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# Redirect Mechanism for IKEv2
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Abstract

IKEv2 is a protocol for setting up VPN tunnels from a remote location to a gateway so that the VPN client can access services in the network behind the gateway. Currently there is no standard mechanism specified that allows an overloaded VPN gateway or a VPN gateway that is being shut down for maintenance to redirect the VPN client to attach to another gateway. This document proposes a redirect mechanism for IKEv2. The proposed mechanism can also be used in Mobile IPv6 to enable the home agent to redirect the mobile node to another home agent.

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## 1. Introduction

IKEv2 [2] is used for setting up IPsec-based VPNs. The IP address of the VPN gateway can be configured on the VPN client. But this does not scale well, when the number of VPN gateways is large. Dynamic discovery of VPN gateways using DNS is quite widely used too. However, using DNS is not flexible when it comes to assigning a VPN gateway to the VPN client based on the load on the VPN gateways. The VPN client typically tries to connect to the IP address of the VPN gateways that appears first in the DNS response. If the VPN tunnel setup fails, then the VPN client tries to attach to the other VPN gateways returned in the DNS response.

This document proposes a redirect mechanism for IKEv2 that enables a VPN gateway to redirect the VPN client to another VPN gateway, for example, based on the load condition. The redirect can be done during during the IKE_SA_INIT or the IKE_AUTH exchange. Gateway-initiated redirect in the middle of a session is also supported. The redirect mechanism can also be used in conjunction with anycast addresses. In this case, anycast address for the cluster of VPN gateways is stored in the DNS instead of a list of unicast IP addresses of the VPN gateways.

The redirect can also happen because of administrative or optimal routing reasons. This document does not attempt to provide an exhaustive list of reasons for redirecting a VPN client to another VPN gateway.

Mobile IPv6 [3] may use IKEv2 for mutual authentication between the mobile node and the home agent. IKEv2 may also be used for home address configuration and setting up IPsec security associations for protecting Mobile IPv6 signaling messages [4]. The IKEv2 exchange precedes the exchange of Mobile IPv6 signaling messages. Therefore the mechanism described in this document can be also be used by a Mobile IPv6 home agent to redirect a mobile node to another home agent.

There is a Home Agent Switch mechanism available for redirecting a mobile node to another home agent, described in [5]. The Home Agent Switch mechanism can only be used after the binding cache had been created at the home agent for the mobile node. The disadvantage with this is that quite a bit of state is created on the home agent before the mobile node can be redirected to another home agent. The mechanism described in this document can be used for redirecting a mobile node before any state related to the Mobile IPv6 binding is created on the home agent.

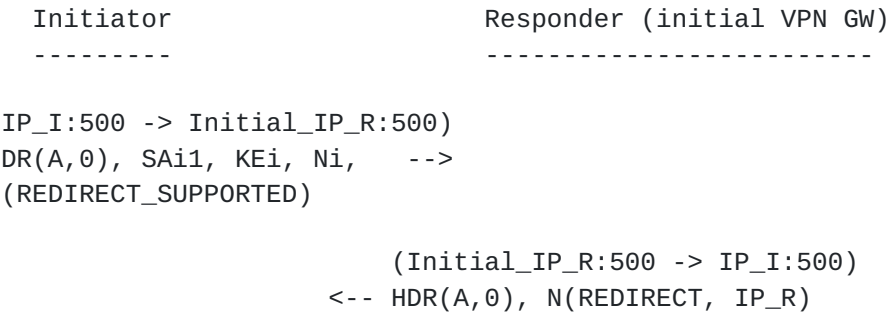
## 2. Terminology

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 [1].

## 3. IKEv2 Exchange with Redirect

To redirect an IKEv2 session to another VPN gateway, the VPN gateway that initially received the IKE_SA_INIT request selects another VPN gateway and responds to the VPN client with a REDIRECT Notification payload. The mechanism by which the initial VPN gateway selects another VPN gateway is out of scope for this document. The IP address of the selected VPN gateway is sent in the REDIRECT payload. The gateway MUST include the nonce data from the Ni payload sent by the initiator in the REDIRECT payload. This prevents certain Denial-of-Service attacks on the initiator that could be caused by an attacker injecting IKE_SA_INIT responses with REDIRECT payloads.

The VPN client indicates support for the IKEv2 redirect mechanism by including a REDIRECT_SUPPORTED notification message in the initial IKE_SA_INIT request. If the IKE_SA_INIT request did not include the REDIRECT_SUPPORTED payload, the responder MUST NOT send the REDIRECT payload to the VPN client.




When the VPN client receives the IKE_SA_INIT response with the REDIRECT payload, it initiates a new IKE_SA_INIT exchange with the VPN gateway listed in the REDIRECT payload. The VPN client includes the IP address of the original VPN gateway that redirected the client. The IKEv2 exchange then proceeds as normal with the selected VPN gateway.

```
   Initiator                  Responder (Selected VPN GW)
   ---------                  ---------------------------

(IP_I:500 -> IP_R:500)
HDR(A,0), SAi1, KEi, Ni,   -->
N(REDIRECTED_FROM, Initial_IP_R)

                           (IP_R:500 -> IP_I:500)
                      <-- HDR(A,B), SAr1, KEr, Nr,[CERTREQ]

(IP_I:500 -> IP_R:500)
HDR(A,B), SK {IDi, [CERT,] [CERTREQ,]
[IDr,]AUTH, SAi2, TSi, TSr} -->

                           (IP_R:500 -> IP_I:500)
                      <-- HDR(A,B), SK {IDr, [CERT,] AUTH,
                                        SAr2, TSi, TSr}
```

When this mechanism is used with Mobile IPv6, a mobile node's security associations with its home agent may expire while it still has a valid binding cache entry at the home agent. In this case, the mobile node MUST NOT use the original home agent address as the destination address in the IKE_SA_INIT exchange to setup new security associations. It MUST try to setup security associations with its existing home agent.

## 4. Use of Anycast Addresses with the Redirect Mechanism

The use of anycast addresses will avoid having to configure a particular VPN gateway's IP address in the DNS. Instead, the anycast address that represents the group of VPN gateways is stored in the DNS. When the VPN client performs a DNS lookup for the VPN gateway, it receives the anycast address of the VPN gateway in the DNS response.

If an anycast address is returned in response to DNS resolution of an FQDN, the VPN client sends the IKE_SA_INIT request to the anycast address. The IKE_SA_INIT request is routed to one of the VPN gateways that is part of the anycast group. The VPN gateway that receives the IKE_SA_INIT request responds with an IKE_SA_INIT reply from the anycast address.

```
    Initiator                   Responder (any VPN GW)
    ---------                   ----------------------

 (IP_I:500 -> ANYCAST:500)
 HDR(A,0), SAi1, KEi, Ni)   -->
 N(REDIRECT_SUPPORTED)

                             (ANYCAST:500 -> IP_I:500)
                        <-- HDR(A,0), N(REDIRECT, IP_R)
```

If the destination address on the IKE_SA_INIT request is an anycast address, the VPN gateway that received the IKE_SA_INIT request MUST include the REDIRECT payload to redirect the VPN client to a unicast address of one of the VPN gateway. The VPN gateway that received the IKE_SA_INIT request MAY redirect the client to its own unicast address, if it is not overloaded.

The rest of the IKEv2 exchange is the same as described in Section 3.

## 5. Gateway Initiated Redirect

The redirect mechanism may also be used by a VPN gateway to redirect the client to another VPN gateway in middle of a session. To redirect a client, the gateway should send an INFORMATIONAL message with the REDIRECT Notify payload. The REDIRECT payload MUST carry information about the new VPN gateway. The gateway MUST NOT include any nonce data in the REDIRECT payload, since it is a gateway-initiated message and is protected by the IKEv2 security association. When the client receives this message, it MUST send an empty message as an acknowledgement. Until the client responds with an acknowledgement, the gateway SHOULD re-transmit the redirect INFORMATIONAL message as described in [2]. The following illustrates the INFORMATIONAL message exchange for gateway-initiated redirect.

```
    Initiator (VPN client)        Responder (VPN GW)
    ----------------------        ------------------

                            <--  HDR, SK {N[REDIRECT, IP_R/FQDN_R]}

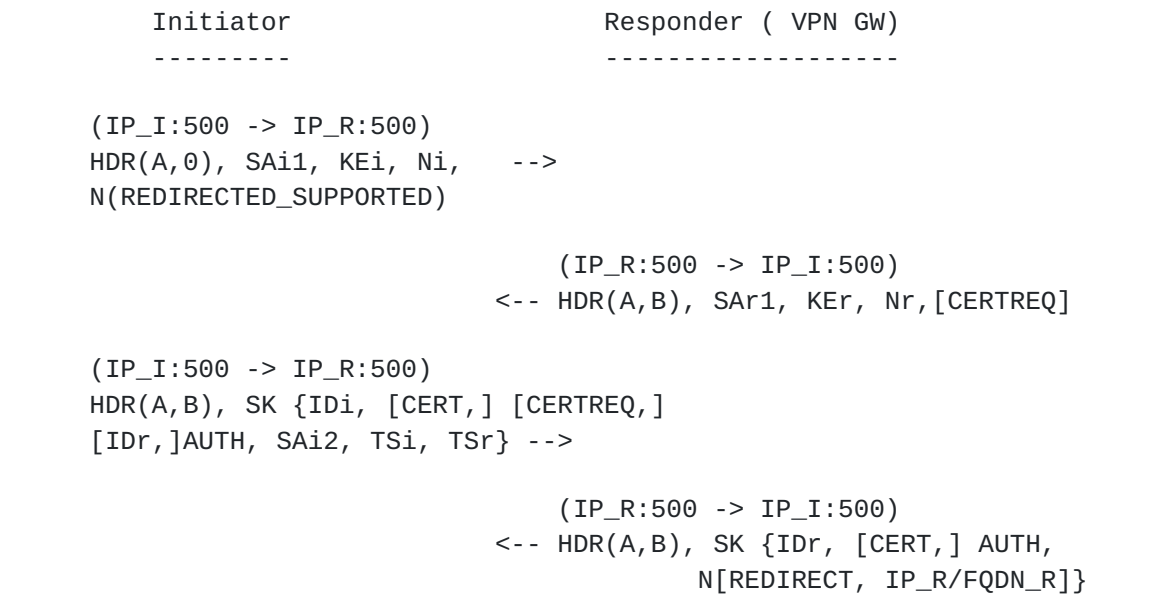
  HDR, SK {} -->
```

The INFORMATIONAL message exchange described above is protected by the existing IKEv2 SA between the client and the gateway.

Once the client sends an acknowledgement to the gateway, it SHOULD delete the existing security associations with the old gateway by sending an Informational message with a DELETE payload. The gateway

MAY also decide to delete the security associations without any signaling from the client, again by sending an Informational message with a DELETE payload. However, it should allow sufficient time for the client to setup the required security associations with the new security gateway. This time period should be configurable on the gateway.

If the gateway decides to redirect the client during the IKE_AUTH exchange, based on the identity presented by the client in the IKE_AUTH request message, it prevents the creation of a CHILD SA and sends the REDIRECT payload in the IKE_AUTH response. When the client receives the IKE_AUTH response with the REDIRECT payload, it SHOULD delete the existing IKEv2 security association with the gateway.

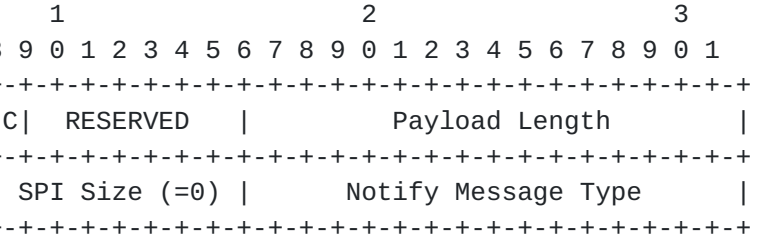



In case the IKE_AUTH exchange involves EAP authentication as described in Section 2.16 of RFC 4306 [2] or multiple authentication methods as described in RFC 4739 [6], the IKE_AUTH exchange is more complicated. The identity presented by the client in the first IKE_AUTH request might be a temporary one. In addition, the gateway might decide to redirect the client based on the interaction with the the AAA server, when EAP authentication is used or the external authentication server, when multiple authentication methods are used. In such cases, the gateway should send the REDIRECT notification payload in the final IKE_AUTH response message that carries the AUTH payload and the traffic selectors.

## 6. Redirect Messages

### 6.1. REDIRECT_SUPPORTED

The REDIRECT_SUPPORTED payload is included in the initial IKE_SA_INIT request by the initiator to indicate support for the IKEv2 redirect mechanism described in this document.

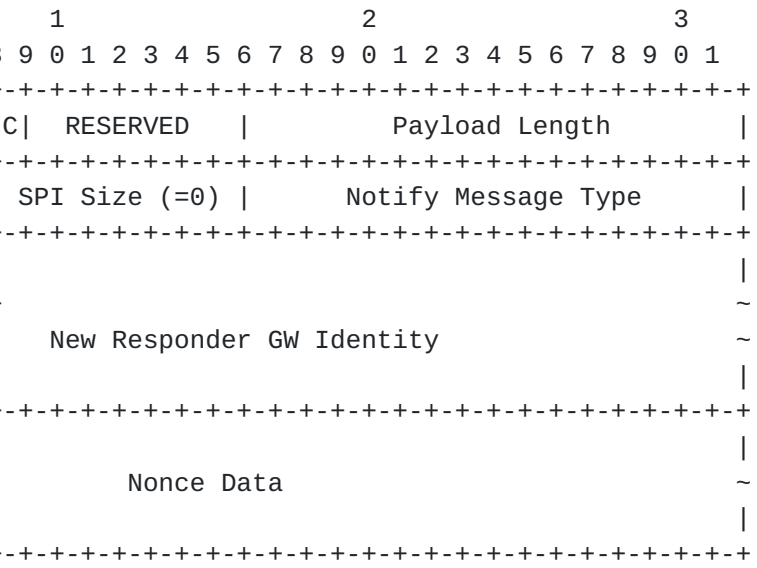



The 'Next Payload', 'Payload Length', 'Protocol ID', 'SPI Size' and the 'Notify Message Type' fields are the same as described in Section 3.10 of [2]. The 'SPI Size' field MUST be set to 0 to indicate that the SPI is not present in this message. The 'Protocol ID' MUST be set to 0, since the notification is not specific to a particular security association.

The 'Payload Length' field MUST be set to '8'. The 'Notify Message Type' field is set to indicate the REDIRECT_SUPPORTED payload <value to be assigned by IANA>.

### 6.2. REDIRECT

The REDIRECT payload is included in an IKE_SA_INIT response from the responder or an INFORMATIONAL message from the responder, when the responder wants to redirect the initiator to another VPN gateway. The message includes the new responder's IP address.



The 'Next Payload', 'Payload Length', 'Protocol ID', 'SPI Size' and the 'Notify Message Type' fields are the same as described in Section 3.10 of [2]. The 'SPI Size' field MUST be set to 0 to indicate that the SPI is not present in this message. The 'Protocol ID' MUST be set to 0, since the notification is not specific to a particular security association.

The 'Payload Length' field is set to the length in octets of the entire payload, including the generic payload header. 'Notify Message Type' field is set to indicate the REDIRECT payload <value to be assigned by IANA>. The 'GW Identity Type' field indicates the type of information that is sent to identify the new VPN gateway. The following values are reserved by this document.

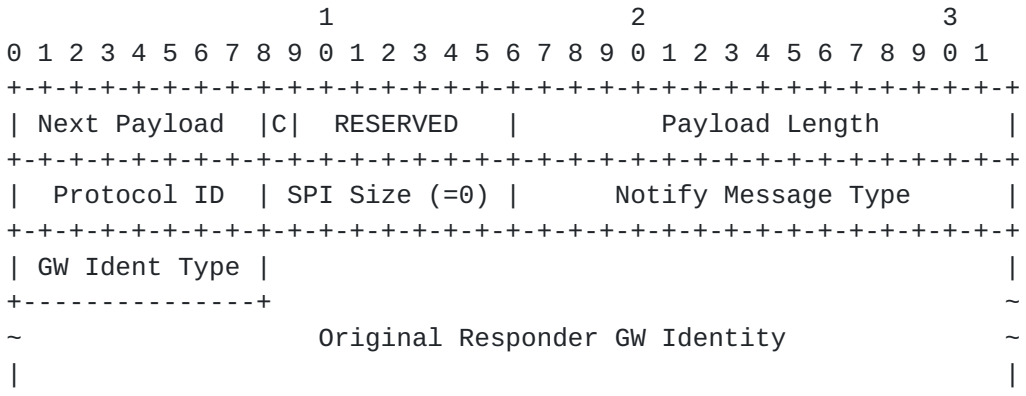
1 - IPv4 address of the new VPN gateway
2 - IPv6 address of the new VPN gateway
3 - FQDN of the new VPN gateway

All other values for this field are reserved and MUST NOT be used. The identity of the new VPN gateway is carried in the 'New Responder GW Identity' field.

The 'Nonce Data' field carries the nonce data from the Ni payload sent by the initiator. The size of the nonce MUST be between 16 and 256 bytes as described in Section 3.9 of [2]. The 'Nonce Data' field is present in the REDIRECT payload only when the REDIRECT payload is sent in the IKE_SA_INIT response message. It MUST NOT be included in the REDIRECT payload if sent in an IKE_AUTH response or in a gateway-initiated redirect message.

## 6.3. REDIRECTED_FROM

The REDIRECTED_FROM message type is included in the IKE_SA_INIT request from the initiator to the new VPN gateway to indicate the IP address of the original VPN gateway that redirected the initiator. The original VPN gateway's IP address is included in the message.



The 'Next Payload', 'Payload Length', 'Protocol ID', 'SPI Size' and the 'Notify Message Type' fields are the same as described in Section 3.10 of [2] The 'SPI Size' field MUST be set to 0 to indicate that the SPI is not present in this message. The 'Protocol ID' MUST be set to 0, since the notification is not specific to a particular security association.

The 'Payload Length' field MUST be set to either '13' or '25' depending on whether an IPv4 or IPv6 address of the original VPN gateway is sent in the message. The 'Notify Message Type' field is set to indicate the REDIRECTED_FROM payload <value to be assigned by IANA>. The 'GW Identity Type' field indicates the type of information that is sent to identify the new VPN gateway. The following values are reserved by this document.

1 - IPv4 address of the original VPN gateway
2 - IPv6 address of the original VPN gateway

All other values for this field are reserved and MUST NOT be used. The identity of the original VPN gateway is carried in the 'Original Responder GW Identity' field.

## 7. Use of the Redirect Mechanism between IKEv2 Peers

The Redirect mechanism described in this document is mainly intended for use in client-gateway scenarios. However, the mechanism can also be used between any two IKEv2 peers. But this protocol is asymmetric, meaning that only the original responder can redirect the original initiator to another server.

## 8. Security Considerations

An eavesdropper on the path between VPN client and server may send a redirect to the client upon receiving an IKE_SA_INIT message from this client. This is no problem regarding DoS attacks for the VPN connection, since an on-path-attacker can as well drop the IKE_SA_INIT requests to prevent VPN access for the client. But an eavesdropper on the path between VPN client and server can redirect a large number of clients to a victim, which is then flooded with IKE_SA_INIT requests. Flooding only happens if many clients initiate IKEv2 exchange at almost the same time, which is considered a rare event. However, this may happen if a Home Agent/VPN server is shutdown for maintenance and all clients need to re-establish VPN connections with another Home Agent/VPN server or if the on-path

attacker forces all IPsec security associations to expire by dropping all received IKEv2 messages.

The use of REDIRECTED_FROM payload is intended to discourage a rogue VPN gateway from redirecting a large number of VPN clients to a particular VPN gateway. It does not prevent such a DoS attack.

Since the redirect message is not always sent as a secure message, it MUST NOT result in the modification of the PAD entries on the client. The new gateway, to which the client is redirected to should be subject to the same authentication and authorization requirements as the original gateway. To support a scenario where the FQDN of the gateway is in the client's PAD entry and the client is redirected to another gateway in the same administrative domain, one can either configure all the possible gateways from the domain or use a wildcard entry like, for example, GW*.example.com, in the client's corresponding PAD entry.

## 9. IANA Considerations

This document defines four new IKEv2 Notification Message types as described in Section 6. The three Notify Message Types must be assigned values between 16396 and 40959.

- REDIRECT_SUPPORTED
- REDIRECT
- REDIRECTED_FROM

## 10. Acknowledgements

The use of anycast address with IKEv2 was first described in [7]. It was then added to an early draft version of RFC 5026 and later removed before the RFC was published. Therefore the authors of [7] and RFC 5026 are acknowledged.

Thanks to Pasi Eronen, with whom the solution described in this document was extensively discussed. Thanks to Tero Kivinen for suggesting the use of REDIRECTED_FROM payload and other comments which helped improve the document. The authors would also like to thank Yaron Sheffer, Sunil Kumar, Fan Zhao, Yoav Nir, Richard Graveman, Kanagavel Rajan, Srini Addepalli, and Arnaud Ebalard for their reviews and comments.

## 11. References

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### 11.2. Informative References

[3] Johnson, D., Perkins, C., and J. Arkko, "Mobility Support in IPv6", RFC 3775, June 2004.

[4] Giaretta, G., Kempf, J., and V. Devarapalli, "Mobile IPv6 Bootstrapping in Split Scenario", RFC 5026, October 2007.

[5] Haley, B., Devarapalli, V., Deng, H., and J. Kempf, "Mobility Header Home Agent Switch Message", RFC 5142, January 2008.

[6] Eronen, P. and J. Korhonen, "Multiple Authentication Exchanges in the Internet Key Exchange (IKEv2) Protocol", RFC 4739, November 2006.

[7] Weniger, K. and F. Dupont, "IKEv2-based Home Agent Assignment in Mobile IPv6/NEMO Bootstrapping", draft-dupont-ikev2-haassign-02 (work in progress), January 2007.

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