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X.509 Internet Public Key Infrastructure Online Certificate Status Protocol - OCSP
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Abstract

This document specifies a protocol useful in determining the current status of a digital certificate without requiring CRLs. Additional mechanisms addressing PKIX operational requirements are specified in separate documents. This document obsoletes RFC 2560 and RFC 6277.

Status of this Memo

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1. Introduction

This document specifies a protocol useful in determining the current status of a digital certificate without requiring CRLs. Additional mechanisms addressing PKIX operational requirements are specified in separate documents.

This specification obsoletes [RFC2560] and [RFC6277]. The primary reason for the publication of this document is to address ambiguities that have been found since the publication of RFC 2560. This document differs from RFC 2560 in only a few areas:

o Section 2.2 extends the use of the "revoked" response to allow this response status certificates that has never been issued.

o Section 2.3 extends the use of the "unauthorized" error response, as specified in [RFC5019].

o Section 4.2.1 and 4.2.2.3 states that a response may include revocation status information for certificates that were not included in the request, as permitted in [RFC5019].

o Section 4.2.2.2 has been updated to clarify when a responder is considered an Authorized Responder.

o Section 4.2.2.3 clarify that the ResponderID field corresponds to the OCSP Responder signer certificate.

o Section 4.3 changes set of cryptographic algorithms that clients must support and the set of cryptographic algorithms that clients should support as specified in [RFC6277].

o Section 4.4.1 specifies the ASN.1 syntax for the nonce extension, which was missing in RFC 2560.

o Section 4.4.7 specifies a new extension that may be included in a request message to specify signature algorithms the client would prefer the server use to sign the response as specified in [RFC6277].

o Section 4.4.8 specifies a new extension that indicates that the responder supports the extended use of the "revoked" response for non-issued certificates defined in section 2.2.

An overview of the protocol is provided in section 2. Functional requirements are specified in section 4. Details of the protocol are in section 5. We cover security issues with the protocol in section

6. Appendix A defines OCSP over HTTP, appendix B accumulates ASN.1 syntactic elements and appendix C specifies the mime types for the messages.

1.1. The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",

"SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document (in uppercase, as shown) are to be interpreted as described in [RFC2119].

2. Protocol Overview

In lieu of or as a supplement to checking against a periodic CRL, it may be necessary to obtain timely information regarding the revocation status of a certificate (cf. [RFC5280], Section 3.3). Examples include high-value funds transfer or large stock trades.

The Online Certificate Status Protocol (OCSP) enables applications to determine the (revocation) state of an identified certificate. OCSP may be used to satisfy some of the operational requirements of providing more timely revocation information than is possible with CRLs and may also be used to obtain additional status information. An OCSP client issues a status request to an OCSP responder and suspends acceptance of the certificate in question until the responder provides a response.

This protocol specifies the data that needs to be exchanged between an application checking the status of a certificate and the server providing that status.

2.1 Request

An OCSP request contains the following data:

-- protocol version
-- service request
-- target certificate identifier
-- optional extensions which MAY be processed by the OCSP Responder

Upon receipt of a request, an OCSP Responder determines if;

1. the message is well formed,

2. the responder is configured to provide the requested service, and;

3. the request contains the information needed by the responder.

If any one of these conditions are not met, the OCSP responder produces an error message; otherwise, it returns a definitive response.

2.2 Response

OCSP responses can be of various types. An OCSP response consists of a response type and the bytes of the actual response. There is one basic type of OCSP response that MUST be supported by all OCSP servers and clients. The rest of this section pertains only to this

basic response type.

All definitive response messages SHALL be digitally signed. The key used to sign the response MUST belong to one of the following:

- the CA who issued the certificate in question
- a Trusted Responder whose public key is trusted by the requester
- a CA Designated Responder (Authorized Responder, defined in section 4.2.2.2) who holds a specially marked certificate issued directly by the CA, indicating that the responder may issue OCSP responses for that CA

A definitive response message is composed of:

- version of the response syntax
- identifier of the responder
- time when the response was generated
- responses for each of the certificates in a request
- optional extensions
- signature algorithm OID
- signature computed across hash of the response

The response for each of the certificates in a request consists of

- target certificate identifier
- certificate status value
- response validity interval
- optional extensions

This specification defines the following definitive response indicators for use in the certificate status value:

- good
- revoked
- unknown

The "good" state indicates a positive response to the status inquiry. At a minimum, this positive response indicates that the certificate is not revoked, but does not necessarily mean that the certificate was ever issued or that the time at which the response was produced is within the certificate's validity interval. Response extensions may be used to convey additional information on assertions made by the responder regarding the status of the certificate such as positive statement about issuance, validity, etc.

The "revoked" state indicates that the certificate has been revoked either permanently or temporarily on hold (i.e. the revocation reason

is certificateHold). This state MAY also be returned if the associated CA has no record of ever having issued a certificate with the certificate serial number in the request, using any current or previous issuing key (referred to as a "non-issued" certificate in this document).

The "unknown" state indicates that the responder doesn't know about the certificate being requested.

NOTE: The "revoked" state for known non-issued certificate serial numbers is allowed in order to reduce the risk of relying parties using CRLs as a fall back mechanism, which would be considerably higher if an "unknown" response was returned.

When a responder responds revoked to a status request for a non-issued certificate, the responder MUST include the extended revoked definition response extension (section 4.4.8) in the response, indicating that the OCSP responder supports the extended definition of revoked state to also cover non-issued certificates. In addition, the SingleResponse related to this non-issued certificate;

- MUST provide the revocation reason certificateHold (6),

- MUST specify the revocationTime January 1, 1970, and;

- MUST NOT include a CRL References extension (section 4.4.2) or any CRL Entry Extensions (section 4.4.5).

2.3 Exception Cases

In case of errors, the OCSP Responder may return an error message. These messages are not signed. Errors can be of the following types:

- malformedRequest
- internalError
- tryLater
- sigRequired
- unauthorized

A server produces the "malformedRequest" response if the request received does not conform to the OCSP syntax.

The response "internalError" indicates that the OCSP responder reached an inconsistent internal state. The query should be retried, potentially with another responder.

In the event that the OCSP responder is operational, but unable to return a status for the requested certificate, the "tryLater"

response can be used to indicate that the service exists, but is temporarily unable to respond.

The response "sigRequired" is returned in cases where the server requires the client sign the request in order to construct a response.

The response "unauthorized" is returned in cases where the client is not authorized to make this query to this server or the server is not capable of responding authoritatively (cf. [RFC5019], Section 2.2.3).

2.4 Semantics of thisUpdate, nextUpdate and producedAt

Responses can contain three times in them - thisUpdate, nextUpdate and producedAt. The semantics of these fields are:

- thisUpdate: The time at which the status being indicated is known to be correct
- nextUpdate: The time at or before which newer information will be available about the status of the certificate
- producedAt: The time at which the OCSP responder signed this response.

If nextUpdate is not set, the responder is indicating that newer revocation information is available all the time.

2.5 Response Pre-production

OCSP responders MAY pre-produce signed responses specifying the status of certificates at a specified time. The time at which the status was known to be correct SHALL be reflected in the thisUpdate field of the response. The time at or before which newer information will be available is reflected in the nextUpdate field, while the time at which the response was produced will appear in the producedAt field of the response.

2.6 OCSP Signature Authority Delegation

The key that signs a certificate's status information need not be the same key that signed the certificate. A certificate's issuer explicitly delegates OCSP signing authority by issuing a certificate containing a unique value for extendedKeyUsage in the OCSP signer's certificate. This certificate MUST be issued directly to the responder by the cognizant CA. Se further section 4.2.2.2.

2.7 CA Key Compromise

If an OCSP responder knows that a particular CA's private key has been compromised, it MAY return the revoked state for all certificates issued by that CA.

3. Functional Requirements

3.1 Certificate Content

In order to convey to OCSP clients a well-known point of information access, CAs SHALL provide the capability to include the AuthorityInfoAccess extension (defined in [RFC5280], section 4.2.2.1) in certificates that can be checked using OCSP. Alternatively, the accessLocation for the OCSP provider may be configured locally at the OCSP client.

CAs that support an OCSP service, either hosted locally or provided by an Authorized Responder, MUST provide for the inclusion of a value for a uniformResourceIndicator (URI) [RFC3986] accessLocation and the OID value id-ad-ocsp for the accessMethod in the AccessDescription SEQUENCE.

The value of the accessLocation field in the subject certificate defines the transport (e.g. HTTP) used to access the OCSP responder and may contain other transport dependent information (e.g. a URL).

3.2 Signed Response Acceptance Requirements

Prior to accepting a signed response as valid, OCSP clients SHALL confirm that:

1. The certificate identified in a received response corresponds to that which was identified in the corresponding request;

2. The signature on the response is valid;

3. The identity of the signer matches the intended recipient of the request.

4. The signer is currently authorized to sign the response.

5. The time at which the status being indicated is known to be correct (thisUpdate) is sufficiently recent.

6. When available, the time at or before which newer information will be available about the status of the certificate (nextUpdate) is greater than the current time.

4. Detailed Protocol

The ASN.1 syntax imports terms defined in [RFC5280]. For signature calculation, the data to be signed is encoded using the ASN.1 distinguished encoding rules (DER) [X.690].

ASN.1 EXPLICIT tagging is used as a default unless specified otherwise.

The terms imported from elsewhere are: Extensions, CertificateSerialNumber, SubjectPublicKeyInfo, Name, AlgorithmIdentifier, CRLReason

4.1 Requests

This section specifies the ASN.1 specification for a confirmation request. The actual formatting of the message could vary depending on the transport mechanism used (HTTP, SMTP, LDAP, etc.).

4.1.1 Request Syntax

```
OCSPRequest     ::=     SEQUENCE {
    tbsRequest                  TBSRequest,
    optionalSignature   [0]     EXPLICIT Signature OPTIONAL }

TBSRequest      ::=     SEQUENCE {
```

```
       version             [0]     EXPLICIT Version DEFAULT v1,
       requestorName       [1]     EXPLICIT GeneralName OPTIONAL,
       requestList                 SEQUENCE OF Request,
       requestExtensions   [2]     EXPLICIT Extensions OPTIONAL }

   Signature       ::=     SEQUENCE {
       signatureAlgorithm      AlgorithmIdentifier,
       signature               BIT STRING,
       certs                  [0] EXPLICIT SEQUENCE OF Certificate
   OPTIONAL}

   Version         ::=             INTEGER  {  v1(0) }

   Request         ::=     SEQUENCE {
       reqCert                     CertID,
       singleRequestExtensions     [0] EXPLICIT Extensions OPTIONAL }

   CertID          ::=     SEQUENCE {
       hashAlgorithm       AlgorithmIdentifier,
       issuerNameHash      OCTET STRING, -- Hash of Issuer's DN
       issuerKeyHash       OCTET STRING, -- Hash of Issuers public key
       serialNumber        CertificateSerialNumber }
```

issuerNameHash is the hash of the Issuer's distinguished name. The hash shall be calculated over the DER encoding of the issuer's name field in the certificate being checked. issuerKeyHash is the hash of the Issuer's public key. The hash shall be calculated over the value (excluding tag and length) of the subject public key field in the issuer's certificate. The hash algorithm used for both these hashes, is identified in hashAlgorithm. serialNumber is the serial number of the certificate for which status is being requested.

4.1.2 Notes on the Request Syntax

The primary reason to use the hash of the CA's public key in addition to the hash of the CA's name, to identify the issuer, is that it is possible that two CAs may choose to use the same Name (uniqueness in the Name is a recommendation that cannot be enforced). Two CAs will never, however, have the same public key unless the CAs either explicitly decided to share their private key, or the key of one of the CAs was compromised.

Support for any specific extension is OPTIONAL. The critical flag SHOULD NOT be set for any of them. Section 4.4 suggests several useful extensions. Additional extensions MAY be defined in additional RFCs. Unrecognized extensions MUST be ignored (unless they have the critical flag set and are not understood).

The requestor MAY choose to sign the OCSP request. In that case, the signature is computed over the tbsRequest structure. If the request is signed, the requestor SHALL specify its name in the requestorName field. Also, for signed requests, the requestor MAY include certificates that help the OCSP responder verify the requestor's signature in the certs field of Signature.

4.2 Response Syntax

This section specifies the ASN.1 specification for a confirmation response. The actual formatting of the message could vary depending on the transport mechanism used (HTTP, SMTP, LDAP, etc.).

4.2.1 ASN.1 Specification of the OCSP Response

An OCSP response at a minimum consists of a responseStatus field indicating the processing status of the prior request. If the value of responseStatus is one of the error conditions, responseBytes are not set.

```
OCSPResponse ::= SEQUENCE {
   responseStatus         OCSPResponseStatus,
   responseBytes          [0] EXPLICIT ResponseBytes OPTIONAL }

OCSPResponseStatus ::= ENUMERATED {
    successful            (0),  --Response has valid confirmations
    malformedRequest      (1),  --Illegal confirmation request
    internalError         (2),  --Internal error in issuer
    tryLater              (3),  --Try again later
                                --(4) is not used
    sigRequired           (5),  --Must sign the request
    unauthorized          (6)   --Request unauthorized
}
```

The value for responseBytes consists of an OBJECT IDENTIFIER and a response syntax identified by that OID encoded as an OCTET STRING.

```
ResponseBytes ::=       SEQUENCE {
    responseType   OBJECT IDENTIFIER,
    response       OCTET STRING }
```

For a basic OCSP responder, responseType will be id-pkix-ocsp-basic.

```
id-pkix-ocsp           OBJECT IDENTIFIER ::= { id-ad-ocsp }
id-pkix-ocsp-basic     OBJECT IDENTIFIER ::= { id-pkix-ocsp 1 }
```

OCSP responders SHALL be capable of producing responses of the id-pkix-ocsp-basic response type. Correspondingly, OCSP clients SHALL be capable of receiving and processing responses of the id-pkix-ocsp-basic response type.

The value for response SHALL be the DER encoding of BasicOCSPResponse.

```
BasicOCSPResponse       ::= SEQUENCE {
   tbsResponseData      ResponseData,
   signatureAlgorithm   AlgorithmIdentifier,
   signature            BIT STRING,
   certs            [0] EXPLICIT SEQUENCE OF Certificate OPTIONAL }
```

The value for signature SHALL be computed on the hash of the DER encoding ResponseData. The responder MAY include certificates in the certs field of BasicOCSPResponse that help the OCSP client verify the responder's signature. If no certificates are included then certs SHOULD be absent.

```
ResponseData ::= SEQUENCE {
   version              [0] EXPLICIT Version DEFAULT v1,
   responderID              ResponderID,
   producedAt               GeneralizedTime,
   responses                SEQUENCE OF SingleResponse,
   responseExtensions   [1] EXPLICIT Extensions OPTIONAL }

ResponderID ::= CHOICE {
   byName               [1] Name,
   byKey                [2] KeyHash }

KeyHash ::= OCTET STRING -- SHA-1 hash of responder's public key
(excluding the tag and length fields)

SingleResponse ::= SEQUENCE {
   certID                       CertID,
   certStatus                   CertStatus,
   thisUpdate                   GeneralizedTime,
   nextUpdate         [0]       EXPLICIT GeneralizedTime OPTIONAL,
   singleExtensions   [1]       EXPLICIT Extensions OPTIONAL }

CertStatus ::= CHOICE {
    good        [0]     IMPLICIT NULL,
    revoked     [1]     IMPLICIT RevokedInfo,
    unknown     [2]     IMPLICIT UnknownInfo }

RevokedInfo ::= SEQUENCE {
    revocationTime              GeneralizedTime,
```

```
       revocationReason    [0]     EXPLICIT CRLReason OPTIONAL }

   UnknownInfo ::= NULL
```

4.2.2 Notes on OCSP Responses

4.2.2.1 Time

The thisUpdate and nextUpdate fields define a recommended validity interval. This interval corresponds to the {thisUpdate, nextUpdate} interval in CRLs. Responses whose nextUpdate value is earlier than the local system time value SHOULD be considered unreliable. Responses whose thisUpdate time is later than the local system time SHOULD be considered unreliable. Responses where the nextUpdate value is not set are equivalent to a CRL with no time for nextUpdate (see Section 2.4).

The producedAt time is the time at which this response was signed.

4.2.2.2 Authorized Responders

The key that signs a certificate's status information need not be the same key that signed the certificate. It is necessary however to ensure that the entity signing this information is authorized to do so. Therefore, a certificate's issuer MAY either sign the OCSP responses itself or it MAY explicitly designate this authority to another entity. OCSP signing delegation SHALL be designated by the inclusion of id-kp-OCSPSigning in an extendedKeyUsage certificate extension included in the OCSP response signer's certificate. This certificate MUST be issued directly by the CA that is identified in the request.

The CA SHOULD use the same issuing key to issue a delegation certificate as was used to sign the certificate being checked for revocation. Systems relying on OCSP responses MUST recognize a delegation certificate as being issued by the CA that issued the certificate in question only if the delegation certificate and the certificate being checked for revocation was signed by the same key.

Note: CA key rollover is not prohibited when issuing a certificate for an authorized responder for backwards compatibility with RFC 2560 [RFC2560]. That is, it is not prohibited to issue a certificate for an authorized responder using a different issuing key than the key used to issued the certificate being checked for revocation. However, such practice is strongly discouraged since clients are not required to recognize a responder with such certificate as an authorized responder.

```
id-kp-OCSPSigning OBJECT IDENTIFIER ::= {id-kp 9}
```

Systems or applications that rely on OCSP responses MUST be capable of detecting and enforcing use of the id-kp-OCSPSigning value as

described above. They MAY provide a means of locally configuring one or more OCSP signing authorities, and specifying the set of CAs for which each signing authority is trusted. They MUST reject the response if the certificate required to validate the signature on the response fails to meet at least one of the following criteria:

1. Matches a local configuration of OCSP signing authority for the certificate in question; or

2. Is the certificate of the CA that issued the certificate in question; or

3. Includes a value of id-kp-OCSPSigning in an ExtendedKeyUsage extension and is issued by the CA that issued the certificate in question as stated above."

Additional acceptance or rejection criteria may apply to either the response itself or to the certificate used to validate the signature on the response.

4.2.2.2.1 Revocation Checking of an Authorized Responder

Since an Authorized OCSP responder provides status information for one or more CAs, OCSP clients need to know how to check that an authorized responder's certificate has not been revoked. CAs may choose to deal with this problem in one of three ways:

- A CA may specify that an OCSP client can trust a responder for the lifetime of the responder's certificate. The CA does so by including the extension id-pkix-ocsp-nocheck. This SHOULD be a non-critical extension. The value of the extension SHALL be NULL. CAs issuing such a certificate should realize that a compromise of the responder's key is as serious as the compromise of a CA key used to sign CRLs, at least for the validity period of this certificate. CA's may choose to issue this type of certificate with a very short lifetime and renew it frequently.

```
id-pkix-ocsp-nocheck OBJECT IDENTIFIER ::= { id-pkix-ocsp 5 }
```

- A CA may specify how the responder's certificate be checked for revocation. This can be done using CRL Distribution Points if the check should be done using CRLs or CRL Distribution Points, or Authority Information Access if the check should be done in some other way. Details for specifying either of these two mechanisms are available in [RFC5280].

- A CA may choose not to specify any method of revocation checking for the responder's certificate, in which case, it would be up to the

OCSP client's local security policy to decide whether that certificate should be checked for revocation or not.

4.2.2.3 Basic Response

The basic response type contains:

- o the version of the response syntax, which MUST be v1 (value is 0) for this version of the basic response syntax;
- o either the name of the responder or a hash of the responder's public key as the ResponderID;
- o the time at which the response was generated;
- o responses for each of the certificates in a request;
- o optional extensions;
- o a signature computed across a hash of the response; and
- o the signature algorithm OID.

The purpose of the ResponderID information is to allow clients to find the certificate used to sign a signed OCSP response. Therefor, the information MUST correspond to the certificate that was used to sign the response.

The responder MAY include certificates in the certs field of BasicOCSPResponse that help the OCSP client verify the responder's signature.

The response for each of the certificates in a request consists of:

- o an identifier of the certificate for which revocation status information is being provided (i.e., the target certificate);
- o the revocation status of the certificate (good, revoked, or unknown);
- o the validity interval of the response; and
- o optional extensions.

The response MUST include a SingleResponse for each certificate in the request and SHOULD NOT include any additional SingleResponse elements. OCSP responders that pre-generate status responses MAY return responses that include additional SingleResponse elements if

necessary to improve response pre-generation performance or cache efficiency. (According to Section 2.2.1 of RFC 5019. [RFC 5019])

4.3 Mandatory and Optional Cryptographic Algorithms

Clients that request OCSP services SHALL be capable of processing responses signed using RSA with SHA-1 (identified by sha1WithRSAEncryption OID specified in [RFC3279]) and RSA with SHA-256 (identified by sha256WithRSAEncryption OID specified in [RFC4055]). Clients SHOULD also be capable of processing responses signed using DSA keys (identified by the id-dsa-with-sha1 OID specified in [RFC3279]). Clients MAY support other algorithms.

4.4 Extensions

This section defines some standard extensions, based on the extension model employed in X.509 version 3 certificates see [RFC5280]. Support for all extensions is optional for both clients and responders. For each extension, the definition indicates its syntax, processing performed by the OCSP Responder, and any extensions which are included in the corresponding response.

4.4.1 Nonce

The nonce cryptographically binds a request and a response to prevent replay attacks. The nonce is included as one of the requestExtensions in requests, while in responses it would be included as one of the responseExtensions. In both the request and the response, the nonce will be identified by the object identifier id-pkix-ocsp-nonce, while the extnValue is the value of the nonce.

```
id-pkix-ocsp           OBJECT IDENTIFIER ::= { id-ad-ocsp } id-pkix-
ocsp-nonce     OBJECT IDENTIFIER ::= { id-pkix-ocsp 2 }

Nonce ::= OCTET STRING
```

4.4.2 CRL References

It may be desirable for the OCSP responder to indicate the CRL on which a revoked or onHold certificate is found. This can be useful where OCSP is used between repositories, and also as an auditing mechanism. The CRL may be specified by a URL (the URL at which the CRL is available), a number (CRL number) or a time (the time at which the relevant CRL was created). These extensions will be specified as singleExtensions. The identifier for this extension will be id-pkix-ocsp-crl, while the value will be CrlID.

```
id-pkix-ocsp-crl       OBJECT IDENTIFIER ::= { id-pkix-ocsp 3 }

CrlID ::= SEQUENCE {
   crlUrl               [0]     EXPLICIT IA5String OPTIONAL,
   crlNum               [1]     EXPLICIT INTEGER OPTIONAL,
   crlTime              [2]     EXPLICIT GeneralizedTime OPTIONAL }
```

For the choice crlUrl, the IA5String will specify the URL at which the CRL is available. For crlNum, the INTEGER will specify the value of the CRL number extension of the relevant CRL. For crlTime, the GeneralizedTime will indicate the time at which the relevant CRL was issued.

4.4.3 Acceptable Response Types

An OCSP client MAY wish to specify the kinds of response types it understands. To do so, it SHOULD use an extension with the OID id-pkix-ocsp-response, and the value AcceptableResponses. This extension is included as one of the requestExtensions in requests. The OIDs included in AcceptableResponses are the OIDs of the various response types this client can accept (e.g., id-pkix-ocsp-basic).

```
id-pkix-ocsp-response  OBJECT IDENTIFIER ::= { id-pkix-ocsp 4 }

AcceptableResponses ::= SEQUENCE OF OBJECT IDENTIFIER
```

As noted in section 4.2.1, OCSP responders SHALL be capable of responding with responses of the id-pkix-ocsp-basic response type. Correspondingly, OCSP clients SHALL be capable of receiving and processing responses of the id-pkix-ocsp-basic response type.

4.4.4 Archive Cutoff

An OCSP responder MAY choose to retain revocation information beyond a certificate's expiration. The date obtained by subtracting this retention interval value from the producedAt time in a response is defined as the certificate's "archive cutoff" date.

OCSP-enabled applications would use an OCSP archive cutoff date to contribute to a proof that a digital signature was (or was not) reliable on the date it was produced even if the certificate needed to validate the signature has long since expired.

OCSP servers that provide support for such historical reference SHOULD include an archive cutoff date extension in responses. If included, this value SHALL be provided as an OCSP singleExtensions extension identified by id-pkix-ocsp-archive-cutoff and of syntax

GeneralizedTime.

```
id-pkix-ocsp-archive-cutoff  OBJECT IDENTIFIER ::= { id-pkix-ocsp 6 }

ArchiveCutoff ::= GeneralizedTime
```

To illustrate, if a server is operated with a 7-year retention interval policy and status was produced at time t1 then the value for ArchiveCutoff in the response would be (t1 - 7 years).

4.4.5 CRL Entry Extensions

All the extensions specified as CRL Entry Extensions - in Section 5.3 of [RFC5280] - are also supported as singleExtensions.

4.4.6 Service Locator

An OCSP server may be operated in a mode whereby the server receives a request and routes it to the OCSP server which is known to be authoritative for the identified certificate. The serviceLocator request extension is defined for this purpose. This extension is included as one of the singleRequestExtensions in requests.

```
id-pkix-ocsp-service-locator OBJECT IDENTIFIER ::= { id-pkix-ocsp 7 }

ServiceLocator ::= SEQUENCE {
    issuer    Name,
    locator   AuthorityInfoAccessSyntax OPTIONAL }
```

Values for these fields are obtained from the corresponding fields in the subject certificate.

4.4.7 Preferred Signature Algorithms

Since algorithms other than the mandatory to implement algorithms are allowed, and since a client currently has no mechanism to indicate it's algorithm preferences, there is always a risk that a server choosing a non-mandatory algorithm, will generate a response that the client may not support.

While an OCSP responder may apply rules for algorithm selection, e.g., using the signature algorithm employed by the CA for signing CRLs and certificates, such rules may fail in common situations:

o The algorithm used to sign the CRLs and certificates may not be consistent with key pair being used by the OCSP responder to sign responses.

- o A request for an unknown certificate provides no basis for a responder to select from among multiple algorithm options.

The last criterion cannot be resolved through the information available from in-band signaling using the RFC 2560 [RFC2560] protocol, without modifying the protocol.

In addition, an OCSP responder may wish to employ different signature algorithms than the one used by the CA to sign certificates and CRLs for several reasons:

- o The responder may employ an algorithm for certificate status response that is less computationally demanding than for signing the certificate itself.

- o An implementation may wish to guard against the possibility of a compromise resulting from a signature algorithm compromise by employing two separate signature algorithms.

This section describes:

- o An extension that allows a client to indicate the set of preferred signature algorithms.

- o Rules for signature algorithm selection that maximizes the probability of successful operation in the case that no supported preferred algorithm(s) are specified.

4.4.7.1 Extension Syntax

A client MAY declare a preferred set of algorithms in a request by including a preferred signature algorithms extension in requestExtensions of the OCSPRequest.

```
id-pkix-ocsp-pref-sig-algs OBJECT IDENTIFIER ::= { id-pkix-ocsp 8 }

PreferredSignatureAlgorithms ::= SEQUENCE OF
                                 PreferredSignatureAlgorithm

PreferredSignatureAlgorithm ::= SEQUENCE {
   sigIdentifier        AlgorithmIdentifier,
   pubKeyAlgIdentifier  SMIMECapability OPTIONAL
   }
```

The syntax of AlgorithmIdentifier is defined in section 4.1.1.2 of

RFC 5280 [RFC5280] The syntax of SMIMECapability is defined in RFC 5751 [RFC5751]

sigIdentifier specifies the signature algorithm the client prefers, e.g. algorithm=ecdsa-with-sha256. Parameters are absent for most common signature algorithms.

pubKeyAlgIdentifier specifies the subject public key algorithm identifier the client prefers in the server's certificate used to validate the OCSP response. e.g. algorithm=id-ecPublicKey and parameters= secp256r1.

pubKeyAlgIdentifier is OPTIONAL and provides means to specify parameters necessary to distinguish among different usages of a particular algorithm, e.g. it may be used by the client to specify what curve it supports for a given elliptic curve algorithm.

The client MUST support each of the specified preferred signature algorithms and the client MUST specify the algorithms in the order of preference, from the most preferred to the least preferred.

Section 4.4.7.1 of this document describes how a server selects an algorithm for signing OCSP responses to the requesting client.

4.4.7.2 Responder Signature Algorithm Selection

RFC 2560 [RFC2560] did not specify a mechanism for deciding the signature algorithm to be used in an OCSP response. This does not provide a sufficient degree of certainty as to the algorithm selected to facilitate interoperability.

4.4.7.2.1 Dynamic Response

A responder MAY maximize the potential for ensuring interoperability by selecting a supported signature algorithm using the following order of precedence, as long as the selected algorithm meets all security requirements of the OCSP responder, where the first method has the highest precedence:

1. Select an algorithm specified as a preferred signing algorithm in the client request

2. Select the signing algorithm used to sign a certificate revocation list (CRL) issued by the certificate issuer providing status information for the certificate specified by CertID

3. Select the signing algorithm used to sign the OCSPRequest

4. Select a signature algorithm that has been advertised as being the default signature algorithm for the signing service using an out of band mechanism

5. Select a mandatory or recommended signing algorithm specified for the version of the OCSP protocol in use

A responder SHOULD always apply the lowest numbered selection mechanism that results in the selection of a known and supported algorithm that meets the responder's criteria for cryptographic algorithm strength.

4.4.7.2.2 Static Response

For purposes of efficiency, an OCSP responder is permitted to generate static responses in advance of a request. The case may not permit the responder to make use of the client request data during the response generation, however the responder SHOULD still use the client request data during the selection of the pre-generated response to be returned. Responders MAY use the historical client requests as part of the input to the decisions of what different algorithms should be used to sign the pre-generated responses.

4.4.8 Extended Revoked Definition

This extension indicates that the responder supports the extended definition of the "revoked" response according to section 2.2, and that this responder MAY respond with a "revoked" status value to a status request for non-issued certificates. When present, this extension MUST be included as one of the responseExtensions in responses.

This Extension MUST be included in the OCSP response when the responder responds "revoked" to a status request for a non-issued certificate. This extension MAY be present in other responses.

The extended revoked definition extension has no defined syntax (has an empty extension value) and is identified by the object identifier id-pkix-ocsp-extended-revoke.

This extension MUST NOT be marked critical.

```
id-pkix-ocsp-extended-revoke OBJECT IDENTIFIER ::= { id-pkix-ocsp 9 }
```

5. Security Considerations

For this service to be effective, certificate-using systems must connect to the certificate status service provider. In the event such a connection cannot be obtained, certificate-using systems could implement CRL processing logic as a fall-back position.

A denial of service vulnerability is evident with respect to a flood of queries. The production of a cryptographic signature significantly affects response generation cycle time, thereby exacerbating the situation. Unsigned error responses open up the protocol to another denial of service attack, where the attacker sends false error responses.

The use of precomputed responses allows replay attacks in which an old (good) response is replayed prior to its expiration date but after the certificate has been revoked. Deployments of OCSP should carefully evaluate the benefit of precomputed responses against the probability of a replay attack and the costs associated with its successful execution.

Requests do not contain the responder they are directed to. This allows an attacker to replay a request to any number of OCSP responders.

The reliance of HTTP caching in some deployment scenarios may result in unexpected results if intermediate servers are incorrectly configured or are known to possess cache management faults. Implementors are advised to take the reliability of HTTP cache mechanisms into account when deploying OCSP over HTTP.

Responding a "revoked" state to certificate that has never been issued may enable someone to obtain a revocation response for a certificate that is not yet issued, but soon will be issued, if the CA issues certificates using sequential certificate serial number assignment. This risk is handled in the spec by requiring compliant implementations to use the certificateHold reason code, which avoids permanently revoking the serial number. One way to completely avoid this issue, for CAs that supports "revoked" responses to status requests for non-issued certificates, is to assign random certificate serial number values with high entropy.

5.1 Preferred Signature Algorithms

The mechanism used to choose the response signing algorithm MUST be considered to be sufficiently secure against cryptanalytic attack for the intended application.

In most applications it is sufficient for the signing algorithm to be at least as secure as the signing algorithm used to sign the original certificate whose status is being queried. This criteria may not hold in long term archival applications however in which the status of a certificate is being queried for a date in the distant past, long after the signing algorithm has ceased being considered trustworthy.

5.1.1 Use of insecure algorithms

It is not always possible for a responder to generate a response that the client is expected to understand and that meets contemporary standards for cryptographic security. In such cases an OCSP responder operator MUST balance the risk of employing a compromised security solution and the cost of mandating an upgrade, including the risk that the alternative chosen by end users will offer even less security or no security.

In archival applications it is quite possible that an OCSP responder might be asked to report the validity of a certificate on a date in the distant past. Such a certificate might employ a signing method that is no longer considered acceptably secure. In such circumstances the responder MUST NOT generate a signature using a signing mechanism that is not considered acceptably secure.

A client MUST accept any signing algorithm in a response that it specified as a preferred signing algorithm in the request. It follows therefore that a client MUST NOT specify as a preferred signing algorithm any algorithm that is either not supported or not considered acceptably secure.

5.1.2 Man in the Middle Downgrade Attack

The mechanism to support client indication of preferred signature algorithms is not protected against a man in the middle downgrade attack. This constraint is not considered to be a significant security concern since the OCSP responder MUST NOT sign OCSP Responses using weak algorithms even if requested by the client. In addition, the client can reject OCSP responses that do not meet its own criteria for acceptable cryptographic security no matter what mechanism is used to determine the signing algorithm of the response.

5.1.3. Denial of Service Attack

Algorithm agility mechanisms defined in this document introduces a slightly increased attack surface for Denial-of-Service attacks where the client request is altered to require algorithms that are not

supported by the server. Denial-of-Service considerations from RFC 4732 [RFC4732] are relevant for this document.

6 IANA Considerations

This draft include MIME type registrations (in Appendix C) that currently resides with RFC 2560, which is obsoleted by publication of this draft as RFC.

7. References

7.1. Normative References

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[RFC5019] Deacon, A. and R. Hurst, "The Lightweight Online Certificate Status Protocol (OCSP) Profile for High-Volume Environments", RFC 5019, September 2007.

[RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 5280, May 2008.

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[RFC6277] Santesson, S. and P. Hallam-Baker, "Online Certificate

Status Protocol Algorithm Agility", RFC 6277, June 2011.

[X.690] ITU-T Recommendation X.690 (1994) | ISO/IEC 8825-1:1995, Information Technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER).

7.2. Informative References

[RFC2560] Myers, M., Ankney, R., Malpani, A., Galperin, S., and C. Adams, "X.509 Internet Public Key Infrastructure Online Certificate Status Protocol - OCSP", RFC 2560, June 1999.

[RFC2616] Fielding, R., Gettys, J., Mogul, J., Frystyk, H., Masinter, L., Leach, P., and T. Berners-Lee, "Hypertext Transfer Protocol -- HTTP/1.1", RFC 2616, June 1999.

[RFC5019] Deacon, A. and R. Hurst, "The Lightweight Online Certificate Status Protocol (OCSP) Profile for High-Volume Environments", RFC 5019, September 2007.

[RFC5912] Hoffman, P. and J. Schaad, "New ASN.1 Modules for the Public Key Infrastructure Using X.509 (PKIX)", RFC 5912, June 2010.

8. Acknowledgement

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Appendix A.

A.1 OCSP over HTTP

This section describes the formatting that will be done to the request and response to support HTTP [RFC2616].

A.1.1 Request

HTTP based OCSP requests can use either the GET or the POST method to submit their requests. To enable HTTP caching, small requests (that after encoding are less than 255 bytes), MAY be submitted using GET. If HTTP caching is not important, or the request is greater than 255 bytes, the request SHOULD be submitted using POST. Where privacy is a requirement, OCSP transactions exchanged using HTTP MAY be protected using either TLS/SSL or some other lower layer protocol.

An OCSP request using the GET method is constructed as follows:

GET {url}/{url-encoding of base-64 encoding of the DER encoding of the OCSPRequest}

where {url} may be derived from the value of AuthorityInfoAccess or other local configuration of the OCSP client.

An OCSP request using the POST method is constructed as follows: The Content-Type header has the value "application/ocsp-request" while the body of the message is the binary value of the DER encoding of the OCSPRequest.

A.1.2 Response

An HTTP-based OCSP response is composed of the appropriate HTTP headers, followed by the binary value of the DER encoding of the OCSPResponse. The Content-Type header has the value "application/ocsp-response". The Content-Length header SHOULD specify the length of the response. Other HTTP headers MAY be present and MAY be ignored if not understood by the requestor.

Appendix B. ASN.1 Modules

This appendix includes the ASN.1 modules for OCSP. Appendix C.1 includes an ASN.1 module that conforms to the 1998 version of ASN.1 for all syntax elements of OCSP other than the preferred signature algorithms extension. An alternative to this module that conforms to the 2002 version of ASN.1 my be found in Section 4 of [RFC5912]. Appendix C.2 includes two ASN.1 modules for the preferred signature algorithms extension, one that conforms to the 1998 version of ASN.1 and one that conforms to the 2002 version of ASN.1.

B.1. OCSP in ASN.1

```
OCSP {iso(1) identified-organization(3) dod(6) internet(1)
      security(5) mechanisms(5) pkix(7) id-mod(0) id-mod-ocsp(14)}

DEFINITIONS EXPLICIT TAGS ::=

BEGIN

IMPORTS

   -- PKIX Certificate Extensions
      AuthorityInfoAccessSyntax, CRLReason, GeneralName
      FROM PKIX1Implicit88 { iso(1) identified-organization(3)
           dod(6) internet(1) security(5) mechanisms(5) pkix(7)
           id-mod(0) id-pkix1-implicit(19) }

      Name, CertificateSerialNumber, Extensions,
      id-kp, id-ad-ocsp, Certificate, AlgorithmIdentifier
      FROM PKIX1Explicit88 { iso(1) identified-organization(3)
           dod(6) internet(1) security(5) mechanisms(5) pkix(7)
           id-mod(0) id-pkix1-explicit(18) };


OCSPRequest ::= SEQUENCE {
   tbsRequest                  TBSRequest,
   optionalSignature   [0] EXPLICIT Signature OPTIONAL }

TBSRequest ::= SEQUENCE {
   version             [0] EXPLICIT Version DEFAULT v1,
   requestorName       [1] EXPLICIT GeneralName OPTIONAL,
   requestList             SEQUENCE OF Request,
   requestExtensions   [2] EXPLICIT Extensions OPTIONAL }

Signature ::= SEQUENCE {
   signatureAlgorithm      AlgorithmIdentifier,
   signature               BIT STRING,
```

```
   certs               [0] EXPLICIT SEQUENCE OF Certificate OPTIONAL }

Version ::= INTEGER { v1(0) }

Request ::= SEQUENCE {
   reqCert                     CertID,
   singleRequestExtensions [0] EXPLICIT Extensions OPTIONAL }

CertID ::= SEQUENCE {
   hashAlgorithm           AlgorithmIdentifier,
   issuerNameHash          OCTET STRING, -- Hash of Issuer's DN
   issuerKeyHash           OCTET STRING, -- Hash of Issuers public key
   serialNumber            CertificateSerialNumber }

OCSPResponse ::= SEQUENCE {
   responseStatus          OCSPResponseStatus,
   responseBytes       [0] EXPLICIT ResponseBytes OPTIONAL }

OCSPResponseStatus ::= ENUMERATED {
   successful          (0),  -- Response has valid confirmations
   malformedRequest    (1),  -- Illegal confirmation request
   internalError       (2),  -- Internal error in issuer
   tryLater            (3),  -- Try again later
                             -- (4) is not used
   sigRequired         (5),  -- Must sign the request
   unauthorized        (6)   -- Request unauthorized
}

ResponseBytes ::= SEQUENCE {
   responseType            OBJECT IDENTIFIER,
   response                OCTET STRING }

BasicOCSPResponse ::= SEQUENCE {
  tbsResponseData          ResponseData,
  signatureAlgorithm       AlgorithmIdentifier,
  signature                BIT STRING,
  certs                [0] EXPLICIT SEQUENCE OF Certificate OPTIONAL }

ResponseData ::= SEQUENCE {
   version             [0] EXPLICIT Version DEFAULT v1,
   responderID             ResponderID,
   producedAt              GeneralizedTime,
   responses               SEQUENCE OF SingleResponse,
   responseExtensions  [1] EXPLICIT Extensions OPTIONAL }

ResponderID ::= CHOICE {
   byName              [1] Name,
   byKey               [2] KeyHash }
```

```
KeyHash ::= OCTET STRING --SHA-1 hash of responder's public key
                         -- (i.e., the SHA-1 hash of the value of the
                         -- BIT STRING subjectPublicKey [excluding
                         -- the tag, length, and number of unused
                         -- bits] in the responder's certificate)

SingleResponse ::= SEQUENCE {
   certID                  CertID,
   certStatus              CertStatus,
   thisUpdate              GeneralizedTime,
   nextUpdate          [0] EXPLICIT GeneralizedTime OPTIONAL,
   singleExtensions    [1] EXPLICIT Extensions OPTIONAL }

CertStatus ::= CHOICE {
   good                [0] IMPLICIT NULL,
   revoked             [1] IMPLICIT RevokedInfo,
   unknown             [2] IMPLICIT UnknownInfo }

RevokedInfo ::= SEQUENCE {
   revocationTime          GeneralizedTime,
   revocationReason    [0] EXPLICIT CRLReason OPTIONAL }

UnknownInfo ::= NULL

ArchiveCutoff ::= GeneralizedTime

AcceptableResponses ::= SEQUENCE OF OBJECT IDENTIFIER

ServiceLocator ::= SEQUENCE {
   issuer                  Name,
   locator                 AuthorityInfoAccessSyntax }

-- Object Identifiers

id-kp-OCSPSigning             OBJECT IDENTIFIER ::= { id-kp 9 }
id-pkix-ocsp                  OBJECT IDENTIFIER ::= { id-ad-ocsp }
id-pkix-ocsp-basic            OBJECT IDENTIFIER ::= { id-pkix-ocsp 1 }
id-pkix-ocsp-nonce            OBJECT IDENTIFIER ::= { id-pkix-ocsp 2 }
id-pkix-ocsp-crl              OBJECT IDENTIFIER ::= { id-pkix-ocsp 3 }
id-pkix-ocsp-response         OBJECT IDENTIFIER ::= { id-pkix-ocsp 4 }
id-pkix-ocsp-nocheck          OBJECT IDENTIFIER ::= { id-pkix-ocsp 5 }
id-pkix-ocsp-archive-cutoff   OBJECT IDENTIFIER ::= { id-pkix-ocsp 6 }
id-pkix-ocsp-service-locator OBJECT IDENTIFIER ::= { id-pkix-ocsp 7 }
id-pkix-ocsp-extended-revoke OBJECT IDENTIFIER ::= { id-pkix-ocsp 9 }

END
```

B.2. Preferred Signature Algorithms ASN.1

B.2.1. ASN.1 Module

```
OCSP-AGILITY-2009 { iso(1) identified-organization(3) dod(6)
     internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
     id-mod-ocsp-agility-2009-93(66) }

DEFINITIONS EXPLICIT TAGS ::=
BEGIN

EXPORTS ALL;   -- export all items from this module
IMPORTS

   id-pkix-ocsp
     FROM OCSP-2009 -- From [RFC5912]
      { iso(1) identified-organization(3) dod(6) internet(1) security(5)
        mechanisms(5) pkix(7) id-mod(0) id-mod-ocsp-02(48) }

   AlgorithmIdentifier{}, SIGNATURE-ALGORITHM, PUBLIC-KEY
     FROM AlgorithmInformation-2009 -- From [RFC5912]
       { iso(1) identified-organization(3) dod(6) internet(1)
         security(5) mechanisms(5) pkix(7) id-mod(0)
         id-mod-algorithmInformation-02(58) }

   EXTENSION
     FROM PKIX-CommonTypes-2009 -- From [RFC5912]
      { iso(1) identified-organization(3) dod(6) internet(1) security(5)
        mechanisms(5) pkix(7) id-mod(0) id-mod-pkixCommon-02(57)} ;

--  Add re-preferred-signature-algorithms to the set of extensions
--  for TBSRequest.requestExtensions

re-preferred-signature-algorithms EXTENSION ::= {
   SYNTAX PreferredSignatureAlgorithms
   IDENTIFIED BY id-pkix-ocsp-pref-sig-algs  }

id-pkix-ocsp-pref-sig-algs OBJECT IDENTIFIER ::= { id-pkix-ocsp 8 }

PreferredSignatureAlgorithms ::= SEQUENCE OF PreferredSignatureAlgorithm

PreferredSignatureAlgorithm ::= SEQUENCE {
   sigIdentifier  AlgorithmIdentifier{SIGNATURE-ALGORITHM, {...}},
   certIdentifier AlgorithmIdentifier{PUBLIC-KEY, {...}} OPTIONAL
}

END
```

B.2.2. 1988 ASN.1 Module

```
OCSP-AGILITY-88 { iso(1) identified-organization(3) dod(6) internet(1)
     security(5) mechanisms(5) pkix(7) id-mod(0)
     id-mod-ocsp-agility-2009-88(67) }

DEFINITIONS EXPLICIT TAGS ::=
BEGIN

-- EXPORTS ALL;
IMPORTS

   id-pkix-ocsp
   FROM OCSP  {iso(1) identified-organization(3) dod(6) internet(1)
     security(5) mechanisms(5) pkix(7) id-mod(0) id-mod-ocsp(14)}

   AlgorithmIdentifier
   FROM PKIX1Explicit88 { iso(1) identified-organization(3) dod(6)
     internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
     id-pkix1-explicit(18) };

id-pkix-ocsp-pref-sig-algs OBJECT IDENTIFIER ::= { id-pkix-ocsp 8 }

PreferredSignatureAlgorithms ::= SEQUENCE OF PreferredSignatureAlgorithm

PreferredSignatureAlgorithm ::= SEQUENCE {
   sigIdentifier   AlgorithmIdentifier,
   certIdentifier  AlgorithmIdentifier OPTIONAL }

END
```

Appendix C. MIME registrations

C.1 application/ocsp-request

To: ietf-types@iana.org Subject: Registration of MIME media type application/ocsp-request

MIME media type name: application

MIME subtype name: ocsp-request

Required parameters: None

Optional parameters: None

Encoding considerations: binary

Security considerations: Carries a request for information. This request may optionally be cryptographically signed.

Interoperability considerations: None

Published specification: IETF PKIX Working Group Draft on Online Certificate Status Protocol - OCSP

Applications which use this media type: OCSP clients

Additional information:

Magic number(s): None
File extension(s): .ORQ
Macintosh File Type Code(s): none

Person & email address to contact for further information:
Stefan Santesson <sts@aaa-sec.com>

Intended usage: COMMON

Author/Change controller: IETF

C.2 application/ocsp-response

To: ietf-types@iana.org
Subject: Registration of MIME media type application/ocsp-response

MIME media type name: application

MIME subtype name: ocsp-response

Required parameters: None

Optional parameters: None
Encoding considerations: binary

Security considerations: Carries a cryptographically signed response

Interoperability considerations: None

Published specification: IETF PKIX Working Group Draft on Online Certificate Status Protocol - OCSP

Applications which use this media type: OCSP servers

Additional information:

Magic number(s): None
File extension(s): .ORS
Macintosh File Type Code(s): none

Person & email address to contact for further information:
Stefan Santesson <sts@aaa-sec.com>

Intended usage: COMMON

Author/Change controller: IETF

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