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IKEv2 Optional SA&TS Payloads in Child Exchange

Abstract

This document describes a method for reducing the size of the Internet Key Exchange version 2 (IKEv2) CREATE_CHILD_SA exchanges used for rekeying of the IKE or Child SA by replacing the SA and TS payloads with a Notify Message payload. Reducing size and complexity of IKEv2 exchanges is especially useful for low power consumption battery powered devices.

Status of This Memo

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1. Introduction

The Internet Key Exchange protocol version 2 (IKEv2) [RFC7296] is used to negotiate Security Association (SA) parameters for the IKE SA and the Child SAs. Cryptographic key material for these SAs have a limited lifetime before it needs to be refreshed, a process referred to as "rekeying". IKEv2 uses the CREATE_CHILD_SA exchange to rekey either the IKE SA or the Child SAs.

When rekeying, a full set of previously negotiated parameters are exchanged. However, most of these parameters will be the same, and some of these parameters MUST be the same.

For example, the Traffic Selector (TS) negotiated for the new Child SA MUST cover the Traffic Selectors negotiated for the old Child SA. And in practically all cases, a new Child SA would not need to cover more Traffic Selectors. In the rare case where this would be needed, a new Child SA could be negotiated instead of the current Child SA being rekeyed. Similarly, IKEv2 states that the cryptographic parameters negotiated for rekeying SHOULD NOT be different. This means that the security properties of the IKE or Child SA in practise do not change during a typical rekey.

This document specifies a method to omit these parameters and replace them with a single Notify Message declaring that all these parameters are identical to the originally negotiated parameters.

For security gateways/ePDG in 4G networks or cRAN/Cloud gateways in 5G networks, gateways typically support more than 100,000 IKE/IPSec tunnels. At any point in time, there will be hundreds or thousands of IKE SAs and Child SAs that are being rekeyed. This takes a large amount of bandwidth and CPU power and any protocol simplification or bandwidth reducing would result in an significant resource saving.

For Internet of Things (IoT) devices which utilize low power consumption technology, reducing the size of rekey exchange reduces its power consumption, as sending bytes over the air is usually the most power consuming operation of such a device. Reducing the CPU operations required to verify the rekey exchanges parameters will also save power and extend the lifetime for these devices.

When using identical parameters during the IKE or Child SA rekey, the SA and TS payloads can be omitted. For an IKE SA rekey, instead of the (large) SA payload, only a Key Exchange (KE) payload and a new Notify Type payload with the new SPI is required. For a Child SA payload, instead of the SA or TS payloads, only an optional Nonce payload (when using PFS) and a new Notify Type payload with the new SPI is needed. This makes the rekey exchange packets much smaller and the peers do not need to verify that the SA or TS parameters are compatible with the old SA.

2. Conventions Used in This Document

2.1. Requirements Language

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. Negotiation of Support for OPTIMIZED REKEY

To indicate support for the optimized rekey negotiation, the initiator includes the OPTIMIZED_REKEY_SUPPORTED Notify payload in the IKE_AUTH exchange request. A responder that supports the optimized rekey exchange includes the OPTIMIZED_REKEY_SUPPORTED Notify payload in its response. Note that the notify indicates support for optimized rekey for both IKE and Child SAs.

When a peer wishes to rekey an IKE SA or Child SA, it MAY use the optimized rekey method during the CREATE_CHILD_SA exchange. A responder MUST accept that the initiator uses a regular or optimized rekey.

The IKE_AUTH message exchange in this case is shown below:

```
Initiator                          Responder
-------------------------------------------------------------------
HDR, SK {IDi, [CERT,] [CERTREQ,]
    [IDr,] AUTH, SAi2, TSi, TSr,
    N(OPTIMIZED_REKEY_SUPPORTED)} -->
                                <-- HDR, SK {IDr, [CERT,] AUTH,
                                        SAr2, TSi, TSr,
                                        N(OPTIMIZED_REKEY_SUPPORTED)}
```

If the responder does not support this extension, as per regular IKEv2 processing, it MUST ignore the unknown Notify payload. The initiator will notice the lack of the OPTIMIZED_REKEY_SUPPORTED Notify in the reply and thus know it cannot use the optimized rekey method.

4. Optimized Rekey of the IKE SA

The initiator of an optimized rekey request sends a CREATE_CHILD_SA payload with the OPTIMIZED_REKEY notify payload containing the new Security Parameter Index (SPI) for the new IKE SA. It omits the SA payload.

The responder of an optimized rekey request performs the same process. It includes the OPTIMIZED_REKEY notify with its new IKE SPI and omits the SA payload.

Both parties send Nonce and KE payloads just as they would do for a regular IKE SA rekey.

The CREATE_CHILD_SA message exchange in this case is shown below:

```
Initiator                          Responder
-------------------------------------------------------------------
HDR, SK {N(OPTIMIZED_REKEY),
    Ni, KEi} -->
                                <-- HDR, SK {N(OPTIMIZED_REKEY),
                                        Nr, KEr}
```

5. Optimized Rekey of Child SAs

The initiator of an optimized rekey request sends a CREATE_CHILD_SA payload with the OPTIMIZED_REKEY notify payload containing the new Security Parameter Index (SPI) for the new Child SA. It omits the SA and TS payloads. If the current Child SA was negotiated with Perfect Forward Secrecy (PFS), a KEi payload MUST be included as well. If no PFS was negotiated for the current Child SA, a KEi payload MUST NOT be included.

The responder of an optimized rekey request performs the same process. It includes the OPTIMIZED_REKEY notify with its new IKE SPI

and omits the SA and TS payloads. Depending on the PFS negotiation of the current Child SA, the responder includes a KEr payload.

Both parties send Nonce payloads just as they would do for a regular Child SA rekey.

Using the received old SPI from the REKEY_SA payload and the new SPI received from the OPTIMIZED_REKEY payload, both parties can perform the Child SA rekey operation.

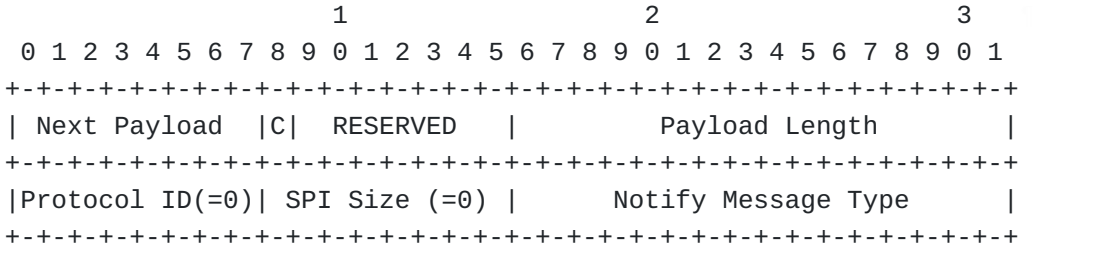
The CREATE_CHILD_SA message exchange in this case is shown below:

```
Initiator                          Responder
-------------------------------------------------------------------
HDR, SK {N(REKEY_SA), N(OPTIMIZED_REKEY),
    Ni, [KEi,]} -->
                                <-- HDR, SK {N(OPTIMIZED_REKEY),
                                        Nr, [KEr,]}
```

6. Payload Formats

6.1. OPTIMIZED_REKEY_SUPPORTED Notify

The OPTIMIZED_REKEY_SUPPORTED Notify Message type notification is used by the initiator and responder to indicate their support for the optimized rekey negotiation.



*Protocol ID (1 octet) - MUST be 0.

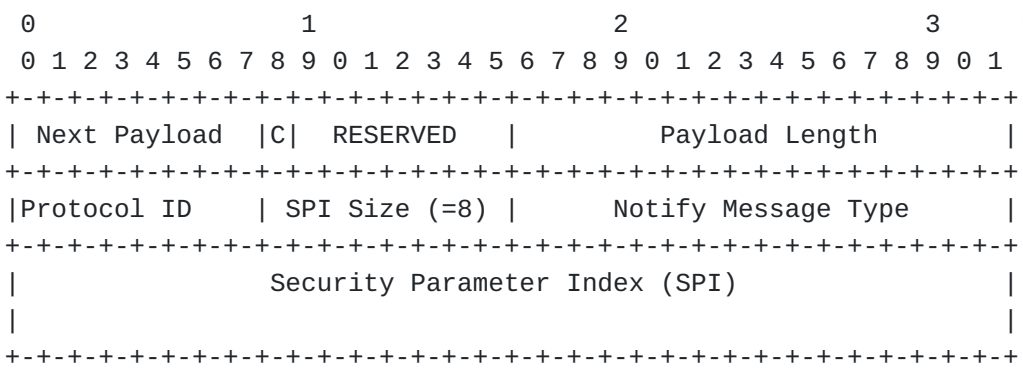
*SPI Size (1 octet) - MUST be 0, meaning no SPI is present.

*Notify Message Type (2 octets) - MUST be set to the value [TBD1].

This Notify Message type contains no data.

6.2. OPTIMIZED_REKEY Notify

The OPTIMIZED_REKEY Notify Message type is used to perform an optimized IKE SA or Child SA rekey.



*Protocol ID (1 octet) - MUST be 1.

*SPI Size (1 octet) - MUST be 8 when rekeying an IKE SA. MUST be 4 when rekeying a Child SA.

*Notify Message Type (2 octets) - MUST be set to the value [TBD2].

*SPI (4 octets or 8 octets) - Security Parameter Index. The peer's new SPI.

7. IANA Considerations

This document defines two new Notify Message Types in the "IKEv2 Notify Message Types - Status Types" registry. IANA is requested to assign codepoints in this registry.

NOTIFY messages: status types	Value
OPTIMIZED_REKEY_SUPPORTED	TBD1
OPTIMIZED_REKEY	TBD2

8. Operational Considerations

Some implementations allow sending rekey messages with a different set of Traffic Selectors or cryptographic parameters in response to a configuration update. IKEv2 states this SHOULD NOT be done. Whether or not optimized rekeying is used, a configuration change that changes the Traffic Selectors or cryptographic parameters MUST NOT use the optimized rekey method. It SHOULD also not use a regular rekey method but instead start an entire new IKE and Child SA negotiation with the new parameters.

9. Security Considerations

The optimized rekey removes sending unnecessary new parameters that originally would have to be validated against the original parameters. In that sense, this optimization enhances the security of the rekey process.

10. Acknowledgments

Special thanks go to Paul Wouters, Valery Smyslov, and Antony Antony.

11. Normative References

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[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>.

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