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Foreword

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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1 Scope

The present document specifies the stage 3 of the PMIPv6 Based Mobility and Tunnelling Protocols used over the PMIP-based S2a, S2b, S5, and S8 reference points defined in 3GPP TS 23.402 [3], and are thus applicable to the Serving GW, PDN Gateway, ePDG, and Trusted Non-3GPP Access. Protocols specifications are compliant with relevant IETF RFCs. In this specification PMIP refers to PMIPv6 as defined in IETF RFC5213 [4].

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.401: "GPRS enhancements for E-UTRAN access ".

[3] 3GPP TS 23.402: "Architecture Enhancements for non-3GPP accesses".

[4] IETF RFC 5213: "Proxy Mobile IPv6".

[5] IETF Draft, "IPv4 Support for Proxy Mobile IPv6", draft-ietf-netlmm-pmip6-ipv4-support-05, work in progress.

[6] IETF Draft, "Binding Revocation for IPv6 Mobility", draft-ietf-mext-binding-revocation-01, work in progress.

[7] IETF Draft, "GRE Key Option for Proxy Mobile IPv6", draft-ietf-netlmm-grekey-option-00, work in progress.

[8] IETF RFC 3775, "Mobility Support in IPv6".

[9] IETF RFC 4282: "The Network Access Identifier".

[10] IETF RFC 4283: "Mobile Node Identifier Option for Mobile IPv6 (MIPv6)".

[11] IETF RFC 5149: "Service Selection for Mobile Ipv6".

[12] 3GPP TS 23.003: "Numbering, addressing and identification".

[13] 3GPP TS 23.007: "Restoration Procedures".

[14] IETF RFC 5094: "Mobile IPv6 Vendor Specific Option"

[15] IANA Private Enterprise Numbers Registry, <http://www.iana.org/assignments/enterprise-numbers>.

[16] 3GPP TS 24.008: "Mobile radio interface Layer 3 specification; Core network protocols".

[17] IETF Draft, draft-ietf-netlmm-pmipv6-heartbeat-00, "Heartbeat Mechanism for Proxy Mobile Ipv6", work in progress.

[18]   IANA Mobile Ipv6 Parameters Registry, <http://www.iana.org/assignments/mobility-parameters
            >.

[19]   3GPP TS 33.402: "3GPP System Architecture Evolution (SAE); Security aspects of non-3GPP
            accesses".

[20]   IETF RFC 2784: "Generic Routing Encapsulation (GRE)".

[21]   IETF RFC 2890: "Key and Sequence Number Extensions to GRE".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

The following terms used in this Technical Specification are defined in the PMIPv6 specification IETF RFC 5213 [4]: IPv6 Home Network Prefix, Proxy Care-of Address, Local Mobility Anchor Address. The following terms used in this Technical Specification are defined in the IPv4 Support for PMIPv6 specification IETF Draft draft-ietf-netlmm-pmip6-ipv4-support [5]: IPv4 Home Address, IPv4 Local Mobility Anchor Address. The following terms used in this Technical Specification are defined in the MIPv6 specification [8] and extended by the PMIPv6 specification IETF RFC 5213 [4]: Binding Cache Entry, Binding Update List Entry. The following terms used in this specification are defined in the Binding Revocation for MIPv6 Mobility [6]: Binding Revocation Indication and Binding Revocation Acknowledgement.

Local Mobility Anchor: Within EPS the Local Mobility Anchor functionality consists of a PMIPv6 Local Mobility Anchor as described in the PMIPv6 specification IETF RFC 5213 [4] with support of IPv4 Support for PMIPv6 as defined in IETF Draft draft-ietf-netlmm-pmip6-ipv4-support [5], Binding Revocation for IPv6 Mobility as defined in IETF Draft draft-ietf-mext-binding-revocation [6], GRE Key Option for PMIPv6 as defined in IETF Draft draft-ietf-netlmm-grekey-option [7], and PMIPv6 Heartbeat Mechanism as defined in IETF Draft draft-netlmm-pmipv6-heartbeat [17].

Mobile Access Gateway: Within EPS the Mobility Access Gateway functionality consists of a PMIPv6 Mobility Access Gateway as described in the PMIPv6 specification IETF RFC 5213 [4] with support of IPv4 Support for PMIPv6 as defined in IETF Draft draft-ietf-netlmm-pmip6-ipv4-support [5], Binding Revocation for IPv6 Mobility as defined in IETF Darft draft-ietf-mext-binding-revocation [6], GRE Key Option for PMIPv6 as defined in IETF Draft draft-ietf-netlmm-grekey-option [7], and PMIPv6 Heartbeat Mechanism as defined in IETF Draft draft-netlmm-pmipv6-heartbeat [17].

PDN Connection: The association between a UE represented by one IPv4 Home Address and/or one IPv6 Home Network Prefix, and a PDN represented by an APN. On a PMIPv6 peer (MAG or LMA) there is a one-to-one mapping between a PDN connection and a PMIPv6 binding.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

BCE	Binding Cache Entry
BRA	Binding Revocation Acknowledgement
BRI	Binding Revocation Indication
BULE	Binding Update List Entry
EPC	Evolved Packet Core
GRE	Generic Routing Encapsulation
GW	Gateway
IPv4-LMAA	IPv4 LMAA

LMA	Local Mobility Anchor
LMAA	LMA Address
MAG	Mobility Access Gateway
MIPv6	Mobile IPv6
PBA	Proxy Binding Acknowledgment
PBU	Proxy Binding Update
PMIPv6	Proxy MIPv6
Proxy-CoA	Proxy Care-of Address

4 General

4.1 PDN Connection

On a PMIPv6 peer (MAG or LMA) there is a one-to-one mapping between a PDN connection and a PMIPv6 binding.

Traffic sent over a given PDN connection is encapsulated with GRE [20] using different, per-interface (PMIP-based S5, PMIP-based S8, S2a, or S2b), per-PDN connection, per direction (uplink and downlink) GRE keys [21] to allow multiplexing and demultiplexing of traffic belonging to different PDN connections at MAG and LMA.

4.2 PMIPv6 Protocol stacks

Protocol stacks for PMIPv6 are depicted in Figure 4.2-1. The MAG functions are defined in 3GPP TS 23.402 [3], e. g., relaying DHCPv4/DHCPv6 packets between the UE and the DHCP server, forwarding the payload packets between the UE and the LMA.
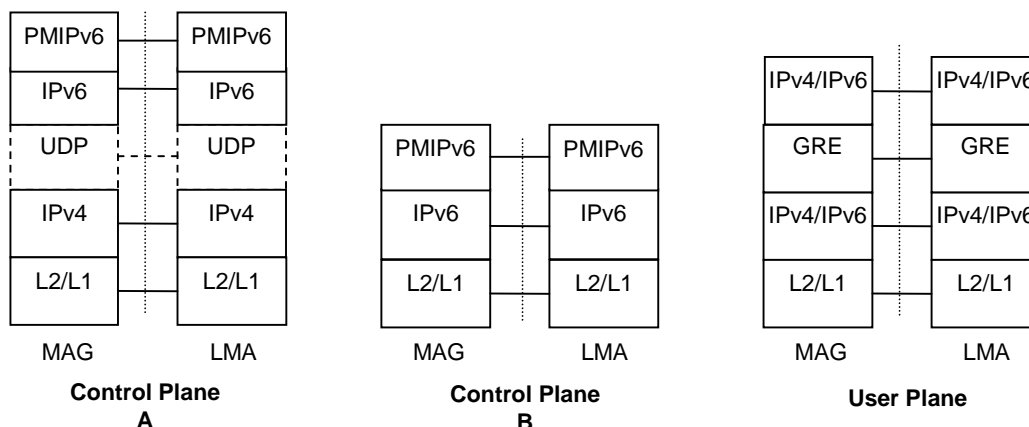
Figure 4.2-1: Protocols stacks for PMIP

The Control Plane A is for PMIPv6 signals transported over IPv4, and the Control Plane B is for PMIPv6 signals transported over IPv6. When IPv4 transport is used, UDP encapsulation may be used as described in draft-ietf-netlmm-pmip6-ipv4-support [5].

5   Mobility Management procedures

5.1   Proxy Mobile IPv6 PDN Connection Creation procedure

5.1.1   General

The PMIPv6 PDN Connection Creation procedure is initiated by the node acting as a MAG to create a new PDN connection with the node acting as an LMA for an UE that either attaches for the first time to the EPC, or connects to an additional PDN. The procedure starts with the MAG sending a PBU including the APN to the LMA to register with the LMA a binding for the UE's PDN connection. The LMA confirms establishment of the binding by sending a PBA to the MAG. Establishment of the binding achieves the following:

- **PDN selection:** The LMA select the PDN based on the APN contained in the PBU.

- **IPv6 Home Network Prefix assignment:** The LMA assigns to the UE's PDN connection an IPv6 Home Network Prefix valid in the selected PDN.

- **IPv4 Home Address assignment:** The LMA assigns to the UE's PDN connection an IPv4 Home Address valid in the selected PDN.

- **Downlink and Uplink GRE Key Assignment:** The MAG and LMA will establish downlink and uplink GRE keys to be used for GRE encapsulation of the PDN connection's downlink and uplink traffic, respectively.

- **GRE Tunnel Establishment:** A GRE tunnel is established between the MAG and LMA with the assigned GRE keys to carry uplink and downlink traffic that the UE respectively sends and receives on the PDN connection.

- **BCE Creation:** The LMA creates a BCE for the PDN connection.

- **BULE Creation:** The MAG creates a BULE for the PDN connection.

- **MAG Link Local Address assignment:** The LMA assigns the MAG link local address.

- **UE Interface Identifier (IID) assignment:** The LMA assigns to the UE an IPv6 Interface Identifier to allow formation of an UE Link Local Address from the well-known link local address prefix (fe80::/64).

5.1.1.1   Proxy Binding Update

The fields of a PBU message for the PMIPv6 PDN Connection Creation procedure are depicted in Table 5.1.1.1-1.

The Mobility Options in a PBU message for the PMIPv6 PDN Connection Creation procedure are depicted in Table 5.1.1.1-2.

Other flags are not used by this specification.

Table 5.1.1.1-1: Fields of a PBU message for the PMIPv6 PDN Connection Creation procedure

Information element	IE Description	Reference
Sequence Number	Set to a locally (i.e. per MAG) monotonically increasing value.	IETF RFC 5213 [4]
Lifetime	Set to the requested number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.1.1.1-2: Mobility Options in a PBU message for the PMIPv6 PDN Connection Creation procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12]
IPv6 Home Network Prefix option	C	For dynamic allocation, set to the value "0::/0" to request allocation for the UE's PDN connection of an IPv6 Home Network Prefix in the PDN corresponding the EPS Access Point Name. For static allocation, set to the received static allocated IPv6 Home Network Prefix. NOTE 1.	IETF RFC 5213 [4]
Link-local Address	M	Link-local address of the MAG. Set to ALL_ZERO (all bits set to 0), indicating that the MAG requests a link-local address to be used on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Set to the value "1" to indicate attachment over a new interface.	IETF RFC 5213 [4]
Access Technology Type option	M	Set to the 3GPP access type (e.g., E-UTRAN) or to the value matching the characteristics of the non-3GPP access (e.g., HRPD) the UE is using to attach to the EPS as defined in the Access Technology Type Option type values registry of the IANA Mobile IPv6 Parameters Registry [18].	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
GRE key option	M	Set to the downlink GRE key to be used for downlink GRE encapsulated packets sent over the PDN connection.	draft-ietf-netlmm-grekey-option [7]
IPv4 Home Address option	C	For dynamic allocation, set to the value "0.0.0.0" to request allocation for the UE's PDN connection of an IPv4 Home Address in the PDN corresponding to the EPS Access Point Name. For static allocation, set to the received static allocated IPv4 Home Address. NOTE 1.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE attaches the new PDN connection, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Mobility Option – Protocol Configuration Options	O	Contain Protocol Configuration Options (Refer tosection 12.1.1).	IETF RFC 5094 [14]
Vendor-Specific Option - PDN GW IP Address	O	Contain PDN GW IP address (on S2a or S2b when used for chained S2a/S2b-PMIP based S8). (Refer to section 12.1.1.4).	IETF RFC 5094 [14]
NOTE 1: At least one of the two options, namely, the IPv6 Home Network Prefix option or the IPv4 Home Address option shall be present. If the UE requires both an IPv6 Home Network Prefix and an IPv4 Home Address, both options shall be included in the same PBU message.			

5.1.1.2 Proxy Binding Acknowledgement

The fields of a PBA message for the PMIPv6 PDN Connection Creation procedure are depicted in Table 5.1.1.2-1.

The Mobility Options in a PBA message for the PMIPv6 PDN Connection Creation procedure are depicted in Table 5.1.1.2-2.

Other flags are not used by this specification.

Table 5.1.1.2-1: Fields of a PBA message for the PMIPv6 PDN Connection Creation procedure

Information element	IE Description	Reference
Status	Set to indicate the result.	IETF RFC 3775 [8]
Sequence Number	Set to the value received in the corresponding PBU.	IETF RFC 5213 [4]
Lifetime	Set to the granted number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.1.1.2-2: Mobility Options in a PBA message for the PMIPv6 PDN Connection Creation procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	C	If it is present in the corresponding PBU, set to the IPv6 Home Network Prefix Allocated for the UE's PDN connection based on the selected PDN corresponding to the EPS Access Point Name for dynamic allocation, or set to the static IPv6 Home Network Prefix received in the PBU for static allocation. In addition, the Interface Identifier (IID) allocated for the UE is encoded in the low order 64 bits of this option, i.e., the IPv6 Home Network Prefix option.	IETF RFC 5213 [4]
Link-local Address	M	Link-local address to be used by the MAG on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Access Technology Type option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
GRE key option	M	Set to the uplink GRE key to be used for uplink GRE encapsulated packets sent over the PDN connection.	draft-ietf-netlmm-grekey-option [7]
IPv4 Address Acknowledgment option	C	If it is present in the corresponding PBU, set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN corresponding to the EPS Access Point Name for dynamic allocation, or set to the static IPv4 Home Address received in the PBU for static allocation.	draft-ietf-netlmm-pmip6-ipv4-support [5]
IPv4 Default Router Address Option	C	Set to the UE"s IPv4 default router address. This option shall be present if and only if IPv4 Home Address option is present.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option - PDN Type	C	Contain PDN type Options (Refer to section 12.1.1.3). This option shall be present if and only if PDN type is changed in the PDN GW compared to what was requested in the PBU.	IETF RFC 5094 [14]
Vendor-Specific Option	C	Contain the PMIPv6 DHCPv4 Address Allocation Procedure Indication option (see section 12.1.1.5). This option shall be present if and only if DHCPv4 is to be used to allocate the IPv4 address to the UE.	IETF RFC 5094[14]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]

5.1.2   MAG procedures

A MAG initiating the PMIPv6 PDN Connection Creation procedure shall follow the "Mobile Node Attachment and Initial Binding Registration" procedure described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications with the following additional requirements:

1. Generate a downlink GRE key that is not already in use locally for the PDN connection's downlink traffic to that UE, as specified in the GRE Key Option for PMIPv6 specification [7].

2. If the static IPv4 Home Address and/or IPv6 Home Network Prefix are available at the MAG, set them in the IPv4 home address option and/or the IPv6 home prefix option in the PBU.

Set other parameters in the PBU as specified by the PBU parameters section for this procedure.

5.1.3   LMA procedures

On reception of a PBU, the LMA shall initiate the "Initial Binding Registration (New Mobility session)" and "Processing Binding Registrations" procedures described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications with the following additional requirements:

1. Select the PDN for the UE's PDN connection based on the APN present in the PBU.

2. Check if the received IPv6 Home prefix and/or IPv4 Home address are topologically correct.

3. If no static IPv6 Home Network Prefix and/or IPv4 Home Address were received in the PBU, allocate the IPv6 Home Network Prefix and/or an IPv4 Home Address for the selected PDN.

4. Generate a uplink GRE key that is not already in use locally for the PDN connection's uplink traffic from that UE, as specified in the GRE Key Option for PMIPv6 specification [7].

5. Assign to the UE an IPv6 Interface Identifier to allow formation of an UE Link Local Address from the well-known link local address prefix (fe80::/64).

6. Set parameters in the PBA as specified by the PBA parameters section for this procedure.

5.2   Proxy Mobile IPv6 PDN Connection Lifetime Extension procedure

5.2.1   General

The PMIPv6 PDN Connection Lifetime Extension procedure is initiated by the node acting as a MAG to prolong the lifetime of an existing PDN connection with the node acting as an LMA for an UE that is already attached. The procedure starts with the MAG sending a PBU to the LMA to extend the binding lifetime for the UE's PDN connection. The LMA confirms that the binding lifetime is extended by sending a PBA to the MAG.

5.2.1.1   Proxy Binding Update

The fields of a PBU message for the PMIPv6 PDN Connection Lifetime Extension procedure are depicted in Table 5.2.1.1-1.

The Mobility Options in a PBU message for the PMIPv6 PDN Connection Lifetime Extension procedure are depicted in Table 5.2.1.1-2.

Other flags are not used by this specification.

Table 5.2.1.1-1: Fields of a PBU message for the PMIPv6 PDN Connection Lifetime Extension procedure

Information element	IE Description	Reference
Sequence Number	Set to a locally (i.e. per MAG) monotonically increasing value.	IETF RFC 5213 [4]
Lifetime	Set to the requested number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.2.1.1-2: Mobility Options in a PBU message for the PMIPv6 PDN Connection Lifetime Extension procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12]
IPv6 Home Network Prefix option	C	Set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN. NOTE 1.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Set to the value "5" to indicate handoff state not changed (Re-registration).	IETF RFC 5213 [4]
Access Technology Type option	M	Set to the 3GPP access type (e.g., E-UTRAN) or to the value matching the characteristics of the non-3GPP access (e.g., HRPD) the UE is using to attach to the EPS as defined in the Access Technology Type Option type values registry of the IANA Mobile IPv6 Parameters Registry [18].	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Home Address option	C	Set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN. NOTE 1.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]
NOTE 1: At least one of the two options, namely, the IPv6 Home Network Prefix option or the IPv4 Home Address option shall be present. If the UE has both IPv4 home address and IPv6 home network prefix registered, both the IPv6 Home Network Prefix option and IPv4 Home Address option shall be included in the same PBU message.			

5.2.1.2 Proxy Binding Acknowledgement

The fields of a PBA message for the PMIPv6 PDN Connection Lifetime Extension procedure are depicted in Table 5.2.1.2-1.

The Mobility Options in a PBA message for the PMIPv6 PDN Connection Lifetime Extension procedure are depicted in Table 5.2.1.2-2.

Other flags are not used by this specification.

Table 5.2.1.2-1: Fields of a PBA message for the PMIPv6 PDN Connection Lifetime Extension procedure

Information element	IE Description	Reference
Status	Set to indicate the result.	IETF RFC 3775 [8]
Sequence Number	Set to the value received in the corresponding PBU.	IETF RFC 5213 [4]
Lifetime	Set to the granted number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.2.1.2-2: Mobility Options in a PBA message for the PMIPv6 PDN Connection Lifetime Extension procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	C	If it is present in the corresponding PBU, set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Access Technology Type option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Address Acknowledgment option	C	If it is present in the corresponding PBU, set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]

5.2.2 MAG procedures

A MAG initiating the PMIPv6 PDN Connection Lifetime Extension procedure shall follow the "Extending Binding Lifetime" procedure described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications, while parameters in the PBU are set as specified by the PBU parameters section for this procedure.

5.2.3 LMA procedures

On reception of a PBU, the LMA shall initiate the "Binding Lifetime Extension without Handover" procedure as described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications, while parameters in the PBA are set as specified by the PBA parameters section for this procedure.

5.3 Proxy Mobile IPv6 PDN Connection Handover procedure

5.3.1 General

The PMIPv6 PDN Connection Handover procedure is initiated by the node acting as a new MAG for the UE to update an existing PDN connection for an UE that is already attached to the EPC. The procedure starts with the MAG sending a PBU including the APN to the LMA to update the binding for the UE's PDN connection. The LMA confirms update of the binding by sending a PBA to the MAG. Update of the binding achieves the following:

- **IPv6 Home Network Prefix re-assignment:** The LMA re-assigns to the UE"s PDN connection the IPv6 Home Network Prefix valid in the selected PDN.

- **IPv4 Home Address re-assignment:** The LMA re-assigns to the UE"s PDN connection the IPv4 Home Address valid in the selected PDN.

- **Downlink and Uplink GRE Key Assignment:** The MAG and LMA will establish downlink and uplink GRE keys to be used for GRE encapsulation of downlink and uplink traffic, respectively on the PDN connection.

- **GRE Tunnel Establishment:** A GRE tunnel is established between the MAG and LMA with the assigned GRE keys to carry uplink and downlink traffic that UE respectively sends and receives on the PDN connection.

- **BCE Update:** The LMA updates or creates the BCE for the PDN connection.

- **BULE Creation:** The new MAG creates a BULE for the PDN connection.

- **IP address(es) preservation:** the IP addresses allocated in the previous initial attachment are reused if IP address(es) preservation decision is made.

- **MAG Link Local Address re-assignment:** The LMA re-assigns the same MAG link local address.

- **UE Interface Identifier (IID) re-assignment:** The LMA re-assigns to the UE the same IPv6 Interface Identifier to allow formation of the same UE Link Local Address from the well-known link local address prefix (fe80::/64).

5.3.1.1 Proxy Binding Update

The fields of a PBU message for the PMIPv6 PDN Connection Handover procedure are depicted in Table 5.3.1.1-1.

The Mobility Options in a PBU message for the PMIPv6 PDN Connection Handover procedure are depicted in Table 5.3.1.1-2.

Table 5.3.1.1-1: Fields of a PBU message for the PDN Connection Handover procedure

Information element	IE Description	Reference
Sequence Number	Set to a locally (i.e. per MAG) monotonically increasing value.	IETF RFC 5213 [4]
Lifetime	Set to the requested number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.3.1.1-2: Mobility Options in a PBU message for the PMIPv6 PDN Connection Handover procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12]
IPv6 Home Network Prefix option	C	If available at the MAG, set to the IPv6 Home Network Prefix allocated to the UE's PDN connection. Otherwise, set to the value "0::/0" to request allocation for the UE's PDN connection of an IPv6 Home Network Prefix for the UE in the PDN corresponding to the EPS Access Point Name. NOTE 1.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Set to the value "2" (Handoff between two different interfaces) in case the handover is an inter access handover (i.e. from 3GPP to non-3GPP, from non-3GPP to 3GPP, or between two non-3GPP accesses) and IP address(es) preservation decision is taken; or Set to the value "3" (Handoff between mobile access gateways for the same interface) in case the handover is an intra access (i.e. between two 3GPP accesses) handover; or Set to the value "4" (Handoff state unknown) in case the handover is an inter access handover (i.e. from 3GPP to non-3GPP, from non-3GPP to 3GPP, or between two non-3GPP accesses) and IP address(es) preservation decision is negative or unknown.	IETF RFC 5213 [4]
Access Technology Type option	M	Set to the 3GPP access type (e.g., E-UTRAN) or to the value matching the characteristics of the non-3GPP access (e.g., HRPD) the UE is using to attach to the EPS as defined in the Access Technology Type Option type values registry of the IANA Mobile IPv6 Parameters Registry [18].	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
GRE key option	M	Set to the downlink GRE key to be used for downlink GRE encapsulated packets sent over the PDN connection.	draft-ietf-netlmm-grekey-option [7]
IPv4 Home Address option	C	If available at the MAG, set to the IPv4 Address allocated to the UE's PDN connection. Otherwise, set to the value "0.0.0.0" to request allocation for the UE's PDN connection of an IPv4 Home Address in the PDN corresponding to the EPS Access Point Name. NOTE 1.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Mobility Option – Protocol Configuration Options	O	Contain Protocol Configuration Options (Refer to section 12.1.1).	IETF RFC 5094 [14]
Vendor-Specific Option - PDN GW IP Address	O	Contain PDN GW IP address (on S2a or S2b when used for chained S2a/S2b-PMIP based S8). (Refer to section 12.1.1.4).	IETF RFC 5094 [14]
NOTE 1: At least one of the two options, namely, the IPv6 Home Network Prefix option or the IPv4 Home Address option shall be present. If the MAG knows the UE has both IPv4 home address and IPv6 home network prefix registered, both the IPv6 Home Network Prefix option and IPv4 Home Address option shall be included in the same PBU message.			

5.3.1.2 Proxy Binding Acknowledgement

The fields of a PBA message for the PMIPv6 PDN Connection Handover procedure are depicted in Table 5.3.1.2-1.

The Mobility Options in a PBA message for the PMIPv6 PDN Connection Handover procedure are depicted in Table 5.3.1.2-2.

Other flags are not used by this specification.

Table 5.3.1.2-1: Fields of a PBA message for the PMIPv6 PDN Connection Handover procedure

Information element	IE Description	Reference
Status	Set to indicate the result.	IETF RFC 3775 [8]
Sequence Number	Set to the value received in the corresponding PBU.	IETF RFC 5213 [4]
Lifetime	Set to the granted number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.3.1.2-2: Mobility Options in a PBA message for the PMIPv6 PDN Connection Handover procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	C	If it is present in the corresponding PBU, set to the IPv6 Home Network Prefix Allocated for the UE's PDN connection based on the selected PDN corresponding to the EPS Access Point Name for dynamic allocation, or set to the static IPv6 Home Network Prefix received in the PBU for static allocation. In addition, the Interface Identifier (IID) allocated for the UE is encoded in the low order 64 bits of this option, i.e., the IPv6 Home Network Prefix option.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Access Technology Type option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
GRE key option	M	Set to the uplink GRE key to be used for uplink GRE encapsulated packets sent over the PDN connection. The same uplink GRE key used for the UE's PDN connection with the previous MAG shall be re-assigned.	draft-ietf-netlmm-grekey-option [7]
IPv4 Address Acknowledgment option	C	If it is present in the corresponding PBU, set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN corresponding to the EPS Access Point Name for dynamic allocation, or set to the static IPv4 Home Address received in the PBU for static allocation.	draft-ietf-netlmm-pmip6-ipv4-support [5]
IPv4 Default Router Address Option	C	Set to the UE"s IPv4 default router address. This option shall be present if and only if IPv4 Home Address option is present.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option - PDN Type	C	Contain PDN type Options (Refer to section 12.1.1.3). This option shall be present if and only if PDN type is changed in the PDN GW compared to what was requested in the PBU.	IETF RFC 5094 [14]
Vendor-Specific Option	C	Contain the PMIPv6 DHCPv4 Address Allocation Procedure Indication option (Refer to section 12.1.1.5). This option shall be present if and only if DHCPv4 is to be used to allocate the IPv4 address to the UE.	IETF RFC 5094[14]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]

5.3.2   MAG procedures

A MAG initiating the PMIPv6 PDN Connection Handover procedure shall follow the "Mobile Node Attachment and Initial Binding Registration" procedure described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications with the following additional requirements:

1. Generate a downlink GRE key that is not already in use locally for the PDN connection's downlink traffic to that UE, as specified in the GRE Key Option for PMIPv6 specification [7].

2. Set other parameters in the PBU as specified by the PBU parameters section for this procedure.

5.3.3   LMA procedures

On reception of a PBU, the LMA shall initiate the "Binding Lifetime Extension (After handoff)" and "Processing Proxy Binding Updates" procedures described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications with the following additional requirements:

1. Re-assign the same uplink GRE key that was used by the previous MAG for the PDN connection's uplink traffic from the UE, as specified in the GRE Key Option for PMIPv6 specification [7].

2. Check if the received IPv6 Home prefix and/or IPv4 Home address are topologically correct.

3. Dynamic IP address allocation:

    a. If Handoff Indicator option is "2" or "3": Re-allocate an IPv6 Home Network Prefix and/or an IPv4 Home Address for the selected PDN.

    b. If Handoff Indicator option is "4": Make the IP address preservation decision as per the PMIPv6 specification [4].

4. Set parameters in the PBA as specified by the PBA parameters section for this procedure.

5.4   Proxy Mobile IPv6 MAG Initiated PDN Connection Deletion procedure

5.4.1   General

The PMIPv6 MAG Initiated PDN Connection Deletion procedure is initiated by the node acting as a MAG to tear down an existing PDN connection with the node acting as an LMA. The procedure starts with the MAG sending a PBU to the LMA to deregister with the LMA a binding for the UE's PDN connection. The LMA confirms deregistration of the binding by sending a PBA to the MAG. Deregistration of the binding achieves the following:

-   **IPv6 Home Network Prefix deallocation:** When the PDN connection is released, the LMA returns the IPv6 Home Network Prefix assigned to the UE's PDN connection to the pool of free IPv6 Home Network Prefixes.

-   **IPv4 Home Address deallocation:** When the PDN connection is released, the LMA returns the IPv4 Home Address assigned to the UE's PDN connection to the pool of free IPv4 Home Network Addresses.

-   **Downlink and Uplink GRE Key de-assignment:** The MAG and LMA will return, respectively, the PDN connection's uplink and downlink GRE keys to their respective pool of free GRE keys.

-   **GRE Tunnel Tear-down:** The GRE tunnel between the MAG and LMA is deleted.

-   **BCE Deletion:** The LMA deletes the BCE for the PDN connection.

-   **BULE Deletion:** The MAG deletes the BULE for the PDN connection.

5.4.1.1   Proxy Binding Update

The fields of a PBU message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure are depicted in Table 5.4.1.1-1.

The Mobility Options in a PBU message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure are depicted in Table 5.4.1.1-2.

Other flags are not used by this specification.

Table 5.4.1.1-1: Fields of a PBU message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure

Information element	IE Description	Reference
Sequence Number	Set to a locally (i.e. per MAG) monotonically increasing value.	IETF RFC 5213 [4]
Lifetime	Set to "0" to request deletion of the BCE.	IETF RFC 3775 [8]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.4.1.1-2: Mobility Options in a PBU message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12]
IPv6 Home Network Prefix option	C	Set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN. NOTE 1.	IETF RFC 5213 [4]
Handoff Indicator option	M	Set to the value "4" to indicate Handoff state unknown.	IETF RFC 5213 [4]
Access Technology Type option	M	Set to the 3GPP access type (e.g., E-UTRAN) or to the value matching the characteristics of the non-3GPP access (e.g., HRPD) the UE is using to attach to the EPS as defined in the Access Technology Type Option type values registry of the IANA Mobile IPv6 Parameters Registry [18].	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Home Address option	C	Set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN. NOTE 1.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]
NOTE 1: At least one of the two options, namely, the IPv6 Home Network Prefix option or the IPv4 Home Address option shall be present. If the UE has both IPv4 home address and IPv6 home network prefix registered, both the IPv6 Home Network Prefix option and IPv4 Home Address option shall be included in the same PBU message.			

5.4.1.2 Proxy Binding Acknowledgement

The fields of a PBA message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure are depicted in Table 5.4.1.2-1.

The Mobility Options in a PBA message for the MAG Initiated PDN Connection Deletion procedure are depicted in Table 5.4.1.2-2.

Other flags are not used by this specification.

Table 5.4.1.2-1: Fields of a PBA message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure

Information element	IE Description	Reference
Status	Set to indicate the result.	IETF RFC 3775 [8]
Sequence Number	Set to a value received in the corresponding PBU.	IETF RFC 5213 [4]
Lifetime	Set to "0" to request deletion of the binding.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.4.1.2-2: Mobility Options in a PBA message for the PMIPv6 MAG Initiated PDN Connection Deletion procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	C	If it is present in the corresponding PBU, set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN.	IETF RFC 5213 [4]
Handoff Indicator option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Access Technology Type option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Address Acknowledgment option	C	If it is present in the corresponding PBU, set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
Vendor-Specific Option	O	Contain Protocol Configuration Options (see section 12.1.1).	IETF RFC 5094 [14]

5.4.2   MAG procedures

A MAG initiating the PMIPv6 Initial MAG Initiated PDN Connection Deletion procedure shall follow the "Mobile Node Detachment and Binding De-Registration" procedure described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications, while parameters in the PBU are set as specified by the PBU parameters section for this procedure.

5.4.3   LMA procedures

On reception of a PBU, the LMA shall initiate the "Binding De-Registration" procedure described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications, while parameters in the PBA are set as specified by the PBA parameters section for this procedure.

5.5   Proxy Mobile IPv6 LMA Initiated PDN Connection Deletion procedure

5.5.1   General

In EPC the PMIPv6 LMA Initiated PDN Connection Deletion is initiated by the node acting as a LMA to notify the node acting as a MAG, that the Binding Cache Entry related to the UE is about to be deactivated, so the MAG should remove the resources related to that PDN connection. The procedure starts with the LMA sending a BRI to the MAG to revoke the binding. The MAG confirms the revocation of the binding by sending a BRA to the LMA.

The LMA Initiated PDN Connection Deletion Procedure initiated by the LMA achieves the following:

- **IPv6 Home Network Prefix release**: When the UE's PDN connection is deactivated, the LMA returns the IPv6 Home Network Prefix assigned to the UE's PDN connection to the pool of free IPv6 Home Network Prefixes.

- **IPv4 Home Address release**: When the UE's PDN connection is deactivated, the LMA returns the IPv4 Home Address assigned to the UE's PDN connection to the pool of free IPv4 Home Network Addresses.

- **Downlink and Uplink GRE keys de-assignment**: The MAG and LMA will return, respectively, the PDN connection's uplink and downlink GRE keys to their respective pool of free GRE keys.

- **GRE tunnel Deletion**: The GRE tunnel is removed from the LMA and the MAG.

- **BCE Deletion**: The LMA deletes the BCE for the PDN connection.

- **BULE Deletion**: The MAG deletes the BULE for the PDN connection.

5.5.1.1   Binding Revocation Indication

The fields of a BRI message for the PMIPv6 LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.5.1.1-1.

The Mobility Options in a BRI message for the LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.5.1.1-2.

Table 5.5.1.1-1: Fields of a BRI message for the PMIPv6

Information element	IE Description	Reference
Sequence Number	A sequence number generated by the LMA, and increased for every BRI sent.	draft-ietf-mext-binding-revocation [6]
Revocation Trigger	Set to a value indicating the event which triggered the revoking node to send the BRI message	draft-ietf-mext-binding-revocation [6]
Proxy Binding Flag (P)	Set to "1" to indicate that the Binding Revocation Indication is for a proxy MIPv6 binding entry.	IETF RFC 5213 [4]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	draft-ietf-mext-binding-revocation [6]
Global Per-Peer Bindings (G)	Set to 0 to indicate that the request is for a specific PMIPv6 BCE.	draft-ietf-mext-binding-revocation [6]

Table 5.5.1.1-2: Mobility Options in a BRI message for the PMIPv6 LMA Initiated PDN Connection Deletion

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE, as specified in 3GPP TS 23.003[12].	3GPP TS 23.003[12]
IPv6 Home Network Prefix option	C	Set to the Home Network Prefix of the UE's PDN connection. NOTE 1.	IETF RFC 5213 [4]
IPv4 Home Address option	C	Set to the IPv4 home address of the UE's PDN connection. NOTE 1.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]
NOTE 1: At least one of the two options, namely, the IPv6 Home Network Prefix option or the IPv4 Home Address option shall be present. If the UE has both IPv4 home address and IPv6 home network prefix registered, both the IPv6 Home Network Prefix option and IPv4 Home Address option shall be included in the same BRI message.			

5.5.1.2   Binding Revocation Acknowledgment

The fields of a BRA message for the PMIPv6 LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.5.1.2-1.

The Mobility Options in a BRA message for the LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.5.1.2-2.

Table 4.1.5.2-1: Fields of a BRA message for a PMIPv6 LMA Initiated PDN Connection Deletion

Information element	IE Description	Reference
Sequence Number	Set to the value received in the corresponding BRI.	draft-ietf-mext-binding-revocation [6]
Status	Indicates the result of the BRI: can be set to 0 for success, 1 for an unspecified failure or 2 for an inexistent UE binding.	draft-ietf-mext-binding-revocation [6]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Revocation Acknowledgment is for a proxy MIPv6 binding entry.	IETF RFC 5213 [4]
Global Per-Peer Bindings (G)	Set to 0; the same value as for the BRI.	draft-ietf-mext-binding-revocation [6]

Table 5.5.1.2-2: Mobility Options in a BRA message for the PMIPv6 LMA Initiated PDN Connection Deletion

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of BRI.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	C	Set to the IPv6 Home Network Prefix of the UE's PDN connection received in BRI.	IETF RFC 5213 [4]
IPv4 Address Acknowledgment option	C	Set to the IPv4 home address of the UE's PDN connection received in BRI.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]

5.5.2   MAG procedures

The MAG shall follow the "Local Mobility Anchor Revokes a PMIPv6 Binding" procedure described in the draft-muhanna-mip6-binding-revocation [6]. The MAG should release the resources associated with the UE's PDN connection referred to in the BRI message.

The MAG shall respond with a BRA.

5.5.3   LMA procedures

The LMA shall send a BRI to the MAG as described in the "Local Mobility Anchor Revokes a PMIPv6 binding" procedure described in the draft-muhanna-mip6-binding-revocation [6]. The LMA shall clear the BCE related to the UE's PDN connection after sending the BRI in case of UE detach.

5.6   Proxy Mobile IPv6 PDN Connection IPv4 address allocation procedure

5.6.1   General

This procedure is initiated by the node acting as a MAG when DHCPv4 message is received from the UE which requires a new IPv4 address. The MAG sends a PBU to LMA requesting a new IPv4 address for an existing PDN connection. The LMA assigns a new IPv4 address by sending a PBA to the MAG. IPv4 address assignment procedure achieves the following:

-    **IPv4 Home Address assignment:** The LMA assigns to the UE's PDN connection an IPv4 Home Address valid in the selected PDN.

5.6.1.1 Proxy Binding Update

The fields of a PBU message for the PMIPv6 PDN Connection IPv4 address allocation procedure are depicted in Table 5.6.1.1-1.

The Mobility Options in a PBU message for the PMIPv6 PDN Connection IPv4 address allocation procedure are depicted in Table 5.6.1.1-2.

Other flags are not used by this specification.

Table 5.6.1.1-1: Fields of a PBU message for the PMIPv6 PDN Connection IPv4 address allocation procedure

Information element	IE Description	Reference
Sequence Number	Set to a locally (i.e. per MAG) monotonically increasing value.	IETF RFC 5213 [4]
Lifetime	Set to the requested number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.6.1.1-2: Mobility Options in a PBU message for the PMIPv6 PDN Connection IPv4 address allocation procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12]
IPv6 Home Network Prefix option	M	Set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Set to the value "5" to indicate handoff state not changed (Re-registration).	IETF RFC 5213 [4]
Access Technology Type option	M	Set to the 3GPP access type (e.g., E-UTRAN) or to the value matching the characteristics of the non-3GPP access (e.g., HRPD) the UE is using to attach to the EPS as defined in the Access Technology Type Option type values registry of the IANA Mobile IPv6 Parameters Registry [18].	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Home Address option	M	For dynamic allocation, set to the value "0.0.0.0" to request allocation for the UE's PDN connection of an IPv4 Home Address in the PDN corresponding to the EPS Access Point Name. For static allocation, set to the received static allocated IPv4 Home Address.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]

5.6.1.2 Proxy Binding Acknowledgement

The fields of a PBA message for the PMIPv6 PDN Connection IPv4 address allocation procedure are depicted in Table 5.6.1.2-1.

The Mobility Options in a PBA message for the PMIPv6 PDN Connection IPv4 address allocation procedure are depicted in Table 5.6.1.2-2.

Other flags are not used by this specification.

Table 5.6.1.2-1: Fields of a PBA message for the PMIPv6 PDN Connection IPv4 address allocation procedure

Information element	IE Description	Reference
Status	Set to indicate the result.	IETF RFC 3775 [8]
Sequence Number	Set to the value received in the corresponding PBU.	IETF RFC 5213 [4]
Lifetime	Set to the granted number of time units the binding shall remain valid.	IETF RFC 3775 [8]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Update message is a proxy registration.	IETF RFC 5213 [4]

Table 5.6.1.2-2: Mobility Options in a PBA message for the PMIPv6 PDN Connection IPv4 address allocation procedure

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
IPv6 Home Network Prefix option	M	Set to the IPv6 Home Network Prefix allocated to the UE's PDN connection based on the selected PDN.	IETF RFC 5213 [4]
Link-local Address	M	Set to the link-local address already allocated to the MAG (in the previous initial binding registration) for use on the access link shared with the UE.	IETF RFC 5213 [4]
Handoff Indicator option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Access Technology Type option	M	Copied from corresponding field of PBU.	IETF RFC 5213 [4]
Timestamp option	M	Set to the current time	IETF RFC 5213 [4]
IPv4 Home Acknowledgement Address option	M	Set to the IPv4 Home Address allocated for the UE's PDN connection based on the selected PDN corresponding to the EPS Access Point Name for dynamic allocation, or set to the static IPv4 Home Address received in the PBU for static allocation.	draft-ietf-netlmm-pmip6-ipv4-support [5]
IPv4 Default Router Address Option	M	Set to the UE"s IPv4 default router address.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12] It is FFS whether this IE could be mandatory	IETF RFC 5149[11]
Vendor-Specific Option	O	Contain 3GPP Vendor-Specific PMIPv6 error code.	IETF RFC 5094 [14]

5.6.2 MAG procedures

The MAG initiating IPv4 Address Allocation using DHCPv4 procedure shall follow the "Extending Binding Lifetime" procedure described in the PMIPv6 [4] and "DHCP Relay Agent co-located with MAG" procedure as described in IPv4 support for PMIPv6 [5] specifications, while parameters in the PBU are set as specified by the PBU parameters section for this procedure.

1. If the static IPv4 Home Address is available at the MAG, set it in the IPv4 home address option in the PBU.

2. Set other parameters in the PBU as specified by the PBU parameters section for this procedure.

5.6.3 LMA procedures

On reception of a PBU, the LMA shall initiate the "Binding Lifetime Extension without Handover" procedures as described in the PMIPv6 [4] and IPv4 support for PMIPv6 [5] specifications with the following additional requirements:

1. Check if the received IPv4 Home address is topologically correct.

2. Allocate an IPv4 Home Address for the selected PDN.

3.   Set parameters in the PBA as specified by the PBA parameters section for this procedure.

5.7   Proxy Mobile IPv6 LMA Initiated IPv4 Address Release procedure

5.7.1   General

In the case when UE is assigned both IPv6 HNP and IPv4 Home Address, if IPv4 Address lease expires or DHCPv4 Release procedure, the node acting as LMA initiates IPv4 Address Release procedure to notify the node acting as MAG about release of IPv4 address of UE for a certain PDN connection. LMA indicates MAG by sending a BRI and MAG confirms by replying with a BRA as described in draft-ietf-mext-binding-revocation [6].

LMA Initiated IPv4 Address Release procedure achieves the following:

- **IPv4 Home Address release**: The LMA returns the IPv4 Home Address assigned to the UE's PDN connection to the pool of free IPv4 Home Network Addresses.

5.7.1.1   Binding Revocation Indication

The fields of a BRI message for the PMIPv6 LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.7.1.1-1.

The Mobility Options in a BRI message for the LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.7.1.1-2.

Table 5.7.1.1-1: Fields of a BRI message for the LMA Initiated IPv4 Address Release

Information element	IE Description	Reference
Sequence Number	A sequence number generated by the LMA, and increased for every BRI sent.	draft-ietf-mext-binding-revocation [6]
Revocation Trigger	Set to 'IPv4 HoA Binding ONLY' to indicate that BRI is only for IPv4 Address Release.	draft-ietf-mext-binding-revocation [6]
Proxy Binding Flag (P)	Set to "1" to indicate that the Binding Revocation Indication is for a proxy MIPv6 binding entry.	draft-ietf-netlmm-proxymip6 [4]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	draft-ietf-mext-binding-revocation [6]
Global Per-Peer Bindings (G)	Set to 0 to indicate that the request is for a specific PMIPv6 BCE.	draft-muhanna-mext-binding-revocation [6]

Table 5.7.1.1-2: Mobility Options in a BRI message for the LMA Initiated IPv4 Address Release

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Set to the NAI identifier of the UE, as specified in 3GPP TS 23.003[12].	3GPP TS 23.003[12]
IPv4 Home Address option	M	Set to the IPv4 home address of the UE's PDN connection.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]

5.7.1.2   Binding Revocation Acknowledgment

The fields of a BRA message for the PMIPv6 LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.7.1.2-1.

The Mobility Options in a BRA message for the LMA Initiated PDN Connection Deletion procedure are depicted in Table 5.7.1.2-2.

Table 5.7.1.2-1: Fields of a BRA message for a LMA Initiated IPv4 Address Release

Information element	IE Description	Reference
Sequence Number	Set to the value received in the corresponding BRI.	draft-ietf-mext-binding-revocation [6]
Status	Indicates the result of the BRI: can be set to 0 for success, 2 for an inexistent UE binding, 3 for IPv4 HoA Binding Does not exist	draft-ietf-mext-binding-revocation [6]
Proxy Binding Flag (P)	Set to "1" to indicate that the Binding Revocation Indication is for a proxy MIPv6 binding entry.	draft-ietf-netlmm-proxymip6 [4]
Global Per-Peer Bindings (G)	Set to 0 to indicate that the request is for a specific PMIPv6 BCE.	draft-muhanna-mext-binding-revocation [6]

Table 5.7.1.2-2: Mobility Options in a BRA message for the LMA Initiated IPv4 Address Release

Information element	Cat.	IE Description	Reference
Mobile Node Identifier option	M	Copied from corresponding field of BRI.	draft-ietf-netlmm-proxymip6 [4]
IPv4 Home Address option	M	Set to the IPv4 home address of the UE's PDN connection received in BRI.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Service Selection Mobility Option	M	Copied from the corresponding field in the PBU message, formatted as defined in 3GPP TS 23.003 [12]	IETF RFC 5149[11]

5.7.2 MAG procedures

The MAG shall follow the procedure for Revocation Trigger in BRI as "IPv4 HoA only" in "Binding Revocation Responder" sub-section of "Mobile Access Gateway" described in the draft-ietf-mext-binding-revocation [6]. The MAG shall respond with a BRA. BRA message parameters are set as per the details in BRA section of the procedure.

5.7.3 LMA procedures

The LMA shall send a BRI to the MAG as described for revoking IPv4 address only in the "Binding Revocation Initiator" sub-section of "Local Mobilty Anchor" described in the draft-ietf-mext-binding-revocation [6]. The LMA shall delete the IPv4 Address from corresponding BCE related to the UE's PDN connection after recieving the BRA in reply to the BRI sent from LMA. BRI message parameters are set as per the details in BRI section of the procedure.

5.8 Proxy Mobile IPv6 Multiple PDN Extensions

5.8.1 General

In EPC a UE can connect or disconnect to multiple distinct PDNs in an independent manner. Thus a distinct PMIPv6 BCE and BULE exist for each of the PDN connections of an UE.

5.8.2 Extensions to PMIPv6 Data Structure

There shall be a unique BCE and BULE for each PDN connection. Each PDN connection can be uniquely identified by the APN in the BCE and BULE. To support Multiple PDNs the MAG and LMA maintains extended data structure compared to the standard PMIPv6 as defined in IETF RFC 5213 [4]. Since multiple PDN connections of a UE can be distinguised based on an APN, both the BCE on the LMA and the BULE on the MAG need to be extended with the following additional field:

- APN of a UE's PDN connection.

5.8.3 Extensions to PMIPv6 BULE and BCE Lookups

To support Multiple PDNs the MAG and LMA perform extended lookups on the extended data structure compared to the standard PMIPv6 as defined in IETF RFC 5213 [4].

In standard PMIPv6 as defined in IETF RFC 5213 [4], a PMIPv6 BCE is looked up based on the Mobile Node Identifier (MN-Id), the access technology types (ATT) and if it exist the MN's link-layer identifier (MN-LL-Id).

In EPC the MN-LL-Id is not used and the EPC support handover between different interfaces for handover between non-3GPP and 3GPP accesses. Since a distinct PMIPv6 BCE exists for each of the PDN connections of an UE, and since multiple PDN connections of a UE can be distinguised based on an APN, there is a one-to-one mapping between a PMIPv6 BCE, a PDN connection, and the (MN-Id, APN) tuple.

Thus, an UE PDN connection can be uniquely indentified by a (MN-Id, APN) tuple, the BCE and BULE are accordingly looked up on a per (MN-Id, APN) tuple basis.

5.9 Serving GW Procedure at Chaining Case

5.9.1 General

Chained S2a/S2b with GTP-based S8 is not supported in this release.

Chained S2a/S2b with PMIP-based S8 is used when VPLMN has business relationship with Non-3GPP Networks and Serving GW in VPLMN supporting a LMA function as local non-3GPP Anchor.

5.9.2 Signalling procedures

When either of the S2a or S2b interfaces is chained with a PMIP-based S8 interface, the Serving GW acts as the signaling endpoint for each interface. On the S2a or S2b interface, the Serving GW acts as an LMA. On the chained PMIP-based S8 interface, the Serving GW acts as MAG. When a procedure is initiated by its peer on a given interface for a given PDN connection, the Serving GW shall trigger an equivalent procedure over the chained interface for the designated PDN connection. The procedure initiated by its peer cannot be completed before the completion of the equivalent procedure initiated over the chained interface.

5.9.2.1 PMIP-based S8 Serving GW procedures

Upon receiving a PMIPv6 message over S8 for an LMA initiated procedure for a given PDN connection, the Serving GW shall initiate the corresponding LMA procedure over S2a or S2b for the designated PDN connection.

Upon receiving a PMIPv6 message over S2a or S2b for a MAG initiated procedure for a given PDN connection, the Serving GW shall initiate the corresponding MAG procedure over PMIP-based S8 for the designated PDN connection.

Table 5.9.2.1-1: procedure, message and IE mapping at PMIPv6 based S8

Initiated procedure	Messages	Initiating interface	Chained interface	Corresponding procedure Chained interface	Corresponding messages
PDN Connection Creation as specified in subclause 5.1	PBU/PBA	S2a or S2b	PMIPv6 based S8	PDN Connection Creation as specified in subclause 5.1	PBU/PBA
PDN Connection Lifetime Extension as specified in subclause 5.2	PBU/PBA	S2a or S2b	PMIPv6 based S8	PDN Connection Lifetime Extension as specified in subclause 5.2	PBU/PBA
PDN Connection Handover as specified in subclause 5.3	PBU/PBA	S2a or S2b	PMIPv6 based S8	PDN Connection Handover as specified in subclause 5.3	PBU/PBA
MAG Initiated PDN Connection Deletion as specified in subclause 5.4	PBU/PBA	S2a or S2b	PMIPv6 based S8	MAG Initiated PDN Connection Deletion as specified in subclause 5.4	PBU/PBA
LMA Initiated PDN Connection Deletion as specified in subclause 5.5	BRI/BRA	PMIPv6 based S8	S2a or S2b	LMA Initiated PDN Connection Deletion as specified in subclause 5.5	BRI/BRA

5.9.3   Payload packets at chained case

When the S2a or S2b interfaces is chained with a PMIP-based S8 interface, both uplink and downlink payload packets are forwarded by the Serving GW between the S2a or S2b PMIPv6 GRE tunnel and the S8 PMIPv6 GRE tunnel for a given PDN connection.

6 Tunnel Management procedures

6.1 General

The Mobile Anchor Gateway (MAG) and the Local Mobility Anchor (LMA) establish and maintain a bi-directional tunnel for each PDN connection, which is used for routing the UE"s PDN connection user-plane traffic between the MAG and the LMA. This tunnel is based on GRE encapsulation and is established as a result of exchanging the Proxy Binding Update (PBU) and the Proxy Binding Acknowledgment (PBA) messages between the MAG and LMA. The PBU and PBA messages establish unique Binding Cache Entry (BCE) and Binding Update List Entry (BULE) entries for each PDN connection at the LMA and the MAG respectively. The tunnel end points are the Proxy-CoA and LMAA with GRE encapsulation (for IPv6 transport network) or IPv4-Proxy-CoA and IPv4-LMAA with GRE encapsulation (for IPv4 transport network), as described in draft-ietf-netlmm-grekey-option [7]. GRE encapsulation shall always be used; the GRE tunneling negotiation described in [7] is not applicable and the GRE Key Identifier Option shall always be present in the PBU messages for PMIPv6 PDN Connection Creation and binding registration after handover.

Tear down of GRE tunnels and cleanup of state is done explicitly by MAG Initiated PDN Connection Deletion or LMA Initiated PDN Connection Deletion; additionally, a timer may be used for managing the tunnel lifetime, equivalent to the description in IETF RFC 5213 [4].

Signalling messages as specified in Section 4 are sent natively without encapsulation in IPv6 transport network and with IPv4 or IPv4-UDP encapsulation in IPv4 transport network as specified in ietf-netlmm-pmip6-ipv4-support [5].

6.2 MAG procedure

When the PDN connectivity is established, the downlink GRE key for the PDN connection downlink traffic is selected by the MAG and sent to LMA in PBU message. This downlink GRE key shall be unique within the tunnel end points.

The uplink GRE key is received from LMA in a PBA message, and also from the MME in case Serving GW relocation occurs. The MAG shall be able to send the PDN connection uplink traffic using the received uplink GRE key towards the LMAA or IPv4-LMAA before sending the PBU or before receiving the PBA.

When the PDN connection is released, the downlink GRE key shall be released by the MAG.

6.3 LMA procedure

When the PDN connectivity is established, the uplink GRE key for the PDN connection uplink traffic is selected by the LMA and sent to MAG in PBA message. This uplink GRE key shall be unique within the LMA.

The LMA function shall be able to accept the PDN connection uplink packets from any trusted MAGs without enforcing that the source IP address must match the CoA in the UE BCE.

When the PDN connection is released, the uplink GRE key shall be released by the LMA.

6.4 Data Structures

6.4.1 Binding Update List Entry

MAG maintains a unique Binding Update List Entry for for each PDN connection of a UE. The required elements of BULE as per 3GPP requirements are described in table 6.4.1-1.

Table 6.4.1-1: Elements of BULE

Element	Description	Reference
Mobile Node Identifier	Set to the NAI identifier of the UE as specified in 3GPP TS 23.003 [12].	3GPP TS 23.003 [12], draft-ietf-netlmm-proxymip6 [4]
Access Point Name	Set to the EPS Access Point Name to which the UE's PDN connection is attached, formatted as defined in 3GPP TS 23.003 [12]	3GPP TS 23.003 [12]
Lifetime	Set to lifetime granted for the binding as received in PBA.	IETF RFC 3775 [8]
Remaining Lifetime	This lifetime is initialized from the lifetime granted for the binding and is decremented until it reaches 0.	IETF RFC 3775 [8]
Sequence Number	The sequence number of the last Proxy Binding Update message sent.	IETF RFC 3775 [8]
Timestamp	Time at which last PBU was sent.	IETF RFC 3775 [8]
Binding Flag	Set to 1 if MAG receives an ICMPv6 parameter problem, code 1, error message in response to a PBU. Set to 0 if MAG continues to send PBU.	IETF RFC 3775 [8]
IPv6 Home Network Prefix	IPv6 Home Network Prefix assigned to the UE's PDN connection.	draft-ietf-netlmm-proxymip6 [4]
Link-local Address	Link-local address to be used by the MAG on the access link shared with the UE.	IETF RFC 5213 [4]
IPv4 Home Address	IPv4 Home Address assigned to UE's PDN connection.	draft-ietf-netlmm-proxymip6 [4]
IPv4 default-router address	The IPv4 default-router address of the mobile node.	draft-ietf-netlmm-pmip6-ipv4-support [5]
LMA IPv6 Address	IPv6 Address of the LMA.	IETF RFC 3775 [8]
LMA IPv4 Address	IPv4 Address of the LMA.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Downlink GRE Key	Downlink GRE key for the PDN connection as selected by MAG.	draft-ietf-netlmm-grekey-option [7]
Uplink GRE key	Uplink GRE key for the PDN connection selected by LMA as received in GRE Key option of PBA	draft-ietf-netlmm-grekey-option [7]
Chained Binding Cache Entry	Reference to the corresponding BCE used for the binding on the S8 interface. It shall be present only in the Serving GW, in case of S2a/S2b - PMIP based-S8 chaining.	

6.4.2 Binding Cache Entry

LMA maintains a unique Binding Cache Entry for each PDN connection for a UE. The required elements of BCE as per 3GPP requirements are described in table 6.4.1-2.

Table 6.4.2-1: Elements of BCE

Element	Element Description	Reference
Mobile Node Identifier	The MN-Id mobility option as received in PBU.	3GPP TS 23.003 [12], draft-ietf-netlmm-proxymip6 [4]
Access Point Name	The Service Selection Mobility option received in PBU	3GPP TS 23.003 [12]
Lifetime	Lifetime granted for the binding.	IETF RFC 3775 [8]
Sequence Number	Sequence number of last received PBU.	IETF RFC 3775 [8]
IPv6 Home Network Prefix	IPv6 Home Network Prefix assigned to the UE's PDN connection.	draft-ietf-netlmm-proxymip6 [4]
Link-local Address	The assigned link local address to MAG for use on the access link shared with the UE.	IETF RFC 5213 [4]
IPv4 Home Address	IPv4 Home Address assigned to UE's PDN connection.	draft-ietf-netlmm-proxymip6 [4]
IPv4 default-router address	The IPv4 default-router address of the mobile node.	draft-ietf-netlmm-pmip6-ipv4-support [5]
IPv6 Proxy care-of-address	MAG IPv6 Address, i.e. the source address of the IP packet in which PBU was received.	IETF RFC 3775 [8]
IPv4 Proxy care-of-address	MAG IPv4 Address.	draft-ietf-netlmm-pmip6-ipv4-support [5]
Access Technology Type	ATT Mobility Option as received in PBU.	draft-ietf-netlmm-proxymip6 [4]
Timestamp	Timestamp option as received in PBU.	
Binding Flag	"1" as it is proxy registration.	draft-ietf-netlmm-proxymip6 [4]
Downlink GRE key	Downlink GRE key for the PDN connection selected by MAG as received in GRE key option of PBU.	draft-ietf-netlmm-grekey-option [7]
Uplink GRE key	Uplink GRE key for the PDN connection selected by LMA.	draft-ietf-netlmm-grekey-option [7]
Chained Binding Update List Entry	Reference to the corresponding BULE used for binding on the S2a / S2b interface. It shall be present only in the Serving GW, in case of S2a/S2b – PMIP-based S8 chaining.	

6.5 Security

Security aspects for PMIPv6 are described in 3GPP TS 33.402 [19].

7 Path Management procedures

7.1 General

The path management procedure is implemented via an exchange of Heartbeat Request and Heartbeat Response messages as defined in IETF Draft draft-ietf-netlmm-pmipv6-heartbeat [17] and can be initiated by a PMIPv6 entity (LMA or MAG) to test the path with a peer PMIPv6 entity. The path management for PMIPv6 is very similar to that of GTP; the main difference is the use of PMIPv6 messages instead of GTP messages.

The restoration procedures that are triggered by path failure detection are specified in 3GPP TS 23.007 [13].

7.2 Heartbeat Mechanism

A LMA or MAG may send a one-time Heartbeat Request to a peer MAG or LMA for path failure detection as defined in IETF Draft draft-ietf-netlmm-pmipv6-heartbeat [17]. The Heartbeat Request messages may be sent for each path if at least one PMIPv6 binding uses that path between the LMA and MAG. When and how often a Heartbeat Request message may be sent is implementation specific but a Heartbeat Request shall not be sent more often than every 60 s on each path.

Both LMA and MAG shall send Heartbeat Response message as a response to a received Heartbeat Request, as defined in IETF Draft draft-ietf-netlmm-pmipv6-heartbeat [17].

7.3 Failure detection

Both LMA and MAG shall support the failure detection procedure, as defined in IETF Draft draft-ietf-netlmm-pmipv6-heartbeat [17], that if more than MISSING_HEARTBEATS_ALLOWED number of responses is not received from the peer, it concludes that the peer PMIPv6 node is not reachable.

7.4 Restart detection

Both LMA and MAG shall support the restart detection procedure, as defined in IETF Draft draft-ietf-netlmm-pmipv6-heartbeat [17], that the Restart Counter value received in the Heartbeat Response message is not same as the previously received value, the receiving node assumes that the peer PMIPv6 node had crashed and recovered.

7.5 Fast Notification of Restarts

Both the LMA and the MAG shall support the sending anUnsolicited Heartbeat Response message as specified in draft-ietf-netlmm-pmipv6-heartbeat [17], such that a node shall send such a message with an incremented Restart Counter value as soon as it recovers from a failure without waiting for a Heartbeat Request message to arrive first.

7.6 UE-specific Error Indication

Both the LMA and the MAG shall support the UE-specific error indication such that a node shall send a message containing a suitable identifier (such as MN-ID or GRE Keys) when no binding exists for a packet incoming for UE.

Editor's note: It is FFS which message is used to signal UE-specific error indication.

7.7 Heartbeat Message

7.7.1 Heartbeat Request

Table 7.7.1-1 specifies the information elements included in the Heartbeat Request message.

Table 7.7.1-1: Fields of a Heartbeat message for the Heartbeat request

Information element	IE Description	Reference
R flag	Set to 0 for a request message.	draft-ietf-netlmm-pmipv6-heartbeat[17]
Sequence Number	Set to a locally monotonically increasing value.	draft-ietf-netlmm-pmipv6-heartbeat [17]
Heartbeat Interval	Set to the value 0 to indicate that no periodic heartbeat messages will be sent.	draft-ietf-netlmm-pmipv6-heartbeat [17]

7.7.2   Heartbeat Response

Table 7.7.2-1 and 7.7.2-2 specifies the information elements included in the Heartbeat Response message.

Table 7.7.2-1: Fields of a Heartbeat message for the Heartbeat request

Information element	IE Description	Reference
R flag	Set to 1 for a response message.	draft-ietf-netlmm-pmipv6-heartbeat [17]
U flag	Set to 0 if the heartbeat response is sent as an answer to a heartbeat request. Set to 1 otherwise.	draft-ietf-netlmm-pmipv6-heartbeat [17]
Sequence Number	Set to the value received in the corresponding Heartbeat Request message.	draft-ietf-netlmm-pmipv6-heartbeat [17]
Heartbeat Interval	Set to zero.	draft-ietf-netlmm-pmipv6-heartbeat [17]

Table 7.7.2-2: Mobility Options in a Heartbeat message for the Heartbeat request

Information element	IE Description	Reference
Restart Counter	indicates the current Restart Counter value	draft-ietf-netlmm-pmipv6-heartbeat [17]

7.8 Partial node failure requiring the removal of a subset of sessions

7.8.1 General

See 3GPP TS 23.007[13] for the description of this function.

> Editor's Note: This function is still ongoing work and needs to be further specified when the work progresses. In particular, it needs to be aligned with the GTP implementation of this feature.

7.8.2 Bulk Binding Revocation Indication message

The fields of a bulk BRI message initiated by the LMA or the MAG are depicted in Table 7.8.1.1-1.

The Mobility Options in a Bulk BRI message sent by the LMA or the MAG are depicted in Table 7.8.1.1-2.

Table 7.8.1.1-1: Fields of a Bulk BRI message for the PMIPv6

Information element	IE Description	Reference
Sequence Number	A sequence number generated by the LMA, and increased for every BRI sent.	draft-muhanna-mext-binding-revocation [6]
Revocation Trigger	Set to a the value of 'Revoking Node Local Policy'	draft-muhanna-mext-binding-revocation [6]
Proxy Binding Flag (P)	Set to "1" to indicate that the Binding Revocation Indication is for a proxy MIPv6 binding entry.	RFC 5213 [4]
Acknowledge (A)	Set to "1" to request an acknowledgement message.	draft-muhanna-mext-binding-revocation [6]
Global Per-Peer Bindings (G)	Set to 1	draft-muhanna-mext-binding-revocation [6]

Table 7.8.1.1-2: Mobility Options in a BRI message for the PMIPv6 LMA or MAG Initiated PDN Connection Deletion

Information element	Cat.	IE Description	Reference
Mobile Node Identifier	C	Set to the IP address of the MAG, only when the Bulk BRI message is sent by the MAG.	3GPP TS 23.402[3]
Vendor-Specific Option - CSID	M	This VSO is the Connection Set Identifier List. It contains one or more Connection Set Identifiers that need to be revoked.	RFC 5094[14]

NOTE: The format of the Connection Set Identifier is FFS.

7.8.3 Bulk Binding Revocation Acknowledgement message

The fields of a Bulk BRA message for the PMIPv6 LMA or MAG bulk Initiated PDN Connection Deletion procedure are depicted in Table 7.8.1.2-1.

Table 7.8.1.2-1: Fields of a BRA message for a PMIPv6 LMA Initiated PDN Connection Deletion

Information element	IE Description	Reference
Sequence Number	Set to the value received in the corresponding Bulk BRI.	draft-muhanna-mext-binding-revocation [6]
Status	Indicates the result of the Bulk BRI: can be set to 0 for success, 1 for an unspecified failure or 4 for Global Revocation NOT Authorized..	draft-muhanna-mext-binding-revocation [6]
Proxy Registration Flag (P)	Set to "1" to indicate that the Binding Revocation Acknowledgment is for a proxy MIPv6 binding entry.	RFC 5213 [4]
Global Per-Peer Bindings (G)	Set to 1; the same value as for the Bulk BRI.	draft-muhanna-mext-binding-revocation [6]

7.8.4 MAG procedures

The MAG can be the initiator or the receiver of a bulk BRI message.

The MAG shall follow the "Local Mobility Anchor Revokes Bulk PMIPv6 Bindings" procedure described in the draft-muhanna-mip6-binding-revocation [6] when it receives a bulk Binding Revocation Indication message, removing the sessions identified by the Connection Set Identifier List Mobility Option.

The MAG shall follow the 'Mobile Access Gateway Revoke Bulk PMIPv6 Bindings' when it sends a Bulk Revocation to the LMA, including the Connection Set Identifier List Mobility Option.

8 PMIP-based S5 and PMIP-based S8 Description

8.1 Initial Attach procedures

8.1.1 General

8.1.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

8.1.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3

8.2 Serving GW Initiated PDN Connection Lifetime Extension procedures

8.2.1 General

8.2.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.2.

8.2.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.3.

8.3 UE, MME or HSS initiated Detach procedures

8.3.1 General

8.3.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.2 repeated for each PDN connection of the UE.

8.3.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.3.

8.4 PDN GW Initiated PDN Disconnection procedures

8.4.1 General

8.4.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 LMA Initiated PDN Connection Deletion as outlined in subclause 5.5.2.

8.4.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 LMA Initiated PDN Connection Deletion for the selected PDN connection as outlined in subclause 5.5.3.

8.5 UE Requested Additional PDN Connectivity procedures

8.5.1 General

8.5.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

8.5.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3.

8.6 Handover procedures

8.6.1 Intra-LTE TAU and Inter-eNodeB Handover with Serving GW Relocation procedures

8.6.1.1 General

8.6.1.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.1.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

8.6.2 TAU/RAU or Handover between GERAN A/Gb Mode or UTRAN Iu Mode and E-UTRAN procedures

8.6.2.1 General

8.6.2.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.2.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

8.6.3 Handover from Trusted or Untrusted Non-3GPP IP Access over S2a/S2b to 3GPP Access Handover E-UTRAN over PMIP based S5/S8 without optimization procedures

8.6.3.1 General

8.6.3.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.3.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3

8.6.4 Handover from Trusted or Untrusted Non-3GPP IP Access over S2a/S2b to 3GPP Access UTRAN/GERAN over PMIP based S5/S8 without optimization

8.6.4.1 General

8.6.4.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.4.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

8.6.5 Handover from Trusted or Untrusted Non-3GPP IP Access over S2c to 3GPP Access over PMIP based S5/S8 without optimization

8.6.5.1 General

8.6.5.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.5.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

8.6.6 Optimised Active Handover: cdma2000 eHRPD Access to EUTRAN

8.6.6.1 General

8.6.6.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.6.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

8.6.7 Optimized Idle Mode Mobility: cdma2000 eHRPD Access to E-UTRAN Access

8.6.7.1 General

8.6.7.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2 repeated for each PDN connection of the UE.

8.6.7.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3..

8.7 UE Requested PDN Disconnection procedures

8.7.1 General

8.7.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion, for the selected PDN connection as outlined in subclause 5.4.2.

8.7.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion, for the selected PDN connection as outlined in subclause 5.4.3.

8.8 IPv4 Address Allocation using DHCP

8.8.1 General

8.8.2 Serving GW procedures

The Serving GW shall follow the MAG procedure for the Proxy Mobile IPv6 PDN Connection IPv4 Address Allocation Procedure as defined in sub clause 5.6.2.

8.8.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the Proxy Mobile IPv6 PDN Connection IPv4 Address Allocation Procedure as defined in sub clause 5.6.3.

8.9 PDN-GW Initiated IPv4 Address Delete Procedure

8.9.1 General

8.9.2 Serving GW procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the Serving GW shall follow the MAG procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.2.

8.9.3 PDN GW procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the PDN GW shall follow the LMA procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.3.

If UE is assigned only IPv4 HoA, then PDN-GW initiated PDN Disconnection procedure is initiated.

9 Trusted Non-3GPP Access over S2a Description

9.1 Initial Attach procedures

9.1.1 General

9.1.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

9.1.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3.

9.2 Trusted Non-3GPP Access Initiated PDN Connection Lifetime Extension procedures

9.2.1 General

9.2.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.2.

9.2.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.3.

9.3 UE / Trusted Non-3GPP Access Initiated Detach and UE Requested PDN Disconnection procedures

9.3.1 General

9.3.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.2 repeated for each PDN connection of the UE.

9.3.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.3.

9.4 HSS / AAA Initiated Detach procedures

9.4.1 General

The HSS/AAA may initiate a detach procedure resulting in a PMIPv6 De-Registration.

9.4.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.2 repeated for each PDN connection of the UE.

9.4.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.3.

9.5 UE Initiated Connectivity to Additional PDN procedures

9.5.1 General

9.5.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

9.5.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3.

9.6 3GPP Access to Trusted Non-3GPP IP Access with PMIPv6 on S2a Handover procedures without optimization

9.6.1 General

9.6.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2.

9.6.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

9.7 PDN GW Initiated Resource Allocation Deactivation procedures

9.7.1 General

9.7.2 Trusted Non-3GPP Access procedures

In PMIPv6 mode, the Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 LMA Initiated PDN Connection Deletion as outlined in subclause 5.5.2.

9.7.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 LMA Initiated PDN Connection Deletion as outlined in subclause 5.5.3.

9.8 IPv4 Address Allocation using DHCP

9.8.1 General

9.8.2 Trusted Non-3GPP Access procedures

The Trusted Non-3GPP Access shall follow the MAG procedure for the Proxy Mobile IPv6 PDN Connection IPv4 Address Allocation Procedure as defined in sub clause 5.6.2.

9.8.3 PDN GW procedures

The PDN GW shall follow the LMA procedure for the Proxy Mobile IPv6 PDN Connection IPv4 Address Allocation Procedure as defined in sub clause 5.6.3.

9.9 PDN-GW Initiated IPv4 Address Delete Procedure

9.9.1 General

9.9.2 Trusted Non-3GPP Access procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the Trusted Non-3GPP Access shall follow the MAG procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.2.

9.9.3 PDN GW procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the PDN GW shall follow the LMA procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.3.

If UE is assigned only IPv4 HoA, then PDN-GW initiated Resource Allocation Deactivation procedure is initiated.

9.10 Optimized E-UTRAN to CDMA2000 eHRPD Handover procedure

9.10.1 General

9.10.2 CDMA2000 HRPD access procedure

In PMIPv6 mode, the CDMA2000 HRPD access shall follow the MAG procedure for the PMIPv6 PDN Connection Handover procedure as outlined in subclause 5.3.2.

9.10.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover procedure as outlined in subclause 5.3.3.

9.11 Optimized Idle Mode Mobility: E-UTRAN Access to cdma2000 eHRPD Access procedure

9.11.1 General

9.11.2 CDMA2000 eHRPD access procedure

In PMIPv6 mode, the CDMA2000 eHRPD access shall follow the MAG procedure for the PMIPv6 PDN Connection Handover procedure as outlined in subclause 5.3.2.

9.11.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover procedure as outlined in subclause 5.3.3.

10 Untrusted Non-3GPP Access over S2b Description

10.1 Initial Attach procedures

10.1.1 General

10.1.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

10.1.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3.

10.2 ePDG Initiated PDN Connection Lifetime Extension procedures

10.2.1 General

10.2.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.2.

10.2.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Lifetime Extension as outlined in subclause 5.2.3.

10.3 UE / ePDG Initiated Detach and UE Requested PDN Disconnection procedures

10.3.1 General

10.3.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.2 repeated for each PDN connection of the UE.

10.3.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.3.

10.4 HSS / AAA Initiated Detach procedures

10.4.1 General

The HSS/AAA may initiate a detach procedure resulting in a PMIPv6 De-Registration.

10.4.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.2 repeated for each PDN connection of the UE.

10.4.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion as outlined in subclause 5.4.3.

10.5 UE Initiated Connectivity to Additional PDN procedures

10.5.1 General

10.5.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.2.

10.5.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Creation as outlined in subclause 5.1.3.

10.6 3GPP Access to Untrusted Non-3GPP IP Access with PMIPv6 on S2b Handover procedures without optimization

10.6.1 General

10.6.2 ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.2.

10.6.3 PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 PDN Connection Handover as outlined in subclause 5.3.3.

10.7   PDN GW Initiated Resource Allocation Deactivation procedures

10.7.1   General

10.7.2   ePDG procedures

In PMIPv6 mode, the ePDG shall follow the MAG procedure for the PMIPv6 LMA Initiated PDN Connection Deletion as outlined in subclause 5.5.2.

10.7.3   PDN GW procedures

In PMIPv6 mode, the PDN GW shall follow the LMA procedure for the PMIPv6 LMA Initiated PDN Connection Deletion as outlined in subclause 5.5.3.

10.8   PDN-GW Initiated IPv4 Address Delete Procedure

10.8.1   General

10.8.2   ePDG procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the ePDG shall follow the MAG procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.2.

10.8.3   PDN GW procedures

If UE is assigned both IPv6 HNP and IPv4 HoA, the PDN GW shall follow the LMA procedure for the LMA Initiated IPv4 Address Release procedure as defined in sub clause 5.7.3.

If UE is assigned only IPv4 HoA, then PDN-GW initiated Resource Allocation Deactivation procedure is initiated.

11   S2a and S2b Chaining with PMIP-based S8 Description

11.1   Initial Attach procedures

11.1.1   General

11.1.2   ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Creation. In addition to the general procedure, it shall include the PDN GW IP address received during the authorization procedure into the PBU request, encoding it into a Vendor-Specific Option (refer to clause 12.1.1.4).

11.1.3   Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 PDN Connection Creation on the S2a/S2b interface. In addition to the general procedure, the Serving GW shall include the PDN GW IP address received in the PBU request into the PBA, using the same encoding (refer to clause 12.1.1.4).

- the MAG procedure for the PMIPv6 PDN Connection Creation on the S8 interface. The Serving GW shall send the PBU request to the PDN GW IP address received on the chained S2a / S2b interface.

11.2   ePDG / Trusted Non-3GPP Access Initiated PDN Connection Lifetime Extension procedures

11.2.1   General

11.2.2   ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Lifetime Extension.

11.2.3   Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 PDN Connection Lifetime Extension on the S2a/S2b interface.

- the MAG procedure for the PMIPv6 PDN Connection Lifetime Extension on the S8 interface.

11.3 UE / ePDG / Trusted Non-3GPP Access Initiated Detach procedures

11.3.1 General

11.3.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion repeated for each PDN connection of the UE.

11.3.3 Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion on the S2a/S2b interface.

- the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion on the S8 interface.

11.4 HSS / AAA Initiated Detach procedures

11.4.1 General

The HSS/AAA may initiate a detach procedure resulting in a PMIPv6 De-Registration.

11.4.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion repeated for each PDN connection of the UE.

11.4.3 Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion on the S2a/S2b interface.

- the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion on the S8 interface.

11.5 UE Initiated Connectivity to Additional PDN procedures

11.5.1 General

11.5.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Creation. In addition to the general procedure, it shall include the PDN GW IP address received during the authorization procedure into the PBU request, encoding it to the Vendor-Specific Option (refer to clause 12.1.1.4).

11.5.3 Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 PDN Connection Creation on the S2a/S2b interface. In addition to the general procedure, the Serving GW shall include the PDN GW IP address received in the PBU request into the PBA, using the same encoding (refer to clause 12.1.1.4).

- the MAG procedure for the PMIPv6 PDN Connection Creation on the S8 interface. The Serving GW shall send the PBU request to the PDN GW IP address received on the chained S2a / S2b interface.

11.6 3GPP Access to Trusted / Untrusted Non-3GPP IP Access Handover procedures without optimization

11.6.1 General

11.6.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 PDN Connection Handover. In addition to the general procedure, it shall include the PDN GW IP address received during the authorization procedure into the PBU request, encoding it to the Vendor-Specific Option (refer to clause 12.1.1.4).

11.6.3 Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 PDN Connection Handover on the S2a/S2b interface. In addition to the general procedure, the Serving GW shall include the PDN GW IP address received in the PBU request into the PBA, using the same encoding (refer to clause 12.1.1.4).

- the MAG procedure for the PMIPv6 PDN Connection Handover on the S8 interface. The Serving GW shall send the PBU request to the PDN GW IP address received on the chained S2a / S2b interface.

11.7 UE Requested PDN Disconnection procedures

11.7.1 General

11.7.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion, for the selected PDN connection.

11.7.3 Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the LMA procedure for the PMIPv6 MAG Initiated PDN Connection Deletion, for the selected PDN connection on the S2a/S2b interface.

- the MAG procedure for the PMIPv6 MAG Initiated PDN Connection Deletion, for the selected PDN connection on the S8 interface.

11.8 PDN GW Initiated Resource Allocation Deactivation procedures

11.8.1 General

11.8.2 ePDG / Trusted Non-3GPP Access procedures

In PMIPv6 mode, the ePDG or Trusted Non-3GPP Access shall follow the MAG procedure for the PMIPv6 LMA Initiated PDN Connection Deletion.

11.8.3   Serving GW procedures

In PMIPv6 mode, the Serving GW shall follow:

- the MAG procedure for the PMIPv6 LMA Initiated PDN Connection Deletion on the S8 interface.

-    the LMA procedure for the PMIPv6 LMA Initiated PDN Connection Deletion on the S2a/S2b interface.

12 Information Elements

12.1 Additional Proxy Mobile IPv6 Information Elements

12.1.1 3GPP Vendor-Specific Mobility Option

The 3GPP Vendor-Specific mobility option conforms to IETF RFC 5094 [14]. The format of the 3GPP Vendor-Specific Mobility Option is shown below:
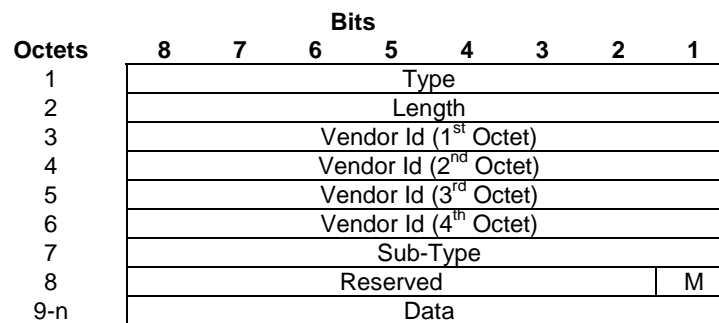
					Bits				
Octets	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Type							
2	Length							
3	Vendor Id (1st Octet)							
4	Vendor Id (2nd Octet)							
5	Vendor Id (3rd Octet)							
6	Vendor Id (4th Octet)							
7	Sub-Type							
8	Reserved							M
9-n	Data							

Figure 12.1.1-1: 3GPP Vendor-Specific Mobility Option

Table 12.1.1-1: Fields in a 3GPP Vendor-Specific Mobility Option

| Information element	IE Description	Reference
Type	Value is decimal 19 the assigned value for the Vendor-Specific mobility option	RFC 5094 [14]
Length	An 8-bit field indicating the length of the option in octets excluding the Type and the Length fields. All other fields are included.	RFC 5094 [14]
Vendor ID	A 32-bit field. Value is set to the SMI Network Management Private Enterprise Number for 3GPP, which is decimal "10415".	IANA [15]
Sub-Type	Indicate the type of the 3GPP Data encoded by the 3GPP Vendor-Specific Mobility Option.	Table 12.1.1-2
Reserved	Value set to zero by sender and ignored by receiver.	Defined here
More Data Fragment (M) Flag	Value set to "1" if this 3GPP Vendor-Specific Mobility Option is followed by another 3GPP Vendor-Specific Mobility Option encoding the follow up data fragment that does not fit in this 3GPP Vendor-Specific Mobility Option. Set to zero otherwise.	Defined here
Data	The 3GPP Data might be split over multiple 3GPP Vendor-Specific Mobility Options in case the total length of the 3GPP Data exceeds 249 bytes. This is the data fragment of the 3GPP Data contained in this specific instance of the 3GPP Vendor-Specific Mobility Option.	Defined here

Table 12.1.1-2: 3GPP Vendor-Specific Mobility Option Subtypes

Information element	IE Description
1	3GPP PCO data, in the format from 3GPP TS 24.008 [16] section 10.5.6.
2	3GPP Vendor-Specific PMIPv6 error code, as specified in subclause 12.1.1.1
3	PDN GW IP address, as specified in clause 12.1.1.4
4	3GPP Vendor-Specific PMIPv6 DHCPv4 Address Allocation Procedure Indication, as specified in subclause 12.1.1.5.

Depending on the need for 3GPP-specific information content, there several items of this information element may be added to the PBU request.

12.1.1.1   3GPP Vendor-Specific PMIPv6 error code

The purpose of the 3GPP Vendor-Specific PMIPv6 error code information element is to carry additional PMIPv6 error code.

Bits

Octets	8	7	6	5	4	3	2	1
1				PMIPv6 Error Code				
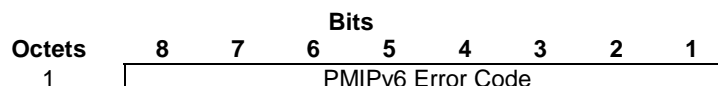
Figure 12.1.1.1-1: 3GPP Vendor-Specific PMIPv6 error code

The following additional error codes are used in Proxy Binding Acknowledgement message. Error Code values less than 128 are reserved.

Error Code	Value
Mandatory IE incorrect	201
Mandatory IE missing	202
Optional IE incorrect	203
No memory is available	212
Missing or unknown APN	219
APN access denied – no subscription	222
MISSING_TIMESTAMP_OPTION	FFS
MISSING_GRE_KEY_OPTION	FFS
MISSING_SERVICE_SELECTION_OPTION	FFS

Editor Note: More error codes may be added once the above mapping is based on GTPv1 values and current PMIPv6 draft. It must be updated when GTPv2 values are available and 3GPP vendor specific error codes are agreed.

12.1.1.2   3GPP Vendor-Specific Connection Set Identifier List

The 3GPP Vendor-Specific Connection Set Identifier List contains one or more Connection Set Identifiers generated by the MAG, the LMA and any other node such as the MME for 3GPP access. It is generated for each new PDN connection, and it is used in case of partial node failure to identify the PDN connections associated with a Connection Set Identifier.

See 3GPP TS 29.274[13] for the format of the VSO.

12.1.1.3 3GPP Vendor-Specific PMIPv6 PDN Type Indication

The purpose of the 3GPP Vendor-Specific PMIPv6 PDN type indication option is to indicate the PDN GW decision on the PDN type changes and a cause for reason of the change was done. This attribute is set by the LMA in the PBA.

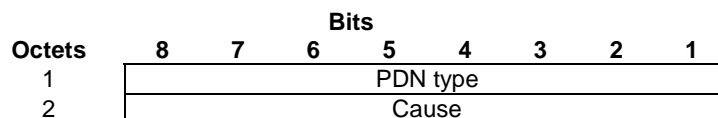The MAG shall set the PDN type accordingly, if this option is present in the PBA.

	Bits							
Octets	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	PDN type							
2	Cause							

Figure 12.1.1.3-1: 3GPP Vendor-Specific PMIPv6 PDN type indication

The following defines the value of the PMIPv6 PDN type indication.

```
PDN type value
#1:      IPv4
#2:      IPv6

Cause value
#xx1:    subscription limitation;
#xx2:    network preference;
#xx3:    single address bearers only allowed
```

Editor"s note: The Cause Value shall be inline with the cause value defined for GTP and NAS signalling.

12.1.1.4 3GPP Vendor-Specific PDN GW IP address

The purpose of the PDN GW IP address information element is to carry the IP address of the PDN GW, to which the receiving Serving GW shall send a PBU request, on the chained S8 interface. This information element shall be included only in the PBU requests creating a new binding (i.e. at initial attach or handover), sent on S2a or S2b interface, in S2a/S2b - PMIP based S8 chaining scenario.The content and encoding of the PDN GW IP address is depicted on Figure 12.1.1.4-1.

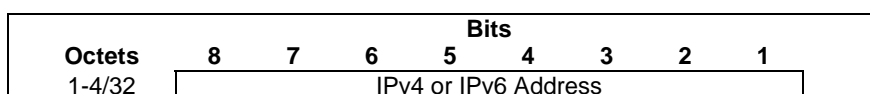|	**Bits**							
Octets	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1-4/32	IPv4 or IPv6 Address							

Figure 12.1.1.4-1: PDN GW IP Address

12.1.1.5 3GPP Vendor-Specific PMIPv6 DHCPv4 Address Allocation Procedure Indication

The purpose of the 3GPP Vendor-Specific PMIPv6 DHCPv4 Address Allocation option is to indicate that DHCPv4 is to be used in allocating the IPv4 address to the UE if the option is presented in the PBA message.

Annex A (informative): Error Code Mapping Table

This table is used in SGW for mapping between GTP Cause and PMIPv6 Status in case S5/S8 is based on PMIPv6 protocol.

Table A-1: Error Code Mapping Table

GTP Cause	PMIPv6 Status
No resources available	Insufficient resources
Service not supported	PROXY_REG_NOT_ENABLED NOT_LMA_FOR_THIS_MOBILE_NODE MAG_NOT_AUTHORIZED_FOR_PROXY_REG
Mandatory IE incorrect	TIMESTAMP_MISMATCH TIMESTAMP_LOWER_THAN_PREV_ACCEPTED
Mandatory IE missing	MISSING_HOME_NETWORK_PREFIX_OPTION MISSING_MN_IDENTIFIER_OPTION MISSING_HANDOFF_INDICATOR_OPTION MISSING_ACCESS_TECH_TYPE_OPTION
Authentication failure	NOT_AUTHORIZED_FOR_HOME_NETWORK_PREFIX
User authentication failed	NOT_AUTHORIZED_FOR_HOME_NETWORK_PREFIX
Context not found	BCE_PBU_PREFIX_SET_DO_NOT_MATCH

Editor Note: The above mapping is based on GTPv1 values and current PMIPv6 draft. It must be updated when GTPv2 values are available and 3GPP vendor specific error codes are agreed.

Annex B (informative): Change History

Change history								
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2008-09	CT#41	CP-080476			V2.0.0 approved in CT#41	2.0.0	8.0.0
2008-12	CT-42	CP-080692	0002		IPv4 Address Acknowledgement option in PBA	8.0.0	8.1.0
		CP-080692	0006	2	IPv4 Address Deletion		
		CP-080692	0007		PDN-GW Initiated Resource Allocation Deactivation		
		CP-080692	0008	2	PDNType-IP Address Option		
		CP-080692	0009	4	PMIP Bulk Revocation Support.		
		CP-080692	0010	1	Link local address		
		CP-080692	0011		Service selection option in the PBA message		
		CP-080692	0012	4	PMIP IPv4 address allocation		
		CP-080692	0019		Interface Id in PBA at HO case		
		CP-080692	0022		Clarification to subclause PMIP6 LMA Initiated PDN Connection Deletion Procedure		
		CP-080692	0023		Update references to latest version of IETF documents		
		CP-080692	0025		Putting back GSM logo on front page		
		CP-080692	0026		PMIPv6 Heartbeat/Path Management Update		
		CP-080692	0031		PMIPv6 clarification		
		CP-080692	0033		Optimized E-UTRAN to CDMA2000 HRPD Handover procedure cleanup		
		CP-080692	0036	1	IPv4-UDP encapsulation option		
		CP-080692	0037	2	S5/S8 procedure corrections		
		CP-080692	0038	1	S2a procedure corrections		
		CP-080692	0039		S2b procedure corrections		
		CP-080692	0040	1	Chaining case procedure corrections		
		CP-080692	0042	1	DHCPv4 Address Allocation 3GPP VSO		
		CP-080692	0043	1	PDN type indicator		
		CP-080692	0044		FFS cleanup		
		CP-080692	0045		HI FFS cleanup		
		CP-080692	0046		Clean up on BULE and BCE		
		CP-080692	0047	2	Clarification on PMIPv6 Protocol Stack		
		CP-080692	0048	3	Modifications for S2a/S2b - PMIP based S8 chaining		

History

Document history		
V8.1.0	January 2009	Publication