

Network Working Group
Internet-Draft
Intended status: Experimental
Expires: February 2, 2014

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August 1, 2013

Home Agent Initiated Flow Binding for Mobile IPv6
draft-yokota-mext-ha-init-flow-binding-06

Abstract

There are scenarios in which the home agent needs to trigger flow binding operations towards the mobile node such as moving a flow from one access network to another based on the network resource availability. In order for the home agent to be able to initiate interactions for flow bindings with the mobile node, this document defines new signaling messages and sub-options for Mobile IPv6. Home agent initiated flow bindings are supported for both IPv4 and IPv6 enabled mobile nodes.

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1. Introduction

[RFC6089] allows a mobile node to bind a particular flow to a care-of address without affecting other flows using the same home address. Binding Update (BU)/Binding Acknowledgement(BA) messages are extended for the mobile node to add, modify, remove and refresh flow binding in a home agent. The operations are always initiated by the mobile node.

While the mobile node manipulates flow bindings by e.g., the user interaction or the change of the attached link condition, these operations are also required for network-related reasons such as dynamic QoS control in the network, load balancing or maintenance in mobility agent nodes. For the latter case, the mobile node is not much aware of the transport network condition away from it or policy and charging status controlled by the operator, thus the network needs to request the mobile node to handle proper flow bindings.

This document defines a new Mobility Header and messages in order for the home agent to request the mobile node to initiate flow bindings in a timely manner. Flow mobility for the mobile nodes with IPv4 home address and IPv4 address of the home agent as described in [RFC5555] is also supported.

2. Terminology

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].

The terminology in this document is based on the definitions in [RFC6275] and [RFC6089].

3. Use Cases

3.1. QoS provisioning

When the user launches a video chat application and starts sending voice and video to the other end, the network may need to provide different QoS treatments to these media based on the operator's policy. In such a case, the network needs to request the user or mobile node to establish separate flows for voice and video.

3.2. Traffic Offload from congested network

The 3G operator may want to move traffic flows from the 3G access to another (e.g., WiFi network) due to instantaneous traffic increase in the 3G access network. Fine-grained traffic offload is desirable. For example, IMS-based VoIP flows must stay in the mobile core network while video streaming flows provided by servers on the Internet could bypass the mobile core network via WiFi access. Since the network knows more about its conditions and has access to the policy server, more timely and well-controlled traffic offloading is possible. The home agent sends an updated flow descriptor to be offloaded to the mobile node.

3.3. Flow movement or deletion in emergency situation

In an emergency situation caused by a natural disaster, it is necessary to accept as many voice calls as possible for safety inquiry to confirm the safety status of family and friends, while non-critical services such as gaming could be put lower priority. In order to save the 3G/LTE radio resources for emergency services, non-critical services may need to be moved to another access or closed down. The home agent requests the mobile node to use WiFi access for non-critical application flows or to terminate them gracefully e.g., by letting it notify the user of possible QoS degradation or ask him/her to finish the corresponding applications before taking any action.

3.4. Service-specific data cap

The mobile operator offers a mobile broadband service with a flat rate subscription limited to 5G Byte per month. Once the allotment is used up, the service is downgraded to 64 K bits per second. This limitation, however, is not applied to IMS-based services (e.g., VoLTE), while video conversations over the Internet will be affected. The operator can indicate this to the user by sending modified flow descriptors as a proposal to adjust the communication data rate or change access for an ongoing session.

4. Protocol Operation

[RFC6089] makes use of Binding Update (BU) / Binding Acknowledgement (BA) signalling to forward, i.e. register or discard a flow binding in a home agent. Flow binding operations are always initiated from the mobile node. In this document, the basic principle of the specification is that the home agent prompts the mobile node to perform flow binding operations. For this purpose, a new Mobility Header and two new messages, that is, Flow Binding Indication (FBI)

and Flow Binding Acknowledgement (FBA) are defined. FBI is used by the home agent to request flow binding operations to the mobile node and FBA is used for acknowledging FBI. In order for the flow binding operation to be complete, BU/BA exchange MUST be initiated by the mobile node after FBI/FBA exchange.

It is assumed that the home agent has already created Binding Cache entries for the mobile node before launching flow binding operations.

Due to access network change on the mobile node side, some interface that used to be active may not be valid at the time of flow binding operation by the home agent, in which case, even if the HA sends the FBI to the MN, the FBA will not return. After retransmitting the FBIs for MAX_FBI_RETRIES times and not receiving the FBA, the HA determines that the target interface is not available.

If the mobile node does not support the FBI message, it responds with a Binding Error message with status set to 2 (unrecognized mobility header (MH) type value) as described in [\[RFC6275\]](#). When the Binding Error message with status set to 2 is received in response to a FBI message, the home agent MUST NOT use FBI message with that mobile node again.

4.1. Adding flow bindings

Adding the flow binding implies associating a particular flow with one of the care-of addresses on the mobile node. The care-of address concerned with the flow binding is present in the destination address of the packet or the alternate care-of address option. Alternatively, the care-of address may be indicated by the Target Care-of Address sub-option defined in [Section 6.2.2](#).

When adding a new flow binding, the home agent sends a FBI with a Flow Identification Mobility option to the mobile node. In Figure 1, which is shown as an example for this operation, the mobile node exchanges both voice and video over Flow Identifier (FID)#1. Based on the operator's policy, the network determines to provide separate QoS for the video flow and the home agent sends the FBI to the mobile node. The Flow Identification Mobility option defined in [\[RFC6089\]](#) includes the current FID and the Traffic Selector (TS) to specify the video flow. The Flow binding action sub-option MUST indicate Add operation defined in [Section 6.2.1](#). The mobile node returns the FBA to the home agent with the same options. The BU/BA exchange follows afterwards to perform the actual flow binding as defined in [RFC6088](#) and the video traffic is exchanged over FID#2.

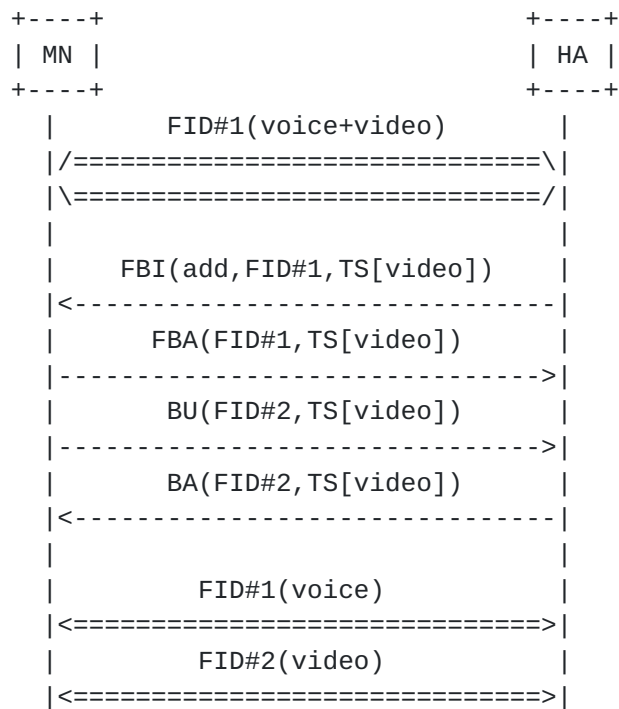


Figure 1: Example call flow for adding a flow binding

4.2. Deleting flow bindings

When removing a flow binding, the home agent sends a FBI with a Flow Identification Mobility option in which the Flow binding action sub-option indicates Delete operation. The Flow Identification Mobility option includes a unique FID for the mobile node to locate the flow binding and remove it.

4.3. Modifying flow bindings

When modifying a flow binding (e.g., changing QoS attributes of the flow as defined in [\[I-D.ietf-netext-pmip6-qos\]](#)) is needed, the home agent sends the mobile node a FBI message with Flow Identification Mobility option. The option includes the FID to be modified. A Traffic Selector sub-option MAY come with the Flow Identification Mobility Option and contain new attributes e.g., in Quality of Service Option.

4.4. Refreshing flow bindings

A flow binding is refreshed by simply including the Flow Identification Mobility option with Refresh Action field in the FBI message. The message should be sent before the expiration of the flow binding. The message updates existing bindings with new information. Hence, all information previously sent in the last

refreshing message need to be resent, otherwise such information will be lost.

4.5. Moving flow bindings

The home agent can request to move a flow associated with one interface of the multi-interfaced mobile node to another by sending a FBI message to the mobile node. The Action field of the flow binding action sub-option is set to Move and the address of the target interface is also included in Target Care-of Address sub-option. After the FBA is returned to the home agent, the flow mobility is performed by the mobile node. Figure 2 shows the movement of a flow label as FID from the interface with sCoA to that with tCoA, which is stored in the Binding Identity Mobility Option.

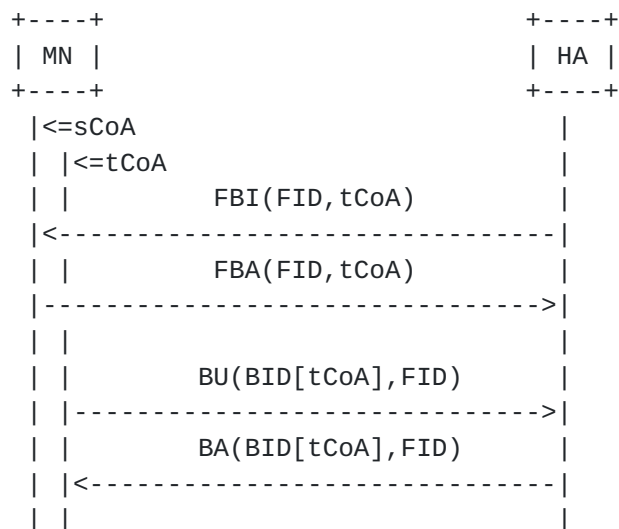


Figure 2: Example call flow for moving a flow binding

4.6. Revoking flow bindings

When the home agent or the network attached to it is overloaded, the home agent can revoke a flow binding registered by the mobile node. The home agent sends the mobile node a FBI message with a Flow Identification Mobility option in which the Flow binding action sub-option indicates Revoke operation. When the MN receives the FBI message with Revoke operation, it decides whether the flow should be removed (de-registration) or moved to another interface and returns the FBA with an appropriate status code. The mobile node SHOULD take an action by sending a new BU, for example, to deregister the flow.

The difference from deleting flow bindings in [Section 4.2](#) is that even if the mobile node does not take any action, the target flow may be revoked by the network with the procedures defined in [\[RFC5846\]](#).

5. Handling of the Flow Bindings List

Flow bindings list defined in [[RFC6089](#)] needs to be modified after each protocol operation defined above as follows:

If FBI contains a flow binding add operation and if the corresponding FBA has a status code equal to zero, home agent MUST add a new entry to the flow bindings list. FID, Flow Descriptor, FID-PRI and Action fields are taken from the Flow Identification Mobility Option. BID is copied from the Binding Reference sub-option. Active/Inactive Flag is set to Active. Note that if BID is not available it may be replaced by Care-of-Address.

If FBI contains a flow binding delete operation and if the corresponding FBA has a status code equal to zero, home agent MUST locate the list entry corresponding to this flow and then delete the entry.

If the home agent sends a Binding Revocation Indication message with Flow Mobility Option where the action field is set to Revoke and if the corresponding Binding Revocation Acknowledgement message indicates acceptance, home agent MUST locate the list entry corresponding to this flow and then delete the entry.

If FBI contains a flow binding modify operation and if the corresponding FBA has a status code equal to zero, home agent MUST delete the list entry corresponding to this flow and then add a new entry setting the values as defined in the Flow Identification Mobility Option.

If FBI contains a flow binding refresh operation and if the corresponding FBA has a status code equal to zero, home agent MUST locate the list entry corresponding to this flow and then set Active/Inactive Flag to Active.

If FBI contains a flow binding move operation and if the corresponding FBA has a status code equal to zero, home agent MUST locate the list entry corresponding to this flow and then change the BID value to the Care-of-Address in the Flow Identification Mobility Option.

If FBI contains a flow binding switch operation and if the corresponding FBA has a status code equal to zero, home agent MUST locate the list entry corresponding to this flow and then delete the entry.

Flow binding operations apply equally to IPv4 packets as well as IPv6 packets as per Dual-Stack Mobile IPv6 [[RFC5555](#)]. In order to support

the situation where there is NAT/firewall between the mobile node and home agent, NAT detection and NAT keepalives mechanisms defined in [RFC5555] MUST be used. When the mobile node and home agent are in IPv6-only and IPv4-only networks, respectively and NAT64 [RFC6146] resides in between, each node would behave as if the other node was in the same network domain. Even though this scenario is not fully described in [RFC5555], the initial mobility binding is always performed by the mobile node and the binding cache is created in the home agent. The destination address of the FBI SHALL be the mobile node's IPv4 care-of address in the binding cache entry.

6. Flow Binding Messages and Options

6.1. Mobility Header

The messages described below follow the Mobility Header format specified in [Section 6.1 of \[RFC6275\]](#).

6.1.1. Flow Binding Indication

The Flow Binding Indication messages are used by the home agent to initiate flow binding operations to the mobile node. The Flow Binding Indication messages use the MH Type value (IANA-TBD1) for Flow Binding message and a Flow Binding Type value of 1, and the format of the Message Data field in the Mobility Header is as follows:

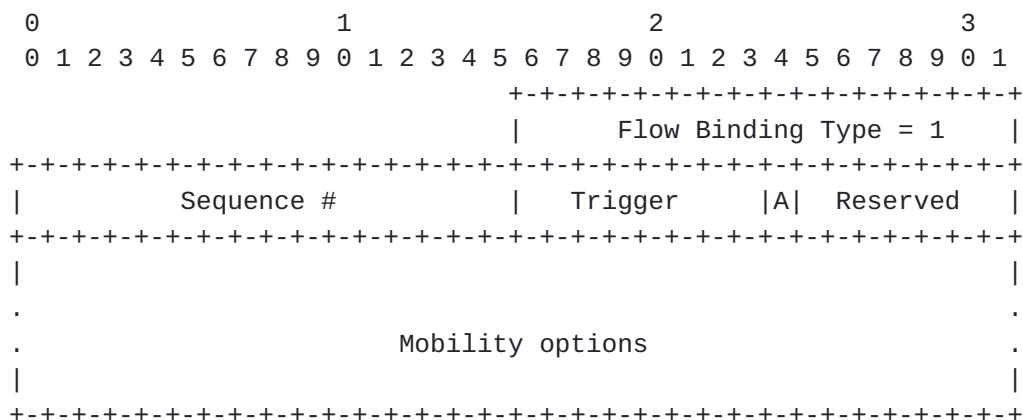


Figure 3: Flow Binding Indication Mobility Header Format

Sequence

A 16-bit unsigned integer used by the home agent to match a returned Flow Binding Acknowledgement with this Flow Binding Indication. It could be a random number.

Trigger

8-bit unsigned integer indicating the event which triggered the home agent to send the Flow Binding Indication message. The following Trigger values are currently defined:

- 0 Reserved
- 1 Unspecified
- 2 Administrative Reason
- 3 Possible Out-of Sync BCE State
- 250-255 Reserved For Testing Purposes only
- All the other values are reserved

Acknowledge (A)

The Acknowledge (A) bit is set by the home agent to request a Flow Binding Acknowledgement be returned upon receipt of the Flow Binding Indication.

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. Flow Identification Mobility Options are included in this field.

6.1.2. Flow Binding Acknowledgement

The Flow Binding Acknowledgement is used to acknowledge receipt of a Flow Binding Indication. The mobile node sends FBA message to acknowledge the reception of FBI to Add, Delete, Modify, Refresh, Move, or Switch a flow binding. On receiving messages with Flow Identification Mobility Option(s), the mobile node should copy each Flow Identification Mobility Option to the Acknowledgement messages. The Flow Binding Acknowledgement has the MH Type value (IANA-TBD1) for Flow Binding message and a Flow Binding Type value of 2. When this value is indicated in the MH Type field, the format of the Message Data field in the Mobility Header is as follows:

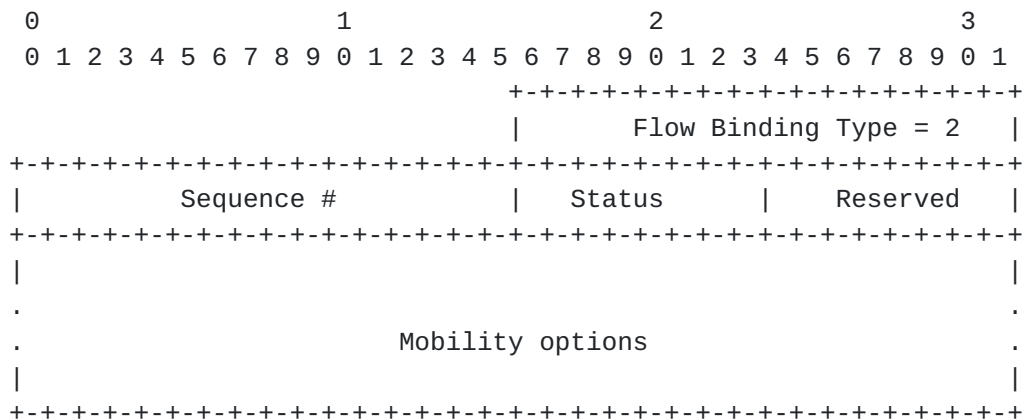


Figure 4: Flow Binding Acknowledgement Mobility Header Format

Sequence #

The sequence number in the Flow Binding Acknowledgement is copied from the Sequence Number field in the Flow Binding Indication.

Status

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

- 0 success
- 128 Binding (target CoA) Does NOT Exist
- 129 Action NOT Authorized
- All the other values are reserved

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. Flow Identification Mobility Options are included in this field.

6.1.3. Flow Binding Revocation Extensions

This specification enables Binding Revocation Indication and Binding Revocation Acknowledgement messages to carry Flow Identification Mobility Options as defined in [[RFC6089](#)] with extensions defined in this document.

6.2. New Options

This document defines new Flow Indication Sub-Options that are included in Flow Identification Mobility Option specified in [\[RFC6089\]](#).

6.2.1. Flow binding action sub-option

This section defines a new sub-option for flow binding actions, which MUST be included in the Flow Identification Mobility Option when it is sent from the home agent to the mobile node via the FBI message. The format of this sub-option is shown in Figure 5.

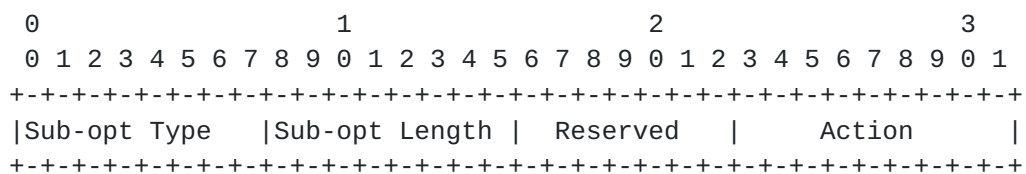


Figure 5: Flow binding action sub-option

Sub-opt Type

To be assigned by IANA (IANA-TBD2)

Sub-opt Length

Length of the sub-option in octets, excluding the Sub-opt Type and Sub-opt Length fields.

Action

This is a 8-bit field that describes the required processing for the option. It can be assigned one of the following new values:

- ```
11 Add a flow binding
12 Delete a flow binding
13 Modify a flow binding
14 Refresh a flow binding
15 Move a flow binding
16 Revoke a flow binding
```

All the other values are reserved for future use

### 6.2.2. Target Care-of-Address sub-option

This section introduces the Target Care-of-Address sub-option, which may be included in the Flow Identification Mobility Option. This sub-option is used to indicate the mobile node to move a flow binding from one interface to another.



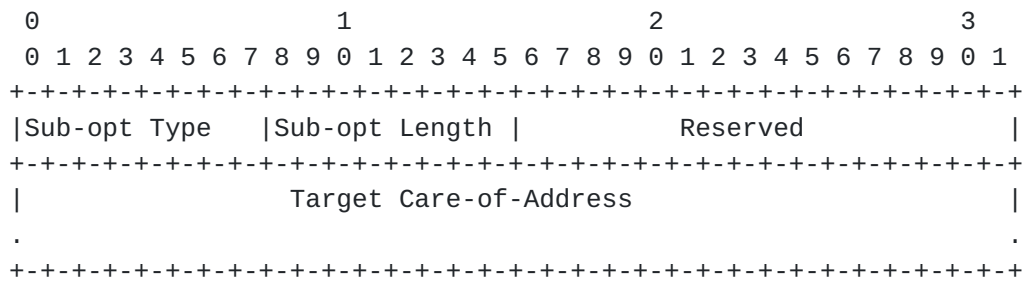


Figure 6: Target Care-of-Address Sub-option

**Sub-opt Type**

To be assigned by IANA (IANA-TBD3)

**Sub-opt Length**

Length of the sub-option in octets, excluding the Sub-opt Type and Sub-opt Length fields.

**Reserved**

This field is unused. It MUST be initialized to zero by the sender and MUST be ignored by the receiver.

**Target Care-of-Address**

The address of an interface that the flow is moved to. This address could be IPv4 or IPv6 address. This sub-option MUST be included when the action taken is "15 Move a flow binding".

**7. Security Considerations**

Security issues for this document follow those of [\[RFC6088\]](#), [\[RFC6089\]](#) and [\[RFC5846\]](#). This specification allows the home agent to manipulate only the binding of a flow(s) that is currently registered with it, which is the same principle described in [\[RFC5846\]](#). No additional security issue specific to this document is identified.

**8. Protocol constants****Maximum FBI retries (MAX\_FBI\_RETRIES)**

This variable specifies the maximum number of times the HA MAY retransmit a Flow Binding Indication message when FBA is not returned within the time period specified by MAX\_FBA\_TIMEOUT. The default value for this parameter is 3.





Maximum FBA timeout (MAX\_FBA\_TIMEOUT)

This variable specifies the maximum time in seconds the HA MUST wait before retransmitting another FBI message. The default for this parameter is 3 seconds.

## **9. IANA considerations**

This document defines one new Mobility Header and two new mobility options to be used in Flow Binding Initiate and Flow Binding Acknowledge messages. A new Mobility Header Type and two new sub-opt type values (IANA-TBD1 through IANA-TBD3) need to be assigned by IANA.

## **10. References**

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[I-D.ietf-netext-pmip6-qos]

Liebsch, M., Seite, P., Yokota, H., Korhonen, J., and S. Gundavelli, "Quality of Service Option for Proxy Mobile IPv6", [draft-ietf-netext-pmip6-qos-03](#) (work in progress), July 2013.

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