

SSE BOF  
Internet-Draft  
Intended status: Standards Track  
Expires: August 7, 2016

R. Moskowitz  
HTT Consulting  
I. Faynberg  
H. Lu  
Alcatel-Lucent  
S. Hares  
Huawei  
P. Giacomin  
FreeLance  
February 4, 2016

Session Security Envelope  
draft-moskowitz-sse-02

Abstract

This memo specifies the details of the Session Security Envelope (SSE). SSE is a session protocol aiming to guarantee confidentiality, integrity and authentication completely independently by the underlying context, namely network and transport layers. A single session using the SSE protocol can include a single transport session or multiple transport sessions. This means that SSE can survive the break-down in network and transport layers or to attacks carried against them. SSE is also applicable in networks lacking in classic inter-networking and transport protocols. SSE relies on modern AEAD block cipher modes of operations, a class of block cipher modes which allows, at the same time, to authenticate the message while encrypting a part of it.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <http://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on August 7, 2016.

## Copyright Notice

Copyright (c) 2016 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<http://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

1.	Introduction . . . . .	2
2.	Terms and Definitions . . . . .	3
2.1.	Requirements Terminology . . . . .	3
2.2.	Notations . . . . .	3
2.3.	Definitions . . . . .	3
3.	SSL Security Boundary . . . . .	3
4.	API . . . . .	3
5.	Packet format . . . . .	4
5.1.	SSE compact format . . . . .	5
5.2.	SSE Large Format . . . . .	5
5.3.	SSE Extreme Format . . . . .	6
5.4.	Header Fields . . . . .	7
5.5.	AEAD integration . . . . .	7
6.	Packet processing and State Machine . . . . .	8
6.1.	Establishing a session . . . . .	8
6.2.	Processing Outgoing Application Data . . . . .	8
6.3.	Processing Incoming Application Data . . . . .	8
7.	IANA Considerations . . . . .	8
8.	Security Considerations . . . . .	8
9.	References . . . . .	9
9.1.	Normative References . . . . .	9
9.2.	Informative References . . . . .	9
	Authors' Addresses . . . . .	9

## 1. Introduction

This memo specifies the details of the Session Security Envelope (SSE). SSE is a session protocol aiming to guarantee confidentiality, integrity and authentication completely independently by the underlying context, namely network and transport layers. A single SSE session can span a single transport session or

multiple transport sessions. These transport sessions can use the same transport layer protocol (E.g. TCP) or use different transport protocols. SSE can survive the break-down in network and transport layers or to attacks carried against them. Moreover SSE will relies on modern AEAD block cipher modes of operations, a class of block cipher modes which allows, at the same time, to authenticate the message while encrypting a part of it.

## 2. Terms and Definitions

### 2.1. Requirements Terminology

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 RFC 2119, BCP 14 [RFC2119] and indicate requirement levels for compliant CoAP.

### 2.2. Notations

This section will contain notations

### 2.3. Definitions

AEAD Block Cypher: (definition needed)

SSE; Session Specific Envelope

## 3. SSL Security Boundary

The security boundary comes at layer above the IP transport layers (TCP, STCP, DTLS). This security allows the data to be secure prior to entering into a specific transport layer. A single SSE session can span 1 or N transport protocol connections. The multiple transport connections running under an SSE session may all use one protocol (e.g. TCP) or multiple protocols (e.g. TCP, STCP, DTLS). The higher layer security boundary provides a common security layer.

## 4. API

The initial API is part of a shim with socket call over a TCP socket.

```
s = int socket(int domain, int type, int protocol)
```

where:

domain: AF\_INET and AF\_INET6 supported

type: SOCK\_SECURE

```

    protocol: Transport protocol (TCP (6), UDP (6), SCTP (132))

int setsockopt(int sockfd, int level, int optname,
              const void *optval, socklen_t optlen);

int getsockopt(int sockfd, int level, int optname,
              const void *optval, socket
where:
sockfd:      # socket file descriptor
optname:    # option name (see below)
optval;     # points to *sse_transport structure;
optlen;     # length of option

optval values:
ADD_SSE_Transport[1]; # add transport to SSE
DELETE_SSE_Transport[2]; # delete transport to SSE
Query_SSE_Transport [3]; # Query transport

optval      *sse_transport[MAX_SSE_TRANSPORTS]; - for add/deletes

struct *sse_add_transport
    int nt_sockfd; # new transport socket
    int protocol; # new protocol
    );

struct

int getsockopt(int sockfd, int level, int optname, void *optval, socklen_t *
optlen);

int setsockopt(int sockfd, int level, int optname,
              const void *optval, socklen_t optlen);

```

Figure 1 - Example SSE Socket API

Note: The prototype for this SECURE\_SOCKET is on a FREEBSD OS.

## 5. Packet format

An SSE PDU is a Session Layer PDU (SPDU). In order to accommodate various use cases three formats are available for the PDU. The only difference between those formats is the size of length and sequence number fields. Following these fields is the encrypted payload and Integrity Check Value (ICV). Encrypted payload and ICV has a substructure depending on the choice of encryption algorithm and mode.

5.1. SSE compact format

SSE compact format aims to provide a Session Security Layer to applications leveraging on constrained network media with packet size limitations or high cost per bit transport.

In the SSE compact format:

SPI is 32 bits.

Length is 12 bits

Sequence Number is 20 bits

12 bits of Length allows (2<sup>12</sup>) 4096 bytes in the Encrypted Payload (does not include the ICV). 20 bits in the Sequence Number allows to send (2<sup>20</sup>) 1048576 packets before renegotiating the key. (The ICV length is set by the KMP parameters, so the length is known and therefore is not included in the length calculation)

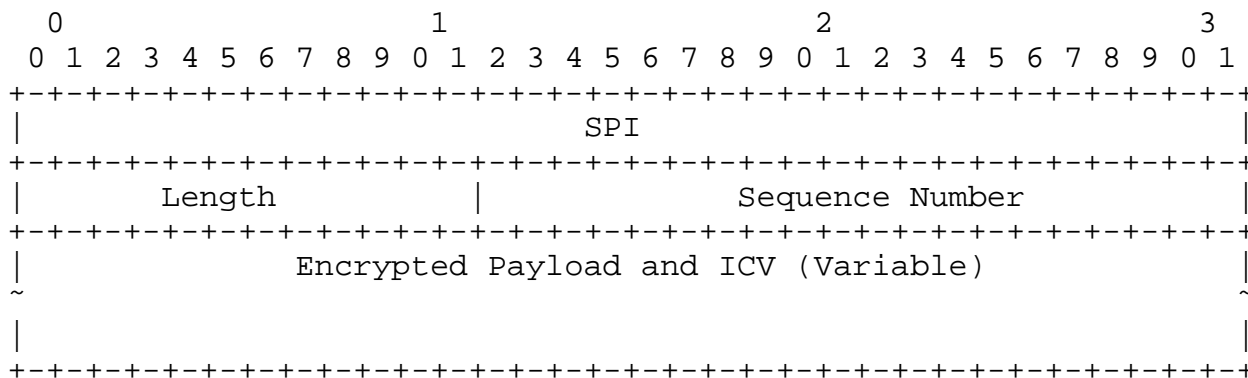


Figure 2 - Compact format

5.2. SSE Large Format

SSE large format aims provide a Session Security Layer to applications which have common sizes of transport packets.

In the SSE compact format:

SPI is 32 bits.

Length is 32 bits

Sequence Number is 32 bits

32 bits of Length allows  $(2^{32})$  or ~4Gbytes in the Encrypted Payload (does not include the ICV). 32 bits in the Sequence Number allows to send  $(2^{32})$  ~40 billion packets before renegotiating the key.

The 32 bits of length allows an IPv6 jumbogram to be included as in the SSE Large Format Payload

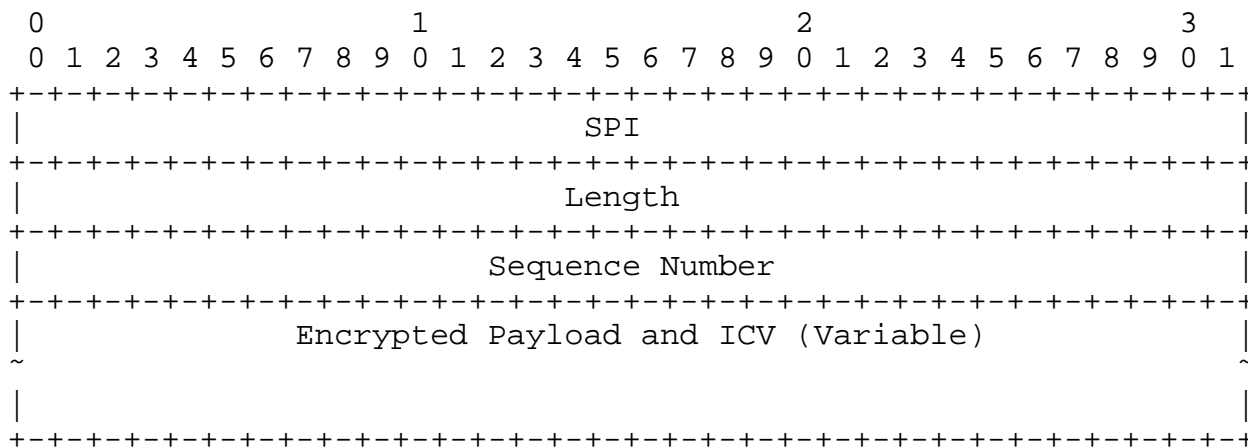


Figure 3 - Large Format

### 5.3. SSE Extreme Format

SSE large format aims provide a Session Security Layer to high performance networks.

In the SSE compact format:

SPI is 32 bits.

Length is 32 bits

Sequence Number is 64 bits

32 bits of Length allows  $(2^{32})$  4294967296 bytes (4Gbytes) in the Encrypted Payload (excluding the ICV). 32 bits in the Sequence Number allows to send  $(2^{64})$  18446744073709551616 (around  $18 * 10^{18}$ ) packets before renegotiating the key.

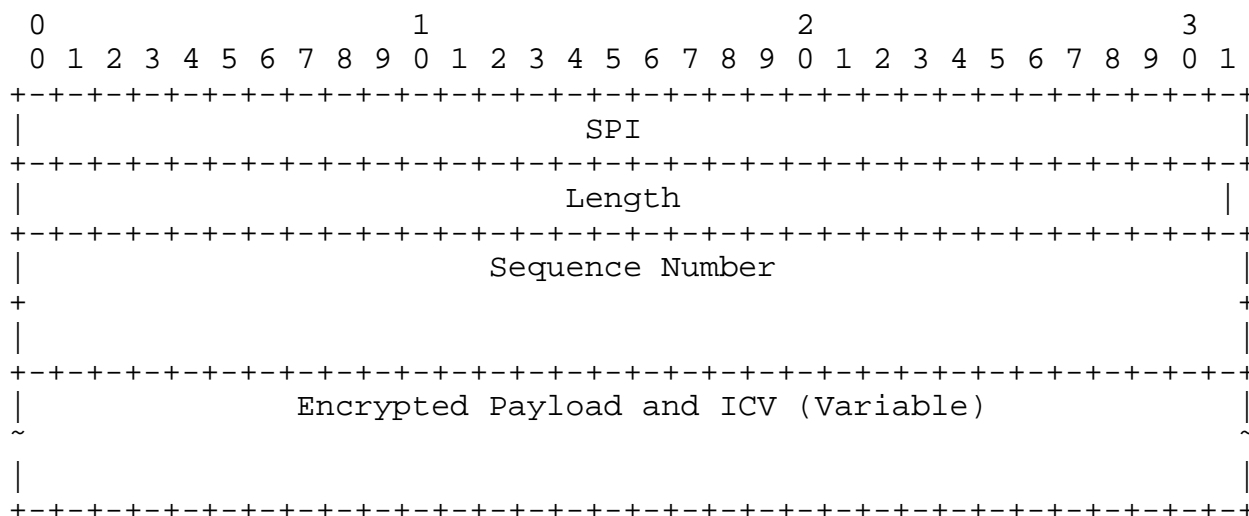


Figure 4 - Extreme Format

#### 5.4. Header Fields

SPI is the Security Parameter Index, a 32 bit number received from the external KMP. It is the index into the Security Association and is typically unidirectional. That is each direction in has its own SPI. A KMP for a unicast communication would provide the two SPIs. Multicast is different. Depending on the requirements, there can be one SPI for all transmitters or one per transmitter.

Length is the length in bytes of the encrypted payload. This does not include the ICV. The length of the ICV depends on the block cipher settings.

Sequence Number is a, strictly increasing by 1, counter. When the field cannot be increased without wrapping a key renegotiation MUST be performed. Please note that this Sequence Number has not the same meaning and implications of a Transport Layer sequence number, hence increasing by 1 is a good idea.

Note: It is common practice to rekey some time BEFORE the number space is exhausted.

#### 5.5. AEAD integration

SSE MUST use AEAD block cipher modes. AEAD block cypher modes will ensure confidentiality on the payload and integrity of both the payload and the headers (SPI, length and sequence number).

## 6. Packet processing and State Machine

SSE will spawn across several ports and protocols, hence each listened port and protocol can be a different SSE instance. See Architecture Draft.

### 6.1. Establishing a session

An application can establish a session via the SSE API, which in turn will interact with a KMP daemon. SSE instance will get all parameters related to the session from the KMP daemon.

Editorial note: Is this a local vulnerability?

### 6.2. Processing Outgoing Application Data

After having established an SSE session, an application can send application- level data using the normal socket calls. The SSE layer will encapsulate the packet, and send it on the appropriate transport session. The application doesn't need to know SPI, sequence number or key. The local SSE knows these facts, and keeps it within the SSE data associated with a set of transport connections.

### 6.3. Processing Incoming Application Data

After having established an SSE session, the packets will be sent to the transport layer for de-encapsulation. After header removal, the socket processing will hand it to the SSE processing for security check. If the packet is deemed secure, the socket will remove the SSE envelope. The application see the byte stream as data from a transport connection.

The application doesn't need to know SPI, sequence number or key, relying on a fake connection. (but its local SSE instance knows it, hence the application own memory where those are stored)

## 7. IANA Considerations

TBD.

## 8. Security Considerations

As SSE uses an AEAD block cipher, it is vulnerable to attack if a sequence number is reused for a given key. Thus implementations of SSE MUST provide for rekeying prior to Sequence Number rollover. An implementation should never assume that for a given context, the sequence number space will never be exhausted. Key Management Protocols like IKEv2 [RFC 4306] or HIP [RFC 7401] could be used to



provide for rekeying management. The KMP SHOULD not create a network layer fate-sharing limitation.

As any security protocol can be used for a resource exhaustion attack, implementations should consider methods to mitigate flooding attacks of messages with valid SPIs but invalid content. Even with the ICV check, resources are still consumed to validate the ICV.

SSE makes no attempt to recommend the ICV length. For constrained network implementations, other sources should guide the implementation as to ICV length selection. The ICV length selection SHOULD be the the responsibility of the KMP.

As with any layered security protocol, SSE makes no claims of protecting lower or higher processes in the communication stack. Each layer's risks and liabilities need be addressed at that level.

## 9. References

### 9.1. Normative References

- [RFC0791] Postel, J., "Internet Protocol", STD 5, RFC 791, DOI 10.17487/RFC0791, September 1981, <<http://www.rfc-editor.org/info/rfc791>>.
- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<http://www.rfc-editor.org/info/rfc2119>>.

### 9.2. Informative References

- [RFC4949] Shirey, R., "Internet Security Glossary, Version 2", FYI 36, RFC 4949, DOI 10.17487/RFC4949, August 2007, <<http://www.rfc-editor.org/info/rfc4949>>.

## Authors' Addresses

Robert Moskowitz  
HTT Consulting  
Oak Park, MI 48237

Email: [rgm@labs.htt-consult.com](mailto:rgm@labs.htt-consult.com)

Igor Faynberg  
Alcatel-Lucent  
Room 2D-144, 600 Mountain Avenue  
Murray Hill, NJ 07974  
USA

Email: igor.faynberg@alcatel-lucent.com

Huilan Lu  
Alcatel-Lucent  
Room 2D-144, 600 Mountain Avenue  
Murray Hill, NJ 07974  
USA

Email: huilan.lu@ALCATEL-LUCENT.COM

Susan Hares  
Huawei  
7453 Hickory Hill  
Saline, MI 48176  
USA

Email: shares@ndzh.com

Pierpaolo Giacomin  
FreeLance

Email: yrz@anche.no