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LMA Coordination in a Dynamic LMA Environment
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Abstract

This document describes local mobility anchor coordination functionality and corresponding mobility options for Proxy Mobile IPv6. The mobility anchor coordination targets LMAs with a dynamic service provisioning behavior, and is achieved by Proxy Binding Update and a Proxy Binding Acknowledgement message exchange between a Local Mobility Anchor (LMA) and a Local Mobility Anchor Coordinator (LMAc).

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1. Introduction

A single-LMA environment may cause a single point of failure and bottleneck for mobility support. Thus, Proxy Mobile IPv6 (PMIPv6) specification supports the use of multiple LMAs in a PMIPv6 domain, but assumes that each LMA serves a preconfigured group of mobile nodes [RFC5213]. Dynamic LMA assignment is discussed in several

documents; e.g. in [RFC 6463], runtime LMA assignment is proposed for the purpose of load sharing in a multi-LMA environment.

In a network with flat architecture, e.g. a user-centric network [UCN], the MAG and LMA functions are implemented in the network elements that are potentially provided by the end users, and thus the offered services are made available according to users' preferences and in a dynamic fashion. As a consequence the number of available LMAs is not known at the time of deployment, which is implicitly assumed in [RFC 6463].

In this proposal the LMAs that are currently offering their anchoring service to MNs, and which are thus available for dynamic selection, are coordinated in the PMIPv6 domain by a broker-like entity.

This document specifies the required protocol extensions to PMIPv6 to exchange the LMA information, coordinate the LMA selection, and enable the dynamic provision of LMAs to the MAG, facilitated in a dynamic, multi-LMA environment.

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC-2119 [RFC2119]. Terminology.

In addition to the terminology defined in [RFC5213], the following terminology is also used:

Local Mobility Anchor Coordinator (LMAc): An LMA which receives PBU messages includes the LMA availability and IP address of the LMA, selects the LMA for the MN, and sends the LMA information to the MAG.

3. Overview of LMA Coordination

As described in section 5.7 of [RFC5213], the PMIPv6 standard assumes the LMA to be assigned to a mobile node via a statically configured profile; other mechanisms are outside the scope of the standard.

In [RFC 6463], runtime LMA assignment is proposed for the purpose of load sharing in multi-LMA environment, however, how the runtime LMA assignment functionality (rfLMA) obtains the information on the available target LMAs (r2LMAs) is not specified.

This draft builds on [RFC6463], and we describe the dynamic assignment of LMAs to mobile nodes by a newly introduced entity referred to as Local Mobility Anchor Coordinator (LMAc).

The LMAc is responsible for the coordination of available LMAs by receiving registration messages from LMAs, selecting an LMA for a specific MN, and sending the selected LMA to the MAG. The MAG finally triggers the standard PMIPv6 procedure. The LMAc is located in the PMIPv6 domain and communicates with MAG and LMA via PMIPv6.

Given the mobility coordination performed by LMAc the availability and resource utilization information about LMAs is known to the network. Consequently, the LMA can be selected dynamically for the MNs when the MN attaches to the network, or in case the current LMA goes out of service.

An example of such an LMA coordination scenario is shown in Figure 1, where a mobile node (MN) has attached to the MAG. Two LMAs (LMA1 and LMA2) provide the LMA functionality. In addition, the Local Mobility Anchor Coordination (LMAc) entity is also part of the PMIPv6 domain to coordinate the LMA selection.

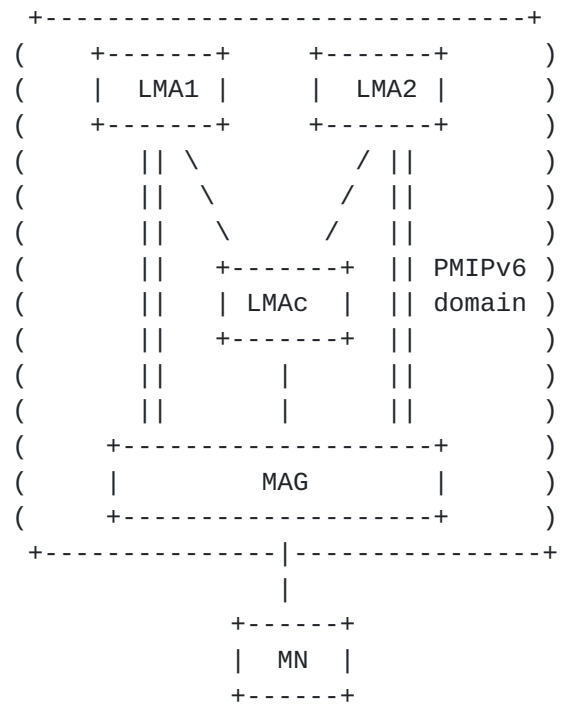

Figure 1 Overview of LMAc

LMA coordination also applies to a mobile network architecture that complies with the 3GPP Evolved Packet Core (EPC) specifications,

where the P-GW plays the role of LMA. The Mobility Management Entity (MME) in 3GPP shall select the P-GW for the UE. MME is required to be aware the context of P-GWs, e.g. available resource in the P-GW, to select a better P-GW for the UE.

3.1. Operational Scenarios

LMA coordination fits well in a user-centric network, where the MAG and LMA functions are implemented in user provided devices, which implies that the offered services are made available according to user's preferences and in a dynamic fashion. The LMAs that are currently offering their service to MNs, and that are available for dynamic selection are required to be known by the LMAc by means of a registration procedure. Subsequently the LMAc is able to select the most suitable anchor node out of the registered LMAs. The specific LMA selection algorithms performed by the LMAc are out of scope of this specification.

There are two operational scenarios on LMA coordination considered in this draft: LMA selection on MN attachment, and LMA re-selection.

3.1.1. LMA Selection on MN Attachment

Figure 2 details the procedure of LMA selection that is triggered when a MN attaches to a MAG that is part of the PMIPv6 domain managed by the LMAc. First, the LMA informs the LMAc of its availability and includes relevant contextual information, such as currently available resources for performing the anchoring service.

The LMAc receives the LMA Register message from LMAs and maintains a list of the currently available LMAs. Upon MN attachment the MAG sends an LMA Request to LMAc and thereby requests the LMA for the MN. The LMAc performs the decision, selects the most suitable LMA for the MN, and sends it to the MAG in LMA Response message.

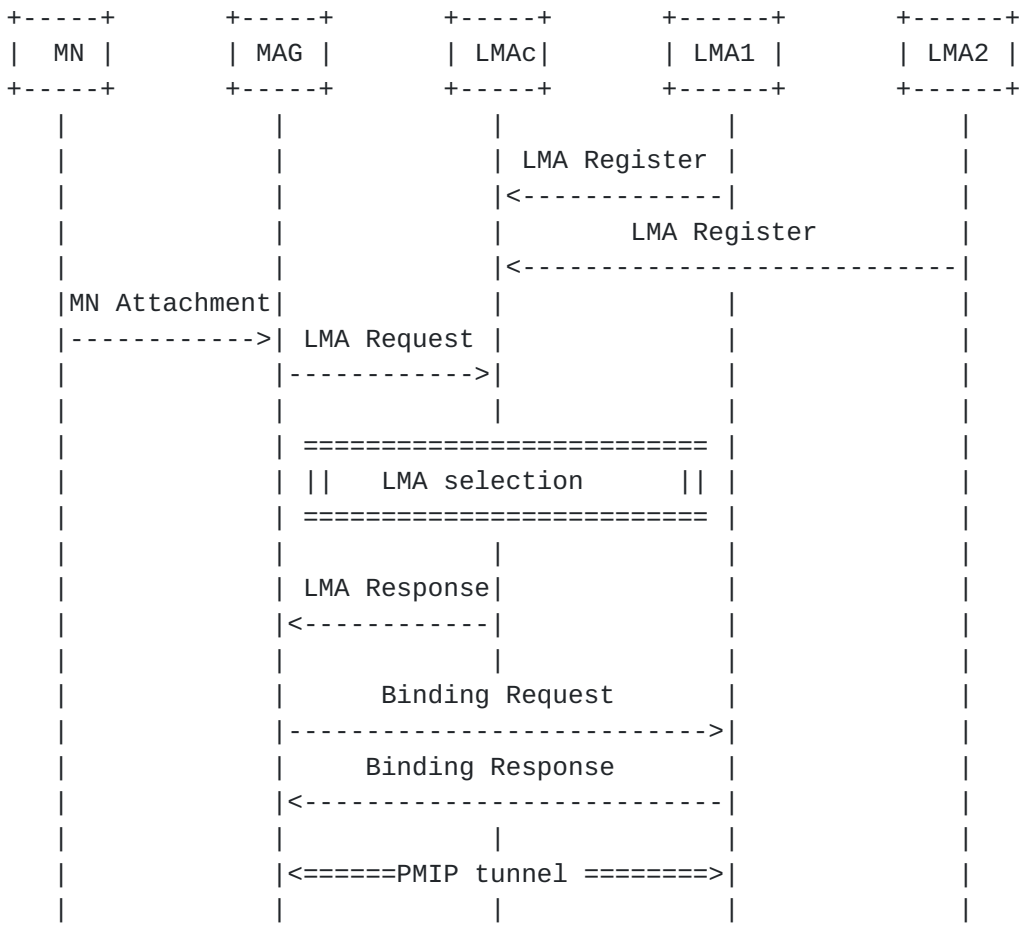

Figure 2 LMA Selection on MN Attachment

3.1.2. LMA Re-Selection

Figure 3 details the procedure of LMA re-selection when the current LMA stops offering its service: When MAG detects out-of-service status of current LMA, it sends LMA Request to LMAc, and requests the LMA for the MN, LMAc performs the decision and selects the LMA for the MN, and sends it to the MAG in LMA Response message.

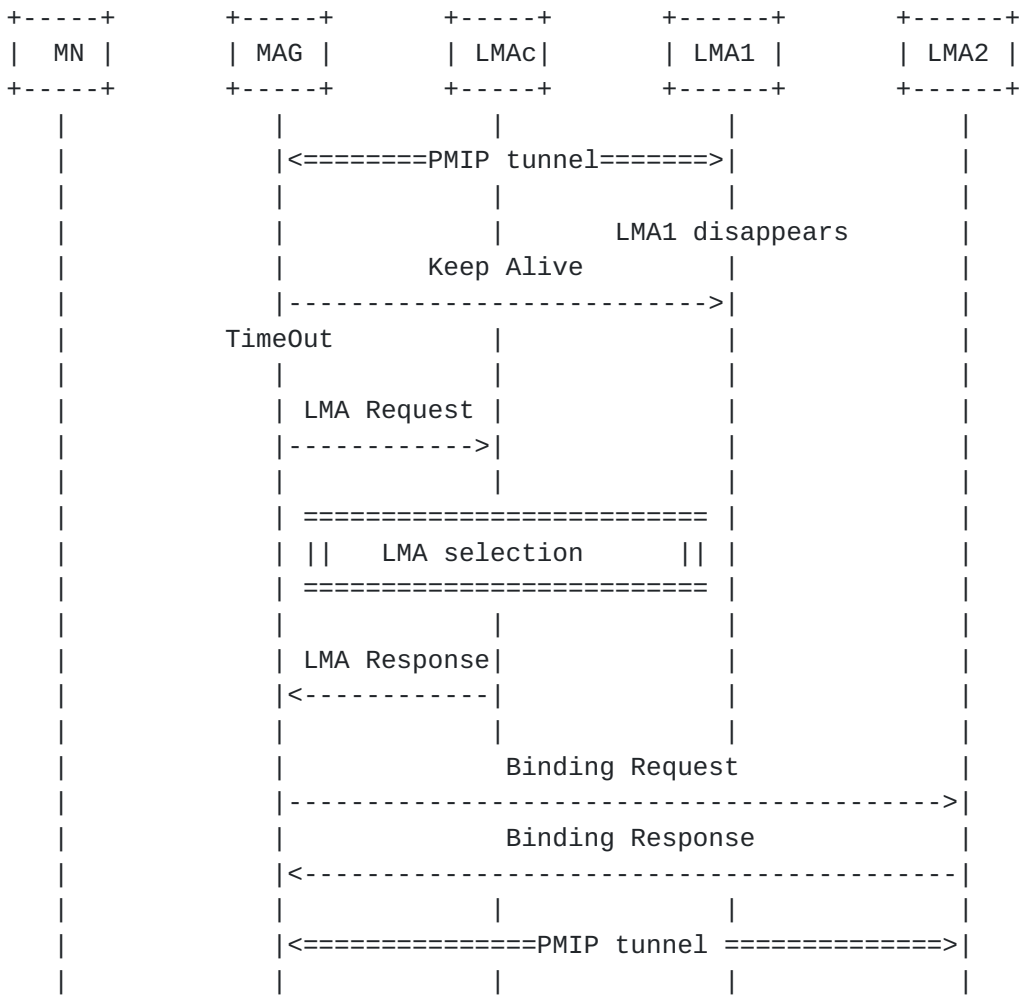

Figure 3 LMA Re-Selection

4. Message Format

The messages exchanged between MAG and LMAc are the same as defined in Runtime LMA Assignment Support for Proxy Mobile IPv6 protocol message [RFC6463]. The MAG considers LMAc as the default LMA and sends a Proxy Binding Update to the LMAc, then retrieves a redirect-to LMA in Proxy Binding Acknowledgement if a better LMA is selected by LMAc.

This section defines extensions to Proxy Mobile IPv6 [RFC5213] and to the Runtime LMA Assignment Support for Proxy Mobile IPv6 protocol message [RFC6463].

4.1. LMA Update mobility option

A new mobility header option, LMA Update mobility option is defined for use with Proxy Binding Update from LMA to LMAc. This option is used to register or deregister an LMA to the LMAc.

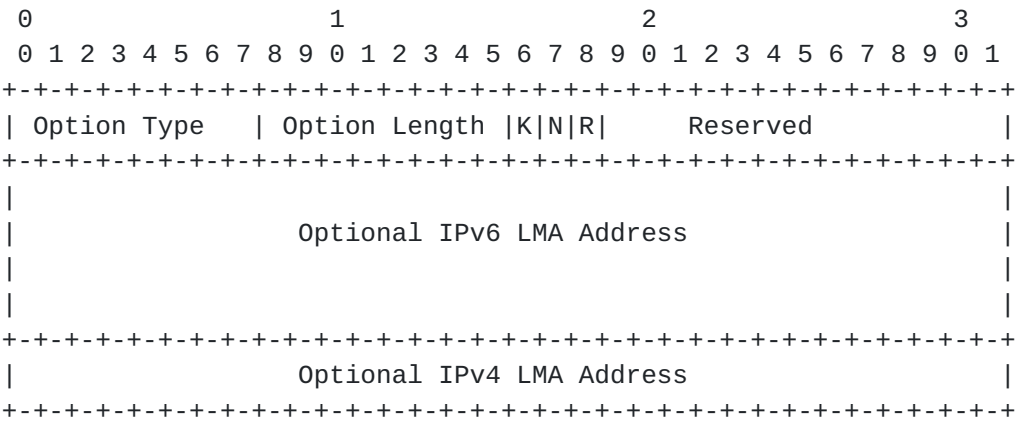

Figure 4 LMA Update Mobility Option

- Option Type: To be defined by IANA.

- Option Length: 8-bit unsigned integer, representing the length of the LMA Update mobility option in octets, excluding the Option Type and Length fields. If the 'K' flag is set and 'N' is unset, then the length MUST be 18. If the 'K' flag is unset and 'N' is set, then the length MUST be 6. Both the 'K' and 'N' flags cannot be set or unset simultaneously.

- 'K' flag: This bit is set (1) if the 'Optional IPv6 LMA Address' is included in the mobility option. Otherwise, the bit is unset (0).

- 'N' flag: This bit is set (1) if the 'Optional IPv4 LMA Address' is included in the mobility option. Otherwise, the bit is unset (0).

- 'R' flag: This bit is set (1) when LMA registers to the LMAc, and is unset (0) when LMA deregisters to the LMAc.

- Reserved: This field is reserved for future use. MUST be set to zero by the sender and ignored by the receiver.

- Optional IPv6 LMA Address: the unicast IPv6 address of the LMA. This value is present when the corresponding PBU was sourced from an IPv6 address.

- Optional IPv4 r2LMA Address: the IPv4 address of the r2LMA. This value is present when the corresponding PBU was sourced from an IPv4 address (for IPv4 transport, see [RFC5844]).

4.2. Existing mobility options reused.

The existing mobility header option, Load Information Mobility Option (see [RFC6463]) can also be used for LMA Register in the Proxy Binding Update from LMA to LMAc, to report priority and key load information of a LMA to LMAc.

5. General Operation

5.1. Overall Operation

5.1.1. LMA Selection on MN Attachment

The overall operation procedure of LMA selection on MN attachment is shown in Figure 5: There are three pairs of PBU/PBA messages. The first pair of PBU/PBA is between LMA and LMAc, to register LMA to the LMAc; the second pair of PBU/PBA is between MAG and LMAc, to select the LMA; and the third pair of PBU/PBA is between MAG and selected LMA, to setup the data tunnel for the MN.

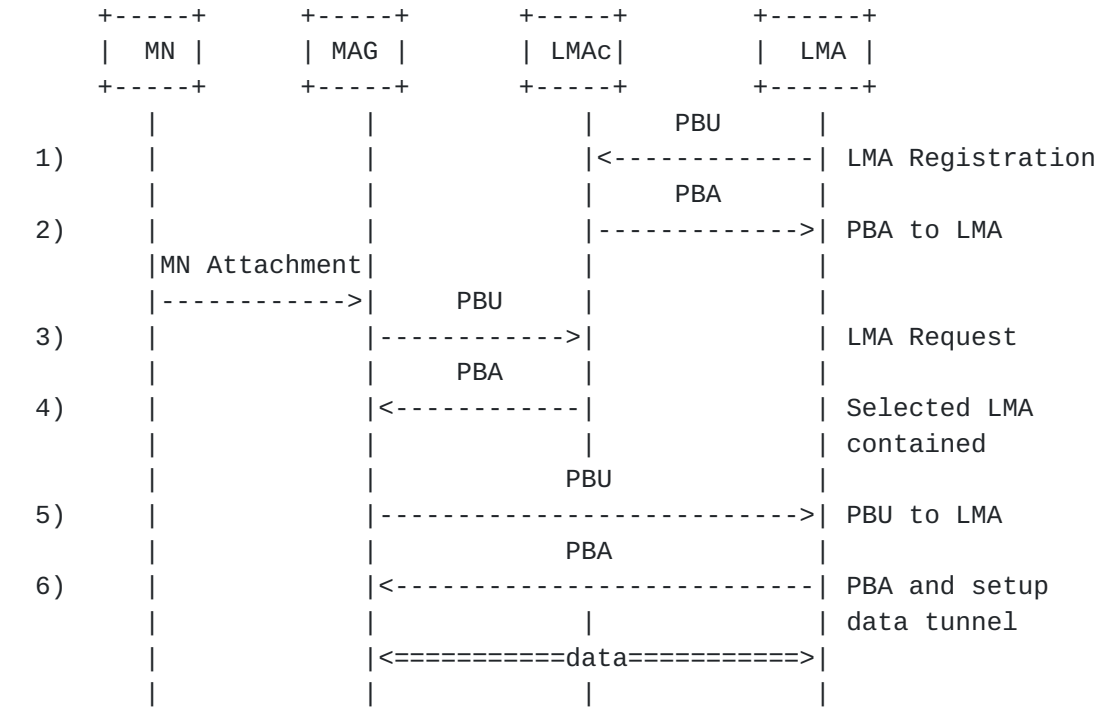

Figure 5 LMA Selection Overall Procedure

5.1.2. LMA Re-Selection

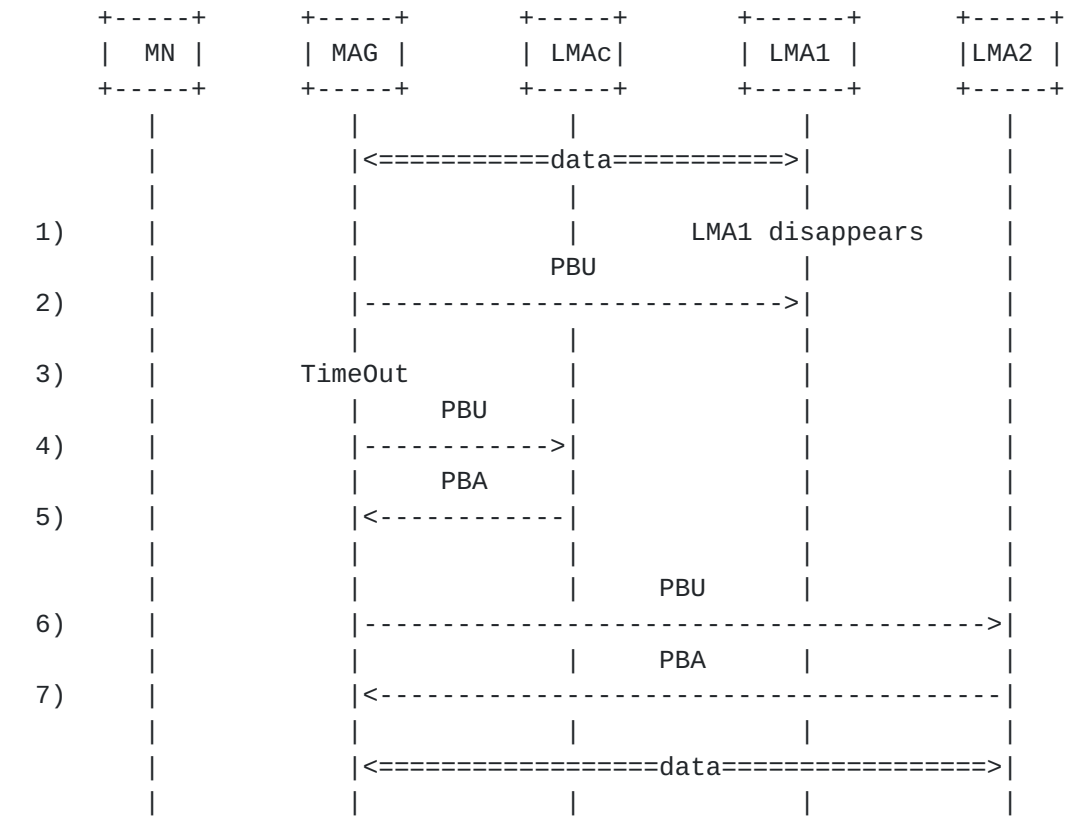

Figure 6 LMA Re-Selection Overall Procedure

The overall operation procedure of LMA re-selection is shown in Figure 6: When LMA1 goes out-of-service, the MAG enters timeout after sending PBU to LMA1 and waiting for the PBA from LMA1; the MAG requests LMA from LMAc by sending PBU to LMAc, and gets the selected LMA in PBA from LMAc; the data tunnel for the MN is setup after the PBU/PBA message exchange between MAG and LMA2.

5.2. LMA Operation

The LMA shall report its availability, IP address, priority and key load information to LMAc periodically.

5.3. LMAc Operation

The LMAc shall receive the availability, IP address, priority and key load information from LMAs and maintain them in its database.

The LMAc shall check the availability of the LMA by a timer to receive LMA Update from the LMA. If the timer expires prior to receiving an update message, the LMA is considered unavailable and it shall be removed from the database.

The LMAc shall make the decision to select the available LMA for the MN based on priority and load information.

The LMAc shall support LMA function in the Runtime LMA Assignment Support for Proxy Mobile IPv6 protocol message [RFC6463], to send the selected LMA to the MAG.

5.4. MAG Operation

The MAG shall detect the LMA out-of-service when sending a PBU to LMA1 and a timeout occurs while waiting for the PBA from LMA1.

The MAG shall support MAG function in the Runtime LMA Assignment Support for Proxy Mobile IPv6 protocol message [RFC6463], to receive the selected LMA from LMAc.

6. Protocol Configuration Variables

The local mobility anchor MUST allow the following variables to be configured by the system management. The configured values for these protocol variables MUST survive server reboots and service restarts.

LMAUpdateReportTimer

This variable specifies the time in seconds the local mobility anchor MUST report its availability to LMAc.

The default value for this variable is 30 seconds.

LMACoordinatorTimeout

This variable specifies the time in seconds for the timer in LMAc to check the availability of the LMA, which is cleared to 0 when LMA Update is received from the LMA. If the timer reaches the timeout value, the LMA is considered unavailable, and it shall be removed from the database.

The default value for this variable is 60 seconds.

7. Security Considerations

The security considerations of PMIPv6 signaling described in RFC 5213 and RFC 6463 apply to this document. This document assumes that the LMAs, LMAc and MAG that participate in LMA coordination have adequate prior agreement and trust relationships between each other.

8. IANA Considerations

New mobility options for use with PMIPv6 are defined in the [RFC6275] "Mobility Options" registry. The mobility options are defined in Section 4.

9. Acknowledgments

The authors would like to thank all participants in EU FP7 User Centric Local Loop (ULOOP) project, www.uloop.eu.

10. References

10.1. Normative References

[RFC5213] S. Gundavelli, K. Leung, V. Devarapalli, K. Chowdhury, and B. Patil, "Proxy Mobile IPv6", RFC 5213, August 2008.

[RFC6463] J. Korhonen, S. Gundavelli, H. YoKota, and X. Cui, "Runtime Local Mobility Anchor (LMA) Assignment Support for Proxy Mobile IPv6", RFC 6463, February 2012.

[RFC6275] C. Perkins, D. Johnson, and J. Arkko, "Mobility Support in IPv6", RFC 6275, July 2011.

10.2. Informative References

[UCN] P. Mendes, W. Moreira, C. Pereira, T. Jamal, A. Bogliolo, H. Haci, and H. Zhu, "Cooperative Networking in User-Centric Wireless Networks", ULOOP Project White Paper 05, September 2012.

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