

TLS
Internet-Draft
Intended status: Standards Track
Expires: September 24, 2015

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March 23, 2015

Transport Layer Security (TLS) Cached Information Extension
draft-ietf-tls-cached-info-19.txt

Abstract

Transport Layer Security (TLS) handshakes often include fairly static information, such as the server certificate and a list of trusted certification authorities (CAs). This information can be of considerable size, particularly if the server certificate is bundled with a complete certificate chain (i.e., the certificates of intermediate CAs up to the root CA).

This document defines an extension that allows a TLS client to inform a server of cached information, allowing the server to omit already available information.

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[1.](#) Introduction

Reducing the amount of information exchanged during a Transport Layer Security handshake to a minimum helps to improve performance in environments where devices are connected to a network with a low bandwidth, and lossy radio technology. With Internet of Things such environments exist, for example, when devices use IEEE 802.15.4 or Bluetooth Smart. For more information about the challenges with smart object deployments please see [[RFC6574](#)].

This specification defines a TLS extension that allows a client and a server to exclude transmission information cached in an earlier TLS handshake.

A typical example exchange may therefore look as follows. First, the client and the server executes the full TLS handshake. The client then caches the certificate provided by the server. When the TLS client connects to the TLS server some time in the future, without using session resumption, it then attaches the `cached_info` extension defined in this document to the client hello message to indicate that it had cached the certificate, and it provides the fingerprint of it. If the server's certificate has not changed then the TLS server does

not need to send its' certificate and the corresponding certificate chain again. In case information has changed, which can be seen from the fingerprint provided by the client, the certificate payload is transmitted to the client to allow the client to update the cache.

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "MUST", "MUST NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

This document refers to the TLS protocol but the description is equally applicable to DTLS as well.

3. Cached Information Extension

This document defines a new extension type (cached_info(TBD)), which is used in client hello and server hello messages. The extension type is specified as follows.

```
enum {  
    cached_info(TBD), (65535)  
} ExtensionType;
```

The extension_data field of this extension, when included in the client hello, MUST contain the CachedInformation structure. The client MAY send multiple CachedObjects of the same CachedInformationType. This may, for example, be the case when the client has cached multiple certificates from a server.


```
enum {
    cert(1), cert_req(2) (255)
} CachedInformationType;

struct {
    select (type) {
        case client:
            CachedInformationType type;
            opaque hash_value<1..255>;
        case server:
            CachedInformationType type;
    } body;
} CachedObject;

struct {
    CachedObject cached_info<1..2^16-1>;
} CachedInformation;
```

This document defines the following types:

Omitting the Server Certificate Message:

With the type field set to 'cert', the client MUST include the message digest of the Certificate message in the hash_value field. For this type the message digest MUST be calculated using SHA-256 [[RFC4634](#)].

Omitting the CertificateRequest Message

With the type set to 'cert_req', the client MUST include the message digest of the CertificateRequest message in the hash_value field. For this type the message digest MUST be calculated using SHA-256 [[RFC4634](#)].

New types can be added following the policy described in the IANA considerations section, see [Section 7](#). Different message digest algorithms for use with these types can also be added by registering a new type that makes use of this updated message digest algorithm.

4. Exchange Specification

Clients supporting this extension MAY include the "cached_info" extension in the (extended) client hello. If the client includes the extension then it MUST contain one or more CachedObject attributes.

A server supporting this extension MAY include the "cached_info" extension in the (extended) server hello. By returning the "cached_info" extension the server indicates that it supports the

cached info types. For each indicated cached info type the server MUST alter the transmission of respective payloads, according to the rules outlined with each type. If the server includes the extension it MUST only include CachedObjects of a type also supported by the client (as expressed in the client hello). For example, if a client indicates support for 'cert' and 'cert_req' then the server cannot respond with a "cached_info" attribute containing support for 'cert_status'.

Since the client includes a fingerprint of information it cached (for each indicated type) the server is able to determine whether cached information is stale. If the server supports this specification and notices a mismatch between the data cached by the client and its own information then the server MUST include the information in full and MUST NOT list the respective type in the "cached_info" extension.

Note: If a server is part of a hosting environment then the client may have cached multiple data items for a single server. To allow the client to select the appropriate information from the cache it is RECOMMENDED that the client utilizes the Server Name Indication extension [[RFC6066](#)].

Following a successful exchange of the "cached_info" extension in the client and server hello, the server alters sending the corresponding handshake message. How information is altered from the handshake messages is defined in [Section 4.1](#), and in [Section 4.2](#) for the types defined in this specification.

[4.1](#). Server Certificate Message

When a ClientHello message contains the "cached_info" extension with a type set to 'cert' then the server MAY send the Certificate message shown in Figure 2 under the following conditions:

The server software implements the "cached_info" extension defined in this specification.

The 'cert' cached info extension is enabled (for example, a policy allows the use of this extension).

The server compared the value in the hash_value field of the client-provided "cached_info" extension with the fingerprint of the Certificate message it normally sends to clients. This check ensures that the information cached by the client is current.

The original Certificate handshake message syntax is defined in [RFC 5246](#) [[RFC5246](#)] and has the structure shown in Figure 1.


```
opaque ASN.1Cert<1..2^24-1>;

struct {
    ASN.1Cert certificate_list<0..2^24-1>;
} Certificate;
```

Figure 1: Certificate Message as defined in [RFC 5246](#).

The new structure of the CertificateRequest message is shown in Figure 2.

```
struct {
    opaque hash_value<1..255>;
} CertificateRequest;
```

Figure 2: Cached Info Certificate Message.

The fingerprint MUST be computed as follows: hash_value:=SHA-256(Certificate)

Note that [RFC 7250](#) [[RFC7250](#)] allows the certificate payload to contain only the SubjectPublicKeyInfo instead of the full information typically found in a certificate. Hence, when this specification is used in combination with [[RFC7250](#)] and the negotiated certificate type is a raw public key then the TLS server omits sending a Certificate payload that contains an ASN.1 Certificate structure with the included SubjectPublicKeyInfo rather than the full certificate. As such, this extension is compatible with the raw public key extension defined in [RFC 7250](#).

[4.2](#). CertificateRequest Message

When a fingerprint for an object of type 'cert_req' is provided in the client hello, the server MAY omit the CertificateRequest message under the following conditions:

The server software implements the "cached_info" extension defined in this specification.

The 'cert_req' cached info extension is enabled (for example, a policy allows the use of this extension).

The server compared the value in the hash_value field of the client-provided "cached_info" extension with the fingerprint of the CertificateRequest message it normally sends to clients. This check ensures that the information cached by the client is current.

The server wants to request a certificate from the client.

The original CertificateRequest handshake message syntax is defined in [RFC 5246](#) [[RFC5246](#)] and has the following structure:

```
opaque DistinguishedName<1..2^16-1>;

struct {
    ClientCertificateType certificate_types<1..2^8-1>;
    SignatureAndHashAlgorithm
        supported_signature_algorithms<2^16-1>;
    DistinguishedName certificate_authorities<0..2^16-1>;
} CertificateRequest;
```

Figure 3: CertificateRequest Message as defined in [RFC 5246](#).

The new structure of the CertificateRequest message is shown in Figure 4.

```
struct {
    opaque hash_value<1..255>;
} CertificateRequest;
```

Figure 4: Cached Info CertificateRequest Message.

The fingerprint MUST be computed as follows: hash_value:=SHA-256(CertificateRequest)

5. Example

Figure 5 illustrates an example exchange using the TLS cached info extension. In the normal TLS handshake exchange shown in flow (A) the TLS server provides its certificate in the Certificate payload to the client, see step [1]. This allows the client to store the certificate for future use. After some time the TLS client again interacts with the same TLS server and makes use of the TLS cached info extension, as shown in flow (B). The TLS client indicates support for this specification via the "cached_info" extension, see [2], and indicates that it has stored the certificate from the earlier exchange (by indicating the 'cert' type). With [3] the TLS server acknowledges the supports of the 'cert' type and by including the value in the server hello informs the client that the content of the certificate payload contains the fingerprint of the certificate instead of the [RFC 5246](#)-defined payload of the certificate message in message [4].

(A) Initial (full) Exchange

```

ClientHello          ->
                    <-  ServerHello
                       Certificate* // [1]
                       ServerKeyExchange*
                       CertificateRequest*
                       ServerHelloDone

Certificate*
ClientKeyExchange
CertificateVerify*
[ChangeCipherSpec]
Finished             ->

                    <- [ChangeCipherSpec]
                       Finished

```

Application Data <-----> Application Data

(B) TLS Cached Extension Usage

```

ClientHello
cached_info=(cert)   -> // [2]
                    <-  ServerHello
                       cached_info=(cert) [3]
                       Certificate [4]
                       ServerKeyExchange*
                       ServerHelloDone

ClientKeyExchange
CertificateVerify*
[ChangeCipherSpec]
Finished             ->

                    <- [ChangeCipherSpec]
                       Finished

```

Application Data <-----> Application Data

Figure 5: Example Message Exchange

6. Security Considerations

This specification defines a mechanism to reference stored state using a fingerprint. Sending a fingerprint of cached information in an unencrypted handshake, as the client and server hello is, may

allow an attacker or observer to correlate independent TLS exchanges. While some information elements used in this specification, such as server certificates, are public objects and usually do not contain sensitive information, other (not yet defined cached info types) may. Those who implement and deploy this specification should therefore make an informed decision whether the cached information is inline with their security and privacy goals. In case of concerns, it is advised to avoid sending the fingerprint of the data objects in clear.

The use of the cached info extension allows the server to omit sending certain TLS messages. Consequently, these omitted messages are not included in the transcript of the handshake in the TLS Finish message per value. However, since the client communicates the hash values of the cached values in the initial handshake message the fingerprints are included in the TLS Finish message.

Clients MUST ensure that they only cache information from legitimate sources. For example, when the client populates the cache from a TLS exchange then it must only cache information after the successful completion of a TLS exchange to ensure that an attacker does not inject incorrect information into the cache. Failure to do so allows for man-in-the-middle attacks.

7. IANA Considerations

7.1. New Entry to the TLS ExtensionType Registry

IANA is requested to add an entry to the existing TLS ExtensionType registry, defined in [RFC 5246](#) [[RFC5246](#)], for cached_info(TBD) defined in this document.

7.2. New Registry for CachedInformationType

IANA is requested to establish a registry for TLS CachedInformationType values. The first entries in the registry are

- o cert(1)
- o cert_req(2)

The policy for adding new values to this registry, following the terminology defined in [RFC 5226](#) [[RFC5226](#)], is as follows:

- o 0-63 (decimal): Standards Action
- o 64-223 (decimal): Specification Required

- o 224-255 (decimal): reserved for Private Use

8. Acknowledgments

We would like to thank the following persons for your detailed document reviews:

- o Paul Wouters and Nikos Mavrogiannopoulos (December 2011)
- o Rob Stradling (February 2012)
- o Ondrej Mikle (in March 2012)
- o Ilari Liusvaara, Adam Langley, and Eric Rescorla (in July 2014)
- o Sean Turner (in August 2014)

Additionally, we would like to thank the TLS working group chairs, Sean Turner and Joe Salowey, as well as the responsible security area director, Stephen Farrell, for their support.

9. References

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