Lightweight Directory Access Protocol (LDAP)
Schema Definitions for X.509 Certificates

1. Introduction

This document provides LDAP [RFC4510] schema definitions [RFC4512] for a subset of elements specified in X.509 [X.509] and X.521 [X.521], including attribute types for certificates, cross certificate pairs, and certificate revocation lists; matching rules to be used with these attribute types; and related object classes. LDAP syntax definitions are also provided for associated assertion and attribute values.

As the semantics of these elements are as defined in X.509 and X.521, knowledge of X.509 and X.521 is necessary to make use of the LDAP schema definitions provided herein.

This document, together with [RFC4510], obsoletes RFCs 2252 and 2256 in their entirety. The changes (in this document) made since RFC 2252 and RFC 2256 include:

- addition of pkiUser, pkiCA, and deltaCRL classes;
- update of attribute types to include equality matching rules in accordance with their X.500 specifications;
- addition of certificate, certificate pair, certificate list, and algorithm identifier matching rules; and
- addition of LDAP syntax for assertion syntaxes for these matching rules.

This document obsoletes RFC 2587. The X.509 schema descriptions for LDAPv2 [RFC1777] are Historic, as is LDAPv2 [RFC3494].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119].

Schema definitions are provided using LDAP description formats [RFC4512]. Definitions provided here are formatted (line wrapped) for readability.

2. Syntaxes

This section describes various syntaxes used in LDAP to transfer certificates and related data types.

2.1. Certificate

( 1.3.6.1.4.1.1466.115.121.1.8 DESC 'X.509 Certificate' )

A value of this syntax is an X.509 Certificate [X.509, clause 7].

Due to changes made to the definition of a Certificate through time, no LDAP-specific encoding is defined for this syntax. Values of this syntax SHOULD be encoded using Distinguished Encoding Rules (DER) [X.690] and MUST only be transferred using the ;binary transfer option [RFC4522]; that is, by requesting and returning values using attribute descriptions such as "userCertificate;binary".

As values of this syntax contain digitally signed data, values of this syntax and the form of each value MUST be preserved as presented.

2.2. CertificateList

( 1.3.6.1.4.1.1466.115.121.1.9 DESC 'X.509 Certificate List' )

A value of this syntax is an X.509 CertificateList [X.509, clause 7.3].
Due to changes made to the definition of a CertificateList through time, no LDAP-specific encoding is defined for this syntax. Values of this syntax SHOULD be encoded using DER [X.690] and MUST only be transferred using the ;binary transfer option [RFC4522]; that is, by requesting and returning values using attribute descriptions such as "certificateRevocationList;binary".

As values of this syntax contain digitally signed data, values of this syntax and the form of each value MUST be preserved as presented.

2.3. CertificatePair

( 1.3.6.1.4.1.1466.115.121.1.10 DESC 'X.509 Certificate Pair' )

A value of this syntax is an X.509 CertificatePair [X.509, clause 11.2.3].

Due to changes made to the definition of an X.509 CertificatePair through time, no LDAP-specific encoding is defined for this syntax. Values of this syntax SHOULD be encoded using DER [X.690] and MUST only be transferred using the ;binary transfer option [RFC4522]; that is, by requesting and returning values using attribute descriptions such as "crossCertificatePair;binary".

As values of this syntax contain digitally signed data, values of this syntax and the form of each value MUST be preserved as presented.

2.4. SupportedAlgorithm

( 1.3.6.1.4.1.1466.115.121.1.49
  DESC 'X.509 Supported Algorithm' )

A value of this syntax is an X.509 SupportedAlgorithm [X.509, clause 11.2.7].

Due to changes made to the definition of an X.509 SupportedAlgorithm through time, no LDAP-specific encoding is defined for this syntax. Values of this syntax SHOULD be encoded using DER [X.690] and MUST only be transferred using the ;binary transfer option [RFC4522]; that is, by requesting and returning values using attribute descriptions such as "supportedAlgorithms;binary".

As values of this syntax contain digitally signed data, values of this syntax and the form of the value MUST be preserved as presented.
2.5.  CertificateExactAssertion

( 1.3.6.1.1.15.1 DESC 'X.509 Certificate Exact Assertion' )

A value of this syntax is an X.509 CertificateExactAssertion [X.509, clause 11.3.1]. Values of this syntax MUST be encoded using the Generic String Encoding Rules (GSER) [RFC3641]. Appendix A.1 provides an equivalent Augmented Backus-Naur Form (ABNF) [RFC4234] grammar for this syntax.

2.6.  CertificateAssertion

( 1.3.6.1.1.15.2 DESC 'X.509 Certificate Assertion' )

A value of this syntax is an X.509 CertificateAssertion [X.509, clause 11.3.2]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.2 provides an equivalent ABNF [RFC4234] grammar for this syntax.

2.7.  CertificatePairExactAssertion

( 1.3.6.1.1.15.3 DESC 'X.509 Certificate Pair Exact Assertion' )

A value of this syntax is an X.509 CertificatePairExactAssertion [X.509, clause 11.3.3]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.3 provides an equivalent ABNF [RFC4234] grammar for this syntax.

2.8.  CertificatePairAssertion

( 1.3.6.1.1.15.4 DESC 'X.509 Certificate Pair Assertion' )

A value of this syntax is an X.509 CertificatePairAssertion [X.509, clause 11.3.4]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.4 provides an equivalent ABNF [RFC4234] grammar for this syntax.

2.9.  CertificateListExactAssertion

( 1.3.6.1.1.15.5 DESC 'X.509 Certificate List Exact Assertion' )

A value of this syntax is an X.509 CertificateListExactAssertion [X.509, clause 11.3.5]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.5 provides an equivalent ABNF grammar for this syntax.
2.10. CertificateListAssertion

( 1.3.6.1.1.15.6 DESC 'X.509 Certificate List Assertion' )

A value of this syntax is an X.509 CertificateListAssertion [X.509, clause 11.3.6]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.6 provides an equivalent ABNF [RFC4234] grammar for this syntax.

2.11. AlgorithmIdentifier

( 1.3.6.1.1.15.7 DESC 'X.509 Algorithm Identifier' )

A value of this syntax is an X.509 AlgorithmIdentifier [X.509, Clause 7]. Values of this syntax MUST be encoded using GSER [RFC3641]. Appendix A.7 provides an equivalent ABNF [RFC4234] grammar for this syntax.

3. Matching Rules

This section introduces a set of certificate and related matching rules for use in LDAP. These rules are intended to act in accordance with their X.500 counterparts.

3.1. certificateExactMatch

The certificateExactMatch matching rule compares the presented certificate exact assertion value with an attribute value of the certificate syntax as described in clause 11.3.1 of [X.509].

( 2.5.13.34 NAME 'certificateExactMatch'
  DESC 'X.509 Certificate Exact Match'
  SYNTAX 1.3.6.1.1.15.1 )

3.2. certificateMatch

The certificateMatch matching rule compares the presented certificate assertion value with an attribute value of the certificate syntax as described in clause 11.3.2 of [X.509].

( 2.5.13.35 NAME 'certificateMatch'
  DESC 'X.509 Certificate Match'
  SYNTAX 1.3.6.1.1.15.2 )
3.3. certificatePairExactMatch

The certificatePairExactMatch matching rule compares the presented certificate pair exact assertion value with an attribute value of the certificate pair syntax as described in clause 11.3.3 of [X.509].

( 2.5.13.36 NAME 'certificatePairExactMatch'
  DESC 'X.509 Certificate Pair Exact Match'
  SYNTAX 1.3.6.1.1.15.3 )

3.4. certificatePairMatch

The certificatePairMatch matching rule compares the presented certificate pair assertion value with an attribute value of the certificate pair syntax as described in clause 11.3.4 of [X.509].

( 2.5.13.37 NAME 'certificatePairMatch'
  DESC 'X.509 Certificate Pair Match'
  SYNTAX 1.3.6.1.1.15.4 )

3.5. certificateListExactMatch

The certificateListExactMatch matching rule compares the presented certificate list exact assertion value with an attribute value of the certificate pair syntax as described in clause 11.3.5 of [X.509].

( 2.5.13.38 NAME 'certificateListExactMatch'
  DESC 'X.509 Certificate List Exact Match'
  SYNTAX 1.3.6.1.1.15.5 )

3.6. certificateListMatch

The certificateListMatch matching rule compares the presented certificate list assertion value with an attribute value of the certificate pair syntax as described in clause 11.3.6 of [X.509].

( 2.5.13.39 NAME 'certificateListMatch'
  DESC 'X.509 Certificate List Match'
  SYNTAX 1.3.6.1.1.15.6 )
3.7. algorithmIdentifierMatch

The algorithmIdentifierMatch mating rule compares a presented algorithm identifier with an attribute value of the supported algorithm as described in clause 11.3.7 of [X.509].

( 2.5.13.40 NAME 'algorithmIdentifier'
   DESC 'X.509 Algorithm Identifier Match'
   SYNTAX 1.3.6.1.1.15.7 )

4. Attribute Types

This section details a set of certificate and related attribute types for use in LDAP.

4.1. userCertificate

The userCertificate attribute holds the X.509 certificates issued to the user by one or more certificate authorities, as discussed in clause 11.2.1 of [X.509].

( 2.5.4.36 NAME 'userCertificate'
   DESC 'X.509 user certificate'
   EQUALITY certificateExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.8 )

As required by this attribute type’s syntax, values of this attribute are requested and transferred using the attribute description "userCertificate;binary".

4.2. cACertificate

The cACertificate attribute holds the X.509 certificates issued to the certificate authority (CA), as discussed in clause 11.2.2 of [X.509].

( 2.5.4.37 NAME 'cACertificate'
   DESC 'X.509 CA certificate'
   EQUALITY certificateExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.8 )

As required by this attribute type’s syntax, values of this attribute are requested and transferred using the attribute description "cACertificate;binary".
4.3. crossCertificatePair

The crossCertificatePair attribute holds an X.509 certificate pair, as discussed in clause 11.2.3 of [X.509].

( 2.5.4.40 NAME 'crossCertificatePair'
   DESC 'X.509 cross certificate pair'
   EQUALITY certificatePairExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.10 )

As required by this attribute type’s syntax, values of this attribute are requested and transferred using the attribute description "crossCertificatePair;binary".

4.4. certificateRevocationList

The certificateRevocationList attribute holds certificate lists, as discussed in 11.2.4 of [X.509].

( 2.5.4.39 NAME 'certificateRevocationList'
   DESC 'X.509 certificate revocation list'
   EQUALITY certificateListExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.9 )

As required by this attribute type’s syntax, values of this attribute are requested and transferred using the attribute description "certificateRevocationList;binary".

4.5. authorityRevocationList

The authorityRevocationList attribute holds certificate lists, as discussed in 11.2.5 of [X.509].

( 2.5.4.38 NAME 'authorityRevocationList'
   DESC 'X.509 authority revocation list'
   EQUALITY certificateListExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.9 )

As required by this attribute type’s syntax, values of this attribute are requested and transferred using the attribute description "authorityRevocationList;binary".
4.6. deltaRevocationList

The deltaRevocationList attribute holds certificate lists, as discussed in 11.2.6 of [X.509].

( 2.5.4.53 NAME 'deltaRevocationList'
   DESC 'X.509 delta revocation list'
   EQUALITY certificateListExactMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.9 )

As required by this attribute type’s syntax, values of this attribute MUST be requested and transferred using the attribute description "deltaRevocationList;binary".

4.7. supportedAlgorithms

The supportedAlgorithms attribute holds supported algorithms, as discussed in 11.2.7 of [X.509].

( 2.5.4.52 NAME 'supportedAlgorithms'
   DESC 'X.509 supported algorithms'
   EQUALITY algorithmIdentifierMatch
   SYNTAX 1.3.6.1.4.1.1466.115.121.1.49 )

As required by this attribute type’s syntax, values of this attribute MUST be requested and transferred using the attribute description "supportedAlgorithms;binary".

5. Object Classes

This section details a set of certificate-related object classes for use in LDAP.

5.1. pkiUser

This object class is used in augment entries for objects that may be subject to certificates, as defined in clause 11.1.1 of [X.509].

( 2.5.6.21 NAME 'pkiUser'
   DESC 'X.509 PKI User'
   SUP top AUXILIARY
   MAY userCertificate )
5.2. pkiCA

This object class is used to augment entries for objects that act as certificate authorities, as defined in clause 11.1.2 of [X.509].

( 2.5.6.22 NAME 'pkiCA'
   DESC 'X.509 PKI Certificate Authority'
   SUP top AUXILIARY
   MAY ( cACertificate $ certificateRevocationList $ authorityRevocationList $ crossCertificatePair ) )

5.3. cRLDistributionPoint

This class is used to represent objects that act as CRL distribution points, as discussed in clause 11.1.3 of [X.509].

( 2.5.6.19 NAME 'cRLDistributionPoint'
   DESC 'X.509 CRL distribution point'
   SUP top STRUCTURAL
   MUST cn
   MAY ( certificateRevocationList $ authorityRevocationList $ deltaRevocationList ) )

5.4. deltaCRL

The deltaCRL object class is used to augment entries to hold delta revocation lists, as discussed in clause 11.1.4 of [X.509].

( 2.5.6.23 NAME 'deltaCRL'
   DESC 'X.509 delta CRL'
   SUP top AUXILIARY
   MAY deltaRevocationList )

5.5. strongAuthenticationUser

This object class is used to augment entries for objects participating in certificate-based authentication, as defined in clause 6.15 of [X.521]. This object class is deprecated in favor of pkiUser.

( 2.5.6.15 NAME 'strongAuthenticationUser'
   DESC 'X.521 strong authentication user'
   SUP top AUXILIARY
   MUST userCertificate )
5.6. userSecurityInformation

This object class is used to augment entries with needed additional associated security information, as defined in clause 6.16 of [X.521].

( 2.5.6.18 NAME 'userSecurityInformation'
   DESC 'X.521 user security information'
   SUP top AUXILIARY
   MAY ( supportedAlgorithms ) )

5.7. certificationAuthority

This object class is used to augment entries for objects that act as certificate authorities, as defined in clause 6.17 of [X.521]. This object class is deprecated in favor of pkiCA.

( 2.5.6.16 NAME 'certificationAuthority'
   DESC 'X.509 certificate authority'
   SUP top AUXILIARY
   MUST ( authorityRevocationList $
             certificateRevocationList $ cACertificate )
   MAY crossCertificatePair )

5.8. certificationAuthority-V2

This object class is used to augment entries for objects that act as certificate authorities, as defined in clause 6.18 of [X.521]. This object class is deprecated in favor of pkiCA.

( 2.5.6.16.2 NAME 'certificationAuthority-V2'
   DESC 'X.509 certificate authority, version 2'
   SUP certificationAuthority AUXILIARY
   MAY deltaRevocationList )

6. Security Considerations


While elements of certificate information are commonly signed, these signatures only protect the integrity of the signed information. In the absence of data integrity protections in LDAP (or lower layer, e.g., IPsec), a server is not assured that client certificate request (or other request) was unaltered in transit. Likewise, a client cannot be assured that the results of the query were unaltered in
transit. Hence, it is generally recommended that implementations make use of authentication and data integrity services in LDAP [RFC4513][RFC4511].

7. IANA Considerations

7.1. Object Identifier Registration

The IANA has registered an LDAP Object Identifier [RFC4520] for use in this technical specification.

Subject: Request for LDAP OID Registration
Person & email address to contact for further information:
Kurt Zeilenga <kurt@OpenLDAP.org>
Specification: RFC 4523
Author/Change Controller: IESG
Comments:
Identifies the LDAP X.509 Certificate schema elements introduced in this document.

7.2. Descriptor Registration

The IANA has updated the LDAP Descriptor registry [RFC44520] as indicated below.

Subject: Request for LDAP Descriptor Registration
Descriptor (short name): see table
Object Identifier: see table
Person & email address to contact for further information:
Kurt Zeilenga <kurt@OpenLDAP.org>
Usage: see table
Specification: RFC 4523
Author/Change Controller: IESG

<table>
<thead>
<tr>
<th>Algorithm Identifier Match</th>
<th>M 2.5.13.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority Revocation List</td>
<td>A 2.5.4.38 *</td>
</tr>
<tr>
<td>cACertificate</td>
<td>A 2.5.4.37 *</td>
</tr>
<tr>
<td>cRLDistributionPoint</td>
<td>O 2.5.6.19 *</td>
</tr>
<tr>
<td>certificateExactMatch</td>
<td>M 2.5.13.34</td>
</tr>
<tr>
<td>certificateListExactMatch</td>
<td>M 2.5.13.38</td>
</tr>
<tr>
<td>certificateListMatch</td>
<td>M 2.5.13.39</td>
</tr>
<tr>
<td>certificateMatch</td>
<td>M 2.5.13.35</td>
</tr>
<tr>
<td>certificatePairExactMatch</td>
<td>M 2.5.13.36</td>
</tr>
<tr>
<td>certificatePairMatch</td>
<td>M 2.5.13.37</td>
</tr>
<tr>
<td>certificateRevocationList</td>
<td>A 2.5.4.39 *</td>
</tr>
<tr>
<td>certificationAuthority</td>
<td>O 2.5.6.16 *</td>
</tr>
<tr>
<td>certificationAuthority-V2</td>
<td>O 2.5.6.16.2 *</td>
</tr>
<tr>
<td>crossCertificatePair</td>
<td>A 2.5.4.40 *</td>
</tr>
</tbody>
</table>
deltaCRL O 2.5.6.23 *
deltaRevocationList A 2.5.4.53 *
pkiCA O 2.5.6.22 *
pkiUser O 2.5.6.21 *
strongAuthenticationUser O 2.5.6.15 *
supportedAlgorithms A 2.5.4.52 *
userCertificate A 2.5.4.36 *
userSecurityInformation O 2.5.6.18 *

* Updates previous registration

8. Acknowledgements

This document is based on X.509, a product of the ITU-T. A number of LDAP schema definitions were based on those found in RFCs 2252 and 2256, both products of the IETF ASID WG. The ABNF productions in Appendix A were provided by Steven Legg. Additional material was borrowed from prior works by David Chadwick and Steven Legg to refine the LDAP X.509 schema.

9. References

9.1. Normative References


9.2. Informative References


Appendix A.

This appendix is informative.

This appendix provides ABNF [RFC4234] grammars for GSER-based [RFC3641] LDAP-specific encodings specified in this document. These grammars were produced using, and relying on, Common Elements for GSER Encodings [RFC3642].

A.1. CertificateExactAssertion

CertificateExactAssertion = "{" sp cea-serialNumber ","
   sp cea-issuer sp "}"

cea-serialNumber = id-serialNumber msp CertificateSerialNumber
cea-issuer = id-issuer msp Name

id-serialNumber = %x73.65.72.69.61.6C.4E.75.6D.62.65.72 ; 'serialNumber'
id-issuer = %x69.73.73.75.65.72 ; 'issuer'

Name = id-rdnSequence ":" RDNSequence
id-rdnSequence = %x72.64.6E.53.65.71.75.65.6E.63.65 ; 'rdnSequence'

CertificateSerialNumber = INTEGER

A.2. CertificateAssertion

CertificateAssertion = "{" [ sp ca-serialNumber ]
   [ sep sp ca-issuer ]
   [ sep sp ca-subjectKeyIdentifier ]
   [ sep sp ca-authorityKeyIdentifier ]
   [ sep sp ca-certificateValid ]
   [ sep sp ca-privateKeyValid ]
   [ sep sp ca-subjectPublicKeyAlgID ]
   [ sep sp ca-keyUsage ]
   [ sep sp ca-subjectAltName ]
   [ sep sp ca-policy ]
   [ sep sp ca-pathToName ]
   [ sep sp ca-subject ]
   [ sep sp ca-nameConstraints ] sp "}"

certificateAssertion = id-serialNumber msp CertificateSerialNumber
ca-issuer = id-issuer msp Name
ca-subjectKeyIdentifier = id-subjectKeyIdentifier msp SubjectKeyIdentifier
ca-authorityKeyIdentifier = id-authorityKeyIdentifier msp AuthorityKeyIdentifier
ca-certificateValid = id-certificateValid msp Time
ca-privateKeyValid = id-privateKeyValid msp GeneralizedTime
ca-subjectPublicKeyAlgID = id-subjectPublicKeyAlgID msp OBJECT-IDENTIFIER
ca-keyUsage = id-keyUsage msp KeyUsage
ca-subjectAltName = id-subjectAltName msp AltNameType
ca-policy = id-policy msp CertPolicySet
ca-pathToName = id-pathToName msp Name
ca-subject = id-subject msp Name
ca-nameConstraints = id-nameConstraints msp NameConstraintsSyntax

id-subjectKeyIdentifier =
  %x73.75.62.6A.65.63.74.4B.65.79.49.64.65.6E.74.69.66.69.65.72
  ; 'subjectKeyIdentifier'
id-authorityKeyIdentifier =
  %x61.75.74.68.6F.72.69.74.79.4B.65.79.49.64.65.6E.74.69.66.69.65.72
  ; 'authorityKeyIdentifier'
id-certificateValid = %x63.65.72.74.69.66.69.65.74.65.56.61.6C.69.64
  ; 'certificateValid'
id-privateKeyValid = %x70.72.69.76.61.74.65.4B.65.79.56.61.6C.69.64
  ; 'privateKeyValid'
id-subjectPublicKeyAlgID =
  %x73.75.62.6A.65.63.74.50.75.62.6C.69.63.4B.65.79.41.6C.67.49.44
  ; 'subjectPublicKeyAlgID'
id-keyUsage = %x6B.65.79.55.73.61.67.65 ; 'keyUsage'
id-subjectAltName = %x73.75.62.6A.65.63.74.41.6C.74.4E.61.6D.65
  ; 'subjectAltName'
id-policy = %x70.6F.6C.69.63.74.73.6F.72.61.69.6E.74.73
  ; 'policy'
id-pathToName = %x70.61.74.68.54.6F.4E.61.6D.65 ; 'pathToName'
id-subject = %x73.75.62.6A.65.63.74 ; 'subject'
id-nameConstraints = %x6E.61.6D.65.43.6F.6E.73.74.72.61.69.6E.74.73
  ; 'nameConstraints'

SubjectKeyIdentifier = KeyIdentifier

KeyIdentifier = OCTET-STRING

AuthorityKeyIdentifier = "{" [ sp aki-keyIdentifier ]
  [ sep sp aki-authorityCertIssuer ]
  [ sep sp aki-authorityCertSerialNumber ] sp "}"

aki-keyIdentifier = id-keyIdentifier msp KeyIdentifier
aki-authorityCertIssuer = id-authorityCertIssuer msp GeneralNames

GeneralNames = "{" sp GeneralName *( "", sp GeneralName ) sp "}"

GeneralName = gn-otherName
  / gn-rfc822Name
  / gn-dNSName
gn-otherName = id-otherName " OtherName
gn-rfc822Name = id-rfc822Name " IA5String
gn-dNSName = id-dNSName " IA5String
 gn-x400Address = id-x400Address " ORAddress
 gn-directoryName = id-directoryName " Name
 gn-ediPartyName = id-ediPartyName " EDIPartyName
 gn-iPAddress = id-iPAddress " OCTET-STRING
 gn-registeredID = gn-id-registeredID " OBJECT-IDENTIFIER

gn-uniformResourceIdentifier = id-uniformResourceIdentifier ":" IA5String

id-otherName = %x6F.74.68.65.72.4E.61.6D.65 ; 'otherName'
 gn-id-registeredID = %x72.65.67.69.73.74.65.72.65.64.69.44
 ; 'registeredID'

OtherName = "(" sp on-type-id "," sp on-value sp ")"
on-type-id = id-type-id msp OBJECT-IDENTIFIER
 on-value = id-value msp Value

; <Value> as defined in Section 3 of [RFC3641]

id-type-id = %x74.79.70.65.2D.69.64 ; 'type-id'
id-value = %x76.61.6C.75.65 ; 'value'

ORAddress = dquote *SafeIA5Character dquote
SafeIA5Character = %x01-21 / %x23-7F / ; ASCII minus dquote
dquote dquote ; escaped double quote
 dquote = %x22 ; '"' (double quote)

; Note: The <ORAddress> rule encodes the x400Address component
; of a GeneralName as a character string between double quotes.
; The character string is first derived according to Section 4.1
; of [RFC2156], and then any embedded double quotes are escaped
; by being repeated. This resulting string is output between
; double quotes.

EDIPartyName = "{" [ sp nameAssigner "," ] sp partyName sp "}"
 nameAssigner = id-nameAssigner msp DirectoryString
 partyName = id-partyName msp DirectoryString
 id-nameAssigner = %x6E.61.6D.65.41.73.73.69.67.65.72
 ; 'nameAssigner'
id-partyName    = %x70.61.72.74.79.4E.61.6D.65 ; 'partyName'

aki-authorityCertSerialNumber = id-authorityCertSerialNumber
msp CertificateSerialNumber

id-keyIdentifier = %x6B.65.79.49.64.65.6E.74.69.66.69.65.72 ; 'keyIdentifier'
id-authorityCertIssuer = %x61.75.74.68.6F.72.69.74.79.43.65.72.74.49.73.73.75.75.67.72 ; 'authorityCertIssuer'

id-authorityCertSerialNumber = %x61.75.74.68.6F.72.69.74.79.43
%x65.72.74.53.65.72.69.61.6C.4E.75.6D.62.65.72 ; 'authorityCertSerialNumber'

Time = time-utcTime / time-generalizedTime
time-utcTime = id-utcTime ":" UTCTime
time-generalizedTime = id-generalizedTime ":" GeneralizedTime
id-utcTime = %x75.74.65.63.54.69.66.65.67.72 ; 'utcTime'
id-generalizedTime = %x67.65.6E.65.72.61.6C.69.7A.65.64.54.69.6D.65 ; 'generalizedTime'

KeyUsage = BIT-STRING / key-usage-bit-list
key-usage-bit-list = "( [ sp key-usage "("," sp key-usage ) ] sp ")"

;; Note: The <key-usage-bit-list> rule encodes the one bits in
;; a KeyUsage value as a comma separated list of identifiers.

key-usage = id-digitalSignature
/ id-nonRepudiation
/ id-keyEncipherment
/ id-dataEncipherment
/ id-keyAgreement
/ id-keyCertSign
/ id-cRLSign
/ id-encipherOnly
/ id-decipherOnly

id-digitalSignature = %x64.69.67.69.74.61.6C.53.69.67.6E.61.74
%x75.72.65 ; 'digitalSignature'
id-nonRepudiation = %x6E.6F.6E.52.65.70.75.64.69.61.74.69.66.65.6E
; 'nonRepudiation'
id-keyEncipherment = %x6B.65.79.45.6E.63.69.70.68.65.72.6D.65.66.74 ; 'keyEncipherment'
id-dataEncipherment = %x64.61.74.61.45.6E.63.69.70.68.65.72.6D.65.66.74
%x74 ; 'dataEncipherment'
id-keyAgreement = %x6B.65.79.41.67.72.65.66.65.74 ; 'keyAgreement'
id-keyCertSign = %x6b.65.79.43.65.72.74.53.69.67.6E
   ; 'keyCertSign'
id-cRLSign = %x63.52.4c.53.69.67.6E ; "cRLSign"
id-encipherOnly = %x65.6e.63.69.70.68.65.72.4f.6e.6c.79
   ; 'encipherOnly'
id-decipherOnly = %x64.65.63.69.70.68.65.72.4f.6e.6c.79
   ; 'decipherOnly'

AltNameType = ant-builtinNameForm / ant-otherNameForm

ant-builtinNameForm = id-builtinNameForm ":" BuiltinNameForm
ant-otherNameForm = id-otherNameForm ":" OBJECT-IDENTIFIER

id-builtinNameForm = %x62.75.69.6c.74.69.6e.4e.61.6d.65.46.6f.72.6d
   ; 'builtinNameForm'
id-otherNameForm   = %x6f.74.68.65.72.4e.61.6d.65.46.6f.72.6d
   ; 'otherNameForm'

BuiltinNameForm = id-rfc822Name
   / id-dNSName
   / id-x400Address
   / id-directoryName
   / id-ediPartyName
   / id-uniformResourceIdentifier
   / id-iPAddress
   / id-registeredId

id-rfc822Name = %x72.66.63.38.32.32.4e.61.6d.65 ; 'rfc822Name'
id-dNSName = %x64.4e.53.4e.61.6d.65 ; 'dNSName'
id-x400Address = %x78.34.30.30.41.64.64.72.65.73.73 ; 'x400Address'
id-directoryName = %x64.69.72.65.63.74.6f.72.79.4e.61.6d.65
   ; 'directoryName'
id-ediPartyName = %x65.64.69.50.61.72.74.79.4e.61.6d.65
   ; 'ediPartyName'
id-iPAddress = %x69.50.41.64.64.72.65.73.73 ; 'iPAddress'
id-registeredId = %x72.65.67.69.73.74.65.72.65.64.49.64
   ; 'registeredId'

id-uniformResourceIdentifier = %x75.6e.69.66.6f.72.6d.52.65.73.6f.75
   %x72.63.65.49.64.65.6e.74.69.66.69.65.72
   ; 'uniformResourceIdentifier'

CertPolicySet = "(" sp CertPolicyId *( "," sp CertPolicyId ) sp ")"
CertPolicyId = OBJECT-IDENTIFIER

NameConstraintsSyntax = "(" [ sp ncs-permittedSubtrees ]
   [ sep sp ncs-excludedSubtrees ] sp ")"
ncs-permittedSubtrees = id-permittedSubtrees msp GeneralSubtrees
ncs-excludedSubtrees = id-excludedSubtrees msp GeneralSubtrees

id-permittedSubtrees =
  %x70.65.72.6D.69.74.74.65.64.53.75.62.74.72.65.65.73
  ; 'permittedSubtrees'
id-excludedSubtrees =
  %x65.78.63.6C.75.64.65.64.53.75.62.74.72.65.65.73
  ; 'excludedSubtrees'

GeneralSubtrees = "{" sp GeneralSubtree
  *( "","" sp GeneralSubtree ) sp "})"
GeneralSubtree = "{" sp gs-base
  [ "," sp gs-minimum ]
  [ "," sp gs-maximum ] sp "})"

gs-base = id-base msp GeneralName
gs-minimum = id-minimum msp BaseDistance
gs-maximum = id-maximum msp BaseDistance

id-base = %x62.61.73.65 ; 'base'
id-minimum = %x6D.69.6E.69.6D.75.6D ; 'minimum'
id-maximum = %x6D.61.78.69.6D.75.6D ; 'maximum'

BaseDistance = INTEGER-0-MAX

A.3. CertificatePairExactAssertion

CertificatePairExactAssertion = "{" [ sp cpea-issuedTo ]
  [ sep sp cpea-issuedBy ] sp "}"
  ; At least one of <cpea-issuedTo> or <cpea-issuedBy> MUST be present.

cpea-issuedTo = id-issuedToThisCAAssertion msp
CertificateExactAssertion

cpea-issuedBy = id-issuedByThisCAAssertion msp
CertificateExactAssertion

id-issuedToThisCAAssertion = %x69.73.73.75.65.64.54.6F.54.68.69.73
  %x43.41.73.73.75.72.74.69.6F.6E ; 'issuedToThisCAAssertion'
id-issuedByThisCAAssertion = %x69.73.73.75.65.64.42.79.54.68.69.73
  %x43.41.73.73.75.72.74.69.6F.6E ; 'issuedByThisCAAssertion'

CertificatePairAssertion = "{" [ sp cpa-issuedTo ]
[ sep sp cpa-issuedBy ] sp "}"

; At least one of <cpa-issuedTo> and <cpa-issuedBy> MUST be present.

cpa-issuedTo = id-issuedToThisCAAssertion msp CertificateAssertion
cpa-issuedBy = id-issuedByThisCAAssertion msp CertificateAssertion

A.5. CertificateListExactAssertion

CertificateListExactAssertion = "{" sp clea-issuer ","
 sp clea-thisUpdate
[ "," sp clea-distributionPoint ] sp "}"

clea-issuer = id-issuer msp Name
clea-thisUpdate = id-thisUpdate msp Time
clea-distributionPoint = id-distributionPoint msp
 DistributionPointName

id-thisUpdate = %x74.68.69.73.55.70.64.61.74.65 ; 'thisUpdate'
id-distributionPoint =
%x64.69.73.74.72.69.62.75.74.69.6F.6E.50.6F.69.6E.74
 ; 'distributionPoint'

DistributionPointName = dpn-fullName / dpn-nameRelativeToCRLIssuer
dpn-fullName = id-fullName ":" GeneralNames
dpn-nameRelativeToCRLIssuer = id-nameRelativeToCRLIssuer ":" RelativeDistinguishedName

id-fullName = %x66.75.6C.6C.4E.61.6D.65 ; 'fullName'
id-nameRelativeToCRLIssuer = %x6E.61.6D.65.52.65.6C.61.74.69.76.65
%x54.6F.43.52.4C.49.73.73.75.65.72 ; 'nameRelativeToCRLIssuer'

A.6. CertificateListAssertion

CertificateListAssertion = "{" [ sp cla-issuer ]
[ sep sp cla-minCRLNumber ]
[ sep sp cla-maxCRLNumber ]
[ sep sp cla-reasonFlags ]
[ sep sp cla-dateAndTime ]
[ sep sp cla-distributionPoint ]
[ sep sp cla-authorityKeyIdentifier ] sp "}"

cla-issuer = id-issuer msp Name
cla-minCRLNumber = id-minCRLNumber msp CRLNumber
cla-maxCRLNumber = id-maxCRLNumber msp CRLNumber
cla-reasonFlags = id-reasonFlags msp ReasonFlags
cla-dateAndTime = id-dateAndTime msp Time
cla-distributionPoint = id-distributionPoint msp DistributionPointName
cla-authorityKeyIdentifier = id-authorityKeyIdentifier msp AuthorityKeyIdentifier

id-minCRLNumber = %x6D.69.6E.43.52.4C.4E.75.6D.62.65.72 ; 'minCRLNumber'
id-maxCRLNumber = %x6D.61.78.43.52.4C.4E.75.6D.62.65.72 ; 'maxCRLNumber'
id-reasonFlags = %x72.65.61.73.66.6E.46.6C.61.67.73 ; 'reasonFlags'
id-dateAndTime = %x64.61.74.65.41.6E.64.54.69.6D.65 ; 'dateAndTime'

CRLNumber = INTEGER-0-MAX

ReasonFlags = BIT-STRING
   / "{" [ sp reason-flag *("," sp reason-flag ) ] sp "}

reason-flag = id-unused
   / id-keyCompromise
   / id-cACompromise
   / id-affiliationChanged
   / id-superseded
   / id-cessationOfOperation
   / id-certificateHold
   / id-privilegeWithdrawn
   / id-aACompromise

id-unused = %x75.6E.75.73.65.6A ; 'unused'
id-keyCompromise = %x6B.65.79.43.6F.6D.70.72.6F.6D.69.73.65 ; 'keyCompromise'
id-cACompromise = %x63.41.43.6F.6D.70.72.6F.6D.69.73.65 ; 'cACompromise'
id-affiliationChanged = %x61.66.66.69.6C.69.61.74.69.6F.6E.43.68.61.6E.67.65.64 ; 'affiliationChanged'
id-superseded = %x73.75.70.65.72.73.65.64.65.64 ; 'superseded'
id-cessationOfOperation = %x63.65.73.73.61.74.69.6F.6E.4F.66.4F.70.65.72.61.74.69.6F.6E ; 'cessationOfOperation'
id-certificateHold = %x63.65.72.74.69.66.69.63.61.74.65.48.6F.6C.64 ; 'certificateHold'
id-privilegeWithdrawn = %x70.72.69.76.69.6C.65.67.65.57.69.74.68.64.72.61.77.6E ; 'privilegeWithdrawn'
id-aACompromise = %x61.41.43.6F.6D.70.72.6F.6D.69.73.65
     ; 'aACompromise'

A.7. AlgorithmIdentifier

   AlgorithmIdentifier = "{" sp ai-algorithm
       [ "", sp ai-parameters ] sp "}"

   ai-algorithm = id-algorithm msp OBJECT-IDENTIFIER
   ai-parameters = id-parameters msp Value
   id-algorithm = %x61.6C.67.6F.72.69.74.68.6D ; 'algorithm'
   id-parameters = %x70.61.72.61.6D.65.74.65.72.73 ; 'parameters'

Author’s Address

   Kurt D. Zeilenga
   OpenLDAP Foundation

   EMail: Kurt@OpenLDAP.org
Full Copyright Statement

Copyright (C) The Internet Society (2006).

This document is subject to the rights, licenses and restrictions contained in BCP 78, and except as set forth therein, the authors retain all their rights.

This document and the information contained herein are provided on an "AS IS" basis and THE CONTRIBUTOR, THE ORGANIZATION HE/SHE REPRESENTS OR IS SPONSORED BY (IF ANY), THE INTERNET SOCIETY AND THE INTERNET ENGINEERING TASK FORCE DISCLAIM ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Intellectual Property

The IETF takes no position regarding the validity or scope of any Intellectual Property Rights or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; nor does it represent that it has made any independent effort to identify any such rights. Information on the procedures with respect to rights in RFC documents can be found in BCP 78 and BCP 79.

Copies of IPR disclosures made to the IETF Secretariat and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this specification can be obtained from the IETF on-line IPR repository at http://www.ietf.org/ipr.

The IETF invites any interested party to bring to its attention any copyrights, patents or patent applications, or other proprietary rights that may cover technology that may be required to implement this standard. Please address the information to the IETF at ietf-ipr@ietf.org.

Acknowledgement

Funding for the RFC Editor function is provided by the IETF Administrative Support Activity (IASA).