                 Fast Handover for Multicast in Proxy Mobile IPv6
                    draft-hui-multimob-fast-handover-03

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Abstract

   This document specifies the predictive fast handover mechanism to solve
   the problem of handover latency and packet loss in Proxy Mobile IPv6
   Multicast. Necessary extensions are specified for Handover Initiate
   (HI) and Handover Acknowledgement (HAck) messages to support
   multicast handover procedure.

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1. Introduction

   Proxy Mobile IPv6 (PMIPv6) protocol provides local mobility
   management to a mobile node without requiring any modification of the
   mobile node. The Local Mobility Anchor (LMA) and Mobile Access
   Gateway (MAG) perform the mobility management signaling on behalf of
   the mobile node. Extensions for LMA and MAG are specified in [1] to
   support IP multicast in PMIPv6. Nevertheless, the basic performance
   including handover latency and packet loss is not considered
   different form that of PMIPv6.

   Fast handover for Mobile IPv6 is specified in [2]. [3] extends the
   FMIPv6 and applies it to the PMIPv6 in order to decrease handover
   latency and packet loss as well as transfer of network-resident
   contexts. However, IP multicast is not considered in fast handover
   for PMIPv6.

   We propose a fast handover mechanism to support multicast for PMIPv6.
   Necessary extensions are specified in HI and HAck message to transfer
   the multicast node's context information and deliver the multicast
   data before the set up of tunnel between n-MAG and LMA.

2. Problem Statement

   The existing solution for PMIPv6 multicast [1] specifies that, only
   after the bi-directional tunnel is built between n-MAG and LMA using
   extended PBU (PBU-M) message, the multicast packet can be
   continuously delivered to MN. It inevitably causes the latency and
   loss of packet during handover process.

   The solution presents two ways to acquire the MN's profile, which
   includes MN' ID and multicast state information. One way is to use
   the Context Transfer Protocol (CXTP) [4] to transfer MN's profile
   from p-MAG to n-MAG. In the other way, if MN's profile is stored in a
   policy store [5], n-MAG obtains MN's multicast state by the same
   mechanism used to acquire MN' ID and profile during MN's attachment
   process [5].

   In another PMIPv6 multicast solution [6], the author proposes normal
   handover and fast handover for proxy mobile multicast service. There
   is no any optimization in normal handover, the handover involves MN
   by running the MLDv2 [7] protocol with n-MAG to receive the related
   multicast packet. In the fast handover procedure, similar to the
   first method used in [1],the context transfer is used to provide
   multicast information. Although n-MAG can acquire the MN' multicast
   information before MN handovers to it, only after n-MAG joins the
   multicast group, it can receive the multicast data.

3. Terminology

   This document refers to [1] [2] [3] for terminology. The following
   terms and abbreviations are additionally used in this document. The
   reference network is illustrated in Figure 1.

   Previous Mobile Access Gateway (p-MAG):

        The MAG that manages mobility related signaling for the MN
        before handover.

   New Mobile Access Gateway (n-MAG):

        The MAG that manages mobility related signaling for the MN after
        handover.

   HO-Initiate:

        A generic signaling that indicates the handover of the MN sent
        from the MN to the p-MAG. It is assumed that HO-Initiate can
        carry the information to identify the MN and to assist the p-MAG
        to resolve the n-MAG.

4. Protocol Operation

   The architecture of fast handover for multicast in Proxy Mobile IPv6
   is shown in Figure 1. A multicast tunnel is established to transfer
   the multicast data from p-MAG to n-MAG before the n-MAG joins the
   multicast group, so that whenever the MN handovers to the n-MAG, it
   can receive the multicast data from n-MAG.

```
                        +----------+
                        |   LMA    |
                        |          |
                        +----------+
                         /      \
                        /        \
                       /          \
          +........../..+      +..\..........+
          . +-------+-+ ._____. +-+-------+ .
          . | p-MAG  |()_____)|  n-MAG  | .
          . +----+----+ .      . +----+----+ .
          .      |      .      .      |      .
          .      |      .      .      |      .
          .   +----+    .      .   +----+    .
          .   | MN |  ---------->  | MN |    .
          .   +----+    .      .   +----+    .
          +............+        +...........+
```
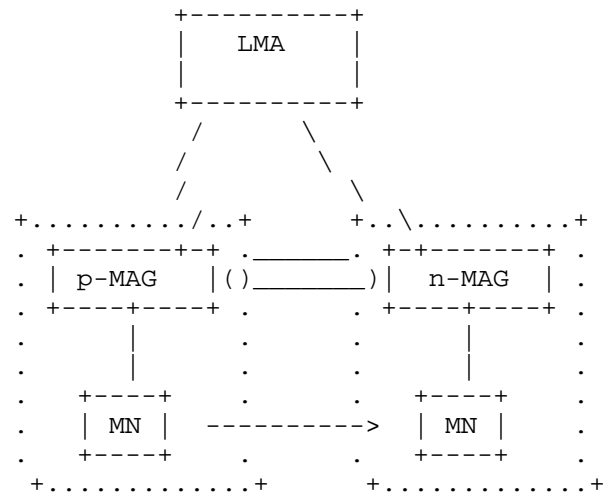
                 Figure 1: Reference network for fast handover

   In order to decrease the handover latency and packet loss, this
   document specifies a bi-directional tunnel between the Previous MAG
   (p-MAG) and the New MAG (n-MAG). As the n-MAG needs the multicast
   node's context information to set up a bi-directional tunnel to
   continuous deliver multicast packet to mobile node, the HI and HAck
   messages are extended to support mobile multicast node's context
   transfer, in which parameters such as MN ID, MN Multicast State, are
   transferred from the p-MAG to the n-MAG. The sequence of events
   illustrating the fast handover for multicast is shown in Figure 2.

```
          MN              p-MAG           n-MAG              LMA

           |               |               |                 |

    (1)  | HO Initiate |               |                 |

         | --(MN ID,-->|               |                 |
```

```
         | n-MAG ID) |                   |                 |

    (2)  |           |       HI          |                 |

         |           | --(MN ID, --> |                     |

         |              MN Multicast State)                 |

         |           |                   |                 |

    (3)  |           | <---HAck---   |                     |

         |           |    (MN ID)    |                     |

         |           |                   |                 |

         |           |    HI/HAck    |                     |

    (4)  |           |<------------->|                     |

         |           |                   |                 |

    (5)  |           |      M data   |                     |

         |           |====tunnel====>|                     |

    (6) ~~~          |                   |                 |

        ~~~          |                   |                 |

         |           |                   |                 |

    (7)  |<=========M data============|                    |

         |           |                   |                 |

    (8)  |           |                   |------PBU-M------->|

         |           |                   |                 |

    (9)  |           |                   |<-----PBA----------|

         |           |                   |                 |

    (10) |           |                   |      M data     |

         |           |                   |<==bi-dir tunnel==>|
```

```
        |               |               |                   |

   (11) |               |     HI/HAck    |                   |

        |               |<------------->|                   |

        |               |               |                   |
```
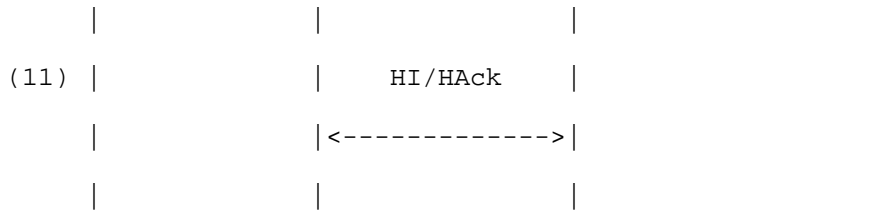
Figure 2: Fast handover for PMIPv6 multicast

The detailed descriptions are as follows:

(1)The MN detects that a handover is imminent and reports the
   MN ID and n-MAG ID.

(2)The p-MAG sends the HI to the n-MAG. The HI message includes
   MN ID and MN Multicast State.

(3)The n-MAG sends the HAck back to the p-MAG.

(4)The n-MAG requests the p-MAG to forward multicast packets by
   setting F flags in the HI message.

(5)A tunnel is established between the p-MAG and n-MAG and multicast
   packets destined for the MN are forwarded from the p-MAG to the
   n-MAG over this tunnel.

(6)The MN undergoes handover to n-MAG.

(7)The n-MAG starts to forward multicast packets destined for the MN.

(8)The n-MAG sends the Proxy Binding Update with multicast extension
   (PBU-M)(proposed in [1]) to the LMA.

(9)The LMA sends back the Proxy Binding Acknowledgment (PBA) to the
   n-MAG.

(10)A bi-directional tunnel is set up for forwarding corresponding
    multicast data.

   (11)Multicast packet forwarding is completed between p-MAG and n-MAG.

5. Message Format

   This document defines new Mobility Header messages for the extended
   HI and HAck and new mobility options for delivering context
   information.

```
 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
                               +--------------+-+-+-----------+
                               |     Code     |U|F|M| Reserved|
 +----------------------------+--------------+-+-+-----------+
 |          Reserved          |          Identifier          |
 +----------------------------+------------------------------+
 |                                                           |
 .                                                           .
 .                     Mobility options                      .
 .                                                           .
 |                                                           |
 +-----------------------------------------------------------+
```
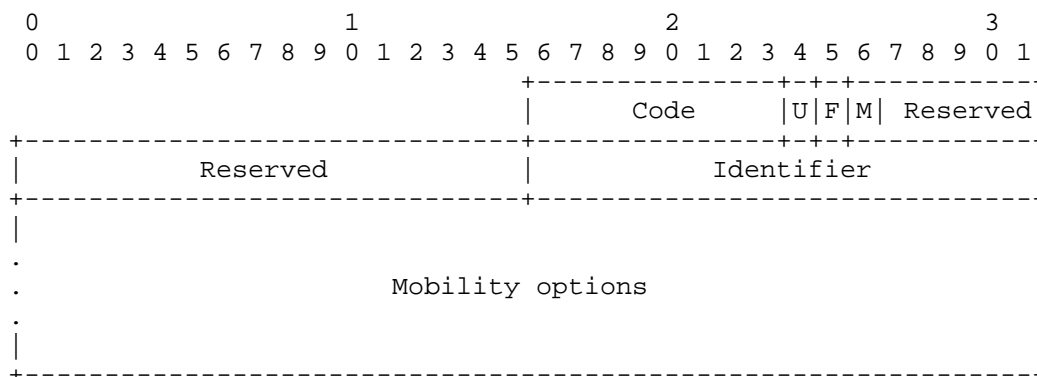   Figure 3: HI Mobility Header message with multicast extension

   A new flag (M) is included in the HI Mobility Header message with
   multicast extension. The rest of the message format remains the same
   as defined in [3].

   When (M) flag is specified in HI Mobility Header message, the
   mobility options field needs to be extended to include the multicast
   addresses.

```
 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
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |  Record Type  | Aux Data Len  |     Number of Sources (N)     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 *                                                               *
 |                                                               |
 *                      Multicast Address                        *
 |                                                               |
 *                                                               *
 |                                                               |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                                                               |
 *                                                               *
 |                                                               |
 *                      Source Address [1]                       *
```

```
        |                                                     |
        *                                                     *
        |                                                     |
        +-                                                   -+
        |                                                     |
        *                                                     *
        |                                                     |
        *              Source Address [2]                     *
        |                                                     |
        *                                                     *
        |                                                     |
        +-                                                   -+
        .                        .                            .
        .                        .                            .
        .                        .                            .
        +-                                                   -+
        |                                                     |
        *                                                     *
        |                                                     |
        *              Source Address [N]                     *
        |                                                     |
        *                                                     *
        |                                                     |
        +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
        |                                                     |
        .                                                     .
        .                Auxiliary Data                       .
        .                                                     .
        |                                                     |
        +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
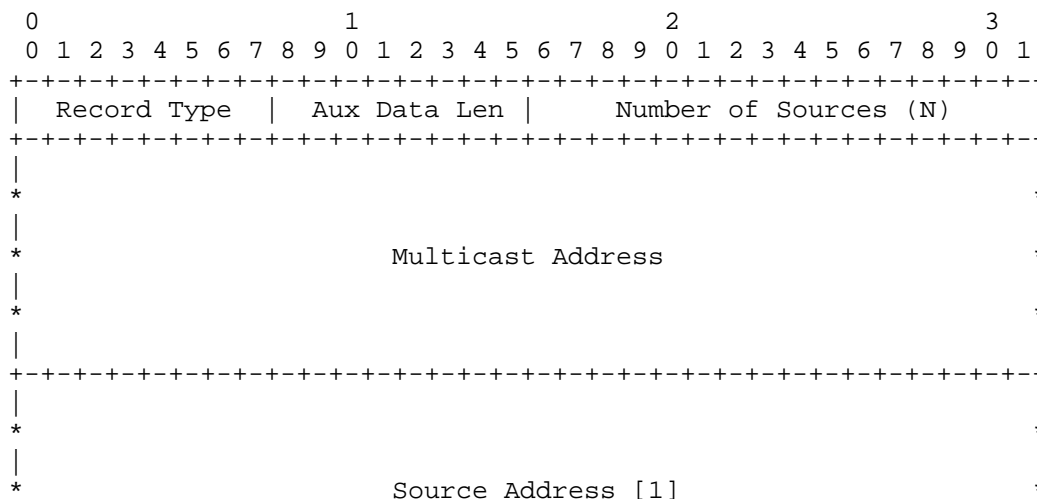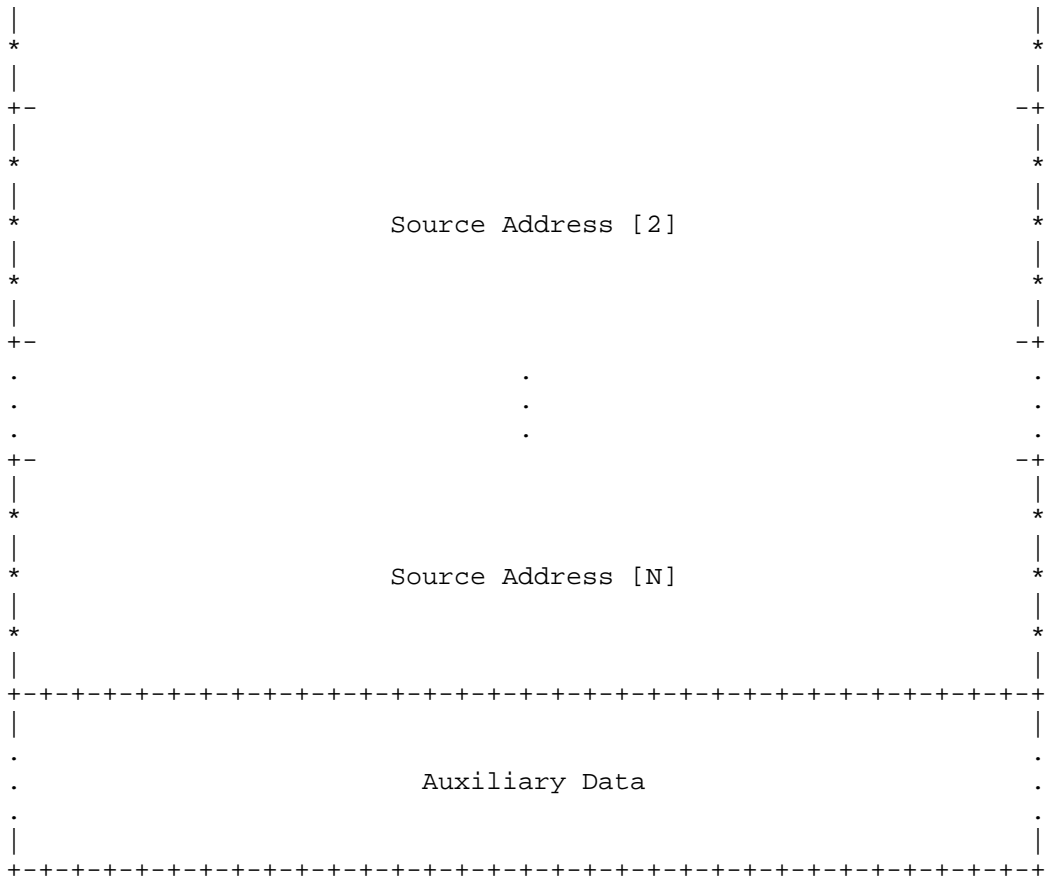
6. Security Considerations

   TBD.

7. IANA Considerations

   This document does not require any IANA action.

8. References

8.1. Normative References

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8.2. Informative References

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