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Datagram Transport Layer Security (DTLS) for Stream Control Transmission Protocol (SCTP)

Abstract

This document describes the usage of the Datagram Transport Layer Security (DTLS) protocol over the Stream Control Transmission Protocol (SCTP).

DTLS over SCTP provides communications privacy for applications that use SCTP as their transport protocol and allows client/server applications to communicate in a way that is designed to prevent eavesdropping and detect tampering or message forgery.

Applications using DTLS over SCTP can use almost all transport features provided by SCTP and its extensions.

Status of This Memo

This is an Internet Standards Track document.

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1. Introduction

1.1. Overview

This document describes the usage of the Datagram Transport Layer Security (DTLS) protocol, as defined in [RFC4347], over the Stream Control Transmission Protocol (SCTP), as defined in [RFC4960].

DTLS over SCTP provides communications privacy for applications that use SCTP as their transport protocol and allows client/server applications to communicate in a way that is designed to prevent eavesdropping and detect tampering or message forgery.

Applications using DTLS over SCTP can use almost all transport features provided by SCTP and its extensions.

TLS, from which DTLS was derived, is designed to run on top of a byte-stream-oriented transport protocol providing a reliable, in-sequence delivery. Thus, TLS is currently mainly being used on top of the Transmission Control Protocol (TCP), as defined in [RFC0793].

TLS over SCTP as described in [RFC3436] has some serious limitations:

- It does not support the unordered delivery of SCTP user messages.
- It does not support partial reliability as defined in [RFC3758].
- It only supports the usage of the same number of streams in both directions.
- It uses a TLS connection for every bidirectional stream, which requires a substantial amount of resources and message exchanges if a large number of streams is used.

DTLS over SCTP as described in this document overcomes these limitations of TLS over SCTP. In particular, DTLS/SCTP supports:

- preservation of message boundaries.
- a large number of unidirectional and bidirectional streams.
- ordered and unordered delivery of SCTP user messages.
- the partial reliability extension as defined in [RFC3758].
- the dynamic address reconfiguration extension as defined in [RFC5061].

However, the following limitations still apply:

- The maximum user message size is 2^14 bytes, which is the DTLS limit.
- The DTLS user cannot perform the SCTP-AUTH key management because this is done by the DTLS layer.

The method described in this document requires that the SCTP implementation supports the optional feature of fragmentation of SCTP user messages as defined in [RFC4960] and the SCTP authentication extension defined in [RFC4895].

1.2. Terminology

This document uses the following terms:

Association: An SCTP association.

Stream: A unidirectional stream of an SCTP association. It is uniquely identified by a stream identifier.

1.3. Abbreviations

DTLS: Datagram Transport Layer Security

MTU: Maximum Transmission Unit

PPID: Payload Protocol Identifier

SCTP: Stream Control Transmission Protocol

TCP: Transmission Control Protocol

TLS: Transport Layer Security

2. Conventions

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

3. DTLS Considerations

3.1. Version of DTLS

This document is based on [RFC4347], and it is expected that DTLS/SCTP as described in this document will work with future versions of DTLS.

3.2. Message Sizes

DTLS limits the DTLS user message size to the current Path MTU minus the header sizes. For the purposes of running over SCTP, the DTLS path MTU MUST be considered to be 2^14.

3.3. Replay Detection

The replay detection of DTLS may result in the DTLS layer dropping messages. Since DTLS/SCTP provides a reliable service if requested by the application, replay detection cannot be used. Therefore, replay detection of DTLS MUST NOT be used.

3.4. Path MTU Discovery

SCTP provides Path MTU discovery and fragmentation/reassembly for user messages. According to Section 3.2, DTLS can send maximum sized messages. Therefore, Path MTU discovery of DTLS MUST NOT be used.

3.5. Retransmission of Messages

SCTP provides a reliable and in-sequence transport service for DTLS messages that require it. See Section 4.4. Therefore, DTLS procedures for retransmissions MUST NOT be used.

4. SCTP Considerations

4.1. Mapping of DTLS Records

The supported maximum length of SCTP user messages MUST be at least 2^14 + 2048 + 13 = 18445 bytes (2^14 + 2048 is the maximum length of the DTLSCiphertext.fragment, and 13 is the size of the DTLS record header). In particular, the SCTP implementation MUST support fragmentation of user messages.

Every SCTP user message MUST consist of exactly one DTLS record.

4.2. DTLS Connection Handling

Each DTLS connection MUST be established and terminated within the same SCTP association. A DTLS connection MUST NOT span multiple SCTP associations.

4.3. Payload Protocol Identifier Usage

Application protocols using DTLS over SCTP SHOULD register and use a separate payload protocol identifier (PPID) and SHOULD NOT reuse the PPID that they registered for running directly over SCTP.

Using the same PPID does not harm as long as the application can determine whether or not DTLS is used. However, for protocol analyzers, for example, it is much easier if a separate PPID is used.

This means, in particular, that there is no specific PPID for DTLS.

4.4. Stream Usage

All DTLS messages of the ChangeCipherSpec, Alert, or Handshake protocol MUST be transported on stream 0 with unlimited reliability and with the ordered delivery feature.

DTLS messages of the ApplicationData protocol SHOULD use multiple streams other than stream 0; they MAY use stream 0 for everything if they do not care about minimizing head of line blocking.

4.5. Chunk Handling

DATA chunks of SCTP MUST be sent in an authenticated way as described in [RFC4895]. Other chunks MAY be sent in an authenticated way. This makes sure that an attacker cannot modify the stream in which a message is sent or affect the ordered/unordered delivery of the message.

If PR-SCTP as defined in [RFC3758] is used, FORWARD-TSN chunks MUST also be sent in an authenticated way as described in [RFC4895]. This makes sure that it is not possible for an attacker to drop messages and use forged FORWARD-TSN, SACK, and/or SHUTDOWN chunks to hide this dropping.

4.6. Renegotiation

DTLS supports renegotiation, and therefore this feature is also available by DTLS/SCTP. It is up to the upper layer to use/allow it or not. Application writers should be aware that allowing renegotiations may result in changes of security parameters.

4.7. Handshake

A DTLS implementation discards DTLS messages from older epochs after some time, as described in Section 4.1 of [RFC4347]. This is not acceptable when the DTLS user performs a reliable data transfer. To avoid discarding messages, the following procedures are required.

Before sending a ChangeCipherSpec message, all outstanding SCTP user messages MUST have been acknowledged by the SCTP peer and MUST NOT be revoked by the SCTP peer.

Prior to processing a received ChangeCipherSpec, all other received SCTP user messages that are buffered in the SCTP layer MUST be read and processed by DTLS.

User messages that arrive between ChangeCipherSpec and Finished messages and use the new epoch have probably passed the Finished message and MUST be buffered by DTLS until the Finished message is read.

4.8. Handling of Endpoint-Pair Shared Secrets

The endpoint-pair shared secret for Shared Key Identifier 0 is empty and MUST be used when establishing a DTLS connection. Whenever the master key changes, a 64-byte shared secret is derived from every master secret and provided as a new endpoint-pair shared secret by using the exporter described in [RFC5705]. The exporter MUST use the

label given in Section 5 and no context. The new Shared Key Identifier MUST be the old Shared Key Identifier incremented by 1. If the old one is 65535, the new one MUST be 1.

Before sending the Finished message, the active SCTP-AUTH key MUST be switched to the new one.

Once the corresponding Finished message from the peer has been received, the old SCTP-AUTH key SHOULD be removed.

4.9. Shutdown

To prevent DTLS from discarding DTLS user messages while it is shutting down, a CloseNotify message MUST only be sent after all outstanding SCTP user messages have been acknowledged by the SCTP peer and MUST NOT still be revoked by the SCTP peer.

Prior to processing a received CloseNotify, all other received SCTP user messages that are buffered in the SCTP layer MUST be read and processed by DTLS.

5. IANA Considerations

IANA added a value to the TLS Exporter Label registry as described in [RFC5705]. The label is "EXPORTER_DTLS_OVER_SCTP".

6. Security Considerations

The security considerations given in [RFC4347], [RFC4895], and [RFC4960] also apply to this document.

It is possible to authenticate DTLS endpoints based on IP addresses in certificates. SCTP associations can use multiple addresses per SCTP endpoint. Therefore, it is possible that DTLS records will be sent from a different IP address than that originally authenticated. This is not a problem provided that no security decisions are made based on that IP address. This is a special case of a general rule: all decisions should be based on the peer's authenticated identity, not on its transport layer identity.

For each message, the SCTP user also provides a stream identifier, a flag to indicate whether the message is sent ordered or unordered, and a payload protocol identifier. Although DTLS can be used to provide privacy for the actual user message, none of these three are protected by DTLS. They are sent as clear text, because they are part of the SCTP DATA chunk header.

DTLS supports cipher suites that contain a NULL cipher algorithm. Negotiating a NULL cipher algorithm will not provide communications privacy for applications and will not provide privacy for user messages.

7. Acknowledgments

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