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**Bulk Re-registration for Proxy Mobile IPv6
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Abstract

Proxy Mobile IPv6 specification requires the Mobile Access Gateway (MAG) to send a separate Proxy Binding Update (PBU) message to the Local Mobility Agent (LMA) for each mobile node (MN) to renew the MN's mobility binding. This document defines a mechanism by which a MAG can update the mobility bindings of multiple MNs attached to it with a single PBU message to the serving LMA. This document also specifies a new mobility option that can be used by the mobility entities in a Proxy Mobile IPv6 domain for carrying the group affiliation of a mobile node in any of the mobility signaling messages.

Requirements Language

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](#)].

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1. Introduction

The Proxy Mobile IPv6 base specification [[RFC5213](#)] uses the mobile node identifier in the mobility signaling messages for identifying the mobile node. However, the signaling messages lack the capability to identify a set of mobile nodes which have a common characteristic. A group identifier associated with a mobile node enables the ability to perform protocol operation on a set of mobile nodes via a single transaction. The group identifier provides a more optimal mechanism for protocol operation which would otherwise require multiple atomic transactions on a per mobile node basis. Following are some of the use-cases where such identifier can be used.

- o In a blade architecture system running the local mobility anchor service, all the mobile node sessions anchored on a given card can be part of one single group. When there is a failure on a specific card, the local mobility anchor can initiate the revocation signaling to the mobile access gateway by sending a single revocation request carrying the group identifier.
- o For periodic re-registrations, the mobile access gateway may send a single re-registration message for each of the mobile nodes' groups and perform re-registrations for all the mobile node's that are part of that group.
- o The mobile access gateway or the local mobility anchor in a proxy mobile IPv6 domain may choose to revoke the registration of mobile node associated with a specific realm. In such cases the mobile access gateway or the local mobility anchor can perform the binding revocation signaling using the group ID associated with a specific set of mobile nodes.

The remainder of this document defines a new mobility option, Mobile Node Group Identifier option, that can be used by a local mobility anchor and a mobile access gateway for exchanging the mobile node's group identifier as well as its application for bulk periodic re-registrations.

2. Terminology

General mobility related terminology is defined in [[RFC3775](#)]. Additional PMIPv6 specific terminology can be found in [[RFC5213](#)].

PMIPv6 domain

Network providing the network based IP mobility service as defined in [[RFC5213](#)].

PMIPv6

Proxy Mobile IPv6 protocol specified in [[RFC5213](#)].

Bulk re-registration

PBU/PBAck message exchange where the bulk re-registration flag (B) is set to 1

Bulk re-registration set

a set of MNs identified by the Mobile Node Group ID option to which the bulk re-registration operation applies.

3. Bulk Re-registration Overview

3.1. Motivation for bulk re-registration

In a PMIPv6 domain a single LMA serves multiple MAGs and the capacity of the LMA in terms of the number of attached MNs can be quite large. It can be expected that LMA capacity in managed networks may easily exceed hundreds of thousands or more attached MNs.

The following simple formula gives an estimate of the average number of re-registration transactions per second as a function of the number of registered MNs and the binding lifetime period:

$$\text{transactions/sec} = (\text{number of registered MNs}) / (\text{binding lifetime} * 4)$$

For 50.000 MNs and the binding lifetime of half an hour this gives:
50000 MNs / 1800 sec = 27,7 transactions/sec

Based on the above formula it is apparent that the default re-registration process where the MAG sends a separate message for each MN is inefficient or suboptimal. These re-registration messages consume significant network resources both in terms of processing power at the LMA and MAG and network bandwidth.

This document proposes an optimization of the re-registration process by which the signaling load for re-registration can be reduced to a single transaction per MAG, irrespective of the number of attached MNs.

According to this proposal a MAG adds a MN to a set of MNs re-registered in a bulk mode by setting the bulk re-registration bit (B) in the PBU message. The PBU message sent in response contains the

Mobile Node Group Identifier mobility option which is defined later in this document. In the context of bulk re-registrations the Mobile Node Group Identifier is an opaque identifier that is allocated by the LMA and which uniquely identifies the bulk set to which the MN was added.

A MAG requests a bulk re-registration for a set of MNs by sending a single PBU message which includes a Mobile Node Group Identifier mobility option and the LMA extends the binding lifetime of MNs that are members of that group. By using this method, the MAG and LMA accomplish the re-registration of MNs attached to a MAG in a single transaction. The number of re-registration transactions at the LMA becomes independent of the number of attached MNs; instead it is dependent only on the number of MAGs.

In addition to minimizing the signaling overhead associated with the lifetime extension of the mobility bindings, the MAG and LMA may use a single timer per bulk re-registration set to monitor the binding lifetime of all the member MNs instead of an individual timer per MN.

3.2. Bulk re-registration operation

The bulk re-registration mechanism allows the MAG and the LMA to extend the binding lifetime for a number of MNs with a single transaction. The MAG and LMA maintain a set of MNs that can be re-registered in bulk mode. Such set is called a bulk re-registration set and is a subset of the MNs attached to a MAG. There can be multiple bulk re-registration sets for a given MAG-LMA pair. Initially the bulk re-registration set is empty. MAG requests to add individual MNs to the bulk set by sending a regular PBU message that identifies an individual MN and additionally the bulk registration flag in the message is set to 1. Based on the received bulk re-registration bit the LMA adds the MN to the bulk re-registration set and responds with the PBAck message with the bulk registration flag (B) set to 1. The LMA identifies the bulk re-registration set to which the MN was added by including the Mobile Node Group ID option in the PBAck message.

Once there is a non-empty bulk re-registration set, MAG can request to extend the binding lifetime for all MNs that are part of the bulk re-registration set by sending a PBU message with the bulk (B) bit set and by including the Mobile Node Group ID identify the bulk re-registration set. Such PBU message lacks any options that identify an individual MN. In particular, the MAG omits both the MN ID (Mobile Node Identifier) and the HNP (Home Network Prefix) options.

There may be different triggers that cause the MAG to request a bulk re-registration. Typically the trigger is the binding lifetime

expiry of a MN that is a member of a bulk re-registration set. There could be other triggers as well, but they may be implementation or domain specific and outside the scope of this specification.

When the MAG requests the MN to be added to the bulk re-registration set, the LMA includes the Mobile Node Group Identifier mobility option in the PBack message. The Mobile Node Group Identifier is an opaque identifier allocated by the LMA that uniquely identifies the bulk set at the LMA to which the MN was added. The MAG associates the MN with the Mobile Node Group Identifier received in the PBack.

The MAG includes the Mobile Node Group Identifier mobility option set to the value previously received from the LMA to request the bulk re-registration for the MNs that are part of this particular bulk re-registration set. The MAG may include multiple instances of the Mobile Node Group Identifier option in the PBU message to request lifetime refreshment for several bulk sets in a single message.

The LMA extends the mobility binding of all MNs that are members of indicated bulk re-registration sets and responds with PBack message echoing the received Mobile Node Group Identifier mobility options.

A MAG may remove a MN from a bulk re-registration set by sending a regular PBU message identifying the MN to be removed and with the bulk re-registration flag set to 0.

When requested to add a MN to the bulk re-registration set, the LMA may reject the request. In this case the LMA processes the PBU message as if the bulk re-registration flag was not set and responds with PBack message where the bulk re-registration flag is set to 0.

4. Message formats

This section introduces extensions to PBU and PBack messages used in this specification.

4.1. Proxy Binding Update message

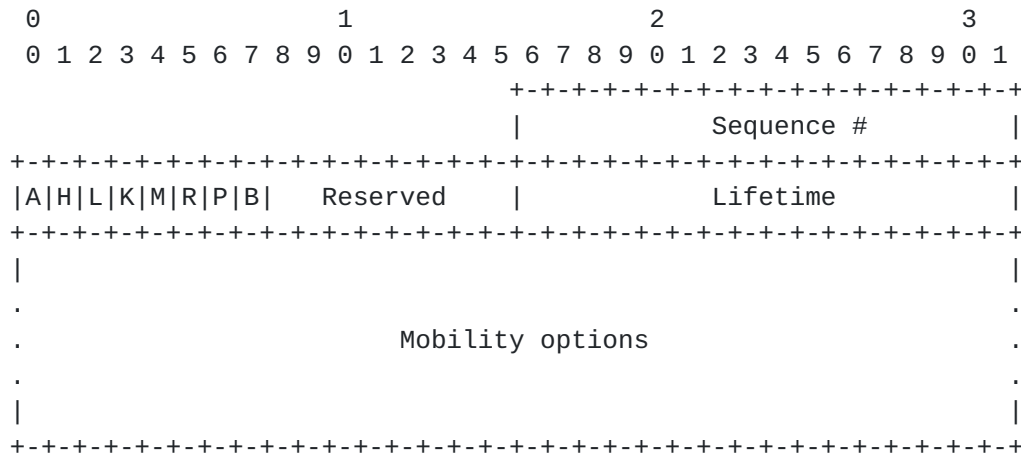


Figure 1

A Proxy Binding Update message is defined in the [RFC5213]. A new flag (B) is defined for the Binding Update message.

Bulk Registration Flag (B)

If the bulk registration flag (B) is set to 1, then the PBU message is a request to add the MN to the bulk re-registration set. If the bulk registration flag (B) is set to 0 and if the MN is found to be a member of the bulk re-registration set, then the MN is removed from the bulk re-registration set.

Mobility Options

For descriptions of the mobility options, refer to [RFC5213]. When the PBU message is sent to refresh bindings in a bulk mode, the message MUST contain at least one Mobile Node Group Identifier mobility option and does not contain the MN-ID and the HNP mobility options.

4.2. Proxy Binding Acknowledgment message

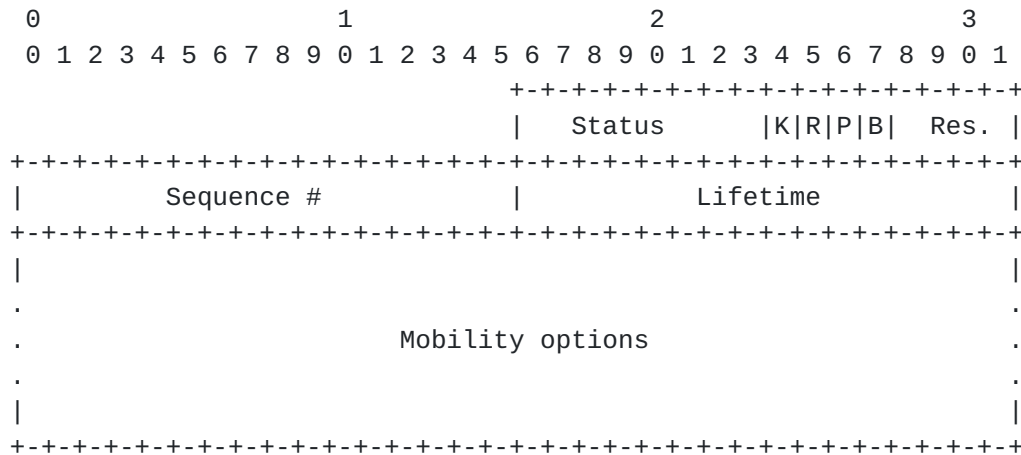


Figure 2: Proxy Binding Acknowledgment message

A Proxy Binding Acknowledgment message is defined in the [RFC5213]. A new flag (B) is defined for the Binding Acknowledgment message.

Bulk Registration Flag (B)

A new flag (B) is included in the Binding Acknowledgment message to indicate to the MAG that the MN was successfully added to the bulk re-registration set. The flag MUST NOT be set to the value of 1 if it was not set to 1 in the corresponding PBU message.

Mobility Options

For descriptions of these options, refer to [RFC5213]. When the bulk registration flag is set to 1 in the PBU message, then the PBAck message MUST also contain the Mobile Node Group Identifier mobility option. When the Mobile Node Group Identifier mobility option(s) were included in the PBU message, the PBAck message echoes back the Mobile Node Group Identifier options from the PBU message.

4.3. Mobile Node Group Identifier Option

A new option, Mobile Node Group Identifier option is defined for using it in Proxy Binding Update and Proxy Binding Acknowledgement messages exchanged between a local mobility anchor and mobile access gateway. This option is used for carrying the mobile node's group identifier.

The alignment requirement for this option is 4n.

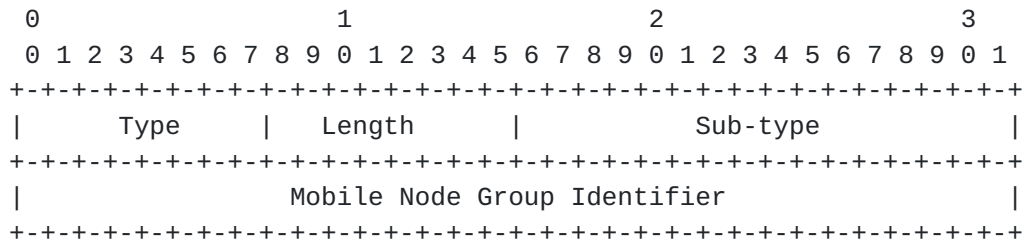


Figure 3: Mobile Node Group Identifier Option

Type

<IANA>

Length

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

Sub-type

Identifies the specific group type. This number space will be managed by the IANA.

Reserved

This 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 A 32-bit field containing the mobile node's group identifier.

The Mobile Node's Group Identifier option reflects the group affiliation that is local to the LMA or MAG, as determined by those respective entities.

5. MAG Operation

The conceptual Binding Update List entry data structure maintained by the MAG, described in [Section 6.1 of \[RFC5213\]](#), MUST be extended to store the mobile node's group identifier.

The Mobile Node Group Identifier option MAY be used in the PBU message sent by the MAG to the LMA. When this option is included, the identifier value in the option MUST be set to the mobile node's group identifier that was assigned previously by the LMA.

When a new MN attaches to a MAG, the MAG registers the MN with the LMA by sending the PBU message formatted as described in [\[RFC5213\]](#).

Additionally, the MAG MAY set the bulk registration flag (B) in the PBU message to 1 to request the LMA to add the MN to the bulk registration set. The decision to request the bulk re-registration mode for a MN is a matter of local policy at the MAG and is outside the scope of this specification.

The MAG SHALL maintain a separate bulk re-registration sets for each LMA.

The MAG SHALL add the MN to its bulk re-registration set when it receives a PBAck message with the bulk registration bit set to 1 and if the corresponding PBU message was requesting the LMA to add the MN to the bulk re-registration set. The MAG SHALL associate the MN being registered with the Mobile Node Group Identifier received in the PBAck message.

When the binding lifetime of any MN contained in the bulk re-registration set is about to expire, the MAG SHALL request the bulk re-registration by sending the PBU message containing the Mobile Node Group Identifier mobility option. The length of the Mobile Node Group Identifier option may be 0 in which case the MAG is requesting a refreshment of the binding lifetime for all MN attached to that MAG that were registered with the B flag set. Alternatively, the MAG MAY include one or more Mobile Node Group Identifier options containing the values that were indicated by the LMA in the PBAck messages when the MN was added to the bulk set. In this case the MAG asks for refreshment of specific bulk sets indicated by the Mobile Node Group Identifier options. The MAG SHALL NOT include the MN ID and the HNP options in the PBU message requesting bulk refreshment.

The MAG MAY trigger a bulk re-registration at any time. The policy and exact conditions for these additional triggers are outside of scope of this specification.

When the MAG receives a PBAck message indicating success and which echoes the Mobile Node Group Identifier options that were included in the corresponding PBU message, the MAG SHALL update the binding lifetime of all MNs belonging to the indicated groups to the lifetime value contained in the PBAck message. If in the case of bulk re-registration the PBAck message repeatedly indicates an error, the MAG SHALL fall back to individual re-registration mode.

Instead of maintaining one timer per MN, the MAG MAY start a single timer per bulk registration set to oversee the binding lifetime of all MNs that are members of that bulk registration set.

If the MAG sets the bulk re-registration bit to 1 in a PBU message but the bulk registration bit (B) is set to 0 in a PBAck message, the

MAG SHALL process the PBAck message as per [RFC5213]. In addition, the MAG SHALL infer that the LMA does not support bulk re-registration procedure. The MAG SHALL switch to regular, per-MN re-registration mode as described in [RFC5213]. The MAG MAY retry the bulk re-registration procedure after sufficient time has elapsed from the previous unsuccessful bulk re-registration. This amount of time SHOULD be configurable at the MAG.

6. LMA operation

The conceptual Binding Cache entry data structure maintained by the LMA, described in [Section 5.1 of \[RFC5213\]](#), MUST be extended to store the mobile node's group identifier.

The Mobile Node Group Identifier option MAY be used in the PBAck message sent by the LMA to the MAG. When this option is included, the identifier value in the option MUST be set to the mobile node's group identifier, local to the local mobility anchor.

When the LMA receives a PBU message with a bulk registration bit (B) set to 1, the LMA SHALL first process the PBU message as per [RFC5213]. Upon successful processing of the message, the LMA SHALL perform additional processing of the PBU message as described further below for bulk mode re-registrations.

If the bulk re-registration flag in the PBU message is set to 1, the LMA MAY add the MN(s) indicated in the PBU to the set of MNs re-registered in a bulk mode, subject to the local policy. The decision whether to enable bulk re-registration mode is a matter of local policy at the LMA and is outside the scope of this specification.

If the LMA decides to accept the bulk re-registration mode for the MN, it SHALL add the MN to a bulk re-registration set. The LMA SHALL maintain distinct bulk re-registrations set for each MAG and there could be several such sets per single MAG.

Upon adding the MN to the bulk re-registration set, the LMA SHALL respond with the PBAck message containing the bulk registration bit set to 1. The LMA SHALL include the Mobile Node Group Identifier option in the PBAck message. The Mobile Node Group Identifier is allocated by the LMA and identifies the particular bulk set to which the MN is assigned.

The PBU message without the MN ID and HNP options but including the Mobile Node Group Identifier mobility option is a valid message and indicates a request for bulk mode re-registration of all MNs that are members of the indicated bulk re-registration set. There MAY be

several Mobile Node Group Identifier options in the PBU message, in which case the MAG requests the bulk refreshment of all MNs that are members of the indicated bulk sets. If the length of the Mobile Node Group Identifier option is zero, the MAG is requesting a lifetime refreshment of all the MN attached to the MAG that are members of any bulk set. The LMA SHALL extend the binding lifetime of all affected MNs attached to the MAG that sent the bulk PBU.

The LMA SHALL set the binding lifetime of all MNs re-registered in a bulk mode to expire at the same point in time.

Upon successful processing of bulk mode re-registration request, the LMA MUST respond with a PBAck message indicating success and echoing the mobility options received from the PBU. The lifetime in the PBAck message indicates the time when binding cache entries of affected MNs will expire.

The LMA MAY reject the request for bulk re-registration. In this case the LMA MUST NOT update binding cache entries of any MNs and SHALL respond with PBAck indicating the reason for the rejection in the status code.

After successfully processing the bulk PBU message, the LMA SHOULD start a single timer to oversee the binding lifetime of all MNs affected by this bulk re-registration transaction.

The LMA not supporting this specification ignores the bulk re-registration bit (B) and the Mobile Node Group Identifier option in a PBU message and processes the message as per the baseline specification [[RFC5213](#)]. In this case the PBAck message sent in response contains the bulk re-registration bit (B) set to 0.

If the LMA that does not support this specification receives a bulk PBU message that does not contain any options identifying a particular MN then the LMA responds with the PBAck message where the status field contains one of the following error codes:

MISSING_HOME_NETWORK_PREFIX_OPTION

MISSING_MN_IDENTIFIER_OPTION

These error codes are defined in the baseline specification [[RFC5213](#)].

7. IANA Considerations

This specification defines a new Mobility Header option, the Mobile

Node Group Identifier option. This option is described in section Figure 3. The Type value for this option needs to be assigned from the same numbering space as allocated for the other mobility options, as defined in [[RFC3775](#)].

Note to RFC Editor: this section may be removed on publication as an RFC.

8. Security Considerations

The mobile node's identifier is always present in the Proxy Mobile IPv6 signaling messages and additionally carrying the group identity of the mobile node introduces similar vulnerabilities. Specifically, it exposes the group affiliation of the user and may result in compromising the privacy of the user or the location information.

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 as specified in [[RFC3775](#)] and does not require any special security considerations.

The bulk re-registration mechanism does not introduce any new security threat or vulnerability to the PMIPv6 specification.

9. Acknowledgements

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10.2. Informative References

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