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Binding Revocation for IPv6 Mobility
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Abstract

This document defines a binding revocation mechanism to terminate a mobile node's mobility session and the associated resources. These semantics are generic enough and can be used by mobility entities in the case of Mobile IPv6 and its extensions. This mechanism allows the mobility entity which initiates the revocation procedure to request its corresponding one to terminate either one, multiple or all specified binding cache entries.

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1. Introduction

In the case of Mobile IPv6 and for administrative reason, sometimes it becomes necessary to inform the mobile node that its registration has been revoked and the mobile node is no longer able to receive IP mobility service using its Home Address. A similar Mobile IPv4 registration revocation mechanism [[RFC3543](#)] has been specified by IETF for providing a revocation mechanism for sessions that were established using Mobile IPv4 registration [[RFC3344](#)].

This document specifies a binding revocation mechanism that can be used to revoke a mobile node's mobility session(s). The same mechanism can be used to revoke bindings created using Mobile IPv6 [[RFC3775](#)] or any of its extensions, e.g. Proxy Mobile IPv6 [[RFC5213](#)]. The proposed revocation mechanism uses a new MH type <IANA-TBD> for revocation signaling which is applicable to Mobile IPv6 [[RFC3775](#)] and Proxy Mobile IPv6 [[RFC5213](#)] and can be used by any two IP mobility entities. As an example, this mechanism allows a local mobility anchor (LMA), involved in providing IP mobility services to a mobile node, to notify the mobile access gateway (MAG) of the termination of a mobile node binding registration. In another example, a mobile access gateway can use this mechanism to notify its local mobility anchor peer with a bulk termination of all or a subset of proxy mobile IPv6 (PMIPv6) bindings that are registered with the local mobility anchor and currently being served by the mobile access gateway.

2. Conventions & Terminology

2.1. Conventions used in this document

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](#)].

2.2. Terminology

All the general mobility related terminology and abbreviations are to be interpreted as defined in Mobile IPv6 [[RFC3775](#)] and Proxy Mobile IPv6 [[RFC5213](#)] specifications.

3. Binding Revocation Protocol and Use Cases Overview

This specification specifies a generic binding revocation mechanism where a mobility node can communicate to the mobile node or another mobility node the identity of the the mobile node registration

binding that is being terminated. In the case when this mechanism is used for bulk termination or multiple bindings, the identities of these bindings are communicated to the mobile node or mobility node using the same generic mechanism. The following subsections describe the protocol overview and applicable use cases.

3.1. Binding Revocation Protocol

In the case of Mobile IPv6, if the home network decides to terminate the service of the mobile node, the home agent sends a Binding Revocation Indication (BRI) message to the mobile node. The home agent includes the home address (HoA) of the mobile node in the Type 2 routing header as specified in [\[RFC3775\]](#) to indicate the impacted mobile node binding. In the case of Dual Stack Mobile IPv6 (DSMIPv6) [\[RFC5555\]](#), the home agent may include the IPv4 Home Address option with the mobile node assigned home IPv4 address. Additionally, if the mobile node registered multiple care-of addresses [\[ID-MCoA\]](#), the home agent includes the Binding Identifier (BID) option(s) in the Binding Revocation Indication message to identify which binding is being revoked. When the mobile node receives a Binding Revocation Indication message with its HoA included in the Type 2 routing header and the Acknowledge (A) bit is set, the mobile node responds by sending a Binding Revocation Acknowledgement (BRA) message.

Similarly, in the case of Proxy Mobile IPv6 [\[RFC5213\]](#), the revocation procedure can be initiated by the local mobility anchor by sending a Binding Revocation Indication message to communicate the termination of a mobile node registration binding to the mobile access gateway. In this case, the local mobility anchor includes the mobile node Home Network Prefix (MN-HNP) option [\[RFC5213\]](#) and the MN-ID option [\[RFC4283\]](#) to indicate to the mobility access gateway the identity of the PMIPv6 binding that needs to be terminated. When the mobile access gateway receives the Binding Revocation Indication message with the Acknowledge (A) bit set, the mobile access gateway responds to the local mobility anchor by sending a Binding Revocation Acknowledgement message.

On the other hand, the mobile access gateway usually sends a de-registration message by sending a Proxy Binding Update with a lifetime of zero to indicate to the local mobility anchor of the termination of the PMIPv6 mobile node binding registration. In this case, the mobile access gateway includes the MN-HNP option, the MN-ID option and all other required mobility options as per [\[RFC5213\]](#) in order for the local mobility anchor to identify the mobile node PMIPv6 binding. Additionally, in the case when the mobile access gateway communicates a bulk termination of PMIPv6 mobility sessions, the mobile access gateway sends a Binding Revocation Indication message with the Global (G) and Acknowledge (A) bits set and includes

the mobile access gateway identity in the MN-ID option. When the local mobility anchor receives such Binding Revocation Indication message, it ensures that the mobile access gateway is authorized to send such bulk termination message and then processes the Binding Revocation Indication message accordingly. If the local mobility anchor processes the Binding Revocation Indication message successfully, the local mobility anchor responds to the mobile access gateway by sending Binding Revocation Acknowledgement message.

In any of the above cases, the initiator of the binding revocation procedure, e.g., home agent, local mobility anchor, mobile access gateway, uses the Revocation Trigger field in the Binding Revocation Indication message to indicate to the receiving node the reason for initiating the revocation procedure.

3.2. MIPv6 and DSMIPv6 Use Case

Binding revocation mechanism is applicable to Mobile IPv6 and DSMIPv6 session(s) when the home agent needs to inform the mobile node that its binding registration has been revoked, e.g. for an administrative reason. This mechanism enables the user to react to the revocation, e.g., reinstate its interrupted Mobile IPv6 services.

In this case, the home agent sends a Binding Revocation Indication message to indicate to the mobile node that its current mobile IPv6 (MIPv6) binding has been revoked and it no longer able to receive IP mobility service. The home agent includes the HoA in Type 2 routing header as used in [[RFC3775](#)] and sets the Revocation Trigger field to a proper value, e.g., Administrative Reason. In the case of DSMIPv6 session, the home agent may additionally include the mobile node assigned IPv4 Home Address in the IPv4 Home Address option. When the mobile node receives the Binding Revocation Indication message, it sends a Binding Revocation Acknowledgement message as described in [Section 11.2](#) to the home agent. Figure 1 illustrates the message sequencing when home agent revokes a mobile node binding registration.

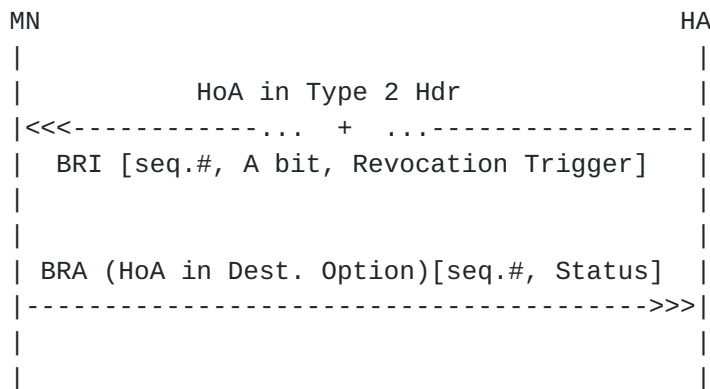


Figure 1: Home Agent Revokes a Mobile Node Binding Registration

3.3. Multi-Care of Addresses (Monami6) Use Case

In the case of multiple care-of addresses registration [[ID-MCoA](#)], the home agent maintains different binding for each pair of care-of address and home address. These bindings are also indexed and identified during the mobile node registration using a BID mobility option. The HA may revoke one or multiple bindings for the same mobile node home address.

If the home agent revokes a single binding for a mobile node with multiple care-of addresses registration, the home agent sends a Binding Revocation Indication message to the mobile node with the corresponding BID option included. If more than one of the mobile node registered care-of addresses need to be revoked, the home agent includes all the corresponding BID options in the same Binding Revocation Indication message. Figure 2 illustrates the message flow when the home agent revokes two registered Care-of addresses for the same mobile node in a single Binding Revocation Indication message.

When the mobile access gateway receives a Binding Revocation Indication message as in [Section 10.1.1](#), the mobile access gateway sends a Binding Revocation Acknowledgement message to the local mobility anchor following the rules described in [Section 10.1.2](#). Similarly, if the local mobility anchor receives a Binding Revocation Indication message with the Acknowledge (A) bit is set, the local mobility anchor responds to the mobile access gateway by sending a Binding Revocation Acknowledgement message.

3.4.1. Local Mobility Anchor Initiates PMIPv6 Binding Revocation

The local mobility anchor may send a Binding Revocation Indication message to the mobile access gateway, hosting a specific PMIPv6 binding, with the appropriate value in the revocation trigger field to indicate that the mobile node binding has been terminated and the mobile access gateway can clean up the applicable resources. When the mobile access gateway receives a Binding Revocation Indication message, the mobile access gateway identifies the respected binding and if the Acknowledge (A) bit was set in the received Binding Revocation Indication message, it sends a Binding Revocation Acknowledgement message to the local mobility anchor. In this case, the mobile access gateway could send a Router Advertisement message to the mobile node with the home network prefix valid lifetime set to zero.

As an example, Figure 3, illustrates the message sequence for revoking a mobile node binding at the source mobile access gateway during the mobile node inter-MAG handover. During the inter-MAG handover, the mobile node moves from the source MAG to the target MAG. The target MAG sends a Proxy Binding Update with the new care-of-address to the local mobility anchor to update the mobile node's point of attachment. Since the mobile node binding at the local mobility anchor points to the source MAG and upon receiving the Proxy Binding Update from the target MAG, the local mobility anchor updates the MN BCE and send a Proxy Binding Acknowledgement to the target MAG. The local mobility anchor can send a Binding Revocation Indication message with the appropriate revocation trigger value, e.g. inter-MAG handover - different Access Types, to the source MAG in order to clean up the applicable resources reserved for the specified mobile node binding. The mobile access gateway acknowledges the Binding Revocation Indication message by sending a Binding Revocation Acknowledgement message to indicate the success or failure of the termination of the mobile node's binding.

The process identified above can also be used by the local mobility anchor in scenarios other than the inter-MAG handover with the proper revocation trigger value to indicate to the peer mobile access gateway that a specific PMIPv6 binding or bindings have been revoked.

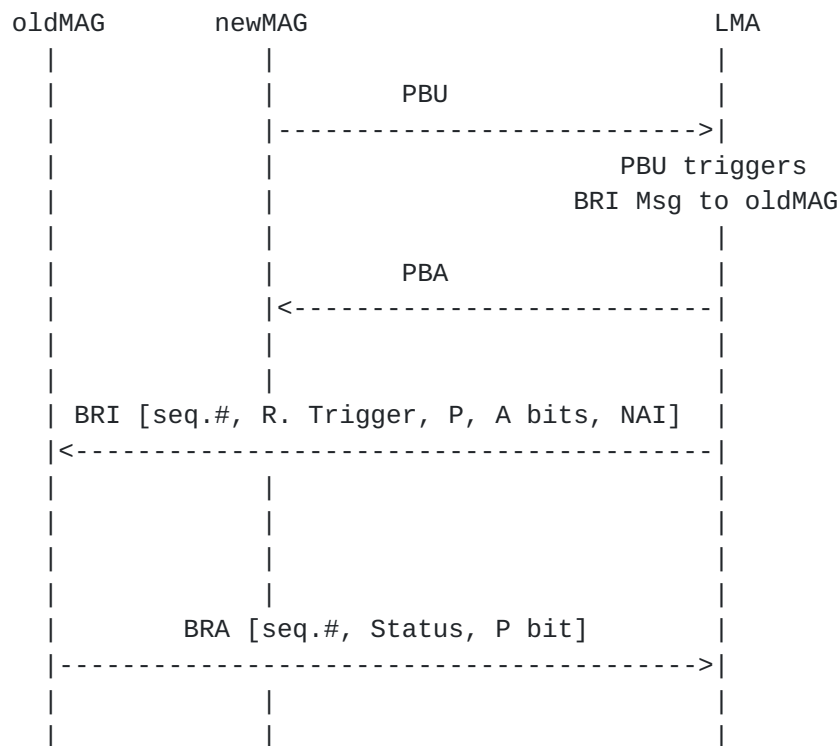


Figure 3: LMA Revokes a MN Registration During Inter-MAG Handover

In addition, the local mobility anchor can send a Binding Revocation Indication message to indicate that all bindings which are hosted by the peer mobile access gateway and registered with the local mobility anchor are being revoked by setting the Global (G) bit as described in [Section 9.1.1](#).

3.4.2. Mobile Access Gateway Revokes Bulk PMIPv6 Bindings

The mobile access gateway sends a BRI message with the Global (G) bit is set to indicate that all mobility bindings which are registered at the local mobility anchor and attached to the mobile access gateway are being revoked as in [Section 10.2.1](#). When the local mobility anchor receives a Binding Revocation Indication message with the Global (G) bit is set from a specified mobile access gateway, the local mobility anchor first checks if the mobile access gateway is authorized to use global revocations and then responds with the appropriate status code by sending a Binding Revocation Acknowledgement message as in [Section 9.2.2](#).

4. Security Model

The binding revocation protocol described here uses the same security association between the mobile node and the home agent or the mobile access gateway and the local mobility anchor that has been used to exchange the corresponding MIPv6 or PMIPv6 Binding Update and Binding Acknowledgement when the mobile node binding was created. If IPsec is used, the traffic selectors associated with the SPD entry protecting the Binding Update and Binding Acknowledgement MUST be extended to include Binding Revocation Signaling MH type <IANA-TBD>. Extending the traffic selectors of the SPD entry in order to reuse the SA protecting Binding Update and Binding Acknowledgement (instead of creating new ones) ensures that those SA will be up and running when the revoking entity needs to send a binding revocation signaling message.

Additionally, in the case when the local mobility anchor receives a Binding Revocation Indication which indicates a bulk termination where the Global (G) bit is set and the Revocation Trigger field is set to "Per-Peer Policy", the local mobility anchor MUST verify that the mobile access gateway sending the binding revocation indication message is authorized to invoke global revocation.

5. Binding Revocation Messages over IPv4 Transport Network

In some deployments, the network between the mobile access gateway and the local mobility anchor may only support IPv4 transport. Another case is when a mobile node which supports client mobile IPv6 roams to an access network where only IPv4 addressing and transport is supported. In this case, the mobile node is required to register an IPv4 home address with its home agent using a mobile IPv6 Binding Update message.

If the Proxy Binding Update and Proxy Binding Acknowledgement messages or the Binding Update and Binding Acknowledgement messages are sent using UDP encapsulation to traverse NATs, then the Binding Revocation messages are sent using the same UDP encapsulation. The same UDP source and destination port numbers and IPv4 addresses used for exchanging the Proxy Binding Update and Proxy Binding Acknowledgement or the Binding Update and Binding Acknowledgement messages will also be used when transporting Binding Revocation messages over IPv4 using UDP encapsulation. For example, the source UDP port number, the destination UDP port number, the source IPv4 address, and the destination IPv4 address of the Binding Revocation Indication message MUST be set to the destination UDP port number, the source UDP port number, destination IPv4 address, and source IPv4 address of the latest successfully processed Proxy Binding Update or

Binding Update message received, respectively. For more details on tunneling Proxy Mobile IPv6 and Mobile IPv6 signaling messages over IPv4, see [[ID-PMIPv6-IPv4](#)] and [[RFC5555](#)], respectively.

6. Binding Revocation Message

This section defines the Binding Revocation Message format using a MH Type <IANA-TBD> as illustrated in Figure 4. The value in the Binding Revocation Type field defines whether the Binding Revocation message is a Binding Revocation Indication or Binding Revocation Acknowledgement. If the Binding Revocation type field is set to 1, the Binding Revocation Message is a Binding Revocation Indication as in [Section 6.1](#). However, if the value is 2, it is a Binding Revocation Acknowledgement message as in [Section 6.2](#).

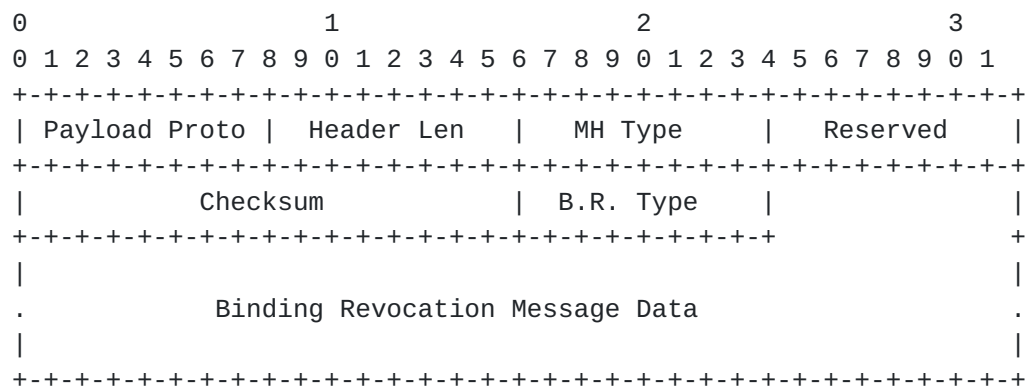


Figure 4: Binding Revocation Message

MH Type

<IANA-TBD> which identifies the mobility message as a Binding Revocation message.

Reserved

8-bit field reserved for future use. The value MUST be initialized to zero by the sender, and MUST be ignored by the receiver.

Checksum

16-bit unsigned integer. This field contains the checksum of the Mobility Header. The checksum is calculated as described in [\[RFC3775\]](#).

Binding Revocation Type

8-bit unsigned integer. It defines the type of the Binding Revocation Message. It can be assigned one of the following values:

- 0 Reserved
- 1 Binding Revocation Indication Message
- 2 Binding Revocation Acknowledgement Message
- All other values are reserved

Binding Revocation Message Data

The Binding Revocation Message Data follows the Binding Revocation Message format that is defined in this document for the specified value in the Binding Revocation Type field. In this specification, it is either a Binding Revocation Indication as in [Section 6.1](#) or Binding Revocation Acknowledgement as in [Section 6.2](#).

6.1. Binding Revocation Indication Message

The Binding Revocation Indication (BRI) message is a Binding Revocation Message which has a MH type <IANA-TBD> and a Binding Revocation Type value of 1. It is used by the revoking mobility node to inform the receiving mobility entity of the identity of a specific binding or bindings which IP mobility service have been revoked. Binding Revocation Indication message is sent as described in [Section 8.1](#), [Section 9.1.1](#), and [Section 10.2.1](#).

When the value 1 is indicated in the B. R. type field of the Binding Revocation Message, the format of the Binding Revocation Message Data follows the Binding Revocation Indication message as in Figure 5

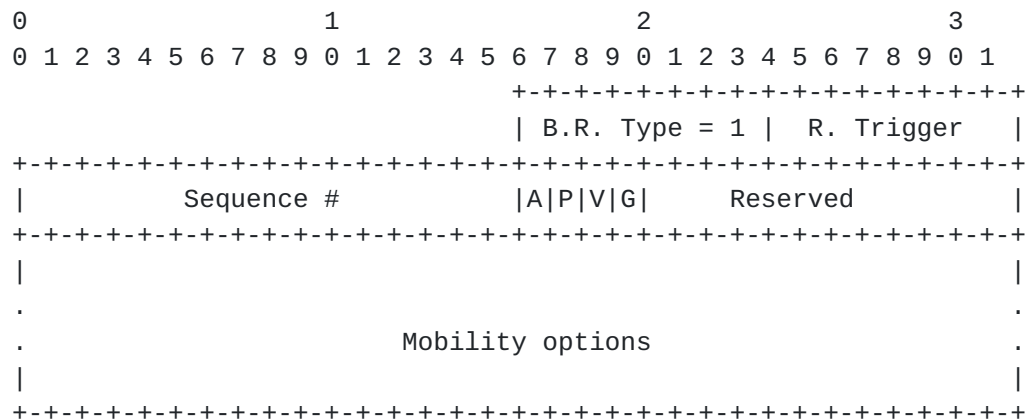


Figure 5: Binding Revocation Indication Message

Revocation Trigger

8-bit unsigned integer indicating the event which triggered the revoking node to send the BRI message. The Reserved and Per-MN Revocation Triggers value are less than 128 except the reserved values 250-255. The per-MN revocation triggers is used when the BRI message intends to revoke one or more bindings for the same mobile node. The Global Revocation Trigger values are greater than 128 and less than 250 and used in the BRI message with the Global (G) bit set for global revocation. The following Revocation Trigger values are currently defined:

Reserved and Per-MN Revocation Trigger:

- 0 Reserved
- 1 Unspecified
- 2 Administrative Reason
- 3 Inter-MAG Handover - same Access Type
- 4 Inter-MAG Handover - different Access Type
- 5 Inter-MAG Handover - Unknown
- 6 User Initiated Session(s) Termination
- 7 Access Network Session(s) Termination
- 8 Possible Out-of Sync BCE State
- 250-255 Reserved For Testing Purposes only
- All other values are Reserved

Global Revocation Trigger:

- 128 Per-Peer Policy
- 129 Revoking Mobility Node Local Policy

Sequence

A 16-bit unsigned integer used by the sending mobility node to match a returned Binding Revocation Acknowledgement with this Binding Revocation Indication. It could be a random number.

Acknowledge (A)

The Acknowledge (A) bit is set by the sending mobility node, e.g. LMA, HA, or MAG, to request a Binding Revocation Acknowledgement be returned upon receipt of the Binding Revocation Indication as in [Section 8.1](#), [Section 9.1.1](#), and [Section 10.2.1](#).

Proxy Binding (P)

The Proxy Binding (P) bit is set by the sending mobility node to indicate that the revoked binding(s) is a PMIPv6 binding.

IPv4 HoA Binding Only (V)

The IPv4 HoA Binding Only (V) bit is set by the sending mobility node, home agent or local mobility anchor, to request the receiving mobility entity the termination of the IPv4 Home Address binding only as in [Section 8.1](#), and [Section 9.1.1](#).

Global (G)

The Global (G) bit is set by the sending mobility node, LMA or MAG, to request the termination of all Per-Peer mobility Bindings or Multiple Bindings which share a common identifier that are served by the sending and receiving mobility entities as in [Section 9.1.1](#) and [Section 10.2.1](#).

Reserved

These fields are unused. They MUST be initialized to zero by the sender and MUST be ignored by the receiver.

Mobility Options

Variable-length field of such length that the complete Mobility Header is an integer multiple of 8 octets long. This field contains zero or more TLV-encoded mobility options. This document does not define any new mobility option. The receiver MUST ignore and skip any options which it does not understand. These mobility

option(s) are used by the receiving mobility entity to identify the specific binding or bindings that the sending mobility entity requesting to be revoked.

The following options are valid in a Binding Revocation Indication:

- o Home Network Prefix option [[RFC5213](#)]. This option MAY be used when the (P) bit is set. This option MUST be present when the BRI is used to revoke a single PMIP binding cache entry.
- o Mobile Node Identifier Option [[RFC4283](#)]. This option is mandatory when the (P) bit is set. Additionally, if the Global (G) bit is set by the mobile access gateway, this option carries the MAG identity.
- o Binding Identifier mobility option [[ID-MCoA](#)]. This option is mandatory if the sending mobility entity requests to terminate one binding of a multi care-of addresses bindings for the same mobile node. The sending mobility entity may include more than one of the BID mobility options.
- o IPv4 Home Address option which contains the mobile node home IPv4 address [[RFC5555](#)]. This option is included only when the IPv4 HoA Binding only (V) bit is set.
- o Alternate Care-of Address mobility option [[RFC3775](#)]. This option MAY be included to indicate the Care-of Address of the mobile node's binding that is being revoked. In the case when the Global (G) bit set, this option identifies all the mobility bindings that share the same care-of address. Additionally, if the Global (G) bit set, more than one Alternate Care-of Address mobility options MAY be present in the Binding Revocation Indication message.

If no options are present in this message, 4 octets of padding are necessary and the Header Len field of the Binding Revocation Message will be set to 1.

[6.2.](#) Binding Revocation Acknowledgement Message

The Binding Revocation Acknowledgement (BRA) message is a Binding Revocation Message which has a MH type <IANA-TBD> and a Binding Revocation Type value of 2. It is used to acknowledge the receipt of a Binding Revocation Indication message described in [Section 6.1](#). This packet is sent as described in [Section 9.2.2](#), [Section 10.1.2](#), and [Section 11.2](#).

When the value 2 is indicated in the Binding Revocation type field of the Binding Revocation Message, the format of the Binding Revocation

Message Data follows the Binding Revocation Acknowledgement message as in Figure 6

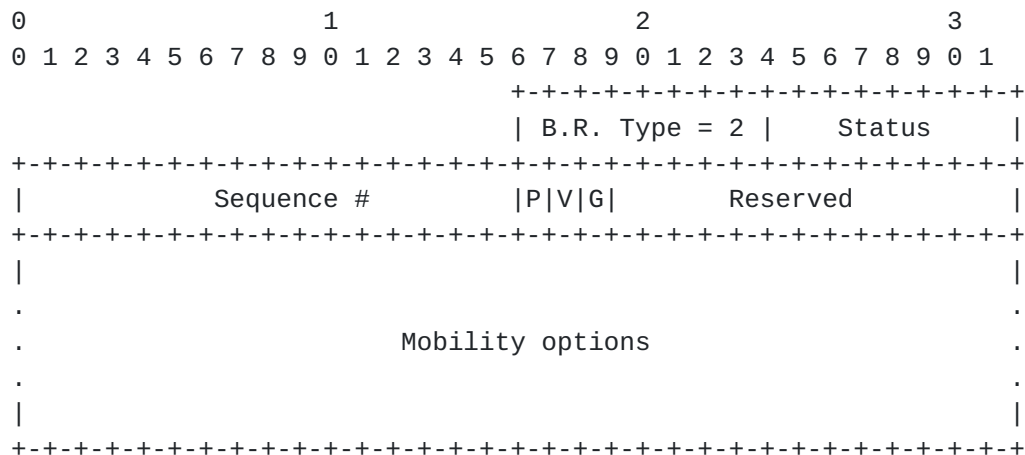


Figure 6: Binding Revocation Acknowledgement Message

Status

8-bit unsigned integer indicating the result of processing the Binding Revocation Indication message by the receiving mobility entity. Values of the Status field less than 128 indicate that the Binding Revocation Indication was processed successfully by the receiving node. Values greater than or equal to 128 indicate that the Binding Revocation Indication was rejected by the receiving node. The following status values are currently defined:

- 0 success
- 1 partial success
- 128 Binding Does NOT Exist
- 129 IPv4 Home Address Option Required
- 130 Global Revocation NOT Authorized
- 131 Revoked Mobile Nodes Identity Required
- 132 Revocation Failed - MN is Attached
- 133 Revocation Trigger NOT Supported
- 134 Revocation Function NOT Supported

Sequence

The sequence number in the Binding Revocation Acknowledgement is copied from the Sequence Number field in the Binding Revocation Indication. It is used by the revoking mobility entity, e.g., HA, LMA, MAG, in matching this Binding Revocation Acknowledgement with the outstanding Binding Revocation Indication.

Proxy Binding (P)

The Proxy Binding (P) bit is set if the (P) bit is set in the corresponding Binding Revocation Indication message.

IPv4 HoA Binding Only (V)

The IPv4 HoA Binding Only (V) bit is set if the (V) bit is set in the corresponding Binding Revocation Indication message.

Global (G)

The Global (G) bit is set if the (G) bit is set in the corresponding Binding Revocation Indication message.

Reserved

These fields are unused. They MUST be initialized to zero by the sender and MUST be ignored by the receiver.

Mobility Options

Variable-length field of such length that the complete Mobility Header is an integer multiple of 8 octets long. This field contains zero or more TLV-encoded mobility options. In the case when the Status field is set to success, no mobility option is required. The mobility option(s) is usually used to communicate information of the bindings that failed the revocation procedure.

The following mobility options are valid in a Binding Revocation Acknowledgement:

- o Home Network Prefix option [[RFC5213](#)]. This option MAY be included when the (P) bit is set.
- o Mobile Node Identifier Option [[RFC4283](#)]. This option MAY be included when the (P) bit is set. This option SHOULD be included if the Home Network Prefix option is included.

- o Binding Identifier mobility option [[ID-MCoA](#)]. This option MAY be included to indicate the specific BID that the receiving node failed to revoke.

If no options are present in this message, 4 octets of padding are necessary and the Header Len field of the Binding Revocation Message will be set to 1.

[7.](#) Binding Revocation Process Operation

The following subsections describe the details of the binding revocation generic process by the different mobility entities.

[7.1.](#) Sending Binding Revocation Messages

When sending a Binding Revocation message, the sending mobility node, initiator, constructs the packet as it would any other Mobility Header with the exception of setting the MH Type field to <IANA-TBD>.

In addition, the mobility entity which initiates the binding revocation process by sending a Binding Revocation Indication message, initiator, MUST construct the Binding Revocation Message Data following the format of the Binding Revocation Indication message as described in [Section 6.1](#). In the BRI message, the initiator MUST set the Sequence Number field to the next sequence number available for Binding Revocation. Since sending Binding Revocation Indication message is not done on a regular basis, a 16 bit sequence number field is large enough to allow the initiator to match the Binding Revocation Acknowledgement to the outstanding Binding Revocation Indication with Acknowledge (A) bit set using the sequence number field only.

However, when the responder acknowledges the Binding Revocation Indication message, the responder MUST construct the Binding Revocation message packet as it would any other Mobility Header with the exception of setting the MH Type field to <IANA-TBD>. It also MUST construct the Binding Revocation Message Data following the format of the Binding Revocation Acknowledgement message as described in [Section 6.2](#). In this case, the responder MUST set the Sequence Number field by copying the value from the Sequence Number field of the received Binding Revocation Indication. Additionally, it MUST set the status field to a valid value that reflects the processing of the received Binding Revocation Indication.

A mobility entity MUST secure Binding Revocation Indication and Binding Revocation Acknowledgement messages with the same underlying security association, e.g., IPsec SA, that has been used to secure the mobile node binding registration signaling.

7.2. Receiving Binding Revocation Messages

When receiving a Binding Revocation message, the receiving mobility node MUST verify the Mobility Header as described in [section 9.2. of \[RFC3775\]](#). If the packet is dropped due to failing any of the Mobility Headers test check, the receiving node MUST follow the processing rules as in [Section 9.2 of \[RFC3775\]](#). If the receiving node does not support the Binding Revocation Indication message and does not recognize the new MH type, it sends a Binding Error message with the Status field set to 2 as described in [\[RFC3775\]](#).

Since some mobility entities, e.g., local mobility anchor and mobile access gateway, are allowed to receive and possibly send a Binding Revocation Indication or Binding Revocation Acknowledgement for different cases, therefore, if IPsec is used to secure signaling between the local mobility anchor and mobile access gateway, it prevents any of them from processing a Binding Revocation message that was not constructed by an authorized party.

Upon receiving a packet carrying a Binding Revocation Indication or Binding Revocation Acknowledgement, the receiving mobility entity verifies that the packet was received protected with the security association that has been used during the binding registration signaling phase, e.g., an IPsec SA.

Upon receiving a packet carrying a Binding Revocation Acknowledgement, the receiving mobility entity, initiator, MUST validate that sequence number in the Sequence Number field matches the sequence number of an outstanding Binding Revocation Indication that was sent by the initiator. If the sequence number does not match any sequence number of any of the outstanding Binding Revocation Indication, the receiving node MUST silently discard the message but MAY log the event.

If a mobility node receives a Binding Revocation Indication message with the Revocation Trigger field is set to a value that NOT supported, the receiving mobility node SHOULD reject the Binding Revocation Indication message by sending a Binding Revocation Acknowledgement message with the Status field set to "Revocation

Trigger NOT Supported".

If a mobility node receives a Binding Revocation Indication message with a Revocation Trigger value that is NOT in line with the Binding Revocation Indication message intent, e.g., the Global (G) bit set and the Revocation Trigger field value is a per-MN specific, the receiving mobility node SHOULD reject the Binding Revocation Indication message by sending a Binding Revocation Acknowledgement message with the Status field set to "Revocation Function NOT Supported".

7.3. Retransmission of Binding Revocation Indication

If the sending mobility entity does not receive a Binding Revocation Acknowledgement in response to the outstanding initial Binding Revocation Indication before the InitMINDelayBRIs timer expires, the mobility entity, e.g. LMA, SHOULD retransmit the same BRI message up to the BRIMaxRetriesNumber as defined in [Section 12](#).

The retransmissions by the sending mobility entity MUST use an exponential back-off process in which the timeout period is doubled upon each retransmission, until either the node receives a response or the timeout period reaches the value MAX_BRACK_TIMEOUT. The sending mobility entity MAY continue to send these messages at this slower rate up to the BRIMaxRetriesNumber.

If the revoking mobility entity does not receive a Binding Revocation Acknowledgement message after the maximum number of retransmits have been sent, the revoking mobility entity can clean the mobile node binding cache and all resources associated with this binding. The revoking mobility entity may log the event.

8. Home Agent Operation

8.1. Sending Binding Revocation Indication

To terminate a mobile node registration and its current binding with the home agent, the home agent sends a packet to the mobile node containing a Binding Revocation Indication, with the packet constructed as follows:

- o The Acknowledge (A) bit MAY be set to request the mobile node to send a Binding Revocation Acknowledgement upon receipt of the Binding Revocation Indication.

- o The Revocation Trigger field MUST be set to indicate to the mobile node the reason for revoking its IP mobility binding with the home agent. The Revocation Trigger may be used by the mobile node to take further steps if necessary.
- o The Binding Revocation Indication MUST be sent using a Type 2 routing header which contains the mobile node's registered IPv6 home address for the binding being revoked.
- o The care-of address for the binding MUST be used as the destination address in the packet's IPv6 header, unless an Alternate Care-of Address mobility option is included in the Binding Revocation Indication.
- o If the home agent needs to only revoke the mobile node's IPv4 home address binding, the home agent MUST set the IPv4 HoA Binding Only (V) bit and MUST include the mobile node's registered IPv4 home address that is being revoked in the IPv4 Home Address option.

The Acknowledge (A) bit in the Binding Revocation Indication requests the mobile node to return a Binding Revocation Acknowledgement in response to this Binding Revocation Indication. As described in [Section 7.3](#), the home agent SHOULD retransmit this Binding Revocation Indication to the mobile node before terminating its IP connection until it receives a matching Binding Revocation Acknowledgement or the BRIMaxRetransmitNumber has been reached.

When the home agent sends a Binding Revocation Indication to the mobile node with the Acknowledge (A) bit set, the home agent sets a flag in the mobile node BCE to indicate that revocation is in progress and starts the InitMINDelayBRIs timer. The home agent maintains the mobile node BCE in this state until it receives a Binding Revocation Acknowledgement or retransmits the Binding Revocation Indication message as described in [Section 7.3](#).

In a race condition case, the home agent may receive a Binding Update from the mobile node while the mobile node's BCE has the revocation in progress flag set, the home agent SHOULD handle this case based on the reason for sending the Binding Revocation Indication message and its local policy. In this case, if the home agent accepts the Binding Update, it needs to update the mobile node BCE accordingly, e.g. removing the revocation in progress flag.

When the home agent needs to revoke one or more of a mobile node bindings that were created using Multi Care-of address registration as in [\[ID-MCoA\]](#), the home agent MUST include all the related BID mobility options that identify these bindings in the Binding

Revocation Indication message. In the case when the home agent needs to revoke all of the mobile node bindings, the home agent SHOULD NOT include any of the BID mobility options.

8.2. Receiving Binding Revocation Acknowledgement

When the home agent receives a packet carrying a valid Binding Revocation Acknowledgement that was successfully processed as in [Section 7.2](#), the home agent SHOULD examine the Status field as follows:

- o If the Status field indicates that the Binding Revocation Indication was processed successfully, the home agent deletes the current timer and the mobile node bindings and all related resources.
- o If the Status field indicates any value other than success, the home agent SHOULD examine any mobility options included in the Binding Revocation Acknowledgement. The home agent MAY log the appropriate event to reflect the received status.

9. Local Mobility Anchor Operation

9.1. Binding Revocation Initiator

9.1.1. Sending Binding Revocation Indication

To terminate a mobile node PMIPv6 registration and its current binding with the local mobility anchor, the local mobility anchor sends a packet to the mobile access gateway containing a Binding Revocation Indication message following the procedure in [Section 7.1](#) and the following rules:

- o The Acknowledge (A) bit MAY be set to request the mobile access gateway to send a Binding Revocation Acknowledgement upon receipt of the Binding Revocation Indication.
- o The Proxy Mobile IP (P) bit MUST be set to indicate that the binding being revoked is a PMIPv6 binding.
- o The Revocation Trigger field MUST be set to indicate to the mobile access gateway the reason for removing the specified mobile node PMIPv6 binding at the local mobility anchor. The Revocation Trigger may be used by the mobile access gateway to learn the mobile node's latest movement.

- o In case of revoking all Per-Peer bindings, the Global (G) bit MUST be set and the Revocation Trigger MUST contain a value of "Per-Peer Policy" to request the mobile access gateway to remove all Per-Peer bindings that are registered with the local mobility anchor and hosted at this mobile access gateway.
- o Whenever the Global (G) bit is set in the Binding Revocation Indication, the Acknowledge (A) bit MUST be set to request the mobile access gateway to send a Binding Revocation Acknowledgement.
- o The packet MUST contain the Mobile Node Identifier, MN-ID, option which contains the mobile node's NAI that was used in the Proxy Binding Update during the mobile node registration.
- o If the Mobile Node Identifier, MN-ID, is registered in more than one of the mobile node's BCE and the local mobility anchor does NOT need to revoke all of the mobile node's bindings, the packet MUST contain another identifier to uniquely identify the mobile node binding(s) that is being revoked, e.g., at least one Home Network Prefix option which contains the mobile node's registered HNP for the binding being revoked.
- o The care-of address for the binding MUST be used as the destination address in the packet's IPv6 header, unless an Alternate Care-of Address mobility option is included in the Binding Revocation Indication message.

The Acknowledge (A) bit in the Binding Revocation Indication requests the mobile access gateway to return a Binding Revocation Acknowledgement. As described in [Section 7.3](#), the local mobility anchor SHOULD retransmit this Binding Revocation Indication before deleting the mobile node IP tunnel to the mobile access gateway until it receives a matching Binding Revocation Acknowledgement or the BRIMaxRetransmitNumber is reached. The local mobility anchor MAY delete the mobile node(s) IP tunnel immediately after sending the Binding Revocation Indication and before receiving the Binding Revocation Acknowledgement message.

When the local mobility anchor sends a Binding Revocation Indication to the mobile access gateway to remove a specific binding and the Acknowledge (A) bit is set, the local mobility anchor sets a flag in the mobile node proxy BCE to indicate that revocation is in progress and starts the InitMINDelayBRIs timer. The local mobility anchor SHOULD maintain the mobile node proxy BCE in this state until it receives a Binding Revocation Acknowledgement or the BRIMaxRetransmitNumber is reached. In the case when the local

mobility anchor sets the Revocation Trigger field to a value which indicates inter-MAG handover, the local mobility anchor MAY switch the mobile node IP tunnel to the target mobile access gateway before sending the Binding Revocation Indication to the source mobile access gateway.

In a race condition case, the local mobility anchor may receive a Proxy Binding Update from the mobile access gateway while the mobile node's proxy BCE has the revocation in progress flag set, the local mobility anchor should handle this case based on the reason for sending the Binding Revocation Indication message and its local policy. In this case, if the local mobility anchor accepts the Proxy Binding Update, it needs to update the mobile node proxy BCE accordingly, e.g. removing the revocation in progress flag.

When the local mobility anchor needs to revoke all mobile nodes proxy BCE that are registered with the local mobility anchor and hosted at the mobile access gateway, it MUST set the Global (G) bit and set the value of the Revocation Trigger field to "Per-Peer Policy". In this case, the local mobility anchor MUST NOT include any mobility options in the this Binding Revocation Indication message.

When the local mobility anchor needs to revoke all mobile nodes proxy BCE that belong to a specific realm, e.g. @example.com, that are registered with the local mobility anchor and hosted at the mobile access gateway, the local mobility anchor MUST set the Global (G) bit and set the value of the Revocation Trigger field to "Revoking Mobility Node Local Policy". In this case, the local mobility anchor MUST include a mobility option in the Binding Revocation Indication to identify the impacted bindings, e.g., MN-ID option with an NAI value of @example.com, to identify all the mobile nodes BCEs that have a MN-ID with a realm that matches the NAI value in the received MN-ID option and need to be removed.

When the mobile node is registered with multiple Home Network Prefixes for the same proxy care-of address, the local mobility anchor SHOULD include a HNP option for each registered HNP in the Binding Revocation Indication. Alternatively, it MAY include only the mobile node identifier, MN-ID, option to indicate to the mobile access gateway to remove all bindings of the specified mobile node NAI in the MN-ID option.

According to Proxy Mobile IPv6 specification [[RFC5213](#)], if the local mobility anchor receives a Proxy Binding Update message from a new mobile access gateway for extending the binding lifetime of the only BCE of this mobile node with the Handoff Indicator value is set to "Inter-MAG Handover - Unknown", the local mobility anchor waits a

period of `MaxDelayBeforeNewBCEAssign` to receive a de-registration message from the previous mobile access gateway before updating the mobile node's BCE with the new point of attachment. If a de-registration message is not received,, the local mobility anchor considers the received Proxy Binding Update message as a request for a new BCE and if processed successfully, the local mobility anchor assigns a different HNP for the new BCE.

This document updates the local mobility anchor's behavior in this case. If the local mobility anchor supports the binding revocation mechanism as described in this document, it SHOULD proactively send a Binding Revocation Indication message to the previous mobile access gateway instead of waiting for a de-registration from the previous mobile access gateway. In the Binding Revocation Indication message, the Acknowledge (A) bit MUST be set and the Revocation Trigger MUST be set to "Inter-MAG Handover - Unknown".

If the local mobility anchor sent a Binding Revocation Indication message with the Revocation Trigger field set to "Inter-MAG Handover - Unknown" and while waiting for a Binding Revocation Acknowledgement response, the following are possible conditions that the local mobility anchor MUST handle as specified below:

- o If the local mobility anchor receives a successful Binding Revocation Acknowledgement message or a de-registration message from the previous mobile access gateway, the local mobility anchor MUST update the mobile node BCE in a similar way as if it received a de-registration message as described in [\[RFC5213\]](#).
- o If the local mobility anchor receives a Binding Revocation Acknowledgement message with the status field set to "Revocation Failed - MN is Attached", the local mobility anchor SHOULD update the mobile node BCE in a similar way as if it did NOT receive a de-registration before the `MaxDelayBeforeNewBCEAssign` timer expires by creating a new BCE as described in [\[RFC5213\]](#).
- o If the local mobility anchor did not receive a Binding Revocation Acknowledgement message nor a de-registration Proxy Binding Update from the previous mobile access gateway after it exhausted all of the Binding Revocation Indication message retransmissions as described in [Section 7.3](#), the local mobility anchor SHOULD update the mobile node's BCE in a similar way as if it did NOT receive a de-registration before the `MaxDelayBeforeNewBCEAssign` timer expires by creating a new BCE as described in [\[RFC5213\]](#). Note that the local mobility anchor SHOULD use the recommended number of retransmissions for the Binding Revocation Indication message

as described in [Section 12](#) to avoid delaying the creation of a new binding cache entry for too long, if the mobile node is actually attaching to the new MAG with a different interface.

When the mobile node is registered with an IPv4 proxy home address in addition to the Home Network Prefix where both of the IPv4 pHoA and HNP are bound to the same proxy CoA, the local mobility anchor MAY revoke the mobile node IPv4 proxy HoA binding to the current mobile node proxy CoA while maintaining the mobile node binding of the HNP to its current pCoA as part of the mobile node BCE. In this case, if the local mobility anchor decides to revoke the mobile node IPv4 proxy HoA ONLY, it MUST send a Binding Revocation Indication message following the procedure in [Section 7.1](#) and the following rules:

- o The IPv4 HoA Binding Only (V) bit MUST be set in the BRI to indicate that only the IPv4 home address binding is being revoked.
- o The Acknowledge (A) bit MUST be set to request the mobile access gateway to send a Binding Revocation Acknowledgement message.
- o The IPv4 Home Address option MUST be included with the mobile node's registered IPv4 home address that is being released in addition to the MN-ID option.
- o The mobile node Home Network Prefix option MUST NOT be included.
- o The Revocation Trigger field MUST be set to an appropriate value, e.g. "User Initiated Session(s) Termination".

[9.1.2.](#) Receiving Binding Revocation Acknowledgement

When the local mobility anchor receives a packet carrying a valid Binding Revocation Acknowledgement that was successfully processed as in [Section 7.2](#) and if the mobile node BCE is in the state of Revocation in progress, the local mobility anchor SHOULD examine the Status field before clearing the mobile node related resources as follows:

- o If the Status field indicates that the BRI was processed successfully, the local mobility anchor MUST delete the current timer and the mobile node proxy bindings and all associated resources.

- o If the Status field indicates partial success value or MN binding does not exist, the local mobility anchor SHOULD examine mobility options that are included in the Binding Revocation Acknowledgement, if any, before deleting the current timer and the mobile node associated proxy bindings and other related resources. It is based on the local mobility anchor local policy how to handle the mobile node BCE(s) that the mobile access gateway indicated it failed the revocation procedure, however, the LMA MAY log the event.

9.2. Binding Revocation Responder

9.2.1. Receiving Binding Revocation Indication

When the local mobility anchor receives a packet carrying a Binding Revocation Indication that was successfully processed as in [Section 7.2](#), the local mobility anchor SHOULD in addition process the message as follows:

- o Binding Revocation Indication is formatted as in [Section 6.1](#) and if the (P) bit is set, the local mobility anchor MUST validate that all impacted binding(s) have the proxy binding flag set.
- o If the Global (G) bit is set and the Revocation Trigger value is "Per-Peer Policy", the Proxy (P) bit MUST be set and the Binding Revocation Indication SHOULD contain the mobile access gateway ID in the MN-ID option. The local mobility anchor MUST verify that the identified mobile access gateway as per the value in the MN-ID option is authorized to use the Global revocation. The mechanism the local mobility anchor uses to verify the mobile access gateway authorization is out of scope of this document.
- o If the Global (G) bit is set and the Revocation Trigger value is "Per-Peer Policy", and only the mobile node identifier, MN-ID, option is included, the local mobility anchor MUST revoke all mobile nodes bindings which proxy CoA is the one used as the source of the IPv6 packet that carried the Binding Revocation Indication. However, if one or more Alternate Care-of Address options are included in addition to the mobile node identifier option, the local mobility anchor MUST revoke all mobile nodes bindings which proxy Care-of Address matches one of the Care-of address(es) in the Alternate Care-of Address option(s).
- o The local mobility anchor identifies all impacted mobile nodes bindings and if the Acknowledge (A) bit is set, the local mobility anchor MUST send a Binding Revocation Acknowledgement following [Section 9.2.2](#) using the appropriate status code.

- o If the Global (G) bit is NOT set, the local mobility anchor SHOULD use the included mobility options to identify the impacted mobile node binding as follows:
 1. If only the mobile node identifier, MN-ID, option is included, the local mobility anchor MUST revoke all bindings for this mobile node which use the specified mobile node NAI.
 2. If the mobile node identifier, MN-ID, and the Home Network Prefix option are included, the local mobility anchor MUST only remove the specified proxy binding.
 3. If the mobile node identifier, MN-ID, option and more than one Home Network Prefix options are included, the local mobility anchor MUST remove all bindings which are referenced by these multiple Home Network Prefixes for the specified mobile node NAI.

The Revocation Trigger field value in the received Binding Revocation Indication could be used by the local mobility anchor to log an event or update some local parameters which tracks the state of the peer mobile access gateway.

9.2.2. Sending Binding Revocation Acknowledgement

When the local mobility anchor receives a valid Binding Revocation Indication with the Acknowledge (A) bit set and after processing the Binding Revocation Indication message, the local mobility anchor sends a packet to the mobile access gateway containing a Binding Revocation Acknowledgement following the process in [Section 7.1](#) and the following:

- o If the (P) bit was set in the received Binding Revocation Indication, the local mobility anchor MUST set the (P) bit in the Binding Revocation Acknowledgement.
- o If the Global (G) bit was set in the received Binding Revocation Indication, the local mobility anchor MUST set the Global (G) bit in the Binding Revocation Acknowledgement.
- o If the IPv4 HoA Binding Only (V) bit was set in the received Binding Revocation Indication, the local mobility anchor MUST set the (V) bit in the Binding Revocation Acknowledgement.
- o The local mobility anchor MUST set the Status field to a valid code that reflects the processing of the received Binding Revocation Indication. If the mobile access gateway is not

authorized to use the Per-Peer Global revocation feature, the local mobility anchor MUST set the Status field to (Global Revocation NOT Authorized).

- o In the case that one of the bindings identified in the received Binding Revocation Indication message has already been released, the local mobility anchor MAY set the Status field to partial success and in this case it MAY include the mobile node identifier or the Home Network Prefix option to identify the binding(s) that failed revocation.
- o The destination IP address of the IPv6 packet of the Binding Revocation Acknowledgement is set to the source IP address of the received Binding Revocation Indication.

10. Mobile Access Gateway Operation

10.1. Binding Revocation Responder

10.1.1. Receiving Binding Revocation Indication

Upon receiving a packet carrying a Binding Revocation Indication, the mobile access gateway MUST validate the packet according to [Section 7.2](#) and the following:

- o Binding Revocation Indication MUST be formatted as in [Section 6.1](#) and the (P) bit is set.
- o If the Acknowledge (A) bit in the received Binding Revocation Indication is set, the mobile access gateway MUST send a Binding Revocation Acknowledgement following [Section 10.1.2](#) using the appropriate status value.
- o If the Global (G) bit is set and the Revocation Trigger field value is "Per-Peer policy", the mobile access gateway identifies all bindings that are registered at the local mobility anchor and hosted at the mobile access gateway. This Binding Revocation Indication does not include any other mobility options. In this case, the mobile access gateway MUST send a Binding Revocation Acknowledgement with the appropriate status code to the local mobility anchor.
- o If the Global (G) bit is set and the Revocation Trigger field value is "Revoking Mobility Node Local Policy", the mobile access gateway MUST identify all bindings that are registered at the local mobility anchor and hosted at the mobile access gateway using the mobility option(s) included in the Binding Revocation

Indication which SHOULD include at least the MN-ID option, e.g., with a wild card NAI. In this case, the mobile access gateway MUST send a Binding Revocation Acknowledgement with the appropriate status code to the local mobility anchor.

- o If the Global (G) bit is set and the Revocation Trigger field value is "Revoking Mobility Node Local Policy", and no mobility options are included in the Binding Revocation Indication message or the mobile access gateway is not able to identify the impacted mobile nodes bindings based on the included mobility options, the mobile access gateway MUST treat this as an error scenario. In this case, the mobile access gateway SHOULD send a Binding Revocation Acknowledgement message with status "Revoked Mobile Nodes Identity Required".
- o If the Revocation Trigger field value in the received Binding Revocation Indication message indicates inter-MAG handover, e.g., Inter-MAG Handover - Unknown, and the Acknowledge (A) bit is set, the mobile access gateway uses the mobility option(s) included in the Binding Revocation Indication message to identify the mobile node binding. The mobile access gateway SHOULD validate that the mobile node is no longer attached to the mobile access gateway before sending a successful Binding Revocation Acknowledgement message to the local mobility anchor. However, if the mobile access gateway verified that the mobile node is still directly attached, the mobile access gateway MUST set the status field in the Binding Revocation Acknowledgement to "Revocation failed - MN is Attached".
- o If the IPv4 HoA Binding Only (V) bit in the received Binding Revocation Indication message is set, the mobile access gateway uses the MN-ID option to identify the mobile node binding entry in the Binding Update List (BUL). It MUST verify that the IPv4 address included in the IPv4 Home Address option in the received Binding Revocation Indication is the same as the IPv4 proxy HoA that is assigned to the mobile node. After the mobile access gateway successfully validates the received IPv4 home address as the mobile node IPv4 HoA, it MUST consider this as an indication to release the mobile node IPv4 proxy HoA binding to the mobile node current proxy CoA ONLY. Consequently, it MUST continue to maintain the mobile node IPv6 proxy HoA or HNP binding to the current mobile node proxy CoA as part of the mobile node binding in the BUL entry and release all resources associated with the MN IPv4 proxy HoA binding to the MN pCoA. In this case, the mobile access gateway MUST send a Binding Revocation Acknowledgement message with the Status field is set to success. On the other hand, if the mobile access gateway is able to identify the mobile node binding using the MN-ID but failed to identify the received

IPv4 proxy HoA, it MUST send a Binding Revocation Acknowledgement with Status field is set to "Binding Does NOT Exist".

The Revocation Trigger field value in the received Binding Revocation Indication could be used by the mobile access gateway to define what actions the mobile access gateway could do to inform the mobile node that its IP connectivity to the current HNP has been terminated, e.g., if the Revocation Trigger field is set to "Administrative Reason", the mobile access gateway may send a RA message after setting the Home Network Prefix valid lifetime to zero.

10.1.2. Sending Binding Revocation Acknowledgement

When the mobile access gateway receives a valid Binding Revocation Indication with the Acknowledge (A) bit set and after processing it, the mobile access gateway sends a packet to the local mobility anchor containing a Binding Revocation Acknowledgement according to the procedure in [Section 7.1](#) and the following:

- o The mobile access gateway MUST set the (P) bit in the Binding Revocation Acknowledgement if it is set in the received Binding Revocation Indication.
- o If the Global (G) bit was set in the received Binding Revocation Indication, the mobile access gateway MUST set the Global (G) bit in the Binding Revocation Acknowledgement.
- o If the IPv4 HoA Binding Only (V) bit was set in the received Binding Revocation Indication, the mobile access gateway MUST set the (V) bit in the Binding Revocation Acknowledgement.
- o The mobile access gateway MUST set the Status field to a valid code that reflects the processing of the received Binding Revocation Indication.
- o In the case that one or more of the bindings identified in the received Binding Revocation Indication message has already been released before receiving the Binding Revocation Indication, the mobile access gateway MAY set the Status field to "partial success" and include the mobile node identifier, MN-ID, or the Home Network Prefix option to identify the binding(s) that failed to be removed as part of the revocation procedure.
- o The destination IP address of the IPv6 packet of the Binding Revocation Acknowledgement is set to the source IP address of the received Binding Revocation Indication.

10.2. Binding Revocation Initiator

10.2.1. Sending Binding Revocation Indication

The mobile access gateway could send a Binding Revocation Indication message to indicate the termination of multiple mobile node bindings, e.g., when using the global revocation with the Global (G) bit set. In this case when an event occurs which requires the mobile access gateway to inform the local mobility anchor to terminate all mobile nodes bindings which are registered at the local mobility anchor and the mobile access gateway, the mobile access gateway sends a Binding Revocation Indication message following [Section 7.1](#) and the following:

- o The Acknowledge (A) bit MUST be set to request the local mobility anchor to send a Binding Revocation Acknowledgement upon receipt of the Binding Revocation Indication.
- o The Proxy Binding (P) bit MUST be set to indicate that bindings that being revoked is a PMIPv6 binding.
- o The Global (G) bit MUST be set and the Revocation Trigger MUST contain a value of "Per-Peer Policy" in the Binding Revocation Indication to request the local mobility anchor to remove all Per-Peer bindings that are registered with the local mobility anchor and hosted at this mobile access gateway. In this case, the MN-ID option MUST be included in the Binding Revocation Indication and contain the mobile access gateway identity. In addition, the mobile access gateway MAY include one or more Alternate Care-of Address option(s). The Alternate Care-of Address option(s) contain the proxy Care-of address(es) the bindings of which are being impacted by this Binding Revocation Indication message.
- o The mobile access gateway address MAY be used as the source address in the packet's IPv6 header.

The Acknowledge (A) bit in the Binding Revocation Indication requests the local mobility anchor to return a Binding Revocation Acknowledgement in response to this Binding Revocation Indication. As described in [Section 7.3](#), the mobile access gateway SHOULD retransmit this Binding Revocation Indication to the local mobility anchor until it receives a matching Binding Revocation Acknowledgement or the BRIMaxRetransmitNumber is reached. The mobile access gateway MAY delete the mobile nodes IP tunnels immediately after sending the Binding Revocation Indication and before receiving a Binding Revocation Acknowledgement message from the LMA.

10.2.2. Receiving Binding Revocation Acknowledgement

When the mobile access gateway receives a packet carrying a valid Binding Revocation Acknowledgement that was successfully processed according to [Section 7.2](#), the mobile access gateway MUST process the received Binding Revocation Acknowledgement as per the followings:

- o When the mobile access gateway receives a packet carrying a valid Binding Revocation Acknowledgement and the Global (G) and Proxy Binding (P) bits are set and the mobile nodes BCEs are in the state of Revocation in Progress, the mobile access gateway SHOULD examine the Status field as follows:
- o If the Status field indicates that the Binding Revocation Indication was processed successfully, the mobile access gateway delete the current timer and the mobile nodes proxy bindings and all associated resources.
- o If the Status field indicates (Global Revocation NOT Authorized), the mobile access gateway is not authorized to participate in a Per-Peer Global Revocation. The mobile access gateway SHOULD NOT retry sending a Binding Revocation Indication with the Global (G) bit set to the same local mobility agent. The mobile access gateway should raise an alarm or log an event to indicate this rejection.

11. Mobile Node Operation

11.1. Receiving Binding Revocation Indication

Upon receiving a packet carrying a Binding Revocation Indication, the mobile node MUST validate the packet according to [Section 7.2](#) and the following tests:

- o The mobile node MUST verify that the IP address in the Type 2 routing header is its Home Address and that its Binding Update List contains an entry for that Home Address. If one of the tests, fails the mobile node SHOULD silently discard the received Binding Revocation Indication message.
- o If the Acknowledge (A) bit is set in the Binding Revocation Indication and its Binding Update List contains an entry for the IP address in the Type 2 routing header, the mobile node MUST send a Binding Revocation Acknowledgement. However, in all other cases when the Acknowledge (A) bit is set in the BRI, the mobile node SHOULD send a Binding Revocation Acknowledgement. In all cases, the mobile node MUST follow [Section 11.2](#) and send a Binding

Revocation Acknowledgement using the appropriate status code.

- o If the IPv4 HoA Binding Only (V) bit is set in the received BRI message, the mobile node MUST verify that there is an IPv4 Home Address option in the received Binding Revocation Indication and the IPv4 address included in the IPv4 Home Address option is the same as its IPv4 HoA that is assigned to the mobile node. If this verification is successful, the mobile node MUST consider this Binding Revocation Indication as an indication to release the mobile node IPv4 HoA binding ONLY to its current Care-of Address. Consequently, the mobile node MUST continue to maintain its IPv6 HoA binding to the current CoA as part of the mobile node binding in the BUL entry and release all resources associated with the MN IPv4 HoA binding. In this case, the mobile node MUST send a Binding Revocation Acknowledgement message with the Status field is set to "success". On the other hand, if the IPv4 Home Address Option was NOT included in the received BRI with the (V) bit set, the MN SHOULD send a Binding Revocation Acknowledgement message with the Status field set to "IPv4 Home Address Option Required". Additionally, if the IPv4 HoA received in the IPv4 Home Address Option is NOT the one assigned to the mobile node, the mobile node SHOULD send a Binding Revocation Acknowledgement with the status field set to "Binding Does NOT Exist".
- o The mobile node MUST verify that the (P) bit in the Binding Revocation Indication is NOT set. If the (P) bit is set, the mobile node MUST silently discard the Binding Revocation Indication message.
- o If the mobile node has registered multiple care-of addresses with its home agent, the mobile node MUST verify which binding is being revoked by examining the content of the Binding Revocation Indication message. If the mobile node received a Binding Revocation Indication with a single or more than one BID options and its home address is included in the Type 2 routing header, the mobile node MUST consider all of the care-of address(es) binding(s), identified in the BID options, with this home address are being revoked.
- o If the mobile node has multi Care-of Address bindings with its home agent and received a Binding Revocation Indication, without any BID option included and its home address was included in the Type 2 routing header, the mobile node MUST consider all of its registered care-of addresses bindings with this home address are being revoked.

The Revocation Trigger field value in the received Binding Revocation

Indication could be used by the mobile node to define what action the mobile node could do to be able to register again and receive its IP mobility service, e.g., contacting its home operator.

11.2. Sending Binding Revocation Acknowledgement

When the mobile node receives a Binding Revocation Indication from its home agent, the mobile node processes the received Binding Revocation Indication as in [Section 11.1](#). If the mobile node is required to send a Binding Revocation Acknowledgement message in response to the received Binding Revocation Indication, the mobile node sends a packet to its home agent containing a Binding Revocation Acknowledgement according to the procedure in [Section 7.1](#) and the following:

- o The mobile node MUST set the Status field to an appropriate value. The mobile node sets the Status field to success to reflect that it has received the Binding Revocation Indication and acknowledge that its IP connectivity with its home agent has been revoked.
- o The destination IP address of the IPv6 packet of the Binding Revocation Acknowledgement is set to the source IP address of the received IPv6 packet of the Binding Revocation Indication. The Mobile Node MUST include its home address in the Home Address Destination Option.

12. Protocol Configuration Variables

Any mobility entity which is allowed to invoke the binding revocation procedure by sending a Binding Revocation Indication message SHOULD allow the following variables to be configured.

BRI Maximum Number of Retries (BRIMaxRetriesNumber)

This variable specifies the maximum Number of times a mobility entity can retransmit a Binding Revocation Indication message before receiving a Binding Revocation Acknowledgement message. The default value for this parameter is 1.

Initial Minimum Delay Between BRI messages (InitMINDelayBRIs)

This variable specifies the initial delay timeout in seconds before the revoking mobility entity retransmits a BRI message. The default is 1 second but not less than 0.5 seconds.

Maximum BRA TIMEOUT (MAX_BRACK_TIMEOUT)

This variable specifies the maximum delay timeout in seconds before the revoking mobility entity retransmits a BRI message. The default is 2 seconds.

13. IANA Considerations

This specification defines a new Binding Revocation Message using a new Mobility Header Type <IANA-TBD>, as described in [Section 6](#). The new Mobility Header type value needs to be assigned from the same numbering space as allocated for the other Mobility Header types.

This document also creates a new name space "Binding Revocation Type" which indicates the type of the binding revocation message. The current binding revocation message types are described in [Section 6.1](#) and [Section 6.2](#), and are the following:

- 0 Reserved
 - 1 Binding Revocation Indication
 - 2 Binding Revocation Acknowledgement
- All other values are reserved

Future values of the Binding Revocation Type can be allocated using Standards Action or IESG Approval [[RFC5226](#)].

In addition, this document also creates a second new namespace for the Revocation Trigger which indicates the reason behind sending the Binding Revocation Indication message. The current Revocation Trigger values are described in [Section 6.1](#), and are the following:

Reserved and Per-MN Revocation Trigger Values:

- 0 Reserved
- 1 Unspecified
- 2 Administrative Reason
- 3 Inter-MAG Handover - same Access Type
- 4 Inter-MAG Handover - different Access Type
- 5 Inter-MAG Handover - Unknown
- 6 User Initiated Session(s) Termination
- 7 Access Network Session(s) Termination
- 8 Possible Out-of Sync BCE State
- 250-255 Reserved For Testing Purposes only

All other values are Reserved

Global Revocation Trigger Values:

- 128 Per-Peer Policy
- 129 Revoking Mobility Node Local Policy

Future values of the Revocation Trigger can be allocated using Standards Action or IESG Approval [[RFC5226](#)].

Furthermore, this document creates a third new name space "Status Code" for the Status field in the Binding Revocation Acknowledgement message. The current values are described in [Section 6.2](#), and are the following:

- 0 success
- 1 partial success
- 128 Binding Does NOT Exist
- 129 IPv4 Home Address Option Required
- 130 Global Revocation NOT Authorized
- 131 Revoked Mobile Nodes Identity Required
- 132 Revocation Failed - MN is Attached
- 133 Revocation Trigger NOT Supported
- 134 Revocation Function NOT Supported

Future values of the Status field can be allocated using Standards Action or IESG Approval [[RFC5226](#)].

All fields labeled "Reserved" are only to be assigned through Standards Action or IESG Approval.

[14.](#) Security Considerations

The protocol described here uses the same security association between the mobile node and the home agent or the mobile access gateway and the local mobility anchor that has been used to exchange the corresponding MIPv6 or PMIPv6 Binding Update and Binding Acknowledgement when the session was established. If IPsec is used, the SPD of this IPsec SA MUST allow the MH type for the Binding Revocation Message defined in this document.

However, in the case when the mobile access gateway sends a Binding Revocation Indication message with the Global (G) bit is set and the Revocation Trigger field is set to "Per-Peer policy", the local mobility anchor MUST verify that the mobile access gateway is authorized to use Per-Peer Global Revocation.

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16. References

16.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [BCP 14](#), [RFC 2119](#), March 1997.
- [RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [BCP 26](#), [RFC 5226](#), May 2008.
- [RFC3775] Johnson, D., Perkins, C., and J. Arkko, "Mobility Support in IPv6", [RFC 3775](#), June 2004.
- [RFC4283] Patel, A., Leung, K., Khalil, M., Akhtar, H., and K. Chowdhury, "Mobile Node Identifier Option for Mobile IPv6 (MIPv6)", [RFC 4283](#), November 2005.
- [RFC5213] Gundavelli, S., Leung, K., Devarapalli, V., Chowdhury, K., and B. Patil, "Proxy Mobile IPv6", [RFC 5213](#), August 2008.
- [ID-PMIP6-IPv4] Wakikawa, R. and S. Gundavelli, "IPv4 Support for Proxy Mobile IPv6", [draft-ietf-netlmm-pmip6-ipv4-support-14](#) (work in progress), July 2009.
- [ID-MCoA] Wakikawa, R., Devarapalli, V., Ernst, T., and K. Nagami, "Multiple Care-of Addresses Registration", [draft-ietf-monami6-multiplecoa-14](#) (work in progress), May 2009.
- [RFC5555] Soliman, H., "Mobile IPv6 Support for Dual Stack Hosts and Routers", [RFC 5555](#), June 2009.

16.2. Informative References

- [RFC3344] Perkins, C., "IP Mobility Support for IPv4", [RFC 3344](#), August 2002.

[RFC3543] Glass, S. and M. Chandra, "Registration Revocation in Mobile IPv4", [RFC 3543](#), August 2003.

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