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Diameter Mobile IPv6: Support for Network Access Server to Diameter Server Interaction

Status of This Memo

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Abstract

A Mobile IPv6 node requires a home agent address, a home address, and a security association with its home agent before it can start utilizing Mobile IPv6. RFC 3775 requires that some or all of these parameters be statically configured. Mobile IPv6 bootstrapping work aims to make this information dynamically available to the mobile node. An important aspect of the Mobile IPv6 bootstrapping solution is to support interworking with existing Authentication, Authorization, and Accounting (AAA) infrastructures. This document describes MIPv6 bootstrapping using the Diameter Network Access Server to home AAA server interface.

Table of Contents

1. Introduction

The Mobile IPv6 (MIPv6) specification [RFC3775] requires a mobile node (MN) to perform registration with a home agent (HA) with information about its current point of attachment (care-of address). The HA creates and maintains the binding between the MN's home address and the MN's care-of address.

In order to register with an HA, the MN needs to know some information, such as the home link prefix, the HA address, the home address(es), the home link prefix length, and security-association-related information.

The aforementioned information may be statically configured. However, static provisioning becomes an administrative burden for an operator. Moreover, it does not address load balancing, failover, opportunistic home link assignment, or assignment of local HAs in close proximity to the MN. Also, the ability to react to sudden environmental or topological changes is minimal. Static provisioning may not be desirable, in light of these limitations.

Dynamic assignment of MIPv6 home registration information is a desirable feature for ease of deployment and network maintenance. For this purpose, the AAA infrastructure, which is used for access authentication, can be leveraged to assign some or all of the necessary parameters. The Diameter server in the Access Service Provider's (ASP's) or Mobility Service Provider's (MSP's) network may return these parameters to the AAA client. Regarding the bootstrapping procedures, the AAA client might either be the Network Access Server, in case of the integrated scenario, or the HA, in case of the split scenario [RFC5026]. The terms "integrated" and "split" are described in the following terminology section and were introduced in [RFC4640] and [AAA].

2. Terminology and Abbreviations

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 RFC 2119 [RFC2119].

General mobility terminology can be found in [RFC3753]. The following additional terms are either borrowed from [RFC4640] or [RFC5026] or are introduced in this document:

Access Service Authorizer (ASA):

A network operator that authenticates an MN and establishes the MN's authorization to receive Internet service.

Access Service Provider (ASP):

A network operator that provides direct IP packet-forwarding to and from the MN.

Mobility Service Authorizer (MSA):

A service provider that authorizes MIPv6 service.

Mobility Service Provider (MSP):

A service provider that provides MIPv6 service. In order to obtain such service, the MN must be authenticated and authorized to do so.

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.

Network Access Server (NAS):

A device that provides an access service for a user to a network.

Home AAA (HAAA):

An Authentication, Authorization, and Accounting server located in the user's home network, i.e., in the home realm.

Local AAA (LAAA):

An Authentication, Authorization, and Accounting proxy located in the local (ASP) network.

Visited AAA (VAAA):

An Authentication, Authorization, and Accounting proxy located in a visited network, i.e., in the visited realm. In a roaming case, the local Diameter proxy has the VAAA role (see Figure 1).

3. Overview

This document addresses the Authentication, Authorization, and Accounting (AAA) functionality required for the MIPv6 bootstrapping solutions outlined in [RFC4640], and focuses on the Diameter-based AAA functionality for the NAS-to-HAAA (home AAA) server communication.

In the integrated scenario, MIPv6 bootstrapping is provided as part of the network access authentication procedure. Figure 1 shows the participating entities.

```
                      +---------------------------+  +-----------------+
                      |Access Service Provider    |  |ASA/MSA/(MSP)    |
                      |(Mobility Service Provider)|  |                 |
                      |                           |  |                 |
                      | +--------+                |  |    +--------+   |
                      | |Local   |      Diameter  |  |    |Home    |   |
                      | |Diameter|<---------------------->|Diameter|   |
                      | |Proxy   |         (*)    |  |    |Server  |   |
                      | +--------+                |  |    +--------+   |
                      |     ^ ^                   |  |        ^        |
                      |     | |                   |  |        |(+)     |
                      |     | |                   |  |        |        |
                      |   Diameter                |  |        v        |
                      |     | |(+)      +-------+ |  |    +-------+    |
                      |     | |         |Home   | |  |    |Home   |    |
                      |     | +-------->|Agent  | |  |    |Agent  |    |
                      |  (*)|           |in ASP | |  |    |in MSP |    |
                      |     v           +-------+ |  |    +-------+    |
   +-------+ IEEE     | +-----------+   +-------+ |  +-----------------+
   |Mobile | 802.1X   | |NAS/Relay  |   |DHCPv6 | |
   |Node   |------------|Diameter   |---|Server | |
   |       | PANA,    | |Client     |(+)|       | |
   +-------+ IKEv2,   | +-----------+   +-------+ |
             DHCP,... +---------------------------+
             (+)
```

Legend:
  (*): Functionality in scope of this specification.
  (+): Extensions described in other documents.

Figure 1: Mobile IPv6 Bootstrapping in the Integrated Scenario

In a typical MIPv6 access scenario, an MN is attached to an ASP's network. During the network attachment procedure, the MN interacts with the NAS/Diameter client. Subsequently, the NAS/Diameter client interacts with the Diameter server over the NAS-to-HAAA interface.

When the Diameter server performs the authentication and authorization for network access, it also determines whether the user is authorized for the MIPv6 service. Based on the MIPv6 service authorization and the user's policy profile, the Diameter server may return several MIPv6 bootstrapping-related parameters to the NAS. The NAS-to-HAAA interface described in this document is not tied to the Dynamic Host Configuration Protocol for IPv6 (DHCPv6) as the only mechanism to convey MIPv6-related configuration parameters from the NAS/Diameter client to the mobile node.

While this specification addresses the bootstrapping of MIPv6 HA information and possibly the assignment of the home link prefix, it does not address how the Security Association (SA) between the MN and the HA for MIPv6 purposes is created. The creation or the use of the SA between the MN and the HA takes places after the procedures described in this specification, and therefore are out of scope.

4. Commands, Attribute-Value Pairs, and Advertising Application Support

4.1. Advertising Application Support

This document does not define a new application. On the other hand, it defines a number of attribute-value pairs (AVPs) used in the interface between NAS to HAAA for the integrated scenario of MIPv6 bootstrapping. These AVPs can be used with any present and future Diameter applications, where permitted by the command ABNF. The examples using existing applications and their commands in the following sections are for informational purposes only. The examples in this document reuse the Extensible Authentication Protocol (EAP) [RFC4072] application and its respective commands.

4.2. Attribute-Value Pair Definitions

4.2.1. MIP6-Agent-Info AVP

The MIP6-Agent-Info AVP (AVP code 486) is of type Grouped and contains necessary information to assign an HA to the MN. When the MIP6-Agent-Info AVP is present in a message, it MUST contain either the MIP-Home-Agent-Address AVP, the MIP-Home-Agent-Host AVP, or both AVPs. The grouped AVP has the following modified ABNF (as defined in [RFC3588]):

```
    MIP6-Agent-Info ::= < AVP-Header: 486 >
                      *2[ MIP-Home-Agent-Address ]
                        [ MIP-Home-Agent-Host ]
                        [ MIP6-Home-Link-Prefix ]
                      * [ AVP ]
```

If both the MIP-Home-Agent-Address and MIP-Home-Agent-Host APVs are present in the MIP6-Agent-Info, the MIP-Home-Agent-Address SHOULD have a precedence over the MIP-Home-Agent-Host. The reason for this recommendation is that the MIP-Home-Agent-Address points to a specific home agent, whereas the MIP-Home-Agent-Host may point to a group of HAs located within the same realm. A Diameter client or agent may use the MIP-Home-Agent-Host AVP, for instance, to find out in which realm the HA is located.

The ABNF allows returning up to two MIPv6 HA addresses. This is a useful feature for deployments where the HA has both IPv6 and IPv4 addresses, and particularly addresses Dual Stack Mobile IPv6 (DSMIPv6) deployment scenarios [DSMIPv6].

The MIP6-Agent-Info AVP MAY also be attached by the NAS or by the intermediating Diameter proxies in a request message when sent to the Diameter server as a hint of a locally assigned HA. This AVP MAY also be attached by the intermediating Diameter proxies in a reply message from the Diameter server, if locally assigned HAs are authorized by the Diameter server. There MAY be multiple instances of the MIP6-Agent-Info AVP in Diameter messages, for example, in cases where the NAS receives HA information from an MN's home network and locally allocated HA information from the visited network. See Section 4.2.5 for further discussion on possible scenarios.

4.2.2. MIP-Home-Agent-Address AVP

The MIP-Home-Agent-Address AVP (AVP Code 334 [RFC4004]) is of type Address and contains the IPv6 or IPv4 address of the MIPv6 HA. The Diameter server MAY decide to assign an HA to the MN that is in close proximity to the point of attachment (e.g., determined by the NAS-Identifier AVP). There may be other reasons for dynamically assigning HAs to the MN, for example, to share the traffic load.

4.2.3. MIP-Home-Agent-Host AVP

The MIP-Home-Agent-Host AVP (AVP Code 348 [RFC4004]) is of type Grouped and contains the identity of the assigned MIPv6 HA. Both the Destination-Realm and the Destination-Host AVPs of the HA are included in the grouped AVP. The usage of the MIP-Home-Agent-Host AVP is equivalent to the MIP-Home-Agent-Address AVP but offers an additional level of indirection by using the DNS infrastructure. The Destination-Host AVP is used to identify an HA, and the Destination-Realm AVP is used to identify the realm where the HA is located.

Depending on the actual deployment and DNS configuration, the Destination-Host AVP MAY represent one or more home agents. It is RECOMMENDED that the Destination-Host AVP identifies exactly one HA.

It is RECOMMENDED that the MIP-Home-Agent-Host AVP is always included in the MIP6-Agent-Info AVP. In this way, the HA can be associated with the corresponding realm of the Diameter entity that added the MIP6-Agent-Info AVP using the Destination-Realm AVP, which is included in the MIP-Home-Agent-Host AVP.

4.2.4. MIP6-Home-Link-Prefix AVP

The MIP6-Home-Link-Prefix AVP (AVP Code 125) is of type OctetString and contains the Mobile IPv6 home network prefix information in a network byte order. The home network prefix MUST be encoded as the 8-bit prefix length information (one octet) followed by the 128-bit field (16 octets) for the available home network prefix. The trailing bits of the IPv6 prefix after the prefix length bits MUST be set to zero (e.g., if the prefix length is 60, then the remaining 68 bits MUST be set to zero).

The HAAA MAY act as a central entity managing prefixes for MNs. In this case, the HAAA returns to the NAS the prefix allocated to the MN. The NAS/ASP then delivers the home link prefix to the MN using, e.g., mechanisms described in [INTEGRATED]. The NAS/ASP MAY propose to the HAAA a specific prefix to allocate to the MN by including the MIP6-Home-Link-Prefix AVP in the request message. However, the HAAA MAY override the prefix allocation hint proposed by the NAS/ASP and return a different prefix in the response message.

4.2.5. MIP6-Feature-Vector AVP

The MIP6-Feature-Vector AVP (AVP Code 124) is of type Unsigned64 and contains a 64-bit flags field of supported capabilities of the NAS/ASP. Sending and receiving the MIP6-Feature-Vector AVP with value 0 MUST be supported, although that does not provide much guidance about specific needs of bootstrapping.

The NAS MAY include this AVP to indicate capabilities of the NAS/ASP to the Diameter server. For example, the NAS may indicate that a local HA can be provided. Similarly, the Diameter server MAY include this AVP to inform the NAS/ASP about which of the NAS/ASP indicated capabilities are supported or authorized by the ASA/MSA(/MSP).

The following capabilities are defined in this document:

MIP6_INTEGRATED (0x0000000000000001)

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

LOCAL_HOME_AGENT_ASSIGNMENT (0x0000000000000002)

When this flag is set in the request message, a local home agent outside the home realm is requested and may be assigned to the MN. When this flag is set by the Diameter server in the answer message, then the assignment of local HAs is authorized by the Diameter server.

A local HA may be assigned by the NAS, LAAA, or VAAA depending on the network architecture and the deployment.

The following examples show how the LOCAL_HOME_AGENT_ASSIGNMENT (referred to as LOCAL-bit in the examples) capability and the MIP-Agent-Info AVP (referred to as HA-Info in the examples) are used to assign HAs -- either a local HA (L-HA) or a home network HA (H-HA). Below are examples of request message combinations as seen by the HAAA:

LOCAL-bit	HA-Info	Meaning
0	-	ASP or [LV]AAA is not able to assign an L-HA.
0	L-HA	Same as above. HA-Info must be ignored.
1	-	ASP or [LV]AAA can/wishes to assign an L-HA.
1	L-HA	Same as above but the ASP or [LV]AAA also provides a hint of the assigned L-HA.

The same as above but for answer message combinations as seen by the NAS:

LOCAL-bit	HA-Info	Meaning
0	-	No HA assignment allowed for HAAA or [LV]AAA.
0	H-HA	L-HA is not allowed. HAAA assigns an H-HA.
1	-	L-HA is allowed. No HAAA- or [LV]AAA-assigned HA.
1	L-HA	L-HA is allowed. [LV]AAA also assigns an L-HA.
1	H-HA	L-HA is allowed. HAAA also assigns an HA.
1	H-HA + L-HA	L-HA is allowed. HAAA assigns an H-HA and [LV]AAA also assigns an L-HA.

An NAS should expect to receive multiple MIP6-Agent-Info AVPs.

5. Examples

5.1. Home Agent Assignment by the NAS

In this scenario, we consider the case where the NAS wishes to allocate a local HA to the MN. The NAS will also inform the Diameter server about the HA address it has assigned to the visiting MN (e.g., 2001:db8:1:c020::1). The Diameter-EAP-Request message, therefore, has the MIP6-Feature-Vector with the LOCAL_HOME_AGENT_ASSIGNMENT and the MIP6_INTEGRATED set. The MIP6-Agent-Info AVP contains the MIP-Home-Agent-Address AVP with the address of the proposed HA.

```
                                                                Diameter
   NAS/VAAA                                                       Server
    |                                                                 |
    |  Diameter-EAP-Request                                           |
    |  MIP6-Feature-Vector=(LOCAL_HOME_AGENT_ASSIGNMENT               |
    |                       | MIP6_INTEGRATED)                        |
    |  MIP6-Agent-Info{                                               |
    |       MIP-Home-Agent-Address(2001:db8:1:c020::1)}               |
    |  }                                                              |
    |  Auth-Request-Type=AUTHORIZE_AUTHENTICATE                       |
    |  EAP-Payload(EAP Start)                                         |
    |---------------------------------------------------------------->|
    |                                                                 |
    |                                                                 |
    :              ...more EAP Request/Response pairs...              :
    |                                                                 |
    |                                                                 |
    |                                            Diameter-EAP-Answer  |
    |               MIP6-Feature-Vector=(LOCAL_HOME_AGENT_ASSIGNMENT  |
    |                                    | MIP6_INTEGRATED)           |
    |                                   Result-Code=DIAMETER_SUCCESS  |
    |                                       EAP-Payload(EAP Success)  |
    |                                         EAP-Master-Session-Key  |
    |                                           (authorization AVPs)  |
    |                                                           ...   |
    |<----------------------------------------------------------------|
    |                                                                 |
```

Figure 2: Home Agent Assignment by the NAS

Depending on the Diameter server’s configuration and the user’s subscription profile, the Diameter server either accepts or rejects the local HA allocated by the NAS. In our example, the Diameter server accepts the proposal, and the MIP6-Feature-Vector AVP with LOCAL_HOME_AGENT_ASSIGNMENT flag (together with the MIP6_INTEGRATED flag) is set and returned to the NAS.

5.2. Home Agent Assignment by the Diameter Server

In this scenario, we consider the case where the NAS supports the Diameter MIPv6 integrated scenario as defined in this document, but does not offer local HA assignment. Hence, the MIP6-Feature-Vector AVP only has the MIP6_INTEGRATED flag set. The Diameter server allocates an HA to the mobile node and conveys the address in the MIP-Home-Agent-Address AVP that is encapsulated in the MIP6-Agent-Info AVP. Additionally, the MIP6-Feature-Vector AVP has the MIP6_INTEGRATED flag set.

```
                                                         Diameter
   NAS                                                     Server
    |                                                        |
    |  Diameter-EAP-Request                                  |
    |  MIP6-Feature-Vector=(MIP6_INTEGRATED)                 |
    |  Auth-Request-Type=AUTHORIZE_AUTHENTICATE              |
    |  EAP-Payload(EAP Start)                                |
    |------------------------------------------------------->|
    |                                                        |
    |                                                        |
    :              ...more EAP Request/Response pairs...     :
    |                                                        |
    |                                                        |
    |                                   Diameter-EAP-Answer  |
    |                                      MIP6-Agent-Info{  |
    |          MIP-Home-Agent-Address(2001:db8:6000:302::1)  |
    |                                                     }  |
    |                 MIP6-Feature-Vector=(MIP6_INTEGRATED)  |
    |                          Result-Code=DIAMETER_SUCCESS  |
    |                              EAP-Payload(EAP Success)  |
    |                                EAP-Master-Session-Key  |
    |                                  (authorization AVPs)  |
    |                                                ...     |
    |<-------------------------------------------------------|
    |                                                        |
```

Figure 3: Home Agent Assignment by the Diameter Server

5.3. Home Agent Assignment by the NAS or Diameter Server

This section shows another message flow for the MIPv6 integrated scenario bootstrapping where the NAS informs the Diameter server that it is able to locally assign an HA to the MN. The Diameter server is able to provide an HA to the MN but also authorizes the assignment of the local HA. The Diameter server then replies to the NAS with HA-related bootstrapping information.

Whether the NAS/ASP then offers a locally assigned HA or the Diameter-server-assigned HA to the MN is, in this example, based on the local ASP policy.

```
                                                                Diameter
   NAS/VAAA                                                       Server
     |                                                                 |
     |   Diameter-EAP-Request                                          |
     |   MIP6-Feature-Vector=(LOCAL_HOME_AGENT_ASSIGNMENT              |
     |                       | MIP6_INTEGRATED)                        |
     |   MIP6-Agent-Info{                                              |
     |        MIP-Home-Agent-Address(2001:db8:1:c020::1)}              |
     |   }                                                             |
     |   Auth-Request-Type=AUTHORIZE_AUTHENTICATE                      |
     |   EAP-Payload(EAP Start)                                        |
     |---------------------------------------------------------------->|
     |                                                                 |
     |                                                                 |
     :              ...more EAP Request/Response pairs...              :
     |                                                                 |
     |                                                                 |
     |                                            Diameter-EAP-Answer  |
     |                                               MIP6-Agent-Info{  |
     |                   MIP-Home-Agent-Address(2001:db8:6000:302::1)} |
     |                MIP6-Feature-Vector=(LOCAL_HOME_AGENT_ASSIGNMENT |
     |                                    | MIP6_INTEGRATED)           |
     |                                    Result-Code=DIAMETER_SUCCESS |
     |                                        EAP-Payload(EAP Success) |
     |                                          EAP-Master-Session-Key |
     |                                            (authorization AVPs) |
     |                                                            ...  |
     |<----------------------------------------------------------------|
     |                                                                 |
```

Figure 4: Home Agent Assignment by the NAS or Diameter Server

If the Diameter server does not allow the MN to use a locally assigned HA, the Diameter server returns to the MN the MIP6-Feature-Vector AVP with the LOCAL_HOME_AGENT_ASSIGNMENT bit unset and the HA address it allocated.

6. Attribute-Value Pair Occurrence Tables

Figure 5 lists the MIPv6 bootstrapping NAS-to-HAAA interface AVPs along with a specification determining how many of each new AVP may be included in a Diameter command. They may be present in any Diameter application request and answer commands, where permitted by the command ABNF.

Attribute Name	Command Req	Command Ans
MIP6-Agent-Info	0+	0+
MIP6-Feature-Vector	0-1	0-1

Figure 5: Generic Request and Answer Commands AVP Table

7. IANA Considerations

7.1. Registration of New AVPs

This specification defines the following AVPs that have been allocated from a normal Diameter AVP Code space (values >= 256):

MIP6-Agent-Info is set to 486

The following new AVPs are to be allocated from RADIUS Attribute Type space [RFC2865] so that they are RADIUS backward-compatible (AVP Code values between 0-255):

MIP6-Feature-Vector is set to 124
MIP6-Home-Link-Prefix is set to 125

7.2. New Registry: Mobility Capability

IANA has created a new registry for the Mobility Capability as described in Section 4.2.5.

Token	Value	Description
MIP6_INTEGRATED	0x0000000000000001	[RFC5447]
LOCAL_HOME_AGENT_ASSIGNMENT	0x0000000000000002	[RFC5447]
Available for Assignment via IANA	2^x	

Allocation rule: Only numeric values that are 2^x (power of two, where x >= 2) are allowed, based on the allocation policy described below.

Following the example policies described in [RFC5226], new values for the Mobility Capability Registry will be assigned based on the "Specification Required" policy. No mechanism to mark entries as "deprecated" is envisioned.

8. Security Considerations

The security considerations for the Diameter interaction required to accomplish the integrated scenario are described in [INTEGRATED]. Additionally, the security considerations for the Diameter base protocol [RFC3588], the Diameter NASREQ application [RFC4005], and the Diameter EAP application (with respect to network access authentication and the transport of keying material) [RFC4072] are applicable to this document. Developers should insure that special attention is paid to configuring the security associations protecting the messages that enable the global positioning and allocation of home agents, for instance, as outlined in Section 5.

Furthermore, the Diameter messages may be transported between the NAS and the Diameter server via one or more AAA brokers or Diameter agents (such as proxies). In this case, the AAA communication from the NAS to the Diameter server relies on the security properties of the intermediate AAA brokers and Diameter agents.

9. Acknowledgments

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