are a local matter.

C.6 Use of Reject

A Reject with problem ***mistypedArgument*** may be returned in the following cases when an error occurs:

Table C-1: Use of Reject

Clause	Qualifier
7.3.3.1, 7.3.3.2	When the name does not conform to the ASN.1 syntax of **DistinguishedName,** or an RDN comprises an empty **SET OF**
7.3.3.8.2	When not compliant with **PresentationAddress** (possibly extended in accordance with extensibility rules)

C.7 Access Points

In order for the DUA to follow a Referral or Search Continuation Reference, the supplied Access-Point shall be one that the DUA is capable of acting upon. If it is not, appropriate User and Manager Advice Action may take place.

C.8 Termination Of Existing Associations

The DUA, if it decides to proceed with the Referral, may optionally terminate any or all of the existing associations, if it is obliged to contact a DSA to which no association pre-exists.

NOTE. It is desirable that DUAs re-use pre-existing associations which are equivalent (e.g. in terms of credentials supplied and other characteristics) to those that the referral would have created.

C.9 User Intervention

User intervention is permitted at any point of the Operation Sequence, and may take any form, including the changing of service controls.

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C.10 Omitting Operation-Progress

If the **operationProgress** element in **nameResolutionPhase** within a continuation reference is supplied set to **notStarted**, it may be omitted.

C.11 Local DSA Failure

In processing a multiple access-point referral, certain error returns represent a possibly local DSA failure. Untried Access Points may be tried at DUA discretion. A DSA which responds with a **busy** Service Error may be retried. A time-out may be abandoned and retried as for a busy Service Error.

C.12 Retries

In processing a multiple access-point referral, a DSA may attempt to contact a DSA more than once, following error returns that indicate an ambiguous result to name resolution. After N unsuccessful retries, the DUA may terminate the procedure. The specification of this value N shall be strictly a local matter.

C.13 Rejects

If in processing a Search Continuation Reference there is any condition for which a Reject is a possible outcome, as specified in clause 6.3.4.12, the whole return-result may be responded to by a Reject with problem **mistypedArgument** or by closing the association.

C.14 Time and Size Limits

In reformulating a new operation following a referral or Search Continuation Reference, time-limit and size-limit may be adjusted; for example:

- time-limit may be made equal to the original value minus the already elapsed time
- size-limit may be made equal to the original value minus the total number of returned entries.

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