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TLS Certificate Compression

Abstract

In TLS handshakes, certificate chains often take up the majority of the bytes transmitted.

This document describes how certificate chains can be compressed to reduce the amount of data transmitted and avoid some round trips.

Status of This Memo

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Table of Contents

1. Introduction

In order to reduce latency and improve performance, it can be useful to reduce the amount of data exchanged during a TLS handshake.

[RFC7924] describes a mechanism that allows a client and a server to avoid transmitting certificates already shared in an earlier handshake, but it doesn't help when the client connects to a server for the first time and doesn't already have knowledge of the server's certificate chain.

This document describes a mechanism that would allow certificates to be compressed during all handshakes.

2. 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 BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Negotiating Certificate Compression

This extension is only supported with TLS 1.3 [RFC8446] and newer; if TLS 1.2 [RFC5246] or earlier is negotiated, the peers MUST ignore this extension.

This document defines a new extension type (compress_certificate(27)), which can be used to signal the supported compression formats for the Certificate message to the peer. Whenever it is sent by the client as a ClientHello message extension ([RFC8446], Section 4.1.2), it indicates support for compressed server certificates. Whenever it is sent by the server as a CertificateRequest extension ([RFC8446], Section 4.3.2), it indicates support for compressed client certificates.

By sending a compress_certificate extension, the sender indicates to the peer the certificate-compression algorithms it is willing to use for decompression. The "extension_data" field of this extension SHALL contain a CertificateCompressionAlgorithms value:

```
enum {
    zlib(1),
    brotli(2),
    zstd(3),
    (65535)
} CertificateCompressionAlgorithm;
```

```
    struct {
        CertificateCompressionAlgorithm algorithms<2..2^8-2>;
    } CertificateCompressionAlgorithms;
```

The compress_certificate extension is a unidirectional indication; no corresponding response extension is needed.

4. Compressed Certificate Message

If the peer has indicated that it supports compression, server and client MAY compress their corresponding Certificate messages (Section 4.4.2 of [RFC8446]) and send them in the form of the CompressedCertificate message (replacing the Certificate message).

The CompressedCertificate message is formed as follows:

```
    struct {
         CertificateCompressionAlgorithm algorithm;
         uint24 uncompressed_length;
         opaque compressed_certificate_message<1..2^24-1>;
    } CompressedCertificate;
```

algorithm: The algorithm used to compress the certificate. The algorithm MUST be one of the algorithms listed in the peer's compress_certificate extension.

uncompressed_length: The length of the Certificate message once it is uncompressed. If, after decompression, the specified length does not match the actual length, the party receiving the invalid message MUST abort the connection with the "bad_certificate" alert. The presence of this field allows the receiver to preallocate the buffer for the uncompressed Certificate message and enforce limits on the message size before performing decompression.

compressed_certificate_message: The result of applying the indicated compression algorithm to the encoded Certificate message that would have been sent if certificate compression was not in use. The compression algorithm defines how the bytes in the compressed_certificate_message field are converted into the Certificate message.

If the specified compression algorithm is zlib, then the Certificate message MUST be compressed with the ZLIB compression algorithm, as defined in [RFC1950]. If the specified compression algorithm is brotli, the Certificate message MUST be compressed with the Brotli compression algorithm, as defined in [RFC7932]. If the specified compression algorithm is zstd, the Certificate message MUST be compressed with the Zstandard compression algorithm, as defined in [RFC8478].

It is possible to define a certificate compression algorithm that uses a preshared dictionary to achieve a higher compression ratio. This document does not define any such algorithms, but additional codepoints may be allocated for such use per the policy in

Section 7.3.

If the received CompressedCertificate message cannot be decompressed, the connection MUST be terminated with the "bad_certificate" alert.

If the format of the Certificate message is altered using the server_certificate_type or client_certificate_type extensions [RFC7250], the resulting altered message is compressed instead.

5. Security Considerations

After decompression, the Certificate message MUST be processed as if it were encoded without being compressed. This way, the parsing and the verification have the same security properties as they would have in TLS normally.

In order for certificate compression to function correctly, the underlying compression algorithm MUST output the same data that was provided as input by the peer.

Since certificate chains are typically presented on a per-server-name or per-user basis, a malicious application does not have control over any individual fragments in the Certificate message, meaning that they cannot leak information about the certificate by modifying the plaintext.

Implementations SHOULD bound the memory usage when decompressing the CompressedCertificate message.

Implementations MUST limit the size of the resulting decompressed chain to the specified uncompressed length, and they MUST abort the connection if the size of the output of the decompression function exceeds that limit. TLS framing imposes a 16777216-byte limit on the certificate message size, and implementations MAY impose a limit that is lower than that; in both cases, they MUST apply the same limit as if no compression were used.

While the Certificate message in TLS 1.3 is encrypted, third parties can draw inferences from the message length observed on the wire. TLS 1.3 provides a padding mechanism (discussed in Sections 5.4 and E.3 of [RFC8446]) to counteract such analysis. Certificate compression alters the length of the Certificate message, and the change in length is dependent on the actual contents of the certificate. Any padding scheme covering the Certificate message has to address compression within its design or disable it altogether.

6. Middlebox Compatibility

It's been observed that a significant number of middleboxes intercept and try to validate the Certificate message exchanged during a TLS handshake. This means that middleboxes that don't understand the CompressedCertificate message might misbehave and drop connections that adopt certificate compression. Because of that, the extension is only supported in the versions of TLS where the certificate message is encrypted in a way that prevents middleboxes from intercepting it -- that is, TLS version 1.3 [RFC8446] and higher.

7. IANA Considerations

7.1. TLS ExtensionType Values

IANA has created an entry, compress_certificate(27), in the "TLS ExtensionType Values" registry (defined in [RFC8446]) with the values in the "TLS 1.3" column set to "CH, CR" and the "Recommended" column entry set to "Yes".

7.2. TLS HandshakeType

IANA has created an entry, compressed_certificate(25), in the "TLS Handshake Type" registry (defined in [RFC8446]), with the "DTLS-OK" column value set to "Yes".

7.3. Compression Algorithms

This document establishes a registry of compression algorithms supported for compressing the Certificate message, titled "TLS Certificate Compression Algorithm IDs", under the existing "Transport Layer Security (TLS) Extensions" registry.

The entries in the registry are:

Algorithm Number	Description	Reference
0	Reserved	RFC 8879
1	zlib	RFC 8879
2	brotli	RFC 8879
3	zstd	RFC 8879
16384 to 65535	Reserved for Experimental Use	

Table 1: TLS Certificate Compression Algorithm IDs

The values in this registry shall be allocated under "IETF Review" policy for values strictly smaller than 256, under "Specification Required" policy for values 256-16383, and under "Experimental Use" otherwise (see [RFC8126] for the definition of relevant policies). Experimental Use extensions can be used both on private networks and over the open Internet.

The procedures for requesting values in the Specification Required space are specified in Section 17 of [RFC8447].

8. References

8.1. Normative References

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8.2. Informative References

[RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", RFC 5246, DOI 10.17487/RFC5246, August 2008, <https://www.rfc-editor.org/info/rfc5246>.

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