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RADIUS Mobile IPv6 Support
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Status of this Memo

Abstract

This document defines new attributes to facilitate Mobile IPv6 operations using RADIUS infrastructure. The operations include bootstrapping of information required by the Mobile Node and the interface between the Network Access Server, Home Agent and the RADIUS server used to assist MIP6 operations.

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1. Introduction

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This document covers two aspects of MIP6 operations: bootstrapping of information required by a Mobile IPv6 Mobile using the AAA infrastructure and the interaction between the Network Access Server(NAS), MIPv6 Home Agent (HA) and the Authentication Authorization and Accounting (AAA) infrastructure.
Mobile IPv6 specification [14] (Johnson, D., Perkins, C., and J. Arkko, “Mobility Support in IPv6,” June 2004.) requires a Mobile Node (MN) to perform registration with an HA with information about its current point of attachment (Care-of Address). The HA creates and maintains binding between the MN's Home Address (HOA) and the MN's Care-of Address.
In order to register with a HA, the MN needs to know some information such as, the Home Link prefix, the HA Address, the HOA, the Home Link prefix Length and security related information in order to secure the Binding Update.
The aforementioned set of information may be statically provisioned in the MN. However, static provisioning of this information has its drawbacks. It increases provisioning and network maintenance burden for the operator. Moreover, static provisioning does not allow load balancing, failover, opportunistic home link assignment etc. For example, the user may be accessing the network from a location that may be geographically far away from the preconfigured home link; the administrative burden to configure the MN's with the respective addresses is large and the ability to react on environmental changes is minimal. In these situations static provisioning may not be desirable.
Dynamic assignment of Mobile IPv6 home registration information is a desirable feature for ease of deployment and network maintenance. For this purpose, the RADIUS infrastructure, which is used for access authentication, can be leveraged to assign some or all of the necessary parameters. The RADIUS server in the Access Service Provider (ASP) or in the Mobility Service Provider's (MSP) network may return these parameters to the AAA client. The AAA client might either be the NAS, in case of the integrated scenario, or the HA, in case of the split

scenario. The terms integrated and split are described in the terminology section and are introduced in [15] (Patel, A. and G. Giaretta, “Problem Statement for bootstrapping Mobile IPv6 (MIPv6),” September 2006.).
The second aspect of MIP6 and RADIUS interworking is the interaction between the HA and the AAA using the RADIUS AAA protocols. From a mobility service provider (MSP) perspective, it is important to verify that the MN is authenticated and authorized to utilize Mobile IPv6 service and that such services are accounted for. Thus, prior to processing the Mobile IPv6 registrations, the HA, participates in the authentication of the MN to verify the MN's identity. The HA also participates in the Mobile IPv6 authorization process involving the RADIUS infrastructure. The HA, due to its role in traffic forwarding, may also perform accounting for the Mobile IPv6 service provided to the MN. This document specifies the interaction between the NAS, HA and the RADIUS server and aligns with the work done in with the Diameter specifications described in [16] (Korhonen, J., Tschofenig, H., Bournelle, J., Giaretta, G., and M. Nakhjiri, “Diameter Mobile IPv6: Support for Home Agent to Diameter Server Interaction,” April 2009.) and [17] (Korhonen, J., Bournelle, J., Tschofenig, H., Perkins, C., and K. Chowdhury, “Diameter Mobile IPv6: Support for Network Access Server to Diameter Server Interaction,” January 2009.).

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2. Terminology

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The keywords "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] (Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels,” March 1997.).
General mobility terminology can be found in [18] (Manner, J. and M. Kojo, “Mobility Related Terminology,” June 2004.). The following additional terms, as defined in [15] (Patel, A. and G. Giaretta, “Problem Statement for bootstrapping Mobile IPv6 (MIPv6),” September 2006.), are used in this document:

Access Service Authorizer (ASA):
A network operator that authenticates a mobile node and establishes the mobile node's authorization to receive Internet service.

Access Service Provider (ASP):
A network operator that provides direct IP packet forwarding to and from the end host.

Mobility Service Authorizer (MSA):
A service provider that authorizes Mobile IPv6 service.

Mobility Service Provider (MSP):

A service provider that provides Mobile IPv6 service. In order to obtain such service, the MN must be authenticated and authorized to obtain the Mobile IPv6 service.

Split Scenario:
A scenario where the mobility service and the network access service are authorized by different entities.

Integrated Scenario:
A scenario where the mobility service and the network access service are authorized by the same entity.

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3. Solution Overview

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This document addresses the authentication, authorization and accounting functionality required by MIPv6 bootstrapping and Authentication as outlined in the MIPv6 bootstrapping problem statement document (see [15] (Patel, A. and G. Giaretta, "Problem Statement for bootstrapping Mobile IPv6 (MIPv6)," September 2006.)). As such, the AAA functionality for the integrated and the split scenario needs to be defined. This requires the ability to offer support for the HA to AAA server and the network access server(NAS) to AAA server communication. To highlight the main use cases, we briefly describe the integrated and the split scenarios in Section 3.1 (RADIUS Transaction in Integrated Scenario) and Section 3.2 (RADIUS Transactions in Split Scenario), respectively.

3.1. RADIUS Transaction in Integrated Scenario

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In the integrated scenario MIPv6 bootstrapping is provided as part of the network access authentication procedure. Figure 1 (Mobile IPv6 Service Access in the Integrated Scenario) shows the participating entities.

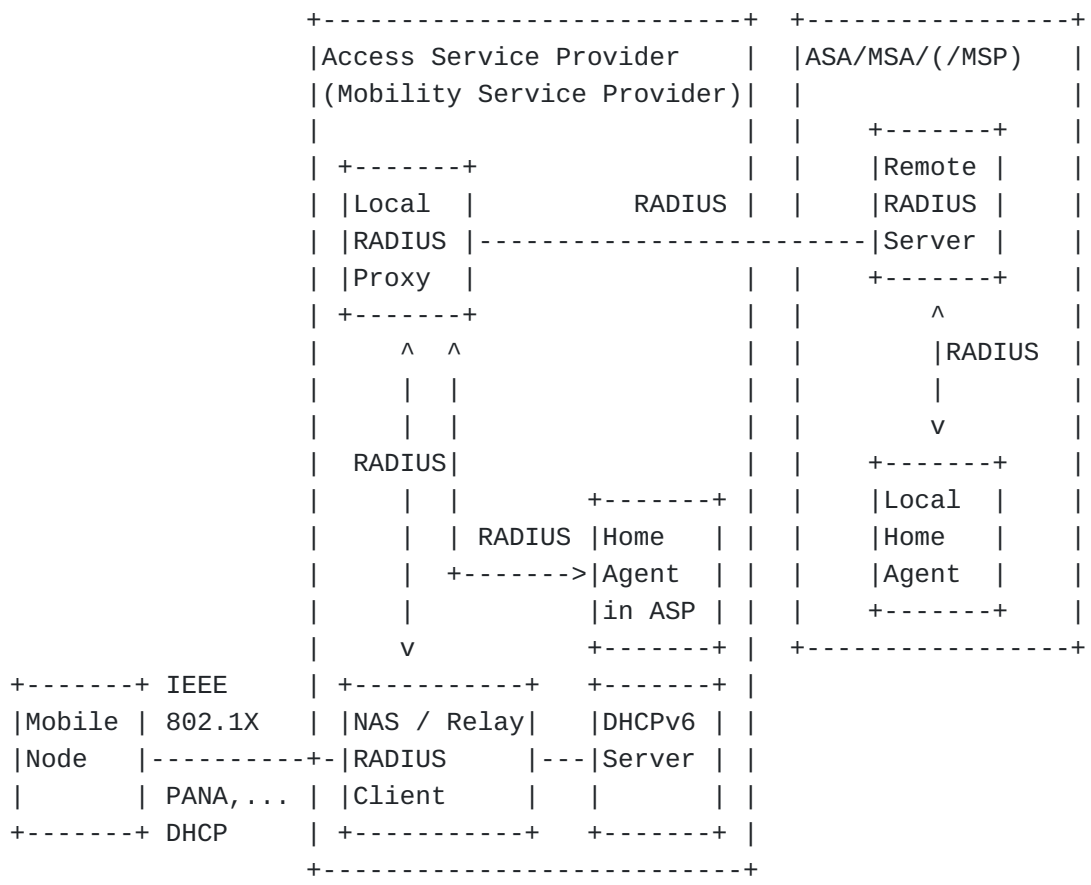

Figure 1: Mobile IPv6 Service Access in the Integrated Scenario

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In the typical Mobile IPv6 access scenario as shown above, the MN attaches in the ASP's network. During this network attachment procedure, the NAS/RADIUS client interacts with the MN. As shown in Figure 1 (Mobile IPv6 Service Access in the Integrated Scenario), the authentication and authorization happens via a RADIUS infrastructure. At the time of authorizing the user for IPv6 access, the RADIUS server in the MSA detects that the user is authorized for Mobile IPv6 access. Based on the MSA's policy, the RADIUS server may allocate several parameters to the MN for use during the subsequent Mobile IPv6 protocol interaction with the HA.
Depending on the details of the solution, interaction with the DHCPv6 server may be required, as described in [2] (Chowdhury, K. and A. Yegin, “MIP6-bootstrapping for the Integrated Scenario,” April 2008.).

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3.2. RADIUS Transactions in Split Scenario

In the split scenario, Mobile IPv6 bootstrapping is not performed as part of the network access authentication procedure. Other RADIUS transactions such as authentication and authorization, accounting and parameter configuration for MIP6 service is provided by the HA to RADIUS transactions.
The Mobile IPv6 RADIUS transaction are executed with the Mobility Service Provider when desired by the MN. Two scenarios can be considered:

1. The MSA and the MSP are the same entity.

2. The MSA and the MSP are different entities.

Since scenario (2) is the more generic scenario we show it in Figure 2 (Mobile IPv6 service access in the split scenario (MSA != MSP)).

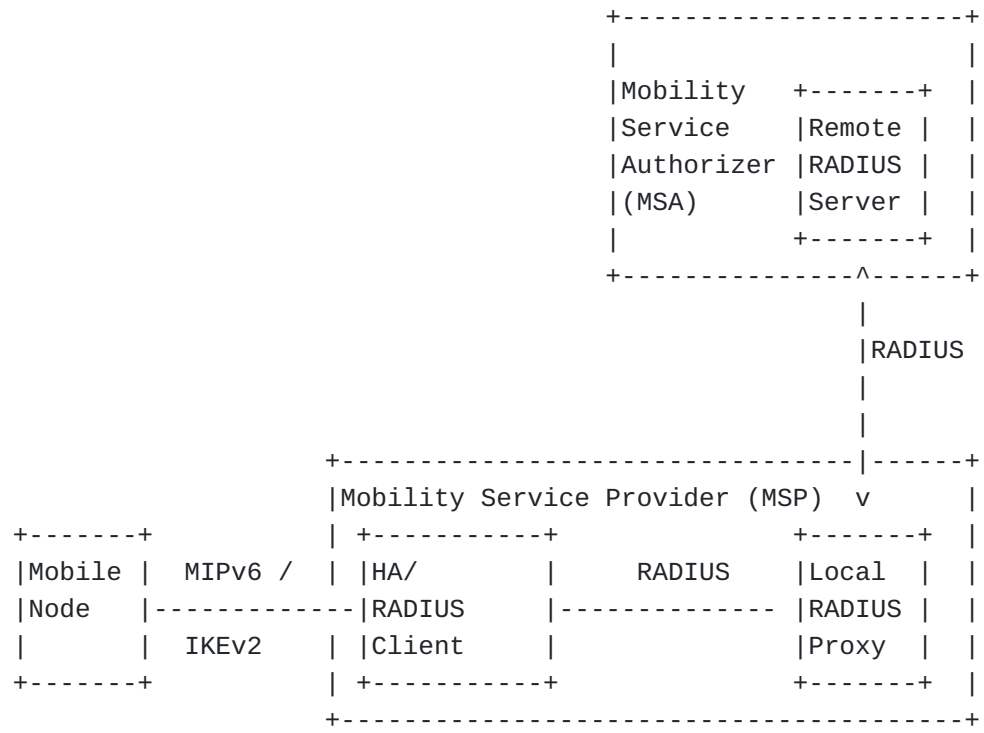

Figure 2: Mobile IPv6 service access in the split scenario (MSA != MSP)

As shown in Figure 2 (Mobile IPv6 service access in the split scenario (MSA != MSP)) the interaction between the RADIUS client and the RADIUS server is triggered by the protocol interaction between the MN and the

HA/RADIUS client using IKEv2 [19] (Dupont, F. and V. Devarapalli, "Mobile IPv6 Operation with IKEv2 and the revised IPsec Architecture," December 2006.) or MIPv6 Authentication Protocol [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.). The important aspect is, however, that for these two approaches, several different authentication and key exchange solutions are available. To establish IPsec security associations for the protection of Mobile IPv6 signaling messages, IKEv2 is used [19] (Dupont, F. and V. Devarapalli, "Mobile IPv6 Operation with IKEv2 and the revised IPsec Architecture," December 2006.). IKEv2 supports EAP-based authentication, certificates and pre-shared secrets. For protection of Mobile IPv6 signaling messages using the MIPv6 Authentication Protocol [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.) a mechanism has been designed that is very similar to the one used by Mobile IPv4. The ability to use different credentials has an impact on the interaction between the HA (acting as a RADIUS client) and the RADIUS Server. For that reason this document illustrates the usage of these authentication mechanisms with different subsections for:

*IKEv2 usage with EAP

*MIPv6 Authentication Protocol using MN-AAA

Authentication schemes using IKEv2 with certificates and pre-shared secrets; or MIPv6 Authentication Protocol using MN-HA only are not covered by this document.
For accounting of Mobile IPv6 services provided to the MN, this specification uses the RADIUS based accounting defined in [4] (Rigney, C., "RADIUS Accounting," June 2000.).
Additionally, the MN might instruct the RADIUS server (via the HA) to perform a dynamic DNS update.

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4. Use of existing RADIUS Attributes

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4.1. User-Name

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If authentication via IKEv2 is used then the User-Name attribute SHALL be set to the IDi payload received in the IKE_AUTH exchange. In the case of the Mobile IPv6 Authentication Protocol the User-Name(1) attribute is set to the value received in the MN-NAI mobility option as defined in [20] (Patel, A., Leung, K., Khalil, M., Akhtar, H., and K. Chowdhury, "Mobile Node Identifier Option for Mobile IPv6 (MIPv6)," November 2005.).

4.2. Service-Type

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The HA uses Service-Type(6) to indicate whether the Access-Request operation is for Authentication and Authorization or just Authorization.

4.3. NAS-Port-Type

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In order for the AAA to distinguish the source of the Access-Request NAS-Port-Type(61) is used as follows:
When the Access-Request originates from an MIP6 HA, NAS-Port-Type MUST be included and its value set to HA6(IANA-TBD1).

4.4. Calling-Station-Id

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In the split-scenario, the HA SHOULD use the Calling-Station-Id(31) to send the MN's COA to the AAA. If used, the string value of the Calling-Station-Id(31) should be set to the 128-bit MN IPv6 COA.

4.5. Use of MS-MPPE-Recv-Key and MS-MPPE-Send-Key

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To transport the MSK from the RADIUS to the HA, RADIUS SHALL utilize the MS-MPPE-Recv-Key and the MS-MPPE-Send-Key as defined in [5] (Zorn, G., “Microsoft Vendor-specific RADIUS Attributes,” March 1999.). The first up to 32 octets of the MSK is stored into the MS-MPPE-Recv-Key, and the next up to 32 octets are stored into the MS-MPPE-Send-Key. The encryption of these attributes is described in [5] (Zorn, G., “Microsoft Vendor-specific RADIUS Attributes,” March 1999.).

4.6. Session-Timeout

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The use of Session-Timeout attribute during bootstrapping operations is covered by various RFC's.
The use of Session-Timeout attribute during the EAP exchanges between the HA and the RADIUS server are as per [6] (Aboba, B. and P. Calhoun,

"RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP)," September 2003.).
In the case of the RADIUS server sending Session-Timeout to the HA in the Access-Accept packet, the HA SHALL use this time as the MIP Registration Lifetime.

4.7. Message Authenticator

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The use of Message Authenticator is mandated during EAP AAA procedures by [6] (Aboba, B. and P. Calhoun, "RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP)," September 2003.). In the case of the HA sending an Access-Request where EAP is not used, then the HA MUST also include the Message Authenticator attribute in the Access-Request packet.

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5. RADIUS attributes

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This section defines format and syntax for the attribute that carries the Mobile IPv6 parameters that are described in the previous section. The attributes MAY be present in Access-Request, Access-Accept, and Accounting-Request packets.

5.1. MIP6-Feature-Vector Attribute

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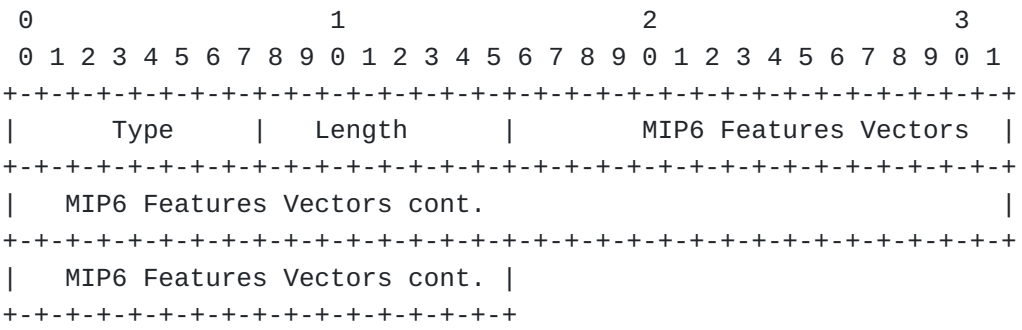
Exactly one of this attribute MUST be sent by the NAS or HA in an Access-Request packet to inidcate support for MIP6. For example, a NAS uses this attribute to indicate whether it can provide a local home agent.
Exactly one of this attribute MUST be sent by the RADIUS server in an Access-Accept packet to indicate support for MIP6 and to select features advetized by the NAS or the HA. For example, if the NAS indicated support for local home agent assignment, the RADIUS server authorizes the NAS to support local home agent assignment by echoing the setting the same flag in the Access-Accept packet.



Type:

MIP6-FV-TYPE to be defined by IANA.

Length:

= 10 octets

Feature Flags:

This field is of type String. Supporting the following values:

MIP6_INTEGRATED (0x0000000000000001)

When this flag is set by the NAS then it means that the Mobile IPv6 integrated scenario bootstrapping functionality is supported by the NAS. When this flag is set by the RADIUS server then the Mobile IPv6 integrated scenario bootstrapping is supported by the RADIUS server.

LOCAL_HOME_AGENT_ASSIGNMENT (0x0000000000000002)

When this flag is set by the NAS then a local home agent can be assigned to the MN. When this flag is set by the Diameter server then the assignment of location HAs is authorized by the Diameter server.

RO_SUPPORTED (0x0000000800000000)

Route optimization is supported. When the Home Agent sets this bit, it indicates support for the route optimization. If this bit is unset in the returned Mobility-Capability AVP, the HAAA does not authorize route optimization for the MN.

In a case the Home Agent or the HAAA cannot authorize the use of route optimization then the Home Agent will send a Binding

> > Acknowledgement with a Status Code set to ACCEPTED_BUT_NO_ROUTE_OPTIMIZATION (status code TBD). This Status Code indicates that the binding registration succeeded but the Home Agent will fail all possible subsequent route optimization attempts because of subscription or operator policy.

5.2. MIP6-HA Attribute

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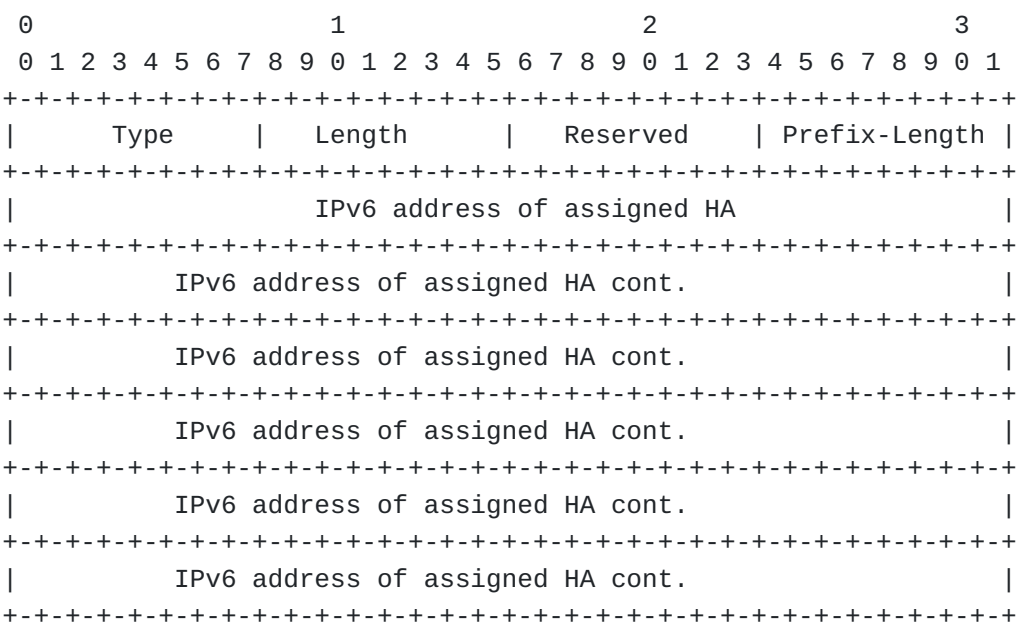
In the case of bootstrapping, the RADIUS server may decide to assign a HA to the MN that is in close proximity to the point of attachment (e.g., as determined by the NAS-ID). There may be other reasons for dynamically assigning HAs to the MN, for example to share the traffic load. The attribute also contains the prefix length so that the MN can easily infer the Home Link prefix from the HA address.
In the case of bootstrapping, one or more of this attribute MAY be sent by the NAS to the RADIUS server in an Access-Request packet as a proposal by the NAS to allocate a local HA to the MN.
In the case of bootstrapping, one or more of this attribute MAY be sent by the RADIUS server to the NAS in an Access-Accept packet. The attribute carries the HA address that may be assigned to the MN.
[EDITOR: WHAT IS THIS ABOUT?] This attribute MAY be MIP6-DNS-MO Attribute sent by the NAS to the RADIUS server in an Access-Request packet as a hint to suggest a dynamic HA that may be assigned to the MN. The RADIUS server MAY use this value or may ignore this suggestion.
If available at the NAS, at least MIP6-HA attribute and/or MIP6-HA-FQDN SHOULD appear in accounting packets to indicate the identity of the serving HA for this session.
In the case of split, the MIP6-HA attribute contains the IPv6 address of the Home Agent as received in the BU message. One and only one of this attribute SHALL be sent by the HA to the RADIUS server.



Type:

MIP6-HA-TYPE to be defined by IANA.

Length:

= 28 octets

Reserved:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

Prefix-Length:

This field indicates the prefix length of the Home Link.

IPv6 address of assigned HA:

128-bit IPv6 address of the assigned HA.

5.3. MIP6-HA-FQDN Attribute

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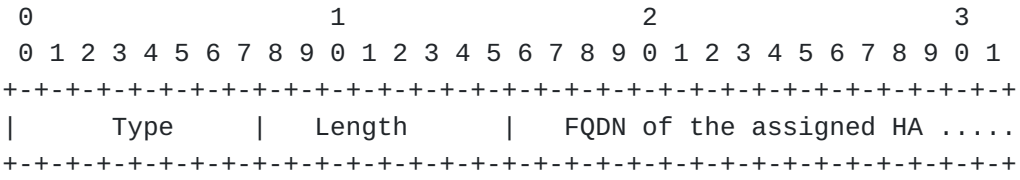
In the case of bootstrapping, one or more instance of this attribute MAY be sent by the NAS to the RADIUS server in an Access-Request packet

as a hint to suggest a dynamic HA that may be assigned to the MN. The RADIUS server MAY use this value or may ignore this suggestion.
In the case of bootstrapping, one or more of this attribute is sent by the RADIUS server to the NAS in an Access-Accept packet. The attribute carries the FQDN of the assigned HA. The mobile node can perform DNS query with the FQDN to derive the HA address.
If available at the NAS, at least MIP6-HA-FQDN attribute and/or MIP6-HA SHOULD appear in accounting packets to indicate the identity of the serving HA for this session.



Type:

ASSIGNED-HA-FQDN-TYPE to be defined by IANA.

Length:

Variable length.

FQDN of the assigned HA:

The data field MUST contain a FQDN as described in [21] (Mockapetris, P., "Domain names - implementation and specification," November 1987.).

5.4. MIP6-HL-Prefix Attribute

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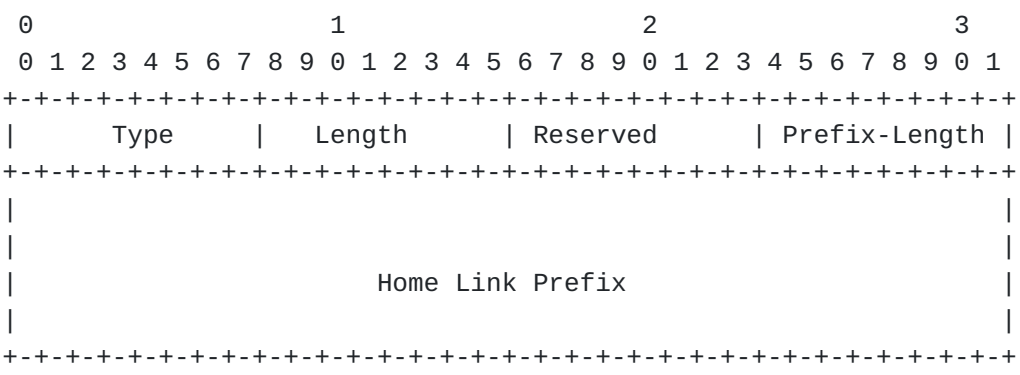
In the case of bootstrapping, this attribute MAY be sent by the NAS to the RADIUS server in an Access-Request packet along with the MIP6-HA and/or MIP6-HA-FQDN attribute as a hint to suggest a Home Link prefix that may be assigned to the MN. The RADIUS server MUST use this value if it accepts the NAS's HA suggestion.
In the case of bootstrapping, this attribute is sent by the RADIUS server to the NAS in an Access-Accept packet and carries the assigned Home Link prefix that is in close proximity to the point of attachment (NAS-ID). The MN can perform [14] (Johnson, D., Perkins, C., and J. Arkko, "Mobility Support in IPv6," June 2004.) specific procedures to discover other information for Mobile IPv6 registration.



Type:

ASSIGNED-HL-TYPE to be defined by IANA.

Length:

>= 4 octets + the minimum length of a prefix.

Reserved:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

Prefix-Length:

This field indicates the prefix length of the Home Link.

Home Link Prefix:

Home Link prefix (upper order bits) of the assigned Home Link where the MN should send binding update.

5.5. MIP6-HOA Attribute

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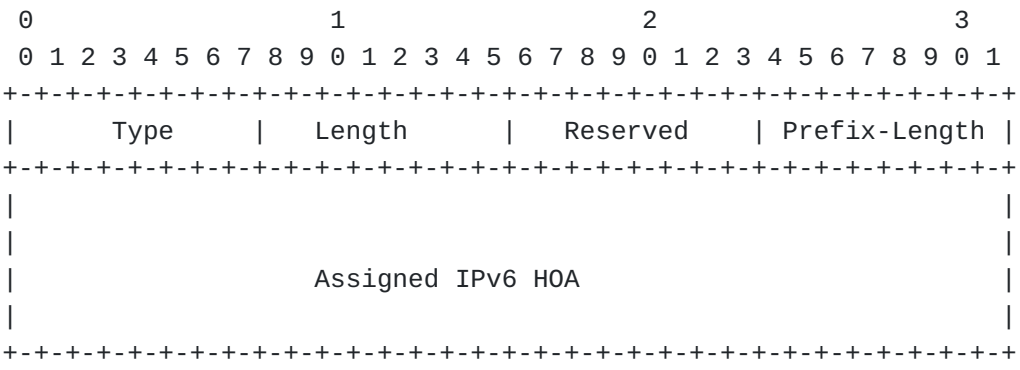
In the bootstrapping case, this attribute is sent by the RADIUS server to the NAS in an Access-Accept packet. The attribute carries the assigned Home IPv6 Address for the MN. This allows the network operator to support mobile devices that are not configured with static addresses. The attribute also contains the prefix length so that the MN can easily infer the Home Link prefix from the HA address.
This attribute MAY be sent by the NAS to the RADIUS server in an Access-Request packet along with the MIP6-HA and/or MIP6-HA-FQDN attribute as a hint to suggest a Home Address that may be assigned to

the MN. The RADIUS server MUST use this value if it accepts the NAS's HA suggestion.
In the case of split, in Access-Request packet, the MIP6-HOA contains the IPv6 Home Address assigned by the HA to the MN. If the MIP6-HOA AVP contains unspecified IPv6 address (0::0), then the Home Agent expects the RADIUS server to assign the Home Address in a subsequent Access-Accept packet. In case the RADIUS server assigns only a Home Network Prefix to the Mobile Node the lower 64 bits of the MIP-Mobile-Node-Address AVP provided address MUST be set to zero.
If available at the NAS, this attribute SHOULD appear in the accounting packets so that the IPv6 addressed used for this session is known in the accounting stream.



Type:

ASSIGNED-HOA-TYPE to be defined by IANA.

Length:

= 20 octets.

Reserved:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

Prefix-Length:

This field indicates the prefix length of the Home Link.

Assigned IPv6 HOA:

IPv6 HOA that is assigned to the MN.

5.6. MIP6-DNS-MO Attribute

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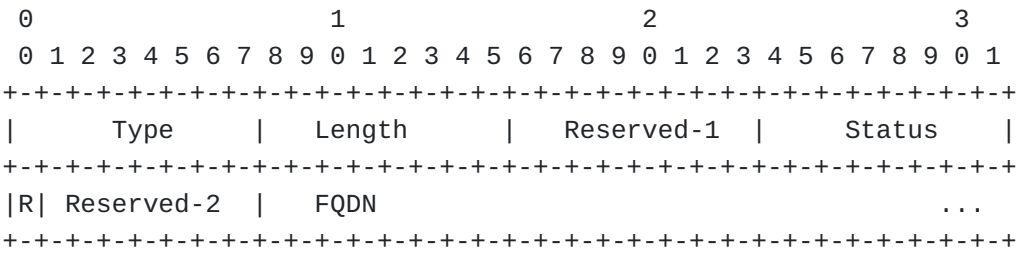
In the case of bootstrapping, the MIP6-DNS-MO attribute is included by the NAS in an Access-Request packet and MUST set its value to the MN's FQDN to indicate to the RADIUS server to perform a dynamic DNS update. Upon receiving this attribute, the RADIUS server SHALL perform a dynamic update of the DNS and MUST inlcude the MIP6-DNS-MO attribute in the Access-Accept indicating the result of the dynmaic DNS update.



Type:

DNS-UPDATE-TYPE to be defined by IANA.

Length:

Variable length.

Reserved-1:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

Status:

This 8 bit unsigned integer field indicates the result of the dynamic DNS update procedure as defined in [7] (Giaretta, G., "Mobile IPv6 bootstrapping in split scenario," July 2007.). This field MUST be set to 0 and ignored by the RADIUS server when the MIP6-DNS-MO is sent from the RADIUS client to the RADIUS server. When the MIP6-DNS-MO is provided in the response, values of the Status field less than 128 indicate that the dynamic DNS update was performed successfully by the RADIUS server. Values greater than or equal to 128 indicate that the dynamic DNS update was not successfully completed. The following values for the Status field are currently defined:

0 DNS update performed

128 Reason unspecified

129 Administratively prohibited

130 DNS Update Failed

R flag:

If this bit for the R flag is set then the RADIUS client requests the RADIUS server to remove the DNS entry identified by the FQDN included in this attribute. If not set, the RADIUS client is requesting the RADIUS server to create or update a DNS entry with the FQDN specified in this attribute and the Home Address carried in another attribute specified in this document.

Reserved-2:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

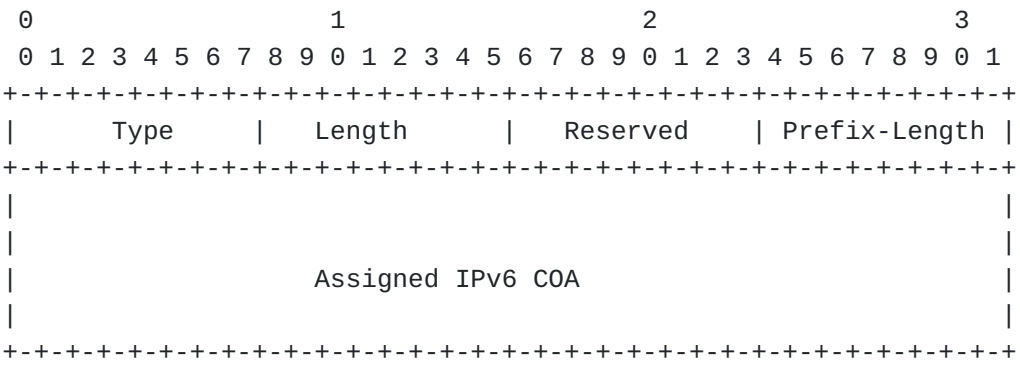
FQDN of the MN:

In an Access-Request packet the data field MUST contain a FQDN. In an Access-Accept packet the data field MAY contain an FQDN. FQDN is described in [21] (Mockapetris, P., “Domain names - implementation and specification,” November 1987.).

5.7. MIP6-Careof-Address

TOC

In the case of split, this attribute is sent from the HA to the RADIUS Server and contains the IPv6 addresss of the Care-of Address of the MN extracted from the BU message.



Type:

ASSIGNED-MIP6-CAREOF-ADDRESS-TYPE to be defined by IANA.

Length:

= 20 octets.

Reserved:

Reserved for future use. The bits MUST be set to zero by the sender, and MUST be ignored by the receiver.

Prefix-Length:

This field indicates the prefix length of the COA Link.

Assigned IPv6 COA:

IPv6 COA that is assigned to the MN.

5.8. MIP6-MN-AAA-SPI

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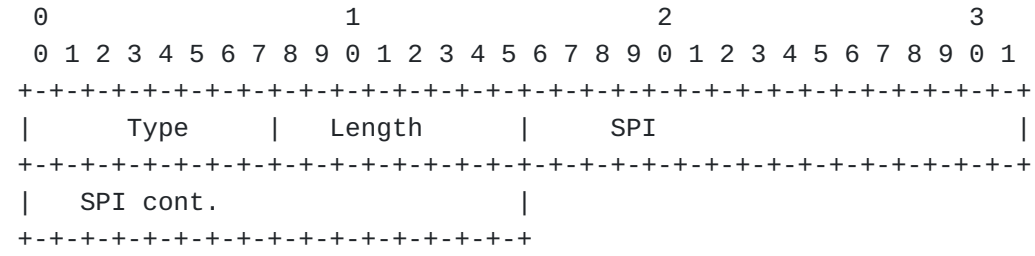
In the case of split, this attribute MUST be present in an Access-Request sent from the HA to the RADIUS Server when using MIPv6 Authentication Protocol. The MIP6-MN-AAA-SPI attribute contains a SPI code extracted from the Mobility Message Authentication Option included in the received BU message.



Type:

ASSIGNED-MIP6-MN-AAA-SPI-TYPE to be defined by IANA.

Length:

6 octets

Integer representing a Security Parameter Index.

5.9. MIP6-Authenticator

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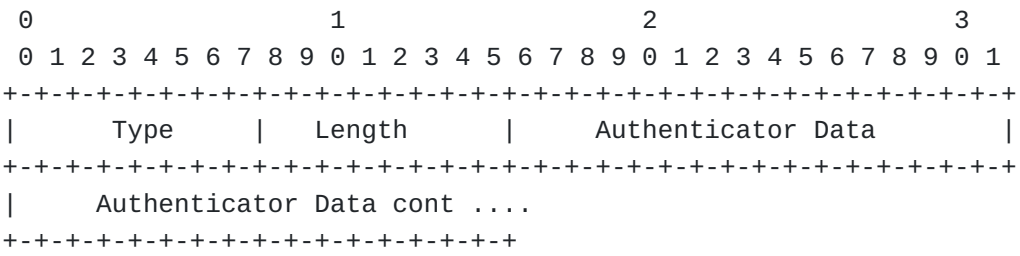
In the case of split, this attribute is sent from the HA to the RADIUS server and contains the Authenticator data from the BU message. The HA extract the data form the MN-AAA Mobility Message Authentication Option if included in the received BU message.
Upon receiving this attribute from the HA, the RADIUS server computes its own version of the Authenticator Data from the received MIP6-MAC-Mobility-Data (see below) and compares it to the value received in the MIP6-Authenticator from the HA. If the values match then the Mobile Node is authenticated.
In the case of split, this attribute MUST be present in an Access-Request sent from the HA to the RADIUS Server when using MIPv6 Authentication Protocol.



Type:

ASSIGNED-MIP6-AUTHENTICATOR-TYPE to be defined by IANA.

Length:

Variable length

String. An OctetString representing authenticator data.

5.10. MIP6-MAC-Mobility-Data

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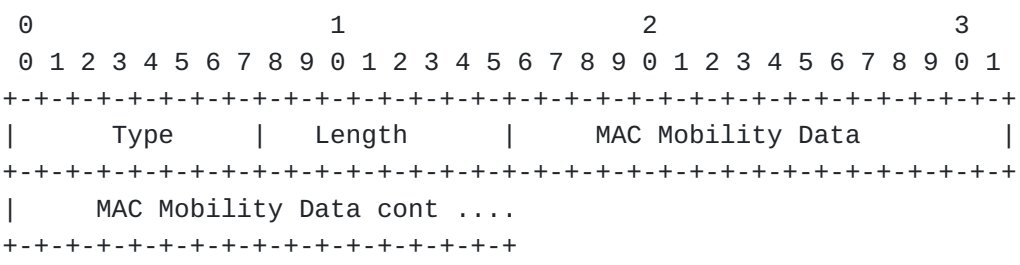
In the case of split, the MIP6-MAC-Mobility-Data attribute is sent from the HA to the RADIUS Server. The attribute contains the calculated MAC_Mobility_Data as defined in [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.).
This attribute MUST be present in an Access-Request sent from the HA to the RADIUS Server when using MIPv6 Authentication Protocol.



Type:

ASSIGNED-MIP6-MAC-MOBILITY-DATA-TYPE to be defined by IANA.

Length:

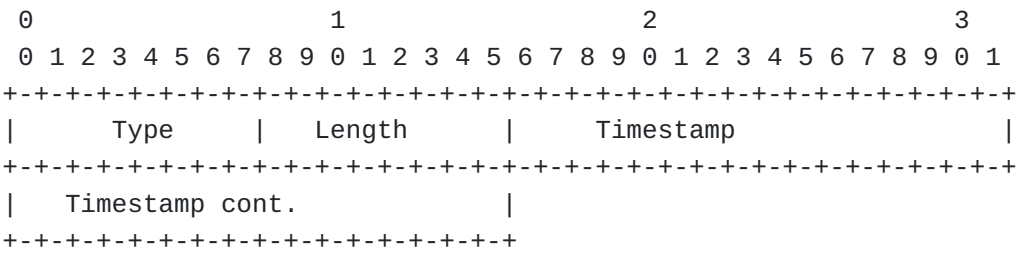
Variable length

String. An OctetString representing authenticator data.

5.11. MIP6-Timestamp

TOC

The MIP6-Timestamp contains the timestamp value from the Mobility message replay protection option, defined in [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.). The Home Agent extracts this value from the received BU message, if available. The support for replay protection is an optional feature in [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.). When the RADIUS server checks the timestamp provided by the MN via the HA and recognizes a clock-drift (outside a locally defined replay protection window) then it MUST initiate the re-synchronization procedure by returning an Access-Accept packet with Result-Code set to MIP6-TIMESTAMP-MISMATCH and attaches the MIP6-Timestamp including it's current time back to the HA.
In the case of split, this attribute is sent from the HA to the RADIUS server when performing MIP6 Authentication protocol. The attribute MUST appear in the Access-Request if the attribute is present in the Mobility message replay protection. Otherwise the attribute MUST NOT appear in the Access-Request packet.
[EDITOR'S NOTE] there is an issue here. In the diameter protocol, if there is a time mismatch we return a result code that states that there was a time mismatch and we return this value. In RADIUS land we return an Access-Reject but we cant really return any other attributes.



Type:

ASSIGNED-MIP6-TIMESTAMP-TYPE to be defined by IANA.

Length:

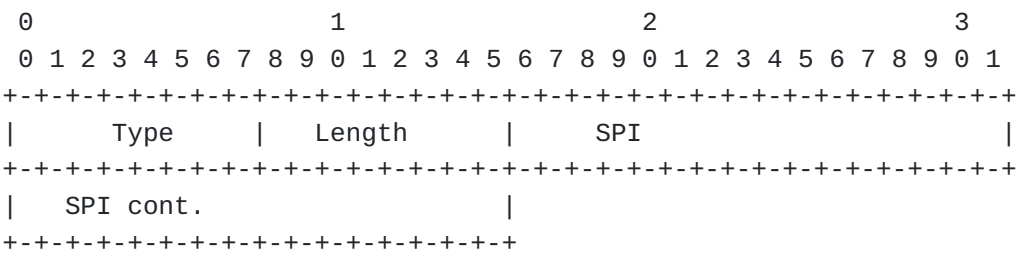
6 octets

Integer representing time since standard epoch of 1/1/1970 in seconds.

5.12. MIP6-MN-HA-SPI

TOC

In the case of split, the MIP6-MN-HA-SPI available to be sent in an Access-Accept packet from the RADIUS server to he HA. It is part of a group of attributes used with the MIPv6 Authentication Protocol and contains the Security Parameter Index used to reference the MN-HA mobility security association.



Type:

ASSIGNED-MIP6-MN-HA-SPI-TYPE to be defined by IANA.

Length:

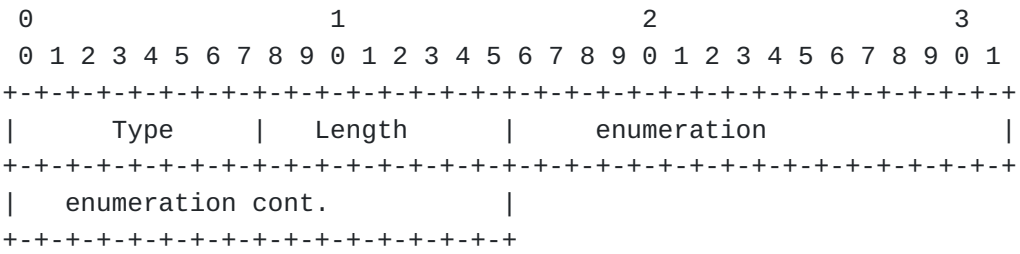
6 octets

Integer representing a Security Parameter Index.

5.13. MIP6-Algorithm-Type

TOC

In the case of split, the MIP6-Algorithm-Type is available to be sent in an Access-Accept packet from the RADIUS server to the HA. It is part of a group of attributes used with the MIPv6 Authentication protocol and contains the algorithm type.



Type:

ASSIGNED-MIP6-ALGORITHM-TYPE to be defined by IANA.

Length:

6 octets

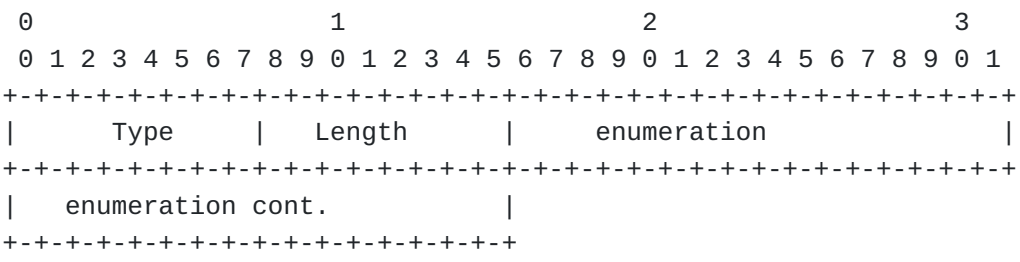
Integer representing an enumeration as supported by [22] (Perkins, C., "IP Mobility Support for IPv4," August 2002.):

2: HMAC-SHA-1 [8] (Krawczyk, H., Bellare, M., and R. Canetti, "HMAC: Keyed-Hashing for Message Authentication," February 1997.)

5.14. MIP6-Replay-Mode

TOC

In the case of split, the MIP6-Replay-Mode is available to be sent in an Access-Accept packet from the RADIUS server to the HA. It is part of a group of attribute used with the MIPv6 Authentication protocol and contains the replay mode as defined in RFC4004 to be used by the HA.



Type:

ASSIGNED-MIP6-REPLAY-MODE-TYPE to be defined by IANA.

Length:

6 octets

Integer representing an enumeration as supported by [22] (Perkins, C., "IP Mobility Support for IPv4," August 2002.):

1: None.

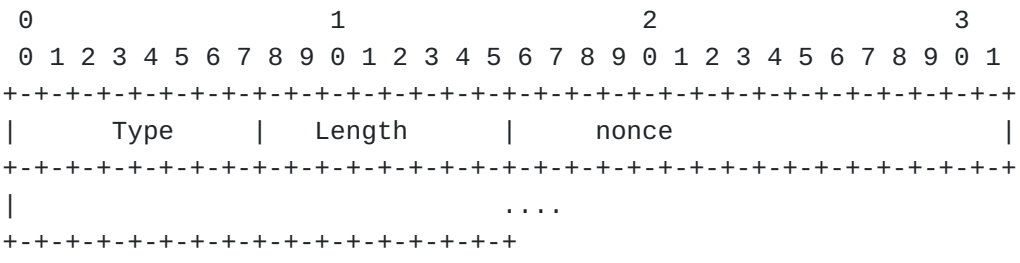
2: Timestamps.

3: Nonces.

5.15. MIP6-Nonce

TOC

In the case of split, the MIP6-Nonce is available to be sent in an Access-Accept packet from the RADIUS Server to the HA. It is part of a group of attributes used with the MIPv6 Authentication protocol and contains the nonce to send to the MN.



Type:

ASSIGNED-MIP6-NONCE-TYPE to be defined by IANA.

Length:

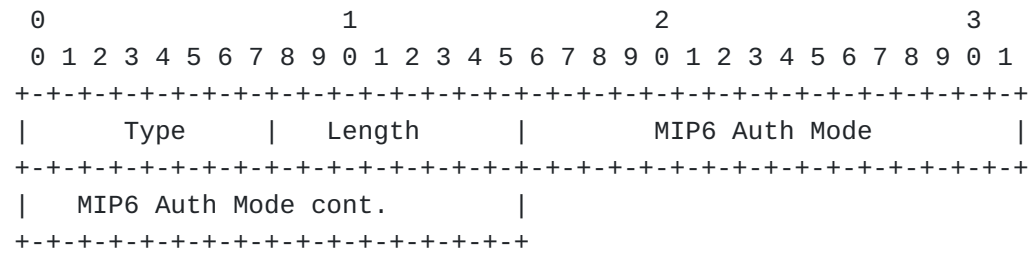
Variable length

String. A binary string representing a nonce.

5.16. MIP6-Auth-Mode

TOC

The MIP6-Auth-Mode is of type enumerated and sent by the HA to the RADIUS server to indicate which procedural variant and credential to use when Authentication Protocol for MIP6 [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.) is being used to authenticate the Binding Update. This specification defines only one value.
If the RADIUS server does not support the Mobile IPv6 Authentication Protocol mode proposed by the HA, then the RADIUS server MUST fail the authentication/authorization by sending an Access-Reject packet to the HA.



Type:

ASSIGNED-MIP6-AUTH-MODE-TYPE to be defined by IANA.

Length:

6 octets

Integer value representing the following values:

1: MIP6_AUTH_MN_AAA

All other values reserved.

6. Message Flows

TOC

6.1. Use of RADIUS in Integrated Scenario (MSA=ASA)

TOC

This section is based on [2] (Chowdhury, K. and A. Yegin, “MIP6-bootstrapping for the Integrated Scenario,” April 2008.) and uses the RADIUS attributes that are defined in this document.

6.1.1. HA allocation in the MSP

TOC

RADIUS is used to authenticate the MN, to authorize it for mobility service and to send information about the assigned HA to the NAS.

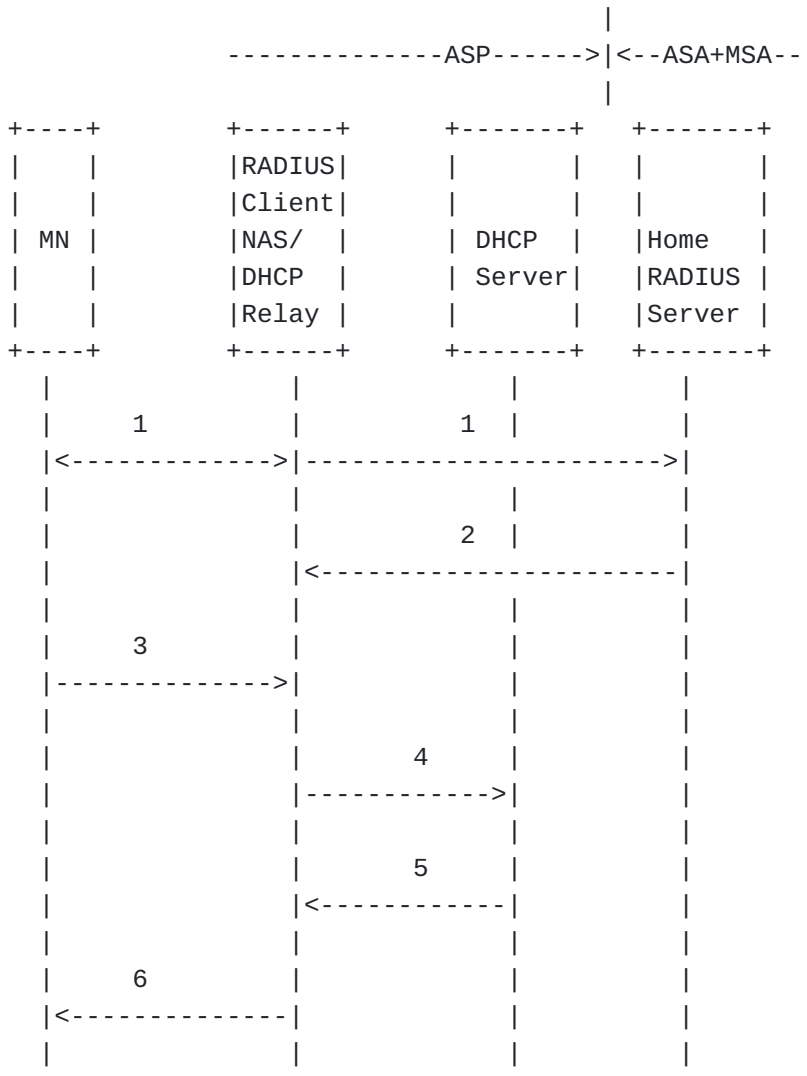


Figure 3: HA allocation in the MSP

In step (1), the MN executes the network access authentication procedure (e.g., IEEE 802.11i/802.1x, PANA) with the NAS. The NAS acts as an authenticator in "pass-through" mode, i.e., the endpoint of the authentication dialogue is the MN's home RADIUS server. This is the typical scenario in case the messages involved in the authentication protocol are transported in EAP.

As per [6] (Aboba, B. and P. Calhoun, “RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP),” September 2003.), the NAS encapsulates/de-capsulates EAP packets into/from RADIUS packets until an Access-Response (either an Access-Accept or an Access/Reject packet is received by the NAS). This concludes the network access authentication phase.

If the NAS has the ability to support MIP6 Bootstrapping it includes the MIP6-Feature-Vector in the first Access-Request message and

indicates whether it supports MIP6 bootstrapping and/or local home agent assignment by setting the appropriate flags therein.
If the NAS indicates support for local home agent assignment, then it may also include the MIP6-HA attribute(s) and/or MIP6-HA-FQDN attribute(s) as a proposal to the RADIUS server to indicate that the HA is to be assigned in the ASP.
In step (2), the RADIUS server sends an Access-Accept packet with the MIP6-Feature-Vector with the Local Home Agent Assignment flag set or cleared. If the flag is cleared then the RADIUS server needs to provide one or more Home Agent(s) to be assigned to the MN. If the flag is set, then it indicates to the NAS that it can assign HA to the MN; the RADIUS server may also include one or more HA addresses thus indicating that the NAS can either allocate a local HA or one specified by the RADIUS server.
In step (3) the MN performs home information discovery procedures as specified in [DHCPv6 for Home Info Discovery in MIPv6][hiopt]. The MN sends a DHCPv6 Information-request message including the Home Network Information option according to the stateless DHCPv6 procedures [23] (Droms, R., “Stateless Dynamic Host Configuration Protocol (DHCP) Service for IPv6,” April 2004.) and [24] (Droms, R., Bound, J., Volz, B., Lemon, T., Perkins, C., and M. Carney, “Dynamic Host Configuration Protocol for IPv6 (DHCPv6),” July 2003.). The MN MUST also include the Option code for the Home Network Information option in the Option Request option in the request. The id-type of the Home Network Identifier Option is set to 1 indicating that the MN is requesting to discover the home network information that pertains to the given realm, i.e., the user's home domain (identified by the NAI of the MN). The OPTION_CLIENTID is set by the MN to identify itself to the DHCP server.
In step (4) the DHCP relay agent forwards this request to the DHCP server. The OPTION_MIP6-RELAY-Option is included in this forwarded message. This option carries the RADIUS MIP6-HA attribute received in the Access-Accept packet.
In step (5), the DHCP server identifies the client (by DUID) and finds out that it requests HA information in the MSP (by the Home Network Identifier Option = 1). The DHCP server extracts the HA address from OPTION_MIP6-RELAY-Option and places it into Home Network Information Option in the Reply message.
In step (6), the Relay Agent forwards the Reply Message to the MN. On reception of this message, the HA address or the FQDN of the HA is available at the MN.

6.1.2. HA allocation in the ASP (visited network)

TOC

This scenario is similar to the one described in Section 7.1.1. The difference is in step (4), where the type-id field in the Home Network Identifier Option is set to zero, indicating that a HA is requested in

the ASP instead of in the MSP. Thus, the information received by the home RADIUS server, via the DHCP relay, in the OPTION_MIP6-RELAY-Option (Information Request) is ignored. The DHCP server allocates a HA from its list of possible HAs and returns it in the Reply message (Home Network Information Option).

6.2. Use of RADIUS In Split Scenario

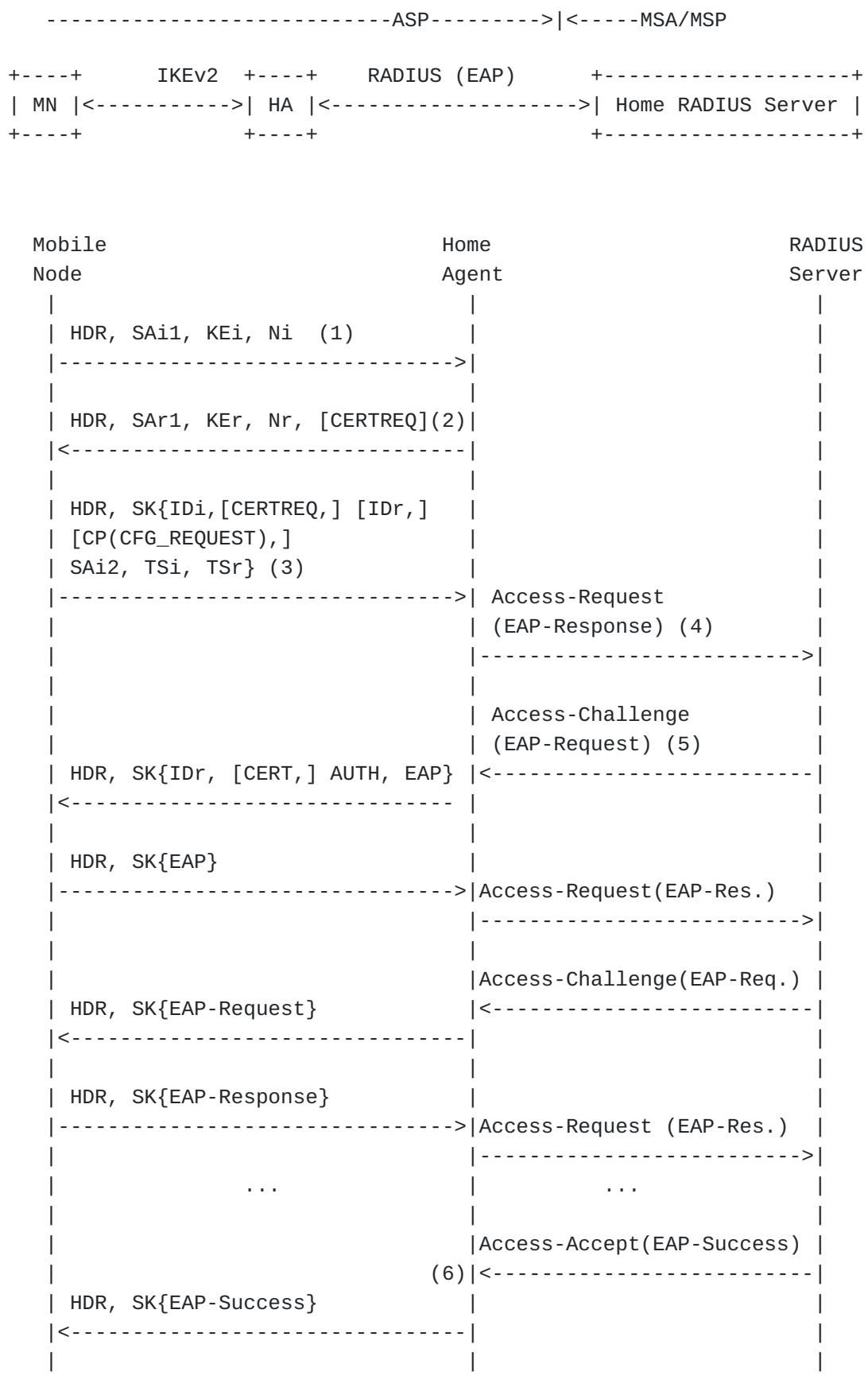
TOC

In this section we present the call flows used in the Split scenario. In the Split scenario the MN can be authenticated and authorized for Mobile IPv6 by using IKEv2 or the Mobile IPv6 Authentication Protocol [3] (Patel, A., "Authentication Protocol for Mobile IPv6," October 2006.). The authentication and or authorization takes place between the HA and the RADIUS server.

6.2.1. Split using IKEv2

TOC

This section describes IKEv2 based authentication and authorization for the SPLIT scenario using IKEv2 and EAP. Use of IKEv2 with certificates or preshared keys is not in scope for this document.
The use of IKEv2 with EAP between the MN and the HA allows the AAA to authenticate the MN. When EAP is used with IKEv2, the RADIUS EAP procedures, as defined in [6] (Aboba, B. and P. Calhoun, "RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP)," September 2003.), are used. EAP methods that do not establish a shared key SHOULD NOT be used, as they are subject to a number of man-in-the-middle attacks as stated in Section 2.16 and Section 5 of RFC 4306 [25] (Kaufman, C., "Internet Key Exchange (IKEv2) Protocol," December 2005.). Attributes specific to Mobile IPv6 bootstrapping are added to the AAA packets.
Figure 4 (Split Scenario Exchange Using IKEv2 and EAP) shows the message flow involved during the authentication phase when EAP is used.


----------ASP---------->|<-----MSA/MSP
+----+ IKEv2 +----+ RADIUS (EAP) +--------------------+
| MN |<----------->| HA |<-------------------->| Home RADIUS Server |
+----+ +----+ +--------------------+
Mobile Node
Home Agent
RADIUS Server
HDR, SAi1, KEi, Ni (1)
HDR, SAr1, KEr, Nr, [CERTREQ](2)
HDR, SK{IDi,[CERTREQ,] [IDr,]
[CP(CFG_REQUEST),]
SAi2, TSi, TSr} (3)
Access-Request
(EAP-Response) (4)
Access-Challenge
(EAP-Request) (5)
HDR, SK{IDr, [CERT,] AUTH, EAP}
HDR, SK{EAP}
Access-Request(EAP-Res.)
Access-Challenge(EAP-Req.)
HDR, SK{EAP-Request}
HDR, SK{EAP-Response}
Access-Request (EAP-Res.)
...
...
Access-Accept(EAP-Success)
(6)
HDR, SK{EAP-Success}

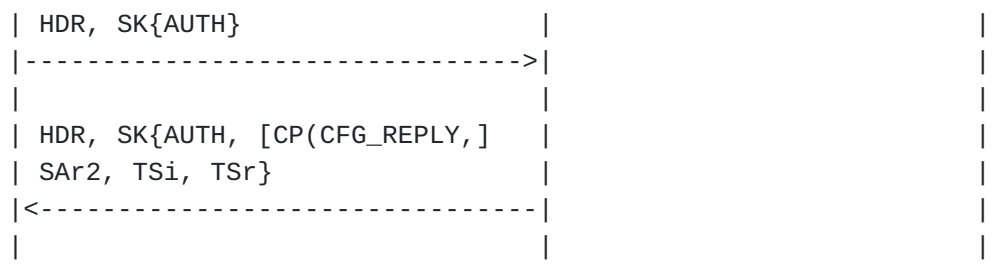


Figure 4: Split Scenario Exchange Using IKEv2 and EAP

Before this scenario started the MN has to know the IP address of the HA to use. The MN may be configured with the HA-IP address or the FQDN of the HA to use or with a mobility service name. In the case where the MN is configured with the domain name of the HA or a mobility service name, it uses DNS to resolve the IP address of the HA to use. Alternatively, MN could have received the information by performing a DHCP request as per [26] (Jang, H., Yegin, A., Chowdhury, K., and J. Choi, “DHCP Options for Home Information Discovery in MIPv6,” May 2008.)

The MN and the HA start the interaction with an IKE_SA_INIT exchange(1) (2). In this phase cryptographic algorithms are negotiated, nonces and Diffie-Hellman parameters are exchanged.

Exchange (3) starts the IKE_AUTH phase. This second phase of IKEv2 authenticates the previous messages, exchanges identities and certificates and establishes the first CHILD_SA. It is used to mutually authenticate the MN (acting as an IKEv2 Initiator) and the HA (acting as an IKEv2 Responder). The identity of the user/MN is provided in the IDi field. The MN indicates its willingness to be authenticated via EAP by omitting the AUTH field in message (3) (see Section 2.16 of [25] (Kaufman, C., “Internet Key Exchange (IKEv2) Protocol,” December 2005.)).

As part of the authentication process, the MN MAY request a Home-Address, a Home Prefix or suggests one, see [27] (Devarapalli, V. and F. Dupont, “Mobile IPv6 Operation with IKEv2 and the Revised IPsec Architecture,” April 2007.), using a CFG_REQUEST payload in the exchange(3).

The HA extracts the IDi field from exchange (3) and sends a RADIUS Access-Request packet(4) towards the authenticating RADIUS server. The User-Name(1) attribute is set to the value received in the IDi field and the EAP-Payload attribute contains a EAP-Response/ Identity with the identity extracted from the IDi field. The Access-Request packet is integrity protected by the Message-Authenticator(89) attribute.

This message is routed to the MN's home RADIUS server/EAP server. The RADIUS server selects the EAP method and replies with the RADIUS Access-Challenge packet(5). Depending on the type of EAP method chosen, a number of Access-Request and Access-Challenge exchanges are conducted

to execute the EAP method between the MN and the RADIUS server/EAP server.
At the end of the EAP authentication phase, the RADIUS server indicates the result of the authentication by either sending an Access-Accept packet(6) containing EAP-Success or an Access-Reject packet containing EAP-Reject. The last IKEv2 message sent by the HA contains the Home Address or the Home Prefix. In the latter case, a CREATE_CHILD_SA exchange is necessary to setup IPSec SAs for Mobile IPv6 signaling.
In some deployment scenarios, the HA may also acts as a IKEv2 Responder for IPSec VPN access. A problem in this case is that the IKEv2 responder may not know if IKEv2 is used for Mobile IPv6 service or for IPSec VPN access service. A network operator needs to be aware of this limitation. The MN may provide a hint of the intended service, for example, by using different identities in the IKE_AUTH message for the IPSec VPN service and Mobile IPv6 service. However, the use of different identities during the IKEv2 negotiation is deployment specific. Another possibility is to make the distinction on the MN subscription basis. In this case the RADIUS server can inform the HA during the IKEv2 negotiation whether the MN is provisioned with an IPSec VPN access service or Mobile IPv6 service.
Eventually, when the HA receives a Binding Update (BU), the HA authenticates and authorizes the MN. It is RECOMMENDED that the HA sends a RADIUS accounting request message every time it receives a BU. Alternatively, if the HA does not support RADIUS Accounting, it SHOULD send a User-Session-Notification packet as defined in [9] (Zorn, G. and A. Lior, “User Session Tracking in RADIUS,” February 2008.) to inform the AAA server that the mobile ip session has termianted.

6.2.2. Split and Mobile IPv6 Authentication Protocol

TOC

Figure 5 (Mobile IPv6 Bootstrapping using the Mobile IPv6 Authentication Protocol) shows the message sequence between the MN, the HA and the RADIUS server during the registration when Mobile IPv6 Authentication Protocol is used. A BU and a Binding Acknowledgement (BA) messages are used in the binding registration process.
Mobile IPv6 Authentication Protocol as specfied in [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.) allows the initial BU to be protected using the MN-HA key or the MN-AAA key. Support for the use of MN-HA key to protected the initial BU is not in scope of this specification.
Receiving a BU at the HA initiates a MIP6-Request to be sent to the RADIUS server. The RADIUS server in turn responds with an Access-Accept or an Access-Reject. The HA may assign a Home Address to the MN and provide it to the RADIUS server in the MIP6-HOA attribute.
According to [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.) the MN uses the Mobile Node Identifier Option,

specifically the MN-NAI mobility option (as defined in [20] (Patel, A., Leung, K., Khalil, M., Akhtar, H., and K. Chowdhury, “Mobile Node Identifier Option for Mobile IPv6 (MIPv6),” November 2005.)) to identify itself. The HA MUST copy the MN-NAI mobility option value to the User-Name(1) attribute in the Access-Request packet.

The procedure described in this specification for the Mobile IPv6 Authentication Protocol is only needed for the initial BU received by the HA. When the HA receives subsequent BUs, they are processed locally in the HA using the MN-HA key received from the AAA upon successful authentication and authorization. It is RECOMMENDED that the HA sends an accounting request packet upon each new BU update reauthentication.

Upon receiving a BU containing the MN-AAA Mobile Message Authentication Option, the HA extracts the Mobility SPI from the Mobility Message Authentication Option and sends it to the RADIUS server in the MIP6-MN-AAA-SPI attribute. The HA also extract the Authentication Data from the Message Authentication Option and includes it in the Access-Request in the MIP6-Authenticator attribute. The HA includes the MIP6-Auth-Mode attribute in the Access-Request setting its value to MIP6_AUTH_MN_AAA indicating that the MN-AAA key is used as the credential protecting the BU.

In the case of RADIUS based authentication, the Mobility SPI MUST be set the well-know value HMAC-SHA1_SPI (see section 8 of [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.)). In this case the HA SHALL compute the MAC_Mobility Data as per [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.) using HMAC_SHA1 as the hash_fn() and include the result in the MIP6-MAC-Mobility-Data attribute in the Access-Request.

The HA inlcudes the MIP6-Authenticator attribute set to the authenticator data extracted from the MN-AAA Mobility Message Authentication Option contained in the BU message.

The MIP6-Timestamp attribute is set to the value contained in the mobility message prelay protection option defined in [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.) if available.

Upon receiving the Access-Request packet from the HA, the RADIUS server MUST ensure that the MIP6-Auth-Mode attribute is present and set to MIP6_AUTH_MN_AAA. If not, the RADIUS Server SHALL respond with an Access-Reject packet which includes Error-Cause (101) attribute with value set to "Invalid Attribute Value". Upon receiving an Access-Reject with Error-Cause (101) attribute set to "Invalid Attribute Value", the HA SHALL reject the BU.

The Access-Request packet MUST contain the MIP6-MN-AAA-SPI attribute with a SPI set the well-know value HMAC-SHA1_SPI (see section 8 of [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.)). If not, the RADIUS server SHALL repond back to the HA with an Access-Reject packet contain Error-Cause (101) attribute set to "Missing Attribute".

The RADIUS server uses the data received in the MIP6-MAC-Mobility-Data attribute to computes its own version of the Authenticator as per [3] (Patel, A., “Authentication Protocol for Mobile IPv6,” October 2006.).

The RADIUS server compares the value computed to the value received in the MIP6-Authenticator. If the values don't match the RADIUS server SHALL respond back with an Access-Reject packet.
If the MN is authenticated and is authorized for MIP6 service, the RADIUS server responds back with an Access-Accpet otherwise it responds with an Access-Reject. In the case of Access-Accept and if the MIP6-MN-HA-SPI value was inclued in the Access-Request packet, the RADIUS server includes the MN-HA security association parameters associated with the MN-HA SPI and the NAI received in the User-Name attributes in the MS-MPPE-Recv-Key, MS-MPPE-Send-Key, MIP6-Algorithm-Type, MIP6-Replay-Mode, MIP6-Nonce. The MS-MPPE-Recv-Key, MS-MPPE-Send-Key must be encrypted using the procedures defined in section 3.3 of [10] (Zorn, G., Leifer, D., Rubens, A., Shriver, J., Holdrege, M., and I. Goyret, "RADIUS Attributes for Tunnel Protocol Support," June 2000.). The RADIUS Access-Accept packet MUST be integrity protected using Message-Authenticator(89) attribute.
If the RADIUS server detected a replay attack when checking the MIP6-Timestamp received in the Access-Request fromt he HA. The RADIUS server SHALL respond back with an Access-Reject.

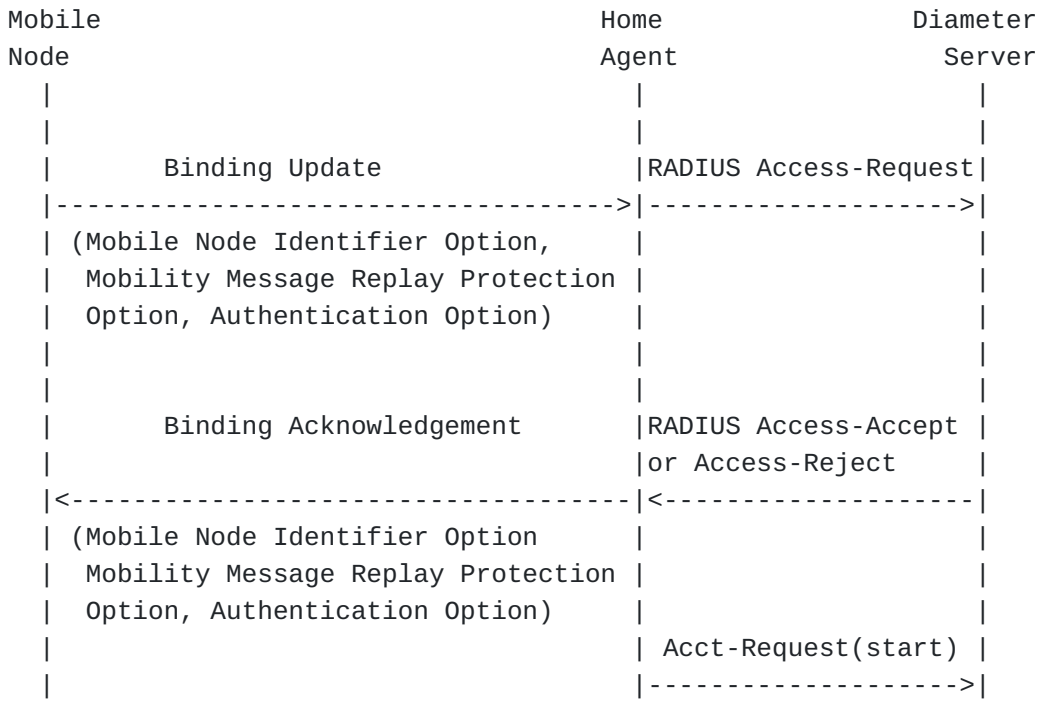


Figure 5: Mobile IPv6 Bootstrapping using the Mobile IPv6 Authentication Protocol

7. Goals for the HA-AAA Interface

TOC

Here, we follow the classification and labels listed in the MIPv6-AAA-Goals document [28] (Giaretta, G., “AAA Goals for Mobile IPv6,” September 2006.).

7.1. General Goals

TOC

G1.1-G1.4 Security
These are standard requirements for a AAA protocol – mutual authentication, integrity, replay protection, confidentiality. IPsec can be used to achieve the goals. Goal G1.5 regarding inactive peer detection needs further investigations since heartbeat messages do not exist (like in the Diameter case, Watch-Dog-Request/Answer).

7.2. Service Authorization

TOC

G2.1. The AAA-HA interface should allow the use of Network Access Identifier (NAI) to identify the MN. The User-Name attribute can be used for the purpose to carry the NAI.
G2.2 The HA should be able to query the AAAH server to verify Mobile IPv6 service authorization for the MN. Any node implementing RADIUS functionality[11] (Rigney, C., Willens, S., Rubens, A., and W. Simpson, “Remote Authentication Dial In User Service (RADIUS),” June 2000.) can possibly initiate a request message. In combination with the ability of the RADIUS protocol to carry EAP messages [6] (Aboba, B. and P. Calhoun, “RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP),” September 2003.) , our solution will enable an HA to query a RADIUS server and verify MIPv6 authorization for the MN.
G2.3 The AAAH server should be able to enforce explicit operational limitations and authorization restrictions on the HA (e.g., packet filters, QoS parameters). Work in progress in the area, including NAS-Filter-Rule, RADIUS quality of service support, prepaid extensions etc. is performed. The relevant attributes may be reused for providing required functionality over the AAAH-HA interface.
G2.4 - G2.6. Issues addressing the maintenance of a Mobile IPv6 session by the AAAH server, e.g., authorization lifetime, extension of the authorization lifetime and explicit session termination by the AAAH server side.
The attribute Session-Timeout may be sent in Access-Challenge or Access-Accept packet by the RADIUS server, thus limiting the

authorization session duration. In order to reauthenticate/reauthorize the user, the Termination-Action attribute can be included, with value 1, meaning the NAS should send a new RADIUS-Request packet. Additional AVPs for dealing with pre-paid sessions (e.g,. volume, resource used— VolumeQuota AVP, ResourceQuota AVP) are specified in RADIUS prepaid extension. Exchanging of application specific authorization request/ answer messages provides extension of the authorization session (e.g., Authorize Only Access-Request sent by the HA (NAS) to the RADIUS server). Initiation of the re-authorization by both sides could be supported. Both sides could initiate session termination – the RADIUS server by sending Disconnect message [29] (Chiba, M., Dommety, G., Eklund, M., Mitton, D., and B. Aboba, "Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)," January 2008.).

7.3. Accounting

TOC

G3.1 The AAA-HA interface must support the transfer of accounting records needed for service control and charging. These include (but may not be limited to): time of binding cache entry creation and deletion, octets sent and received by the MN in bi-directional tunneling, etc. The requirements for accounting over the AAAH-HA interface does not require enhancements to the existing accounting functionality.

7.4. MN Authentication

TOC

G4.1 The AAA-HA interface MUST support pass-through EAP authentication with the HA working as EAP authenticator operating in pass-through mode and the AAAH server working as back-end authentication server.
These issues require the functionality of AAAH server working as a back-end authentication server and HA working as NAS and EAP authenticator in pass-through mode for providing a MN authentication. This document suggests this mode of operation in the context of the relevant scenarios.

7.5. Provisioning of Configuration Parameters

TOC

G5.1 The HA should be able to communicate to the AAAH server the HOA allocated to the MN (e.g. for allowing the AAAH server to perform DNS update on behalf of the MN).

This document describes needed AVPs for this purpose, see section "DNS Update Mobility Option Attribute"

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8. Table of Attributes

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The following tables provides a guide to which attributes may be found in RADIUS packet and in what number.

The following defines the meaning of the notation used in the following tables:

0	An instance of this attribute MUST NOT be present.
1	Exactly one instance of this attribute MUST be present
0-1	Zero or one instance of this attribute MAY be present.
0+	Zero or more instance of this attriubte MAY be present

The table below describes the RADIUS messages used for bootstrapping and are exchanged between the NAS and the RADIUS Server.

Request	Accept	Reject	Challenge	Type	Attribute
1	1	0	0	MIP6-FV-TYPE	MIP6-Feature-Vector
0+[ac]	0+[a]	0	0	MIP6-HA-TYPE	MIP6-HA
0+[ac]	0+[a]	0	0	MIP6-HA-FQDN-TYPE	MIP6-HA-FQDN
0-1[b]	0-1	0	0	MIP6-HL-PREFIX-TYPE	MIP6-HL-Prefix
0-1[b]	0-1	0	0	MIP6-HOA-TYPE	MIP6-HOA
0-1	0-1	0	0	MIP6-DNS-MO-TYPE	MIP6-DNS-MO

Notes:

[a] Either MIP6-HA or MIP6-HA-FQDN MAY appear in a RADIUS packet.

[b] If MIP6-HA or MIP6-HA-FQDN are present in the Access-Request then these attributes MUST also be present in the Access-Request. If the RADIUS server accepts the NAS suggestion for the HA, then the RADIUS server MUST also include the values received for these attributes in the Access-Accept.

[c] If these attributes are present in an Access-Request, then LOCAL_HOME_AGENT_ASSIGNMENT flag of the MIP6-Feature-Vector MUST be set. Otherwise these attributes are ignored.

The following tables lists the commands and attributes used in the interaction between the HA and RADIUS server. Each table corresponds to the different authentication modes supported. These attributes are in addition to the any other attributes specified by an other specification (for example, RADIUS EAP)

Table of attributes for IKEv2 and EAP-based Authentication:

Request	Accept	Reject	Challenge	Type	Attribute
1	0	0	0	61	NAS-Port-Type
1	0	0	0	80	Message-Authenticator
0-1	0-1	0	0	MIP6-FV-TYPE	MIP6-Feature-Vector
1	0-1	0	0	MIP6-HOA-TYPE	MIP6-HOA

0	0	0	0	MIP6-CAREOF-ADDRESS-TYPE	MIP6-Careof-Address
0	0	0	0	MIP6-MN-AAA-SPI-TYPE	MIP6-MN-AAA-SPI
0-1	0	0	0	MIP6-HA-TYPE	MIP6-HA
0-1	0	0	0	MIP6-AUTHENTICATOR-TYPE	MIP6-Authenticator
0-1	0	0	0	MIP6-MAC-MOBILITY-DATA-TYPE	MIP6-MAC-Mobility-Data
0	0	0	0	MIP6-TIMESTAMP-TYPE	MIP6-Timestamp
0	0	0	0	MIP6-MN-HA-SPI-TYPE	MIP6-MN-HA-SPI
0	0	0	0	MIP6-ALGORITH-TYPE	MIP6-Algorithm-Type
0	0	0	0	MIP6-REPLY-MODE	MIP6-Replay-Mode
0	0	0	0	MIP6-NONCE-TYPE	MIP6-Nonce

Table of attribute for MIPv6 Authentication Protocol:

Request	Accept	Reject	Challenge	Type	Attribute
1	0	0	0	61	NAS-Port-Type
0-1	0	0	0	80	Message-Authenticator
0-1	0-1	0	0	MIP6-FV-TYPE	MIP6-Feature-Vector
1	0	0	0	MIP6-AUTH-MODE-TYPE	MIP6-Auth-Mode
1	0-1	0	0	MIP6-HOA-TYPE	MIP6-HOA
1	0	0	0	MIP6-CAREOF-ADDRESS-TYPE	MIP6-Careof-Address
1	0	0	0	MIP6-MN-AAA-SPI-TYPE	MIP6-MN-AAA-SPI
1	0	0	0	MIP6-HA-TYPE	MIP6-HA
1	0	0	0	MIP6-AUTHENTICATOR-TYPE	MIP6-Authenticator
1	0	0	0	MIP6-MAC-MOBILITY-DATA-TYPE	MIP6-MAC-Mobility-Data
0-1	0	0	0	MIP6-TIMESTAMP-TYPE	MIP6-Timestamp
0	1	0	0	MIP6-MN-HA-SPI-TYPE	MIP6-MN-HA-SPI
0	1	0	0	MIP6-ALGORITH-TYPE	MIP6-Algorithm-Type
0	1	0	0	MIP6-REPLY-MODE	MIP6-Replay-Mode
0	1	0	0	MIP6-NONCE-TYPE	MIP6-Nonce

As used in accounting packets:

Request	Interim	Stop	Type	Attribute
0-1	0-1	0-1	MIP6-HA-TYPE	MIP6-HA Attribute
0-1	0-1	0-1	MIP6-HA-FQDN-TYPE	MIP6-HA-FQDN Attribute
0	0	0	MIP6-HL-PREFIX-TYPE	MIP6-HL-Prefix Attribute
0-1	0-1	0-1	MIP6-HOA-TYPE	MIP6-HOA Attribute
0	0	0	MIP6-DNS-MO-TYPE	MIP6-DNS-MO Attribute

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9. Diameter Considerations

When used in Diameter, the attributes defined in this specification can be used as Diameter AVPs from the Code space 1-255 (RADIUS attribute compatibility space). No additional Diameter Code values are therefore allocated. The data types and flag rules for the attributes are as follows:

		AVP Flag rules				
Attribute Name	Value Type	MUST	MAY	SHLD NOT	MUST NOT	Encr
MIP6-HA	Address	M	P		V	Y
MIP6-HA-FQDN	UTF8String	M	P		V	Y
MIP6-HL-Prefix	OctetString	M	P		V	Y
MIP6-HOA	Address	M	P		V	Y
MIP6-DNS-MO	OctetString	M	P		V	Y

Other than MIP6-HA and HOA-IPv6, the attributes in this specification have no special translation requirements for Diameter to RADIUS or RADIUS to Diameter gateways; they are copied as is, except for changes relating to headers, alignment, and padding. See also [12] (Calhoun, P., Loughney, J., Guttman, E., Zorn, G., and J. Arkko, “Diameter Base Protocol,” September 2003.) Section 4.1 and [30] (Calhoun, P., Zorn, G., Spence, D., and D. Mitton, “Diameter Network Access Server Application,” August 2005.) Section 9. MIP6-HA and HOA-IPv6 must be translated between their RADIUS representation of String to a Diameter Address format which requires that the AddressType field be set to 2 for IP6 (IP version 6)

What this specification says about the applicability of the attributes for RADIUS Access-Request packets applies in Diameter to AA-Request [30] (Calhoun, P., Zorn, G., Spence, D., and D. Mitton, “Diameter Network Access Server Application,” August 2005.) or Diameter-EAP-Request [31] (Eronen, P., Hiller, T., and G. Zorn, “Diameter Extensible Authentication Protocol (EAP) Application,” August 2005.). What is said about Access-Challenge applies in Diameter to AA-Answer [30] (Calhoun, P., Zorn, G., Spence, D., and D. Mitton, “Diameter Network Access Server Application,” August 2005.) or Diameter-EAP-Answer [31] (Eronen, P., Hiller, T., and G. Zorn, “Diameter Extensible Authentication Protocol (EAP) Application,” August 2005.) with Result-Code AVP set to DIAMETER_MULTI_ROUND_AUTH.

What is said about Access-Accept applies in Diameter to AA-Answer or Diameter-EAP-Answer messages that indicate success. Similarly, what is said about RADIUS Access-Reject packets applies in Diameter to AA-Answer or Diameter-EAP-Answer messages that indicate failure.

What is said about Accounting-Request applies to Diameter Accounting-Request [30] (Calhoun, P., Zorn, G., Spence, D., and D. Mitton, "Diameter Network Access Server Application," August 2005.) as well.

10. Security Considerations

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Assignment of these values to a user should be based on successful authentication of the user at the NAS and/or at the HA. The RADIUS server should only assign these values to a user who is authorized for Mobile IPv6 service (this check could be performed with the user's subscription profile in the Home Network).
The NAS and the HA to the RADIUS server transactions must be adequately secured. Otherwise there is a possibility that the user may receive fraudulent values from a rogue RADIUS server potentially hijacking the user's Mobile IPv6 session.
These new attributes do not introduce additional security considerations besides the ones identified in [11] (Rigney, C., Willens, S., Rubens, A., and W. Simpson, "Remote Authentication Dial In User Service (RADIUS)," June 2000.).

11. IANA Considerations

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11.1. Registration of new AVPs

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This specification defines the following new RADIUS attributes:

> MIP6-Feature-Vector is set to MIP6-FV-TYPE
>
> MIP6-HA is set to MIP6-HA-TYPE
>
> MIP6-HA-FQDN is set to MIP6-HA-FQDN-TYPE
>
> MIP6-HL-Prefix is set to MIP6-HL-PREFIX-TYPE
>
> MIP6-HOA is set to MIP6-HOsA-TYPE
>
> MIP6-DNS-MO is set to MIP6-DNS-MO-TYPE

11.2. New Registry: Mobility Capability

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For MIP6-FV-TYPE flag values must be generated:

Token	Value	Description
MIP6_INTEGRATED	0x0000000000000001	[RFC TBD]
LOCAL_HOME_AGENT_ASSIGNMENT	0x0000000000000002	[RFC TBD]
Available for Assignment via IANA	2^x	

Allocation rule: Only numeric values that are 2^x (power of two) are allowed based on the allocation policy described below.
Following the policies outlined in [1] new values with a description of their semantic for usage with the MIP6-Feature-Vector AVP together with a Token will be assigned after Expert Review initiated by the O&M Area Directors in consultation with the DIME working group chairs or the working group chairs of a designated successor working group. Updates can be provided based on expert approval only. A designated expert will be appointed by the O&M Area Directors. No mechanism to mark entries as "deprecated" is envisioned. Based on expert approval it is possible to delete entries from the registry.

11.3. Addition of existing values

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A new value HA6(IANA-TBD1) MUST be assigned to NAS-Port-Type(61)

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12. Acknowledgements

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13. References

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