Inter-Technology Handover for Proxy MIPv6
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Abstract

The IETF is specifying Proxy Mobile IPv6 for network-based localized
mobility management, which takes basic operation for registration,
tunnel management and de-registration into account in a first
protocol release. This document proposes an extension to Proxy
Mobile IPv6 to suit MNs, which have multiple network interfaces
implemented and hand over from one network interface to another
network interface while remaining anchored at the same Local Mobility
Anchor. This extension avoids that the LMA will prematurely forward
data packets for the mobile node to the mobile node's new interface
before the address configuration of this interface has completed.
With the proposed extension, packet buffering at the new MAG is not
necessary and packet losses during an inter-technology handover can
be avoided.

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[1](#). Requirements notation

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 [[RFC2119](#)].

2. Introduction

The NetLMM WG is specifying Proxy Mobile IPv6 for network-based
localized mobility management (NetLMM), taking basic support for
registration, de-registration and handover into account in a first
protocol release. This document proposes an extension to Proxy
Mobile IPv6 to suit MNs, which have multiple network interfaces
implemented and hand over from one network interface to another
network interface while remaining anchored at the same Local Mobility
Anchor. Without such extension, inter-technology handover could
result in tremendous packet loss.

When an inter-technology handover occurs, the mobile node needs to
perform address configuration for the new interface. For IPv6, this
typically requires the mobile node to send a Router Solicitation and
await a Router Advertisement. The mobile node may also need to
perform duplicate address detection. During this time, the mobile
node's new interface is not fully configured and not yet ready to
receive data packets. If the LMA decides to forward data packets for
the mobile node via the new MAG, severe packet delay and jitter as
well as packet losses can occur.

This document proposes an extension to Proxy Mobile IPv6 that allows
classification of a new binding as 'preliminary' and to 'activate'
such binding only when the MN's new interface is fully configured and
ready to receive data packets. Thanks to this extension, the LMA
will not prematurely forward data packets for the MN to the new MAG
before the address configuration for the MN's new interface is not
completed. The result of this proposed extension is that packet
buffering at the new MAG is not necessary and packet losses during an
inter-technology handover can be avoided.

3. **Terminology and Functional Components**

   o   MAG - Mobility Access Gateway. PMIPv6 functional component
       defined in [I-D.ietf-netlmm-proxymip6]. The MAG function is
       assumed to be located on the PMIPv6 domain's access routers.

   o   LMA - Local Mobility Anchor. PMIPv6 functional component defined
       in [I-D.ietf-netlmm-proxymip6].

   o   pAR - Previous Access Router. Equivalent to current access
       router. In a layer 3 handover situation, the access router which
       the mobile node is leaving.

   o   nAR - New Access Router. Equivalent to handover target access
       router. In a layer 3 handover situation, the access router
       towards which the mobile node is moving.

   o   pMAG - previous MAG. In a layer 3 handover situation, the MAG
       function located on the previous access router

   o   nMAG - new MAG. In a layer 3 handover situation, the MAG function
       located on the new access router.

   o   IF - Interface. Any network interface, which offers an MN
       wireless or wired access to the network infrastructure. In case
       an MN has multiple interfaces implemented, they are numbered (IF1,
       IF2, ...)

   o   Inter-RAT handover. Handover between different radio access
       technologies.

4. **Problem Statement**

   A problem that can occur during an inter-technology handover is that
   the MN's new interface or the associated access link may not be ready
   to receive or forward data packets immediately after the handover.
   This section evaluates some of these issues in more detail.

4.1. **IP address auto-configuration**

   One reason of delaying availability of an MN's network interface can
   be that the MN needs to perform certain protocol operations to
   configure its new interface and these operations can take time. In
   order to complete the address auto-configuration on its new
   interface, the MN needs to send a router solicitation and awaits a
   router advertisement. Upon receiving a router advertisement from the
   new MAG, the MN can complete its address configuration and the MN's
   new interface is now ready to receive packets.

   During the address configuration of the MN's interface, if the LMA
   and the new MAG have already established a tunnel and the LMA starts
   forwarding data packets for the MN to the new MAG, these data packets
   may get delayed or lost in case address configuration of the MN's new
   interface has not yet completed, hence it's not yet ready to receive
   data. However, delaying the registration signaling, which is sent
   from the new MAG to the LMA after the MN's new interface has attached
   to the network, is not possible, as the new MAG retrieves
   configuration data for the MN from the LMA. With host-based mobility
   protocols, such as Mobile IPv6 [RFC3775], MNs can easily control when
   a binding is updated. This is different for network-based mobility
   management, where hosts are not involved in IP mobility management
   [RFC4831]

   The aforementioned problem is illustrated in Figure 1, which assumes
   that the HNP will be assigned under control of the LMA. Hence, the
   HNP option in the PBU, which is sent by the new MAG to the LMA, is
   set to ALL_ZERO. An MN has attached to the network with interface
   IF1 and receives data on this interface. When the MN's new interface
   IF2 comes up and is detected by the new MAG, the new MAG sends a PBU
   and receives a PBA from the LMA. If the LMA decides to forward data
   packets for the MN via the new MAG, the new MAG has to buffer these
   packets until address configuration of the MN's new interface has
   completed and the MN's new interface is ready to receive packets.
   While setting up IF2, the MN may not reply to address resolution
   signaling, as sent by the new MAG (A). If the MAG's buffer overflows
   or the MN cannot reply to address resolution signaling for too long,
   data packets for the MN are dropped and the MN can experience severe
   packet losses during an inter-technology handover (B).

```
    +------+                     +----+      +----+             +---+
    |  MN  |                     |pMAG|      |nMAG|             |LMA|
    +------+                     +----+      +----+             +---+
    IF2 IF1                        |           |                 |
     |   |                         |           |                 |
     |   |- - - - - - --- - Attach |           |                 |
     |   |                         |--------------PBU--------------->|
     |   |                         |<-------------PBA----------------|
     |   |--------RtSol------->|       |           |                 |
     |   |<-------RtAdv--------|       |           |                 |
     |  Addr.                  |       |           |                 |
     |  Conf.                  |       |           |                 |
     |   |<-------------------|================data===========|--
     |   |                     |       |           |                 |
     |- - - - - - - - --- - - - - - - - Attach                       |
     |   |                     |           |--------PBU------->|
     |   |                     |           |<--------PBA--------|
     |   |                     |           |<-====data===========|--
  (A)?|<-----------NSol--------------------|<-====data===========|--
     |   |                     |      (B) ?|<-====data===========|--
     |   |                     |          ?|<-====data===========|--
     |-----------RtSol-------------------->|<-====data===========|--
     |<----------RtAdv--------------------|           :             |
   Addr.  |                     |           |           :             |
   Conf.  |                     |           |           :             |
     |<-----------NSol--------------------|           :             |
     |-----------NAdv-------------------->|                         |
    !|<----------------------------------|======data===========|--
     |   |                     |           |                         |
     |   |                     |           |                         |
```
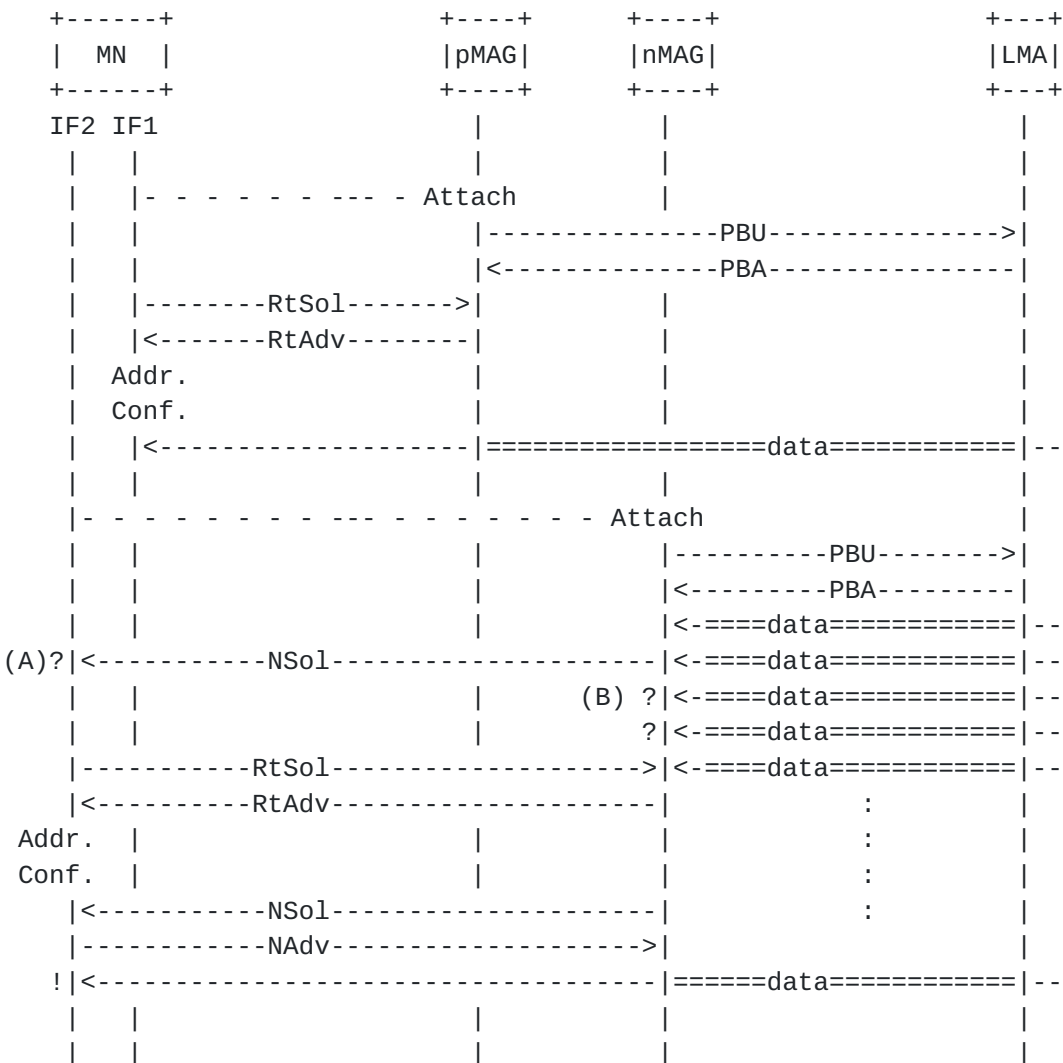
                Figure 1: Issue with inter-RAT mobility.

   Duplicate Address Detection (DAD) tests affect the delay, during
   which an MN's interface does not reply to Neighbor Solicitations,
   considerably. During such delay, MAGs must buffer all packets for
   the addressed MN until Neighbor Discovery has been performed
   completely to avoid packet loss. Normally, routers consider a
   neighbor queue size of 3 packets. Using this default setting on MAGs
   can easily result in packet loss in case completion of the Neighbor
   Discovery procedure is delayed.

   Even if the MN does not perform DAD tests (DAD_TRANSMITS = 0), some
   aspects of MN address configuration according to [RFC4862] can cause
   MNs missing the initial Neighbor Solicitation being sent from its new
   MAG. First of all, this can happen due to processing delay on MNs
   and in case the Neighbor Solicitation follows immediately after the

   Router Advertisement, which carries the HNP assigned to the MN's IF2.
   Relevant for successful Neighbor Discovery is that the MN's IF2 has
   joined the auto-configured IPv6 address' Solicited Node Multicast
   Address. According to [RFC4862], MNs delay joining a Solicited Node
   Multicast Address according to a randomly chosen interval between 0
   and MAX_RTR_SOLICITATION_DELAY seconds. By default, the parameter
   MAX_RTR_SOLICITATION_DELAY is set to 1 second. If MNs follow this
   procedure, the MN's IF2 will very likely miss the initial Neighbor
   Solicitation.

   In case the MN's IF2 does not respond to an initial Neighbor
   Solicitation, the new MAG follows the procedure in [RFC4861] and
   waits RETRANS_TIMER milliseconds before it attempts to address a
   further Neighbor Solicitation to the Solicited Node Multicast Address
   of IF2. By default, RETRANS_TIMER is set to 1000 ms, which requires
   the new MAG to buffer all packets destined to the MN's IF2 during at
   least 1 second to avoid packet loss.

4.2. Delay in setting up an access link

   Another risk for a delay in forwarding data packets from a new MAG to
   the MN's IF2 can be some latency in setting up a particular access
   technology's radio bearer or access specific security associations
   after the new MAG received the MN's HNP from the LMA via the PBA
   signaling message.

   In case an access technology needs the MN's IP address or HNP to set
   up a radio bearer between an MN's IF2 and the network infrastructure,
   the responsible network component might have to wait until the nMAG
   has received the associated information from the LMA in the Proxy
   Binding Acknowledgment. Delay in forwarding packets from the nMAG to
   the MN's IF2 depends now on the latency in setting up the radio
   bearer.

   A similar problem can occur in case the set up of a required security
   association between the MN's IF2 and the network takes time and such
   set up can be performed only after the MN's IP address or HNP is
   available on the nMAG.

4.3. Procedural sequences on the LMA

   In case of an intra-technology handover it's beneficial for an MN to
   receive data packets after a handover as soon as possible after the
   MN's IF attached to the infrastructure and to the associated new MAG.
   Delay in address configuration is not an issue, as the IF has an IPv6
   address configured and has already joined the associated Solicited
   Node Multicast Address. Hence, the MN's IF is prepared to reply to
   initial Neighbor Solicitations being sent by the new MAG.

According to the procedure described in [I-D.ietf-netlmm-proxymip6],
an LMA updates its BCE and associated forwarding information after it
received a PBU from a MAG and before it sends a PBA. In case of an
inter-technology handover, such procedure can be disadvantageous
because data packets, which arrive at the new MAG, may initiate the
Neighbor Discovery Procedure before the new MAG can actually send the
MN's HNP for IF2 in the previously solicited Router Advertisement.
This will result in ignoring the initial Neighbor Solicitation and
may cause an overflow in the nMAG's neighbor queue. In this context,
we characterize such a procedure on the LMA as 'Forward-before-
Signaling' (FbS), which is illustrated in Figure 2.

```
   +------+              +----+    +----+              +---+
   |  MN  |              |pMAG|    |nMAG|              |LMA|
   +------+              +----+    +----+              +---+
   IF2 IF1                 |         |                   |
    |   |                  |         |                   |
    |   |<-----------------|================data=========|--
    |   |                  |         |                   |
    |- - - - - - - - --- - - - - - - - Attach            |
    |-----------RtSol------------------->|               |
    |   |                  |         |----------PBU-------->|
    |   |                  |         |              [switch
    |   |                  |         |               forward
    |   |                  |         |               path]
   ?|<-----------NSol--------------------|<-====data=========|--
    |   |                  |         |                   |
    |<-----------RtAdv-------------------|<---------PBA---------|
   Addr. |                 |         ?|<-====data=========|--
   Conf. |                 |         ?|<-====data=========|--
    |                      |         ?|<-====data=========|--
    |<-----------NSol--------------------|           :     |
    |-----------NAdv-------------------->|           :     |
   !|<----------------------------------|======data=========|--
    |   |                  |         |                   |
    |   |                  |         |                   |
```
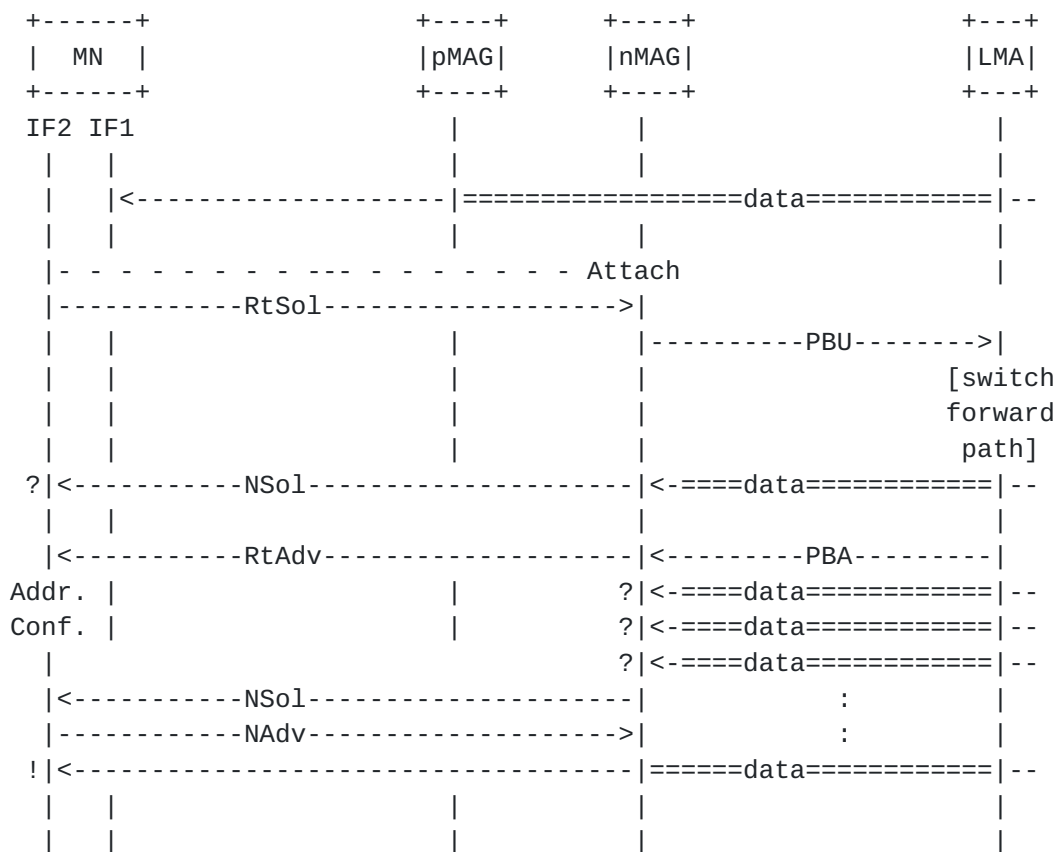
Figure 2: Issue with Forward-before-Signaling for inter-RAT mobility.

In case of an inter-technology handover, it could be beneficial if an
LMA proceeds according to 'Forward-after-Signaling' (FaS). Such
procedure considers replying to a PBU before the LMA switches the
associated BCE's forwarding information. This could at least
increase the probability, that the MN's IF2 receives HNP information
before any request for address resolution.

4.4. Demand for a general solution

To reduce the risk of packet loss, some settings on an MN could be
chosen appropriately to speed up the process of network interface
configuration. This could include omitting DAD tests (DAD_TRANSMITS
= 0) and setting the parameter MAX_RTR_SOLICITATION_DELAY to 0, which
allows joining the configured Solicited Node Multicast Address
immediately. The latter optimization is acceptable in particular for
point-to-point links and when the network assigns individual prefixes
to MNs.

Also following an FaS procedure on the LMA in case of an inter-
technology handover can reduce the risk of packet loss. Furthermore,
increasing the neighbor queue size on MAGs could help to reduce
packet loss, but does not solve the jitter problem. Preferable is a
general solution based on an extension to the Proxy MIPv6 base
protocol.

This document proposes an extension to Proxy Mobile IPv6 that
provides the new MAG with a signaling mechanism to notify the LMA
when the MN's new interface is fully configured and ready to receive
data packets. Thanks to this signaling mechanism, the LMA will not
prematurely forward data packets for the MN to the new MAG before the
address configuration of the MN's new interface is not complete. The
result of this proposed extension is that excessive packet buffering
at the new MAG is not necessary and packet losses during an inter-
technology handover can be avoided.

5. PMIPv6 Extensions

   This section describes an extension to [I-D.ietf-netlmm-proxymip6] to
   solve the problem of using a handover target technology before it is
   ready to receive and send IP packets. The key extension is to allow
   classification of an MN's binding cache entry on the LMA as
   'preliminary' or 'active'. Classification can be performed either
   locally on the LMA or on a network component, which is not colocated
   with the LMA. An example about how classification can be controlled
   and signaled is described in Section 5.1, whereas Section 5.2
   describes associated extensions to existing signaling and states.

5.1. Description and use of extensions

   In an inter-technology handover scenario, an MN activates a network
   interface, which is different from the currently used one. The new
   interface should serve as interface through which the MN sends and
   receives packets. After a handover, the MN shuts down the previously
   used interface. The extension to the base PMIPv6 protocol as
   described in this document forwards downlink packets to an MN's new
   interface only when the new interface is ready to receive and send IP
   packets.

   Figure 3 illustrates the components of a PMIPv6 network, which
   comprises the MN's LMA as well as its pMAG and the nMAG. The pMAG is
   supposed to support an access network, which conforms to the
   technology of Interface 1 (IF1) of the MN, whereas the nMAG supports
   an access network, which conforms to the technology of IF2.

   The MN attaches to the PMIPv6 network with IF1 according to the
   procedure in [I-D.ietf-netlmm-proxymip6]. The MN starts receiving
   data packets on IF1. When the MN activates IF2 to prepare an inter-
   technology handover, the nMAG receives an attach indication and sends
   the PBU to the LMA to retrieve configuration information for the MN
   (e.g. HNP). The LMA is able to identify a technology change for the
   MN's binding, for example by means of processing the Access
   Technology Type option, which comes along with the PBU. Also the MN
   Interface Identifier option helps the LMA also to identify an
   interface change. Alternative mechanisms to learn about the nature
   of a handover are possible, such as the explicit notification from
   the nMAG or from any other network component. This requires the LMA
   to maintain information about the MN's currently used technology into
   the MN's binding cache entry, as it is considered in
   [I-D.ietf-netlmm-proxymip6].

   If the LMA detects a technology change for the same MN, it enters the
   nMAG as forwarding information into the binding cache, but classifies
   this binding as 'preliminary' (A). The status 'preliminary' causes

the LMA to keep using the previous binding as forwarding information
until the preliminary binding will be activated. The LMA
acknowledges the PBU by means of sending a PBA to the nMAG. The PBA
carries the MN's HNP as well as a flag, which indicates the status
'preliminary' to the nMAG (B). The nMAG learns through the PBA, that
an explicit activation of the binding is required. If explicit
activation of the binding is expected from the nMAG, the nMAG should
find out when the MN's new interface has been set up and configured
completely. For example, the nMAG could listen to Neighbor
Solicitations from the MN's IF2, which indicate that the MN has
configured a global address at IF2 and performs duplicate address
detection. Details about how the nMAG finds out that IF2 is ready
for being used is out of scope of this version of the document.

As soon as IF2 has been set up completely (C), the nMAG sends a
further PBU to the LMA to 'activate' the previously as 'preliminary'
classified binding. The PBU should indicate explicit activation of a
binding. The activation causes the LMA to change forwarding
information to refer to the nMAG and adjust the MN's binding cache
entry accordingly (D). From that moment, downlink packets will be
forwarded towards the MN's IF2 (E).

Note: As the status 'preliminary' needs to be explicitly changed to
'active' before the LMA uses the new forwarding information, this
example makes use of a further PBU/PBA handshake between the nMAG and
the LMA. Alternative mechanisms are possible to activate the new
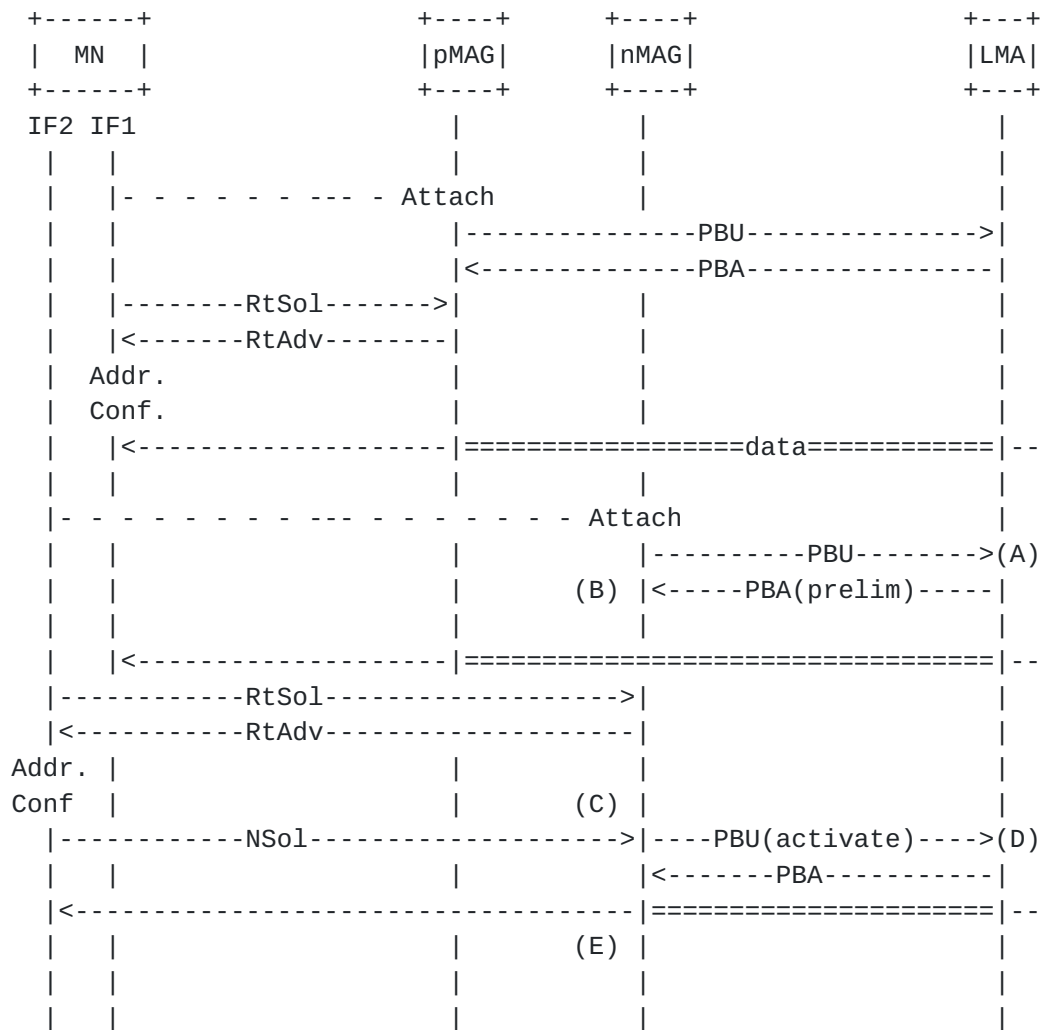state on the LMA.

```
     +------+                   +----+      +----+                 +---+
     |  MN  |                   |pMAG|      |nMAG|                 |LMA|
     +------+                   +----+      +----+                 +---+
     IF2 IF1                      |           |                     |
      |   |                       |           |                     |
      |   |- - - - - - --- - Attach           |                     |
      |   |                       |--------------PBU--------------->|
      |   |                       |<-------------PBA----------------|
      |   |--------RtSol------->|             |                     |
      |   |<-------RtAdv--------|             |                     |
      |  Addr.                    |           |                     |
      |  Conf.                    |           |                     |
      |   |<-------------------|================data===========|--
      |   |                       |           |                     |
      |- - - - - - - - --- - - - - - - - - Attach                   |
      |   |                       |           |----------PBU-------->(A)
      |   |                       |      (B) |<-----PBA(prelim)-----|
      |   |                       |           |                     |
      |   |<-------------------|==============================|--
      |-----------RtSol------------------->|                     |
      |<-----------RtAdv-------------------|                     |
     Addr. |                     |           |                     |
     Conf  |                     |      (C) |                     |
      |-----------NSol-------------------->|----PBU(activate)---->(D)
      |   |                       |           |<-------PBA-----------|
      |<-----------------------------------|====================|--
      |   |                       |      (E) |                     |
      |   |                       |           |                     |
      |   |                       |           |                     |
```

Figure 3: Solution for inter-RAT mobility.

5.2. Protocol extensions

5.2.1. Impact to the binding management

The extension proposed in Section 5.1 requires maintenance of two
forwarding entries on the LMA during an inter-technology handover
procedure. One of these entries is marked as 'active', whereas the
other one is 'preliminary'. Extensions to an MN's entry in the LMA's
binding cache should comprise the interface identifier of the
associated tunnel towards a MAG, as well as the associated access
technology. The interface identifier and access technology type info
can be take from the PBU received at the LMA and linked to each
forwarding entry accordingly.

MAGs should maintain the status of an MN's binding in their binding
update list. This is in particular important in case a new MAG needs
to explicitly activate a binding after the associated MN's new
interface has proven to be ready for IP traffic.

5.2.2. Signaling message extensions

5.2.2.1. Proxy Binding Update message

The PBU message should carry a binding status flag to allow
indication and control of a binding status. In the PBU, the flag can
in particular be used from a MAG to signal activation of a binding
after the MN's new interface or the associated access link has been
set up completely. If a MAG is not sure about the status of a
binding, the MAG should assume that sending the PBU will result in an
active binding status and learn about the real status from the PBA
sent by the LMA.

As an alternative to a binding status flag in the PBU and the PBA and
for discussion, we propose the use of a new Binding Control and
Indication (BCI) option. The format and use of such an option is
described in Appendix A.

Figure 4 illustrates the Proxy Binding Update message with a binding
status flag.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
                                +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                                |          Sequence #           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|A|H|L|K|M|R|P|S|   Reserved    |            Lifetime           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                       Mobility options                        .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
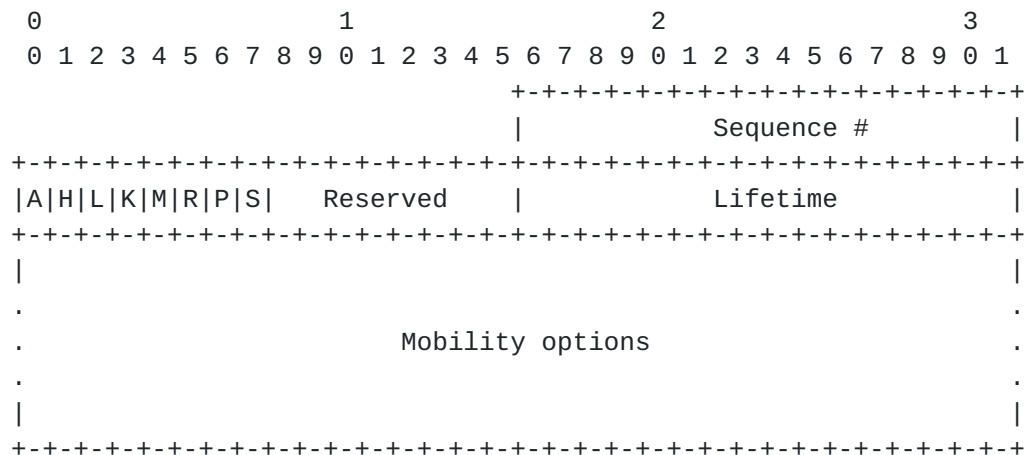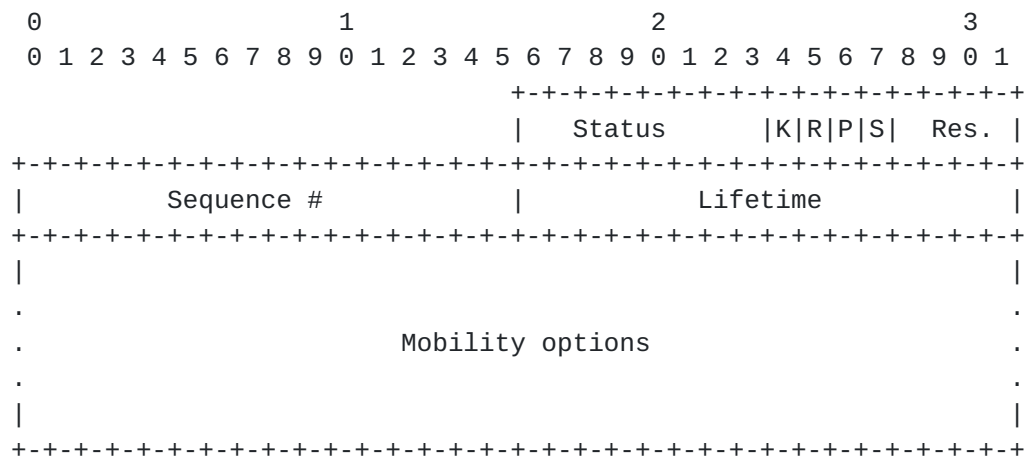
Figure 4

Binding Status Flag (S): A new flag (S) is included in the Proxy
Binding Update message to indicate and control the status of a
binding. A value of 1 indicates the status PRELIMINARY, whereas a
value of 0 allows a MAG to ACTIVATE a binding. In case a MAG does

not know about the status of a binding when a Proxy Binding Update is
sent, it MUST set the S-flag to a value of 0.

The other fields of the Proxy Binding Update message are used
according to [I-D.ietf-netlmm-proxymip6].

5.2.2.2. Proxy Binding Acknowledgment message

Also the PBA message should carry the binding status flag to allow
indication of a binding status. In case the LMA classifies a binding
as 'preliminary', it indicates the status to the MAG, which has sent
the PBU, in the PBA. After a MAG explicitly activated a binding,
which has been classified as 'preliminary' beforehand, the LMA should
indicate the result of processing the PBU in the PBA by means of
setting the binding status flag appropriately.

Figure 5 illustrates the Proxy Binding Acknowlegdment message with a
binding status flag.

```
     0                   1                   2                   3
     0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
                                    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
                                    |    Status     |K|R|P|S| Res. |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |          Sequence #           |            Lifetime           |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
    |                                                               |
    .                                                               .
    .                      Mobility options                         .
    .                                                               .
    |                                                               |
    +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 5

Binding Status Flag (S): A new flag is included in the Proxy Binding
Acknowledgment message to indicate the status of a binding. A value
of 1 indicates the status PRELIMINARY, whereas a status ACTIVE is
indicated with value 0.

The other fields of the Proxy Binding Acknowledgment message are used
according to [I-D.ietf-netlmm-proxymip6].

6. Security Considerations

Signaling between MAGs and LMAs as well as information carried by PBU and PBA messages is protected and authenticated according to the mechanisms described in [I-D.ietf-netlmm-proxymip6].

In case MAGs or LMAs make use of a further protocol interface to an external component, the associated protocol must be protected and information must be authenticated. Such protocol interface may for example be used by an LMA or a MAG to learn about the nature of a handover or about the status of an MN's interface.

7. IANA Considerations

In case a BCI option as proposed in Appendix A will be used for binding control and status indication, there is a need to assign a type to identify the BCI option.

8. Acknowledgments

   May thanks to Jun Awano for his valuable comments and the associated
   fruitful discussion about binding control and status indications.

9. Normative References

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Appendix A.   Proposal for a Binding Control and Indication (BCI) option

Section 5.2.2 proposes adding a Binding Status flag to the Proxy
Binding Update message. In the context of preliminary bindings and
possible future extensions, which may require binding control and
binding status indication, we propose a new Binding Control and
Indication (BCI) option. The use of such an option allows to omit
the Binding Status flags in the PBU and the PBA messages.

The BCI option is meant to complement the Handoff Indicator (HI)
option, which is specified in [I-D.ietf-netlmm-proxymip6], and allows
clear separation between handoff type indications and binding status
indications. Furthermore, the BCI option can be used to control the
binding according to a pre-defined procedure. One example is the
controlled activation of a preliminary binding from a MAG. Further
application scenarios are possible, such as the control of bindings
to coordinate uplink traffic, as proposed in
[I-D.muhanna-netlmm-pmipv6-support-transient-coa].

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |    Type       |    Length     |            BCI Mask           |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |           Reserved            |             BID               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 6

Type: Identifies the BCI option. To be assigned by IANA.

Length: 8-bit unsigned integer indicating the length of the option in
octets, excluding the Type and the Length fields.

Binding Control and Indication (BCI) Mask: Mask to control and
indicate the status of a binding. For this draft, the following
values are proposed:

[0x0000]: Active Binding

[0x0001]: Preliminary Binding

Other bits of this mask must set to 0 and be ignored until their
meaning is specified.

   Binding ID (BID): In case an LMA distinguishes BCEs and possibly
   multiple bindings per MN by means of a binding identifier, this field
   can be used to refer to a particular binding by means of the BID
   field. In case binding identifiers are not used beyond local
   management on an LMA, this field must be set to 0.

   Note 1: Using a BCI Mask allows simultaneous setting of multiple bits
   for control and indication in this option.

   Note 2: In case the binding identifiers are not used, alternatively
   this field and the preceding Reserved field can be omitted. The
   Length field of this option must be adjusted accordingly.

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