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           Bulk Binding Update Support for Proxy Mobile IPv6
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Abstract

   For extending the lifetime of a mobility session, the Proxy Mobile
   IPv6 specification requires the mobile access gateway to send a Proxy
   Binding Update message to the local mobility anchor on a per-session
   basis. In the absence of signaling semantics for performing
   operations with group specific scope, it results in significant
   amount of signaling traffic on a periodic basis between a given
   mobile access gateway and a local mobility anchor. This document
   defines optimizations to the binding update and revocation operations
   in Proxy Mobile IPv6 for performing operations with group specific
   scope with the use of a group identifier.

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1. Introduction

The Proxy Mobile IPv6 base specification [RFC5213] requires the
Mobile Node Identifier option to be present in the mobility signaling
messages, such as in the Proxy Binding Update and Proxy Binding
Acknowledgement messages. It essentially limits the operational
scope of the binding update operation to a single mobility session.
These signaling messages lack the capability to identify a group of
mobility sessions, so the binding update and revocation related
operations can be performed on all the mobility sessions that are
part of that group.

There is a need to have semantics for associating a group identity to
a mobility session, so the scope of the binding update and revocation
related operations can be extended to all the mobility sessions
identified by the group identifier. The group identifier therefore
provides a considerably improved mechanism for protocol operations
which would otherwise require multiple atomic transactions on a per
mobility session basis. Following are some of the use-cases where
the group identifier can be used.

o For extending the lifetime of a mobility session, the mobile
   access gateway periodically sends a Proxy Binding Update message
   to the local mobility anchor on a per-session basis. This process
   can be optimized by allowing the mobile access gateway to send a
   single Proxy Binding Update [RFC5213] message for a group of
   mobility sessions, identified by a group identifier. The local
   mobility anchor upon accepting the request can update the lifetime
   of all the mobility sessions that are part of that group.

o A local mobility anchor, or a mobile access gateway service hosted
   on blade architecture system, on detecting a failure of a specific
   service card, can potentially request the peer to revoke all the
   sessions that are hosted on that service card, identified by a
   common group identifier. Potentially, a single Binding Revocation
   Request [RFC5846] message carrying the group identifier can be
   used to revoke all the sessions hosted on that service card, which
   otherwise needs to be handled on a per-session basis.

This document defines a new mobility option, Mobile Node Group
Identifier option, and the extensions to binding update and binding
revocation related procedures for performing binding operations with
group specific scope.

2. Conventions & Terminology

2.1. Conventions

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].

2.2. Terminology

All the mobility related terms used in this document are to be interpreted as defined in the base Proxy Mobile IPv6 specifications [RFC5213] and [RFC5844]. Additionally, this document uses the following abbreviations:

Bulk Binding Update

   A binding update operation that has group specific scope. A binding operation is associated with a specific mobility session. However, a Bulk binding update operation is associated with multiple mobility sessions. This operation is not relevant for new mobility session creation.

Bulk Binding Update Group

   A group of mobility sessions that are part of the same logical group and therefore share a common group identifier. This group is the bulk binding update group. This bulk binding update group is maintained by both the mobile access gateway and the local mobility anchor, and the grouping logic is local to that node. A mobility session therefore can be identified by two bulk binding update group identifiers, one specific group created by the mobile access gateway and the other specific group created by the local mobility anchor. The bulk binding update group identifiers are exchanged as part of the initial mobility session creation. The mobility entities thereafter can perform binding update related operations such as lifetime extension and revocation operations on an entire bulk binding update group, identified by a group identifier.

3. Bulk Binding Update Overview

3.1. Motivation

In a typical Proxy Mobile IPv6 domain, a local mobility anchor serves multiple mobile access gateways and the capacity of that node with respect to the number of mobility sessions that it can host is quite high, typically in the order of few millions. As the number of mobility sessions hosted by a local mobility anchor goes up, so is

the amount of signaling traffic related to periodic binding update
related traffic.

The currently specified approach of binding update procedure for
extending the lifetime, where the mobile access gateway is required
to send a unique binding update message for each mobility session,
even when there is no change to the session state is inefficient or
sub-optimal. These periodic binding update messages consume
significant amount of network resources, both in terms of processing
power and in terms of network bandwidth and at both the peers. There
is an opportunity to optimize the signaling procedures by allowing
the local mobility anchor and the mobile access gateway to perform
bulk binding update operations. This document specifies extensions
to Proxy Mobile IPv6 signaling for performing binding update and
revocation operations on a group of mobility sessions. These
extensions do not take away the existing functionality of performing
binding operations on a single mobility session.

3.2. General Operation

The bulk binding update mechanism specified in this document allows
the mobile access gateway and the local mobility anchor to perform
binding update and revocation operations on a group of mobility
sessions. As part of the initial signaling during mobility session
establishment, the local mobility anchor and the mobile access
gateway exchange the respective bulk binding update group identifiers
for that mobility session. Subsequently both the peers can perform
bulk operations on those groups by presenting the bulk binding update
group identifier in the signaling messages.

A mobile access gateway when sending a Proxy Binding Update message
after detecting a new mobile node on its access link, can request the
local mobility anchor to assign a bulk binding update group
identifier for the mobile node's mobility session. This is indicated
by setting the (B) flag in the Proxy Binding Update to a value of
(1). The mobile access gateway will also assign a bulk binding
update group identifier (or it may assign a default bulk binding
update group - ALL-Sessions) and include that in the Mobile Node
Group Identifier option.

The local mobility anchor upon accepting the request will group the
mobility session to a specific bulk binding update group (or it may
assign it to the default bulk binding update group - ALL-Sessions)
and return this bulk binding update group identifier in Proxy Binding
Acknowledgement message. It will also set the (B) flag in the Proxy
Binding Acknowledgement message to a value of (1). The bulk binding
update group identifier is carried in the Mobile Node Group
Identifier option, described in Section 4.3.

   Once the bulk binding update group identifiers are exchanged, the
   local mobility anchor and the mobile access gateway can perform
   binding operations on those entire groups, by including the bulk
   binding update group identifier in the signaling messages. For
   example, the mobile access gateway can extend the lifetime of all the
   mobility sessions that are part of a group by sending a single Proxy
   Binding Update message with that bulk binding update group
   identifier. Similarly, the local mobility anchor can revoke all the
   mobility sessions that are part of a group, by including that group
   identifier in the Proxy Binding Revocation message.

   Figure 1 explains the operational sequence of the bulk binding update
   and revocation operations on a group of mobile nodes, MN1, MN2 and
   MN3.

                     MAG   LMA
            (1) | |
     MN1-------| (2) PBU |
                  |--------------------------->|
                  | * (3)
                  | (4) PBA |
                  |<---------------------------|
                  * (5) |
            (6) | |
     MN2-------| |
                  * (7)........................|
            (8) | |
     MN3-------| |
                  * (9)........................|
                  | |
                  | (10) PBU |
                  |--------------------------->|
                  | * (11)
                  | (12) PBA |
                  |<---------------------------|
                  * (13) |
                  | |
                  | (14) BRI |
                  |<---------------------------|
                  | * (15)
                  | (16) BRA |
                  |--------------------------->|
                  * (17) |
                  | |
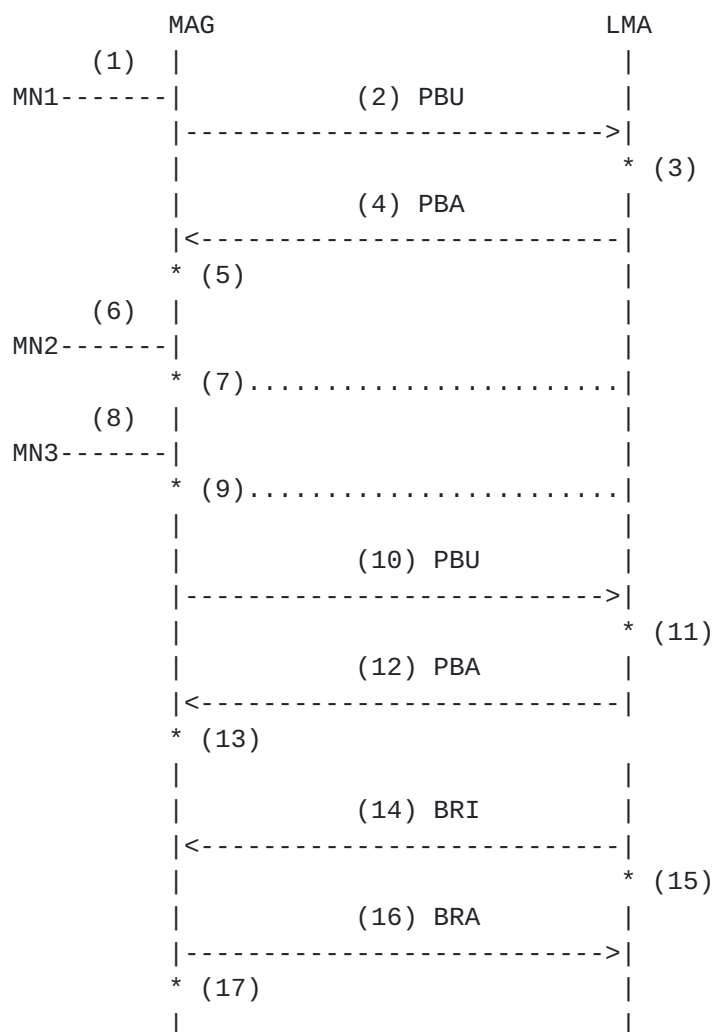
                  Figure 1: Exchange of Group Identifier

o (1) to (2): MAG detects the mobile node's (MN1) attachment to the
   access link. The MAG groups the mobile node to a specific bulk
   binding update group, (M1). The MAG notifies this group
   identifier to the LMA by including it in the Mobile Node Group
   Identifier option of the PBU message.

o (3): The LMA upon accepting the PBU, creates a mobility session
   and groups the mobility session to a specific bulk binding update
   group, (L1). The LMA updates the mobile node's BCE entry to
   include the bulk binding update group identifier, (L1) and the
   bulk binding update group identifier presented by the MAG, (M1).
   The LMA also notifies the MAG about the bulk binding update group
   identifier (L1), by including it in the PBA.

o (4) to (5): The MAG upon receiving the PBA updates the BUL entry
   for that mobility session to include the bulk binding update group
   identifiers (L1) and (M1). At this point, both the LMA and MAG
   are aware of the mobile node's bulk binding update group
   identifiers assigned by the peers.

o (6) to (9): The above steps (1 through 5) are repeated here for
   MN2 and MN3, details are omitted. At the end of step (9), the MAG
   completes the signaling with the LMA. The MAG assigns the mobile
   nodes, MN2 and MN3 to bulk binding update groups, M1 and M2
   respectively, while the LMA assigns them both to the same to the
   bulk binding update group, (L1).

o At this point, LMA has assigned MN1, MN2 and MN3 to the bulk
   binding update group of (L1), while the MAG has assigned MN1 and
   MN2 to the group (M1) and MN3 to group (M2). Both the peers can
   now perform binding operations on a group of mobility sessions
   identified by the respective bulk binding update group identifier.

o (10) to (13): The MAG sends a periodic binding update message for
   extending the lifetime of all the mobility sessions that are part
   of the bulk binding update group, (M1). It includes the bulk
   binding update group identifier, (M1) in the PBU. The LMA upon
   accepting the PBU, extends the lifetime of both MN1 and MN2, which
   are part of the group (M1).

o (14) to (16): The LMA decides to revoke all the sessions that are
   part of bulk binding update group, L1. The LMA sends a BRI
   message with the bulk binding update group identifier, (L1). The
   MAG upon accepting the BRI message revokes all the MN1, MN2 and
   MN3 mobility sessions, which are part of that bulk binding update
   group, (L1).

4. Message formats

   This section identifies the extensions to Proxy Mobile IPv6 signaling
   messages that are required for supporting this specification.

4.1. Extensions to Proxy Binding Update Message

```
 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|F|T|B| Reserved  |            Lifetime           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                       Mobility options                        .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                                 Figure 2

   A new flag, Bulk-Binding-Update (B) flag is defined in the Proxy
   Binding Update message specified in [RFC5213]. The bit-value of
   Bulk-Binding-Update (B) flag in the flags field of the message will
   be (IANA-1).

   If the Bulk-Binding-Update flag (B) is set to a value of (1), it
   informs the local mobility anchor to enable bulk binding update
   support for the mobility session associated with this message. If
   the (B) flag is set to a value of (0), the local mobility anchor MUST
   exclude the mobility session associated with this message, from any
   bulk binding related operations and any binding update, or binding
   revocation operations with bulk specific scope will not be relevant
   to that mobility session.

   This flag is relevant only for Proxy Mobile IPv6 and therefore MUST
   be set to value of (0), when the (P) flag is set to a value of (0).

   All other fields in the Proxy Binding Update message and the mobility
   options that can be carried in the message confirm to the respective
   specifications.

4.2. Extensions to Proxy Binding Acknowledgment Message

```
 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|T|B| Res.|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Sequence #            |            Lifetime           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                                                               |
.                                                               .
.                        Mobility options                       .
.                                                               .
|                                                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
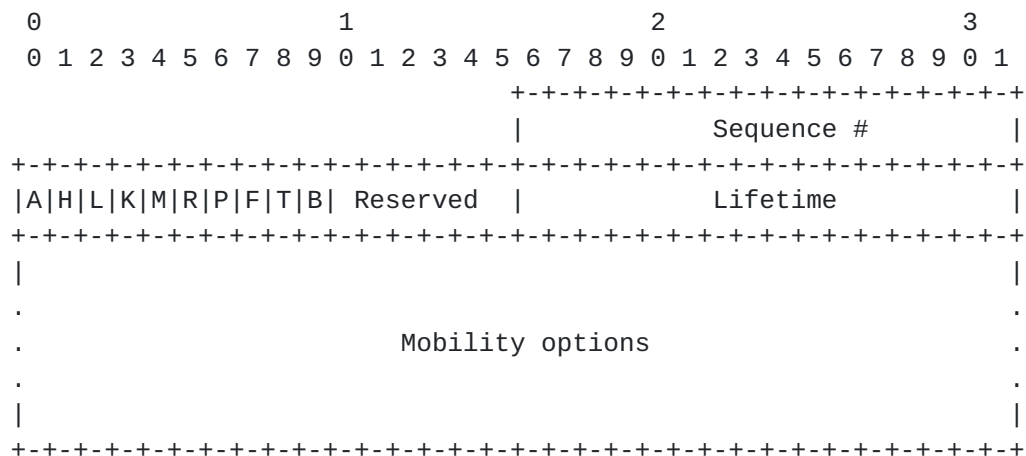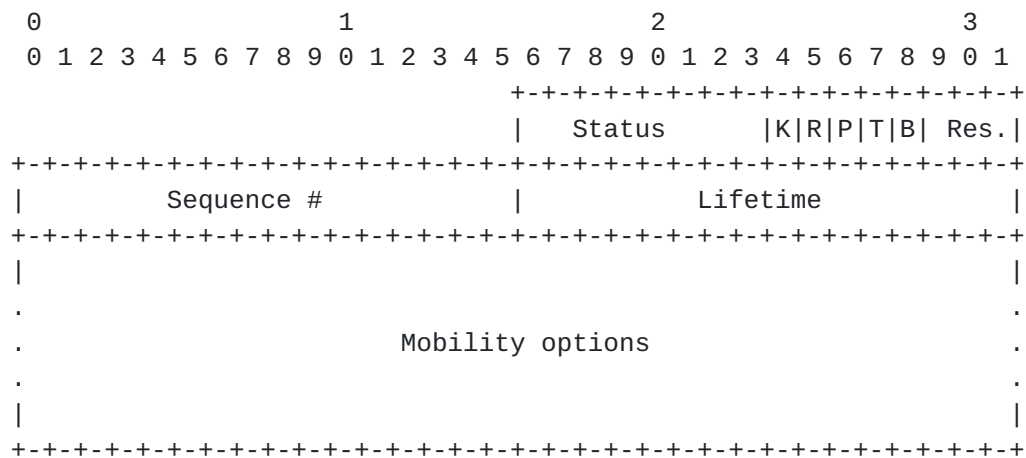
Figure 3: Proxy Binding Acknowledgment Message

A new flag, Bulk-Binding-Update (B) flag is defined in the Proxy
Binding Acknowledgment message specified in [RFC5213]. The bit-value
of Bulk-Binding-Update (B) flag in the flags field of the message is
(IANA-2).

If the Bulk-Binding-Update flag (B) is set to a value of (1), it
serves as an indication to the mobile access gateway that the local
mobility anchor has enabled bulk binding update support for the
mobility session associated with this message. The value of the flag
MUST be set to the value of (0), if the value of the (B) flag in the
Proxy Binding Update message that it received from the mobile access
gateway was set to a value of (0).

This flag is relevant only for Proxy Mobile IPv6 and therefore MUST
be set to value of (0), when the (P) flag is set to a value of (0).

All other fields in the Proxy Binding Acknowledgment message and the
mobility options that can be carried in the message conform to the
respective specifications.

4.3. Mobile Node Group Identifier Option

A new option, Mobile Node Group Identifier option is defined for
using it in Proxy Mobile IPv6 signaling messages exchanged between a
local mobility anchor and a mobile access gateway. This option is
used for carrying the mobile node's group identifier. There can be
multiple instances of this option in a given signaling message,
however, each of the instance SHOULD have a different sub-type value.
This option is a generic option and this specification uses only the
sub-type value of (1).

The type value for this option is (IANA-3).

```
 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     |   Sub-type    |   Reserved    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Mobile Node Group Identifier                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

                Figure 4: Mobile Node Group Identifier Option

Type
   <(IANA-3)>

Length
   This is an 8-bit unsigned integer indicating the length in octets
   of this option, excluding the type and length fields. The value
   for this field MUST be set to a value of (6).

Sub-type
   This 8-bit field identifies the specific mobile node's group type.
   This number space will be managed by the IANA. The sub-type value
   of (1) is reserved for Bulk Binding Update Group.

Reserved
   This 8-bit field is unused for now. The value MUST be initialized
   to (0) by the sender and MUST be ignored by the receiver.

Mobile Node Group Identifier   This 32-bit field contains the mobile
   node's group identifier. The value of (0) is reserved and SHOULD
   NOT be used. The value of (1) ALL-SESSIONS, is the default group
   of all mobility sessions established between a given local
   mobility anchor and a mobile access gateway.

4.4. Status Codes

This document defines the following new Status codes values for use
in the Proxy Binding Acknowledgement message. These values are to be
allocated from the same numbering space, as defined in Section 6.1.8
of [RFC6275].

   INVALID_MOBILE_NODE_GROUP_IDENTIFIER: (IANA-5)

Invalid group identifier value in the request

5. Protocol Considerations

5.1. MAG Considerations

The following are the considerations relevant for the mobile access gateway when supporting this specification.

5.1.1. Extensions to Binding Update List Entry Data Structure

The conceptual Binding Update List entry data structure maintained by the mobile access gateway, described in Section 6.1 of [RFC5213], is extended to include the following REQUIRED additional fields.

o MAG-Bulk-Binding-Update-Group-Id - It is the bulk binding update group identifier assigned by this mobile access gateway for this mobility session. This is a 32-bit unsigned integer. This identifier is not globally unique within a Proxy Mobile IPv6 domain, the same group identifier value may be used by other nodes.

o LMA-Bulk-Binding-Update-Group-Id - It is the bulk binding update group identifier assigned by the local mobility anchor for this mobility session. This is a 32-bit unsigned integer. This identifier is received in the Mobile Node Group Identifier option of the Proxy Binding Acknowledgement message. This identifier is not globally unique within a Proxy Mobile IPv6 domain, the same group identifier value may be used by other nodes.

5.1.2. Requesting Bulk Binding Update Support for a Mobility Session

The following are the considerations for the mobile access gateway for requesting bulk binding update support for a mobility session."

o When sending a Proxy Binding Update message to the local mobility anchor, the mobile access gateway can choose to request the local mobility anchor to enable bulk binding update support for the mobility session associated with that Proxy Binding Update request. When making such request, the Bulk-Binding-Update flag (B) in the request MUST be set to a value of (1) and the Mobile Node Group Identifier option MUST be present. The decision to request the bulk binding update support for a mobile node is a matter of local policy at the mobile access gateway and is controlled by the configuration variable, RequestBulkBindingUpdateSupportForMobilitySession.

o The mobile access gateway MUST assign a bulk binding update group
   identifier for the mobility session. Considerations on how the
   mobile access gateway assigns a group identifier to a mobility
   session is outside the scope of this document. This group
   identifier can be unique to the service card on which the mobility
   session is hosted, or based on other grouping considerations.
   When there is no such group assignment is done, the mobile access
   gateway SHOULD assign the default group identifier value of (ALL-
   SESSIONS). This assigned group identifier value MUST be present
   in the Mobile Node Group Identifier option and the the sub-type
   value in the option MUST be set to value of (1) (bulk binding
   update group).

o If the received Proxy Binding Acknowledgment message has the Bulk-
   Binding-Update flag (B) in the reply set to a value of (0), this
   is in response to a Proxy Binding Update request with the Bulk-
   Binding-Update flag (B) set to a value of (1), it is an indication
   that the local mobility anchor has denied the request for enabling
   bulk binding update support for that mobility session and that the
   mobility session is not associated with any bulk binding update
   group. The mobile access gateway SHOULD set the bulk binding
   update group identifier values, LMA-Bulk-Binding-Update-Group-Id
   and MAG-Bulk-Binding-Update-Group-Id values to (0), in the Binding
   Update List entry for that mobility session. Furthermore, the
   mobility session should be excluded from any bulk binding update
   operations.

o If the received Proxy Binding Acknowledgment message has the
   status code value set to (0) (Proxy Binding Update accepted) and
   the Bulk-Binding-Update flag (B) in the reply is set to a value of
   (1), it is an indication that the local mobility anchor has
   accepted the request to allow bulk binding update support for that
   mobility session. Furthermore, the Mobile Node Group Identifier
   option in the reply, with sub-type value of (1) (bulk binding
   update group), contains the bulk binding update group identifier
   for that mobility session assigned by the local mobility anchor.
   The mobile access gateway MUST update the LMA-Bulk-Binding-Update-
   Group-Id and MAG-Bulk-Binding-Update-Group-Id parameters in the
   Binding Update List entry for that mobility session. However, if
   the received Proxy Binding Acknowledgement message has the Bulk-
   Binding-Update flag (B) set to a value of (1), but if the Mobile
   Node Group Identifier option is not present, the message MUST be
   considered as malformed and ignored.

o At any point of time, the mobile access gateway chooses to request
   the local mobility anchor to disable bulk binding update support
   for a mobility session, it MUST send a Proxy Binding Update
   message with the (B) flag set to a value of (0) and the Mobile

Node Group Identifier option MUST NOT be present. This message is
sent as a normal binding update request for lifetime extension.
Requirements from section 6.9.1 [RFC5213] apply. Furthermore, the
mobile access gateway MUST update Binding Update List entry, by
setting the bulk binding update group identifier values, LMA-Bulk-
Binding-Update-Group-Id and MAG-Bulk-Binding-Update-Group-Id
values to (0) and the mobility session MUST be excluded from any
bulk binding update operations.

5.1.3. Supporting Bulk Binding Updates

The following section identifies the considerations for mobile access
gateway for performing binding update and revocation operations with
group specific scope.

o For extending the lifetime of all mobility sessions that share the
   same bulk binding update group identifier, the mobile access
   gateway can choose to send a Bulk binding update request. For
   making such request, it can send a Proxy Binding Update message to
   the local mobility anchor, including the Mobile Node Group
   Identifier option with sub-type value of (1) (bulk binding update
   group), and with the Bulk-Binding-Update flag (B) set to a value
   of (0). The identifier value in the option MUST be set to the
   bulk binding update group identifier of the group for which bulk
   binding update operation is being requested. The message MUST NOT
   include any individual session identifiers such as, Mobile Node
   Identifier option [RFC4283], Home Network Prefix option [RFC5213],
   the IPv4 Home Address Request option [RFC5844], or the GRE Key
   option [RFC5845]. All the Considerations from section 5.3.3
   [RFC5213] MUST be followed when sending the bulk binding update
   request, with the exception related to the use of Mobile Node
   Group Identifier option in place of the individual session
   identifiers (Mobile Node Identifier option, Home Network Prefix
   option, GRE Key option, IPv4 Home Address Address Request option).

o When requesting binding revocation for all the sessions that share
   the same bulk binding update group identifier, the mobile access
   gateway can choose to send a bulk revocation request. For making
   such request, it can send a Binding Revocation Indication message
   [RFC5846] to the local mobility anchor, including the Mobile Node
   Group Identifier option, with sub-type value of (1) (bulk binding
   update group). The identifier value in the option MUST be set to
   the bulk binding update group identifier of the group for which
   bulk binding update operation is being requested. The message
   MUST NOT include any individual session identifiers such as,
   Mobile Node Identifier option [RFC4283], Home Network Prefix
   option [RFC5213], the IPv4 Home Address Request option [RFC5844]
   or the GRE Key option [RFC5845]. All the Considerations from

section 9.2 [RFC5846] MUST be followed when sending the bulk
binding update request, with the exception related to the use of
Mobile Node Group Identifier option in place of the individual
session identifiers (Mobile Node Identifier option, Home Network
Prefix option, GRE Key option, IPv4 Home Address Address Request
option).

o Any time the mobile access gateway receives a Binding Revocation
   Indication message [RFC5846], with a Mobile Node Group Identifier
   option present in the request and with sub-type value of (1) (bulk
   binding update group), this message serves as a bulk revocation
   request, with the request scope for revoking of all the mobility
   sessions that are part of that bulk binding update group specific
   to that local mobility anchor, and identified by the group
   identifier in Mobile Node Group Identifier option.

o All the considerations from [RFC5846] apply when processing
   binding revocation request, except making the scope of the
   operation apply to a set of mobility sessions identified by the
   bulk binding update group identifier present in the request.

o If the received Binding Revocation Indication message includes a
   Mobile Node Identifier option [RFC4283], Home Network Prefix
   option [RFC5213], the IPv4 Home Address Request option [RFC5844],
   or the GRE Key Option [RFC5845], the mobile access gateway MUST
   consider this as an invalid message; it MUST reject the Binding
   Revocation Indication message and send a Binding Revocation
   Acknowledgement message with the Status field set to a value of
   128 (Binding Does NOT Exist).

5.2. LMA Considerations

The following are the considerations relevant for local mobility
anchor when supporting this specification.

5.2.1. Extensions to Binding Cache Entry Data Structure

The conceptual Binding Cache entry data structure maintained by the
local mobility anchor, described in Section 5.1 of [RFC5213], is
extended to include the following REQUIRED additional fields.

o MAG-Bulk-Binding-Update-Group-Id - It is the bulk binding update
   group identifier assigned by the mobile access gateway for this
   mobility session. This is a 32-bit unsigned integer. This
   identifier is received in the Mobile Node Group Identifier option
   of the Proxy Binding Acknowledgement message. This identifier is
   not globally unique within a Proxy Mobile IPv6 domain, the same
   group identifier value may be used by other nodes.

o LMA-Bulk-Binding-Update-Group-Id - It is the bulk binding update
   group identifier assigned by this local mobility anchor for this
   mobility session. This is a 32-bit unsigned integer. This
   identifier is not globally unique within a Proxy Mobile IPv6
   domain, the same group identifier value may be used by other
   nodes.

5.2.2. Enabling Bulk Binding Update Support for a Mobility Session

The local mobility anchor will process a received Proxy Binding
Update message as specified in [RFC5213]. However, if the (B) flag
in the received Proxy Binding Update message is set to a value of (1)
and if it includes a Mobile Node Group Identifier option with sub-
type value of (1) (bulk binding update group), following processing
takes place:

o If the (B) flag in the received Proxy Binding Update message is
   set to a value of (1) and with the Mobile Node Group Identifier
   option present in the request, the message serves as a request to
   the local mobility anchor to enable bulk binding update support
   for that mobility session.

o Upon successful processing and acceptance of the Proxy Binding
   Update, the local mobility anchor can choose to enable bulk
   binding update support for this mobility session. The decision
   whether to enable bulk binding update support for that mobility
   session is a matter of local policy and is controlled by the
   configuration variable, AcceptBulkBindingUpdateReqMobilitySession.

o For enabling the bulk binding update support for the mobility
   session, the local mobility anchor MUST associate the mobility
   session to a specific bulk binding update group locally. The
   specific details on how the local mobility anchor associates the
   given mobility session to a specific bulk binding update group is
   outside the scope of this document. The local mobility anchor can
   choose to assign a default bulk binding update group identifier
   value of (ALL-SESSIONS), indicating that all the mobility sessions
   from that mobile access gateway are part of that group. The local
   mobility anchor SHOULD update the bulk binding update group
   identifier values in the Binding Cache entry, LMA-Bulk-Binding-
   Update-Group-Id and MAG-Bulk-Binding-Update-Group-Id to the
   respective values.

o If the bulk binding update support is enabled for the mobile
   node's mobility session, the local mobility anchor MUST send the
   assigned bulk binding update group identifier as part of the
   Mobile Node Group Identifier option, with sub-type value of (1)
   (bulk binding update group) in the Proxy Binding Acknowledgment

message that it sends to the mobile access gateway. The (B) flag
in the Proxy Binding Acknowledgment message MUST be set to value
of (1).

o If the bulk binding update support is not enabled for the mobility
   session, the local mobility anchor MUST NOT include the Mobile
   Node Group Identifier option with a sub-type value of (1) (bulk
   binding update group), in the Proxy Binding Acknowledgment message
   that it sends to the mobile access gateway. Furthermore, the (B)
   flag in the Proxy Binding Acknowledgment message MUST be set to
   value of (0). It is to be noted that the Mobile Node Group
   Identifier option is a generic option and new sub-types may be
   defined by future specifications.

o If the received Proxy Binding Update message is not a bulk binding
   update request, (i.e., the (B) flag is set to a value of (0) and
   the Mobile Node Group Identifier option with sub-type value of (1)
   (bulk binding update group) is not present), but is a request for
   extending the lifetime of an existing mobility session, for which
   the bulk binding update support is already enabled, then the local
   mobility anchor MUST process the request as specified in
   [RFC5213]. However, the value of (0) in the (B) flag in the
   message serves as a request for the local mobility anchor to
   disable bulk binding update support for that mobility session.
   Upon accepting the request, the local mobility anchor SHOULD set
   the parameters, LMA-Bulk-Binding-Update-Group-Id and MAG-Bulk-
   Binding-Update-Group-Id in the Binding Cache entry to a value of
   (0) and the mobility session MUST be excluded from any bulk
   binding update operations.

o Any time the local mobility anchor detects that the mobile node
   has roamed and changed its point of attachment to a new mobile
   access gateway, it SHOULD also update the bulk binding update
   group identifier of the mobility session. Additionally, it should
   also update the existing group identifiers associated with that
   session. As part of sending the Proxy Binding Acknowledgment to
   the new mobile access gateway, it MUST include the updated group
   identifier in the Mobile Node Group identifier option, with a sub-
   type value of (1). However, if the if the received Proxy Binding
   Update from the new mobile access gateway did not have the (B)
   flag set to a value of (1), then it MUST NOT include the mobility
   session in any of bulk binding update group and MUST NOT include
   the Mobile Node Group identifier option with the sub-type value of
   (1).

o Any time a mobile node's mobility session is de-registered by the
   mobile access gateway, or the session is revoked for
   administrative or any other reasons, the mobility session MUST

also be removed from the bulk binding update group.

[5.2.3]. Supporting Bulk Binding Updates

The following section identifies the considerations for local
mobility anchor for performing bulk binding update and revocation
operations with group specific scope.

o Any time the local mobility anchor receives a Proxy Binding Update
   message with the (B) flag in the request is set to a value of (0)
   and if a Mobile Node Group Identifier option present in the
   request and with sub-type value of (1) (bulk binding update
   group), the local mobility anchor MUST consider the request as a
   bulk binding update request, with the request scope for all the
   mobility sessions that are part of that bulk binding update group,
   specific to that mobile access gateway, and identified by the
   group identifier in Mobile Node Group Identifier option. However,
   if the received request also includes any individual session
   identifiers such as, Mobile Node Identifier option [RFC4283], Home
   Network Prefix option [RFC5213], the IPv4 Home Address Request
   option [RFC5844], or the GRE Key option [RFC5845] the local
   mobility anchor MUST consider this as an invalid message; it MUST
   reject the Proxy Binding Update message and send a Proxy Binding
   Acknowledgement message with the Status field set to
   INVALID_MOBILE_NODE_GROUP_IDENTIFIER (Invalid group identifier
   value in the request).

o The local mobility anchor MUST consider the message as a request
   for extending the lifetime of all the mobility sessions that are
   associated to each of group identifier from the Mobile Node Group
   Identifier option. However, if the Mobile Node Group Identifier
   option, with sub-type value of (1) (bulk binding update group),
   has an unknown group identifier, then the local mobility anchor
   MUST reject the Proxy Binding Update message and send a Proxy
   Binding Acknowledgement message with the Status field set to
   INVALID_MOBILE_NODE_GROUP_IDENTIFIER (Invalid group identifier
   value in the request).

o Upon accepting the bulk binding update request, the local mobility
   anchor SHOULD extend the lifetime for all the mobility sessions
   that are part of bulk binding update group identified by the group
   identifier in the Mobile Node Group Identifier in the message.
   Considerations from [RFC5213] MUST be applied for extending the
   lifetime of a mobile node's session. It MUST also send a Proxy
   Binding Acknowledgment message with the Status field value set to
   0 (Proxy Binding Update accepted). The lifetime field in the
   message MUST be set to the allocated lifetime for all the mobility
   sessions. The message MUST also include the Mobile Node Group

      Identifier option, with sub-type value of (1) (bulk binding update
      group), with the identifier value copied from the Mobile Node
      Group Identifier option present in the received Proxy Binding
      Update message.

   o If the local mobility anchor rejects the bulk binding update
      request for any administrative reason, then it MUST NOT update the
      lifetime in the binding cache entries of any of the mobile nodes
      identified by the group identifier. The local mobility anchor
      SHOULD send a Proxy Binding Acknowledgment indicating the reason
      for the rejection in the status code.

   o Any time the local mobility anchor receives a Binding Revocation
      Indication Message [RFC5846], with a Mobile Node Group Identifier
      option present in the request and with sub-type value of (1) (bulk
      binding update group), the local mobility anchor MUST consider the
      request as a bulk revocation request, with the request scope
      including all the mobility sessions that are part of that bulk
      binding update group, specific to that mobile access gateway, and
      identified by the group identifier in Mobile Node Group Identifier
      option. However, if the received request also includes a Mobile
      Node Identifier option [RFC4283], Home Network Prefix option
      [RFC5213], the IPv4 Home Address Request option [RFC5844], or the
      GRE Key Option [RFC5845], the local mobility anchor MUST consider
      this as an invalid message; it MUST reject the Binding Revocation
      Indication message and send a Binding Revocation Acknowledgement
      message with the Status field set to a value of 128 (Binding Does
      NOT Exist). All the considerations from [RFC5846] apply when
      processing binding revocation request, except making the scope of
      the operation apply to a set of mobility sessions identified by
      the group identifier present in the request.

   o Upon accepting the Binding Revocation Indication request and
      completing the operation, the local mobility anchor MUST send a
      Binding Revocation Acknowledgement message with the Status field
      set to a value of 0 (success). The message MUST include the
      Mobile Node Group Identifier option, with the identifier value
      copied from the Mobile Node Group Identifier option present in the
      received Binding Revocation Indication message.

6. Protocol Configuration Variables

6.1. Local Mobility Anchor - Configuration Variables

   This specification adds a new configuration variable for the local
   mobility anchor. The configured value for this variable is expected
   to survive server reboots and service restarts.

AcceptBulkBindingUpdateReqMobilitySession

   This flag indicates whether or not the local mobility anchor will
   accept the request from the mobile access gateway to enable bulk
   binding update support for the mobility session. The default
   value for this flag is set to (1), indicating that it will accept
   the request from the mobile access gateway. If the value of the
   flag is set to (0), the local mobility anchor will deny the
   request.

6.2. Mobile Access Gateway - Configuration Variables

This specification adds a new configuration variable for the mobile
access gateway. The configured value for this variable is expected
to survive server reboots and service restarts.

RequestBulkBindingUpdateSupportForMobilitySession

   This flag indicates whether or not the mobile access gateway will
   request the local mobility anchor to enable bulk binding update
   support for the mobility session. The default value for this flag
   is set to (1), indicating that the the mobile access gateway will
   set the bulk binding update flag (B) in the Proxy Binding Update
   request to a value of (1). If the flag is set to a value of (0),
   the mobile access gateway will set the bulk binding update flag
   (B) in the Proxy Binding Update to a value of (0).

7. IANA Considerations

This document requires the following five IANA actions.

o Action-1: This specification defines a new flag (B) to the Proxy
   Binding Update message, specified in [RFC5213]. This flag is
   described in Section 4.1. The value of the flag (B) needs to be
   allocated from the Binding Update Flags registry.

o Action-2: This specification defines a new flag (B) to the Proxy
   Binding Acknowledgment message, specified in [RFC5213]. This flag
   is described in Section 4.2. The value of the flag (B) needs to
   be allocated from the Binding Acknowledgment Flags registry.

o Action-3: This specification defines a new Mobility Header option,
   the Mobile Node Group Identifier option. This option is described
   in Section 4.3. The Type value for this option needs to be
   assigned from the same numbering space as allocated for the other
   mobility options [RFC6275].

o Action-4: The Sub-type field of the Mobile Node Group Identifier
   option introduces a new number space. This number space needs to
   be managed by IANA, under the Registry, Mobile Node Group
   Identifier Type Registry. This specification reserves the sub-
   type value of (1) (Bulk Binding Update Group). Approval of new
   sub-type values are to be made through IANA Expert Review. The
   value range of this field is 0 through 255, but the values 0 and
   255 are marked as reserved. The remaining values 2-254 are
   available for allocation.

o Action-5: This document also defines a new status value
   INVALID_MOBILE_NODE_GROUP_IDENTIFIER (Invalid group identifier
   value in the request: IANA-5) for use in Proxy Binding
   Acknowledgement message, as described in Section 4.4. This value
   is to be assigned from the same number space as allocated for
   other Status codes [RFC6275]. The allocated value has to be
   greater than 128.

8. Security Considerations

The Mobile Node Group Identifier option defined in this specification
is for use in Proxy Binding Update and Proxy Binding Acknowledgement
messages. This option is carried like any other mobility header
option and it does not require any other special security
considerations.

The bulk binding update and the bulk revocation operations specified
in this document, perform operations on a group of mobility sessions.
If proper authorization checks are not in place, a malicious node may
be able to hijack a mobile node's mobility session or may carry out a
denial- of-service attack. To prevent this attack, this
specification requires the local mobility anchor to allow only
authorized mobile access gateways to perform bulk operations.

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