Proxy Mobile IPv6 Localized Routing
draft-loureiro-netext-pmipv6-ro-02.txt

Abstract

   The IETF specified Proxy Mobile IPv6 as protocol for network-based
   mobility management. In Proxy Mobile IPv6, mobile nodes are attached
   to the network through Mobility Access Gateways and registered with a
   Local Mobility Anchor. Traffic from and to the mobile node traverses
   the mobile node's Local Mobility Anchor, irrespective of the location
   of the mobile node's corresponding communication endpoint. This
   document specifies a protocol extension to Proxy Mobile IPv6 which
   allows the set up and maintenance of a localized routing path between
   two communicating mobile nodes' Mobility Access Gateways without
   traversing the mobile nodes' Local Mobility Anchor(s). The protocol
   component of a rendezvous control point ensures stable maintenance of
   routing states during handover in scenarios with multiple mobility
   anchors, where states for the two communication endpoints are
   distributed between these anchors.

Status of this Memo

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[1](#). Introduction

The IETF specified Proxy Mobile IPv6 (PMIPv6) [[RFC5213](#)] as solution for network-based mobility management. In PMIPv6, Mobile Nodes (MNs) are registered with a Local Mobility Anchor (LMA) maintaining a binding between the MN's Home Network Prefix (HNP) and its locator, which is represented by the currently used Mobility Access Gateway (MAG). The MAG's IP address serves as Proxy Care-of Address (Proxy CoA) and is bound to the MN's HNP. Downlink packets, which address the MN's HNP, are forwarded by the MN's LMA by means of an IP tunnel to the MN's current MAG, which terminates the tunnel and delivers the packet to the MN by means of link-layer or point-to-point mechanisms. Uplink packets are tunneled by the MN's MAG to the LMA and then forwarded to the Internet.

The PMIPv6 architecture implies that all packets being sent or received by a MN traverse the associated LMA, irrespective of where an MN's correspondent communication endpoint is connected. In case two MNs attach to the same PMIPv6 domain, the routing path for the local communication between these nodes may be sub-optimal, as packets traverse the MNs' LMA(s) [[I-D.ietf-netext-pmip6-lr-ps](#)]. This document specifies an extension to PMIPv6 as per [[RFC5213](#)] to set up a localized path and associated routing states for local communication between the two MNs' MAGs within a PMIPv6 domain and to maintain these routing states during the MNs' handover.

The specified protocol for localized routing follows the network-based mobility management paradigm [[RFC4831](#)] and does not require any signaling from the MNs to establish a localized routing path between the two MNs' MAGs. The present protocol is based on [[I-D.abeille-netlmm-proxymip6ro](#)] and supports reliable set up and maintenance of localized routes independent of whether both MNs attach to the same or different LMA and MAG. The protocol relies on a route optimization controller (ROC) function, which is associated with each LMA. In case both MNs are registered with different LMAs, only one selected LMA takes over the control to maintain states on PMIPv6 components during an MN's handover. Hence, the LMA which controls the set up and update of localized routing states represents the rendezvous control point for the route update procedure. Coordination of the route update procedure from a rendezvous point ensures stable maintenance of localized routing during one or both MNs' handover without running into a race condition situation.

2. **Conventions and Terminology**

   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].

   This document uses the terminology of RFC 5213 [RFC5213]. The
   following terms are used in the context of this draft:

   o Mobile Node (MN): Mobile Node without IP mobility support, which
      is attached to a Mobility Access Gateway (MAG) and registered with
      a Local Mobility Anchor (LMA) according to the PMIPv6
      specification RFC 5213 [RFC5213]

   o Correspondent Node (CN) - Correspondent Node with or without IP
      mobility support. The CN represents the communication peer of an
      MN, which is attached to a MAG and registered with an LMA
      according to the PMIPv6 specification.

   o Source MN - Mobile Node associated with the LMA/MAG that triggers
      the localized routing procedure.

   o Destination MN - Mobile Node associated with the LMA/MAG that did
      not initiate the localized routing procedure.

   o Localized Routing - Result of signaling to set up routing states
      on relevant network entities to allow forwarding of data packets
      between an MN and a CN within a single PMIPv6 domain without
      traversing the MN's LMA and without traversing the CN's mobility
      anchor.

   o Localized Routing States - Information for localized routing on
      relevant forwarding entities on the optimized data path between an
      MN and a CN. Such information includes route entries and may
      include further information about the MN and the CN, such as IDs.

   o RO Trigger - This function is assigned to a network entity, which
      first detects that localized routing can be established between
      the MAGs of two MNs.

   o RO Control - This function is an integral part of an LMA which
      supports the set up and maintenance of localized routing. In case
      localized routing needs to be set up between two nodes, which are
      registered with different LMAs, only one LMA takes over the
      control to set up and maintain localized routing. The controlling
      LMA is selected during the initial establishment of a localized
      routing path and is responsible for coordinating subsequent
      updates of localized routing states due to movements of the MNs.

3. General Procedure

   According to the PMIPv6 protocol [RFC5213], all traffic generated by
   an MN attached to a MAG is routed through this MAG to the respective
   LMA. In the case of Figure 1 all traffic from MN to CN is routed
   through MAG1 to LMA1 and then through LMA2 and MAG3 towards CN. The
   detection of the possibility to establish a localized path can then
   be assigned to the LMA of MN (LMA1) and it may be determined by
   analyzing the source/destination addresses of MN and CN, for example.

   Referring to the reference architecture illustrated in Figure 1, LMA1
   will detect the possibility to establish a localized forwarding path
   between the two MNs and functions as RO Trigger, whereas the role of
   the RO Controller is assigned to the peer LMA (LMA2). In the case of
   both MNs being associated to the same LMA and different MAGs, the
   role of RO Controller and RO Trigger is assigned to the same LMA.
   The RO Controller coordinates the setup of the localized path at the
   involved MAGs and is also responsible for updating the localized
   routing states in case of handover of one of the MNs.

   The specific case of setting up localized routing in the scenario of
   multiple LMAs possibly requires the resolution of a destination MN's
   IP address into the routable IP address of the destination MN's LMA.
   This is due to the fact that, upon traffic inspection and detection
   of the possibility of route localization, the LMA can only acquire
   the IP address of both MNs from the data packet but not the IP
   address of the peer LMA. An approach to solve this issue is out of
   scope of this document but discussed in
   [I-D.liebsch-dime-pmip6-lmaresolve].

   After states for localized routing have been established, these
   states are assigned a Lifetime, which can be extended. Upon
   expiration of the Lifetime, MAGs and LMAs delete the associated
   localized routing states.

   Lifetime refreshing for localized routing states is done
   independently by each MAG at the respective LMA. A detailed policy
   when to update localized routing states is out of scope of this
   specification, but can be based on the result of probes for ongoing
   traffic. To avoid expiration of localized routing states, MAGs can
   refresh the associated lifetime and inform the respective LMA about
   the lifetime extension by means of a Refresh message.

```
                     Internet Backbone
                  .........................
                  :                       :
                  |                       |
              +----+                  +----+
              |LMA1|-----------------|LMA2|
              +----+                  +----+
                 |                       |
                 |                       |
           +-----+------+            +----+
           |            |            |
        +----+      +----+        +----+
        |MAG1|      |MAG2|        |MAG3|
        +----+      +----+        +----+
          :                          :
        +---+                      +---+
        |MN |                      |CN |
        +---+                      +---+
```
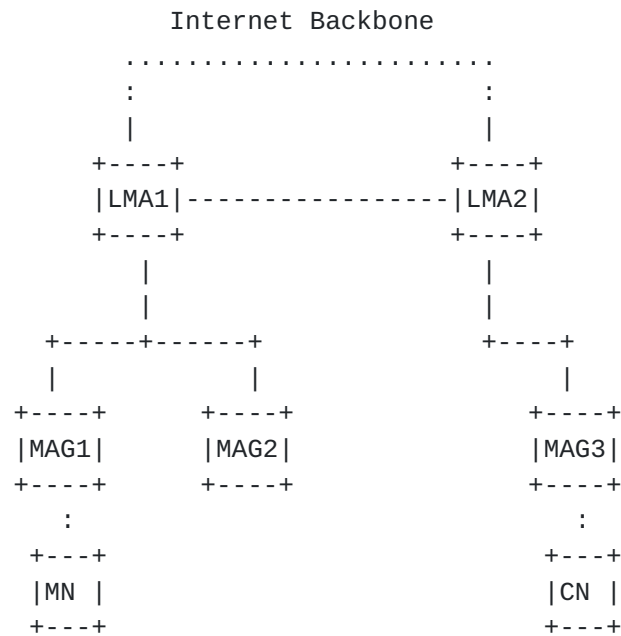
                 Figure 1: Reference Architecture

   Two different modes of operation can be supported for the currently
   specified protocol. The proxy mode, in which messages between MAGs
   are relayed through the LMAs, and the direct mode, in which the MAGs
   are allowed to exchange signaling messages directly at the cost of
   having to setup security associations between them but requiring a
   smaller number of message exchanging to setup the localized paths.
   The present draft focuses on the direct mode, although future
   versions of the document might consider the specification of the
   proxy mode. Considerations on the proxy mode can be checked in
   [I-D.abeille-netlmm-proxymip6ro].

4. Protocol Overview

In order to support the set up and maintenance of the localized
routing procedure, this document introduces the following new
signaling messages:

o RO Trigger - This message is sent from an LMA to inform another
   LMA that it must initiate a localized routing procedure towards a
   MAG associated to it. It's only used on scenarios with more than
   one LMA.

o RO Trigger Ack - This message is sent from an LMA to inform
   another LMA about the success of the localized routing path
   establishment. It's only used on scenarios with more than one
   LMA.

o RO Init - This message is sent from an LMA to a MAG in order to
   inform it that it should setup RO according to the received
   information. It triggers the MAG to contact the peer MAG in order
   to setup the localized reverse path.

o RO Init Ack - This message is sent from MAG to LMA in order to
   inform the status of the localized routing initiation setup.

o RO Setup - This message is sent from MAG to MAG and informs the
   receiving MAG that it should setup a localized routing path
   according to the received information.

o RO Setup Ack - This message is sent from MAG to MAG in order to
   inform the status of the RO setup.

o RO Refresh - This message is sent from MAG to LMA in order to
   refresh the lifetime of an existing localized routing state.

o RO Refresh Ack - This message is sent from LMA to MAG in order to
   inform the status of the lifetime refresh request.

All the scenarios considered in the following chapters assume that
traffic is initiated from MN towards CN.

4.1. Setup of Localized Routing - Single LMA

For the scenario of Figure 2, two mobile nodes are assumed to be
registered with the same LMA and associated with different MAGs (MAG1
and MAG2). When traffic starts from the mobile node attached to MAG1
towards the mobile node attached to MAG2, it is detected by LMA1 and
it triggers route localization. LMA1 sends a RO Init (1.) message
immediately to MAG2 because it recognizes that the target mobile node

is registered to itself so it knows the destination MAG (MAG2). At
this point MAG2 starts activating the localized routing states for
the traffic towards MAG1 and instructs MAG1 to do the same on the
inverse path by sending RO Setup (2.). If everything succeeds on the
side of MAG1 it sends back RO Setup Ack (3.) to MAG2 with a
successful code and MAG2 finally notifies LMA1 of the completion of
the procedure by sending RO Init Ack (4.) back to LMA1. In case of
failure to setup the forwarding state at MAG2 it should send
immediately RO Init Ack with a failure code back to LMA1 instead of
sending RO Setup to MAG1.

```
     +----+                  +----+                  +----+
     |MAG1|                  |LMA1|                  |MAG2|
     +----+                  +----+                  +----+
        |                       |                       |
        |                   [Trigger]                   |
        |                       |                       |
        |                  [RO Control]                 |
        |                       |                       |
        |                       |------1.RO Init-------->|
        |                       |                       |
        |<----------------2. RO Setup-------------------|
        |-----------------3. RO Setup Ack-------------->|
        |                       |<----4. RO Init Ack-----|
        |                       |                       |
        |                       |                       |
```
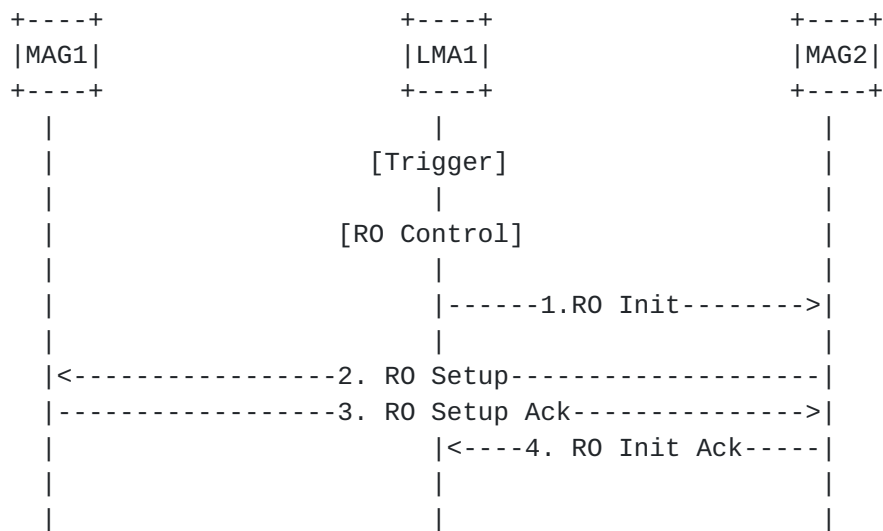
                Figure 2: Route Optimization Setup - Single LMA

   Note: For the case of single LMA scenarios, the role of Trigger and
   RO Control is always assigned to the same LMA.

4.2. Setup of Localized Routing - Multiple LMAs

   In Figure 3, two mobile nodes are registered with different LMAs
   (LMA1 and LMA2) and attached to two different MAGs (MAG1 and MAG2).
   LMA1 detects the possibility of localizing the route and since there
   are currently no associated states it triggers LMA2 by sending RO
   Trigger (1.) and assigns the role of RO Control to LMA2. The
   remaining of the signaling is similar to Figure 2 with the exception
   that LMA2 must inform LMA1 of the final result of the procedure with
   RO Trigger Ack (6.).

```
   +----+               +----+                 +----+                   +----+
   |MAG1|               |LMA1|                 |LMA2|                   |MAG2|
   +----+               +----+                 +----+                   +----+
     |                    |                      |                       |
     |                 [Trigger]                 |                       |
     |                    |                      |                       |
     |                    |---1.RO Trigger----->|                       |
     |                    |                      |                       |
     |                    |              [RO Control]                   |
     |                    |                      |                       |
     |                    |                      |----2.RO Init------->|
     |<--------------------3. RO Setup----------------------------|
     |--------------------4. RO Setup Ack------------------------>|
     |                    |                      |<---5. RO Init Ack---|
     |                    |<-6. RO Trigger Ack--|                       |
     |                    |                      |                       |
     |                    |                      |                       |
```

                 Figure 3: Route Optimization Setup - Multiple LMAs

4.3. Maintenance during Handover - Single LMA

   In Figure 4, it is assumed that there is already a localized path
   established between the mobile node attached to pMAG1 and the mobile
   node attached to MAG2, it is also assumed that the MN performs an
   handover to nMAG1. When LMA1 receives the PBU (1.) from nMAG1 it
   recognizes that there are active route localized states for that
   mobile node that need to be installed at nMAG1 and updated at MAG2,
   so it proceeds to send RO Init (3.) to MAG2 following the same
   procedure as in Figure 2. The localized routing states at pMAG1 can
   be left to expire together with the BUL entry or can be explicitly
   deleted if there is a mechanism that allows for MN detachment
   detection.

```
   +-----+            +-----+              +----+              +----+
   |nMAG1|            |pMAG1|              |LMA1|              |MAG2|
   +-----+            +-----+              +----+              +----+
      |                  |                   |                   |
      |                  |             [RO Control]             |
      |                  |                   |                   |
      |-------------1.PBU------------------>|                   |
      |<------------2.PBA-------------------|                   |
      |                  |                   |                   |
      |                  |              [Trigger]               |
      |                  |                   |                   |
      |                  |                   |-----3.RO Init------>|
      |<------------------4. RO Setup----------------------------|
      |------------------5. RO Setup Ack----------------------->|
      |                  |                   |<--6.RO Init Ack-----|
      |                  |                   |                   |
      |                  |                   |                   |
```

Figure 4: Route Optimization Maintenance during Handover - Single LMA

4.4. Maintenance during Handover - Multiple LMAs

In Figure 5, it is assumed an already established localized path
between two MNs that are registered under different LMAs. Like in
Figure 4, the MN at pMAG1 will perform an handover to nMAG1. Upon
receiving the PBU (1.), LMA1 will recognize the existence of active
localized routing states and therefore informs LMA2 that it needs to
start updating the localized routing states by sending RO Trigger
(3.). The remaining of the signaling is similar to Figure 3 with the
exception that LMA2 must inform LMA1 of the final result of the
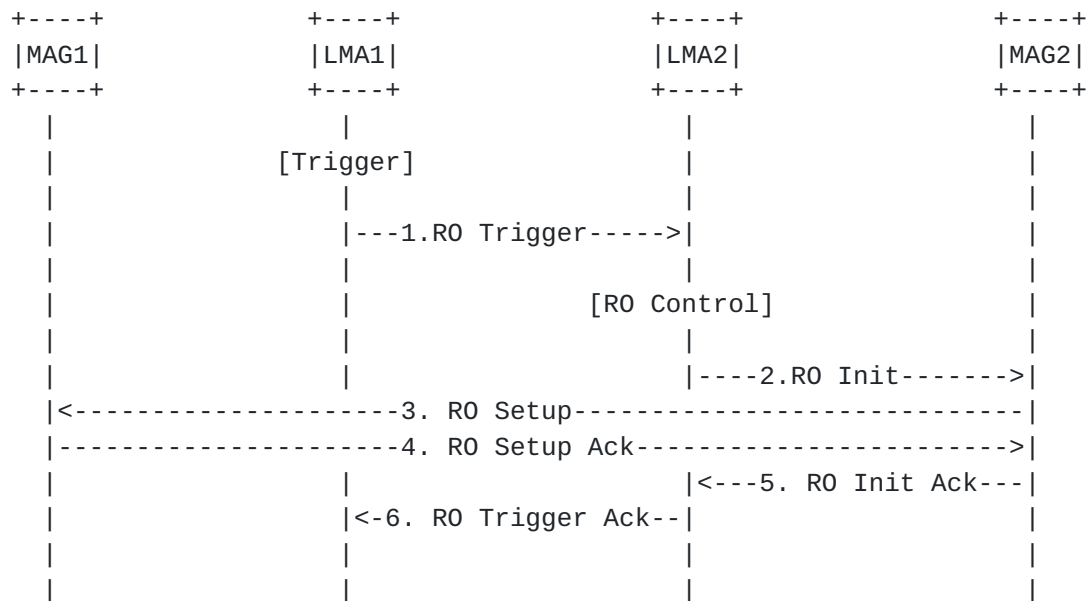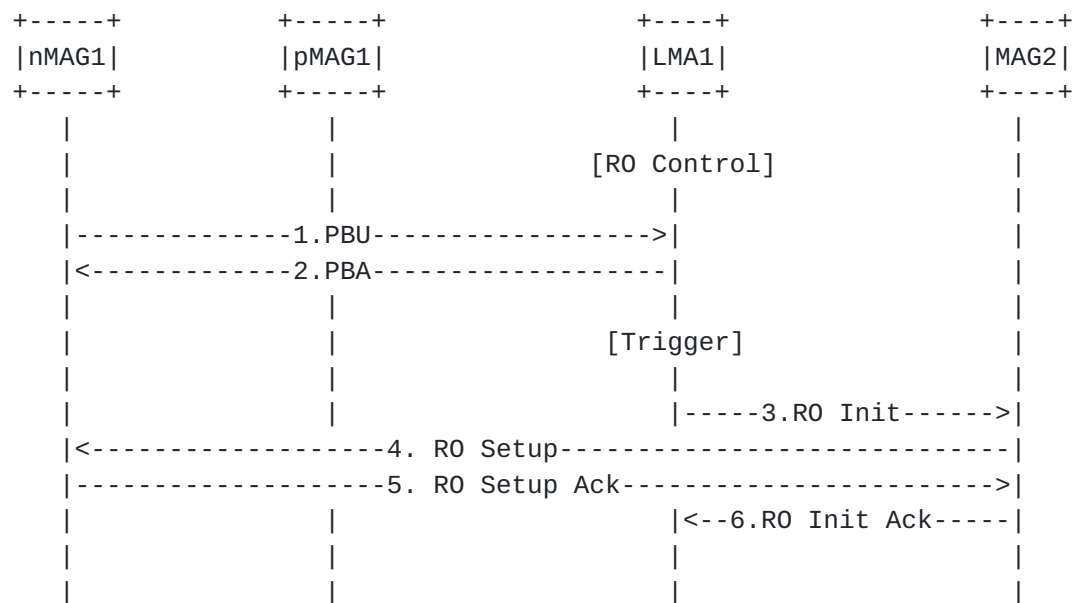procedure with RO Trigger Ack (6.). Similarly to the previous case,
the localized routing states at pMAG1 can be left to expire or
deleted explicitly.

```
 +-----+   +-----+       +----+             +----+            +----+
 |nMAG1|   |pMAG1|       |LMA1|             |LMA2|            |MAG2|
 +-----+   +-----+       +----+             +----+            +----+
    |         |             |                 |                 |
    |         |             |            [RO Control]           |
    |         |             |                 |                 |
    |-------1.PBU--------->|                 |                 |
    |<------2.PBA----------|                 |                 |
    |         |             |                 |                 |
    |         |       [Trigger]              |                 |
    |         |             |                 |                 |
    |         |             |---3.RO Trigger---->|              |
    |         |             |                 |----4.RO Init--->|
    |<--------------------5.RO Setup----------------------------|
    |--------------------6.RO Setup Ack------------------------>|
    |         |             |                 |<-7.RO Init Ack--|
    |         |             |<--8.RO Trigger Ack-|              |
    |         |             |                 |                 |
    |         |             |                 |                 |
```
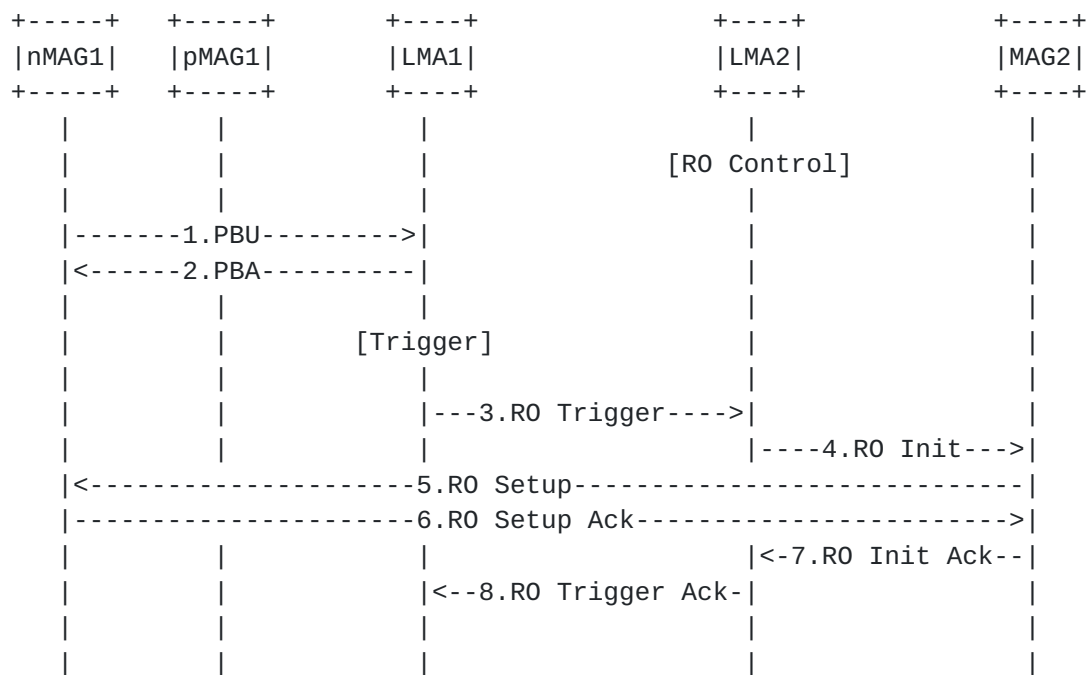
Figure 5: Route Optimization Maintenance during Handover - Multiple
                              LMAs

   Note: In the case that the MN being attached to MAG2 performs the
   handover, there would be a direct RO Init message from LMA2 towards
   the new MAG (no RO trigger message is sent) due to the fact that the
   RO Control is assigned to LMA2.

4.5. Extension of the Localized Routing Lifetime

   Upon an expiring lifetime of localized routing states, it can be
   refreshed by any of the involved MAGs towards the respective LMA.
   This is accomplished by sending a RO Refresh message (1.) to the LMA,
   as depicted in Figure 6. The LMA replies with the status with a RO
   Refresh Ack message (2.). Expired localized routing states, which
   are not refreshed, are deleted and the traffic goes back to being
   forwarded through the LMA.

   In case of a multi-LMA scenario, MAGs can refresh the localized
   routing state lifetime by sending a RO Refresh message towards the
   respective LMA. The receiving LMA must reply back with the status in
   a RO Refresh Ack message. As in the single-LMA scenario above,
   expired localized routing states are deleted.

```
      +----+                  +----+                   +----+
      |MAG1|                  |LMA1|                   |MAG2|
      +----+                  +----+                   +----+
         |                      |                        |
         |                      |                  [RO Timer]
         |                      |                        |
         |                      |<-----1.RO Refresh------|
         |                      |                        |
         |                      |----2.RO Refresh Ack--->|
         |                      |                        |
         |                      |                        |
```
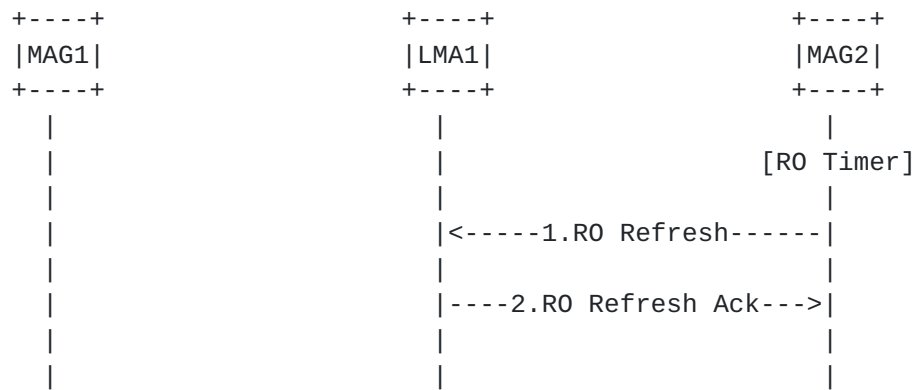
        Figure 6: Lifetime Extension of Localized Routing States

5. Message Format

5.1. Protocol Messages

   This version of the protocol defines 4 new protocol commands plus
   associated Acknowledgements. The protocol messages extend the set of
   Mobility Header types, whereas some of these messages do not apply to
   the protocol interface between a MAG and an LMA, but to the interface
   between two MAGs or between two LMAs respectively.

   A list of currently specified messages is given below for the
   discussion of the protocol specification, whereas the detailed format
   of the options will be added in an updated version of the document.

   All formats of the new Mobility Header types carry a RO_Lifetime
   field to signal the lifetime of a localized routing state.

   All formats of the new Mobility Header types which represent an
   Acknowledgement of a control message carry a Status code in the
   header.

   RO Trigger -   Route Optimization Trigger. Including the format is
      t.b.d. The following list are valid options, which must be
      included with this message:

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

      MAG-ADDR Option - IPv6 address of the Source MN's MAG.

   RO Trigger Ack -   Route Optimization Trigger Acknowledgment.
      Including the format is t.b.d. The following list are valid
      options, which must be included with this message:

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

   RO Init - Route Optimization Initiation. Including the format is
      t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

      MAG-ADDR Option - IPv6 address of the Source MN's MAG.

   RO Init Ack - Route Optimization Initiation Acknowledgment.
      Including the format is t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

   RO Setup - Route Optimization Setup. Including the format is t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

      MAG-ADDR Option - IPv6 address of the Destination MN's MAG.

   RO Setup Ack - Route Optimization Setup Acknowledgment. Including
      the format is t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

   RO Refresh - Route Optimization Refresh. Including the format is
      t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

   RO Refresh Ack - Route Optimization Refresh Acknowledgment.
      Including the format is t.b.d.

      HNP Option - Home Network Prefix of Source MN.

      HNP Option - Home Network Prefix of Destination MN.

5.2. Message Options

   This version of the protocol defines 1 new Mobility Header option,
   which is applied with the signaling messages specified in this
   document. All options must meet the 32-bit boundary alignment. A
   list of currently used options is given below for the discussion of
   the protocol specification, whereas the detailed format of the
   options will be added in an updated version of the document.

   MAG-ADDR -   IPv6 address of the source/destination MN's MAG.
      Including the format is t.b.d.

   To signal the IPv6 address/prefix of the source and destination MN as
   communication endpoints, this specification uses the Home Network
   Prefix option of [RFC5213].

   To signal the IPv4 HoA of the source and destination MN as
   communication endpoints, this specification uses the IPv4 Home
   Address option of [RFC5555].

6. IPv4 Considerations

6.1. Localized routing for IPv4 Home Addresses

   IPv4 or dual stack enabled hosts may be served by a PMIPv6 network
   according to [I-D.ietf-netlmm-pmip6-ipv4-support]. To support the
   set up and maintenance of localized routes for IPv4 Home Addresses in
   PMIPv6, MAGs must add both MNs' IPv4 Home Addresses into their
   conceptual data structures where they store information about the
   MNs' routing states. Furthermore, MAGs must support encapsulation of
   IPv4 packets and dynamically enter and update the associated
   forwarding entry towards the correspondent MAG in their routing
   table. For uplink traffic, MAGs must take routing decisions on the
   IP address tuple represented by the source and the destination
   address of the packet.

   To signal the IPv4 Home Address of the two MNs, whose routing path
   needs to be optimized, the localized routing protocol messages
   include a IPv4 HoA option in their signaling messages. In case of
   localized routing for IPv4 HoAs, the IPv4 HoA option of the source
   and destination MN must be included in all signaling messages for the
   setup and maintenance of the localized routing states to identify the
   communication endpoints. According to the definition in this
   document, the MN which originates the communication and whose IP
   packet triggers the set up of a localized routing path, is considered
   as the Source, whereas the recipient of this packet is considered as
   the Destination.

6.2. IPv4 transport network

   In case the transport network between PMIPv6 components supports IPv4
   only, encapsulation of signaling messages for localized routing is
   performed according to [I-D.ietf-netlmm-pmip6-ipv4-support]. The
   same encapsulation modes apply to the protocol interface between
   MAGs. In such case, a MAG must enable the same or a different IPv4
   address as used for the signaling with the LMA for the signaling with
   the correspondent MAG. The same applies to LMAs, which must enable
   an IPv4 address for the signaling with a potentially correspondent
   LMA. Selection of an appropriate encapsulation mode is out of scope
   of this version of the specification. In case of an IPv4 transport
   network which has a NAT between a MAG and an LMA or even between
   MAGs, using IPv4-UDP encapsulation is recommended.

   NATs between MAGs may be detected according to the NAT presence
   detection scheme as described in
   [I-D.ietf-netlmm-pmip6-ipv4-support], whereas instead of a PBU/PBA
   handshake the RO Setup/RO Setup Ack signaling handshake is being used
   to apply the detection mechanism.

7. Extension for MAG requested Localized Routing

Some operators may have different policies and enable detection of
the possibility to set up a localized routing path for an MN's
traffic at the MN's MAG. The protocol specified in this document
considers an LMA component to still enforce localized routing, as
required in [RFC5213], but the MN's MAG could request the setup of a
localized routing path at its LMA. In such case, the MAG can send a
request to set up a localized routing path to its LMA and indicates
the MN's and the CN's address. The RO Request command is
acknowledged by the LMA and indicates the LMA's intention to proceed
with the request (proceed, deny) with a RO Request Ack. The procedure
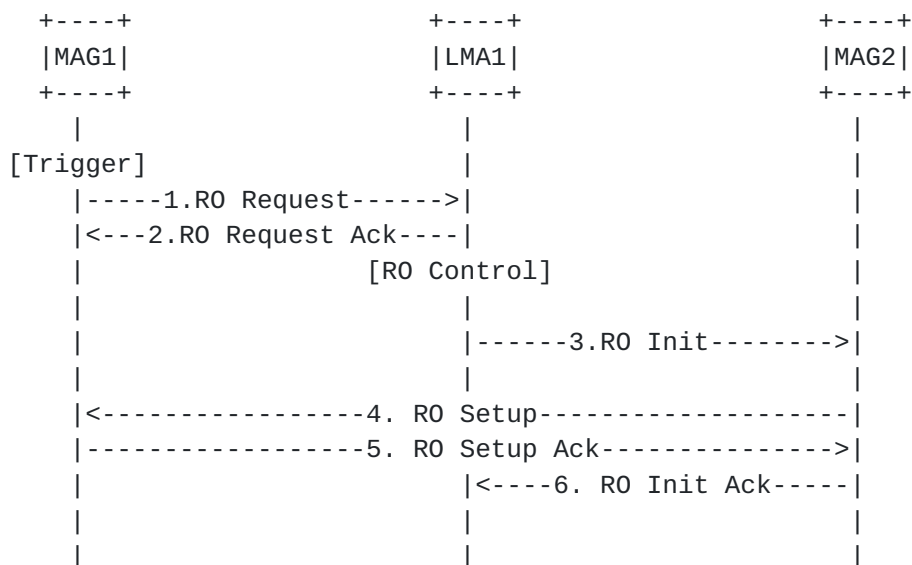for MAG requested localized routing is depicted in Figure 7.


```
         +----+                +----+                +----+
         |MAG1|                |LMA1|                |MAG2|
         +----+                +----+                +----+
           |                     |                     |
       [Trigger]                 |                     |
           |-----1.RO Request------>|                  |
           |<---2.RO Request Ack----|                  |
           |                  [RO Control]              |
           |                     |                     |
           |                     |------3.RO Init-------->|
           |                     |                     |
           |<----------------4. RO Setup-------------------|
           |-----------------5. RO Setup Ack-------------->|
           |                     |<----6. RO Init Ack-----|
           |                     |                     |
           |                     |                     |
```

         Figure 7: MAG requested setup of a localized routing path

8. Summary of achievements to meet LR Requirements

   Although [RFC5213] does not mandate any special requirements
   regarding route optimization, it is stated that path optimization
   should be enforced by the MN's LMA. The specified protocol meets
   this requirement by introducing the ROC function located at the LMA
   which controls the set up and update of localized routing states. By
   controlling the localized routing setup and maintenance from a
   dedicated LMA, a stable protocol operation is achieved in terms of
   the following:

   o Consistent protocol message sequence for all topologies and
      mobility scenarios

   o Stable Localized Routing state update in case of handover (even
      for exceptional case as identified in
      [I-D.ietf-netext-pmip6-lr-ps] section 3.2)

   o Efficient means to handle distributed mobility states in scenarios
      with multiple LMAs

   Another characteristic of the proposed solution lies in the way the
   setup of localized routing is performed by using inter-LMA signaling
   for scenarios with multiple LMAs (A12 and A22 according to
   [I-D.ietf-netext-pmip6-lr-ps]). This poses advantages in terms of
   having to perform discovery of peer LMA only once during the lifetime
   of the data sessions between the MN and the CN, since these nodes do
   not change LMAs. This is different for MAGs, which change during the
   MN's and/or the CN's handover. On the other hand, introducing for
   example direct signaling between the MN's MAG and the CN's LMA may
   require discovery and the dynamic setup of a new security association
   every time the MN or CN perform handover.

9. IANA Considerations

This document defines 8 new Mobility Header types for the MH type
field in the Mobility Header. These types are described in
Section 5.1. According to the protocol specification, the Mobility
Header type identifies also the protocol interface, on which a
protocol message is being applied.

This document defines 1 new Mobility Header option. This option is
described in Section 5.2.

10. Security Considerations

   Security threats for localized routing in network-based mobility
   management comprise the danger of unauthorized set up or redirect of
   an established forwarding path by a malicious node. Signaling
   messages of this protocol between a MAG and an LMA as well as between
   LMAs must be authenticated by means of IPsec [RFC4301]. The use of
   IPsec between an LMA and a MAG follows [RFC5213].

   Protection of signaling messages between an LMA and a MAG uses the
   mechanisms of Encapsulating Security Payload (ESP) [RFC4301] in
   transport mode with mandatory data origin authentication by means of
   a non-null payload authentication algorithm. The use of encryption
   is optional. The same requirements apply to signaling between LMAs
   as well as between MAGs. In particular, if the network which
   interconnects two LMAs and/or two MAGs is not trusted, the use of
   encryption is recommended to support confidentiality protection
   between LMAs and between MAGs respectively.

11. Contributors

   This document is based on an early contribution to the NetLMM Working
   Group [I-D.abeille-netlmm-proxymip6ro]. Many thanks to Julien
   Abeille, who contributed a lot to the original concept of this
   protocol extension to Proxy Mobile IPv6.

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