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DIAMETER Mobile IP Extensions

Status of this Memo

Abstract

This document specifies an extension to the DIAMETER base protocol that allows a DIAMETER server to authenticate, authorize and collect accounting information for services rendered to a mobile node. Combined with the Inter-Domain capability of the base protocol, this extension allows mobile nodes to receive service from foreign service providers. The DIAMETER Accounting extension will be used by the Foreign and Home agents to transfer usage information to the DIAMETER servers.

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1.0 Introduction

Mobile IP, as defined in [4], defines a method that allows a Mobile Node to change its point of attachment to the Internet with minimal service disruption. Mobile IP does not provide any specific support for mobility across disparate administrative domains, and therefore does not specify how usage can be accounted for, which has limited the applicability of Mobile IP in a IPv4 commercial deployment. The Mobile IP protocol [4] requires that mobile nodes have static home agent and home addresses, which is not desirable in a commercial network. Recent specification [8] allows a mobile node to use its NAI instead of its home address, which better accommodates current administrative practice.

This document specifies Extension 4 to the DIAMETER base protocol [1] that allows a DIAMETER server to authenticate, authorize and collect accounting information for services rendered to a mobile node. DIAMETER nodes conforming to this specification MUST include an Extension-Id AVP with a value of four in the Device-Reboot-Ind Command [1]. Combined with the Inter-Domain capability of the base protocol, this extension allows mobile nodes to receive service from foreign service providers. The DIAMETER Accounting extension [12] will be used by the Foreign and Home agents to transfer usage information to the DIAMETER servers.

The Mobile IP protocol [4] specifies a security model that requires that mobile nodes and home agents share a pre-existing security association, which leads to scaling and configuration issues. This specification defines DIAMETER functions that allow the AAA server to act as a Key Distribution Center (KDC), whereby dynamic registration

keys are created and distributed to the mobility entities for the purposes of securing Mobile IP Registration messages.

As with the DIAMETER base protocol, AAA servers implementing the Mobile IP extension can process users' identities supplied in a Network Access Identifier (NAI) format [6], which is used for DIAMETER message routing purposes. Mobile nodes include their NAI in Registration messages, as defined in [8]. The use of the NAI is consistent with the roaming model defined by the ROAMOPS Working Group [7].

The DIAMETER Mobile-IP Extension meets the requirements specified in

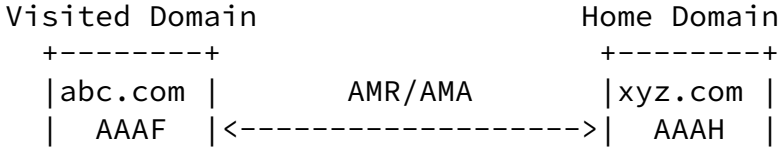
[3, 16]. Later subsections in this introductory section provide some examples and message flows of the Mobile IP and DIAMETER messages that occur when a Mobile Node requests service in a foreign network. In this document, the role of the "attendant" [3] is performed by the foreign agent for the Mobile-IP Extension, and these terms will be used interchangeably.

1.1 Requirements language

In this document, the key words "MAY", "MUST, "MUST NOT", "optional", "recommended", "SHOULD", and "SHOULD NOT", are to be interpreted as described in [11].

1.2 Inter-Domain Mobile IP

When a Mobile Node node requests service by issuing a Registration Request to the foreign agent, the foreign agent creates the AA-Mobile-Node-Request (AMR) message, which includes the AVPs defined in section 2.1. The Home Address, Home Agent, Mobile Node NAI and other important fields are extracted from the registration messages for possible inclusion as DIAMETER AVPs. The AMR message is then forwarded to the local DIAMETER server, known as the AAA-Foreign, or AAAF.



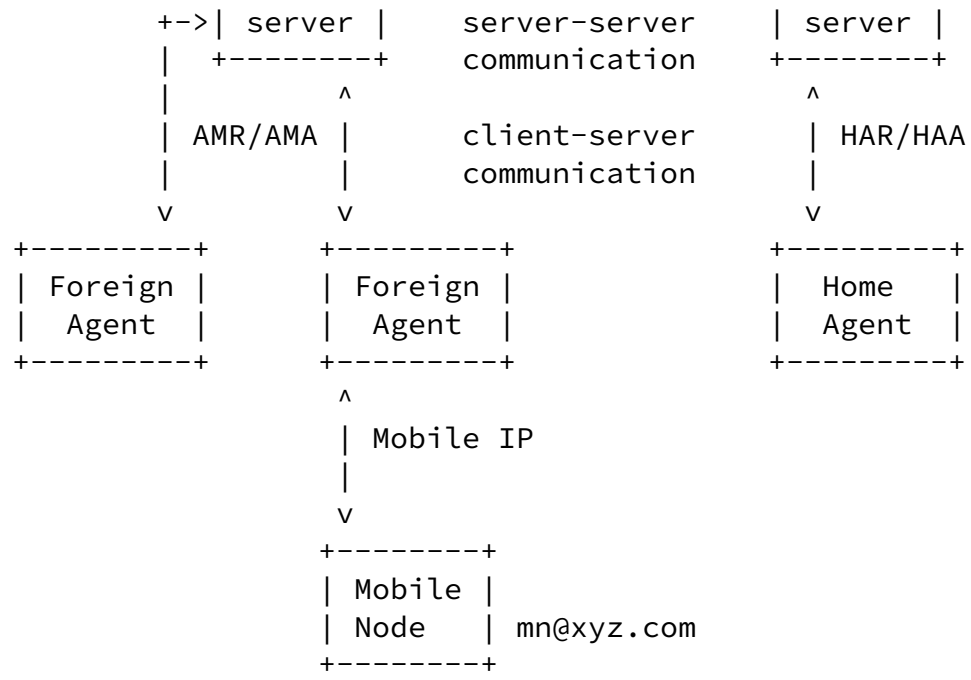
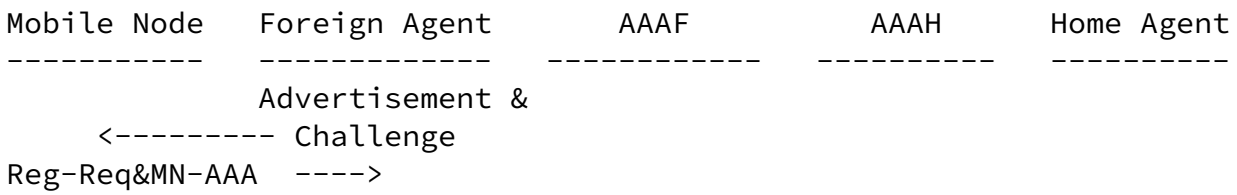


Figure 1: Inter-Domain Mobility

Upon receiving the AMR, the AAAF follows the procedures outlined in [1] to determine whether the AMR should be processed locally, or if it should be forwarded to another DIAMETER Server, known as the AAA-Home, or AAAH. Figure 1 shows an example in which a mobile node (mn@xyz.com) requests service from a foreign provider (abc.com). The request received by the AAAF is forwarded to abc.com's AAAH server.

Figure 2 shows the message flows involved when the attendant (foreign agent) invokes the AAA infrastructure to request that a mobile node be authenticated and authorized. Note that it is not required that the foreign agent invoke AAA services every time a Registration Request is received from the mobile, but rather only when the prior authorization from the AAAH expires. The expiration time of the authorization (and registration keys, if allocated by the AAA server) is communicated through the Session-Time AVP in the AA-Mobile-Node-Answer (AMA, see section 2.2) from the AAAH.



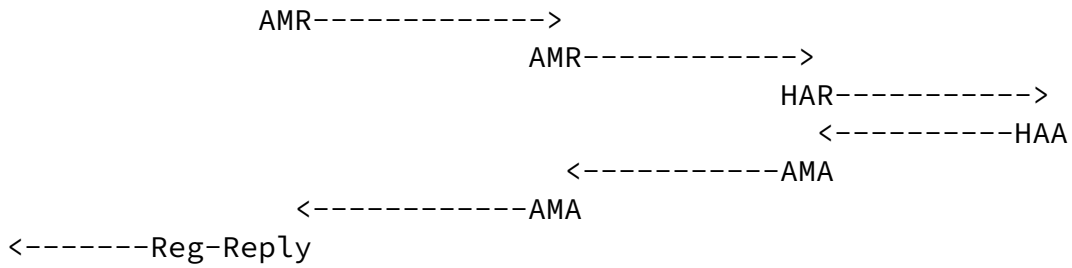


Figure 2: Mobile IP/DIAMETER Message Exchange

The foreign agent (as shown in Figure 2) MAY provide a challenge, which gives it direct control over the replay protection in the Mobile IP registration process, as described in [5]. The mobile node includes the Challenge and MN-AAA authentication extension to enable authorization by AAAH. If the authentication data supplied in the MN-AAA extension is invalid, AAAH returns the response (AMA) with the Result-Code AVP set to DIAMETER_ERROR_AUTH_FAILURE (see section 3.0).

If the Mobile Node was successfully authenticated, the AAAH checks for the Home-Agent-Address AVP. If one was specified, the AAAH checks that the address is that of a known Home Agent, and one that the Mobile Node is allowed to request. If no Home Agent was specified, and if the MIP-Feature-Vector has the Home-Agent-Requested flag set, and if allowed by policy in the home domain, the AAAH SHOULD allocate a home agent on behalf of the Mobile Node. This can be done in a variety of ways, including using a load balancing

algorithm in order to keep the load on all home agents equal. The actual algorithm used and the method of discovering the home agents is outside the scope of this specification.

If AAAH does not know the address of the home agent (perhaps because it will be allocated by AAAF within the visited domain as described in section 1.3), then AAAH sends an AMA message back to AAAF which does not contain a MIP-Reg-Reply AVP.

Otherwise, if the home agent address is known, the AAAH then sends a Home-Agent-MIP-Request (HAR), which contains the Mobile IP Registration Request message data encapsulated in the MIP-Reg-Request AVP, to the assigned or requested Home Agent. The AAAH MAY allocate a home address for the mobile node, and include it in a Mobile-Node-Address AVP within the HAR, or else leave this allocation

responsibility for the Home Agent.

Upon receipt of the HAR, the Home Agent first processes the DIAMETER message. If the HAR is invalid, a HAA is returned with the Result-Code AVP set to DIAMETER_ERROR_BAD_HAR (see section 3.0). Otherwise, the Home Agent processes the MIP-Reg-Req AVP and creates the Registration Reply, encapsulating it within the MIP-Reg-Reply AVP. If a home address is needed, the Home Agent MUST assign one and include the address in both the Registration Reply and within the DIAMETER Mobile-Node-Address AVP. The DIAMETER response is then forwarded to the AAAH.

Upon receipt of the HAA, the AAAH sets the Command-Code field to AA-Mobile-Node-Answer (AMA) and forwards the message to the AAAF. The AAAH includes the Home-Agent-Address and Mobile-Node-Address AVPs in the AMA message, enabling appropriate firewall controls for the penetration of tunneled traffic between the Home Agent and the Mobile Node.

The AAAF is responsible for ensuring that the AMA message is properly forwarded to the correct foreign agent.

1.3 Allocation of Home Agent in Foreign Network

The DIAMETER Mobile IP extension allows a Home Agent to be allocated in a foreign network, as required in [3, 16]. When a foreign agent detects that the mobile node has a home agent address equal to 0.0.0.0 or 255.255.255.255 in the Registration Request message, it MUST add a MIP-Feature-Vector AVP with the Home-Agent-Requested flag set to one. If the home agent address is equal to 255.255.255.255, then the foreign agent also MUST set the Home-Address-Allocatable-Only-in-Home-Domain flag equal to one.

When the AAAF receives a AMR message with the Home-Agent-Requested flag set to one, and the Home-Address-Allocatable-Only-in-Home-Domain flag equal to zero, AAAF MAY set the Foreign-Home-Agent-Available flag in the MIP-Feature-Vector AVP to inform the AAAH that it is willing and able to assign a Home Agent for the Mobile Node.

In the event that the mobile node requests a home agent in the foreign network, and the AAAF authorizes its use, the AAAF MUST set

the Home-Agent-In-Foreign-Network bit in the MIP-Feature-Vector AVP. This could happen when the AAA request is sent to "extend" a mobile node's current session.

When the AAAH receives a AMR message, it first checks the authentication data supplied by the mobile node, according to the MIP-Reg-Req AVP and MN-AAA-Auth AVP, and determines whether to authorize the mobile node. If the AMR indicates that the AAAF has offered to allocate a home agent for the mobile node, then the AAAH must decide whether its local policy would allow the user to have a Home Agent in the foreign network. If so, and after checking authorization from the data in the AMR message, the AAAH sends the AMA message to the AAAF that does not contain the Home-Agent-Address.

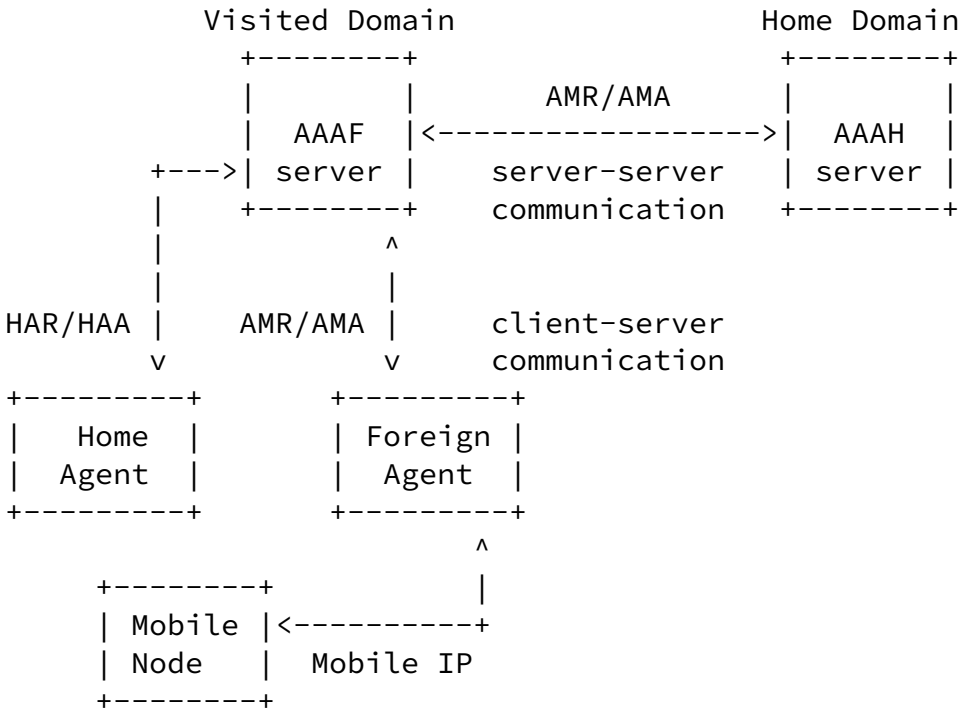


Figure 3: Home Agent allocated in Visited Domain

Upon receipt of a HAA from the Home Agent in the Visited Domain, with the Result-Code AVP indicating success, the AAAF MUST issue a HAI message to the AAAH. The HAI message MUST include the Home-Agent-Address and the Mobile-Node-Address AVPs.

Mobile Node Foreign Agent Home Agent AAAF AAAH

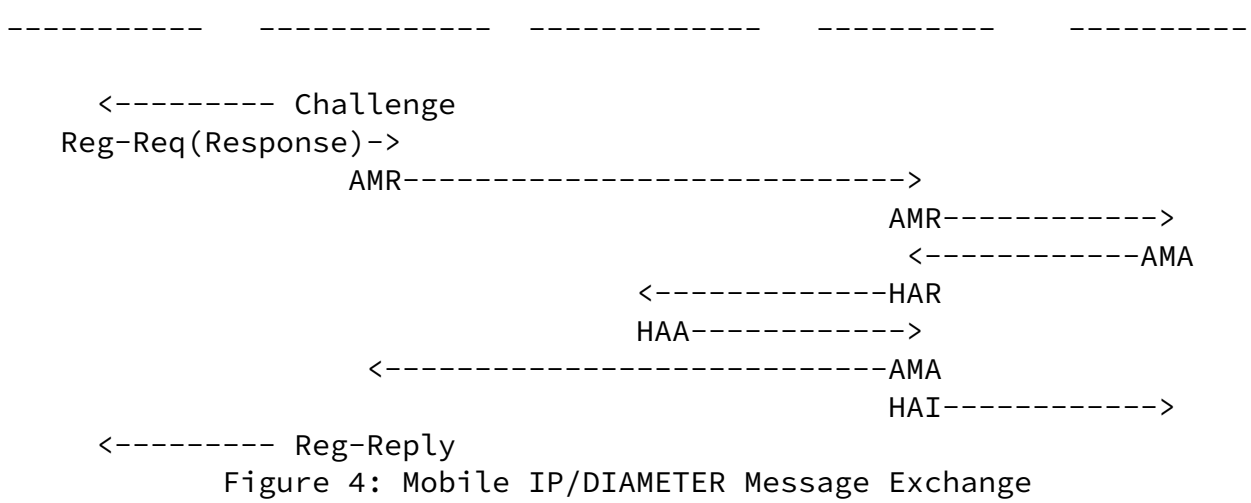


Figure 4: Mobile IP/DIAMETER Message Exchange

If the Mobile Node moves to another Foreign Network, it can either request to keep the same Home Agent within the old foreign network, or it can request that a new one be assigned in the new network, by setting the Home Agent address to 0.0.0.0 in its Registration Request message. When the Mobile Node requests such a service, the AAAH MUST interact with two AAAFs if it is willing to allow the Mobile Node to receive such service. The AAAH issues the HAR to the AAAF that oversees that Home Agent, and the AMA is issued to the AAAF that oversees the Foreign Agent.

1.4 DIAMETER Session Termination

A Foreign and Home Agent following this specification MAY expect their respective DIAMETER servers to maintain session state information for each mobile node in their networks. In order for the DIAMETER Server to release any resources allocated to a specific mobile node, the mobility agents MUST send a Session-Termination-Request (STR) [1] to their respective DIAMETER servers.

The Home DIAMETER server SHOULD only deallocate all resources after the STR is received from the Home Agent. This ensures that a Mobile Node that moves from one Foreign Agent to another (hand-off) does not cause the Home DIAMETER Server to free all resources for the Mobile Node. The DIAMETER Server is free to initiate the session termination at any time by issuing the Session-Termination-Ind (STI) [1].

2.0 Command-Code Values

This section defines Command-Code [1] values that MUST be supported by all DIAMETER implementations conforming to this specification. The following Command Codes are defined in this specification:

Command-Name	Abbreviation	Code	Section
AA-Mobile-Node-Request	AMR	260	2.1
AA-Mobile-Node-Answer	AMA	261	2.2
Home-Agent-MIP-Request	HAR	262	2.3
Home-Agent-MIP-Answer	HAA	263	2.4
Home-Agent-Allocated-Ind	HAI	279	2.5

2.1 AA-Mobile-Node-Request (AMR) Command

The AA-Mobile-Node-Request (AMR), indicated by the Command-Code field set to 260, is sent by an attendant, acting as a DIAMETER client, to a server in order to request the authentication and authorization of a Mobile Node. The Foreign Agent uses information found in the Registration Request to construct the AMR such as:

home address (Mobile-Node-Address AVP),
home agent address (Home-Agent-Address AVP),
mobile node NAI (User-Name AVP [1]).

If the mobile node's home address is zero, the foreign agent MUST NOT include a Mobile-Node-Address AVP in the AMR. In this case, the AAAF MAY set the Foreign-Home-Agent-Available flag in the MIP-Feature-Vector AVP in the AMR message to indicate that it is willing to assign a Home Agent in the visited domain.

If the Previous-FA-NAI AVP is found in the request, the DIAMETER client requests that the server return the registration key that was assigned to the previous Foreign Agent for use with the Mobile Node and Home Agent. The registration key is identified through the use of the Mobile-Node-Address AVP.

Message Format

```
<AA-Mobile-Node-Request> ::= <DIAMETER Header, Command-Code=260>
                             <Session-ID AVP>
                             [<User-Name AVP>
                              <Host-Name AVP>]
                             <MIP-Reg-Request AVP>
                             <MN-AAA-Auth AVP>
                             [<Mobile-Node-Address AVP>]
                             [<Home-Agent-Address AVP>]
                             [<MIP-Feature-Vector AVP>]
                             [<FA-MN-Preferred-SPI>]
                             [<FA-HA-Preferred-SPI>]
                             [<Previous-FA-NAI AVP> |
                              <Previous-FA-Addr AVP>]
                             [<Proxy-State [1] AVP>]
                             [<Timestamp AVP>
                              <Nonce AVP>
                              <Integrity-Check-Value AVP>]
```

2.2 AA-Mobile-Node-Answer (AMA) Command

The AA-Mobile-Node-Answer (AMA), indicated by the Command-Code field set to 261, is sent by the AAAH in response to the AA-Mobile-Node-Request message. The Result-Code AVP MAY contain one of the values defined in section 3.0, in addition to the values defined in [1]. If the home agent is situated in the home domain, a successful response MUST include the MIP-Reg-Reply AVP.

The Home-Agent-Address AVP contains the Home Agent assigned to the Mobile Node, while the Mobile-Node-Address AVP contains the home address that was assigned.

The AMA message MUST contain the FA-to-HA-Key, FA-to-MN-Key and MIP-Reg-Reply AVPs if they were received by AAAH in the HAA message.

Message Format

```
<AA-Mobile-Node-Answer> ::= <DIAMETER Header, Command-Code=261>
                            <Session-Id AVP>
                            <Session-Timeout AVP>
                            <Result-Code AVP>
                            [<Host-Name AVP>]
                            [<MIP-Reg-Reply AVP>]
                            [<MN-to-HA-Key AVP>]
                            [<FA-to-MN-Key AVP>]
                            [<FA-to-HA-Key AVP>]
                            [<Home-Agent-Address AVP>]
                            [<Mobile-Node-Address AVP>]
                            [<Proxy-State [1] AVP>]
                            [<Timestamp AVP>
                             <Nonce AVP>
                             <Integrity-Check-Value AVP>]
```

2.3 Home-Agent-MIP-Request (HAR) Command

The Home-Agent-MIP-Request (HAR), indicated by the Command-Code field set to 262, is sent by the AAA to the Home Agent. If the Home Agent is to be assigned in a foreign network, the HAR is issued by AAAF. If the HAR message does not include a Mobile-Node-Address AVP, and the Registration Request has 0.0.0.0 for the home address, and the HAR is successfully processed, the Home Agent MUST allocate one such address to the mobile node. If the home agent's local AAA server allocates the mobile node's home address, it MUST include the assigned address in an Mobile-Node-Address AVP.

If a AAAF receives a HAR that does not include the MIP-Reg-Reply AVP,

then a Home Agent MUST be assigned in the foreign network.

When registration keys are requested for use by the mobile node (see section 5.0), the AAAH MUST create them and include them in the HAR message. When a Foreign-Home registration key is requested, it will be created and distributed by the AAA server in the same domain as the home agent.

Message Format

```
<Home-Agent-MIP-Request> ::= <DIAMETER Header, Command-Code=262>
                             <Session-Id AVP>
                             <Session-Timeout AVP>
                             <MIP-Reg-Request AVP>
                             [<Host-Name AVP>
                              <User-Name AVP>]
                             [<MN-to-HA-Key AVP>]
                             [<MN-to-FA-Key AVP>]
                             [<HA-to-MN-Key AVP>]
                             [<HA-to-FA-Key AVP>]
                             [<Mobile-Node-Address AVP>]
                             [<Proxy-State [1] AVP>]
                             [<Timestamp AVP>
                              <Nonce AVP>
                              <Integrity-Check-Value AVP>]
```

2.4 Home-Agent-MIP-Answer (HAA) Command

The Home-Agent-MIP-Answer (HAA), indicated by the Command-Code field set to 263, is sent by the Home Agent to its local AAA server in response to a Home-Agent-MIP-Request. If the home agent allocated a home address for the Mobile Node, the address MUST be included in the

Mobile-Node-Address AVP. The Result-Code AVP MAY contain one of the values defined in section 3.0 instead of the values defined in [1].

Message Format

```
<Home-Agent-MIP-Answer> ::= <DIAMETER Header, Command-Code=263>
                            <Session-Id AVP>
                            <Session-Timeout AVP>
                            <Result-Code AVP>
                            [<Home-Agent-Address AVP>]
                            [<Mobile-Node-Address AVP>]
                            [<Proxy-State [1] AVP>]
                            [<Timestamp AVP>
                             <Nonce AVP>
                             <Integrity-Check-Value AVP>]
```

2.5 Home-Agent-Allocated-Ind (HAI) Command

The Home-Agent-Allocated-Ind (HAI), indicated by the Command-Code field set to 279, is sent by the AAAF to the AAAH upon receipt of a successful HAA when the Home Agent was assigned in the visited network. The HAI MUST include the Home-Agent-Address and Mobile-

Node-Address AVPs.

Message Format

```
<Home-Agent-Allocated-Ind> ::= <DIAMETER Header, Command-Code=279>
                               <Session-Id AVP>
                               <Session-Timeout AVP>
                               [<Home-Agent-Address AVP>]
                               [<Mobile-Node-Address AVP>]
                               [<Proxy-State [1] AVP>]
                               [<Timestamp AVP>
                                <Nonce AVP>
                                <Integrity-Check-Value AVP>]
```

3.0 Result-Code AVP Values

This section defines new Result-Code [1] values that MUST be

supported by all DIAMETER implementations that conform to this specification.

DIAMETER_ERROR_BAD_KEY 16
This error code is used by the Home Agent to indicate to the local DIAMETER server that the key generated is invalid.

DIAMETER_ERROR_BAD_HOME_ADDRESS 17
This error code is used by the Home Agent to indicate that the Home Address chosen by the Mobile Node or assigned by the local DIAMETER server is unavailable.

DIAMETER_ERROR_TOO_BUSY 18
This error code is used by the Home Agent to inform the DIAMETER Server that it cannot handle an extra Mobile Node. Upon receiving this error the DIAMETER Server can try to use an alternate Home Agent if one is available.

DIAMETER_ERROR_MIP_REPLY_FAILURE 19
This error code is used by the Home Agent to inform the DIAMETER server that the Registration Request failed.

DIAMETER_ERROR_AUTH_FAILURE 20
This error code is used by AAAH to inform AAAF that the authentication data in the MN-AAA authentication extension is invalid.

DIAMETER_ERROR_BAD_HAR-day 21
This error code is used by HA to inform the AAA server that the Home-Agent-Request (HAR) message could not be processed

correctly.

4.0 Mandatory AVPs

The following table describes the DIAMETER AVPs defined in the Mobile IP extension, their AVP Code values, types, possible flag values and whether the AVP MAY be encrypted.

	AVP Flag rules

Attribute Name	AVP Code	Section Defined	Value Type	MUST	MAY	SHLD NOT	MUST NOT	May Encr
MIP-Reg-Request	320	4.1	Data	M	P		V	Y
MIP-Reg-Request	321	4.2	Data	M	P		V	Y
MN-AAA-Auth	322	4.3	Complex	M	P		V	Y
Mobile-Node-Address	333	4.4	Address	M	P		V	Y
Home-Agent-Address	334	4.5	Address	M	P		V	Y
Previous-FA-NAI	335	4.6	String	M	P		V	Y
Previous-FA-Addr	336	4.7	Address	M	P		V	Y
MIP-Feature-Vector	337	4.8	Integer32	M	P		V	Y

4.1 MIP-Reg-Request AVP

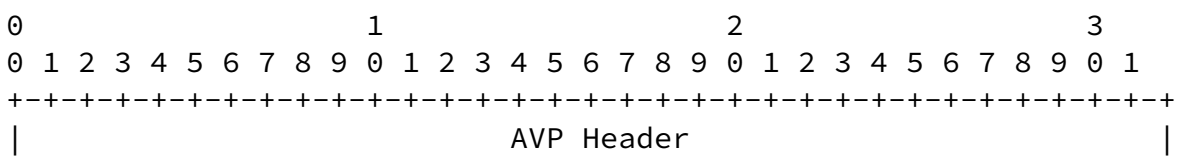
The MIP-Reg-Request AVP (AVP Code 320) is of type data and contains the Mobile IP Registration Request [4] sent by the Mobile Node to the Foreign Agent.

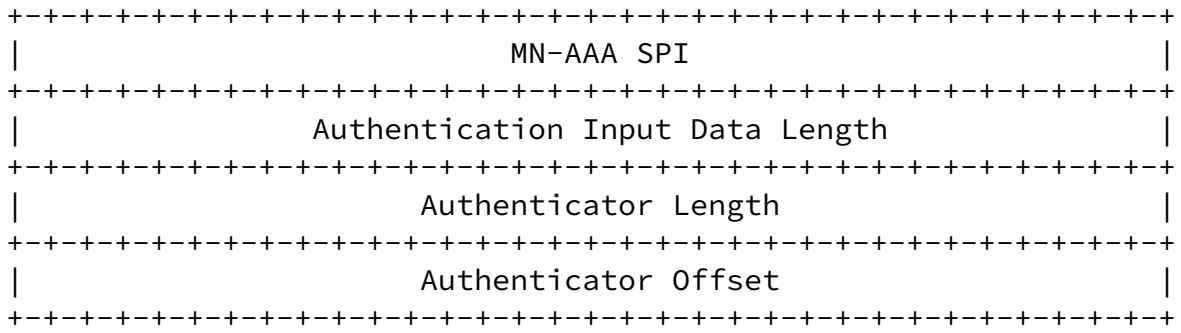
4.2 MIP-Reg-Reply AVP

The MIP-Reg-Reply AVP (AVP Code 321) is of type data and contains the Mobile IP Registration Reply [4] sent by the Home Agent to the Foreign Agent.

4.3 MN-AAA-Auth AVP

The MN-AAA-Auth AVP (AVP Code 322) is of type complex and contains some ancillary data to simplify processing of the authentication data in the Mobile IP Registration Request [4] by the target AAA server. The ancillary data fields have the following format:





MN-AAA SPI
: The SPI which indicates the algorithm by which the targeted AAA server (AAAH) should attempt to validate the Authenticator computed by the mobile node over the Registration Request data

Authentication Input Data Length
: The length in bytes of the Registration Request data (data portion of MIP-Reg-Request AVP) that should be used as input to the algorithm (indicated by the MN-AAA SPI) used to determine whether the Authenticator Data supplied by the Mobile Node is valid.

Authenticator Length
: The length of the authenticator to be validated by the targeted AAA server (i.e., AAAH).

Authenticator Offset
: The offset into the Registration Request Data, of the authenticator to be validated by the targeted AAA server (i.e., AAAH).

4.4 Mobile-Node-Address AVP

The Mobile-Node-Address AVP (AVP Code 333) is of type Address and contains the Mobile Node's Home Address.

4.5 Home-Agent-Address AVP

The Home-Agent-Addess AVP (AVP Code 334) is of type Address and contains the Mobile Node's Home Agent Address.

4.6 Previous-FA-NAI AVP

The Previous-FA-NAI AVP (AVP Code 335) is of type String and contains the Network Access Identifier [6] of the Mobile Node's old Foreign Agent. The Mobile Node MAY include this information in the Registration Request when it moves its point of attachment to a new foreign agent under the same administrative domain as the old FA (identified by the realm portion of the NAI).

When this AVP is present in the AA-Mobile-Node-Request, it indicates that the local DIAMETER server overseeing the Foreign Agent should attempt to return the registration key that was previously allocated to the old Foreign Agent for the Mobile Node. The registration key is identified through the use of the Mobile-Node-Address AVP, which MUST be present if this extension is present.

In many circumstances, this allows the Mobile Node to move from one Foreign Agent to another within the same administrative domain without having to send the request back to the Mobile Node's Home DIAMETER Server (AAAH).

4.7 Previous-FA-Addr AVP

The Previous-FA-Addr AVP (AVP Code 336) is of type Address and contains the IP Address of the Mobile Node's old Foreign Agent. The Mobile Node MAY include this information in the Previous Foreign Agent Notification Extension to the Mobile IP Registration Request when it moves its point of attachment to a new foreign agent.

When this AVP is present in the AA-Mobile-Node-Request, it indicates that the local DIAMETER server overseeing the Foreign Agent should attempt to return the registration key that was previously allocated to the old Foreign Agent for the Mobile Node. The registration key is identified through the use of the Mobile-Node-Address AVP, which MUST be present if this extension is present.

In many circumstances, this allows the Mobile Node to move from one Foreign Agent to another within the same administrative domain without having to send the request back to the Mobile Node's Home DIAMETER Server (AAAH).

4.8 MIP-Feature-Vector AVP

The MIP-Feature-Vector AVP (AVP Code 337) is of type Integer32 and is added with flag values set by the Foreign Agent or by the AAAF owned

by the same administrative domain as the Foreign Agent. The Foreign

Agent SHOULD include MIP-Feature-Vector AVP within the AMR message it sends to the AAAF.

Flag values currently defined include:

1	Mobile-Node-Home-Address-Requested
2	Home-Address-Allocatable-Only-in-Home-Domain
4	Home-Agent-Requested
8	Foreign-Home-Agent-Available
16	MN-HA-Key-Request
32	MN-FA-Key-Request
64	FA-HA-Key-Request
128	Home-Agent-In-Foreign-Network

The flags are set according to the following rules.

If the mobile node includes a valid home address (i.e., not equal to 0.0.0.0 or 255.255.255.255) in its Registration Request, the Foreign Agent zeroes the Mobile-Node-Home-Address-Requested flag in the MIP-Feature-Vector AVP.

If the mobile node sets the home address field equal to 0.0.0.0 in its Registration Request, the Foreign Agent sets the Mobile-Node-Home-Address-Requested flag to one, and zeroes the Home-Address-Allocatable-Only-in-Home-Domain flag in the MIP-Feature-Vector AVP.

If the mobile node sets the home address field equal to 255.255.255.255 in its Registration Request, the Foreign Agent sets both the Mobile-Node-Home-Address-Requested flag and the Home-Address-Allocatable-Only-in-Home-Domain flag to one in the MIP-Feature-Vector AVP.

If the mobile node sets the home agent field equal to 0.0.0.0 in its Registration Request, the Foreign Agent sets the Home-Agent-Requested flag to one in the MIP-Feature-Vector AVP.

Whenever the Foreign Agent sets either the Home-Address-Requested flag or the Home-Agent-Request flag to one, it MUST also set the MN-HA-Key-Request flag to one.

If the mobile node includes a Registration Key Request [17] extension

in its Registration Request, the Foreign Agent sets the MN-FA-Key-Request flag to one in the MIP-Feature-Vector AVP.

If the mobile node requests a home agent in the foreign network, and the AAAF authorizes the request, the AAAF MUST set the Home-Agent-In-Foreign-Network bit to one.

The Foreign Agent MUST NOT set the FA-HA-Key-Request flag, Foreign-

Home-Agent-Available, and Home-Agent-In-Foreign-Network flag to one.

When the AAAF receives the AMR message, it MUST first verify that the sender was an authorized Foreign Agent. The AAAF then takes any actions indicated by the settings of the MIP-Feature-Vector AVP flags. The AAAF then MAY set additional flags. Only the AAAF may set the FA-HA-Key-Request flag or the Foreign-Home-Agent-Available flag to one. This is done according to local administrative policy. When the AAAF has finished setting additional flags according to its local policy, then the AAAF transmits the AMR with the possibly modified MIP-Feature-Vector AVP to the AAAH.

5.0 Key Distribution Center

The mobile node and mobility agents use registration keys to compute authentication extensions applied to registration messages, as defined in [4]: Mobile-Foreign, Foreign-Home and Mobile-Home. If registration keys are requested the AAA server(s) MUST create them after the Mobile Node is successfully authenticated and authorized.

The keys destined for each mobility entity are encrypted either using the secret shared with the entity [1], or via its public key [9], as indicated by the relevant security association. If the AAAH does not communicate directly with the Foreign Agent, those keys are encrypted using the security association shared with the AAAF. The Session-Timeout AVP contains the number of seconds before registration keys destined for the Home Agent and/or Foreign Agent expire. A value of zero indicates infinity (no timeout).

AAA support for key distribution departs slightly from the existing SPI usage, as described in [4]. The SPI values are used as key identifiers, meaning that each registration key has its own SPI

value; nodes that share a key also share an SPI. If no preferred SPI value is indicated the registration keys the foreign agent needs, the AAA server MAY generate SPI values for the Mobility Agents as opposed to the receiver choosing its own SPI value. For example, suppose a Mobile Node and a Foreign Agent share a key that was generatied by AAAH with a corresponding SPI value of 37,496. All Mobile-Foreign Authentication extensions will be computed by either entity (in this example) using the shared key and MUST include the SPI value of 37,496.

Once the registration keys have been distributed, subsequent Mobile IP registrations need not invoke the AAA infrastructure until the keys expire. These registrations MUST include the Mobile-Home authentication extension. In addition, subsequent registrations MUST also include Mobile-Foreign authentication extension if the Mobile-

Foreign key was generated and distributed by AAA; similarly for subsequent use of the Foreign-Home authentication extensions.

Each registration key that is generated by AAA will generally be distributed to two parties; for instance, a Mobile-Foreign key goes to both a mobile node and a foreign agent. The methods by which the key is encoded will depend upon the security associations available to the AAA server and each recipient of the key. These methods will often be different for the two recipients, so that the registration key under consideration has to be encoded twice.

See sections 6.1 and 6.2 for details about the format of the AVPs used to distribute the registration keys.

5.1 Distributing the Mobile-Home Registration Key

If the mobile node does not have a Mobile-Home registration key, then the AAAH is likely to be the only entity trusted that is available to the mobile node. Thus, the AAAH has to generate the Mobile-Home registration key, and encode it for eventual consumption by the mobile node and home agent.

If the home agent is in the home domain, then AAAH can directly encode the Mobile-Home registration key into a HA-MN-Key AVP and include that AVP in the HAR message for delivery to the home agent.

If, on the other hand, the home agent is to be allocated in the visited domain, the AAAH does not transmit the HAR to the home agent. Instead, AAAH has to include the HA-MN-Key AVP in the AMR message which it sends to the AAAF. In this latter case, the Mobile-Home registration key is encoded into HA-MN-Key AVP using the method indicated by the security association between the AAAF and the AAAH. When the AAAF receives the AMR, it first allocates a home agent, and then creates a HAR message for that home agent. After the AAAF decodes the registration key, it re-encodes the key into a new HA-MN-Key AVP which is to be included within the HAR message.

The AAAH also has to arrange for the key to be delivered to the mobile node. Unfortunately, the AAA server only knows about DIAMETER messages and AVPs, and the mobile node only knows about Mobile IP messages and extensions[4]. The AAA server has to rely on a mobility agent (that also understands DIAMETER) to transfer the key into a Mobile IP MN-HA Key Reply extension to the Registration Reply message. This mobility agent (actually, the mobile node's home agent) can format the Reply message and extensions correctly for eventual delivery to the mobile node, by way of an AMA message sent to the appropriate foreign agent in the visited domain. That foreign agent will use the information in the MIP-Reg-Reply AVP to create a

Mobile IP Registration Reply message, containing the MN-HA Key Reply extension, and transmit it to the mobile node.

For this purpose, AAAH encodes the Mobile-Home registration key into a MN-HA-Key AVP, using its security association with the mobile node. If the home agent is in the home domain, AAAH puts the MN-HA-Key AVP into the HAR message. Otherwise, the AAAH puts the MN-HA-Key AVP into the AMR message which will be sent back to AAAF. When AAAF creates the HAR message for the home agent in the visited domain, and decodes the registration key in the HA-MN-Key AVP from the AVP received from AAAH, AAAF then recodes the registration key into a new HA-MN-Key AVP which is to be included as part of the HAR message. In either case, the home agent creates a Registration Reply with the MN-HA Key Reply extension, and formats the reply data into a MIP-Reg-Rep-AVP for delivery in a HAA message to the AAA server. After the HAA message is parsed by the AAA server, the AMA message containing the MIP-Reg-Rep AVP will eventually be received by the attendant (i.e., the foreign agent). The foreign agent can then use that AVP to recreate a Registration Reply message, containing the

MN-HA Key Reply extension, for delivery to the mobile node.

In summary, the AAAH generates the Mobile-Home registration key and encodes it into a HA-MN-Key AVP and a MN-HA-Key AVP. These AVPs are delivered to a home agent by including them in a HAR message sent from either AAAH or AAAF. The home agent decodes the key for its own use. The home agent also copies the encoded registration key from the MN-HA-Key AVP into a MN-HA Key Reply extension appended to the Mobile IP Registration Reply message. This Registration Reply message MUST also include the Mobile-Home authentication extension, created using the newly allocated Mobile-Home registration key. The home agent then encodes the Registration Reply message and extensions into a MIP-Reg-Reply AVP included as part of the HAA message to be sent back to the AAA server.

5.2 Distributing the Mobile-Foreign Registration Key

The Mobile-Foreign registration key is also generated by AAAH (upon request), so that it can be encoded into a MN-FA-Key AVP and copied by the home agent into a "Registration Key Reply from Home Agent" extension [17] to the Mobile IP Registration Reply message. Since the foreign agent is in the same administrative domain as AAAF, the sequence of events for handling the FA-MN-Key AVP is similar to the way the HA-MN-Key AVP is handled when the home agent is allocated in the visited domain. Most of the other considerations for distributing the Mobile-Foreign registration key are also similar.

When the home agent is in the home domain, AAAH includes the MN-FA-Key AVP in the HAR message. Otherwise, AAAH includes the MN-FA-Key

AVP in the AMR message to be sent back to the AAAF. In the latter case, AAAF sends the HAR message to the (newly allocated) home agent.

In either case, the home agent decodes the key, and recodes it into the key reply extension to the Mobile IP registration message. Then the home agent (as before) copies the Registration Reply message into the MIP-Reg-Reply AVP and places the result (possibly also containing the MN-HA Key Reply extension as in section 1.4.1) into the HAA message to be sent back to the AAA server. The home agent MUST also append a Foreign-Home authentication extension to the Registration Reply message, using the newly allocated Foreign-Home registration key.

When the home agent is in the home domain, AAAH receives the HAA, and then includes the MIP-Reg-Reply AVP in the AMA message to be sent to AAAF. Otherwise, AAAF receives the HAA, and inserts it into an AMA message to be sent to the foreign agent.

AAAH also has to make the Mobile-Foreign registration key available to AAAF. It does this by encoding the key into a FA-MN-Key AVP, using its security association with AAAF, and placing the results in the AMA. Then the AAAF decodes the registration key, and recodes it into a newly formulated FA-MN-Key AVP which is to be sent to the foreign agent in the AMA message containing the MIP-Reg-Reply AVP from the home agent.

5.3 Distributing the Foreign-Home Registration Key

If the home agent is in the home domain, then AAAH has to generate the Foreign-Home registration key. Otherwise, it is generated by AAAF.

In the former case, AAAH encodes the registration key into a HA-FA-Key AVP and includes that AVP as part of the HAR message sent to the home agent, and waits for the HAA message to be returned.

Whether or not AAAH sends the HAR message, it also further encodes the same registration key and puts it into a FA-HA-Key AVP included as part of the AMA message to be transmitted back to AAAF.

If the home agent is in the visited domain, the AAAH includes the HA-FA-Key AVP as part of the AMR also. In this case, AAAF has to decode the Foreign-Home registration key and include it as part of the HAR message to be sent to the (newly allocated) home agent.

In either case, AAAF sends a AMA message, containing a MIP-Reg-Reply AVP and the FA-HA-Key AVP, to the foreign agent. First, the foreign agent recreates the necessary Registration Reply message from the AMA

message. Then the foreign agent recovers the Foreign-Home registration key, using its security association with AAAF. The foreign agent MUST then use this key to create a Mobile-Foreign authentication extension to the Registration Reply message.

5.4 Key Distribution Example

Figure 5 provides an example of subsequent Mobile IP message exchange, assuming that AAAH distributed registration keys for all three MN-FA, FA-HA and HA-MN authentication extensions.

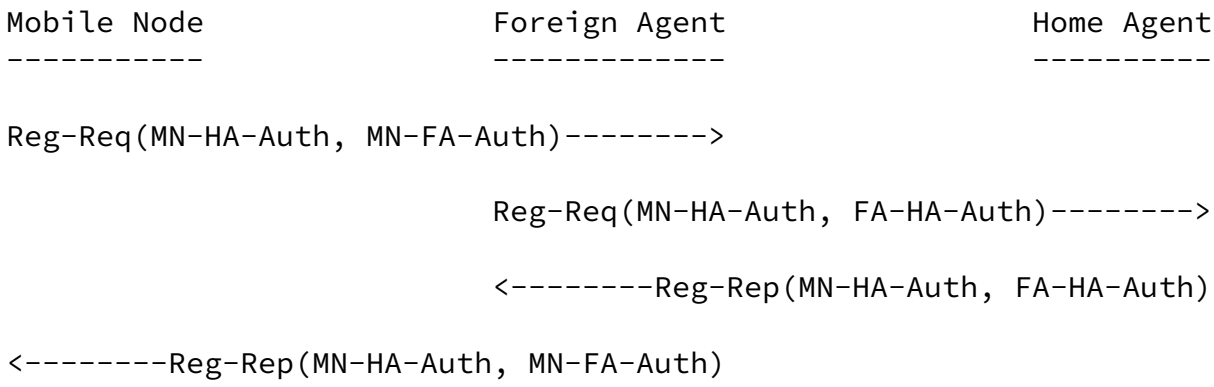


Figure 5: Mobile IP Message Exchange

6.0 Key Distribution Center (KDC) AVPs

The Mobile-IP protocol defines a set of security associations shared between the Mobile Node, Foreign Agent and Home Agents. These three security associations (Mobile-Home, Mobile-Foreign, and Foreign-Home), can be dynamically created by the AAAH. This requires that the AAAH create Mobile-IP Registration Keys, and that these keys be distributed to the three mobile entities, via the DIAMETER Protocol. AAA servers supporting the DIAMETER Mobile IP Extension MUST implement the KDC AVPs defined in this document. In other words, AAA servers MUST be able to create three registration keys: the Mobile-Home, Mobile-Foreign, and Foreign-Home keys.

Each of these keys is encrypted two different ways, as needed for each key recipient. The mobile node and home agent registration keys are sent to the Home Agent, while the foreign agent's keys are sent to the foreign agent via the AAAF. This leads to six different AVPs, since there are three keys, and each one has to be able to be encrypted in two different ways.

The names of the KDC AVPs indicate the two entities sharing the security association defined by the encrypted key material; the

intended receiver of the AVP is the first named entity. So, for instance, the MN-to-HA-Key AVP contains the Mobile-Home key encrypted in a way that allows it to be recovered by the mobile node.

If strong authentication and confidentiality of the registration keys is required, it is recommended that the strong security extension [9] be used.

The following table describes the DIAMETER AVPs defined in the Mobile IP extension, their AVP Code values, types, possible flag values and whether the AVP MAY be encrypted.

				AVP Flag rules				
Attribute Name	AVP Code	Section Defined	Value Type	MUST	MAY	SHLD NOT	MUST NOT	MAY Encr
MN-to-FA-Key	325	6.1	Complex	M	P		V	Y
MN-to-HA-Key	331	6.1	Complex	M	P		V	Y
FA-to-MN-Key	326	6.2	Complex	M	P		V	Y
FA-to-HA-Key	328	6.2	Complex	M	P		V	Y
HA-to-MN-Key	332	6.2	Complex	M	P		V	Y
HA-to-FA-Key	329	6.2	Complex	M	P		V	Y
FA-MN-Preferred-SPI	324	6.3	Integer32	M	P		V	Y
FA-HA-Preferred-SPI	327	6.4	Integer32	M	P		V	Y

6.1 Mobile Node Registration Key AVPs

The registration key AVPs destined for the Mobile Node are of type complex, and are created by the AAAH. There are two Mobile Node Registration Key AVPs; the MN-FA Key and the HA-MN Key.

The MN-to-FA-Key AVP (AVP Code 325) contains the data immediately following the Mobile IP extension header of the "Unsolicited MN-FA Key From AAA Subtype", as documented in [15].

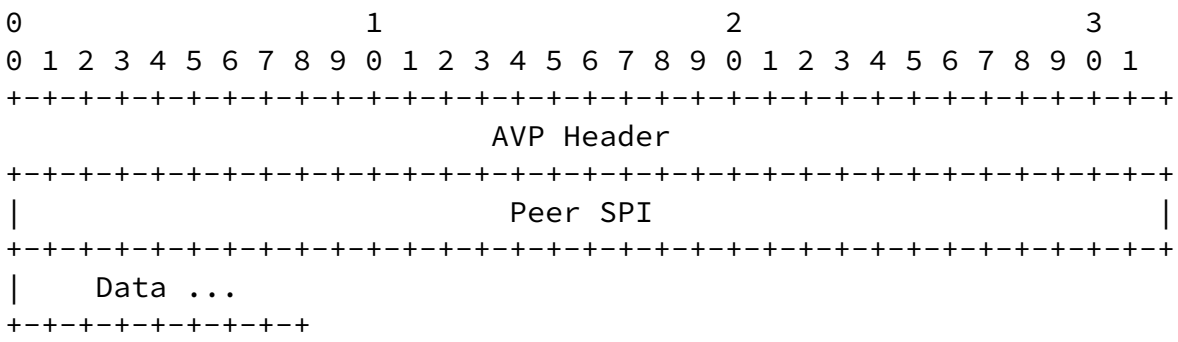
The HA-to-MN-Key AVP (AVP Code 331) contains the data immediately following the Mobile IP extension header of the "Unsolicited MN-HA Key From AAA Subtype", as documented in [15].

The AAA SPI field of a Mobile IP registration key extension is set to the value the AAAH shares with the Mobile Node. The HA-MN-Key's HA SPI field [15] contains the same value as the one found in the HA-to-MN-Key AVP. The MN-FA-Key's FA SPI [15] field contains the same

value as the one found in the FA-to-MN-Key AVP. The registration key's Lifetime field is set to the same value as the one found in the Session-Timeout AVP.

6.2 Mobility Agent Session Key AVPs

The registration keys AVPs destined for the Foreign and Home Agents are of type complex, and MUST have the AVP length field set to at least 13. The AVP has the following format:



AVP Code
- 326 for FA-to-MN Key, destined for Foreign Agent
- 328 for FA-to-HA Key, destined for Foreign Agent
- 329 for HA-to-FA Key, destined for Home Agent
- 332 for HA-to-MN Key, destined for Home Agent

Peer SPI
A 32-bit opaque value, which the target MUST use to index all the necessary information recovered from the security information after it is decoded.

Data
The data field contains the key used to create a Mobility Security Association between the mobility nodes.

6.3 FA-MN-Preferred-SPI AVP

The FA-Preferred-SPI AVP (AVP Code 324) is of type Integer32 and is sent in the AA-Mobile-Node-Request by the Foreign Agent. The AVP contains the SPI that the Foreign Agent would prefer to have assigned

by the AAAH in the FA-to-MN-Key AVP.

6.4 FA-HA-Preferred-SPI AVP

The FA-Preferred-SPI AVP (AVP Code 324) is of type Integer32 and is

sent in the AA-Mobile-Node-Request by the Foreign Agent. The AVP contains the SPI that the Foreign Agent would prefer to have assigned by the AAAH in the FA-to-HA-Key AVP.

7.0 Interactions with Resource Management

The Resource Management extension [18] provides the ability for a DIAMETER node to query a peer for session state information. The document states that service-specific extensions are responsible for specifying what AVPs are to be present in the Resource-Token [18] AVP.

In addition to the AVPs listed in [18], the Resource-Token with the Extension-Id AVP set to four (4) MUST include the Mobile-Node-Address and the Home-Agent-Address AVP.

8.0 Acknowledgements

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9.0 IANA Considerations

The command codes defined in Section 2.0 are values taken from the Command-Code [1] address space and extended in [9], [12] and [14]. IANA should record the values as defined in Section 2.0.

The Result-Code values defined in Section 3.0 are error codes as defined in [1] and extended in [9], [12] and [14]. They correspond to error values specific to the Mobile IP extension. IANA should record

the values as defined in Section 3.0.

The AVPs defined in sections 4.0 and 6.0 were allocated from the AVP numbering space defined in [1], and extended in [9], [12] and [14]. IANA should record the values as defined in Sections 4.0 and 6.0.

10.0 Security Considerations

This specification describes the DIAMETER extension necessary to authenticate and authorize a Mobile IP Mobile Node. The authentication algorithm used is dependent upon the transforms available by the Mobile IP protocol, and [5]. This specification also

defines a method by which the home DIAMETER server can create and distribute registration keys to be used to authenticate Mobile IP registration messages. The keys are distributed in an encrypted format through the DIAMETER protocol, and SHOULD be encrypted using the methods defined in [9].

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