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CBOR Object Signing and Encryption (COSE): Headers for carrying and referencing X.509 certificates
draft-ietf-cose-x509-00

Abstract

The CBOR Encoded Message (COSE) structure syntax uses the COSE Key structure for placing keys in a message. This document extends the way that keys can be identified and transported by providing parameters that refer to or contain X.509 certificates in messages and in the COSE Key structure.

This document defines a set of hash algorithms for COSE. These algorithms are needed in order to have X.509 certificates referred to by a thumbprint.

Contributing to this document

The source for this draft is being maintained in GitHub. Suggested changes should be submitted as pull requests at <https://github.com/cose-wg/X509>. Instructions are on that page as well. Editorial changes can be managed in GitHub, but any substantial issues need to be discussed on the COSE mailing list.

Status of This Memo

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

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This Internet-Draft will expire on August 2, 2019.

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1. Introduction

In the process of writing [RFC8152] discussions where held on the question of X.509 certificates [RFC5280] and if there was a needed to provide for them. At the time there were no use cases presented that appeared to have a sufficient set of support to include these headers. Since that time a number of cases where X.509 certificate support is necessary have been defined. This document provides a set

of headers that will allow applications to transport and refer to X.509 certificates in a consistent manner.

Some of the constrained device situations are being used where an X.509 PKI is already installed. One of these situations is the 6tish

environment for enrollment of devices where the certificates are installed at the factory. The [I-D.selander-ace-cose-ecdhe] draft was also written with the idea that long term certificates could be used to provide for authentication of devices and uses them to establish session keys. A final scenario is the use of COSE as a messaging application where long term existence of keys can be used along with a central authentication authority. The use of certificates in this scenario allows for key management to be used which is well understood.

When [RFC8152] was written, there were no requirements for hash algorithms to be included in the algorithm registry. The use of thumbprints to refer to X.509 certificates is defined in this document which requires the use of hash algorithms. There have also been other working groups in the IETF that have expressed a requirement for hash algorithms to do have sections of content be provided by reference rather than including it in the main message. This document defines a set of hash algorithms for both of these purposes.

1.1. Requirements Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

1.2. Open Questions

Should we define an extended key usage?

Are there any special certificate valiation text to be added?

List of other hash algorithms to be added.

Specific security considerations issues.

2. X.509 COSE Headers

The use of X.509 certificates allows for an existing trust infrastructure to be used with COSE. This includes the full suite of enrollment protocols, trust anchors, trust chaining and revocation checking that have been defined over time by the IETF and other organizations. The key structures that have been defined in COSE currently do not support all of these properties although some may be found in COSE Web Tokens (CWT) [RFC8392].

It is not necessarily expected that constrained devices will fully support the evaluation and processing of X.509 certificates, it is perfectly reasonable for a certificate to be assigned to a device which it can then provide to a relying party along with a signature or encrypted message, the relying party not being a constrained device.

Certificates obtained from any of these methods MUST still be validated. This validation can be done via the PKIX rules in [RFC5280] or by using a different trust structure, such as a trusted certificate distributer for self-signed certificates. The PKIX validation includes matching against the trust anchors configured for the application. These rules apply to certificates of a chain length of one as well as longer chains. If the application cannot establish a trust in the certificate, then it cannot be used.

The header parameters defined in this document are:

x5bag: This header parameters contains a bag of X.509 certificates. The set of certificates in this header are unordered and may contain self-signed certificates. The certificate bag can contain certificates which are completely extraneous to the message. (An example of this would be to carry a certificate with a key agreement key usage in a signed message.) As the certificates are unordered, the party evaluating the signature will need to do the necessary path building. Certificates needed for any particular chain to be built may be absent from the bag.

As this header element does not provide any trust, the header

parameter can be in either a protected or unprotected header bag.

This header parameter allows for a single or a bag of X.509 certificates to be carried in the message.

* If a single certificate is conveyed, it is placed in a CBOR bstr.

* If multiple certificates are conveyed, a CBOR array of bstrs is used. Each certificate being in it's own slot.

x5chain: This header parameter contains an ordered array of X.509 certificates. The certificates are to be ordered starting with the certificate containing the end-entity key followed by the certificate which signed it and so on. There is no requirement for the entire chain to be present in the element if there is reason to believe that the relying party will already have it.

As this header element does not provide any trust, the header parameter can be in either a protected or unprotected header bag.

This header parameter allows for a single or a bag of X.509 certificates to be carried in the message.

* If a single certificate is conveyed, it is placed in a CBOR bstr.

* If multiple certificates are conveyed, a CBOR array of bstrs is used. Each certificate being in it's own slot.

x5t: This header parameter provides the ability to identify an X.509 certificate by a hash value. The parameter is an array of two elements. The first element is an algorithm identifier which is a signed integer or a string containing the hash algorithm identifier. The second element is a binary string containing the hash value.

As this header element does not provide any trust, the header parameter can be in either a protected or unprotected header bag. For interoperability, applications which use this header parameter

MUST support the hash algorithm 'sha256', but can use other hash algorithms.

x5u: This header parameter provides the ability to identify an X.509 certificate by a URL. The referenced resource can be any of the following media types:

* application/pkix-cert [RFC2585]

* application/pkcs7-mime; smime-type="certs-only" [I-D.ietf-lamps-rfc5751-bis]

* application/x-pem-file [RFC7468] Should we support a PEM type? I cannot find a registered media type for one

As this header element implies a trust relationship, the header parameter MUST be in the protected header bag.
The URL provided MUST provide integrity protection and server authentication. For example, an HTTP or CoAP GET request to retrieve a certificate MUST use TLS [RFC5246] or DTLS. If the certificate does not chain to an existing trust anchor, the certificate MUST NOT be trusted unless the server is configured as trusted to provide new trust anchors. This will normally be the situation when self-signed certificates are used.

The header parameters used in the following locations:

o COSE_Signature and COSE_Sign0 objects, in these objects they identify the key that was used for generating signature.

o COSE_recipient objects, in this location they may be used to identify the certificate for the recipient of the message.

Name	Value	value type	description
x5bag	TBD4	COSE_X509	An unordered bag of X.509 certificates
x5chain	TBD3	COSE_X509	An ordered chain of X.509 certificates

x5t	TBD1	COSE_CertHash	Hash of an X.509 certificate
x5u	TBD2	uri	URL pointing to an X.509 certificate

Table 1: X.509 COSE Headers

Below is an equivalent CDDL [I-D.ietf-cbor-cddl] description of the text above.

```
COSE_X509 = bstr / [ 2*certs: bstr ]
COSE_CertHash = [ hashAlg: (int / tstr), hashValue: bstr ]
```

3. X.509 certificates and static-static ECDH

The header parameters defined in the previous section are used to identify the recipient certificates for the ECDH key agreement algorithms. In this section we define the algorithm specific parameters that are used for identifying or transporting the senders key for static-static key agreement algorithms.

Name	Value	Type	Algorithm	Description>
static key X.509 thumbprint	TBD	COSE_CertHash	ECDH-SS+HKDF-256, ECDH-SS+HKDF-512,	Thumbprint for the senders X.509

			ECDH-SS+A128KW, ECDH-SS+AES192KW, ECDH-SS+AES256KW	certificate
static key X.509 URL	TBD	uri	ECDH-SS+HKDF-256, ECDH-SS+HKDF-512, ECDH-SS+A128KW, ECDH-SS+AES192KW, ECDH-SS+AES256KW	URL for the senders X.509 certificate
static key X.509 cert chain	TBD	COSE_X509	ECDH-SS+HKDF-256, ECDH-SS+HKDF-512, ECDH-SS+A128KW, ECDH-SS+AES192KW, ECDH-SS+AES256KW	static key X.509 certificate chain

Table 2: Static ECDH Algorithm Values

4. Hash Algorithm Identifiers

The core COSE document did have a need for a standalone hash algorithm, and thus did not define any. In this document, two hash algorithms are defined for use with the 'x5t' header parameter.

4.1. SHA-2 256-bit Hash

Define an algorithm identifier for SHA-256.

4.2. SHA-2 256-bit Hash trucated to 64 bits

This hash function uses the SHA-2 256-bit hash function as in the previous section, however it truncates the result to 64-bits for transmission. The fact that it is a truncated hash means that there is now a high likelihood that collisions will occur, thus this hash function cannot be used in situations where a unique items is required to be identified. Luckily for the case of identifying a certificate that is not a requirement, the only requirement is that the number of potential certificates (and thus keys) to be tried is reduced to a small number. (Hopefully that number is one, but it can not be assumed to be.) After the set of certificates has been filtered down, the public key in each certificate will need to be tried for the operation in question. The certificate can be validated either before or after it has been checked as working. The trade-offs involved are:

- Certificate validation before using the key will imply that more network traffic may be required in order to fetch certificates and do revocation checking.

- Certificate validation after using the key means that bad keys can be used and, if not carefully checked, the result may be used prior to completing the certificate validation. Using unvalidated keys can expose the device to more timing and oracle attacks as the attacker would be able to see if the key operation succeeded or failed as no network traffic to validate the certificate would ensue.

5. IANA Considerations

5.1. COSE Header Parameter Registry

IANA is requested to register the new COSE Header items in Table 1 in the "COSE Header Parameters" registry.

5.2. COSE Header Algorithm Parameter Registry

IANA is requested to register the new COSE Header items in Table 2 in the "COSE Header Algorithm Parameters" registry.

5.3. COSE Algorithm Registry

IANA is requested to register the following algorithms in the "COSE Algorithms" registry.

Name	Value	Description	Reference	Recommended
SHA-256	TBD	SHA-2 256-bit Hash	[This Document]	Yes
SHA-256/64	TBD	SHA-2 256-bit Hash trucated to 64-bits	[This Document]	No

6. Security Considerations

There are security considerations:

Self-signed certificates and Trust Anchors

7. References

7.1. Normative References

[I-D.schaad-cose-rfc8152bis-struct]
Schaad, J., "CBOR Object Signing and Encryption (COSE) - Structures and Process", draft-schaad-cose-rfc8152bis-struct-01 (work in progress), December 2018.

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[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>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

7.2. Informative References

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Birkholz, H., Vigano, C., and C. Bormann, "Concise data definition language (CDDL): a notational convention to

express CBOR and JSON data structures", draft-ietf-cbor-cddl-06 (work in progress), November 2018.

[I-D.ietf-lamps-rfc5751-bis]
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Selander, G., Mattsson, J., and F. Palombini, "Ephemeral Diffie-Hellman Over COSE (EDHOC)", draft-selander-ace-cose-ecdhe-11 (work in progress), January 2019.

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[RFC7468] Josefsson, S. and S. Leonard, "Textual Encodings of PKIX, PKCS, and CMS Structures", RFC 7468, DOI 10.17487/RFC7468, April 2015, <https://www.rfc-editor.org/info/rfc7468>.

[RFC8152] Schaad, J., "CBOR Object Signing and Encryption (COSE)", RFC 8152, DOI 10.17487/RFC8152, July 2017, <https://www.rfc-editor.org/info/rfc8152>.

[RFC8392] Jones, M., Wahlstroem, E., Erdtman, S., and H. Tschofenig, "CBOR Web Token (CWT)", RFC 8392, DOI 10.17487/RFC8392, May 2018, <https://www.rfc-editor.org/info/rfc8392>.

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