

Network Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: January 28, 2019

V. Smyslov  
ELVIS-PLUS  
July 27, 2018

Auxiliary Exchange in the IKEv2 Protocol  
draft-smyslov-ipsecme-ikev2-aux-01

## Abstract

This document defines a new exchange, called Auxiliary Exchange, for the Internet Key Exchange protocol Version 2 (IKEv2). This exchange can be used for transferring large amount of data in the process of IKEv2 Security Association (SA) establishment. Introducing Auxiliary Exchange allows to re-use existing IKE Fragmentation mechanism, that helps to avoid IP fragmentation of large IKE messages, but cannot be used in the initial IKEv2 exchange.

## 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 January 28, 2019.

## Copyright Notice

Copyright (c) 2018 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

Internet-Draft

Auxiliary Exchange in IKEv2

July 2018

the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

## Table of Contents

<a href="#">1.</a>	<a href="#">Introduction</a>	<a href="#">2</a>
<a href="#">2.</a>	<a href="#">Terminology and Notation</a>	<a href="#">3</a>
<a href="#">3.</a>	<a href="#">Auxiliary Exchange Details</a>	<a href="#">3</a>
<a href="#">3.1.</a>	<a href="#">Support for Auxiliary Exchange Negotiation</a>	<a href="#">3</a>
<a href="#">3.2.</a>	<a href="#">Using Auxiliary Exchange</a>	<a href="#">4</a>
<a href="#">3.3.</a>	<a href="#">IKE_AUX Protection and Authentication</a>	<a href="#">4</a>
<a href="#">3.3.1.</a>	<a href="#">Protection of IKE_AUX Messages</a>	<a href="#">4</a>
<a href="#">3.3.2.</a>	<a href="#">Authentication of IKE_AUX Exchanges</a>	<a href="#">5</a>
<a href="#">3.4.</a>	<a href="#">Error Handling in IKE_AUX</a>	<a href="#">7</a>
<a href="#">4.</a>	<a href="#">Interaction with other IKEv2 Extensions</a>	<a href="#">7</a>
<a href="#">5.</a>	<a href="#">Security Considerations</a>	<a href="#">7</a>
<a href="#">6.</a>	<a href="#">IANA Considerations</a>	<a href="#">8</a>
<a href="#">7.</a>	<a href="#">Acknowledgements</a>	<a href="#">8</a>
<a href="#">8.</a>	<a href="#">References</a>	<a href="#">8</a>
<a href="#">8.1.</a>	<a href="#">Normative References</a>	<a href="#">8</a>
<a href="#">8.2.</a>	<a href="#">Informative References</a>	<a href="#">9</a>
	<a href="#">Author's Address</a>	<a href="#">9</a>

## [1.](#) Introduction

The Internet Key Exchange protocol version 2 (IKEv2) defined in [\[RFC7296\]](#) uses UDP as a transport for its messages. If size of the messages is large enough, IP fragmentation takes place that may interfere badly with some network devices. The problem is described in more detail in [\[RFC7383\]](#), which also defines an extension to the IKEv2 called IKE Fragmentation. This extension allows IKE messages to be fragmented at IKE level, eliminating possible issues caused by IP fragmentation. However, the IKE Fragmentation cannot be used in the initial IKEv2 exchange, IKE\_SA\_INIT. This limitation in most cases is not a problem, since the IKE\_SA\_INIT messages used to be small enough to not cause IP fragmentation.

Recent progress in Quantum Computing has brought a concern that classical Diffie-Hellman key exchange methods will become insecure in a relatively near future and should be replaced with Quantum Computer (QC) resistant ones. Currently most of QC-resistant key exchange methods have large public keys. If these keys are exchanged in the IKE\_SA\_INIT, then most probably IP fragmentation would take place,

therefore all the problems caused by it would become inevitable.

A possible solution to the problem would be to use TCP as a transport for IKEv2, as described in [[RFC8229](#)]. However this approach has

significant drawbacks and is intended to be a "last resort" when UDP transport is blocked by intermediate network devices.

This document defines a new exchange for the IKEv2 protocol, called Auxiliary Exchange or IKE\_AUX. One or more these exchanges may take place right after the IKE\_SA\_INIT exchange and prior to the IKE\_AUTH exchange. These exchanges may be used to exchange large amounts of data, which don't fit into the IKE\_SA\_INIT exchange without causing IP fragmentation. The IKE\_AUX messages can be fragmented using IKE Fragmentation mechanism.

While ability to transfer large public keys of QC-resistant key exchange methods was a primary motivation for the Auxiliary Exchange, its application is not limited to this use case. This exchange may be used whenever some data need to be transferred before the IKE\_AUTH exchange and for some reason the IKE\_SA\_INIT exchange is not suited for this purpose. It is expected that separate specifications will define how and when the IKE\_AUX exchange is used in the IKEv2.

## [2.](#) Terminology and Notation

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.](#) Auxiliary Exchange Details

### [3.1.](#) Support for Auxiliary Exchange Negotiation

The initiator indicates its support for Auxiliary Exchange by including a notification of type AUX\_EXCHANGE\_SUPPORTED in the IKE\_SA\_INIT request message. If the responder also supports this exchange, it includes this notification in the response message.

Initiator	Responder
-----	-----
HDR, SAi1, KEi, Ni, [N(AUX_EXCHANGE_SUPPORTED)]	-->
	<-- HDR, SAr1, KEr, Nr, [CERTREQ], [N(AUX_EXCHANGE_SUPPORTED)]

The AUX\_EXCHANGE\_SUPPORTED is a Status Type IKEv2 notification. Its Notify Message Type is <TBA by IANA>. Protocol ID and SPI Size are both set to 0. This specification doesn't define any data this notification may contain, so the Notification Data is left empty. However, future enhancements of this specification may override this.

Smyslov	Expires January 28, 2019	[Page 3]
---------	--------------------------	----------

---

Internet-Draft	Auxiliary Exchange in IKEv2	July 2018
----------------	-----------------------------	-----------

Implementations MUST ignore the non-empty Notification Data if they don't understand its purpose.

### [3.2.](#) Using Auxiliary Exchange

If both peers indicated their support for the Auxiliary Exchange, the initiator may use one or more these exchanges to transfer additional data. Using the IKE\_AUX exchange is optional, the initiator may find it unnecessary after completing the IKE\_SA\_INIT exchange.

The Auxiliary Exchange is denoted as IKE\_AUX, its Exchange Type is <TBA by IANA>.

Initiator	Responder
-----	-----
HDR, ..., SK {...} -->	
	<-- HDR, ..., SK {...}

The initiator may use several IKE\_AUX exchanges if necessary. Since initiator's Window Size is initially set to one ([Section 2.3 of \[RFC7296\]](#)), these exchanges MUST follow each other and MUST all be completed before the IKE\_AUTH exchange is initiated. The IKE SA MUST NOT be considered as established until the IKE\_AUTH exchange is successfully completed.

The Message IDs for the IKE\_AUX exchanges MUST be chosen according to the standard IKEv2 rule, described in the [Section 2.2. of \[RFC7296\]](#), i.e. it is set to 1 for the first IKE\_AUX exchange, 2 for the next (if any) and so on. The message ID for the first pair of the

IKE\_AUTH messages is one more than the last IKE\_AUX Message ID.

The content of the IKE\_AUX messages depends on the data being transferred and will be defined by specifications utilizing this exchange. However, since the main motivation for IKE\_AUX is to avoid IP fragmentation when large amount of data need to be transferred prior to IKE\_AUTH, the Encrypted payload SHOULD be present in the IKE\_AUX messages and payloads containing large data SHOULD be placed inside. This will allow IKE Fragmentation [[RFC7383](#)] to take place, provided it is supported by the peers and negotiated in the initial exchange.

### [3.3.](#) IKE\_AUX Protection and Authentication

#### [3.3.1.](#) Protection of IKE\_AUX Messages

The keys SK\_e[i/r] and SK\_a[i/r] for the Encrypted payload in the IKE\_AUX exchanges are computed in a standard fashion, as defined in the [Section 2.14 of \[RFC7296\]](#). Every subsequent IKE\_AUX exchange

Smyslov

Expires January 28, 2019

[Page 4]

---

Internet-Draft

Auxiliary Exchange in IKEv2

July 2018

uses the most recently calculated keys before this exchange is started. The first IKE\_AUX exchange always uses SK\_e[i/r] and SK\_a[i/r] keys that were computed as result the IKE\_SA\_INIT exchange. If this IKE\_AUX exchange performs additional key exchange resulting in the update of SK\_e[i/r] and SK\_a[i/r], then these updated keys are used for encryption and authentication of next IKE\_AUX exchange, otherwise the current keys are used, and so on.

#### [3.3.2.](#) Authentication of IKE\_AUX Exchanges

The data transferred in the IKE\_AUX exchanges must be authenticated in the IKE\_AUTH exchange. For this purpose the definition of the blob to be signed (or MAC'ed) from the [Section 2.15 of \[RFC7296\]](#) is modified as follows:

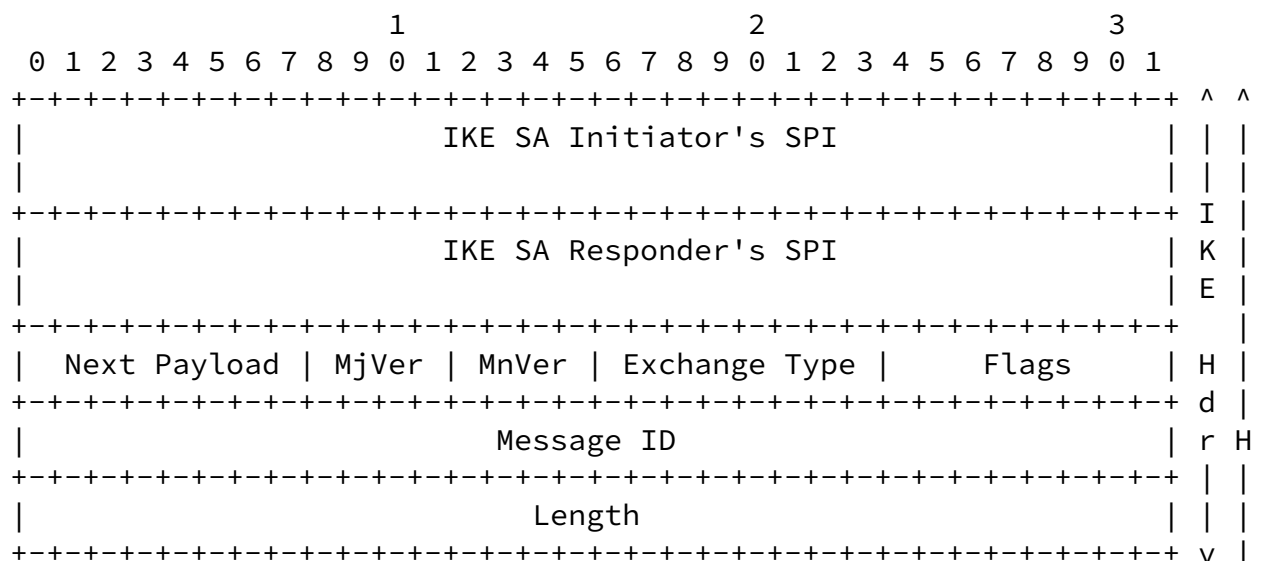
```
InitiatorSignedOctets = RealMessage1 | AUX_I | NonceRData | MACedIDForI
AUX_I = [AUX_PRF_I_1 [| AUX_PRF_I_2 [| AUX_PRF_I_3]]] ...
AUX_PRF_I_1 = prf(SK_pi_1, IKE_AUX_I_1_H [| IKE_AUX_I_1_E])
AUX_PRF_I_2 = prf(SK_pi_2, IKE_AUX_I_2_H [| IKE_AUX_I_2_E])
AUX_PRF_I_3 = prf(SK_pi_3, IKE_AUX_I_3_H [| IKE_AUX_I_3_E])
...
```

```

ResponderSignedOctets = RealMessage2 | AUX_R | NonceIDData | MACedIDForR
AUX_R = [AUX_PRF_R_1 [| AUX_PRF_R_2 [| AUX_PRF_R_3]]] ...
AUX_PRF_R_1 = prf(SK_pr_1, IKE_AUX_R_1_H [| IKE_AUX_R_1_E])
AUX_PRF_R_2 = prf(SK_pr_2, IKE_AUX_R_2_H [| IKE_AUX_R_2_E])
AUX_PRF_R_3 = prf(SK_pr_3, IKE_AUX_R_3_H [| IKE_AUX_R_3_E])
...

```

AUX\_PRF\_I\_1/AUX\_PRF\_R\_1, AUX\_PRF\_I\_2/AUX\_PRF\_R\_2, AUX\_PRF\_I\_3/AUX\_PRF\_R\_1, etc. represent the results of applying the negotiated prf to the content of the IKE\_AUX messages sent by the initiator (AUX\_PRF\_I\_\*) by the responder (AUX\_PRF\_R\_\*) in an order of increasing MessageIDs (i.e. in an order the IKE\_AUX exchanges took place). The prf is applied to the two chunks of data: IKE\_AUX\_[I/R]\_\*\_H and optionally IKE\_AUX\_[I/R]\_\*\_E. The IKE\_AUX\_[I/R]\_\*\_H chunk lasts from the first octet of the IKE Header (not including prepended four octets of zeros, if any) to the last octet of the Encrypted Payload header (or to the end of the message in case the Encrypted payload is not present). The IKE\_AUX\_[I/R]\_\*\_E chunk is computed if the Encrypted payload is present and consists of the not yet encrypted content of the Encrypted payload, excluding Initialization Vector, Padding, Pad Length and Integrity Checksum Data fields (see 3.14 of [[RFC7296](#)] for description of the Encrypted payload). In other words, the IKE\_AUX\_[I/R]\_\*\_E chunk is the inner payloads of the Encrypted payload in plaintext form.



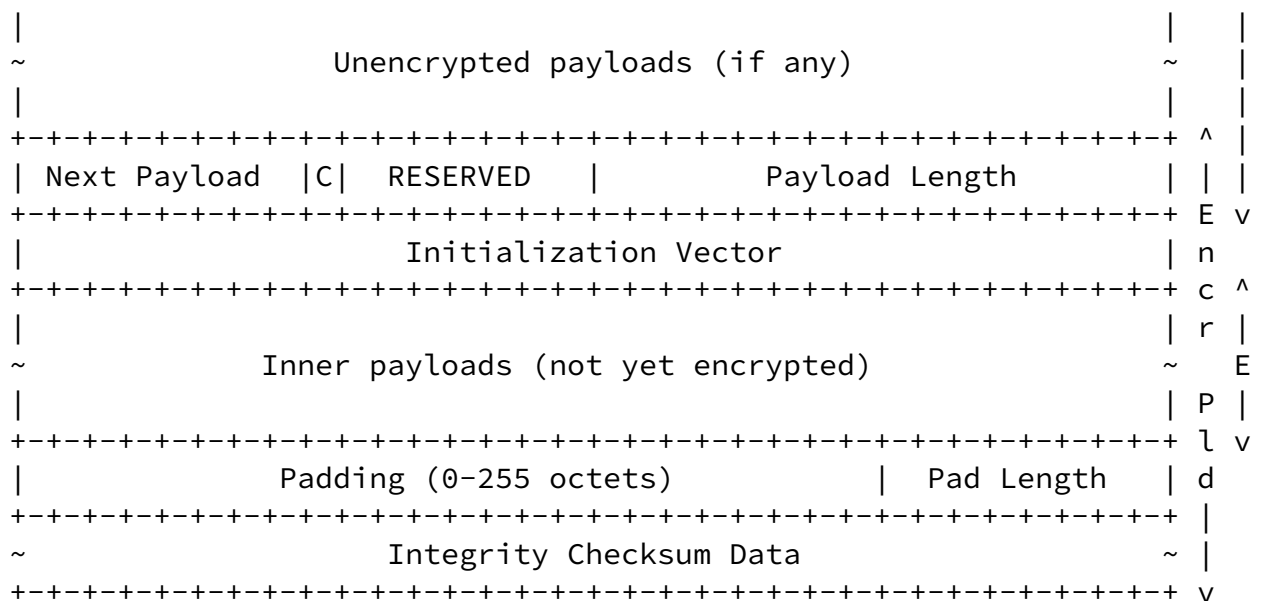


Figure 1: Data to Authenticate in IKE\_AUX Exchange

Figure 1 illustrates the layout of the IKE\_AUX\*\_\*\_H (denoted as H) and the IKE\_AUX\*\_\*\_E (denoted as E) chunks in case the Encrypted payload is present in the message. Note, that while the Encrypted payload is not required to be present in the IKE\_AUX messages, the intended purpose of this exchange is to allow transferring large amount of data utilizing IKE fragmentation, so in most cases the Encrypted payload will be present.

The calculations are applied to whole messages only, before possible fragmentation. This ensures that the AUX\_I/AUX\_R will be the same regardless of whether fragmentation takes place or not ([RFC7383] allows sending first unfragmented message and then trying fragmentation in case of no reply).

Each calculation of AUX\_PRF\_[I/R]\_\* uses its own key SK\_p[i/r]\_\*, which is the most recently updated SK\_p[i/r] key available before the corresponded IKE\_AUX exchange is started. The first IKE\_AUX exchange always uses SK\_p[i/r] key that was computed in the IKE\_SA\_INIT as SK\_p[i/r]\_1. If the first IKE\_AUX exchange performs additional key exchange resulting in SK\_p[i/r] update, then this updated SK\_p[i/r] is used as SK\_p[i/r]\_2, otherwise the original SK\_p[i/r] is used, and so on. Note, that if keys are updated then for any given IKE\_AUX

exchange the keys SK\_e[i/r] and SK\_a[i/r] used for IKE\_AUX messages protection (see [Section 3.3.1](#)) and the keys SK\_p[i/r] for their authentication are always from the same generation.

#### [3.4.](#) Error Handling in IKE\_AUX

Since IKE\_AUX messages are not authenticated until the IKE\_AUTH exchange successfully completes, possible errors need to be handled carefully. There is a trade-off between providing a better diagnostics of the problem and a risk to become a part of DoS attack. See [Section 2.21.1](#) and 2.21.2 of [[RFC7296](#)] describe how errors are handled in initial IKEv2 exchanges, these considerations are applied to an IKE\_AUX exchange too.

#### [4.](#) Interaction with other IKEv2 Extensions

The IKE\_AUTH exchanges may be used in the IKEv2 Session Resumption [[RFC5723](#)] between the IKE\_SESSION\_RESUME and the IKE\_AUTH exchanges.

#### [5.](#) Security Considerations

The data that is transferred by means of the IKE\_AUX exchanges is not authenticated until the subsequent IKE\_AUTH exchange is completed. However, if the data is placed inside the Encrypted payload, then it is protected from passive eavesdroppers. In addition the peers can be certain that they receives messages from the party he/she performed the IKE\_SA\_INIT with if they can successfully verify the Integrity Checksum Data of the Encrypted payload.

The main application for Auxiliary Exchange is to transfer large amount of data before IKE SA is set up without causing IP fragmentation. For that reason it is expected that in most cases IKE Fragmentation will be employed in the IKE\_AUX exchanges. [Section 5 of \[\[RFC7383\]\(#\)\]](#) contains security considerations for IKE Fragmentation.

Note, that if an attacker was able to break key exchange in real time (e.g. by means of Quantum Computer), then the security of IKE\_AUX would degrade. In particular, such an attacker would be able both to read data contained in the Encrypted payload and to forge it. The forgery would become evident in the IKE\_AUTH exchange (provided the

attacker cannot break employed authentication mechanism), but the



ability to inject forged IKE\_AUX messages with valid ICV would allow the attacker to mount Denial-of-Service attack. Moreover, if in this situation the negotiated prf was not secure against preimage attack with known key, then the attacker could forge IKE\_AUX messages without later being detected in the IKE\_AUTH exchange. To do this the attacker should find the same AUX\_PRF\_\*\_\* value for the forged message as for original.

## 6. IANA Considerations

This document defines a new Exchange Type in the "IKEv2 Exchange Types" registry:

<TBA>           IKE\_AUX

This document also defines a new Notify Message Types in the "Notify Message Types - Status Types" registry:

<TBA>           AUX\_EXCHANGE\_SUPPORTED

## 7. Acknowledgements

The idea to use an intermediate exchange between IKE\_SA\_INIT and IKE\_AUTH was first suggested by Tero Kivinen. Scott Fluhrer and Daniel Van Geest identified a possible problem with authentication of IKE\_AUX exchange and helped to resolve it.

## 8. References

### 8.1. 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/info/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/info/rfc8174>>.
- [RFC7296] Kaufman, C., Hoffman, P., Nir, Y., Eronen, P., and T. Kivinen, "Internet Key Exchange Protocol Version 2 (IKEv2)", STD 79, [RFC 7296](#), DOI 10.17487/RFC7296, October 2014, <<https://www.rfc-editor.org/info/rfc7296>>.

- [RFC7383] Smyslov, V., "Internet Key Exchange Protocol Version 2 (IKEv2) Message Fragmentation", [RFC 7383](#), DOI 10.17487/RFC7383, November 2014, <<https://www.rfc-editor.org/info/rfc7383>>.

## 8.2. Informative References

- [RFC8229] Pauly, T., Touati, S., and R. Mantha, "TCP Encapsulation of IKE and IPsec Packets", [RFC 8229](#), DOI 10.17487/RFC8229, August 2017, <<https://www.rfc-editor.org/info/rfc8229>>.
- [RFC5723] Sheffer, Y. and H. Tschofenig, "Internet Key Exchange Protocol Version 2 (IKEv2) Session Resumption", [RFC 5723](#), DOI 10.17487/RFC5723, January 2010, <<https://www.rfc-editor.org/info/rfc5723>>.

## Author's Address

Valery Smyslov  
ELVIS-PLUS  
PO Box 81  
Moscow (Zelenograd) 124460  
RU

Phone: +7 495 276 0211  
Email: [svan@elvis.ru](mailto:svan@elvis.ru)

Smyslov

Expires January 28, 2019

[Page 9]