             An Internet Key Exchange Protocol Version 2 (IKEv2)
              Extension to Support EAP Re-authentication Protocol (ERP)

Abstract

   This document updates the Internet Key Exchange Protocol version 2
   (IKEv2) described in RFC 5996. This extension allows an IKE Security
   Association (SA) to be created and authenticated using the Extensible
   Authentication Protocol (EAP) Re-authentication Protocol extension,
   as described in RFC 6696.

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1. Introduction

   IKEv2, as specified in [RFC5996], allows (Section 2.16)
   authentication of the initiator using an EAP method. Using EAP
   significantly increases the count of round trips required to
   establish the IPsec SA and also may require user interaction. This
   makes it inconvenient to allow a single remote access client to
   create multiple IPsec tunnels with multiple IPsec gateways that
   belong to the same domain.

   The EAP Re-authentication Protocol (ERP), as described in [RFC6696],
   allows an EAP peer to authenticate to multiple authenticators while
   performing the full EAP method only once. Subsequent authentications
   require fewer round trips and no user interaction.

   Bringing these two technologies together allows a remote access IPsec
   client to create multiple tunnels with different gateways that belong
   to a single domain as well as using the keys from other contexts of
   using EAP, such as network access within the same domain, to
   transparently connect to VPN gateways within this domain.

   Additionally, it allows for faster set up of new tunnels when
   previous tunnels have been torn down due to things like network
   outage, device suspension, or a temporary move out of range. This is
   similar to the session resumption mechanism described in [RFC5723].
   One exception being that instead of a ticket stored by the client,
   the re-authentication Master Session Key (rMSK) (see Section 4.6 of
   [RFC6696]) is used as the session key stored on both the client and
   the Authentication, Authorization, and Accounting (AAA) server.

1.1. Conventions Used in This Document

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 [RFC2119].

2. Usage Scenarios

This work is motivated by the following scenarios:

o Multiple tunnels for a single remote access VPN client. Suppose a
   company has offices in New York City, Paris, and Shanghai. For
   historical reasons, the email server is located in the Paris
   office, most of the servers hosting the company's intranet are
   located in Shanghai, and the finance department servers are in New
   York City. An employee using a remote access VPN may need to
   connect to servers from all three locations. While it is possible
   to connect to a single gateway, and have that gateway route the
   requests to the other gateways (perhaps through site to site VPN),
   this is not efficient; it is more desirable to have the client
   initiate three different tunnels. It is, however, not desirable
   to have the user type in a password three times.

o Roaming. In these days of mobile phones and tablets, users often
   move from the wireless LAN in their office, where access may be
   granted through 802.1x, to a cellular network, where a VPN is
   necessary, and back again. Both the VPN server and the 802.1x
   access point are authenticators that connect to the same AAA
   servers. So it makes sense to make the transition smooth, without
   requiring user interaction. The device still needs to detect
   whether it is within the protected network, in which case it
   should not use VPN. However, this process is beyond the scope of
   this document. [SECBEAC] is a now-abandoned attempt at this.

o Resumption. If a device gets disconnected from an IKE peer, ERP
   can be used to reconnect to the same gateway without user
   intervention.

3. Protocol Outline

Supporting EAP Re-authentication Extension (ERX) requires an EAP
payload in the first IKE_AUTH request. This is a deviation from the
rules in [RFC5996], so support needs to be indicated through a Notify
payload in the IKE_SA_INIT response. This Notify serves the same
purpose as the EAP-Initiate/Re-auth-Start message of ERX, as
specified in Section 5.3.1 of [RFC6696]. The "Domain Name" field
contains the content of the Domain-Name TLV as specified in Section
5.3.1.1 of the same document.

A supporting initiator that has unexpired keys for this domain will
send the EAP-Initiate/Re-auth message in an EAP payload in the first
IKE_AUTH request.

The responder sends the EAP payload content to a backend AAA server.
If that server has a valid rMSK for that session, it sends those
along with an EAP-Finish/Re-auth message. The responder then
forwards the EAP-Finish/Re-auth message to the initiator in an EAP
payload within the first IKE_AUTH response.

The initiator then sends an additional IKE_AUTH request that includes
the AUTH payload, which has been calculated using the rMSK in the
role of the MSK as described in Sections 2.15 and 2.16 of [RFC5996].
The responder replies similarly, and the IKE_AUTH exchange is
finished.

If the backend AAA server does not have valid keys for the Re-auth-
Start message, it sends back a normal EAP request, and no rMSK key.
EAP flow continues as in [RFC5996].

The following figure is adapted from Appendixes C.1 and C.3 of
[RFC5996], with most of the optional payloads removed. Note that the
EAP-Initiate/Re-auth message is added.

```
IKE_SA_INIT Exchange:
│  init request          --> SA, KE, Ni,
│
│  init response         <-- SA, KE, Nr,
│                            N[ERX_SUPPORTED]
│
IKE_AUTH Exchanges:
│  first request         --> EAP(EAP-Initiate/Re-auth),
│                            IDi,
│                            SA, TSi, TSr
│
│  first response        <-- IDr, [CERT+], AUTH,
│                            EAP(EAP-Finish/Re-auth)
│
│  last request          --> AUTH
│
│  last response         <-- AUTH,
│                            SA, TSi, TSr
```

The IDi payload MUST have ID Type ID_RFC822_ADDR, and the data field
MUST contain the same value as the KeyName-NAI TLV in the EAP-
Initiate/Re-auth message. See Section 3.2 for details.

3.1. Clarification about EAP Codes

Section 3.16 of [RFC5996] enumerates the EAP codes in EAP messages
that are carried in EAP payloads. The enumeration goes only to 4.
It is not clear whether or not that list is supposed to be
exhaustive.

To clarify, an implementation conforming to this specification MUST
accept and transmit EAP messages with at least the codes for Initiate
and Finish (5 and 6) from Section 5.3 of [RFC6696], in addition to
the four codes enumerated in [RFC5996]. This document is
intentionally silent about other EAP codes that are not enumerated in
those documents.

3.2. Username in the Protocol

The authors, as well as participants of the HOKEY and IPsecME working
groups, believe that all use cases for this extension to IKE have a
single backend AAA server doing both the authentication and the re-
authentication. The reasoning behind this is that IKE runs over the
Internet and would naturally connect to the user's home network.

This section addresses instances where this is not the case.

Section 5.3.2 of [RFC6696] describes the EAP-Initiate/Re-auth packet,
which, in the case of IKEv2, is carried in the first IKE_AUTH
request. This packet contains the KeyName-NAI TLV. This TLV
contains the username used in authentication. It is relayed to the
AAA server in the AccessRequest message and is returned from the AAA
server in the AccessAccept message.

The username part of the Network Access Identifier (NAI) within the
TLV is the EMSKName [RFC5295] encoded in hexadecimal digits. The
domain part is the domain name of the home domain of the user. The
username part is ephemeral in the sense that a new one is generated
for each full authentication. This ephemeral value is not a good
basis for making policy decisions, and it is also a poor source of
user identification for the purposes of logging.

Instead, it is up to the implementation in the IPsec gateway to make
policy decisions based on other factors. The following list is by no
means exhaustive:

o In some cases, the home domain name may be enough to make policy
   decisions. If all users with a particular home domain get the
   same authorization, then policy does not depend on the real
   username. Meaningful logs can still be issued by correlating VPN
   gateway IKE events with AAA servers access records.

o Sometimes users receive different authorizations based on groups
   to which they belong. The AAA server can communicate such
   information to the VPN gateway, for example, using the CLASS
   attribute [RFC2865] in RADIUS and Diameter [RFC6733]. Logging
   again depends on correlation with AAA servers.

o AAA servers may support extensions that allow them to communicate
   with their clients (in our case -- the VPN gateway) to push user
   information. For example, a certain product integrates a RADIUS
   server with the Lightweight Directory Access Protocol (LDAP)
   [RFC4511], so a client could query the server using LDAP and
   receive the real record for this user. Others may provide this
   data through vendor-specific extensions to RADIUS or Diameter.

In any case, authorization is a major issue in deployments, if the
backend AAA server supporting the re-authentication is different from
the AAA server that had supported the original authentication. It is
up to the re-authenticating AAA server to provide the necessary
information for authorization. A conforming implementation of this
protocol MAY reject initiators for which it is unable to make policy
decisions because of these reasons.

4. ERX_SUPPORTED Notification

   The Notify payload is as described in [RFC5996]:

```
                        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 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   ! Next Payload  !C!  RESERVED   !         Payload Length        !
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   !  Protocol ID  !   SPI Size    !    ERX Notify Message Type    !
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   !                         Domain Name                           !
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

o Protocol ID (1 octet) - MUST be zero, as this message is related
   to an IKE SA.

o Security Parameter Index (SPI) Size (1 octet) - MUST be zero, in
   conformance with Section 3.10 of [RFC5996].

o ERX Notify Message Type (2 octets) - MUST be 16427, the value
   assigned for ERX.

o Domain Name (variable) - contains the domain name or realm, as
   these terms are used in [RFC6696] and encoded as ASCII, as
   specified in [RFC4282].

5. Operational Considerations

   This specification changes the behavior of IKE peers, both initiators
   and responders. The behavior of backend AAA servers is not changed
   by this specification, but they are required to support [RFC6696].
   The same goes for the EAP client, if it's not integrated into the IKE
   initiator (for example, if the EAP client is an operating system
   component).

   This specification is silent about key storage and key lifetimes on
   either the EAP client or the EAP server. These issues are covered in
   Sections 3, 4, and 5 of [RFC6696]. The key lifetime may be
   communicated from the AAA server to the EAP client via the Lifetime
   attribute in the EAP-Finish/Re-auth message. If the server does not
   have a valid key, while the client does have one, regular EAP is used
   (see Section 3). This should not happen if lifetimes are
   communicated. In such a case, the IKEv2 initiator / EAP client MAY
   alert the user and MAY log the event. Note that this does not
   necessarily indicate an attack. It could simply be a loss of state
   on the AAA server.

6. Security Considerations

   The protocol extension described in this document extends the
   authentication from one EAP context, which may or may not be part of
   IKEv2, to an IKEv2 context. Successful completion of the protocol
   proves to the authenticator, which in our case is a VPN gateway, that
   the supplicant or VPN client has authenticated in some other EAP
   context.

   The protocol supplies the authenticator with the domain name with
   which the supplicant has authenticated, but does not supply it with a
   specific identity. Instead, the gateway receives an EMSKName, which
   is an ephemeral ID. With this variant of the IKEv2 protocol, the
   initiator never sends its real identity on the wire while the server
   does. This is different from the usual IKEv2 practice of the
   initiator revealing its identity first.

   If the domain name is sufficient to make access control decisions,
   this is enough. If not, then the gateway needs to find out either
   the real name or authorization information for that particular user.
   This may be done using the AAA protocol or by some other federation
   protocol, which is out of scope for this specification.

7. IANA Considerations

   IANA has assigned a notify message type of 16427 from the "IKEv2
   Notify Message Types - Status Types" registry with the name
   "ERX_SUPPORTED".

8. Acknowledgements

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