

Internet Engineering Task Force (IETF)
Request for Comments: 9593
Category: Standards Track
ISSN: 2070-1721

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July 2024

Announcing Supported Authentication Methods in the Internet Key Exchange Protocol Version 2 (IKEv2)

Abstract

This specification defines a mechanism that allows implementations of the Internet Key Exchange Protocol Version 2 (IKEv2) to indicate the list of supported authentication methods to their peers while establishing IKEv2 Security Associations (SAs). This mechanism improves interoperability when IKEv2 partners are configured with multiple credentials of different types for authenticating each other.

Status of This Memo

This is an Internet Standards Track document.

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A.1. No Need to Use the IKE_INTERMEDIATE Exchange

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Acknowledgments

Author's Address

1. Introduction

The Internet Key Exchange Protocol Version 2 (IKEv2), defined in [RFC7296], performs authenticated key exchange in IPsec. IKEv2, unlike its predecessor IKEv1, defined in [RFC2409], doesn't include a mechanism to negotiate an authentication method that the peers would use to authenticate each other. It is assumed that each peer selects whichever authentication method it thinks is appropriate, depending on authentication credentials it has.

This approach generally works well when there is no ambiguity in selecting authentication credentials. SA establishment failure between peers may occur when there are several credentials of different types configured on one peer, while only some of them are supported on the other peer. Another problem situation is when a single credential may be used to produce different types of authentication tokens (e.g., signatures of different formats). Since IKEv2 requires that each peer use exactly one authentication method, and it doesn't provide means for peers to indicate to the other side which authentication methods they support, the peer that supports a wider range of authentication methods (or authentication token formats) could improperly select a method (or format) that is not supported by the other side.

Emerging post-quantum signature algorithms may bring additional challenges for implementations, especially if so-called hybrid schemes are used (e.g., see [COMPOSITE-SIGS]).

This specification defines an extension to the IKEv2 protocol that allows peers to announce their supported authentication methods, thus decreasing risks of SA establishment failure in situations when there are several ways for the peers to authenticate themselves.

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. Protocol Details

When establishing an IKE SA, each party may send to its peer a list of the authentication methods it supports and is configured to use. For this purpose, this specification introduces a new Notify Message Type `SUPPORTED_AUTH_METHODS`. The Notify payload with this Notify Message Type is utilized to convey the supported authentication methods of the party sending it. The sending party may additionally specify that some of the authentication methods are only for use with the particular trust anchors. The receiving party may take this information into consideration when selecting an algorithm for its authentication (i.e., the algorithm used for calculation of the AUTH payload) if several alternatives are available. To simplify the receiver's task of linking the announced authentication methods with the trust anchors, the protocol ensures that the `SUPPORTED_AUTH_METHODS` notification is always co-located with the

CERTREQ payload in the same message.

3.1. Exchanges

The initiator starts the IKE_SA_INIT exchange as usual. If the responder is willing to use this extension, it includes a new notification SUPPORTED_AUTH_METHODS in the IKE_SA_INIT response message. This notification contains a list of authentication methods supported by the responder, ordered by their preference.

Initiator	Responder
-----	-----
HDR, SAi1, KEi, Ni -->	
	<-- HDR, SAR1, KEr, Nr, [CERTREQ,] [N(SUPPORTED_AUTH_METHODS)(...)]

Figure 1: The IKE_SA_INIT Exchange

If the initiator doesn't support this extension, it ignores the received notification as an unknown status notify.

Regardless of whether the notification is received, if the initiator supports and is willing to use this extension, it includes the SUPPORTED_AUTH_METHODS notification in the IKE_AUTH request message, with a list of authentication methods supported by the initiator, ordered by their preference.

Initiator	Responder
-----	-----
HDR, SK {IDi, [CERT,] [CERTREQ,] [IDr,] AUTH, SAi2, TSi, TSr, [N(SUPPORTED_AUTH_METHODS)(...)] } -->	
	<-- HDR, SK {IDr, [CERT,] AUTH, SAR2, TSi, TSr }

Figure 2: The IKE_AUTH Exchange

Because the responder sends the SUPPORTED_AUTH_METHODS notification in the IKE_SA_INIT exchange, it must take into account that the response message could grow so much that the IP fragmentation might take place.

- * the SUPPORTED_AUTH_METHODS notification to be included is so large, that the responder suspects that IP fragmentation of the resulting IKE_SA_INIT response message may happen;
- * both peers support the IKE_INTERMEDIATE exchange, defined in [RFC9242] (i.e., the responder has received and is going to send the INTERMEDIATE_EXCHANGE_SUPPORTED notification);

then the responder MAY choose not to send an actual list of the supported authentication methods in the IKE_SA_INIT exchange and instead ask the initiator to start the IKE_INTERMEDIATE exchange for the list to be sent in. This would allow using IKE fragmentation [RFC7383] for long messages (which cannot be used in the IKE_SA_INIT exchange), thus avoiding IP fragmentation. In this case, the responder includes a SUPPORTED_AUTH_METHODS notification containing no data in the IKE_SA_INIT response.

If the initiator receives the empty SUPPORTED_AUTH_METHODS notification in the IKE_SA_INIT exchange, it means that the responder is going to send the list of the supported authentication methods in the IKE_INTERMEDIATE exchange. If this exchange is to be initiated anyway for some other reason, then the responder MAY use it to send the SUPPORTED_AUTH_METHODS notification. Otherwise, the initiator MAY start the IKE_INTERMEDIATE exchange for this sole purpose by

sending an empty `IKE_INTERMEDIATE` request. The initiator MAY also indicate its identity (and possibly the perceived responder's identity too) by including the `IDI` payload (possibly along with the `IDr` payload) in the `IKE_INTERMEDIATE` request. This information could help the responder to send back only those authentication methods that are configured to be used for authentication of this particular initiator. If these payloads are sent, they MUST be identical to the `IDI`/`IDr` payloads sent later in the `IKE_AUTH` request.

If the responder has sent any `CERTREQ` payload in the `IKE_SA_INIT`, then it SHOULD resend the same payload(s) in the `IKE_INTERMEDIATE` response containing the `SUPPORTED_AUTH_METHODS` notification if any of the included Announcements has a non-zero Cert Link field (see Sections 3.2.2 and 3.2.3). This requirement allows peers to have a list of Announcements and a list of CAs in the same message, which simplifies their linking. Note that this requirement is always fulfilled for the `IKE_SA_INIT` and `IKE_AUTH` exchanges. However, if for any reason the responder doesn't resend `CERTREQ` payload(s) in the `IKE_INTERMEDIATE` exchange, then the initiator MUST NOT abort negotiation. Instead, the initiator MAY either link the Announcements to the CAs received in the `IKE_SA_INIT` response, or it MAY ignore the Announcements containing links to CAs.

If multiple `IKE_INTERMEDIATE` exchanges take place during IKE SA establishments, it is RECOMMENDED that the responder use the last `IKE_INTERMEDIATE` exchange (the one just before `IKE_AUTH`) to send the list of supported authentication methods. However, it is not always possible for the responder to know how many `IKE_INTERMEDIATE` exchanges the initiator will use. In this case the responder MAY send the list in any `IKE_INTERMEDIATE` exchange. If the initiator sends `IDI`/`IDr` in an `IKE_INTERMEDIATE` request, then it is RECOMMENDED that the responder sends back the list of authentication methods in the response.

Initiator	Responder
-----	-----
HDR, SAi1, KEi, Ni -->	
	<-- HDR, SAR1, KEr, Nr, [CERTREQ,] [N(SUPPORTED_AUTH_METHODS)]
HDR, SK {..., [IDI, [IDr,]]} -->	
	<-- HDR, SK {..., [CERTREQ,] [N(SUPPORTED_AUTH_METHODS)(...)] }
HDR, SK {IDI, [CERT,] [CERTREQ,] [IDr,] AUTH, SAi2, TSi, TSr, [N(SUPPORTED_AUTH_METHODS)(...)] } -->	
	<-- HDR, SK {IDr, [CERT,] AUTH, SAR2, TSi, TSr }

Figure 3: Using the `IKE_INTERMEDIATE` Exchange for Sending Authentication Methods

Note that sending the `SUPPORTED_AUTH_METHODS` notification and using information obtained from it are optional for both the initiator and the responder. If multiple `SUPPORTED_AUTH_METHODS` notifications are included in a message, all their announcements form a single ordered list, unless overridden by other extension (see Section 4).

3.2. `SUPPORTED_AUTH_METHODS` Notify Message Type

The format of the `SUPPORTED_AUTH_METHODS` Notify payload is shown below.

	1	2	3																		
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1

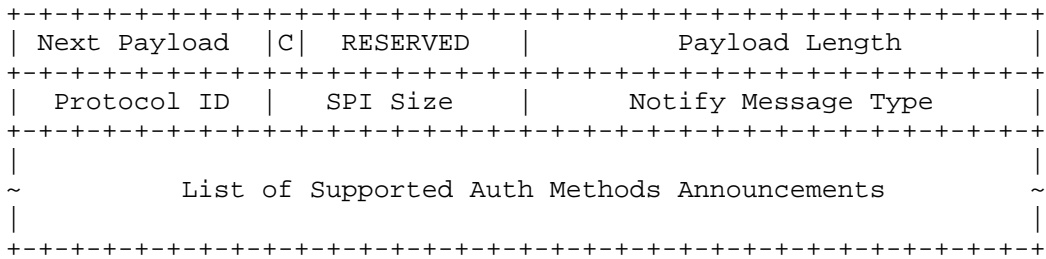


Figure 4: SUPPORTED_AUTH_METHODS Notify Payload Format

The Notify payload format is defined in Section 3.10 of [RFC7296]. When a Notify payload of type SUPPORTED_AUTH_METHODS is sent, the Protocol ID field is set to 0, the SPI Size is set to 0 (meaning there is no SPI field), and the Notify Message Type is set to 16443.

Notification data contains the list of supported authentication methods announcements. Each individual announcement is a variable-size data blob whose format depends on the announced authentication method. The blob always starts with an octet containing the length of the blob followed by an octet containing the authentication method. Authentication methods are represented as values from the "IKEv2 Authentication Method" registry defined in [IKEV2-IANA]. The meaning of the remaining octets of the blob, if any, depends on the authentication method. Note that, for the currently defined authentication methods, the length octet fully defines both the format and the semantics of the blob.

If more authentication methods are defined in the future, the corresponding documents must describe the semantics of the announcements for these methods. Implementations MUST ignore announcements whose semantics they don't understand.

3.2.1. 2-Octet Announcement

If the announcement contains an authentication method that is not concerned with public key cryptography, then the following format is used.

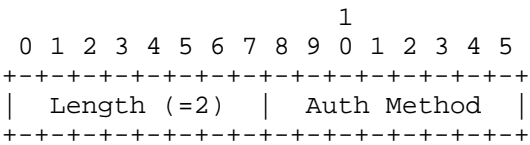


Figure 5: 2-Octet Announcement Format

Length: Length of the blob in octets; must be 2 for this case.

Auth Method: Announced authentication method.

This format is applicable for the authentication methods "Shared Key Message Integrity Code" (2) and "NULL Authentication" (13). Note that the authentication method "Generic Secure Password Authentication Method" (12) would also fall in this category; however, it is negotiated separately (see [RFC6467]), and for this reason there is no point to announce it via this mechanism. See also Section 4.

3.2.2. 3-Octet Announcement

If the announcement contains an authentication method that is concerned with public key cryptography, then the following format is used. This format allows linking the announcement with a particular trust anchor from the Certificate Request payload.

supersedes previously defined signature authentication methods. In this case, the real authentication algorithm is identified via AlgorithmIdentifier ASN.1 object. Appendix A of [RFC7427] contains examples of commonly used ASN.1 objects.

4. Interaction with IKEv2 Extensions concerning Authentication

Generally in IKEv2 each party independently determines the way it authenticates itself to the peer. In other words, authentication methods selected by the peers need not be the same. However, some IKEv2 extensions break this rule.

The prominent example is "Secure Password Framework for Internet Key Exchange Version 2" [RFC6467], which defines a framework for using secure password authentication in IKEv2. With this framework, peers negotiate using one of the secure password methods in the IKE_SA_INIT exchange -- the initiator sends a list of supported methods in the request, and the responder picks one of them and sends it back in the response.

If peers negotiate secure password authentication, then the selected method is used by both initiator and responder, and no other authentication methods are involved. For this reason, there is no point to announce supported authentication methods in this case. Thus, if the peers choose to go with secure password authentication, they MUST NOT send the SUPPORTED_AUTH_METHODS notification.

In the situation when peers are going to use Multiple Authentication Exchanges [RFC4739], they MAY include multiple SUPPORTED_AUTH_METHODS notifications (instead of one), each containing authentication methods appropriate for each authentication round. The notifications are included in the order of the preference of performing authentication rounds.

5. IANA Considerations

This document defines a new type in the "IKEv2 Notify Message Status Types" registry:

Value	Notify Message Status Type	Reference
16443	SUPPORTED_AUTH_METHODS	RFC 9593

Table 1

6. Security Considerations

Security considerations for the IKEv2 protocol are discussed in [RFC7296]. Security properties of different authentication methods vary. Refer to corresponding documents, listed in the "IKEv2 Authentication Method" registry on [IKEV2-IANA] for discussion of security properties of each authentication method.

Announcing authentication methods gives an eavesdropper additional information about peers' capabilities. If a peer advertises "NULL Authentication" along with other methods, then an active on-path attacker can encourage peers to use NULL authentication by removing all other announcements. Note that this is not a real "downgrade" attack, since authentication methods in IKEv2 are not negotiated, and in this case NULL authentication should be allowed by local security policy.

Similarly, if an on-path attacker can break some of the announced authentication methods online, then the attacker can encourage peers

to use one of these weaker methods by removing all other announcements, and if this succeeds, then perform a person-in-the-middle attack.

7. References

7.1. Normative References

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Appendix A. Examples of Announcing Supported Authentication Methods

This appendix shows some examples of announcing authentication methods. This appendix is purely informative; if it disagrees with the body of this document, the other text is considered correct. Note that some payloads that are not relevant to this specification may be omitted for brevity.

A.1. No Need to Use the IKE_INTERMEDIATE Exchange

This example illustrates the situation when the SUPPORTED_AUTH_METHODS Notify payload fits into the IKE_SA_INIT message, and thus the IKE_INTERMEDIATE exchange is not needed. In this scenario, the responder announces that it supports the "Shared Key Message Integrity Code" and the "NULL Authentication" authentication methods. The initiator informs the responder that it supports only the "Shared Key Message Integrity Code" authentication method.

Initiator	Responder
-----	-----
	IKE_SA_INIT
HDR, SAi1, KEi, Ni -->	<-- HDR, SAR1, KEr, Nr, N(SUPPORTED_AUTH_METHODS(PSK, NULL))
	IKE_AUTH
HDR, SK {IDi, AUTH, SAi2, TSi, TSr, N(SUPPORTED_AUTH_METHODS(PSK))} -->	<-- HDR, SK {IDr, AUTH, SAR2, TSi, TSr}

A.2. With Use of the IKE_INTERMEDIATE Exchange

This example illustrates the situation when the IKE_INTERMEDIATE exchange is used. In this scenario, the responder announces that it supports the "Digital signature" authentication method using the RSASSA-PSS algorithm with CA1 and CA2 and the same method using the ECDSA algorithm with CA3. The initiator supports only the "Digital signature" authentication method using the RSASSA-PSS algorithm with no link to a particular CA.

Initiator	Responder
-----	-----
	IKE_SA_INIT
HDR, SAi1, KEi, Ni, N(SIGNATURE_HASH_ALGORITHMS) -->	<-- HDR, SAR1, KEr, Nr, CERTREQ(CA1, CA2, CA3), N(SIGNATURE_HASH_ALGORITHMS), N(SUPPORTED_AUTH_METHODS())

```

                                IKE_INTERMEDIATE
HDR, SK {..., IDi}] -->
                                <-- HDR, SK {...,
                                CERTREQ(CA1, CA2, CA3),
                                N(SUPPORTED_AUTH_METHODS(
                                SIGNATURE(RSASSA-PSS:1),
                                SIGNATURE(RSASSA-PSS:2),
                                SIGNATURE(ECDSA:3)))}

                                IKE_AUTH
HDR, SK {IDi, CERT, CERTREQ(CA2),
AUTH, SAI2, TSi, TSr,
N(SUPPORTED_AUTH_METHODS(
SIGNATURE(RSASSA-PSS:0)))} -->
                                <-- HDR, SK {IDr, CERT,
                                AUTH, SAr2, TSi, TSr}

```

Acknowledgments

The author would like to thank Paul Wouters for his valuable comments and proposals. The author is also grateful to Daniel Van Geest, who made proposals for protocol improvement. Reese Enghardt and Rifaat Shekh-Yusef contributed to the clarity of the document.

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