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Large Record Sizes for TLS and DTLS with Reduced Overhead
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Abstract

TLS 1.3 records limit the inner plaintext (TLSInnerPlaintext) size to 2^14 + 1 bytes, which includes one byte for the content type. Records also have a 3-byte overhead due to the fixed opaque_type and legacy_record_version fields. This document defines a TLS extension that allows endpoints to negotiate a larger maximum inner plaintext size, up to 2^32 - 256 bytes, while reducing overhead.

About This Document

This note is to be removed before publishing as an RFC.

The latest revision of this draft can be found at https://tlswg.github.io/super-jumbo-record-limit/draft-ietf-tls-super-jumbo-record-limit.html. Status information for this document may be found at https://datatracker.ietf.org/doc/draft-ietf-tls-super-jumbo-record-limit/.

Discussion of this document takes place on the Transport Layer Security Working Group mailing list (mailto:tls@ietf.org), which is archived at https://mailarchive.ietf.org/arch/browse/tls/. Subscribe at https://www.ietf.org/mailman/listinfo/tls/.

Source for this draft and an issue tracker can be found at https://github.com/tlswg/super-jumbo-record-limit.

Status of This Memo

Copyright Notice

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1. Introduction

TLS 1.3 records limit the inner plaintext (TLSInnerPlaintext) size to 2^14 + 1 bytes, which includes one byte for the content type. Records also have a 3-byte overhead due to the fixed opaque_type and legacy_record_version fields. TLS-based protocols are increasingly used to secure long-lived interfaces in critical infrastructure, such as telecommunication networks. In some infrastructure use cases, the upper layer of DTLS expects a message oriented service and uses message sizes much larger than 2^14-bytes. In these cases, the 2^14-byte limit in TLS necessitates an additional protocol layer for fragmentation, resulting in increased CPU and memory consumption and

additional complexity. Allowing 2^32-byte records would eliminate additional fragmentation in almost all use cases. In [RFC6083] (DTLS over SCTP), the 2^14-byte limit is a severe restriction.

This document defines a "large_record_size_limit" extension that allows endpoints to negotiate a larger maximum inner plaintext (TLSInnerPlaintext) size. This extension is valid in TLS 1.3 and DTLS 1.3. The extension works similarly to the "record_size_limit" extension defined in [RFC8449]. Additionally, this document defines new TLS 1.3 TLSLargeCiphertext and DTLS 1.3 unified_hdr structures to enable inner plaintexts up to 2^32 - 256 bytes with reduced overhead. For example, inner plaintexts up to 2^16 - 256 bytes can be supported with 3 bytes less overhead, which is useful in constrained IoT environments. The "large_record_size_limit" extension is incompatible with middleboxes expecting TLS 1.2 records.

2. Terminology

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. The "large_record_size_limit" Extension

The ExtensionData of the "large_record_size_limit" extension is LargeRecordSizeLimit:

```
uint32 LargeRecordSizeLimit;
```

LargeRecordSizeLimit denotes the maximum size, in bytes, of inner plaintexts that the endpoint is willing to receive. It includes the content type and padding (i.e., the complete length of TLSInnerPlaintext). AEAD expansion is not included.

The large record size limit only applies to records sent toward the endpoint that advertises the limit. An endpoint can send records that are larger than the limit it advertises as its own limit. A TLS endpoint that receives a record larger than its advertised limit MUST generate a fatal "record_overflow" alert; a DTLS endpoint that receives a record larger than its advertised limit MAY either generate a fatal "record_overflow" alert or discard the record. An endpoint MUST NOT add padding to records that would cause the length of TLSInnerPlaintext to exceed the limit advertised by the other endpoint.

Endpoints MUST NOT send a "large_record_size_limit" extension with a value smaller than 64 or larger than 2^32 - 256. An endpoint MUST treat receipt of a smaller or larger value as a fatal error and generate an "illegal_parameter" alert.

The server sends the "large_record_size_limit" extension in the EncryptedExtensions message. During resumption, the limit is renegotiated. Records are subject to the limits that were set in the handshake that produces the keys that are used to protect those records. This admits the possibility that the extension might not be negotiated during resumption.

Unprotected messages and records protected with early_traffic_secret or handshake_traffic_secret are not subject to the large record size limit.

When the "large_record_size_limit" extension is negotiated:

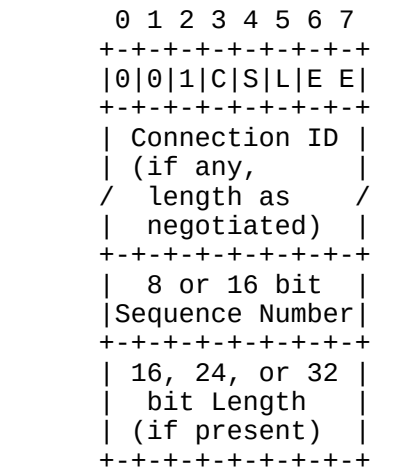
* All TLS 1.3 records protected with application_traffic_secret MUST use the TLSLargeCiphertext structure instead of the TLSCiphertext structure. The size of the length field depends on the limit advertised by the receiver. If the limit is less than 2^16 - 255 an uint16 is used, if the limit is larger than 2^24 - 256 an uint32 is used, and otherwise an uint24 is used. The length is fixed for the connection. Different lengths might be used in different directions.

```
enum { u16(0), u24(1), u32(2) } Length;

struct {
    select (Length.type) {
        case u16: uint16;
        case u24: uint24;
        case u32: uint32;
    };
 } VarLength;

struct {
    VarLength length;
    opaque encrypted_record[TLSLargeCiphertext.length];
} TLSLargeCiphertext;
```

* All DTLS 1.3 records protected with application_traffic_secret and with length present MUST use a unified_hdr structure with a length equal to the TLS 1.3 length field defined above.



* An endpoint MAY generate records protected with application_traffic_secret with inner plaintext that is equal to or smaller than the LargeRecordSizeLimit value it receives from its peer. An endpoint MUST NOT generate a protected record with inner plaintext that is larger than the LargeRecordSizeLimit value it receives from its peer.

The "large_record_size_limit" extension is not compatible with middleboxes expecting TLS 1.2 records and SHOULD NOT be negotiated where such middleboxes are expected. A server MUST NOT send extension responses to more than one of "large_record_size_limit", "record_size_limit", and "max_fragment_length". A client MUST treat receipt of more than one of "large_record_size_limit", "record_size_limit", and "max_fragment_length" as a fatal error, and it SHOULD generate an "illegal_parameter" alert.

The Path Maximum Transmission Unit (PMTU) in DTLS also limits the size of records. The record size limit does not affect PMTU discovery and SHOULD be set independently. The record size limit is fixed during the handshake and so should be set based on constraints at the endpoint and not based on the current network environment. In comparison, the PMTU is determined by the network path and can change dynamically over time.

4. Limits on Key Usage

The maximum record size limit is an input to the AEAD limits calculations in TLS 1.3 [RFC8446] and DTLS 1.3 [RFC9147]. Increasing the maximum record size to more than 2^14 + 256 bytes while keeping the same confidentiality and integrity advantage per write key therefore requires lower AEAD limits. When the "large_record_size" has been negotiated record size limit larger than 2^14 + 1 bytes, existing AEAD limits SHALL be decreased by a factor of (LargeRecordSizeLimit) / (2^14-256). For example, when AES-CGM is used in TLS 1.3 [RFC8446] with a 64 kB record limit, only arounf 2^22.5 records (about 6 million) may be encrypted on a given connection.

5. Security Considerations

Large record sizes might require more memory allocation for senders and receivers. Additionally, larger record sizes also means that more processing is done before verification of non-authentic records fails.

The use of larger record sizes can either simplify or complicate traffic analysis, depending on the application. The LargeRecordSizeLimit is just an upper limit and it is still the sender that decides the size of the inner plaintexts up to that limit.

6. IANA Considerations

IANA is requested to assign a new value in the TLS ExtensionType Values registry defined by [RFC8447]:

* The Extension Name should be large_record_size_limit
* The TLS 1.3 value should be CH, EE
* The DTLS-Only value should be N
* The Recommended value should be Y
* The Reference should be this document

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/rfc/rfc2119>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

[RFC8446] Rescorla, E., "The Transport Layer Security (TLS) Protocol Version 1.3", RFC 8446, DOI 10.17487/RFC8446, August 2018, <https://www.rfc-editor.org/rfc/rfc8446>.

[RFC8447] Salowey, J. and S. Turner, "IANA Registry Updates for TLS and DTLS", RFC 8447, DOI 10.17487/RFC8447, August 2018, <https://www.rfc-editor.org/rfc/rfc8447>.

[RFC8449] Thomson, M., "Record Size Limit Extension for TLS", RFC 8449, DOI 10.17487/RFC8449, August 2018, <https://www.rfc-editor.org/rfc/rfc8449>.

[RFC9147] Rescorla, E., Tschofenig, H., and N. Modadugu, "The Datagram Transport Layer Security (DTLS) Protocol Version 1.3", RFC 9147, DOI 10.17487/RFC9147, April 2022, <https://www.rfc-editor.org/rfc/rfc9147>.

7.2. Informative References

[RFC6083] Tuexen, M., Seggelmann, R., and E. Rescorla, "Datagram Transport Layer Security (DTLS) for Stream Control Transmission Protocol (SCTP)", RFC 6083, DOI 10.17487/RFC6083, January 2011, <https://www.rfc-editor.org/rfc/rfc6083>.

Change Log

This section is to be removed before publishing as an RFC.

Changes from -04 to -05:

* Grammar and comprehension tweaks.

* Added change log

Changes from -03 to -04:

* Corrected uint24 to uint32.

Changes from -02 to -03:

* Major rewrite based on discussions at IETF 119

* New independant extension instead of flag extension used together with record_size_limit

* New record format without opaque_type and legacy_record_version fields. This reduces overhead

* Support inner plaintext size up to 2^32 - 256 bytes

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