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Proof-of-Possession Key Semantics for CBOR Web Tokens (CWTs) draft-ietf-ace-cwt-proof-of-possession-01

Abstract

This specification describes how to declare in a CBOR Web Token (CWT) that the presenter of the CWT possesses a particular proof-of-possession key. Being able to prove possession of a key is also sometimes described as being the holder-of-key. This specification provides equivalent functionality to "Proof-of-Possession Key Semantics for JSON Web Tokens (JWTs)" (RFC 7800), but using CBOR and CWTs rather than JSON and JWTs.

Table of Contents

1. Introduction

This specification describes how a CBOR Web Token [CWT] can declare that the presenter of the CWT possesses a particular proof-of-possession (PoP) key. Proof of possession of a key is also sometimes

described as being the holder-of-key. This specification provides equivalent functionality to "Proof-of-Possession Key Semantics for JSON Web Tokens (JWTs)" [RFC7800], but using CBOR [RFC7049] and CWTs [CWT] rather than JSON [RFC7159] and JWTs [JWT].

1.1. Notational Conventions

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 [RFC2119].

Unless otherwise noted, all the protocol parameter names and values are case sensitive.

2. Terminology

This specification uses terms defined in the CBOR Web Token [CWT], CBOR Object Signing and Encryption (COSE) [RFC8152], and Concise Binary Object Representation (CBOR) [RFC7049] specifications.

These terms are defined by this specification:

Issuer
: Party that creates the CWT and binds its claims to the proof-of-possession key.

Presenter
: Party that proves possession of a private key (for asymmetric key cryptography) or secret key (for symmetric key cryptography) to a recipient.

Recipient
: Party that receives the CWT containing the proof-of-possession key information from the presenter.

3. Representations for Proof-of-Possession Keys

By including a "cnf" (confirmation) claim in a CWT, the issuer of the CWT declares that the presenter possesses a particular key and that the recipient can cryptographically confirm that the presenter has possession of that key. The value of the "cnf" claim is a CBOR map and the members of that map identify the proof-of-possession key.

The presenter can be identified in one of several ways by the CWT depending upon the application requirements. If the CWT contains a "sub" (subject) claim [CWT], the presenter is normally the subject identified by the CWT. (In some applications, the subject identifier

will be relative to the issuer identified by the "iss" (issuer) claim [CWT].) If the CWT contains no "sub" claim, the presenter is normally the issuer identified by the CWT using the "iss" claim. The case in which the presenter is the subject of the CWT is analogous to Security Assertion Markup Language (SAML) 2.0 [OASIS.saml-core-2.0-os] SubjectConfirmation usage. At least one of the "sub" and "iss" claims is typically present in the CWT and some use cases may require that both be present.

3.1. Confirmation Claim

The "cnf" claim is used in the CWT to contain members used to identify the proof-of-possession key. Other members of the "cnf" map may be defined because a proof-of-possession key may not be the only means of confirming the authenticity of the token. This is analogous to the SAML 2.0 [OASIS.saml-core-2.0-os] SubjectConfirmation element in which a number of different subject confirmation methods can be included (including proof-of-possession key information).

The set of confirmation members that a CWT must contain to be considered valid is context dependent and is outside the scope of this specification. Specific applications of CWTs will require implementations to understand and process some confirmation members in particular ways. However, in the absence of such requirements, all confirmation members that are not understood by implementations MUST be ignored.

This specification establishes the IANA "CWT Confirmation Methods" registry for these members in Section 6.2 and registers the members defined by this specification. Other specifications can register other members used for confirmation, including other members for conveying proof-of-possession keys using different key representations.

The "cnf" claim value MUST represent only a single proof-of-possession key. At most one of the "COSE_Key" and "Encrypted_COSE_Key" confirmation values defined below may be present. Note that if an application needs to represent multiple proof-of-possession keys in the same CWT, one way for it to achieve this is to use other claim names, in addition to "cnf", to hold the additional proof-of-possession key information. These claims could use the same syntax and semantics as the "cnf" claim. Those claims would be defined by applications or other specifications and could be registered in the IANA "CBOR Web Token Claims" registry [IANA.CWT.Claims].

Name	Key	Value type
COSE_Key	1	COSE_Key
Encrypted_COSE_Key	2	COSE_Encrypt or COSE_Encrypt0
kid	3	binary string

Figure 1: Summary of the cnf names, keys, and value types

3.2. Representation of an Asymmetric Proof-of-Possession Key

When the key held by the presenter is an asymmetric private key, the "COSE_Key" member is a COSE_Key [RFC8152] representing the corresponding asymmetric public key. The following example (using CBOR diagonstic notation) demonstrates such a declaration in the CWT Claims Set of a CWT:

```
{
/iss/ 1 : "coaps://server.example.com",
/aud/ 3 : "coaps://client.example.org",
/exp/ 4 : 1361398824,
/cnf/ 8 :{
  /COSE_Key/ 1 :{
    /kty/ 1 : /EC/ 2,
    /crv/ -1 : /P-256/ 1,
    /x/ -2 : b64'18wHLeIgW9wVN6VD1Txgpqy2LszYkMf6J8njVAibvhM',
    /y/ -3 : b64'-V4dS4UaLMgP_4fY4j8ir7cl1TXlFdAgcx55o7TkcSA'
   }
 }
}
```

The COSE_Key MUST contain the required key members for a COSE_Key of that key type and MAY contain other COSE_Key members, including the "kid" (Key ID) member.

The "COSE_Key" member MAY also be used for a COSE_Key representing a symmetric key, provided that the CWT is encrypted so that the key is not revealed to unintended parties. The means of encrypting a CWT is explained in [CWT]. If the CWT is not encrypted, the symmetric key MUST be encrypted as described below.

3.3. Representation of an Encrypted Symmetric Proof-of-Possession Key

When the key held by the presenter is a symmetric key, the "Encrypted_COSE_Key" member is an encrypted COSE_Key [RFC8152] representing the symmetric key encrypted to a key known to the recipient using COSE_Encrypt or COSE_Encrypt0.

The following example (using CBOR diagnostic notation, with linebreaks for readability) illustrates a symmetric key that could subsequently be encrypted for use in the "Encrypted_COSE_Key" member:

```
  {
   /kty/ 1 : /Symmetric/ 4,
   /alg/ 3 : /HMAC256/ 5,
   /k/ -1 : h'6684523ab17337f173500e5728c628547cb37df
              e68449c65f885d1b73b49eae1A0B0C0D0E0F10'
  }
```

The COSE_Key representation is used as the plaintext when encrypting the key. The COSE_Key could, for instance, be encrypted using a COSE_Encrypt0 representation using the AES-CCM-16-64-128 algorithm.

The following example CWT Claims Set of a CWT (using CBOR diagnostic notation, with linebreaks for readability) illustrates the use of an encrypted symmetric key as the "Encrypted_COSE_Key" member value:

```
{
 /iss/ 1 : "coaps://server.example.com",
 /sub/ 2 : "24400320",
 /aud/ 3: "s6BhdRkqt3",
 /exp/ 4 : 1311281970,
 /iat/ 5 : 1311280970,
 /cnf/ 8 : {
 /COSE_Encrypt0/ 2 : [
     /protected header / h'A1010A' /{ \alg\ 1:10 \AES-CCM-16-64-128\}/,
     /unprotected header/ { / iv / 5: h'636898994FF0EC7BFCF6D3F95B'},
     /ciphertext/  h'0573318A3573EB983E55A7C2F06CADD0796C9E584F1D0E3E
                     A8C5B052592A8B2694BE9654F0431F38D5BBC8049FA7F13F'
   ]
  }
}
```

The example above was generated with the key:

```
          h'61626304050607080 90a0b0c0d0e0f10'
```

3.4. Representation of a Key ID for a Proof-of-Possession Key

The proof-of-possession key can also be identified by the use of a Key ID instead of communicating the actual key, provided the recipient is able to obtain the identified key using the Key ID. In this case, the issuer of a CWT declares that the presenter possesses a particular key and that the recipient can cryptographically confirm proof of possession of the key by the presenter by including a "cnf"

claim in the CWT whose value is a CBOR map with the CBOR map containing a "kid" member identifying the key.

The following example (using CBOR diagnostic notation) demonstrates such a declaration in the CWT Claims Set of a CWT:

```
{
 /iss/ 1 : "coaps://server.example.com",
 /aud/ 3 : "coaps://client.example.org",
 /exp/ 4 : 1361398824,
 /cnf/ 8 : {
   /kid/ 2 : h'dfd1aa976d8d4575a0fe34b96de2bfad'
  }
}
```

The content of the "kid" value is application specific. For instance, some applications may choose to use a cryptographic hash of the public key value as the "kid" value.

3.5. Specifics Intentionally Not Specified

Proof of possession is typically demonstrated by having the presenter sign a value determined by the recipient using the key possessed by the presenter. This value is sometimes called a "nonce" or a "challenge".

The means of communicating the nonce and the nature of its contents are intentionally not described in this specification, as different protocols will communicate this information in different ways. Likewise, the means of communicating the signed nonce is also not specified, as this is also protocol specific.

Note that another means of proving possession of the key when it is a symmetric key is to encrypt the key to the recipient. The means of obtaining a key for the recipient is likewise protocol specific.

4. Security Considerations

All of the security considerations that are discussed in [CWT] also apply here. In addition, proof of possession introduces its own unique security issues. Possessing a key is only valuable if it is kept secret. Appropriate means must be used to ensure that unintended parties do not learn private key or symmetric key values.

Applications utilizing proof of possession should also utilize audience restriction, as described in Section 4.1.3 of [JWT], as it provides different protections. Proof of possession can be used by recipients to reject messages from unauthorized senders. Audience

restriction can be used by recipients to reject messages intended for different recipients.

A recipient might not understand the "cnf" claim. Applications that require the proof-of-possession keys communicated with it to be understood and processed must ensure that the parts of this specification that they use are implemented.

Proof of possession via encrypted symmetric secrets is subject to replay attacks. This attack can, for example, be avoided when a signed nonce or challenge is used since the recipient can use a distinct nonce or challenge for each interaction. Replay can also be avoided if a sub-key is derived from a shared secret that is specific to the instance of the PoP demonstration.

As is the case with other information included in a CWT, it is necessary to apply data origin authentication and integrity protection (via a keyed message digest or a digital signature). Data origin authentication ensures that the recipient of the CWT learns about the entity that created the CWT since this will be important for any policy decisions. Integrity protection prevents an adversary from changing any elements conveyed within the CWT payload. Special care has to be applied when carrying symmetric keys inside the CWT since those not only require integrity protection but also confidentiality protection.

As described in Section 6 (Key Identification) and Appendix D (Notes on Key Selection) of [JWS], it is important to make explicit trust decisions about the keys. Proof-of-possession signatures made with keys not meeting the application's trust criteria MUST NOT not be relied upon.

5. Privacy Considerations

A proof-of-possession key can be used as a correlation handle if the same key is used with multiple parties. Thus, for privacy reasons, it is recommended that different proof-of-possession keys be used when interacting with different parties.

6. IANA Considerations

The following registration procedure is used for all the registries established by this specification.

Values are registered on a Specification Required [RFC5226] basis after a three-week review period on the cwt-reg-review@ietf.org mailing list, on the advice of one or more Designated Experts. However, to allow for the allocation of values prior to publication,

the Designated Experts may approve registration once they are satisfied that such a specification will be published. [[Note to the RFC Editor: The name of the mailing list should be determined in consultation with the IESG and IANA. Suggested name: cwt-reg-review@ietf.org.]]

Registration requests sent to the mailing list for review should use an appropriate subject (e.g., "Request to Register CWT Confirmation Method: example"). Registration requests that are undetermined for a period longer than 21 days can be brought to the IESG's attention (using the iesg@ietf.org mailing list) for resolution.

Criteria that should be applied by the Designated Experts include determining whether the proposed registration duplicates existing functionality, determining whether it is likely to be of general applicability or whether it is useful only for a single application, and evaluating the security properties of the item being registered and whether the registration makes sense.

It is suggested that multiple Designated Experts be appointed who are able to represent the perspectives of different applications using this specification in order to enable broadly informed review of registration decisions. In cases where a registration decision could be perceived as creating a conflict of interest for a particular Expert, that Expert should defer to the judgment of the other Experts.

6.1. CBOR Web Token Claims Registration

This specification registers the "cnf" claim in the IANA "CBOR Web Token Claims" registry [IANA.CWT.Claims] established by [CWT].

6.1.1. Registry Contents

- Claim Name: "cnf"
- Claim Description: Confirmation
- JWT Claim Name: "cnf"
- Claim Key: TBD (maybe 8)
- Claim Value Type(s): map
- Change Controller: IESG
- Specification Document(s): Section 3.1 of [[this document]]

6.2. CWT Confirmation Methods Registry

This specification establishes the IANA "CWT Confirmation Methods" registry for CWT "cnf" member values. The registry records the confirmation method member and a reference to the specification that defines it.

6.2.1. Registration Template

Confirmation Method Name:
The human-readable name requested (e.g., "kid").

Confirmation Method Description:
Brief description of the confirmation method (e.g., "Key Identifier").

JWT Confirmation Method Name:
Claim Name of the equivalent JWT confirmation method value, as registered in [IANA.JWT.Claims]. CWT claims should normally have a corresponding JWT claim. If a corresponding JWT claim would not make sense, the Designated Experts can choose to accept registrations for which the JWT Claim Name is listed as "N/A".

Confirmation Key:
CBOR map key value for the confirmation method.

Confirmation Value Type(s):
CBOR types that can be used for the confirmation method value.

Change Controller:
For Standards Track RFCs, list the "IESG". For others, give the name of the responsible party. Other details (e.g., postal address, email address, home page URI) may also be included.

Specification Document(s):
Reference to the document or documents that specify the parameter, preferably including URIs that can be used to retrieve copies of the documents. An indication of the relevant sections may also be included but is not required.

6.2.2. Initial Registry Contents

- Confirmation Method Name: "COSE_Key"
- Confirmation Method Description: COSE_Key Representing Public Key
- JWT Confirmation Method Name: "jwk"
- Confirmation Key: 1
- Confirmation Value Type(s): map
- Change Controller: IESG
- Specification Document(s): Section 3.2 of [[this document]]

- Confirmation Method Name: "Encrypted_COSE_Key"
- Confirmation Method Description: Encrypted COSE_Key
- JWT Confirmation Method Name: "jwe"
- Confirmation Key: 2

- Confirmation Value Type(s): array (with an optional COSE_Encrypt or COSE_Encrypt0 tag)
- Change Controller: IESG
- Specification Document(s): Section 3.3 of [[this document]]

- Confirmation Method Name: "kid"
- Confirmation Method Description: Key Identifier
- JWT Confirmation Method Name: "kid"
- Confirmation Key: 3
- Confirmation Value Type(s): binary string
- Change Controller: IESG
- Specification Document(s): Section 3.4 of [[this document]]

7. References

7.1. Normative References

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7.2. Informative References

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Open Issues

- Convert the examples from JSON/JWT to CBOR/CWT.

Document History

[[to be removed by the RFC Editor before publication as an RFC]]

-01

- Now uses CBOR diagnostic notation for the examples.
- Added a table summarizing the "cnf" names, keys, and value types.
- Addressed some of Jim Schaad's feedback on -00.

-00

- Created the initial working group draft from draft-jones-ace-cwt-proof-of-possession-01.

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