Internet Engineering Task Force (IETF)
Request for Comments: 6253
Updates: 5201
Category: Experimental
ISSN: 2070-1721

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May 2011

Host Identity Protocol Certificates

Abstract

The Certificate (CERT) parameter is a container for digital certificates. It is used for carrying these certificates in Host Identity Protocol (HIP) control packets. This document specifies the CERT parameter and the error signaling in case of a failed verification. Additionally, this document specifies the representations of Host Identity Tags in X.509 version 3 (v3) and Simple Public Key Infrastructure (SPKI) certificates.

The concrete use of certificates, including how certificates are obtained, requested, and which actions are taken upon successful or failed verification, is specific to the scenario in which the certificates are used. Hence, the definition of these scenario-specific aspects is left to the documents that use the CERT parameter.

This document updates RFC 5201.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for examination, experimental implementation, and evaluation.

This document defines an Experimental Protocol for the Internet community. This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Not all documents approved by the IESG are a candidate for any level of Internet Standard; see Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6253.

1. Introduction

Digital certificates bind pieces of information to a public key by means of a digital signature and thus enable the holder of a private key to generate cryptographically verifiable statements. The Host Identity Protocol (HIP) [RFC5201] defines a new cryptographic namespace based on asymmetric cryptography. The identity of each host is derived from a public key, allowing hosts to digitally sign data and issue certificates with their private key. This document specifies the CERT parameter, which is used to transmit digital certificates in HIP. It fills the placeholder specified in Section 5.2 of [RFC5201] and thus updates [RFC5201].

1.1. Requirements Language

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 RFC 2119 [RFC2119].

2. CERT Parameter

The CERT parameter is a container for certain types of digital certificates. It does not specify any certificate semantics. However, it defines supplementary parameters that help HIP hosts to transmit semantically grouped CERT parameters in a more systematic way. The specific use of the CERT parameter for different use cases is intentionally not discussed in this document, because it is specific to a concrete use case. Hence, the use of the CERT parameter will be defined in the documents that use the CERT parameter.

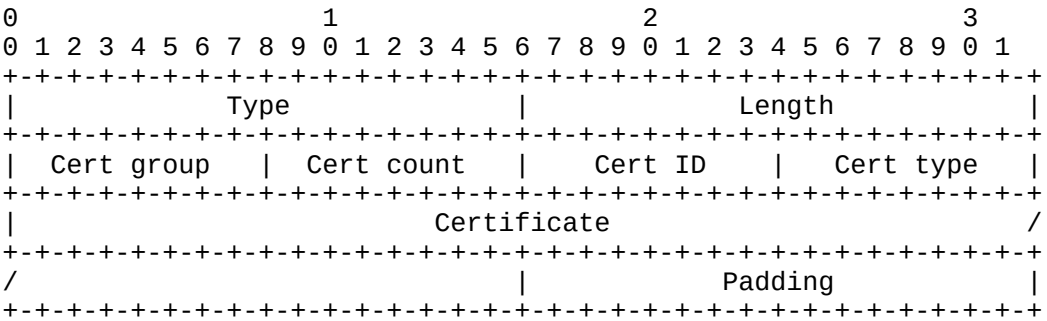
The CERT parameter is covered and protected, when present, by the HIP SIGNATURE field and is a non-critical parameter.

The CERT parameter can be used in all HIP packets. However, using it in the first Initiator (I1) packet is NOT RECOMMENDED, because it can increase the processing times of I1s, which can be problematic when processing storms of I1s. Each HIP control packet MAY contain multiple CERT parameters. These parameters MAY be related or unrelated. Related certificates are managed in Cert groups. A Cert group specifies a group of related CERT parameters that SHOULD be interpreted in a certain order (e.g., for expressing certificate chains). For grouping CERT parameters, the Cert group and the Cert count field MUST be set. Ungrouped certificates exhibit a unique Cert group field and set the Cert count to 1. CERT parameters with the same Cert group number in the group field indicate a logical grouping. The Cert count field indicates the number of CERT parameters in the group.

CERT parameters that belong to the same Cert group MAY be contained in multiple sequential HIP control packets. This is indicated by a higher Cert count than the amount of CERT parameters with matching Cert group fields in a HIP control packet. The CERT parameters MUST be placed in ascending order, within a HIP control packet, according to their Cert group field. Cert groups MAY only span multiple packets if the Cert group does not fit the packet. A HIP packet MUST NOT contain more than one incomplete Cert group that continues in the next HIP control packet.

The Cert ID acts as a sequence number to identify the certificates in a Cert group. The numbers in the Cert ID field MUST start from 1 up to Cert count.

The Cert group and Cert ID namespaces are managed locally by each host that sends CERT parameters in HIP control packets.



Type	768
Length	Length in octets, excluding Type, Length, and Padding.
Cert group	Group ID grouping multiple related CERT parameters.
Cert count	Total count of certificates that are sent, possibly in several consecutive HIP control packets.
Cert ID	The sequence number for this certificate.
Cert Type	Indicates the type of the certificate.
Padding	Any Padding, if necessary, to make the TLV a multiple of 8 bytes.

The certificates MUST use the algorithms defined in [RFC5201] as the signature and hash algorithms.

The following certificate types are defined:

Cert format	Type number
Reserved	0
X.509 v3	1
SPKI	2
Hash and URL of X.509 v3	3
Hash and URL of SPKI	4
LDAP URL of X.509 v3	5
LDAP URL of SPKI	6
Distinguished Name of X.509 v3	7
Distinguished Name of SPKI	8

The next sections outline the use of Host Identity Tags (HITs) in X.509 v3 and in Simple Public Key Infrastructure (SPKI) certificates. X.509 v3 certificates and the handling procedures are defined in [RFC5280]. The wire format for X.509 v3 is the Distinguished Encoding Rules format as defined in [X.690]. The SPKI, the handling procedures, and the formats are defined in [RFC2693].

Hash and Uniform Resource Locator (URL) encodings (3 and 4) are used as defined in Section 3.6 of [RFC5996]. Using hash and URL encodings results in smaller HIP control packets than by including the certificate(s), but requires the receiver to resolve the URL or check a local cache against the hash.

Lightweight Directory Access Protocol (LDAP) URL encodings (5 and 6) are used as defined in [RFC4516]. Using LDAP URL encoding results in smaller HIP control packets but requires the receiver to retrieve the certificate or check a local cache against the URL.

Distinguished Name (DN) encodings (7 and 8) are represented by the string representation of the certificate's subject DN as defined in [RFC4514]. Using the DN encoding results in smaller HIP control packets, but requires the receiver to retrieve the certificate or check a local cache against the DN.

3. X.509 v3 Certificate Object and Host Identities

If needed, HITs can represent an issuer, a subject, or both in X.509 v3. HITs are represented as IPv6 addresses as defined in [RFC4843]. When the Host Identifier (HI) is used to sign the certificate, the respective HIT MUST be placed into the Issuer Alternative Name (IAN) extension using the GeneralName form iPAddress as defined in [RFC5280]. When the certificate is issued for a HIP host, identified by a HIT and HI, the respective HIT MUST be placed into the Subject Alternative Name (SAN) extension using the GeneralName form iPAddress, and the full HI is presented as the subject's public key info as defined in [RFC5280].

The following examples illustrate how HITs are presented as issuer and subject in the X.509 v3 extension alternative names.

```
Format of X509v3 extensions:
    X509v3 Issuer Alternative Name:
        IP Address:hit-of-issuer
    X509v3 Subject Alternative Name:
        IP Address:hit-of-subject

Example X509v3 extensions:
    X509v3 Issuer Alternative Name:
        IP Address:2001:14:6cf:fae7:bb79:bf78:7d64:c056
    X509v3 Subject Alternative Name:
        IP Address:2001:1c:5a14:26de:a07c:385b:de35:60e3
```

Appendix B shows a full example of an X.509 v3 certificate with HIP content.

As another example, consider a managed Public Key Infrastructure (PKI) environment in which the peers have certificates that are anchored in (potentially different) managed trust chains. In this scenario, the certificates issued to HIP hosts are signed by intermediate Certification Authorities (CAs) up to a root CA. In this example, the managed PKI environment is neither HIP aware, nor can it be configured to compute HITs and include them in the certificates.

When HIP communications are established, the HIP hosts not only need to send their identity certificates (or pointers to their certificates), but also the chain of intermediate CAs (or pointers to the CAs) up to the root CA, or to a CA that is trusted by the remote peer. This chain of certificates MUST be sent in a Cert group as specified in Section 2. The HIP peers validate each other's certificates and compute peer HITs based on the certificate public keys.

4. SPKI Cert Object and Host Identities

When using SPKI certificates to transmit information related to HIP hosts, HITs need to be enclosed within the certificates. HITs can represent an issuer, a subject, or both. In the following, we define the representation of those identifiers for SPKI given as S-expressions. Note that the S-expressions are only the human-readable representation of SPKI certificates. Full HIs are presented in the public key sequences of SPKI certificates.

As an example, the Host Identity Tag of a host is expressed as follows:

```
Format:  (hash hit hit-of-host)
Example: (hash hit 2001:13:724d:f3c0:6ff0:33c2:15d8:5f50)
```

Appendix A shows a full example of a SPKI certificate with HIP content.

5. Revocation of Certificates

Revocation of X.509 v3 certificates is handled as defined in Section 5 of [RFC5280]. Revocation of SPKI certificates is handled as defined in Section 5 of [RFC2693].

6. Error Signaling

If the Initiator does not send the certificate that the Responder requires, the Responder may take actions (e.g., reject the connection). The Responder MAY signal this to the Initiator by sending a HIP NOTIFY message with NOTIFICATION parameter error type CREDENTIALS_REQUIRED.

If the verification of a certificate fails, a verifier MAY signal this to the provider of the certificate by sending a HIP NOTIFY message with NOTIFICATION parameter error type INVALID_CERTIFICATE.

NOTIFICATION PARAMETER - ERROR TYPES	Value
CREDENTIALS_REQUIRED	48
The Responder is unwilling to set up an association, as the Initiator did not send the needed credentials.	
INVALID_CERTIFICATE	50
Sent in response to a failed verification of a certificate. Notification Data MAY contain n groups of 2 octets (n calculated from the NOTIFICATION parameter length), in order Cert group and Cert ID of the Certificate parameter that caused the failure.	

7. IANA Considerations

This document defines the CERT parameter for the Host Identity Protocol [RFC5201]. This parameter is defined in Section 2 with type 768. The parameter type number is also defined in [RFC5201].

The CERT parameter has an 8-bit unsigned integer field for different certificate types, for which IANA has created and now maintains a new sub-registry entitled "HIP Certificate Types" under the "Host Identity Protocol (HIP) Parameters". Initial values for the Certificate type registry are given in Section 2. New values for the Certificate types from the unassigned space are assigned through IETF Review.

In Section 6, this document defines two new types for the "NOTIFY Message Types" sub-registry under "Host Identity Protocol (HIP) Parameters".

8. Security Considerations

Certificate grouping allows the certificates to be sent in multiple consecutive packets. This might allow similar attacks, as IP-layer fragmentation allows, for example, the sending of fragments in the wrong order and skipping some fragments to delay or stall packet processing by the victim in order to use resources (e.g., CPU or memory). Hence, hosts SHOULD implement mechanisms to discard certificate groups with outstanding certificates if state space is scarce.

Checking of the URL and LDAP entries might allow denial-of-service (DoS) attacks, where the target host may be subjected to bogus work.

Security considerations for SPKI certificates are discussed in [RFC2693] and for X.509 v3 in [RFC5280].

9. Acknowledgements

The authors would like to thank A. Keranen, D. Mattes, M. Komu, and T. Henderson for the fruitful conversations on the subject. D. Mattes most notably contributed the non-HIP aware use case in Section 3.

10. Normative References

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Appendix A. SPKI Certificate Example

This section shows an SPKI certificate with encoded HITs. The example has been indented for readability.

```
(sequence
  (public_key
    (rsa-pkcs1-sha1
      (e #010001#)
      (n |yDwznOwX0w+zvQbpWoTnfWrUPLKW2NFrpXbsIcH/QBSLb
          k1RKTZhLasFwvtSHAjqh220W8gRiQAGIqKplyrDEqSrJp
          OdIsHIQ8BQhJAyILWA1Sa6f5wAnWozDfgdXoKLNdT8ZNB
          mzluPiw4ozc78p6MHElH75Hm3yHaWxT+s83M=|
      )
      )
    )
    (cert
      (issuer
        (hash hit 2001:15:2453:698a:9aa:253a:dcb5:981e)
      )
      (subject
        (hash hit 2001:12:ccd6:4715:72a3:2ab1:77e4:4acc)
      )
      (not-before "2011-01-12_13:43:09")
      (not-after "2011-01-22_13:43:09")
    )
    (signature
      (hash sha1 |h5fC8HUMATTtK0cjYqIgeN3HCIMA|)
      |u8NTRutINI/AeeZgN6bngjvjYPtVahvY7MhGfenTpT7MCgBy
      NoZglqH5Cy2vH6LrQFYWx0MjWoYwHKimEuBKCNd4TK6hrCyAI
      CIDJAZ70TyKXgONwDNWPOmcc3lFmsih8ezkoBseFWHqRGISIm
      MLdeaMciP4lVfxPY2AQKdMrBc=|
  )
)
```

Appendix B. X.509 v3 Certificate Example

This section shows a X.509 v3 certificate with encoded HITs.

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number: 0 (0x0)
        Signature Algorithm: sha1WithRSAEncryption
        Issuer: CN=Example issuing host, DC=example, DC=com
        Validity
            Not Before: Mar 11 09:01:39 2011 GMT
            Not After : Mar 21 09:01:39 2011 GMT
        Subject: CN=Example subject host, DC=example, DC=com
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (1024 bit)
                Modulus (1024 bit):
                    00:c0:db:38:50:8e:63:ed:96:ea:c6:c4:ec:a3:36:
                    62:e2:28:e9:74:9c:f5:2f:cb:58:0e:52:54:60:b5:
                    fa:98:87:0d:22:ab:d8:6a:61:74:a9:ee:0b:ae:cd:
                    18:6f:05:ab:69:66:42:46:00:a2:c0:0c:3a:28:67:
                    09:cc:52:27:da:79:3e:67:d7:d8:d0:7c:f1:a1:26:
                    fa:38:8f:73:f5:b0:20:c6:f2:0b:7d:77:43:aa:c7:
                    98:91:7e:1e:04:31:0d:ca:94:55:20:c4:4f:ba:b1:
                    df:d4:61:9d:dd:b9:b5:47:94:6c:06:91:69:30:42:
                    9c:0a:8b:e3:00:ce:49:ab:e3
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Issuer Alternative Name:
                IP Address:2001:13:8d83:41c5:dc9f:38ed:e742:7281
            X509v3 Subject Alternative Name:
                IP Address:2001:1c:6e02:d3e0:9b90:8417:673e:99db
    Signature Algorithm: sha1WithRSAEncryption
        83:68:b4:38:63:a6:ae:57:68:e2:4d:73:5d:8f:11:e4:ba:30:
        a0:19:ca:86:22:e9:6b:e9:36:96:af:95:bd:e8:02:b9:72:2f:
        30:a2:62:ac:b2:fa:3d:25:c5:24:fd:8d:32:aa:01:4f:a5:8a:
        f5:06:52:56:0a:86:55:39:2b:ee:7a:7b:46:14:d7:5d:15:82:
        4d:74:06:ca:b7:8c:54:c1:6b:33:7f:77:82:d8:95:e1:05:ca:
        e2:0d:22:1d:86:fc:1c:c4:a4:cf:c6:bc:ab:ec:b8:2a:1e:4b:
        04:7e:49:9c:8f:9d:98:58:9c:63:c5:97:b5:41:94:f7:ef:93:
        57:29
```

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