Network Working Group
Internet Draft
Intended Status: Informational
Expires: February 1, 2020

M. Jenkins
NSA
Sean Turner
sn3rd
July 31, 2019

The SODP (Secure Object Delivery Protocol) Server Interfaces: NSA's Profile for Delivery of Certificates, CRLs, and Symmetric Keys to Clients

draft-turner-sodp-profile-02.txt

Abstract

This document specifies protocol interfaces profiled by the US NSA (United States National Security Agency) for NSS (National Security System) servers that provide public key certificates, CRLs (Certificate Revocation Lists), and symmetric keys to NSS clients. Servers that support these interfaces are referred to as SODP (Secure Object Delivery Protocol) servers. The intended audience for this profile comprises developers of client devices that will obtain key management services from NSA-operated SODP servers. Interfaces supported by SODP servers include: EST (Enrollment over Secure Transport) and its extensions as well as CMC (Certificate Management over CMS (Cryptographic Message Syntax)).

This profile applies to the capabilities, configuration, and operation of all components of US National Security Systems (SP 800-59). It is also appropriate for other US Government systems that process high-value information. It is made publicly available for use by developers and operators of these and any other system deployments.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at http://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

Table of Contents

1. Introduction 3
1.1. Documents to be Familiar With 3
1.2. Document Organization 4
1.3. Environment 4
2. Abstract Syntax Notation One 6
3. EST Interface 6
3.1. Hypertext Transfer Protocol Layer 6
3.2. Transport Layer Security 6
3.3. Eligibility 6
3.4. Authentication 7
3.5. Authorization 7
3.6. EST and EST Extensions 7
3.6.1. /pal 7
3.6.2. /cacerts 7
3.6.3. /simpleenroll 8
3.6.4. /simplereenroll 8
3.6.5. /fullcmc 8
3.6.6. /serverkeygen 8
3.6.7. /csrattrs 9
3.6.8. /crls 9
3.6.9. /symmetrickeys 9
3.6.10. /eecerts, /firmware, /tamp 9
4. CMC Interface 10
4.1. RFC 5273 Transport Protocols 10
4.2. Eligibility 10
4.3. Authentication 10
4.4. Authorization 10
4.5. Simple PKI Requests/Responses 11
4.6. Full PKI Requests/Responses 11
5. Trust Anchor Profile 11
6. Non-Self-Signed Certification Authority Certificate Profile . 11

7. End-Entity Certificate Profile 13
7.1. Source of Authority Certificate Profile 14
7.2. Client Certificate Profile 14
8. Relying Party Applications 14
9. CRL Profile 15
10. IANA Considerations 16
11. Security Considerations 16
12. References 16
12.1. Normative References 16
12.2. Informative References 20
Authors' Addresses 20

1. Introduction

This document specifies protocol interfaces profiled by the US NSA (United States National Security Agency) for NSS (National Security System) servers that provide public key certificates, CRLs (Certificate Revocation Lists), and symmetric keys to NSS clients. Servers that support these interfaces are referred to as SODP (Secure Object Delivery Protocol) servers. The purpose of this document is to indicate options from, and requirements additional to, the base specifications listed in Section 1.1 that are necessary for client interoperability with NSA-operated SODP servers. Clients are always devices, and need not implement all of the interfaces specified herein; clients are free to choose which interfaces to implement based on their operational requirements. Interfaces supported by SODP servers include:

- EST (Enrollment over Secure Transport) [RFC7030] and its extensions [RFC8295], and
- CMC (Certificate Management over CMS (Cryptographic Message Syntax)) [RFC5274][RFC6402] for both Simple PKI (Public Key Infrastructure) requests and responses (i.e., PKCS#10 requests and PKCS#7 responses) and Full PKI requests and responses.

This profile applies to the capabilities, configuration, and operation of all components of US National Security Systems [SP 800-59]. It is also appropriate for other US Government systems that process high-value information. It is made publicly available for use by developers and operators of these and any other system deployments.

This profile conforms to the existing requirements of NSA's Commercial National Security Algorithms. As operational needs evolve over time, this profile will be updated to incorporate new commercial algorithms and protocols as they are developed and approved for use.

1.1. Documents to be Familiar With

Familiarity with the follow specifications is assumed:

- o EST [RFC7030] and EST extensions [RFC8295];
- o PKI-related specifications [RFC2986], [RFC3739], [RFC5274], [RFC5280], [RFC5912], [RFC5913], [RFC5916], [RFC5917], [RFC6010], and [RFC6402];
- o Key-format-related specifications [RFC5915], [RFC5958], [RFC5959], [RFC6031], [RFC6032], [RFC6160], [RFC6161], [RFC6162], [RFC7191], [RFC7192], [RFC7292], and [RFC7906];
- o CMS-related (Cryptographic Message Syntax) RFCs [RFC5652], [RFC6268], and;
- o CNSA-related (Commercial National Security Algorithm) drafts [RFC8603], [ID.cnsa-smime-profile], [ID.cnsa-cmc-profile], and [ID.cnsa-tls-profile]. The profile defined herein does not support RSA-based algorithms.

The requirements from RFCs apply throughout this profile and are generally not repeated here. This document is purposely written without [RFC2119] language.

1.2. Document Organization

The document is organized as follows:

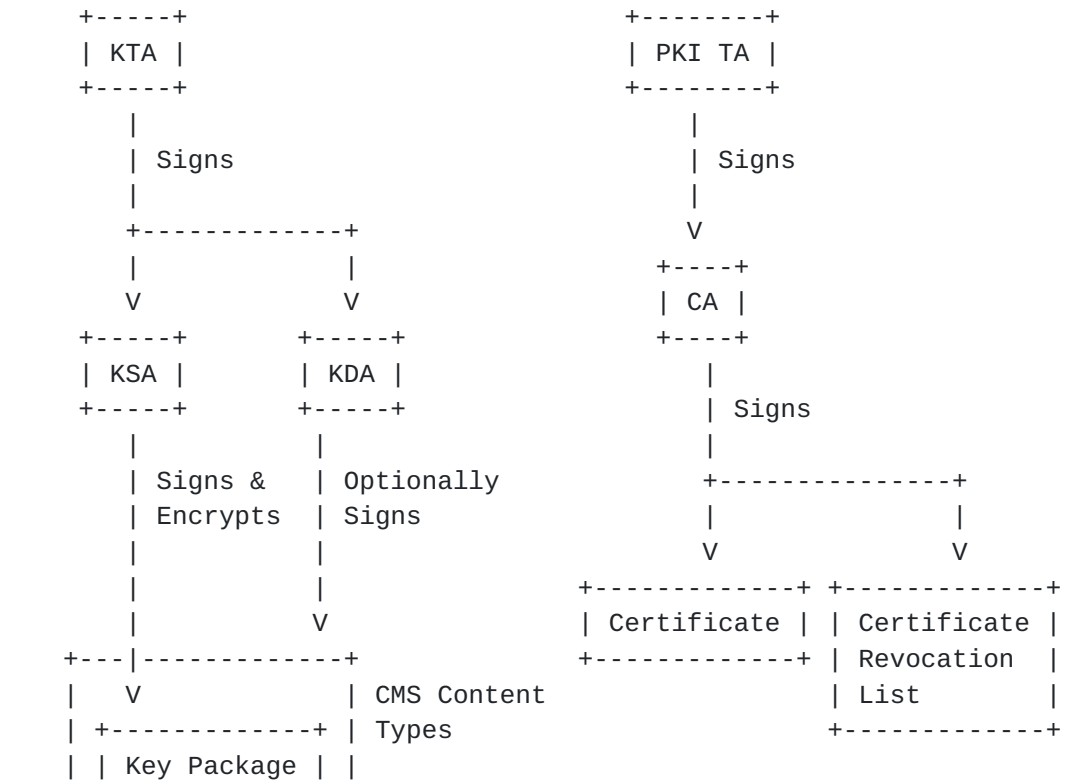
- o The remainder of this section describes the operational environment used by clients to retrieve secure objects.
- o Section 2 specifies the version of ASN.1 (Abstract Syntax Notation One) version used.
- o Section 3 specifies SODP's EST interface.
- o Section 4 specifies SODP's CMC interfaces; one section each for Simple PKI requests/responses and Full PKI requests/responses.
- o Sections 5-9 respectively specify TA, CA, and EE certificates as well as CRL.

1.3. Environment

The environment is Client-Server-based from which clients obtain secure "objects" or "packages". Objects/packages vary based on the SOA (Source of Authority) but all objects are "secured" minimally through the use of one or more digital signatures and zero or more layers of encryption, as profiled in this document. An SOA is the authority for the creation of objects that the client will recognize as valid. An SOA can delegate its authority to other actors; delegation occurs through the issuance of certificates. An object or package is the generic term for certificates, certificate status information, and keys (both asymmetric and symmetric). All of the objects except for the certificates and certificate status information are directly encapsulated in and protected by CMS content

types. CMS content types that provide security are referred to as CMS-protecting content types. All others are simply referred to as CMS content types. All secured objects are distributed either as CMS packages or as part of a CMS package.

In the following example depicted in Figure 1, there are two SOAs: one for symmetric keys, as depicted by the KTA (Key Trust Anchor), and one for public key certificates, as depicted by the PKI TA (Trust Anchor). The KTA is responsible for the creation and distribution of symmetric keys. The KTA delegates the creation and distribution responsibilities to separate entities through the issuance of certificates to a KSA (Key Source Authority) and a KDA (Key Distribution Authority). The KSA generates the keys, digitally signs the keys, and encrypts the key for the end client using CMS content types for each step. The KDA distributes the KSA-generated and -protected key to the client; the key may also be signed by the KDA. The resulting CMS package is provided to the client through the EST extension's /symmetrickey service. The PKI TA is responsible for the creation, distribution, and management of public key certificates. The PKI TA delegates these responsibilities to CAs (Certification Authorities) and CAs in turn are responsible for creating, distributing, and managing EEs (End-Entities) certificates; CAs distribute PKI-related information through the /cacerts, /crls, /eecerts, /fulcmc, /simpleenroll, /simplereenroll, /csrattrs EST and EST extension services.



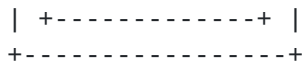


Figure 1 - Operating Environment (Key and PKI Sources of Authority)

For clients that support the CMC interface and not the EST interface, the environment includes only the PKI TAs.

2. Abstract Syntax Notation One

Implementations of this specification use the '02/'08 ASN.1 (Abstract Syntax Notation One) version; '02/'08 ASN.1 modules can be found in [RFC5911], [RFC5912], and [RFC6268] (use RFC 6268 for the CMS syntax) while other specifications already include the '02/'08 ASN.1 along with the '88 ASN.1. See Section 1.1 of [RFC6268] for a discussion about the differences between the '02 and '08 ASN.1 versions.

3. EST Interface

EST [RFC7030] and EST extensions [RFC8295] client options are specified in this section.

3.1. Hypertext Transfer Protocol Layer

Clients that receive redirection responses (3xx status codes) will terminate the connection ([RFC7030], Section 3.2.1).

Clients include an HTTP Accept header with each HTTP GET request to indicate the PAL Package Type supported ([RFC8295], Section 2.1.1).

3.2. Transport Layer Security

TLS implementations are configured as specified in [ID.cnsa-tls-profile]; the notable exception is that RSA-based algorithms are not used.

3.3. Eligibility

At the EST interface, servers enroll only clients that they have an established relationship with. To accomplish this, client owners/operators interact in person with the human acting as the RA (Registration Authority) to ensure the information included in the transmitted certificate request, which is sometimes called a CSR (Certificate Signing Request), is associated with a client. The mechanism by which the owner/operator interact with the RA as well as the information provided is beyond the scope of this document. The information exchanged by the owner/operator might be something as

simple as the subject name included in the to-be sent CSR or a copy of an entire certificate that will be used to verify the certificate request.

3.4. Authentication

Mutual authentication occurs via "Certificate TLS Authentication" ([RFC7030], Section 2.1). Clients provide their certificate to servers in the TLS Certificate message, which is sent in response to the server's TLS Certificate Request message. Clients reject all server attempts to authenticate that do not validate back to a TA.

3.5. Authorization

Clients always use an explicit TA database ([RFC7030], Section 3.6.1). At a minimum, clients support two TAs; one for the PKI and one for symmetric keys.

Clients check that the server's certificate includes the id-kp-cmcRA EKU (Extended Key Usage) value ([RFC6402], Section 2.10).

Clients that support processing the CMS Content Constraints extension [RFC6010] ensure returned CMS content is from an SOA or is from an entity authorized by an SOA for that CMS content; see Section 6.0 for SOA certificates.

3.6. EST and EST Extensions

This section profiles SODP's EST [RFC7030] and EST Extensions [RFC8295] interfaces.

3.6.1. /pal

The PAL (Package Availability List) is limited to 32 entries, where the 32nd PAL entry links to an additional PAL (i.e., is PAL Package Type 0001).

The PAL is XML [XML].

3.6.2. /cacerts

The CA certificates located in the explicit TA database are distributed to the client when it is registered. This TA distribution mechanism is out-of-scope.

CA certificates provided through this service are as specified in Sections 5 and 6 of this document.

3.6.3. /simpleenroll

CSRs follow the specifications in Section 5.1 of [ID.cnsa-cmc-profile], with two exceptions. First, the Change Subject Name and the POP Link Witness V2 attributes, which are CMC-specific requirements do not apply. Second, RSA-based algorithms are not used.

Client requests include the tls-unique value in the challenge-password attribute, as specified in [RFC7030], or the id-aa-estIdentityLinking attribute, as specified in [RFC7894].

Client certificates provided through this service are as specified in Section 7 of this document.

The HTTP content-type of "text/plain" ([RFC2046], Section 4.1) is used to return human readable errors.

3.6.4. /simplereenroll

There are no additional requirements for requests beyond those specified in Sections 3.4 and 3.6.3 of this document.

The HTTP content-type of "text/plain" ([RFC2046], Section 4.1) is used to return human readable errors.

3.6.5. /fullcmc

Requests are as specified in [ID.cnsa-cmc-profile] with the notable exception that RSA-based algorithms are not supported.

Additional attributes for returned CMS packages can be found in [RFC7906].

Certificates provided through this service are as specified in Section 7 of this document.

3.6.6. /serverkeygen

PKCS#12 [RFC7292], sometimes referred to as "PFX" (Personal inFormation eXchange), "P12", and "PKCS#12" files, are used to provide server-generated asymmetric private keys and the associated certificate to clients. This interface is a one-way interface as the RA requests these from the server.

PFXs [RFC7292] are exchanged using both password privacy mode and integrity password mode. The PRF algorithm for both the PBES2 and PBMAC1 is HMAC-SHA-384 and the PBES2 encryption scheme is AES-256.

The HTTP content-type of "text/plain" ([RFC2046], Section 4.1) is used to return human readable errors.

/serverkeygen/return is not supported at this time.

3.6.7. /csrattrs

Clients use this service to retrieve partially filled PKIRequests: PKIRequests with no public key or proof-of-possession signature, i.e., their values are set to zero length either a zero length BIT STRING or OCTET STRING. The pKCS7PDU attribute, defined in [RFC2985], includes the partially filled PKIRequest as the only element in the CsrAttrs sequence. Even though the CsrAttrs syntax is defined as a set, there is only ever exactly one instance of values present.

3.6.8. /crls

CRLs provided through this service are as specified in Section 9 of this document.

3.6.9. /symmetrickeys

Clients that claim to support SODP-interoperation will be able to process the following messages from a SODP server: additional encryption and origin authentication ([RFC8295], Section 5); server-provided Symmetric Key Content Type [RFC6032] encapsulated in an Encrypted Key Content Type using the EnvelopedData choice [RFC6033] with a SOA certificate that includes the CMS Content Constraints extension (see Section 7.1).

Client-supported algorithms to decrypt the server-returned symmetric key are as follows:

- Message Digest: See Section 5 of [ID.cnsa-smime-profile].
- Digital Signature Algorithm: See Section 6.1 of [ID.cnsa-smime-profile].
- Key Agreement: See Section 7.1 of [ID.cnsa-smime-profile].
- Key Wrap: AES-256 Key Wrap with Padding [RFC6033] is used. AES-128 Key Wrap with Padding is not used.
- Content Encryption: AES-256 Key Wrap with Padding [RFC6033] is used. AES-128 Key Wrap with Padding is not used.

  /serverkeygen/return is not used at this time.

3.6.10. /eecerts, /firmware, /tamp

/eecerts, /firmware, /tamp are not used at this time.

4. CMC Interface

CMC [RFC5274][RFC6402] clients options are specified in this section.

4.1. RFC 5273 Transport Protocols

Clients use only the HTTPS-based transport; the TLS implementation and configuration is as specified in [ID.cnsa-tls-profile]; the notable exception is that RSA-based algorithms are not supported.

Clients that receive HTTP redirection responses (3xx status codes) will terminate the connection ([RFC7030], Section 3.2.1).

4.2. Eligibility

At the CMC interface, servers enroll only clients that they have an established relationship with. To accomplish this, client owners/operators interact in person with the human acting as the RA (Registration Authority) to ensure the information included in the transmitted certificate request, which is sometimes called a CSR (Certificate Signing Request), is associated with a client. The mechanism by which the owner/operator interact with the RA as well as the information provided is beyond the scope of this document. The information exchanged by the owner/operator might be something as simple as the subject name included in the to-be sent CSR or a copy of an entire certificate that will be used to verify the certificate request.

4.3. Authentication

Mutual authentication occurs via client and server signing of CMC protocol elements, as required by [ID.cnsa-cmc-profile]. All such signatures must be validated against an installed TA; any that fail validation are rejected.

4.4. Authorization

Clients support the simultaneous presence of as many TAs as are required for all of the functions of the client, and only these TAs.

Clients check that the server's certificate includes the id-kp-cmcRA EKU (Extended Key Usage) value [RFC6402], Section 2.10.

Clients that support processing the CMS Content Constraints extension [RFC6010] ensure returned CMS content is from an SOA or is from an entity authorized by an SOA for that CMS content; see Section 6.0 for SOA certificates

4.5. Simple PKI Requests/Responses

CSRs follow the specifications in Section 5.1 of [ID.cnsa-cmc-profile], with two exceptions. First, the Change Subject Name and the POP Link Witness V2 attributes, which are CMC-specific requirements do not apply. Second, RSA-based algorithms are not used.

Certificates provided through this service are as specified in Section 7 of this document.

4.6. Full PKI Requests/Responses

Requests are as specified in [ID.cnsa-cmc-profile] with the notable exception that RSA-based algorithms are not used.

Additional attributes for returned CMC packages can be found in [RFC7906].

Certificates provided through this service are as specified in Section 7 of this document.

5. Trust Anchor Profile

Clients are free to store the TA in format of their choosing; however, servers provide TA information in the form of self-signed CA certificates. This section documents requirements for self-signed certificates in addition to those specified in [RFC8603], which in turn specifies requirements in addition to those in [RFC5280].

RSA-based algorithms are not used.

Issuer and subject names are composed of only the following naming attributes: country name, domain component, organization name, organizational unit name, common name, state or province name, distinguished name qualifier, and serial number.

In the Subject Key Identifier extension, the keyIdentifier is the 64 low-order bits of the subject's subjectPublicKey field.

In the Key Usage extension, the nonRepudiation bit is never set.

6. Non-Self-Signed Certification Authority Certificate Profile

This section documents requirements for non-self signed CA certificates in addition to those specified in [RFC8603], which in turn specifies requirements in addition to those in [RFC5280].

RSA-based algorithms are not used.

Subject names are composed of only the following naming attributes: country name, domain component, organization name, organizational unit name, common name, state or province name, distinguished name qualifier, and serial number.

In the Authority Key Identifier extension, the keyIdentifier choice is always used. The keyIdentifier is the 64 low-order bits of the issuer's subjectPublicKey field.

In the Subject Key Identifier extension, the keyIdentifier is the 64 low-order bits of the subject's subjectPublicKey field.

In the Key Usage extension, the nonRepudiation bit is never set.

The Certificate Policies extension is always included and policyQualifiers are never used.

Non-self-signed CA certificates can also include the following:

- Name Constraints: permittedSubtrees constraints are applied and excludedSubstree constraints are not. Of the GeneralName choices, issuers support the following: rfc822Name, dNSName, uniformResourceIdentifier, and iPAddress (both IPv4 and IPv6) as well as hardwareModuleName, which is defined in [RFC4108]. Note that rfc822Name, dNSName, and uniformResourceIdentifier are defined as IA5 strings and the character sets allowed is not uniform amongst these three name forms.

- CRL Distribution Points: A distributionPoint is always the fullName choice; the uniformResourceIdentifier GeneralName choice is always included but others can also be used as long as the first element in the sequence of CRLDistributionPoints is the uniformResourceIdentifier choice; the reasons and CRLIssuer fields are never populated. This extension is never marked critical.

- Authority Information Access: Only one instance of AccessDescription is included. accessMethod is id-caIssuers and accessLocation's GeneralName is always the uniformResourceIdentifier choice.

- Extended Key Usage: EST servers and RAs include the id-kp-cmcRA EKU and the CAs include the id-kp-cmcCA, which are both specified in [RFC6402].

Issuers include the Authority Clearance Constraints extension

[RFC5913] in non-self-signed CA certificates that are issued to non-SOAs; values for the CP (Certificate Policy) OID (Object IDentifier) and the supported classList values are found in the Issuer's CP. Criticality is determined by the issuer and a securityCategories is never included. Only one instance of Clearance is generated in the AuthorityClearanceConstraints sequence.

Issuers include a critical CMS Content Constraints extension [RFC6010] in CA certificates used to issue SOA certificates. The content types included depend on the packages the SOA sources, but include key packages (i.e., Encrypted Key Packages, Symmetric Key Packages, and Asymmetric Key Packages).

7. End-Entity Certificate Profile

This section documents requirements for EE signature and key establishment certificates in addition to those listed in [RFC8603], which in turn specifies requirements in addition to those in [RFC5280].

RSA-based algorithms are not used.

Subject names are composed of the following naming attributes: country name, domain component, organization name, organizational unit name, common name, state or province name, distinguished name qualifier, and serial number.

In the Authority Key Identifier extension, the keyIdentifier choice is always used. The keyIdentifier is the 64 low-order bits of the issuer's subjectPublicKey field.

In the Subject Key Identifier extension, the keyIdentifier is the 64 low-order bits of the subject's subjectPublicKey field.

In the Key Usage extension, signature certificates only assert digitalSignature and key establishment certificates only assert keyAgreement.

The Certificate Policies extension is always included and policyQualifiers are never used.

When included, the non-critical CRL Distribution Point extension's distributionPoint is always identified by the fullName choice; the uniformResourceIdentifier GeneralName choice is always included but others can also be used as long as the first element in the sequence of distribution points is the URI choice and it is an HTTP/HTTPS scheme; the reasons and cRLIssuer fields are never populated.

The following subsections provide additional requirements for the different types of EE certificates.

7.1. Source of Authority Certificate Profile

This section specifies the format for SOA certificates, i.e., certificates issued to those entities that are authorized to create, digitally sign, encrypt, and distribute key packages; these certificates are issued by non-PKI TAs.

The Subject Alternative Name extension is always included. The following choices are supported rfc822Name, dnsName, ediPartyName, uniformResourceIdentifier, or ipAddress (both IPv4 and IPv6). This extension is never critical.

A critical CMS Content Constraints extension [RFC6010] is included in SOA signature certificates. The content types included depend on the packages the SOA sources (e.g., Encrypted Key Packages, Symmetric Key Packages, Asymmetric Key Packages).

7.2. Client Certificate Profile

This section specifies the format for certificates issued to clients.

A non-critical Subject Directory Attributes extension is always included with the following attributes:

- Device Owner [RFC5916]
- Clearance Sponsor [RFC5917]
- Clearance [RFC5913]

The following extensions are also included at the discretion of the CA:

- The Authority Information Access extension with only one instance of the accessMethod id-caIssuers and the accessLocation's GeneralName using the uniformResourceIdentifier choice.

- A non-critical Subject Alternative Name extension that includes the hardwareModuleName form [RFC4108], rfc822Name, or uniformResourceIdentifier.

- A critical Subject Alternative Name extension that includes: dNSName, rfc822Name, ediPartyName, uniformResourceIdentifier, or ipAddress (both IPv4 and IPv6).

8. Relying Party Applications

This section documents requirements for RPs (Relying Parties) in addition to those listed in [RFC8603], which in turn specifies requirements in addition to those in [RFC5280].

RSA-based algorithms are not supported.

RPs support the Authority Key Identifier and the Subject Key Identifier extensions.

RPs should support the following extensions: CRL Distribution Points, Authority Information Access, Subject Directory Attribute, Authority Clearance Constraints, and CMS Content Constraints extensions.

Within the Subject Directory Attribute extension, RPs should support the Clearance Sponsor, Clearance, and Device Owner attributes.

RPs support the id-kp-cmcRA and id-kp-cmcCA EKUs.

Failure to support extensions in this section might limit the suitability of a device for certain applications.

9. CRL Profile

This section documents requirements for CRLs in addition to those listed in [RFC8603], which in turn specifies requirements in addition to those in [RFC5280].

RSA-based algorithms are not used.

Two types of CRLs are produced: complete base CRLs and partitioned base CRLs.

crlEntryExtensions are never included and the reasons and cRLIssuer fields are never populated.

All CRLs include the following CRL extensions:

- The Authority Key Identifier extension: The keyIdentifier is the 64 low-order bits of the issuer's subjectPublicKey field.

- As per [RFC5280], the CRL Number extension.

The only other extension included in partitioned base CRLs is the Issuing Distribution Point extension. The distributionPoint is always identified by the fullName choice; the uniformResourceIdenifier GeneralName choice is always included but others can also be used as long as the first element in the sequence of distribution points is the uniformResourceIdenifier choice and the

scheme is an HTTP/HTTPS scheme; all other fields are omitted.

10. IANA Considerations

None.

11. Security Considerations

This entire document is about security. This document profiles the use of many protocols and services: EST, CMC, and PKCS#10/#7/#12 as well as certificates, CRLs, and their extensions [RFC5280]. These have been referred to throughout this document and those specifications should be consulted for security considerations related to implemented protocol and services.

12. References

12.1. Normative References

[RFC2046] Freed, N. and N. Borenstein, "Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types", RFC 2046, DOI 10.17487/RFC2046, November 1996, <https://www.rfc-editor.org/info/rfc2046>.

[RFC2985] Nystrom, M. and B. Kaliski, "PKCS #9: Selected Object Classes and Attribute Types Version 2.0", RFC 2985, DOI 10.17487/RFC2985, November 2000, <https://www.rfc-editor.org/info/rfc2985>.

[RFC2986] Nystrom, M. and B. Kaliski, "PKCS #10: Certification Request Syntax Specification Version 1.7", RFC 2986, DOI 10.17487/RFC2986, November 2000, <https://www.rfc-editor.org/info/rfc2986>.

[RFC3739] Santesson, S., Nystrom, M., and T. Polk, "Internet X.509 Public Key Infrastructure: Qualified Certificates Profile", RFC 3739, DOI 10.17487/RFC3739, March 2004, <https://www.rfc-editor.org/info/rfc3739>.

[RFC4108] Housley, R., "Using Cryptographic Message Syntax (CMS) to Protect Firmware Packages", RFC 4108, DOI 10.17487/RFC4108, August 2005, <https://www.rfc-editor.org/info/rfc4108>.

[RFC5274] Schaad, J. and M. Myers, "Certificate Management Messages over CMS (CMC): Compliance Requirements", RFC 5274, DOI 10.17487/RFC5274, June 2008, <https://www.rfc-editor.org/info/rfc5274>.

[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, DOI 10.17487/RFC5280, May 2008, <https://www.rfc-editor.org/info/rfc5280>.

[RFC5652] Housley, R., "Cryptographic Message Syntax (CMS)", STD 70, RFC 5652, DOI 10.17487/RFC5652, September 2009, <https://www.rfc-editor.org/info/rfc5652>.

[RFC5911] Hoffman, P. and J. Schaad, "New ASN.1 Modules for Cryptographic Message Syntax (CMS) and S/MIME", RFC 5911, DOI 10.17487/RFC5911, June 2010, <https://www.rfc-editor.org/info/rfc5911>.

[RFC5912] Hoffman, P. and J. Schaad, "New ASN.1 Modules for the Public Key Infrastructure Using X.509 (PKIX)", RFC 5912, DOI 10.17487/RFC5912, June 2010, <https://www.rfc-editor.org/info/rfc5912>.

[RFC5913] Turner, S. and S. Chokhani, "Clearance Attribute and Authority Clearance Constraints Certificate Extension", RFC 5913, DOI 10.17487/RFC5913, June 2010, <https://www.rfc-editor.org/info/rfc5913>.

[RFC5915] Turner, S. and D. Brown, "Elliptic Curve Private Key Structure", RFC 5915, DOI 10.17487/RFC5915, June 2010, <https://www.rfc-editor.org/info/rfc5915>.

[RFC5916] Turner, S., "Device Owner Attribute", RFC 5916, DOI 10.17487/RFC5916, June 2010, <https://www.rfc-editor.org/info/rfc5916>.

[RFC5917] Turner, S., "Clearance Sponsor Attribute", RFC 5917, DOI 10.17487/RFC5917, June 2010, <https://www.rfc-editor.org/info/rfc5917>.

[RFC5958] Turner, S., "Asymmetric Key Packages", RFC 5958, DOI 10.17487/RFC5958, August 2010, <https://www.rfc-editor.org/info/rfc5958>.

[RFC5959] Turner, S., "Algorithms for Asymmetric Key Package Content Type", RFC 5959, DOI 10.17487/RFC5959, August 2010, <https://www.rfc-editor.org/info/rfc5959>.

[RFC6010] Housley, R., Ashmore, S., and C. Wallace, "Cryptographic Message Syntax (CMS) Content Constraints Extension", RFC 6010, DOI 10.17487/RFC6010, September 2010,

<https://www.rfc-editor.org/info/rfc6010>.

[RFC6031] Turner, S. and R. Housley, "Cryptographic Message Syntax (CMS) Symmetric Key Package Content Type", RFC 6031, DOI 10.17487/RFC6031, December 2010, <https://www.rfc-editor.org/info/rfc6031>.

[RFC6032] Turner, S. and R. Housley, "Cryptographic Message Syntax (CMS) Encrypted Key Package Content Type", RFC 6032, DOI 10.17487/RFC6032, December 2010, <https://www.rfc-editor.org/info/rfc6032>.

[RFC6033] Turner, S., "Algorithms for Cryptographic Message Syntax (CMS) Encrypted Key Package Content Type", RFC 6033, DOI 10.17487/RFC6033, December 2010, <https://www.rfc-editor.org/info/rfc6033>.

[RFC6160] Turner, S., "Algorithms for Cryptographic Message Syntax (CMS) Protection of Symmetric Key Package Content Types", RFC 6160, DOI 10.17487/RFC6160, April 2011, <https://www.rfc-editor.org/info/rfc6160>.

[RFC6161] Turner, S., "Elliptic Curve Algorithms for Cryptographic Message Syntax (CMS) Encrypted Key Package Content Type", RFC 6161, DOI 10.17487/RFC6161, April 2011, <https://www.rfc-editor.org/info/rfc6161>.

[RFC6162] Turner, S., "Elliptic Curve Algorithms for Cryptographic Message Syntax (CMS) Asymmetric Key Package Content Type", RFC 6162, DOI 10.17487/RFC6162, April 2011, <https://www.rfc-editor.org/info/rfc6162>.

[RFC6268] Schaad, J. and S. Turner, "Additional New ASN.1 Modules for the Cryptographic Message Syntax (CMS) and the Public Key Infrastructure Using X.509 (PKIX)", RFC 6268, DOI 10.17487/RFC6268, July 2011, <https://www.rfc-editor.org/info/rfc6268>.

[RFC6402] Schaad, J., "Certificate Management over CMS (CMC) Updates", RFC 6402, DOI 10.17487/RFC6402, November 2011, <https://www.rfc-editor.org/info/rfc6402>.

[RFC7030] Pritikin, M., Ed., Yee, P., Ed., and D. Harkins, Ed., "Enrollment over Secure Transport", RFC 7030, DOI 10.17487/RFC7030, October 2013, <https://www.rfc-editor.org/info/rfc7030>.

[RFC7191] Housley, R., "Cryptographic Message Syntax (CMS) Key

Package Receipt and Error Content Types", RFC 7191, DOI 10.17487/RFC7191, April 2014, <https://www.rfc-editor.org/info/rfc7191>.

[RFC7192] Turner, S., "Algorithms for Cryptographic Message Syntax (CMS) Key Package Receipt and Error Content Types", RFC 7192, DOI 10.17487/RFC7192, April 2014, <https://www.rfc-editor.org/info/rfc7192>.

[RFC7292] Moriarty, K., Ed., Nystrom, M., Parkinson, S., Rusch, A., and M. Scott, "PKCS #12: Personal Information Exchange Syntax v1.1", RFC 7292, DOI 10.17487/RFC7292, July 2014, <https://www.rfc-editor.org/info/rfc7292>.

[RFC7894] Pritikin, M. and C. Wallace, "Alternative Challenge Password Attributes for Enrollment over Secure Transport", RFC 7894, DOI 10.17487/RFC7894, June 2016, <https://www.rfc-editor.org/info/rfc7894>.

[RFC7906] Timmel, P., Housley, R., and S. Turner, "NSA's Cryptographic Message Syntax (CMS) Key Management Attributes", RFC 7906, DOI 10.17487/RFC7906, June 2016, <https://www.rfc-editor.org/info/rfc7906>.

[RFC8295] Turner, S., "EST (Enrollment over Secure Transport) Extensions", RFC 8295, DOI 10.17487/RFC8295, January 2018, <https://www.rfc-editor.org/info/rfc8295>.

[RFC8603] Jenkins, M. and L. Zieglar, "Commercial National Security Algorithm (CNSA) Suite Certificate and Certificate Revocation List (CRL) Profile", RFC 8603, DOI 10.17487/RFC8603, May 2019, <https://www.rfc-editor.org/info/rfc8603>.

[XML] Bray, T., Paoli, J., Sperberg-McQueen, M., Maler, E., and F. Yergeau, "Extensible Markup Language (XML) 1.0 (Fifth Edition)", World Wide Web Consortium Recommendation REC-xml-20081126, November 2008, <https://www.w3.org/TR/2008/REC-xml-20081126/>.

[SP 800-59] National Institute of Standards and Technology, "Guideline for Identifying an Information System as a National Security System", SP 800-59, August 2003, <https://csrc.nist.gov/publications/detail/sp/800-59/final>.

[ID.cnsa-smime-profile] Jenkins, M., "Using CNSA Suite Algorithms in Secure/Multipurpose Internet Mail Extensions(S/MIME)",

work-in-progress, <https://www.ietf.org/internet-drafts/draft-jenkins-smime-profile-00>.

[ID.cnsa-cmc-profile] Jenkins, M. and L. Zieglar, "Commercial National Security Algorithm (CNSA) Suite Profile of Certificate Management over CMS", work-in-progress, <https://www.ietf.org/internet-drafts/draft-jenkins-cmc-profile-01>.

[ID.cnsa-tls-profile] Authors, "Commercial National Security Algorithm (CNSA) Suite Profile of TLS", work-in-progress, <https://www.ietf.org/internet-drafts/draft-authors-tls-profile-00>.

12.2. Informative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

None.

Authors' Addresses

Michael Jenkins
National Security Agency

EMail: mjjenki@nsa.gov

Sean Turner
sn3rd

EMail: sean@sn3rd.com