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Transport Layer Security (TLS) Cached Information Extension
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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 path (including all intermediary certificates up to the trust anchor public key).

This document defines an extension that omits the exchange of already available information. The TLS client informs a server of cached information, for example from a previous TLS handshake, allowing the server to omit the already available information.

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[1.](#) Introduction

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 path (including all intermediary certificates up to the trust anchor public key).

Optimizing the exchange of information to a minimum helps to improve performance in environments where devices are connected to a network with characteristics like low bandwidth, high latency and high loss rate. These types of networks exist, for example, when smart objects are connected using a low power IEEE 802.15.4 radio. 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 of cached information from the TLS handshake.

A typical example exchange may therefore look as follows. First, the client and the server executes the usual TLS handshake. The client may, for example, decide to cache 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_information` 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 had not changed then the TLS server does not need to send the full certificate to the client again. In case the information had changed, the certificate payload is transmitted to the client to allow the client to update it's state information.

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](#)].

3. Cached Information Extension

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

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

The `extension_data` field of this extension, when included in the client hello, MUST contain the `CachedInformation` structure.


```
enum {
    certificate_chain(1), trusted_cas(2) (255)
} CachedInformationType;

struct {
    CachedInformationType type;
    HashAlgorithm hash;
    opaque hash_value<1..255>;
} CachedObject;

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

When the `CachedInformationType` identifies a `certificate_chain`, then the `hash_value` field **MUST** include the hash calculated over the `certificate_list` element of the `Certificate` payload provided by the TLS server in an earlier exchange, excluding the three length bytes of the `certificate_list` vector.

When the `CachedInformationType` identifies a `trusted_cas`, then the `hash_value` **MUST** include a hash calculated over the `certificate_authorities` element of the `CertificateRequest` payload provided by the TLS server in an earlier exchange, excluding the two length bytes of the `certificate_authorities` vector.

The hash algorithm used to calculate hash values is conveyed in the 'hash' field of the `CachedObject` element. The list of registered hash algorithms can be found in the TLS HashAlgorithm Registry, which was created by [RFC 5246](#) [[RFC5246](#)]. The value zero (0) for 'none' is not an allowed choice for a hash algorithm and **MUST NOT** be used.

This document establishes a registry for `CachedInformationType` types and additional values can be added following the policy described in [Section 7](#).

4. Exchange Specification

Clients supporting this extension **MAY** include the "cached_information" extension in the (extended) client hello, which **MAY** contain zero or more `CachedObject` attributes.

A server supporting this extension **MAY** include the "cached_information" extension in the (extended) server hello, which **MAY** contain one or more `CachedObject` attributes it supports. By returning the "cached_information" extension the server indicates that it supports caching of each present `CachedObject` that matches

the specified hash value. The server MAY support other cached objects that are not present in the extension.

Note: If clients make use of the Server Name Indication [[RFC6066](#)] then clients may need to cache multiple data items for a single server since servers may host multiple 'virtual' servers at a single underlying network address.

Following a successful exchange of the "cached_information" extensions in the client and server hello, the server omits sending the corresponding handshake message. How information is omitted from the handshake message is defined per cached info type. [Section 4.1](#) and [Section 4.2](#) defines the syntax of the fingerprinted information.

The handshake protocol MUST proceed using the information as if it was provided in the handshake protocol. The Finished message MUST be calculated over the actual data exchanged in the handshake protocol. That is, the Finished message will be calculated over the information that was omitted from transmission by means of its present hash in the client hello and not through its presence in the handshake exchange.

The server MUST NOT include more than one fingerprint for a single information element, i.e., at maximum only one CachedObject structure per replaced information is provided.

[4.1.](#) Omitting the Certificate Chain

When an object of type 'certificate_chain' is provided in the client hello, the server MAY replace the sequence of certificates with an empty sequence with an actual length field of zero (=empty vector).

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

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

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

Note that [[I-D.ietf-tls-oob-pubkey](#)] 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 [[I-D.ietf-tls-oob-pubkey](#)] and the negotiated certificate type is a raw public key then the TLS server omits

sending a Certificate payload that contains an ASN.1Cert structure of the SubjectPublicKeyInfo.

4.2. Omitting the Trusted CAs

When a fingerprint for an object of type 'trusted_cas' is provided in the client hello, the server MAY send a DistinguishedName in the Certificate Request message with an actual length field of zero (=empty vector).

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

```
opaque DistinguishedName<1..216-1>;

struct {
    ClientCertificateType certificate_types<1..28-1>;
    SignatureAndHashAlgorithm
        supported_signature_algorithms<216-1>;
    DistinguishedName certificate_authorities<0..216-1>;
} CertificateRequest;
```

5. Example

Figure 1 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_information extension, see [2], and indicates that it has stored the certificate_chain from the earlier exchange. With [3] the TLS server indicates that it also supports this specification and informs the client that it also supports caching of other objects beyond the 'certificate_chain', namely 'trusted_cas' (also defined in this document), and the 'foo-bar' extension (i.e., an imaginary extension that yet needs to be defined). With [4] the TLS server omits sending the certificate chain, as described in [Section 4.1](#).

(A) Initial (full) Exchange

client_hello ->

<- server_hello,


```

                                certificate, // [1]
                                server_key_exchange,
                                server_hello_done

client_key_exchange,
change_cipher_spec,
finished                                ->

                                <- change_cipher_spec,
                                finished

Application Data      <----->      Application Data

```

(B) TLS Cached Extension Usage

```

client_hello,
cached_information=(certificate_chain)  -> // [2]
                                <-  server_hello,
                                cached_information= // [3]
                                (certificate_chain, trusted_cas, foo-bar)
                                certificate, // [4]
                                server_key_exchange,
                                server_hello_done

client_key_exchange,
change_cipher_spec,
finished                                ->

                                <- change_cipher_spec,
                                finished

Application Data      <----->      Application Data

```

Figure 1: 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 not sensitive in this regard, others may be. 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 hash algorithm used in this specification is required to have reasonable random properties in order to provide reasonably unique identifiers. There is no requirement that this hash algorithm must have strong collision resistance.

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_information`(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 `certificate_chain`(1)
- o `trusted_cas`(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

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9. References

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9.2. Informative References

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