ERICSSON

Session Management

TECHNICAL PRODUCT DESCRIPTION

5/221 02-AXB 250 12-V3 Uen LB

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Contents

1 Introduction

This document describes session management in the EPG product over the Gn/Gp, S1-U, S4, S5/S8, S12, S2a, S2b, and S11 interfaces for GSM, WCDMA, LTE, NB-IoT, trusted non-3GPP network, and untrusted non-3GPP network.

Note: In this document, the term bearer refers to Packet Data Protocol (PDP) context, EPS bearer, and PMIPv6 PDN connection. To facilitate the understanding of this document, refer to CPI Library Readers' Guide.

1.1 Supported Nodes

The functionality described in this document is supported by the following nodes:

— GGSN

— PGW

— SGW

1.2 Scope

This document gives a description of session and bearer management in the GPRS and EPS networks, including activation, modification, and deactivation of sessions and bearers.

The signalling between nodes not directly connected to the EPG is simplified in the described procedures.

Exceptional case handling towards external nodes is not described in this document. For more information on session management in the GPRS and EPS, refer to SoC with 3GPP TS 23.060, SoC with 3GPP TS 23.401, and SoC with 3GPP TS 23.402.

For descriptions of the counters related to the GGSN and PGW, refer to Counters and Gauges for the GGSN and PGW.

For descriptions of the counters and gauges related to SGW, refer to Counters and Gauges for the SGW.

Alarms and alerts related to session management are listed in Fault Management Description.

1.3 Target Groups

This document is intended as an introduction to EPG session management for network operators, network and service planners, as well as system engineers and administrators.

2 Overview

The EPG allows simultaneous combination of the GGSN, SGW, and PGW functionality on one physical node.

2.1 Technical Specification

For a technical specification of EPG session management-related feature support level and characteristics, refer to EPG Technical Product Description Overview.

2.2 Concepts

The following sections describe important concepts related to session management.

2.2.1 GTP

GPRS Tunneling Protocol (GTP) is used in GPRS for communication between the GGSN or PGW and the SGSN. It includes the following subprotocols:

— GPRS Tunneling Protocol - Control plane (GTP-C), used for control plane signalling

— GPRS Tunneling Protocol - User plane (GTP-U), used for payload on the user plane

The SGW communicates with an MME or SGSN using GTP version 2 (GTPv2), which is an enhanced version of GTP-C

The User Plane payload uses GTP-U for communication. The data is carried in the following five types:

— In the case of GPRS access to the EPC, if Direct Tunnel is not used (in the case of Iu) or is not applicable (in the case of Gb), the data is carried over the Iu/Gb interface between the UTRAN/GERAN and the SGSN and over the S4 interface between the SGSN and the SGW and then over the S5/S8 interface between the SGW and the PGW.

— In the case of GPRS access to the EPC, if Direct Tunnel is used, the data is carried over the S12 interface between the RNC and the SGW and then over the S5/S8 interface between the SGW and the PGW.

— In the case of the EPS, the data is carried over the S1-U interface between the eNodeB and the SGW and then over the S5/S8 interface between the SGW and the PGW.

- In the case of trusted WLAN access, the data is carried over the GTP-based S2a interface between the PGW and the TWAN in a trusted non-3GPP network.
- In the case of untrusted WLAN access, the data is carried over the S2b interface between the PGW and the Evolved Packet Data Gateway (ePDG) in an untrusted non-3GPP network.

For a further description of the messages exchanged between the eNodeB/RNC and the SGW, refer to S1-U and S12 Interface Description.

For a further description of the messages exchanged between the SGSN and the SGW, refer to S4 Interface Description.

For a further description of the messages exchanged between the MME and the SGW, refer to S11 Interface Description.

For a further description of the messages exchanged between the SGW and the PGW, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

For a further description of the messages exchanged between the TWAN and the PGW, refer to GTP-Based S2a Interface Description.

For a further description of the messages exchanged between the ePDG and the PGW, refer to S2b Interface Description.

2.2.2 PMIPv6

Proxy Mobile Internet Protocol version 6 (PMIPv6) is used for communication between the PGW and a Mobile Access Gateway (MAG) in a CDMA2000 network over the PMIPv6-based S2a interface. The PMIPv6 is a network-based mobility management protocol. It enables communication between the UE and Packet Data Networks (PDNs), and keeps track of the current position of the UE device.

A GRE tunnel is established between the PGW and the MAG to transfer payload for CDMA2000 sessions.

In the EPG, the PMIPv6-based S2a interface supports PMIPv6 for CDMA2000 access.

For a further description of the communication between the MAG and the PGW over the PMIPv6-based S2a interface, refer to PMIPv6-Based S2a Interface Description.

2.2.3 User Equipment

The UE is a device used to access a PDN through the EPS or GPRS and is identified by an International Mobile Subscriber Identity (IMSI) or International Mobile Equipment Identity (IMEI).

Note: For a UE-initiated emergency attach, if the IMSI is unauthenticated or not included in the request message, the IMEI is used to identify the UE.

The UE device can be considered in idle mode or in connected mode in SGW when the uplink tunnel is established.

- In idle mode, the UE has no downlink user plane established.
- In connected mode, the UE has downlink user plane established and can receive payload.
- In connected mode, if multiple bearers are established for a PDN connection of a WCDMA UE and Direct Tunnel is used, some bearers may have downlink user plane established and others may not. If downlink packets are received on the bearers that do not have downlink user plane, a `Downlink Data Notification` message is sent to the SGSN.

2.2.4 User Session for GTP-Based Access

A user session is the connection between the UE and an APN. In the EPS, a PDN connection that includes one default EPS bearer is established at initial attach stage. Additional PDN connection and dedicated EPS bearers can also be created directly after initial attach or later. In GPRS, the connection to the PDN is called a PDP session. A primary PDP context is used to achieve this and additional PDP session and secondary PDP context can also be included.

In GSM or WCDMA access to the EPC, the PDN connection is called a PDP session in the terminal, the RAN and the SGSN, and is called default bearer or dedicated bearer in the SGSN, the SGW, and the PGW. The SGSN does the mapping between the PDP contexts and EPS bearers.

The PDN connection is identified by an APN and the UE IP address. If supported, the UE can activate multiple, simultaneous PDN connections.

Note: The PGW supports multiple PDN connections from one UE on the GTP-based S2a interface, but only one per APN. The PGW also supports multiple PDN connections from one UE on the S2b interface, but only one per APN.

2.2.5 User Session for PMIPv6-Based Access

After a UE-initiated PDN connection creation (called Initial Binding Registration procedure within the PMIPv6 terminology), a PMIPv6 GRE tunnel for the payload is created between the MAG in the CDMA2000 network and the PGW. The EPG supports multiple PDN connections, but only one per APN. This means that the UE device may run several services simultaneously through the GRE tunnel.

2.2.6 Bearers

A user session incorporates one or more bearers, constituting virtual data channels that connects the UE to an APN. In the EPG, a bearer corresponds to a PDP context in GPRS, an EPS bearer in EPS/trusted WLAN access/untrusted WLAN access, and a conceptual representation of a PDN connection in CDMA. A bearer can be either the default bearer or a dedicated bearer.

2.2.6.1 PDP Context

In the GPRS, the UE initiates the PDP context activation procedure to activate a PDP context to establish a virtual data channel to an APN. After a successful primary PDP context activation, the subscriber can communicate with the APN and the UE is known in the GGSN or PGW. Subsequent PDP contexts can be established by UE-initiated or network-initiated secondary PDP context activation procedures. Deactivation of a primary PDP context results also in deactivation of associated secondary PDP contexts.

Note: The GGSN does not support UE-initiated secondary PDP context activation using the Gx or Gy interfaces, or local policies.

The PGW does not support UE-initiated secondary PDP context activation.

2.2.6.2 EPS Bearer

In the EPS, a default EPS bearer is established when the UE connects to an APN, and it remains established throughout the lifetime of the PDN connection. The EPS bearer provides the UE with a continuous IP connectivity. This bearer is referred to as the default EPS bearer. Additional dedicated bearers can be activated for the PDN connection through the PCRF- or PGW-initiated dedicated bearer activation procedures.

2.2.6.3 PDP Context in the Access Network and EPS Bearer in the Core Network

When GSM or WCDMA access is connected to the EPC, the UE initiates the PDP context activation procedure to activate a PDP context to establish a virtual data channel to an APN. The PDP context is mapped to an EPS bearer by the SGSN as the default bearer. Subsequent PDP contexts can be established by the network-initiated dedicated bearer establishment procedures.

Note: UE-Initiated secondary PDP context activation is not supported using the S4 interface.

3 Session Management Functions

Session management is a control plane function that establishes and handles connections between the UE and one or more PDNs. A session is the length of time between the creation of the first PDN connection and the termination of the last PDN connection.

A GTP-based session, both for GPRS and EPS, is conceptualized in Figure 1.

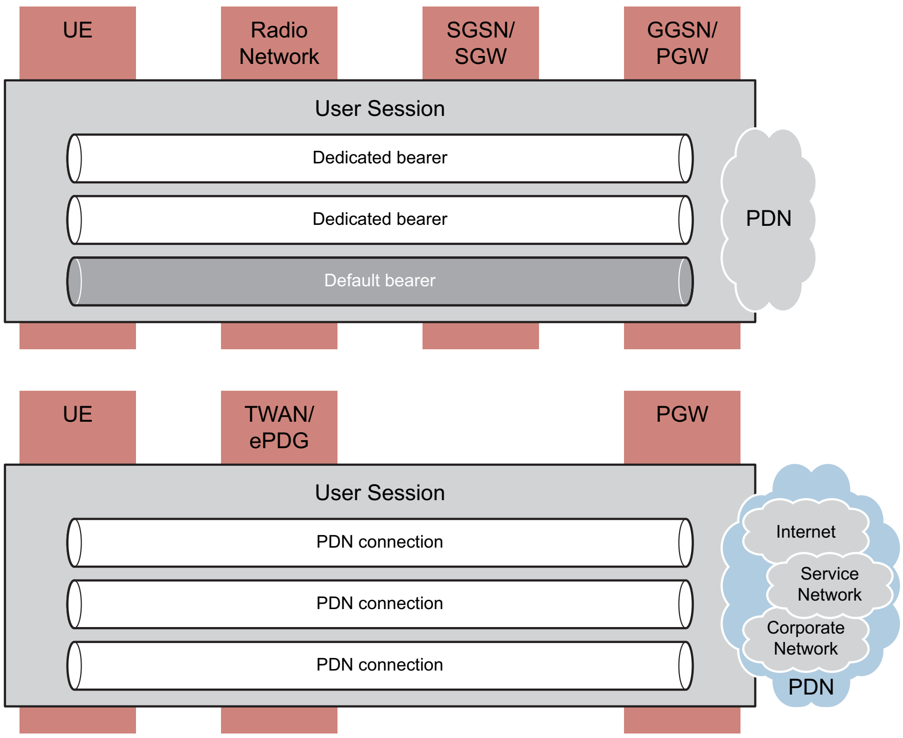

Figure 1 Logical View of a GTP-Based Session

A PMIPv6-based session is conceptualized in Figure 2.

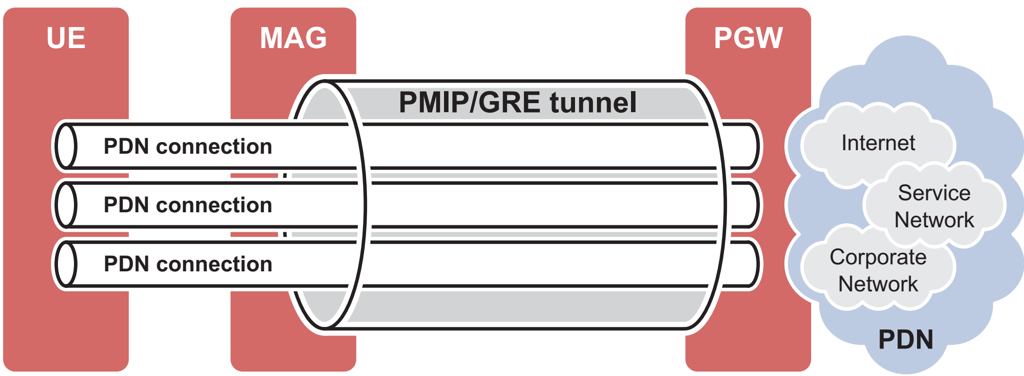

Figure 2 Logical Structure of a PMIPv6-Based Session

Session management supports the following main procedures:

- Creation of bearers
- Modification of bearers
- Termination of bearers

These procedures deal with allocation of IP addresses and Quality of Service (QoS) parameters. Bearers are set up and controlled through the GTP. For more information on GTP, refer to Tunneling and VPNs.

Each bearer established for a specific IP address and APN belongs to the same user session. The default bearer activation procedure is used when establishing the first bearer for a user session. If services that require additional bearers are requested by the UE or the network, additional dedicated bearers can be set up. When such a case happens in PMIPv6-based access, more PDN connections are created.

The following GTP paths can be set up:

- SGSN to GGSN or PGW
- MME/SGSN to SGW
- PGW to SGW (in a combined PGW and SGW)
- External PGW to SGW
- External SGW to PGW
- TWAN to PGW
- ePDG to PGW

The following PMIPv6 path is possible to set up:

- MAG to PGW

Note: The GTP paths are always set up between the SGSN, SGW, TWAN, or ePDG and the IP addresses included in these two IEs, never between the SGSN and the source IP address of the `Create PDP Context Response` or the SGW/TWAN/ePDG and the source IP address of the `Create Session Response` message.

Primary and secondary PDP contexts are supported. In addition, both dynamic and static allocation of IP addresses is supported. Primary PDP contexts can be established to various GGSNs or PGWs, but secondary PDP contexts are established to the same GGSN as its related primary PDP context and cannot be established on PGWs.

Similarly, default and dedicated EPS bearers are supported by the SGW and the PGW. Dedicated EPS bearers are associated to a respective default bearer and are always network-initiated. But only the default bearer is supported by the TWAN/ePDG and the PGW.

For PMIPv6-based S2a access, PDN connections are supported by the PGW. Secondary PDP contexts, or dedicated bearers are not applicable for PMIPv6-based S2a access.

3.1 Signalling Message Types

This section describes the categories of GTP signalling messages for the GGSN, PGW, and SGW.

For information about PMIPv6 signalling messages, refer to PMIPv6-Based S2a Interface Description.

Path Management Messages

The main purpose of these messages is to supervise a User Data Protocol (UDP)/IP path to ensure that a connectivity failure can be detected in a timely manner. Typically, a path is an IP connection between two GTP peers, each with its own IP address.

On a supervised path, the GGSN, PGW, or SGW sends `Echo Request` and `Echo Response` messages to maintain path connectivity to remote nodes. If a path failure is detected toward a remote node after a time interval, the GTP Path Failure alert is triggered. It is configurable for the SGW to trigger a `GTP Path Error` alarm instead for the GTP-C path toward an SGSN/MME node.

To configure path management, refer to GTP Interface Configuration.

To configure the triggering of `GTP Path Error` alarm, refer to GTP Interface Configuration.

Tunnel Management Messages

These contain messages that establish, modify, and release GTP tunnels.

The SGSN/MME has a dedicated IP address for `Create PDP Context Request` for the primary PDP context and `Create Session Request` messages. This IP address must be configured in the DNS server that the SGSN/MME contacts before sending a `Create PDP Context Request` for the primary PDP context or `Create Session Request` message.

When the GGSN/PGW receives a `Create PDP Context Request` for the primary PDP context or `Create Session Request` message, the GGSN/PGW may choose to use another, internal IP address for the PDN connection. This address is provided by the GGSN/PGW in the `Create PDP Context Response` or `Create Session Response` message back to the SGSN/MME.

The SGSN/MME then uses this address for subsequent initial control signalling messages for the same PDN connection. Examples of such messages for the GTPv1-based Gn/Gp interface are `Update PDP Context Request` and `Delete PDP Context Request`. Examples for GTPv2-based interfaces are `Modify Bearer Request`, `Delete Session Request`, and `Delete Bearer Command`.

The SGSN/MME does not use this address for other `Create PDP Context Request` for the primary PDP context or `Create Session Request` messages.

In all response messages sent from the GGSN/PGW, the source and destination addresses in the IP header, and the source and destination ports in the UDP header, are swapped.

The Recovery IE is always included in a `Create PDP Context Response` or `Create Session Response` message, if the bearer is successfully created on GGSN or PGW (`Cause-value` = `Request Accepted`, New PDP/PDN type due to network preference or New PDP/PDN type due to single address bearer only). The value of the Recovery IE is given by the restart counter of the PGW, according to 3GPP TS 29.060 and 3GPP TS 29.274, the Recovery IE is connected to the signalling address provided in the `Create PDP Context Response` or `Create Session Response` message. If the `Create PDP Context Response` or `Create Session Response` signals that GGSN or PGW rejected the creation of the bearer, no Recovery IE is included.

There is one restart counter for the PGW. This restart counter is used in GTP signalling messages and echo responses as the Recovery Information Element (IE).

3.2 Service Access through WLAN

This section describes service access through WLAN which can be provided by the Gn, GTP-based S2a, and S2b interfaces.

3.2.1 Service Access through WLAN on Gn Interface

When a user accesses a service from a Gn WLAN, the TTG assumes the role of the SGSN, creating PDP contexts for service access through the GGSN. Support for WLAN access can be configured per APN, as described in APN Configuration.

3.2.2 Service Access through WLAN on GTP-Based S2a Interface

When a user accesses a service from an GTP-based S2a WLAN, the TWAN triggers the `Create Session Request` to the PGW. Support for the trusted WLAN access can be configured per APN, as described in APN Configuration.

3.2.3 Service Access through WLAN on S2b Interface

When a user accesses a service from a S2b WLAN, the ePDG triggers the `Create Session Request` to the PGW. Support for untrusted WLAN access can be configured per APN, as described in APN Configuration.

3.3 Control Plane CIoT EPS Optimization

The EPG supports the 3GPP standard of optimizing the EPS for IoT traffic using the Control Plane CIoT EPS optimization. The Control Plane CIoT EPS optimization involves the S11-U interface on the SGW.

The UE devices with RAT type NB-IoT and E-UTRAN can use Control Plane CIoT EPS optimization. When the MME and UE devices handles the user data transported in the Data over NAS (DoNAS), the MME requests the usage of the S11-U interface.

The S11-U interface can be configured together with the S1-U, S4-U, and S12 interfaces as a single logical interface. The S11-U interface can be optionally configured as a separate logic interface from the S1-U, S4-U, and S12 interfaces.

For more information about the session management over the S11-U interface, see Section 8 on page 93.

3.4 TFT Handling

For end-user services that require a different QoS than provided on the default bearer, a dedicated bearer can be activated. It shares the same address and APN as the default bearer for the same PDN connection. The services carried by the dedicated bearer are defined in a Traffic Flow Template (TFT).

Note: For PMIPv6-based S2a access, the PDN connections are equivalent to the default bearer. All services for the PMIPv6-based S2a access use the default bearer QoS.

For UE-initiated secondary PDP contexts, the TFT is provided by the UE. For network-initiated dedicated bearers, the TFT is created by the PGW based on PCC rules provided by the PCRF. A TFT is a list of packet filters unique for each bearer, and is used downlink in the user plane to forward packets into the appropriate GTP tunnel. The TFT incorporates packet filters such as QoS and security. Using the packet filters the GGSN or PGW maps the incoming datagrams into the correct bearer. TFTs are validated on the PSC to ensure their correctness according to the rules for operations on TFTs as defined in the 3GPP standard. TFTs can be created, modified, and deleted by the GGSN or PGW for IPv4 payload and for IPv6 payload.

Some of the attributes in Table 1 can coexist in a packet filter while others mutually exclude each other. In Table 1 the possible combinations are shown. Only those attributes marked with an X can be specified for a single packet filter. All marked attributes can be specified, but at least one attribute must be specified. Attributes not marked with IP version in Table 1 are supported for both IPv4 and IPv6.

Table 1 Valid TFT Combination Types

	Valid Combination Types		
Packet filter attribute	**I**	**II**	**III**
Source Address and Subnet Mask	X	X	X
Protocol Number (IPv4) / Next Header (IPv6)	X	X	
Destination Port Range	X		
Source Port Range	X		
TOS (IPv4) / Traffic Class (IPv6) and Mask	X	X	X
Flow Label (IPv6)			X

3.5 APN Overview

This section describes the different APNs related to the GGSN or PGW and how the GGSN or PGW select which APN to use on the Gi and SGi network.

The following list defines the different APNs related to the GGSN or PGW:

— Logical APN—mapped through configuration to an APN or to a list of one or more APNs. A logical APN cannot be chosen as selected APN.

— Selected APN—selected by the GGSN or PGW to be used on the Gi and SGi networks. A selected APN cannot be a logical APN.

  The selected APN points out the network that the GGSN or PGW establishes a connection with.

— Requested APN—sent to the GGSN or PGW from the SGSN, SGW, TWAN, ePDG, or MAG in a packet. A Requested APN can be a logical APN.

— Username-Based APN Selection (UBS)—APN in the Protocol Configuration Option (PCO) field sent to the GGSN or PGW from the SGSN in a GTP packet. This APN cannot be a logical APN. This APN is only used if the Requested APN is a logical APN.

  In the PCO field, a username can be provided, which includes an APN. For example, from the username `user@apn-name.com`, the GGSN or PGW extracts the APN `apn-name.com`.

— APN obtained through RADIUS-assisted APN selection—received from the RADIUS server. This APN can be chosen as selected APN.

— Service APN and Base APN are used for Aware Policy-Based Routing (APR). Service APNs are APNs configured for APR, and they are associated to a base APN. Fore more information about APR, refer to Aware Policy-Based Routing.

— Emergency APNs are APNs configured for IMS emergency session. For more information about IMS emergency session, refer to IMS Emergency Session.

— Default APN—selected by the GGSN or PGW to be used on the Gi and SGi networks if the selected APN is not chosen by CC-Based APN selection, RADIUS-Assisted APN Selection or UBS.

— APN obtained through PCRF-assisted APN selection—This APN can be chosen as the selected APN.

3.5.1 APN Selection

The GGSN or PGW receives at least one APN in a packet from the SGSN, SGW, TWAN, ePDG, or MAG. The packet includes a requested APN and can include an APN in the PCO field. The GGSN or PGW compares the received APN with the APN database. If the APN is not an emergency APN, the GGSN or PGW checks the logical APN list. If the APN is not logical, the GGSN or PGW checks if RADIUS-assisted APN selection or the PCRF-assisted APN selection is enabled. Based on the selection rules described in Figure 3, the GGSN or PGW selects which APN should be used as the selected APN.

Each APN in the APN database can be chosen as the selected APN, while each logical APN has its own list of related APNs (these are included in the APN database), which can be chosen as the selected APN.

If RADIUS-assisted APN selection is used and the procedure is successful, then that APN is the selected APN, not necessarily the APN directly received from the RADIUS server.

If the PCRF-assisted APN selection procedure is successful, then that APN is the selected APN.

The RADIUS-assisted and PCRF-assisted APN selection cannot work together. When creating a user session, RADIUS authentication is completed before Policy Control so if RADIUS changes the APN, the PCRF cannot change the APN.

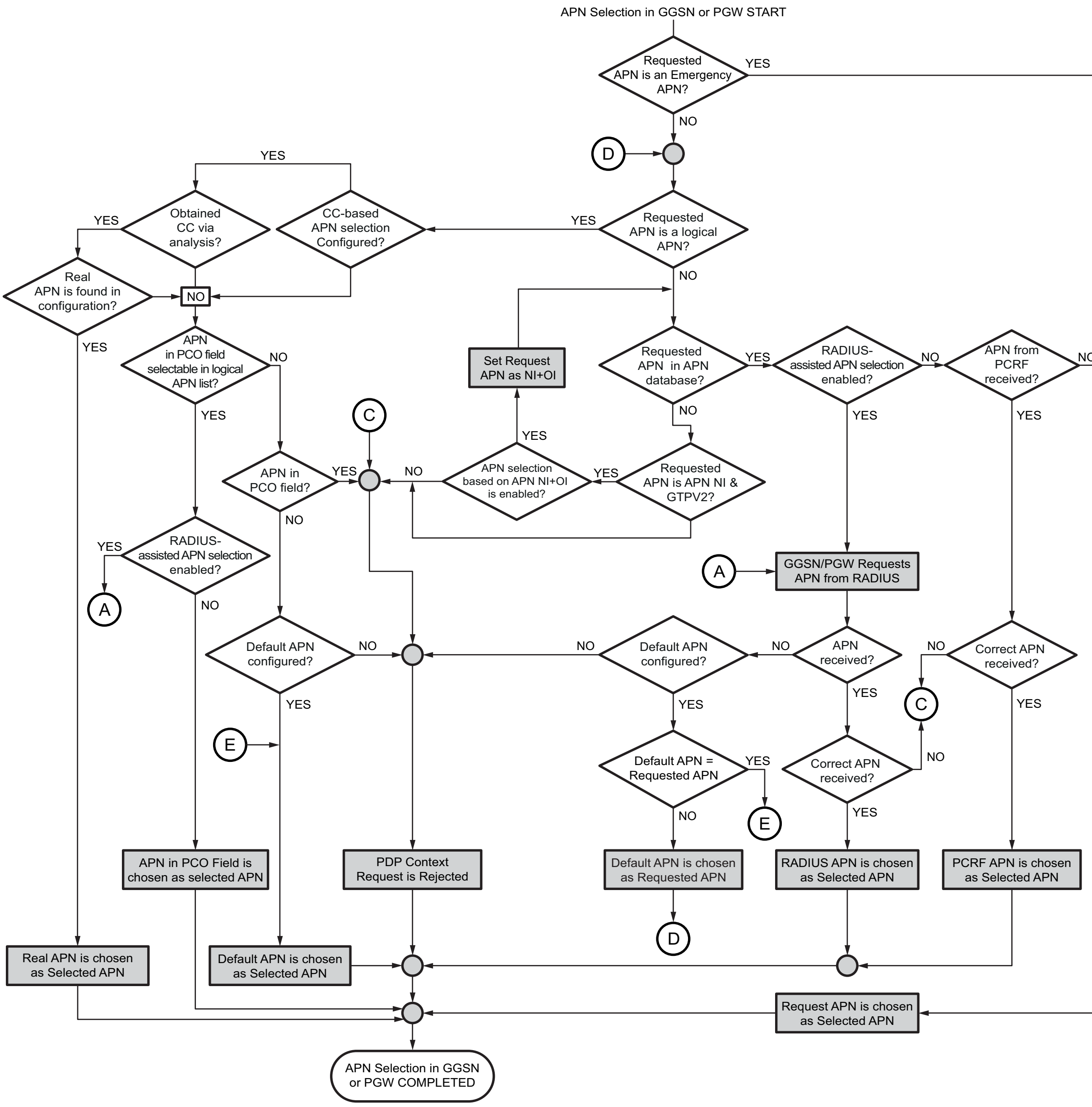

Figure 3 APN Selection in GGSN or PGW

3.5.2 Logical APNs

A logical APN is a layer of abstraction that can optionally be added to an APN. The one-to-one mapping between an APN and a PDN remains the same. The use of logical APNs allows manipulation of the APN selection rules that can result in a different APN being selected than that specified by the programmed UE, either transparently to the UE or based on input from the user.

A logical APN can be used to do the following:

- One or more logical APNs can be mapped to an APN through configuration. Upon receipt of a `Create PDP Context Request`, `Create Session Request`, or `Proxy Binding Update` (PBU) message that contains one of the logical APNs, the GGSN or PGW substitutes the APN transparently to the UE user. This feature is called APN alias.
- A logical APN can be mapped to a list of one or more APNs from which the UE can choose by specifying a special syntax during the authentication phase of session establishment. This feature is called User-name Based APN Selection (UBS).

UBS

Note: UBS is not supported for PMIPv6-based S2a access.

In the course of session creation, the user’s APN must be determined before the user is authenticated. APN information can be included in the session creation request from the UE.

To make it possible for a UE to access more than a single APN, each individual APN has to be configured in the UE. Unfortunately, due to vendor specific solutions and a lack of standardization in the UE, the configuration is a very complex task to perform.

UBS is a network-based proprietary solution, giving the user access to multiple APNs without the need for specific APN configuration in the UE. This solution can be used in the current time frame until consistent, widely accepted, standardized solutions for device configuration become available on the market.

The APN is selected based on the username. The username has the format `user@apn-name.com`, provided in the connection request. If the user, for example, is using running Windows on the UE, the username could be configured in a standard Windows Dial-up Connection, specific for the APN. APN selection is further described in Section 3.5.1 on page 13.

The only network node that is affected by the UBS feature is the GGSN or PGW. In communication with external systems, such as charging systems and RADIUS servers, the GGSN or PGW provides the APN which is finally selected by the UBS feature. The logical APN is not communicated.

From the corporate customer’s point of view, the solution looks like a standard APN-based (non-UBS) solution for corporate access, but without the need to configure APNs in the UE.

The solution can be implemented in parallel and interoperate with a solution where several APNs are used for public access.

The APN wildcard cannot be defined for the subscribers using this solution.

3.5.3 RADIUS-Assisted APN Selection

Note: RADIUS-assisted APN selection is not supported for PMIPv6-based S2a access.

The purpose of the RADIUS-assisted APN selection is to base the APN selection on subscription information. That is, the selection is based on the APN included in the `Create PDP Context Request` or `Create Session Request` message, if RADIUS-assisted APN selection is enabled on the GGSN or PGW for that APN.

A `Create PDP Context Request` from the SGSN or `Create Session Request` from the MME is received by the GGSN or PGW. The GGSN or PGW checks if RADIUS-assisted APN selection is configured for the Requested APN (included in the create PDP context request). If RADIUS-assisted APN selection is configured, the GGSN or PGW requests a new APN from a RADIUS server. When an APN has been obtained, it is chosen as selected APN. If no APN is received from the RADIUS server, and a default APN is configured and is equal to the requested APN, the default APN is chosen as selected APN. The selection rules are described further in Figure 3.

Note: It is recommended that the default APN does not have RADIUS-assisted APN selection enabled. If no APN is received in the `Access-Accept` message, then the default APN is used. If the default APN is configured with RADIUS-assisted APN selection, one of the following situations occurs:

- If the default APN is the same as the requested APN in the `Create Session Request`, the session creation is successful.
- If the default APN is not the same as the requested APN in the `Create Session Request`, there are no more `Access-Request` messages and the `Create Session Response` replies with cause value `APN access denied - no subscription`.

The create PDP context or create session request is rejected if any of the following situations occurs:

- No RADIUS server is dedicated to RADIUS-assisted APN selection.
- No RADIUS-assisted APN selection `Access-Accept` message is received from the RADIUS server.
- A RADIUS-assisted APN selection `Access-Reject` message is received from the RADIUS server.
- The RADIUS-assisted APN selection `Access-Accept` message received from the RADIUS server has an incorrect format.
- The APN received from the RADIUS server is unknown by the GGSN or PGW.

3.5.4 CC-Based APN Selection

Note: CC-Based APN selection is not supported for PMIPv6-based S2a access.

The purpose of CC-based APN selection is to base the APN selection on subscription type. The subscription type can be for example prepaid or postpaid. For prepaid subscribers, all traffic must be analyzed with deep packet inspection. For postpaid subscribers, the traffic passes through the GGSN or PGW without inspection. The GGSN or PGW can choose different APNs for prepaid subscribers and postpaid subscribers.

The CC-based APN selection procedure is described as follows:

1. The GGSN or PGW receives a `Create PDP Context Request` or `Create Session Request`message.
2. The GGSN or PGW checks if CC-based APN selection is configured for the logical APN.
    - If CC is received from SGSN or MME and the IMSI analysis does not state “override”, this CC is used for CC-based APN selection.
    - If no CC is received and the IMSI analysis states “override”, the CC from IMSI analysis is used.
    - Otherwise, the preconfigured default CC on node level is used.
3. If a real APN found in configuration matches the CC value, this APN is used.
4. If this selection procedure could not select an APN successfully, the GGSN or PGW performs the next step of the APN selection procedure. The selection rules are described further in Figure 3.

For information on how to configure CC-based APN selection, refer to APN Configuration.

3.5.5 Default APN Selection

If configured, the default APN is chosen as the selected APN if the selected APN is not chosen by CC-Based APN Selection, RADIUS-Assisted APN Selection, and UBS. See Figure 3 for the APN selection flow.

If the default APN is not configured in the GGSN or PGW, the `Create PDP Context Request`, `Create Session Request`, or `PBU` message is rejected with the appropriate error code.

For information on how to configure the default APN, refer to APN Configuration.

3.5.6 PCRF-Assisted APN Selection

PCRF-assisted APN selection is described as follows:

1. The PCRF changes the APN during the `Create Session` procedure in the `CCA-Initial` message.

2. The `Create Session` procedure is aborted and restarted with the new APN.

The APN provided by the PCRF must be configured in the PGW as an APN to be used on Gi and SGI networks.

PCRF-assisted APN selection has the following limitations:

— The PCRF-assisted APN selection is not supported for PMIPv6-based S2a access.

— The PCRF selects the APN for a user session only once.

— The PCRF-assisted APN selection does not work together with RADIUS Authentication if the optional message attribute `acct-session-id` is enabled. For more information, refer to RADIUS Configuration.

— If the EPG is configured to include the requested APN in CCR-I messages over Gx, PCRF-assisted APN selection takes a lower priority. For information about including the requested APN in CCR-I messages, see Policy Control Configuration.

The PCRF-assisted APN selection rules are described further in Figure 3.

3.6 Quality of Service

The support of QoS enables the operators to differentiate strands of traffic. In GPRS, the QoS is negotiated among the UE, the radio network and the core network, while in EPS, the QoS applied to the bearer is decided by the core network. For more information about QoS, refer to Quality of Service on the GGSN and PGW and Quality of Service on the SGW.

3.7 Admission Control and Bit Rate Enforcement

The purpose of the admission control function is to provide access control related to QoS and the number of bearer. Bit rate enforcement ensures that the correct bandwidth is not exceeded.

For more information on admission control, refer to Overload Protection. For information on bit rate enforcement, refer to Quality of Service on the GGSN and PGW.

3.8 Payload Limit

The payload limit is the configured maximum amount of active payload in the GGSN or PGW. This limit cannot be set higher than the licensed payload capacity.

If the payload limit is reached, an alarm is triggered and all packets exceeding the limit are discarded. The alarm is cleared when the level is below 90% of the configured payload limit.

For information on how to configure the payload limit, refer to APN Configuration.

3.9 Downlink Data Notification Delay

The SGW delays sending the `Downlink Data Notification` messages according to the delay value specified by the MME. This function reduces the MME load caused by the unnecessary `Downlink Data Notification` messages during the UE triggered service request procedure.

The SGW decodes the delay value in the following IEs of the `Downlink Data Notification Acknowledge` message, the `Modify Access Bearers Request` message, or the `Modify Bearer Request` message over the S4 and S11 interfaces, and updates the delay value every 30 seconds.

The following IEs are supported for the S4 and S11 interfaces:

— S4

- The SGW decodes the delay value in the `Data Notification Delay` IE of the `Downlink Data Notification Acknowledge` message.
- The SGW decodes the delay value in the `Delay Downlink Packet Notification Request` IE of the `Modify Bearer Request` message.

For more information, refer to S4 Interface Description.

— S11

- The SGW decodes the delay value in the `Data Notification Delay` IE of the `Downlink Data Notification Acknowledge` message.
- The SGW decodes the delay value in the `Delay Downlink Packet Notification Request` IE of the `Modify Access Bearers Request` message and the `Modify Bearer Request` message.

For more information, refer to S11 Interface Description.

Note:

— Delay value is applied with Downlink Data Notification control methods, such as Downlink Data Notification Throttling, Downlink Data Notification Interval, and Smart Paging.

— The SGW does not apply delay value for the high priority traffic which is identified by ServiceID-aware Smart Paging.

3.10 Suspend Downlink Data Notification

The SGW suspends sending the `Downlink Data Notification` messages to the MME if uplink traffic is received within a user-defined period before the downlink traffic. This function reduces the MME load caused by the unnecessary `Downlink Data Notification` messages during the UE-Triggered Service Request procedure. To configure the suspension period between the uplink traffic and downlink traffic for `Downlink Data Notification` messages, refer to GTP Properties Configuration.

Note: The SGW does not suspend `Downlink Data Notification` messages for the high priority traffic identified by ServiceID-aware Smart Paging and DSCP-aware Smart Paging.

3.11 Monitoring Bearer Activity and Duration

The purpose of this function is to supervise and trigger the deletion of inactive bearers.

Note: If the `idle-timeout` timer expires in the default EPS bearer for a session, the session is not deleted as long as a dedicated bearer exists for the session.

Bearer activity can be monitored in two ways, both of which can be active at the same time:

- Monitoring the number of minutes since uplink payload or events were last forwarded on the bearer. The timer is optionally reset at bearer update.
- Monitoring the duration of the bearer, regardless of payload activity. The timer is optionally reset at bearer update.

Monitoring of bearer activity can be configured on both node and APN level, where configuration on APN level overrides node-level configuration.

`idle-timeout` can be configured separately for dedicated EPS bearers or secondary PDP contexts.

Time-out values can also be configured for different bearers based on the following parameters:

- Time-out settings received over RADIUS
- Time-out settings received over 3GPP AAA server
- The SGSN PLMN ID of the bearer
- Roaming status for the UE (If the SGSN PLMN ID of the bearer is different from the PLMN ID of the GGSN or PGW)
- The CC profile of the bearer

— Default time-out settings

Note: For the eUTRAN users, the idle timeout value can be configured differently.

An evaluation procedure determines the time-out settings that apply to a certain bearer.

3.11.1 Evaluation of Bearer Time-Out Parameters

The following procedure is used to determine the time-out settings that apply to monitoring of a bearer. The time-out settings for monitoring of payload and event activity, and for monitoring bearer duration are evaluated separately, using the same procedure.

Evaluation of APN-Level Configuration

APN-level evaluation of parameter is performed as follows:

1. If monitoring of bearers is not disabled, continue to the next step.
2. If `idle-timeout` is configured for the dedicated bearer on QCI level, when the dedicated bearers are established with the same QCI, the parameter is set to this value. Otherwise, continue to the next step.
3. If `idle-timeout` is configured for the dedicated bearer on APN level, when the dedicated bearer is established, the parameter is set to this value. Otherwise, continue to the next step.
4. If time-out defined by RADIUS is configured, the parameter is set to a value received from a RADIUS server. The values for the timers are received from a RADIUS server at bearer activation.

   If no value is received from the RADIUS server, the activity and duration of the bearer is not monitored. If time-out defined by RADIUS is not configured, continue to the next step.
5. If time-out defined by 3GPP AAA server is enabled, the parameter is set to a value received from 3GPP AAA server. If no value is received from 3GPP AAA server during PDN setup, continue to the next step. If no value is received from 3GPP AAA server during session update, continue to the next step.

   If time-out defined by 3GPP AAA server is not enabled, continue to the next step.
6. If time-out based on SGSN PLMN ID is configured for the SGSN PLMN ID of the bearer, the parameter is set to this value. Otherwise, continue to the next step.
7. If the UE is roaming, and time-out settings for roaming UE are configured, the parameter is set to this value. Otherwise, continue to the next step.

8. If time-out based on charging characteristics profile is configured for the charging characteristic profile of the bearer, the parameter is set to this value.

Evaluation of Node-Level Configuration

Node level evaluation of parameter is performed as follows:

1. If `idle-timeout` is not configured, continue to the next step.
2. If `idle-timeout` is configured for the dedicated bearer on QCI level, when the dedicated bearers are established with the same QCI, the parameter is set to this value. Otherwise, continue to the next step.
3. If `idle-timeout` is configured for the dedicated bearer, the parameter is set to this value when the dedicated bearer is established. Otherwise, continue to the next step.
4. If time-out defined by RADIUS is disabled on APN level, continue to the next step. Otherwise, if time-out defined by RADIUS is configured, the parameter is set to a value received from a RADIUS server. If no value is received from the RADIUS server, the activity and duration of the bearer is not monitored.
5. If time-out defined by 3GPP AAA is disabled on APN level, continue to the next step. Otherwise, if time-out defined by 3GPP AAA Sever is enabled, the parameter is set to a value received from 3GPP AAA server. If no value is received from 3GPP AAA server, continue to the next step.
6. If time-out based on SGSN PLMN ID is disabled on APN level, continue to the next step. Otherwise, if time-out based on SGSN PLMN ID is configured for the SGSN PLMN ID of the bearer, the parameter is set to this value.
7. If time-out settings for roaming UE is disabled on APN level, continue to the next step. Otherwise, if the UE is roaming and time-out settings for roaming UE are configured, the parameter is set to this value.
8. If time-out based on charging characteristics profile is disabled on APN level, continue to the next step. Otherwise, if time-out based on charging characteristics profile is configured for the charging characteristic profile of the bearer, the parameter is set to this value.
9. If default time-out settings are disabled on APN level, then the activity and duration of the bearer is not monitored. Otherwise, if default time-out settings are configured, the parameter is set to this value.

3.12 Terminate Idle Sessions

The termination of idle sessions is an optional feature controlled by the action command `terminate-idle-session-start`. The command is used to terminate idle user sessions on the SGW, PGW, or GGSN nodes. It is used to empty a node partially or fully without impacting active user sessions.

The command can only be run once a node has been blocked. For the GGSN or PGW, a blocked node means that any attempts to create user sessions are rejected. For the SGW, a blocked node means that the attempts to create new user sessions are rejected, except the attempts for the UE devices that are already attached to the SGW.

The termination of idle sessions stops once there are no remaining user sessions on the node or explicitly, at any time by the action command `terminate-idle-session-stop`. The termination of idle sessions has to be restarted using the `terminate-idle-session-start` command if either, any of the PSCs, SSCs, or CPBs on a standalone SGW or a combined GW restart while the command is running, or in case of CPB failover.

The termination of idle sessions can be monitored using the action command `terminate-idle-session-show`.

Refer to EPG Software Configuration Overview for details regarding the action commands.

When a user session is terminated the GTP cause value `Reactivation Requested` is included in the delete message sent to the SGSN (over the Gn/Gp interface), MME (S11) or SGW (S5/S8). If the SGSN, MME, or DNS are configured to use `Reactivation Requested`, the nodes are then aware that the node is blocked and any re-establishment requests are sent towards other available SGW, PGW or GGSN nodes in the network. This cause code is not included for all other interfaces on the PGW.

Note: User sessions that never enter idle state are not terminated when using the `terminate-idle-session-start` command.

To empty a full node may take a long time. The `terminate` command can be used at any time to terminate all user sessions. In that case also active user sessions are terminated.

3.12.1 Terminate Idle Sessions on the SGW

If `terminate-idle-session-start` is initiated, the SGW starts to terminate idle user sessions. The SGW terminates all user sessions belonging to a UE as close together as possible. A user session is considered idle in the SGW when the following criteria are met for all bearers associated with the UE:

- The QCI value is not exempted from idle termination. By default, the QCI values 1, 65, 66, 67, 69, 82, and 83 are not terminated when idle. For information on how to configure QCI values for idle termination, refer to GTP Interface Configuration.
- There are no established GTP-U tunnels between the SGW and eNodeB.

The termination of idle user sessions is limited by the configured throttling rates. Refer to GTP Properties Configuration for more information on throttling rates on the SGW.

Note: When blocked, the SGW accepts the attempts to create user sessions from the MME for UE devices that are already attached to the SGW. Terminating idle sessions can take up to several hours; during this period, UE devices that are already attached to the SGW can establish additional user sessions, including emergency user sessions.

See Section 8.10.2 on page 125 for information on PDN disconnection over the S11 interface.

See Section 9.3.2 on page 147 for information on PDN disconnection over the S4 interface.

3.12.2 Terminate Idle Sessions on the GGSN or PGW

If `terminate-idle-session-start` is initiated, the GGSN or PGW starts to terminate idle user sessions.

The idle timeout is set using the start command, `terminate-idle-session-start idle-monitor-timer <timer-value>`. The idle timeout is defined as the maximum time in seconds for which a user session is kept with no uplink payload.

The idle timeout timer is reset when there is uplink payload again for a user session.

A user session is terminated if the following criteria are met for all bearers belonging to the user session:

- No uplink payload has been received for at least the time specified by `idle-monitor-timer`.

  Note: The “specified time” is given as an argument to the command

- The QCI value is not exempted from idle termination. By default, the QCI values 1, 65, 66, 67, and 69 are not terminated when idle. For information on how to configure QCI values for idle termination, refer to GTP Interface Configuration.

- The user session is not connected to an emergency APN.

Note: There may still be other user sessions associated with the UE which are not deleted at the same time.

The cause value `Reactivation Requested` is included in `Delete Bearer Request` messages sent over the S5/S8 interface towards the SGW and `Delete PDP Context Request` messages sent over the Gn/Gp interface towards SGSN.

`Delete Bearer Request` messages sent over GTP-based S2a and S2b, and `Binding Revocation Acknowledgement` messages sent over the PMIPv6 based S2a interface, do not include the `Reactivation Requested` cause value.

The termination of idle user sessions in PGW is limited by the configured throttling rates.

See the following sections for more information:

— Section 4.3.1 on page 59; GGSN or PGW-initiated deactivation over the Gn/Gp and Iu-u interfaces.

— Section 5.3 on page 69; PGW-initiated PDN connection deletion over the GTP-based S2a interface.

— Section 6.4 on page 78; PGW-initiated PDN connection deletion over the PMIPv6-based S2a interface.

— Section 7.4 on page 90; PGW-initiated PDN connection deletion over the S2b interface.

— Section 8.10.2 on page 125; PGW-initiated PDN disconnection over the S11 interface.

— Section 9.3.1 on page 145; PGW-initiated bearer deletion and PDN connection deactivation over the S4 interface.

3.12.3 Terminate Idle Sessions on the Combined GW

The `terminate-idle-session-start` command is run separately on the SGW and the PGW.

3.13 End-User IP Addresses

IP addresses can be public or private, and dynamic or static. Public IP addresses are assigned by official Internet authorities, and these addresses are routable in the Internet. Private IP addresses are assigned by the Internet Service Provider (ISP), and these addresses are only routable in local networks. The GGSN or PGW supports two versions of IP for end-users, IPv4 and IPv6. For packet transport between the GGSN or PGW and its adjacent nodes, only IPv4 is supported.

Each bearer or PDN connection established by the UE refers to IP addresses allocated to the UE. The GGSN or PGW supports static and dynamic IP address allocation for assigning an IP address to the UE during PDN connection creation. For more information, refer to APN Configuration. IP address assignment settings are configured for each APN. After the UE user terminates the last bearer for an IP address, the IP address is available for allocation to another UE.

3.13.1 Static IP Address Allocation

Static IP address allocation offers subscribers the opportunity to always use the same IP address. If static IP addresses are used for UE in an APN, they must be assigned by an ISP or corporate network manager. In this case the GGSN or PGW is not responsible for IP address allocation.

3.13.2 Dynamic IP Address Allocation

Dynamic IP address allocation enables operators, ISPs, or corporate networks to use and reuse IP addresses from a pool allocated to the PLMN or some other network. Only active bearers require an allocated IP address. Thus, one IP address can be used for successive bearers. This significantly reduces the total number of IP addresses required for each PLMN. The GGSN or PGW can allocate dynamic IP addresses using inband or shared RADIUS server, Dynamic Host Configuration Protocol (DHCP) servers, Layer 2 Tunneling Protocol (L2TP), or shared IP pool.

Address allocation is independent of how the UE is authenticated. For example, an APN can be configured to use RADIUS authentication and the GGSN- or PGW-shared IP pool for address allocation.

The shared IP pool of IP addresses is configured per APN. The number of addresses in the IP pool is unlimited. The EPG can be configured optionally to select shared IP pool based on Location Area Identity (LAI)/Tracking Area Identity (TAI). Each APN can link one direct shared IP pool and multiple location-based shared IP pools. When the LAI/TAI-based selection of the shared IP pool is enabled, if there is an IP pool mapped to a location area, IP addresses are allocated from the location-based shared IP pool. Otherwise, IP addresses are allocated from the shared IP pool that is linked to the APN directly. Shared IP pool selection based on LAI or TAI can be disabled for IPv4 address allocation. For information on how to disable LAI- or TAI-based shared IP pool selection for IPv4 address allocation, refer to APN Configuration.

Note: The LAI/TAI-based selection of the shared IP pool is supported in the EPG for GSM, WCDMA, LTE network.

The LAI/TAI-based selection of the shared IP pool is not applicable for service APN.

For more information about IP address allocation from shared IP pools after an ICR switchover, refer to Inter-Chassis Redundancy.

The GGSN or PGW supports a quarantine timer when allocating IP addresses from the internal pool, preventing that an IP address is reused before the timer expires. In addition to the quarantine timer, the GGSN or PGW also has two counters with the possibility to set alarm levels. The counters read and set off an alarm for two events in the supervision of the IP addresses. They are used for shared IP pool. One counter handles the number of available IP addresses in the internal GGSN or PGW IP-address pool (per APN). The other counter handles the number of IP-addresses in quarantine. Alarm for shared IP pool does not need to be configured.

The GGSN or PGW provides the function of a DHCP client (IPv4 only) as defined in RFC 2131.

If an APN is configured to use DHCP, the GGSN or PGW acts as the DHCP proxy client to the UE that need addresses allocated dynamically. For each UE, the GGSN or PGW has to renew the lease periodically, until the bearer is deleted.

Before an optional (RADIUS) authentication, the GGSN or PGW sends a `DHCPDISCOVER` message to the DHCP server. The server responds with a `DHCPOFFER` message. The GGSN or PGW then sends a `DHCPREQUEST` message to the DHCP server. When the IP address is received from the DHCP server, the GGSN or PGW performs RADIUS Authentication (if configured), and then sends the `Create PDP Context Response` or `Create Session Response` message to the UE (including the UE IP address).

Note: IP address allocation using RADIUS is not supported for PMIPv6-based S2a access.

IPv6 address allocation through L2TP is not supported.

Only if the PGW sends a request including the subnet selection option to the DHCP Server, the PGW can compare the subnet selection option included in the following response messages with the one in the request message:

- `DHCPOFFER`
- `DHCPACK`

If the subnet selection option is not included in the response message, the PGW discards the `DHCPOFFER` or `DHCPACK` message.

If the subnet selection option is included in the response message, and if the both options are identical, the PGW handles the received `DHCPOFFER` or `DHCPACK` message. Otherwise the PGW discards the corresponding `DHCPOFFER` or `DHCPACK` message.

This function is disabled by default. For information about configuring this function, refer to APN Configuration.

3.14 IMS Support

Communication between UE and the IP Multimedia Subsystem (IMS) is enabled by the GGSN or PGW through configuration of Proxy Call Session Control Function (P-CSCF) server addresses. For VoLTE, a dedicated APN called IMS is used. The default bearer for this APN is used for IMS signalling. For IMS services other than VoLTE, the UE may use a general-purpose bearer or set up a dedicated bearer for IMS signalling.

3.14.1 P-CSCF Server

The UE requesting IMS services must be connected to a P-CSCF server. The UE may request P-CSCF server IP addresses during session establishment.

The P-CSCF server IP addresses can be configured or requested by the following ways:

- Local configuration, which is applicable in the LTE, GSM, WCDMA, CDMA, trusted WLAN, and untrusted WLAN networks, as described in Section 3.14.1.1 on page 28
- P-CSCF discovery by DNS procedure, which is applicable in the LTE, CDMA, trusted WLAN, and untrusted WLAN networks, as described in Section 3.14.1.2 on page 31

If the DNS function is enabled and if the PGW receives the P-CSCF FQDN, then P-CSCF discovery by DNS procedure is preferably used, otherwise the local configuration is used to allocate the P-CSCF server IP addresses.

Note: The PGW does not send a P-CSCF address list when the UE does not require a P-CSCF address. The UE can use the P-CSCF addresses configured in UE.

3.14.1.1 Local Configurable P-CSCF Server IP Address

If the GGSN or PGW supports UE-to-IMS communication, it supplies one primary and one secondary (if available) P-CSCF server IP address to UE if the UE has requested P-CSCF server address. It is also configurable to supply three P-CSCF server IP addresses to UE.

For different access network, different IEs are supported for carrying the P-CSCF address information. The IE used in the response message is the same as the one used in request message.

Table 2 shows the supported IEs, the corresponding protocol/interface, and message for different access network.

Table 2 Supported Protocol, Interface, and IE

Network	Protocol/Interface	Message	IE
LTE	GTP-based S5/S8	Create Session Request Create Session Response	PCO
GSM/WCDMA	GTP-based S5/S8	Create Session Request Create Session Response	PCO
	GTP-based Gn/Gp	Create PDP context Request Create PDP context Response	PCO

Network	Protocol/Interface	Message	IE
Trusted WLAN	GTP-based S2a	Create Session Request Create Session Response	PCO, APCO[1]
Untrusted WLAN	GTP-based S2b	Create Session Request Create Session Response	Private Extension, PCO, APCO[1]
CDMA	PMIP-based S2a	Proxy Binding Update Proxy Binding Acknowledge	PCO

(1) The IEs in the message are in sequence

The P-CSCF server IP addresses are managed with pool mechanism. The GGSN or PGW supports to configure a primary and a secondary (if available) P-CSCF address pool. The GGSN or PGW supports to configure an IMSI-based P-CSCF category or a P-CSCF category based on IMSI and PLMN. Both primary and secondary P-CSCF address pool can be referenced in the P-CSCF category. The selection of the primary and secondary P-CSCF pool is according to the matched IMSI, , or the matched IMSI and the serving node PLMN ID when the serving node PLMN ID is configured. The P-CSCF category selection based on IMSI and PLMN has the higher priority. For more information, refer to APN Configuration. Each pool can be configured with IPv4 address and/or IPv6 address.

If a P-CSCF pool is configured with more than two P-CSCF addresses, these addresses are distributed to bearers in a round-robin or a weight-based manner.

The P-CSCF address allocation rules are further described in Figure 4, the GGSN or PGW ensures an appropriate load-balancing between the different P-CSCF servers.

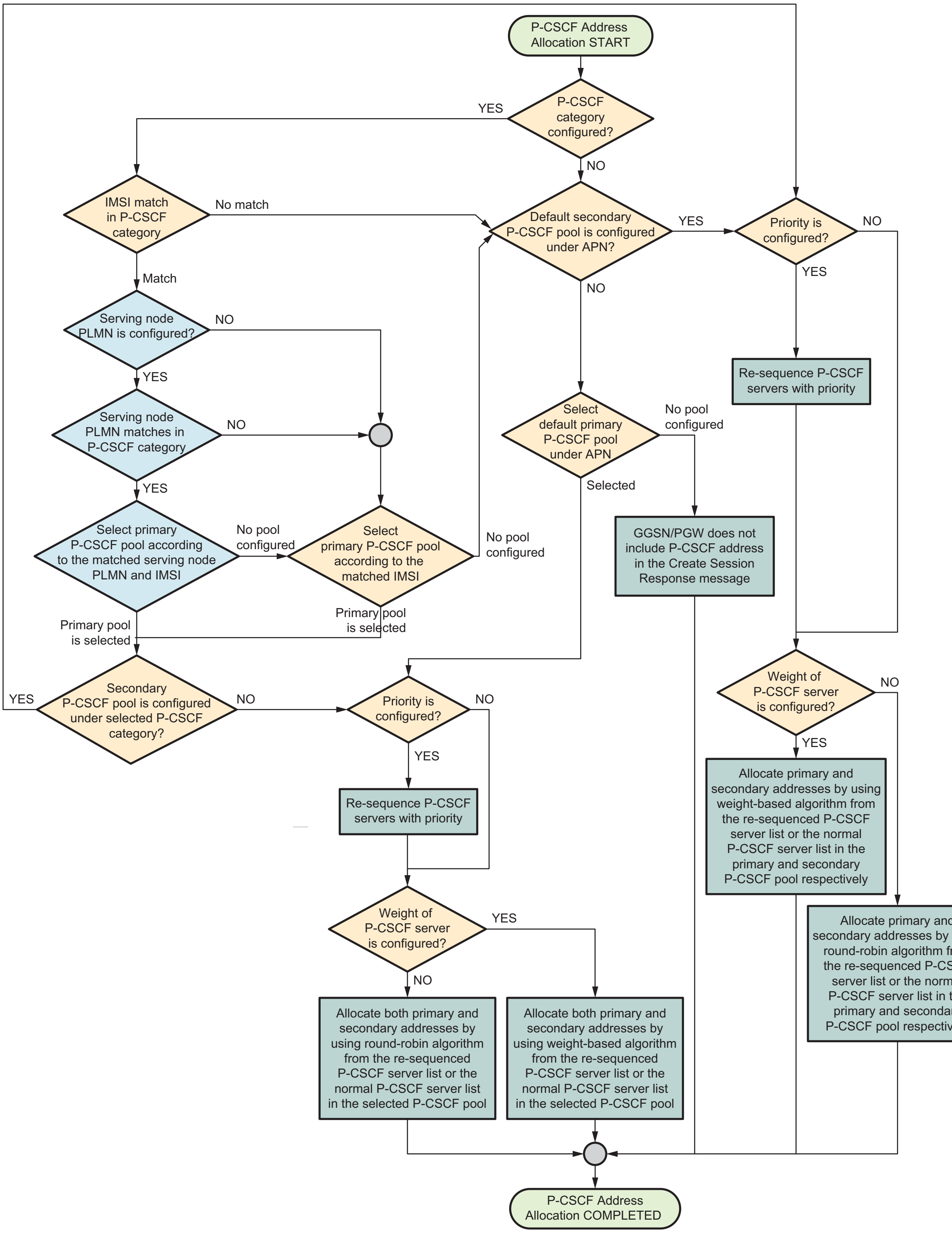

Figure 4 P-CSCF Address Allocation

Note: If the serving node PLMN ID is configured, use the serving node PLMN ID and IMSI to match. If the serving node PLMN ID or IMSI is not matched or missing, then use IMSI to match. If IMSI is not matched or missing (for CDMA network with PMIPv6-based S2a interface), the default P-CSCF pool that is configured under the APN is used.

If both the P-CSCF category and default P-CSCF pool under the APN are not configured, the GGSN or PGW does not include P-CSCF server IP address in the `Create Session Response` or `Proxy Binding Acknowledgement` (PBA) message.

The PGW also supports to configure three P-CSCF server IP addresses returned from pool:

— If the primary and the secondary P-CSCF address pool are both configured under the P-CSCF category or APN, the PGW selects the first IP address from the primary P-CSCF address pool, and selects the second and the third IP address from the secondary P-CSCF address pool. All three IP addresses are distributed in a round-robin or weight-based manner.

— If the secondary P-CSCF address pool is not configured under the P-CSCF category or APN, the PGW selects the three IP addresses from the primary P-CSCF address pool. If the weight-based manner is configured, the first and the second IP address are distributed in a weight-based manner, the third IP address is distributed in a round-robin manner. If the weight-based manner is not configured, all the three IP addresses are distributed in a round-robin manner.

Note: If all P-CSCF servers are assigned a weight equal to 1 and the priority is not configured, the IP addresses are distributed in a round-robin manner.

If the UE requested P-CSCF IP address type is not configured in the **primary** P-CSCF address pool, the EPG does not return a P-CSCF address.

For more information about the P-CSCF server IP address related configuration, refer to APN Configuration.

3.14.1.2 P-CSCF Discovery by DNS Procedure

The PGW supports the P-CSCF discovery by DNS procedure. The PGW accesses the 3GPP AAA server to get the P-CSCF FQDN in case the P-CSCF address is requested by UE in session creation. The PGW performs DNS query to get the P-CSCF address based on the FQDN received from AAA server. For detailed information, refer to DNS Support.

Table 3 shows the supported protocol, interface, and IE in different access networks.

Table 3 Supported protocol, interface, and IE

Network	Protocol/Interface	Message	IE
LTE	GTP-based S5/S8	Create Session Request Create Session Response	PCO
Trusted WLAN	GTP-based S2a	Create Session Request Create Session Response	PCO, APCO(1)
Untrusted WLAN	GTP-based S2b	Create Session Request Create Session Response	Private Extension, PCO, APCO(1)
CDMA	PMIP-based S2a	Proxy Binding Update Proxy Binding Acknowledge	PCO

(1) The IEs in the message are in sequence.

3.14.1.3 HSS-Based P-CSCF Restoration

HSS-Based P-CSCF Restoration for 3GPP Access

If either the MME or S4-SGSN supports PCO based extension of the HSS-based P-CSCF restoration procedure, then in the event of receiving P-CSCF Restoration Indication from HSS due to PCRF failure, a `Modify Bearer Request` message is sent to the SGW including a P-CSCF Restoration Indication. The SGW forwards the message to the PGW, the following actions are taken to retain the IMS services.

If both the following conditions are met:

— The UE indicates supporting of P-CSCF re-selection during session establishment

— The PGW sends a P-CSCF address list during session establishment

The PGW sends a `Update Bearer Request` message with a P-CSCF address list in PCO to the SGW and the SGW forwards the message to the MME or S4-SGSN.

The MME or S4-SGSN forwards the P-CSCF address list to the UE, the UE then originates IMS session using the received first P-CSCF address. If the first P-CSCF is available to communicate, the IMS service is retained. If the first P-CSCF is failed to communicate, the UE contacts the received second P-CSCF address and the IMS service can be retained.

The PGW gets the P-CSCF address list either by DNS query or the local configuration. If the DNS query fails or the DNS function is not configured, the PGW uses the local configured P-CSCF list.

If the PGW does not send a P-CSCF address list during session establishment or the UE doesn’t indicate supporting of P-CSCF re-selection during session establishment, the PGW sends a `Delete Bearer Request` message with cause code `Reactivation Requested` to the SGW.

Note: When the PGW does not send the P-CSCF IP addresses during session establishment for the IMS APN, the UE may use the P-CSCF address configured in the UE.

The `P-CSCF Re-selection support` is applicable for GSM and WCDMA access types using S3/S4 architecture and LTE.

The PGW can be configured not to check the UE capability of the P-CSCF reselection support. For more information about the P-CSCF reselection support related configuration, refer to APN Configuration.

HSS-Based P-CSCF Restoration for Untrusted WLAN Access

If the UE and the ePDG support P-CSCF restoration extension for untrusted WLAN access, then in the event of receiving P-CSCF Restoration Indication from HSS due to P-CSCF failure, the 3GPP AAA Server supporting the HSS-based P-CSCF restoration for untrusted WLAN procedure, transfers the indication to the PGW in a `RAR` message. The following actions are taken to retain the IMS services.

The PGW sends an `Update Bearer Request` message with a P-CSCF address list in APCO to th ePDG, if both of the following conditions are met:

- The UE indicates support for P-CSCF reselection for untrusted WLAN access, and request a P-CSCF address list during session establishment using S2b interface
- The PGW sends a P-CSCF address list to ePDG during session establishment.

The ePDG forwards the P-CSCF address list to the UE. The UE then initiates an IMS session using the first P-CSCF address from the received address list. If the first P-CSCF is available, the IMS service is retained. If the first P-CSCF is unavailable, the UE contacts the next P-CSCF from the received address list and the IMS service can be retained.

The PGW gets the P-CSCF address list either by DNS query or the local configuration. If the DNS query fails or the DNS function is not configured, the PGW uses the local configured P-CSCF list.

If the PGW does not send a P-CSCF address list during session establishment or the UE does not indicate support for P-CSCF reselection during session establishment, the PGW sends a `Delete Bearer Request` message with cause code `Reactivation Requested` to the ePDG.

Note: When the PGW does not send the P-CSCF IP addresses during session establishment for the IMS APN, the UE may use the P-CSCF address configured in the UE.

The PGW can be configured not to check the UE support for P-CSCF reselection. For more information about configuration related to P-CSCF reselection support, refer to Diameter AAA Interface Configuration.

3.14.1.4 PCRF-Based P-CSCF Restoration

The EPG supports PCRF-based P-CSCF Restoration Enhancement when the connection between a UE and a P-CSCF fails.

The PGW indicates supporting of PCSCF-Restoration-Enhancement during session establishment. The PGW deactivates PDN connection with cause code `Reactivation Requested` when the PGW receives `PCSCF-Restoration-Indication` AVP in the RAR message.

For more information, refer to Policy Control Configuration.

Note: PCRF-based P-CSCF Restoration is only applicable for LTE access.

3.14.2 UE-Requested IMS Signalling Bearer on Gn

The UE can request the creation of a bearer dedicated to IMS signalling. This request is made by setting the `IM CN Subsystem Signaling` flag in the PCO field of the `Create PDP Context Request`. If the GGSN or PGW is configured to support IMS signalling bearers for an APN, such a bearer creation is accepted, otherwise the GGSN or PGW resets the flag in the `Create PDP Context Response` and a bearer is created as a normal bearer.

3.14.3 Access Control

Bearers dedicated to IMS signalling shall normally have access limited to the P-CSCF servers. This can be achieved in the GGSN and PGW by using normal access control as described in SACC Overview. Optionally, access control can be disabled in the GGSN and PGW for bearers dedicated to IMS signalling.

3.14.4 Disabling Signalling Indication

UE devices request prioritized handling of a bearer in the radio network by setting the `Signalling Indication` flag in the bearer activation request. The GGSN or PGW can reset the `Signaling Indication` flag as part of the QoS negotiation. The QoS is then downgraded and no prioritized handling takes place.

3.14.5 IMS Emergency Session

IMS emergency session is an optional feature. All the PDN connections must be attached to a configured emergency APN to enable the IMS emergency session. For detailed information, refer to IMS Emergency Session.

3.15 Resource Failures

If the EPG receives a request message that it cannot accept because of resource-related reasons, the EPG rejects it with a cause code appropriate for the situation.

Some of the resource-related failure cases are shown in Table 4.

Table 4 Resource-Related Failure Cases

Description	Action
The requested APN does not exist.	The request is rejected with cause value `Missing or unknown APN`.
The maximum number of sessions configured for the APN is reached.	The request is rejected with cause value `No resources available`.
The APN is shut down.	The request is rejected with cause value `No resources available`.
PDN authentication fails.	The request is rejected with cause value `User authentication failed`.
No IP address is available from shared IP pool.	The request is rejected with cause value `All dynamic addresses are occupied`.
No IP address received from RADIUS or DHCP server.	The request is rejected with cause value `All dynamic addresses are occupied`.

3.16 Single IMSI Multiple MSISDN (SIMM)

The EPG supports the use of the same IMSI with different MSISDNs in different PDP contexts or EPS bearers, but not at the same time. This means that a subscriber can have several numbers connected to the same SIM card.

Note: The SIMM functionality can only be used if it is implemented in the HLR/HSS. External nodes inter-working with the EPG ensure that the PDP contexts or EPS bearers using different MSISDN for the same IMSI, cannot exist simultaneously.

3.17 Roaming Detection

The SGW supports roaming detection and traffic separation on the S5 and S8 interfaces, that is, home-routed traffic roaming and local breakout architecture for LTE networks. Roaming detection is only possible when the S5 and S8 interfaces are configured separately. For information about the separate S5 and S8 interfaces, refer to SGW S5/S8 Interface Description. For information on configuring separate S5 and S8 interfaces, refer to GTP Interface Configuration.

If the EPG is configured for home-routed traffic roaming architecture, the contents of a Create Session Request message (APN IE) from the MME together with a list of equivalent PLMN-IDs in the SGW are used to distinguish between roaming and non-roaming users. A PLMN-ID consists of a Mobile Country Code (MCC) and Mobile Network Code (MNC) component. A list of equivalent PLMN-IDs consists of up to 30 PLMN IDs. For more information about configuring a list of equivalent PLMN-IDs to support roaming detection, refer to Offline Charging Configuration.

Depending upon how the contents of a Create Session Request message (APN IE) compare with the list of equivalent PLMN-IDs, the EPG forwards GTP-C messages as follows:

— If the PLMN-ID of an APN IE matches an entry configured in the list of equivalent PLMN-IDs for the SGW, the user is classified as non-roaming and the EPG forwards GTP-C messages over the S5 interface.

— If the PLMN-ID of an APN IE does not match an entry configured in the list of equivalent PLMN-IDs for the SGW, the user is classified as roaming and the EPG routes GTP-C messages over the S8 interface.

If no S5/S8 interface separation is configured, the EPG forwards GTP-C messages over the combined S5/S8 SGW GTP-C interface. For the EPG, separation of the S5/S8 interface into the S5 and S8 interfaces is implemented in the SGW only.

3.18 Content Filtering

The EPG supports content filtering for Hypertext Transfer Protocol (HTTP) services with the help of an external content categorization engine. This enables the operator to pass, block, or redirect traffic to specific web services, based on the content category. For more information, refer to Content Filtering.

3.19 RAT Type Handling When UE Moves from LTE to GSM/WCDMA

When the UE moves from the LTE access to the GSM/WCDMA access that is connected to SGSN by using Gn/Gp interface which uses GTP version 1 (GTPv1), if the RAT type is not received and cannot be derived from SGSN IP address mapping, the PGW uses the default RAT type.

The default RAT type can be configured on node level. If the default RAT type is configured as `geran`, `utran`, or `gan`, there is an RAT-change event. The configured default RAT type value is used for external interfaces, such as the Gx, Gy, Ga, Gi/SGi interfaces. The changed RAT type is reported over Gx and Gy when the corresponding event trigger is provisioned. The changed RAT type is also reported over Gy when the corresponding trigger is locally configured. If the default RAT type is not configured or configured as `keep-value`, there is no RAT-change event, and the previous RAT type is kept and used for external interfaces. For more information about the default RAT type configuration, refer to APN Configuration.

Note: If the default RAT type is not configured or removed, `keep-value` is used as default value.

In other procedures over GTPv1 tunnel, if the RAT type is not received, the RAT type is considered as not changed.

Note: When the UE moves from the LTE access to the GSM/WCDMA access that is connected to SGSN by using S4-SGSN, the RAT type is always received over S4 and S5/S8 interfaces because a changed RAT type is mandatory over GTPv2.

3.20 Reporting Access Network Information (NetLoc)

The EPG supports the NetLoc, which is an optional feature with license control. The function of the NetLoc is to provide access network information to the PCRF as requested. The purpose with the NetLoc is to provide IMS with a trusted network determined location and time zone information.

During the Dynamic Charging Rules (DCR) installation, modification, or removal, which triggers the IP-CAN bearer create/update/deletion procedure, if the NetLoc feature is activated, and the `ACCESS_NETWORK_INFO_REPORT (45)` event trigger is set, and the `Required-Access-Info` AVP is received from a Gx RAR message, the EPG obtains the access network information report parameters (ULI, ULI Timestamp, or UE Time Zone). If the access type is `E-UTRAN`, the EPG reports the ULI, ULI Timestamp, or UE Time Zone to the PCRF, depending on the corresponding DCR rules.

If the access type is untrusted WLAN, the PGW reports the following access network information detected by the ePDG to PCRF as requested.

- UE local IP address
- UE UDP Port Number or UE TCP Port number (if NAT is detected)

For more information about this feature, refer to Policy Control.

For more information about NetLoc configuration, refer to Policy Control Configuration.

3.21 PGW Pause Charging

PGW pause charging enables the SGW to notify the PGW, on a per PDN connection basis, to temporarily pause charging. Pause charging occurs when the UE is idle including the power saving state (PSM or extended idle mode DRX) is used and the SGW starts to drop downlink payload, resulting in the configured packets or bytes threshold being exceeded. Pausing charging in the PGW results in end users not being charged if traffic is not forwarded from the SGW to the UE. When the UE is active again, the SGW notifies the PGW to resume charging.

For signal flows that are specific to PGW pause charging, see Section 8.12 on page 128.

PGW pause charging is supported both in the SGW and the PGW and can be enabled or disabled. The following attributes can be configured in the SGW:

— `packets-loss-threshold` - used to set the threshold at which pause charging is activated.

— `bytes-loss-threshold` - used to set the threshold at which pause charging is activated.

— `decay-factor` - the value used to divide the number of dropped packets to create the starting value of the next time interval.

— `decay-timer` - used to set the time interval at which the number of dropped bytes or packets is re-calculated using the decay factor.

— `penalty-factor` - used to calculate the starting value when measuring lost bytes or packets at the beginning of a session after an abnormal release.

The feature can be configured on the S5, S8, and S5/S8 interfaces. PGW pause charging is supported for S11 (E-UTRAN), and IRAT handover from non-3GPP and GPRS connections, but not S4 or S4 to S11 IRAT handover.

In the PGW, pause charging support can be enabled on the entire node, per APN, or by PLMN and RAT using roaming class user groups. For information on PGW pause charging negotiation scenarios, see Section 3.21.4 on page 40.

For more information on how to configure PGW pause charging, refer to PGW Pause Charging Configuration.

3.21.1 Byte and Packet Loss Thresholds

PGW pause charging uses two configurable thresholds, `bytes-loss-threshold` and `packets-loss-threshold`. When either of the thresholds are exceeded the SGW notifies the PGW to temporarily pause charging on a per PDN connection basis.

3.21.2 Decay Factor

The decay factor uses the following configurable attributes:

— `packets-loss-threshold`

— `bytes-loss-threshold`

— `decay-factor`

— decay-timer

The decay factor is used to control when the SGW signals the PGW to pause charging. If the number of dropped bytes or packets exceeds the configured thresholds, the PGW pauses charging for the PDN connection. If neither of the thresholds are reached by the end of an interval, the starting number of dropped bytes or packets in the next interval is reset to a new value, determined by multiplying the current number of dropped bytes or packets by the decay factor, then dividing by 100,000

The value used for the beginning of an interval is found using (x*decay-factor)/100,000, where x equals the current number of dropped bytes or packets. The decay factor parameter (decay-factor) has the default value of 100,000, which neutralizes any effect of the decay factor.

The graph in Figure 5 depicts how the decay factor is calculated. In the following example, the decay factor is less than 100,000 and D refers to decay-factor/100,000.

The number of packets dropped, x, is calculated using the decay factor, D, over three intervals. At the end of interval one, T1, the number of packets dropped is x_1. At the start of interval two, I2, the number of packets dropped is reset to x_1*D. At the end of interval two, the number of packets dropped during the interval is added to x_1*D to give x_2. By the end of interval three, I3, the number of packets dropped during the interval plus x_2*D exceeds the pause charging threshold, x_T, and the SGW notifies the PGW to pause charging.

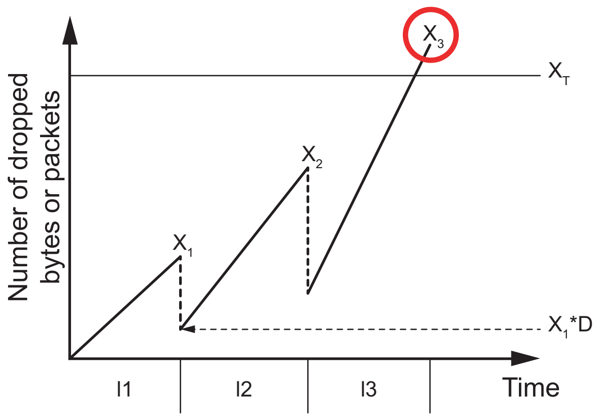

Figure 5 The Decay Factor in PGW Pause Charging

3.21.3 Penalty Factor

The penalty factor is used to calculate the initial values of the internal Packets_Loss_for_PDN and Bytes_Loss_for_PDN counters when the UE goes into idle state during the S1 release due to an abnormal release of the radio link.

Abnormal release of the radio link could occur for example, if the radio connection to the UE is lost resulting in downlink data being dropped by the eNodeB. In such a situation, the eNodeB could initiate the S1 release procedure whilst data continues to be dropped and is therefore not counted. The penalty factor is to compensate for bytes and packets which are not counted.

The value for `Packets_Loss_for_PDN` is found by using `packets-loss-threshold*(penalty-factor/100)` and rounding up to the nearest whole number.

The value for `Bytes_Loss_for_PDN` is found by using `bytes-loss-threshold*(penalty-factor/100)` and rounding up to the nearest whole number.

If a session goes from connected to idle state during the S1 release due to a normal release of the radio link, the starting `Packets_Loss_for_PDN` and `Bytes_Loss_for_PDN` counter values will be zero when the UE next becomes idle.

The penalty factor parameter (`penalty-factor`) has the default value of `0`, and can be configured.

3.21.4 PGW Pause Charging Negotiation Scenarios

The PGW negotiates support for pause charging with the SGW at PDN connection establishment over the S5/S8 interface.

The PGW removes existing negotiation and negotiates support for pause charging with the new target SGW at SGW relocation over the S5/S8 interface.

The PGW removes existing pause charging negotiation and does not negotiate pause charging for a S5/S8 PDN connection that is handed over to a non-S5/S8 PGW access (Gn/Gp, S2a, and S2b).

The PGW does not negotiate pause charging for a PDN connection that is established over a non-S5/S8 PGW access (Gn/Gp, S2a, and S2b).

The PGW stops pause charging for a PDN connection and removes the previously negotiated status if the negotiation in the PGW is explicitly removed at SGW relocation or at the handover to non-S5/S8 PGW access.

The PGW stops pause charging for a PDN connection but keeps the previously negotiated status if a suspend procedure is started as part of the CS fallback procedure, or if the `force-stop` action is triggered in the EPG CLI.

3.22 Bearer Control Mode

Bearer Control Mode (BCM) determines if network initiated dedicated bearers can be established for the user session. The BCM for a user session is selected based on the support for network initiated dedicated bearers in the UE and in the serving network. The BCM is selected by either the PCRF, if used, or by the GGSN or PGW. For more information about BCM and BCM selection, refer to Policy Control.

3.23 Presence Reporting Area

The Presence Reporting Area (PRA) reports the presence of a UE in a pre-defined policy area to the PCRF. The EPG supports both types of PRA: "Core Network pre-configured Presence Reporting Area" and "UE-dedicated Presence Reporting Area".

When the PCRF subscribes to PRA, the EPG starts the PRA Action including a PRA List to the MME through the S11 interface. The MME informs the PGW of the UE PRA status when the MME receives the PRA Action START or when UE moves in or out of the defined PRA area. The PCRF decides different policy based on the reported PRA from the PGW.

When the PCRF unsubscribes to PRA, the EPG removes the armed PRA event, and informs the MME to stop the PRA action.

For more information about this feature, refer to PGW S5/S8 Interface Description, SGW S5/S8 Interface Description, and Policy Control.

For more information about configuring the PRA, refer to Policy Control Configuration.

3.24 MSISDN Notification

The MSISDN notification procedure allows the UE to query the PGW for the MSISDN for the purpose of user information. The UE encodes the PCO in the MS to network direction to indicate the MSISDN query. The PGW provides the MSISDN, if available, in the PCO IE in the network to MS direction.

The PGW supports the MSISDN notification during the PDN connection creation or PDP context activation for the user sessions accessed by interfaces:

— S5/S8

— GTP-based S2a and S2b

— Gn/Gp

When UE requests the MSISDN in the PCO container `000E` in the `Create Session Request` message or the `Activate PDP Context Request` message, the PGW provides the MSISDN, in the PCO container `000E` in the `Create Session Response` message or the `Activate PDP Context Response` message. If the MSISDN is not available, the PGW provides an empty `000E` container in the PCO in the `Create Session Response` message or the `Activate PDP Context Response` message.

3.25 Detection and Handling of Late Arriving Requests

The originating node, for example the MME, SGSN, TWAN, or the ePDG, sends a `Create Session Request` message which includes an `Origination Time Stamp` IE indicating the absolute time at which the request was initiated and a `Maximum Wait Time` IE indicating the maximum time period to complete the processing of the request. The EPG can be configured to detect and reject late overlapping or timed-out `Create Session Request` messages based on this information.

A `Create Session Request` message is called a late overlapping request if it arrives after a newer request for which a session has already been established in the EPG. A late overlapping request can either result in a hanging session in the network, or tear down the existing valid session.

A timed-out request is a `Create Session Request` message that has timed out at the originating node. A timed-out request may cause unnecessary signalling and hanging sessions in the upstream nodes.

The following interfaces support detection and handling of late arriving requests:

— S4

— S11

— S5/S8

— GTP-based S2a

— S2b

Detection and handling of late arriving requests is configurable in the SGW and PGW. By default the function is not enabled. If not enabled, the SGW or PGW ignores the received `Origination Time Stamp` IE and `Maximum Wait Time` IE without detection and handling of the late arriving requests, and does not forward the two IEs to the upstream nodes.

For more information about how to enable detection and handling of late arriving requests in the SGW, refer to GTP Interface Configuration.

Note: After ICR switch over, the EPG is not able to detect the overlapping request for the received `Create Session Request` message if the message collides with an existing session which is established before the ICR switch over.

For more information about how to enable detection and handling of late arriving requests in the PGW, refer to APN Configuration and Policy Control Configuration.

3.25.1 Detection and Handling of Late Overlapping Requests

When detection and handling of late arriving requests is enabled, upon receiving the `Origination Time Stamp` IE in the `Create Session Request` message, the EPG detects if the request is a late overlapping request. If the `Create Session Request` collides with an existing session and has a less recent `Origination Time Stamp`, that is, an older `Origination Time Stamp` than the existing session, the EPG detects the `Create Session Request` as a late overlapping request and rejects it with a `Create Session Response` message including the `Late Overlapping Request` cause code.

Note: If no `Origination Time Stamp` is provided in the `Create Session Request` message or stored for the existing session, the EPG accepts the request.

When detection and handling of late arriving request is enabled, the SGW can be configured not to detect the late overlapping request. For more information about the configuration, refer to GTP Interface Configuration.

3.25.2 Detection and Handling of Timed-out Requests

When detection and handling of late arriving request is enabled, upon receiving the `Origination Time Stamp` IE and the `Maximum Wait Time` IE in the `Create Session Request` message, the EPG detects if the request is a timed-out request. The `Maximum Wait Time` together with the `Origination Time Stamp` indicate the absolute time at which the request times out at the originating node. The EPG calculates the absolute time, and compares the absolute time with the EPG node time when the `Create Session Request` is processed. If the absolute time is older than the EPG node time, the EPG detects the `Create Session Request` as a timed-out request.

Upon receiving the `Create Session Request` message, the EPG detects if the request is a timed-out request. The EPG rejects the timed-out request with a `Create Session Response` message including the `Timed Out Request` cause code.

Upon receiving the response message from the upstream nodes, the EPG additionally checks if the request is a timed-out request. The EPG rejects the timed-out request with a `Create Session Response` message including the `Timed Out Request` cause code, and initiates the session deletion towards the upstream nodes to remove the session which has been established in the upstream nodes.

— The SGW additionally detects the timed-out request upon receiving the successful `Create Session Response` message from the PGW.

— The PGW additionally detects the timed-out request upon receiving the successful response from the PCRF and S6bAuth AAA.

When detection and handling of late arriving requests is enabled, the SGW or PGW can be configured not to detect timed-out requests. When the EPG is in NTP failure, it cannot provide a correct detection of the timed-out request. The EPG can be configured not to detect timed-out requests, but still forwards the `Maximum Wait Time` IE and the `Origination Time Stamp` IE to the upstream nodes so they can detect and handle the timed-out request.

For more information about how to disable detection and handling of timed-out requests in the SGW, refer to GTP Interface Configuration.

For more information about how to disable detection and handling of timed-out requests in the PGW, refer to APN Configuration.

Figure 6 shows when receiving the successful response from the PCRF and S6bAuth AAA, the PGW rejects a request and sends the `Timed Out Request` cause code in the `Create Session Response` message to the SGW, and the SGW forwards the message to the MME.

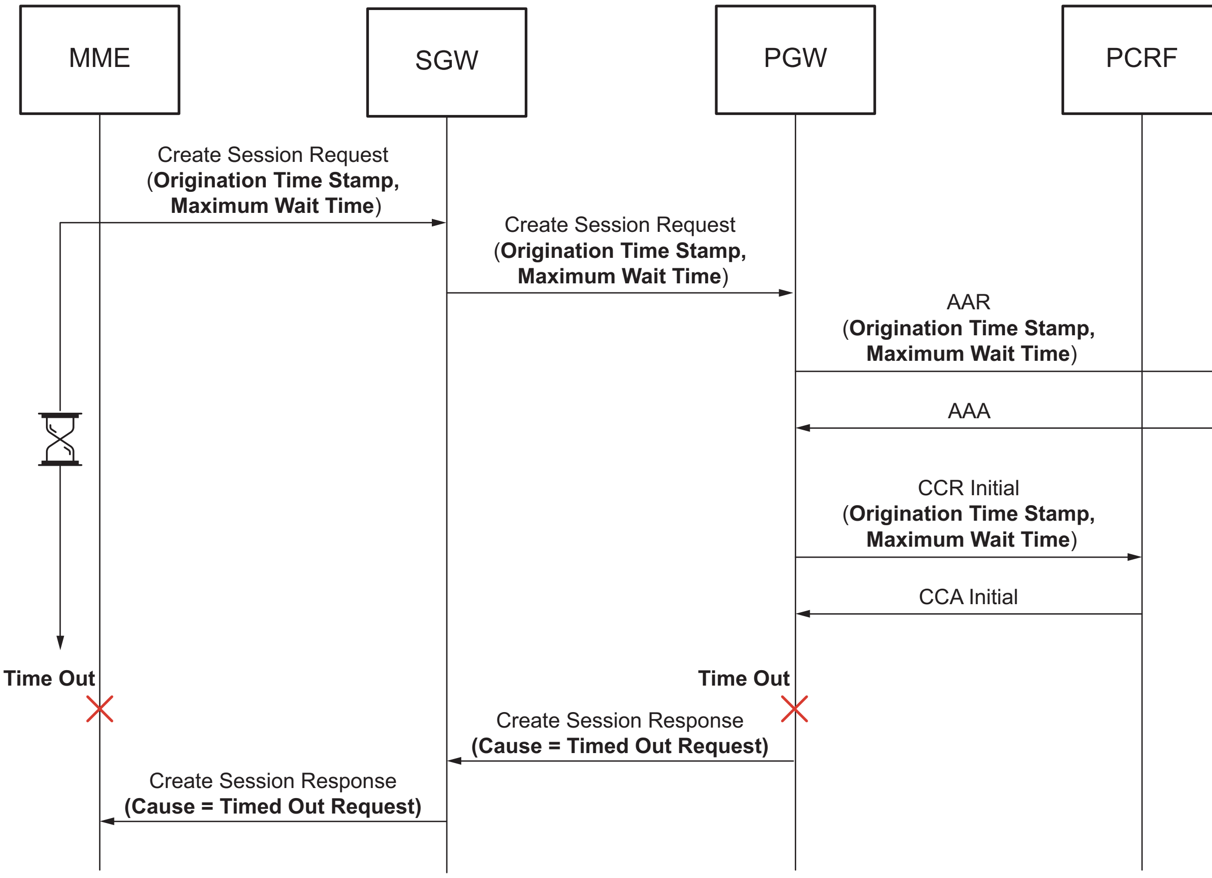

Figure 6 Requests which have Timed Out

3.25.3 Forwarding Origination Time Stamp IE and Maximum Wait Time IE

When detection and handling of late arriving requests is enabled, by default the EPG forwards the `Origination Time Stamp` IE and the `Maximum Wait Time` IE to the upstream nodes if the `Create Session Request` is not detected as a late arriving request. With this information, the upstream nodes can detect and handle the late arriving request.

— The SGW can be configured not to forward the `Origination Time Stamp` IE or the `Maximum Wait Time` IE to the PGW. For more information about the configuration, refer to GTP Interface Configuration.

— The PGW can be configured not to forward the `Origination Time Stamp` IE or the `Maximum Wait Time` IE to the PCRF or S6bAuth AAA. For more information about the configuration, refer to Diameter AAA Interface Configuration and Policy Control Configuration.

3.26 PDN Connection Suspension

This section describes the suspension of a PDN connection. Signalling during this procedure is shown in Figure 7.

For details on the messages sent between the SGW and the PGW, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

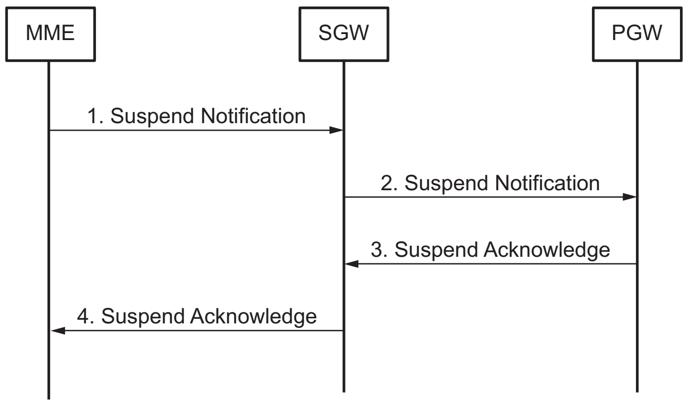

Figure 7 Signalling during the PDN Connection Suspension Procedure

The suspension procedure consists of the following steps:

1. The MME sends a `Suspend Notification` message to the SGW.

2. The SGW marks the PDN connection as suspended, releases all the downlink GTP-U tunnels to the eNode B, and starts dropping user traffic directed to the suspended UE. Meanwhile, the SGW forwards the `Suspend Notification` message to the PGW.

3. The PGW marks all bearers of the session as suspended and responds with a `Suspend Acknowledge` message to the SGW. Meanwhile, the packets received in the suspended bearers are discarded and not charged.

4. The SGW responds with a `Suspend Acknowledge` message to the MME.

3.27 PDN Connection Resume

This section describes the resume of a PDN connection.

For details on the messages sent between the SGW and the PGW, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

3.27.1 PDN Connection Explicit Resume

This section describes the explicit resume of a PDN connection. Signalling during this procedure is shown in Figure 8.

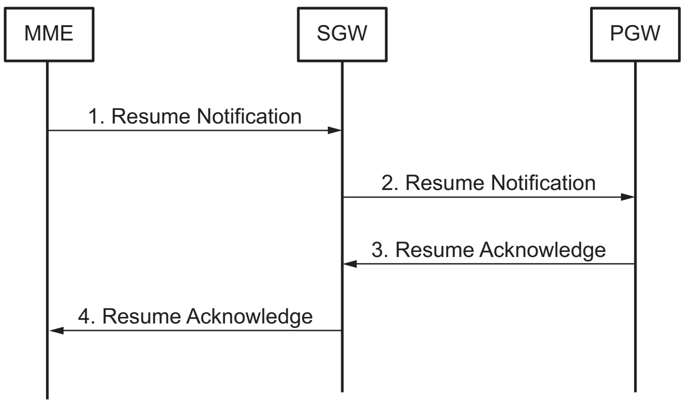

Figure 8 Signalling during the PDN Connection Explicit Resume Procedure

The explicit resume procedure consists of the following steps:

1. The MME sends a `Resume Notification` message to the SGW.

2. The SGW resumes the suspended PDN connection and starts buffering user traffic directed to the idle UE. Meanwhile, the SGW forwards the `Resume Notification` message to the PGW.

3. The PGW responds with a `Resume Acknowledge` message to the SGW and clears the suspended status for all the bearers. Meanwhile, the PGW stops discarding the packets and continues to charge normally.

4. The SGW responds with a `Resume Acknowledge` message to the MME.

3.27.2 PDN Connection Implicit Resume

This section describes the implicit resume of a PDN connection.

During a handover from the 3GPP access network to the non-3GPP access network, the PGW acts as follows:

— Clears the suspended status of all the PDNs or bearers.

— Stops discarding the packets and continues to charge normally.

3.27.2.1 PDN Connection Implicit Resume for E-UTRAN/S4-SGSN

This section describes the implicit resume of a PDN connection for E-UTRAN and S4-SGSN. Signalling during this procedure is shown in Figure 9.

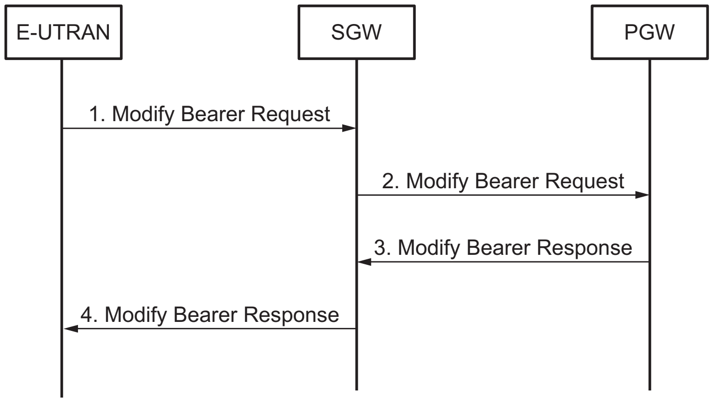

Figure 9 Signalling during the PDN Connection Implicit Resume Procedure for E-UTRAN

The implicit resume procedure for E-UTRAN/S4-SGSN consists of the following steps:

1. The E-UTRAN/S4-SGSN sends a `Modify Bearer Request` message to the SGW.

2. The SGW resumes the suspended PDN connection and starts buffering user traffic directed to the idle UE. Meanwhile, the SGW forwards the `Modify Bearer Request` message to the PGW.

3. The PGW responds with a `Modify Bearer Response` message to the SGW and clears the suspended status for all the bearers of the session. Meanwhile, the PGW stops discarding the packets and continues to charge normally.

4. The SGW responds with a `Modify Bearer Response` message to the E-UTRAN/S4-SGSN.

3.27.2.2 PDN Connection Implicit Resume for Gn-SGSN

This section describes the implicit resume of a PDN connection for Gn-SGSN. Signalling during this procedure is shown in Figure 10.

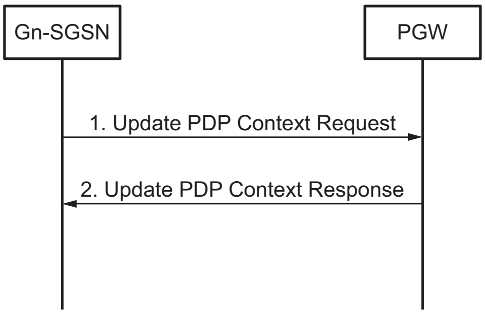

Figure 10 Signalling during the PDN Connection Implicit Resume Procedure for Gn-SGSN

The implicit resume procedure for Gn-SGSN consists of the following steps:

1. The Gn-SGSN sends an `Update PDP Context Request` message to the PGW.

2. The PGW responds with an `Update PDP Context Response` message to the Gn-SGSN and clears the suspended status for all the bearers of the PDN. Meanwhile, the PGW stops discarding the packets and continues to charge normally.

3.27.2.3 PDN Connection Implicit Resume for Trusted Non-3GPP (CDMA2000) Access

This section describes the implicit resume of a PDN connection for trusted non-3GPP (CDMA2000) access. Signalling during this procedure is shown in Figure 11.

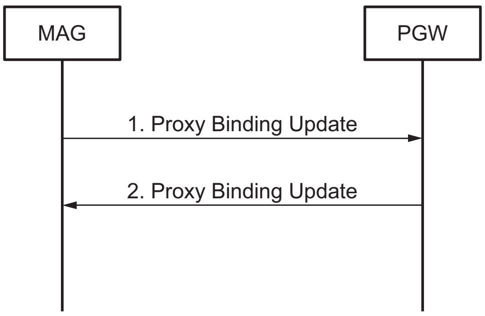

Figure 11 Signalling during the PDN Connection Implicit Resume Procedure for Trusted Non-3GPP (CDMA2000) Access

The implicit resume procedure for trusted non-3GPP (CDMA2000) access consists of the following steps:

1. The Mobile Access Gateway (MAG) sends a `Proxy Binding Update` (PBU) message over the PMIPv6-based S2a interface to the PGW.

2. The PGW responds with a PBU message to the MAG and resumes the suspended PDN connections that are being handed over. Meanwhile, the PGW performs the handover.

3.27.2.4 PDN Connection Implicit Resume for Trusted Non-3GPP (WLAN) Access

This section describes the implicit resume of a PDN connection for trusted non-3GPP (WLAN) access. Signalling during this procedure is shown in Figure 12.

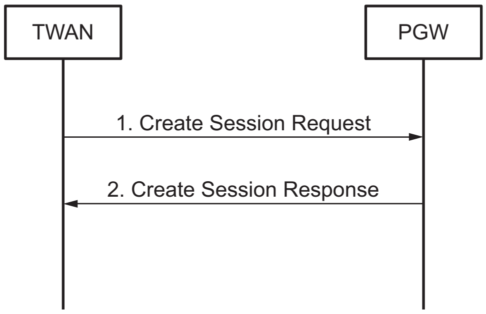

Figure 12 Signalling during the PDN Connection Implicit Resume Procedure for Trusted Non-3GPP (WLAN) Access

The implicit resume procedure for trusted non-3GPP (WLAN) access consists of the following steps:

1. The Trusted WLAN Access Network (TWAN) sends a `Create Session Request` message over the GTP-based S2a interface to the PGW.

2. The PGW responds with a `Create Session Response` message to the TWAN and resumes the suspended PDN connections that are being handed over. Meanwhile, the PGW performs the handover.

3.27.2.5 PDN Connection Implicit Resume for Untrusted Non-3GPP (WLAN) Access

This section describes the implicit resume of a PDN connection for untrusted non-3GPP (WLAN) access. Signalling during this procedure is shown in Figure 13.

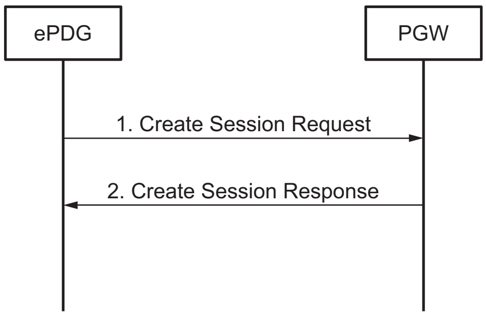

Figure 13 Signalling during the PDN Connection Implicit Resume Procedure for Untrusted Non-3GPP (WLAN) Access

The implicit resume procedure for untrusted non-3GPP (WLAN) access consists of the following steps:

1. The Evolved Packet Data Gateway (ePDG) sends a `Create Session Request` message over the S2b interface to the PGW.

2. The PGW responds with a `Create Session Response` message to the ePDG and resumes the suspended PDN connections that are being handed over. Meanwhile, the PGW performs the handover.

4 Session Management over the Gn/Gp and Iu-U Interfaces

The GGSN and PGW support session management of PDP contexts established over the Gn interface. For information on the messages exchanged between the GGSN or PGW and the SGSN, refer to Gn/Gp Interface Description.

For information on GPRS, refer to Ericsson Packet Core Network Overview.

4.1 PDP Context Activation

The UE initiates the PDP context activation procedure to activate a PDP context in order to establish a virtual data channel to an APN through the GPRS network. After a successful PDP context activation, the subscriber can communicate with the APN and the UE is known in the GGSN or PGW. The UE must be attached to the GPRS network in order to activate PDP contexts. PDP contexts are created in the UE, SGSN, and GGSN or PGW.

UE-initiated and network-initiated secondary PDP contexts are also supported. For UE-initiated secondary PDP context activations, the UE-initiated PDP context activation procedure is used but the SACC functionality is not supported. The UE must first have an active primary PDP context and then receive verification from the SGSN. An active secondary PDP context uses the same GGSN as the primary. Another QoS can be offered, but no new APN is selected, and no new IP address is allocated. The UE uses the allocated PDP context throughout the whole session.

For network-initiated secondary PDP context activations, see Section 4.1.3 on page 54.

The UE-initiated PDP context activation procedure is shown in Figure 14. Optionally, the SGSN can transparently forward the PCO received from the UE or a GGSN or PGW in any request message or response message.

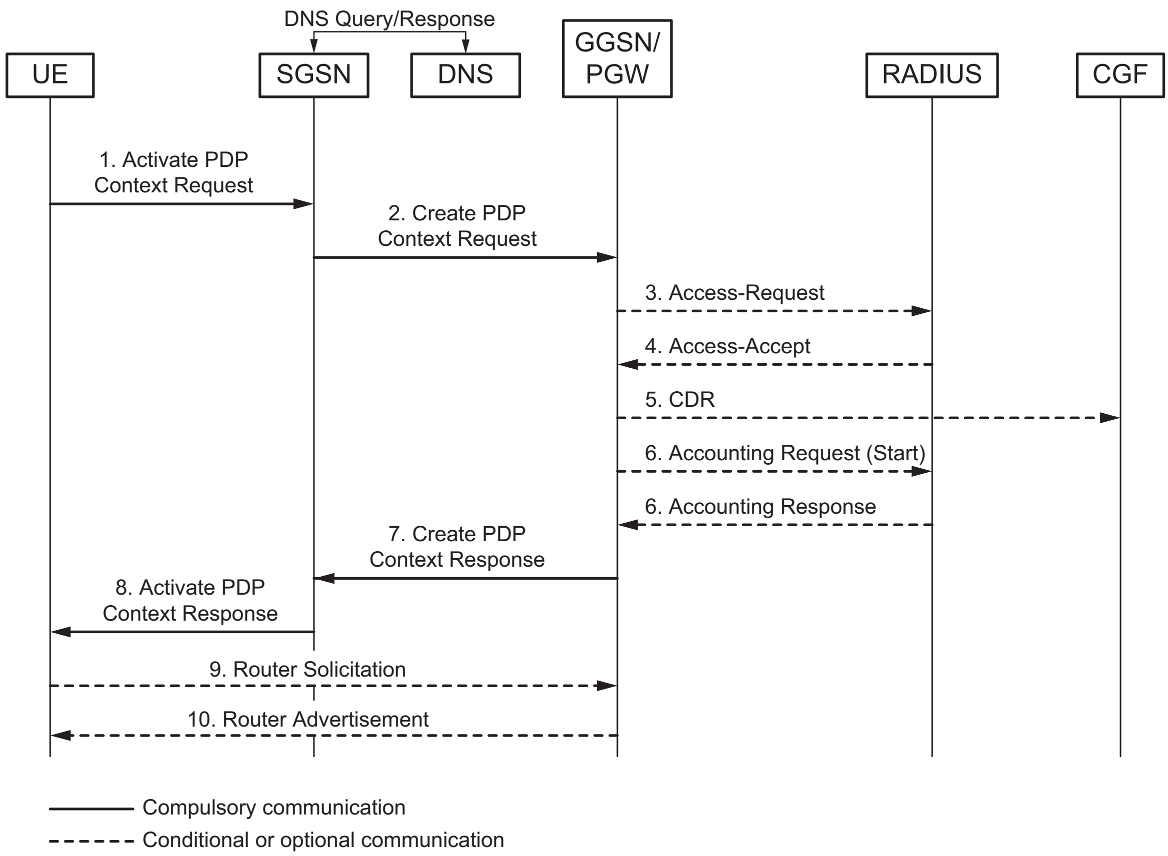

Figure 14 UE-Initiated PDP Context Activation Procedure

The following steps describe the UE-initiated PDP context activation procedure:

1. The UE sends an `Activate PDP Context Request` message to the SGSN. In addition to the requested QoS, the message contains information on the requested APN, the IP address, and PDP type, that is, IPv4 or IPv6 (optional parameters), or IPv4v6.

2. The SGSN validates the `Activate PDP Context Request` message using the information provided by the UE and the subscriber record. If valid, the SGSN resolves the APN into a list of GGSN or PGW IP addresses and sends a `Create PDP Context Request` message to the first GGSN or PGW IP address in the list.

   Optionally, the `Create PDP Context Request` message includes the IPv4 link MTU in PCO IE received from the UE.

   The node controller parses and validates the GTP header and the IE, and distributes the messages to a session controller. A secondary PDP context is always distributed to the same session controller that handles the primary PDP context. Secondary PDP contexts are only supported by the GGSN. The method for selecting a session controller is described in Resilience.

3. If a RADIUS authentication server is configured for the APN, the GGSN or PGW sends an `Access Request` message to the RADIUS server.

4. The RADIUS server checks that the user can be accepted and returns an `Access Response` message to the GGSN or PGW. The response (when positive) can also include IP address information.

   Note: RADIUS Authentication is only applicable to the primary PDP contexts.

   For IPv4 a DHCP server can be used instead of a RADIUS server and if the APN uses the GGSN or PGW-internal IP address pool, no external server is contacted.

   Note: If Service Aware Charging and Control (SACC) is used, additional messages are sent towards external servers. For more information on SACC, refer to SACC Overview.

5. The GGSN or PGW generates a Charging ID and a Charging Data Record (CDR) that are directly transferred to the Charging Gateway Functionality (CGF) using GPRS Tunneling Protocol Prime (GTP'). The CDR can also be stored locally on a CPB for later transfer to the charging gateway.

   The GGSN or PGW assigns TEID and performs access control related to APN configured data such as number of contexts, QoS capacity level, and interface capacity data. The GSC distributes the payload handling to a user plane. Payload handling for a secondary PDP context is distributed to the same user plane that handles the primary PDP context.

6. If a RADIUS accounting server is configured for the APN, the GGSN or PGW sends an `Accounting Start Request` message to the RADIUS server, which returns an `Accounting Start Response` message.

   Note: If the optional configuration RADIUS unacknowledge mode is activated, the GGSN or PGW sends a `Create PDP Context` message to the SGSN without first waiting for the Accounting Start Response from the RADIUS server.

7. If the GGSN or PGW accepts the `Create PDP Context Request` message, it responds with a `Create PDP Context Response` message to the SGSN. Otherwise, it responds with a `Create PDP Context Reject` message. The SGSN can, depending on reject cause, try the second GGSN or PGW IP address in the list received from the DNS, and so on until the list is exhausted.

   If the IPv4 link MTU in PCO IE is requested by the UE, the GGSN or PGW sends the MTU size based on the following:

   — If an APN MTU size is configured, the PGW sends the configured APN MTU size.

   — If no APN MTU size is configured, the PGW sends the configured PGW MTU size.

8. If the SGSN accepts the Activate PDP Context Request, the SGSN sends an `Activate PDP Context Accept` message to the UE.

9. After receiving `Attach Accept`, the UE sends a `Router Solicitation` message to trigger a `Router Advertisement` message.

10. The GGSN or PGW sends the assigned IPv6 prefix and RA flags (M, O) to the UE.

4.1.1 Activation Reject

FM is included at all stages of the PDP context activation. If an error occurs, a `Create PDP Context Reject` message is sent to the SGSN with the cause of the error while the database for the PDP context is cleaned up.

Note: It is possible to configure the cause codes sent to the SGSN. For more information, refer to APN Configuration.

4.1.2 Create Request for Existing PDP Context

If the PGW receives a Create PDP Context Request for an existing bearer, the PGW does the following:

1. It buffers the received Create PDP Context Request.

2. It internally deletes the existing bearer or the entire session if it is a default bearer.

3. It creates a new session by handling the buffered request.

Note: The existing bearer can only be a Gn/Gp or S5/S8 bearer.

Note: The PGW detects the collision of the incoming request and the existing bearer when both of the following conditions are satisfied:

- The IMSI of the incoming request is equal to the IMSI of the existing bearer.
- The NSAPI of the incoming request is equal to the EBI or the NSAPI of the existing bearer.

If a Create PDP Context Request message is received for an existing bearer while a transaction for the bearer is in progress, the PGW silently discards the request and deletes the existing bearer. The PGW waits for the peer node to retransmit the Create PDP Context Request message, and establishes a new PDN connection when it receives the retransmitted message.

If `updateThroughCreate` is configured, the Create PDP Context Request is handled as an `Update Session Request` message and the PGW keeps the PDP context.

4.1.3 Network Requested Secondary PDP Context Activation

The network requested secondary PDP context activation procedure is shown in Figure 15. This procedure lets the GGSN or PGW initiate the dedicated bearer activation and can be triggered by the installation of dynamic PCC rules from the PCRF, or by the GGSN or PGW, for example using the Dedicated Bearer Based on Service Detection feature.

For more detailed information on the network requested secondary PDP contexts procedure, refer to Gx+ Interface Description, for more information about Dedicated Bearer Based on Service Detection, refer to Quality of Service on the GGSN and PGW.

Note: Before the RAB is established for the secondary PDP context, the payload corresponding to the network requested secondary PDP contexts is routed through primary PDP context if it is allowed.

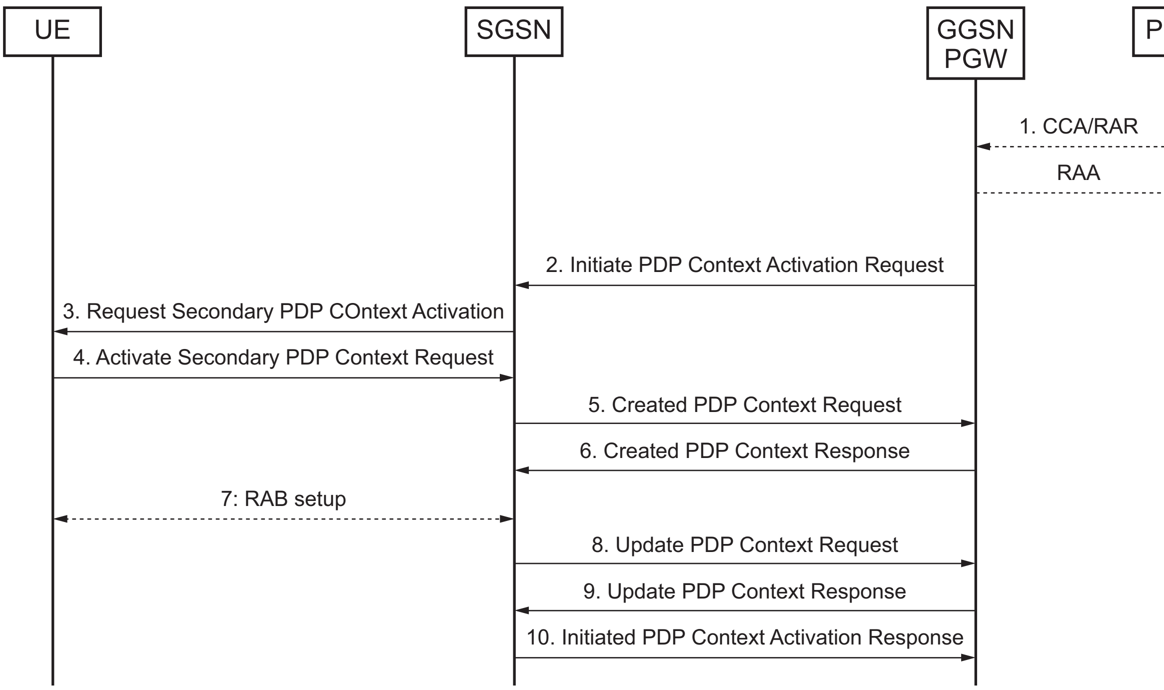

Figure 15 Signalling during the Network Requested Secondary PDP Context Activation Procedure

The network requested secondary PDP context activation procedure consists of the following steps:

1. If Policy and Charging Control (PCC) is deployed, the PCRF initiates a PCC Session Modification procedure by sending a `CCA` message with request type Update or a `RAR` message. The message includes the following information:

   — Allocation Retention Priority (ARP)

— QoS Class Identifier (QCI)

— Filters

If a RAR message was sent from the PCRF, the PGW sends a Re-Authorization Answer (RAA) message to the PCRF.

2. The GGSN or PGW sends an `Initiate PDP Context Activation Request` message to the SGSN with the requested QoS and TFT filters derived from the filters received from the PCRF.

3. The SGSN sends a `Request Secondary PDP Context Activation` to the UE with the QoS and TFT filters.

4. The UE initiates a secondary PDP context activation procedure by sending an `Activate Secondary PDP Context` message to the SGSN with the requested QoS and TFT filters.

5. The SGSN sends a `Create PDP Context Request` message to the GGSN or PGW with the requested QoS and TFT filters.

6. The GGSN or PGW acknowledges the secondary PDP context activation by sending a `Create PDP Context Response` to the SGSN.

7. The SGSN performs RAB setup.

8. The SGSN informs the GGSN or PGW about the successful RAB establishment by sending an `Update PDP Context Request` message with the `RAN Procedure Ready` flag set.

9. The GGSN or PGW acknowledges the `RAN Procedure Ready` by sending an `Update PDP Context Response` to the SGSN.

10. The SGSN sends an `Initiate PDP Context Activation Response` message to the GGSN or PGW, ending the procedure.

4.2 PDP Context Modification

A GGSN or PGW can, due to changes to subscriber data, modify parameters that were negotiated during the PDP context activation procedure. A PDP context is modified through a PDP context modification procedure initiated by the SGSN, UE, GGSN or PGW, or PCRF.

4.2.1 SGSN-Initiated and UE-Initiated Modification

The GGSN or PGW handles SGSN-initiated and UE-initiated PDP context modifications identically.

The PDP context modification procedure is shown in Figure 16. Optionally, the SGSN can transparently forward the protocol configuration option received from the UE or a GGSN or PGW in any request, response, or accept message.

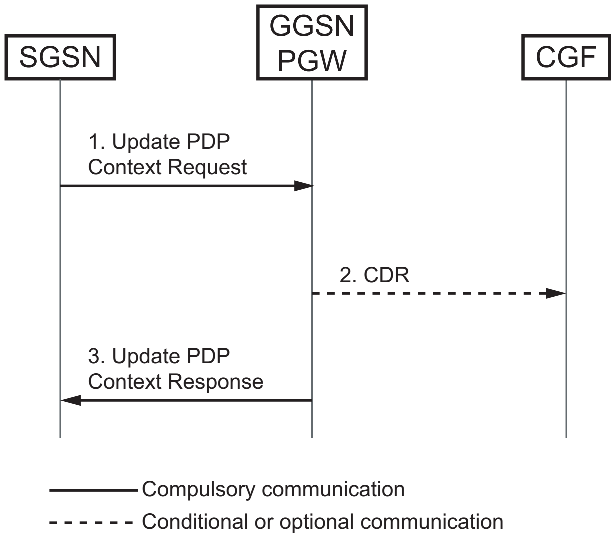

Figure 16 UE-Initiated and SGSN-Initiated PDP Context Modification

1. The SGSN sends the GGSN or PGW an `Update PDP Context Request` message, for example, to negotiate a new QoS.

   Note: If Service Aware Charging and Control (SACC) is used, additional messages are sent towards external servers. For more information on SACC, refer to SACC Overview.

   If a RADIUS accounting server is configured for the APN, the GGSN or PGW sends an `Accounting-Request (Interim-Update)` message to the RADIUS server, which returns an `Accounting-Response` message. For more information, refer to Gi and SGi Interface Description.

2. The GGSN or PGW generates a partial CDR that is directly transferred to the charging gateway using GTP'. The CDR can also be stored locally on a CPB for later transfer.

3. The GGSN or PGW responds with an `Update PDP Context Response` message to the SGSN.

4.2.1.1 Modification Reject

The SGSN, not having received an `Update PDP Context Response` message within the configured time limit, retransmits the `Update PDP Context Request` message to the GGSN or PGW the configured number of times. If a response still fails to appear, the modification procedure is rejected. Also, when the `Update PDP Context Response` message indicates that the request is not accepted, the modification procedure is rejected. At rejection, if the modification procedure was initiated by the UE, the PDP context remains active with the same QoS, except for when the GGSN or PGW lacks a PDP context. If the modification procedure was initiated by the SGSN, the PDP context is deactivated at rejection.

4.2.2 GGSN or PGW-Initiated Modification

When Gx+ initiated QoS modification is enabled, the Policy and Charging Rules Function (PCRF) can initiate an unsolicited update of the QoS for a PDP context. To renegotiate the QoS with the SGSN, the GGSN or PGW can then initiate a PDP context modification procedure.

The GGSN or PGW-Initiated PDP context modification procedure is shown in Figure 17.

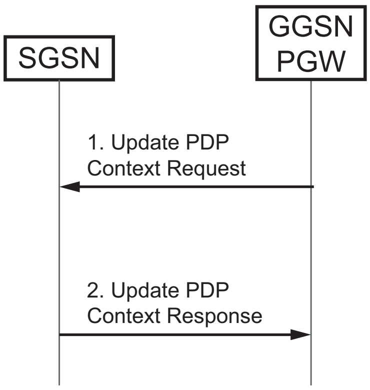

Figure 17 GGSN or PGW-Initiated PDP Context Modification Procedure

The following steps describe the PDP context modification procedure:

1. The GGSN or PGW sends an `Update PDP Context Request` message to the SGSN.

2. The SGSN returns an `Update PDP Context Response` message to the GGSN or PGW, indicating that the modification is completed.

4.2.2.1 Intruding Signal

If the PGW is waiting to receive an `Update PDP Context Response` message, but receives a `Delete PDP Context Request` message, the PGW prioritizes `Delete PDP Context Request` without waiting for the `Update PDP Context Response`.

If the PGW is waiting to receive an `Update PDP Context Response` message, but receives a `Create PDP Context Request` message, the PGW prioritizes `Create PDP Context Request` without waiting for the `Update PDP Context Response`.

If the PGW is waiting to receive an `Update PDP Context Response` message, but receives a `Create Session Request` message, the PGW prioritizes `Create Session Request` without waiting for the `Update PDP Context Response`.

Note: If the EPG receives an `Update PDP Context Response` for the aborted procedure, the EPG ignores that response.

4.2.2.2 No Response

If the GGSN or PGW does not receive a valid `Update PDP Context Response` message from the SGSN within the configured wait time, the GGSN or PGW retransmits the `Update PDP Context Request` message. The number of attempts the GGSN or PGW makes to retransmit a GTP request is determined by configuration. If no response appears, the GGSN or PGW deactivates the PDP context. For information on configuration of the wait time and maximum number of retransmit attempts, refer to GTP Interface Configuration.

4.2.2.3 PCRF-Initiated PDP Context Modification

The PCRF modifies the QoS information for a primary PDP context by sending a `CCA-update` or a `RAR` message. The PCRF can also modify a secondary PDP context by updating an existing dynamic PCC rule or by installing a new dynamic PCC rule with identical QCI and ARP priority-level values. For more detailed information on the secondary PDP context modifications procedure, refer to Gx+ Interface Description.

4.3 PDP Context Deactivation

A PDP context is deactivated through a PDP context deactivation procedure initiated either by the GGSN or PGW, SGSN, UE, PCRF, or the RADIUS server. After a successful PDP context deactivation the subscriber can no longer communicate with PDNs, since a PDP context is a prerequisite for communication.

At GPRS detach, any active PDP context for the UE is implicitly deactivated.

The GGSN or PGW handles SGSN- and UE-initiated PDP context deactivations identically.

If SACC is used, additional signalling messages (such as termination messages) are handled as follows:

- When GGSN or PGW-initiated deactivation is triggered, the messages are sent and received from the external servers after the deactivation procedure ends. For example, the GGSN or PGW sends a `CCR Terminate` message to the PCRF or the OCS after a `Delete-PDP-Context-Response` message is received from the SGSN.

- When SGSN or UE-initiated deactivation is triggered, the messages are sent and received from the external servers before the deactivation procedure begins. For example, the GGSN or PGW sends a `CCR Terminate` message to the PCRF or the OCS before initiating the deactivation procedure.

4.3.1 GGSN or PGW-Initiated Deactivation

A GGSN or PGW can initiate a deactivation procedure, for example, if a set of IP addresses are deleted, a PDP context is inactive (see Section 3.11.1 on page 21) or the GGSN or PGW loses connection with the PDN. A GGSN or PGW can also trigger a deactivation for charging reasons.

An example of a GGSN or PGW-initiated PDP context deactivation procedure with a RADIUS accounting server is shown in Figure 18. Optionally, the SGSN can transparently forward the protocol configuration option received from the UE or a GGSN or PGW in any request, response, or accept message.

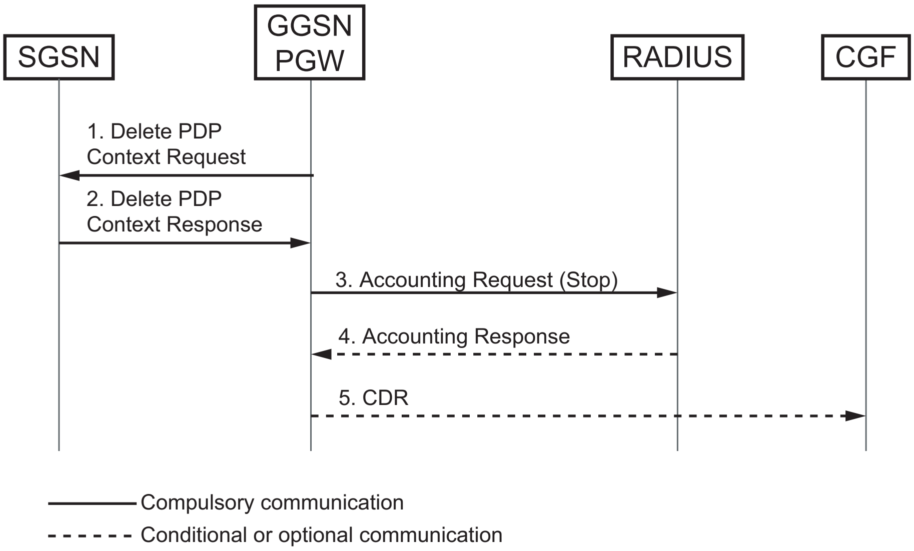

Figure 18 GGSN or PGW-Initiated PDP Context Deactivation Procedure

The following steps describe the GGSN or PGW-initiated PDP context deactivation procedure:

1. The GGSN or PGW sends a `Delete PDP Context Request` message to the SGSN. If this PDP context deactivation procedure is manually triggered (by CLI), the `Delete PDP Context Request` message can be configured to include the `Reactivation requested` cause code. This cause code requires the UE to reactivate the PDP context activation procedure for the corresponding APN. For more information about how to include the `Reactivation requested` cause code, refer to GTP Interface Configuration.

   The `Reactivation requested` cause code is also used in the `terminate-idle-session-start` command. For more information see Section 3.12 on page 22.

2. The SGSN returns a `Delete PDP Context Response` message to the GGSN or PGW indicating the deactivation of the last PDP context is completed. If the UE was using a dynamic PDP address or addresses, the GGSN or PGW releases it and makes this PDP address available for subsequent activation by other UE.

3. The GGSN or PGW sends an `Accounting Request (Stop)` message to the RADIUS server to terminate the accounting session.

Note: For IPv4, a DHCP server can be used instead of a RADIUS server and if the APN uses the GGSN or PGW-internal IP address pool, no external server is contacted.

4. The RADIUS server responds with an `Accounting Response (Stop)` message.

   Note: If the optional RADIUS unacknowledge mode is enabled, the GGSN or PGW does not wait for the `Accounting Response (Stop)` message from the RADIUS server. It is therefore necessary to ensure that IP addresses are properly released in the RADIUS server.

5. The GGSN or PGW generates a partial CDR that is directly transferred to the charging gateway using GTP'. The CDR can also be stored locally on a CPB for later transfer.

Note: If the primary PDP context is deactivated, the GGSN or PGW initiates a deactivation procedure for the entire session.

4.3.1.1 PCRF-Initiated Deactivation

The PCRF can initiate a deactivation procedure for network-initiated secondary PDP context. For more detailed information on the network-initiated secondary PDP contexts procedure, refer to Gx+ Interface Description.

4.3.2 SGSN-Initiated and UE-Initiated Deactivation

The GGSN or PGW handles SGSN-initiated and UE-initiated PDP context deactivations identically.

An SGSN can initiate a deactivation procedure, for example, when the HLR has modified or deleted subscriber data in the SGSN, when the UE with active PDP contexts is detached, when the response from the GGSN or PGW is delayed (if the NSAPI is included in the `Create PDP Context Response`), or for WCDMA Systems, when a Radio Access Bearer (RAB) reestablishment fails.

The UE can initiate a deactivation procedure, for example, to end a session.

The SGSN-initiated PDP context deactivation procedure is shown in Figure 19. The procedure can be initiated directly by the SGSN or indirectly by the HLR or UE. Optionally, the SGSN can transparently forward the protocol configuration option received from the UE or a GGSN or PGW in any request, response, or accept message.

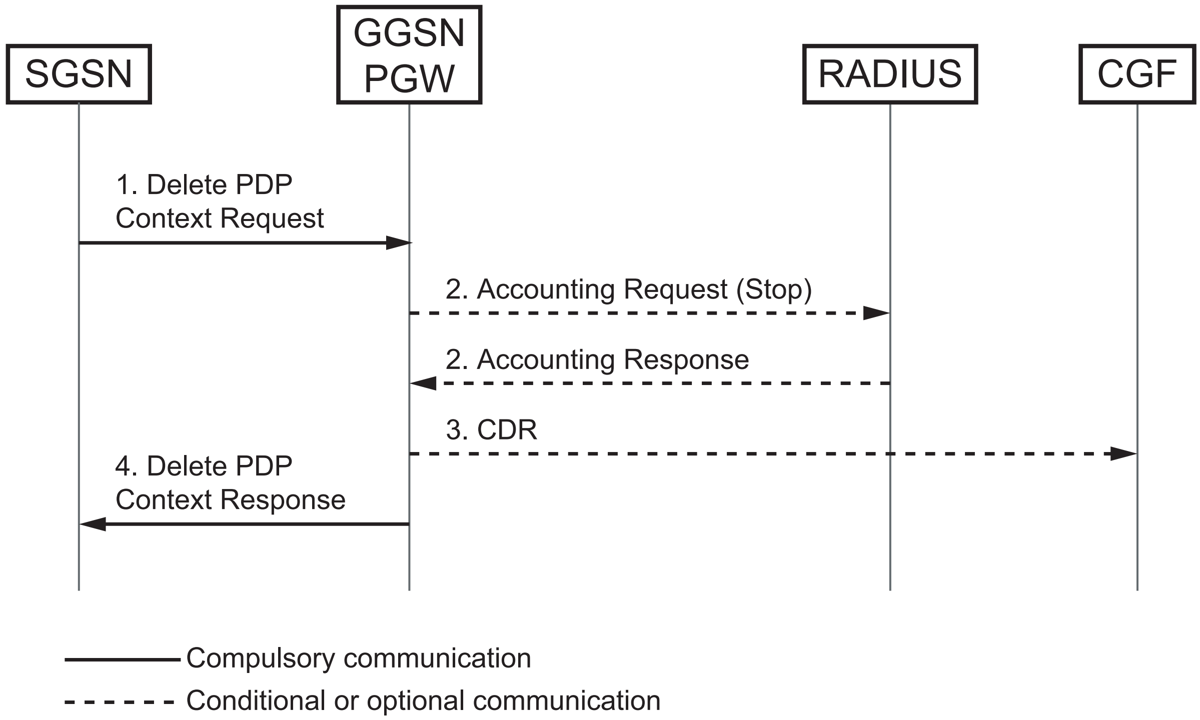

Figure 19 SGSN-Initiated PDP Context Deactivation Procedure

The following steps describe the SGSN-initiated PDP context deactivation procedure:

1. The SGSN sends a `Delete PDP Context Request` message to the GGSN or PGW.

2. If a RADIUS accounting server is configured for the APN, the GGSN or PGW sends an `Accounting Request (Stop)` message to the RADIUS server, which returns an `Accounting Response (Stop)` message.

   Note: If the optional RADIUS unacknowledge mode is enabled, the GGSN or PGW does not wait for the `Accounting Response (Stop)` message from the RADIUS server. It is therefore necessary to ensure that IP addresses are properly released in the RADIUS server.

3. The GGSN or PGW generates a partial CDR that is directly transferred to the charging gateway using GTP'. The CDR can also be stored locally on a CPB for later transfer.

4. The GGSN or PGW removes the PDP context and returns a `Delete PDP Context Response` message to the SGSN.

4.3.3 RADIUS-Initiated Deactivation

The GGSN and PGW can be configured to accept disconnection requests from RADIUS servers and to deactivate an associated PDP context. For more information, refer to Gi and SGi Interface Description.

The GGSN and PGW can also be configured to disable the IP source address check when receiving disconnect requests from RADIUS. For more information, refer to RADIUS Configuration.

5 Session Management over the GTP-Based S2a Interface

Session management over the GTP-based S2a interface is handled through the TWAN and the PGW.

For more information about the GTP-based S2a interface, refer to GTP-Based S2a Interface Description.

5.1 PDN Connection Creation

Creation of a PDN connection is initiated by the TWAN and is implemented through the PGW for a UE device in a trusted WLAN access network. The connection is created by exchanging `Create Session Request` and `Create Session Response` messages between the TWAN and the PGW. Figure 20 shows the signalling between the TWAN and the PGW during the PDN connection creation procedure.

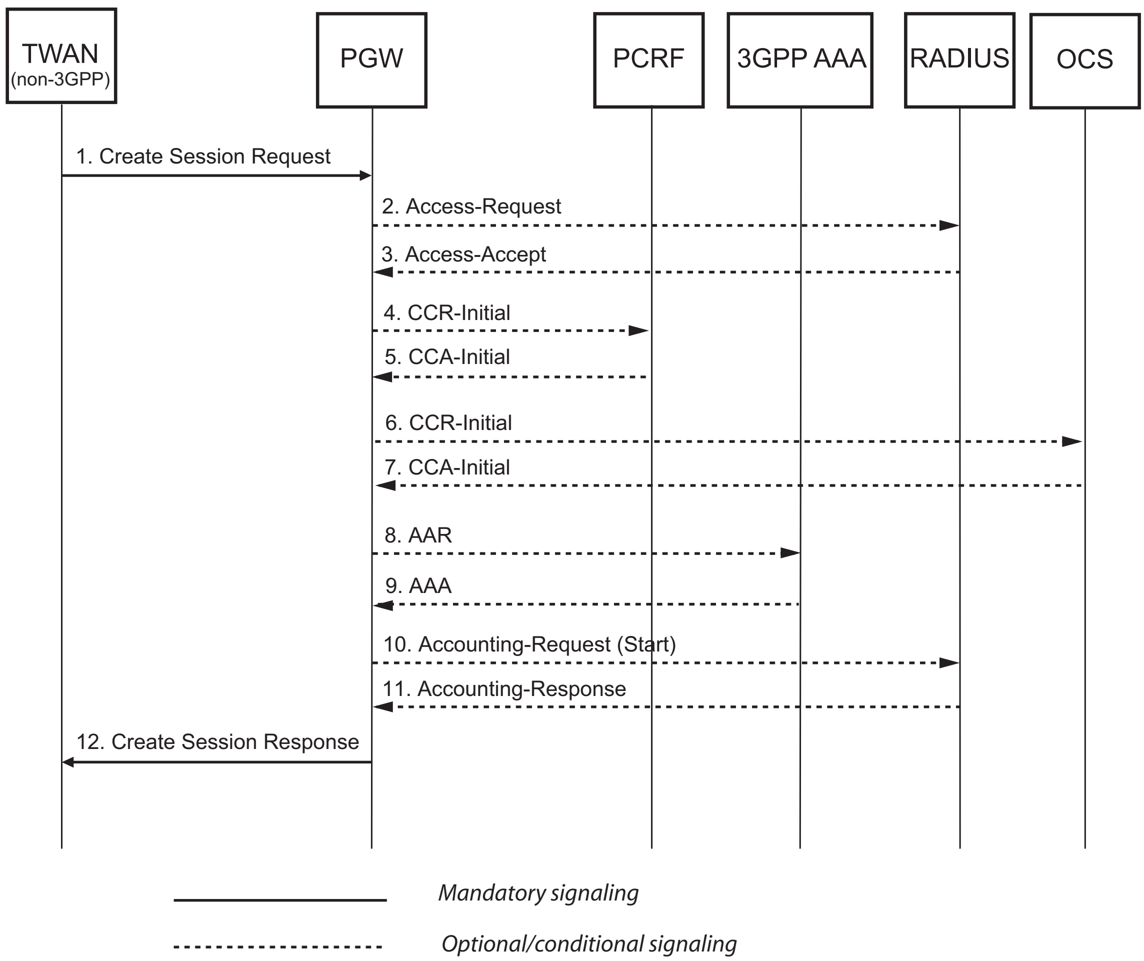

Figure 20 Signalling during the PDN Connection Creation Procedure

A TWAN-initiated PDN connection creation procedure involves the following steps:

1. The TWAN sends a `Create Session Request` message to the PGW, and waits for response. The request includes the IMSI of the UE, an APN selected by the TWAN, and QoS information. The RAT type indicates `WLAN`.

The PGW selects an APN according to Section 3.5.1 on page 13, and performs admission control based on resource availability. The PGW then assigns an IP address to the UE according to the description in Section 3.13 on page 25.

Note: The IMS emergency call from trusted WLAN access is not supported. The multiple PDN connection with the same APN over S2a interface is not supported.

2. The PGW sends authentication information to the RADIUS authentication server in the `Access-Request` message to request access for the PDN connection.

3. The RADIUS server responds with an `Access-Accept` message.

4. If PCC is deployed, the PGW sends a `Credit-Control-Request` (CCR-Initial) message to the PCRF.

5. The PCRF responds with a `Credit-Control-Answer` (CCA-Initial) message to the PGW, and a Gx+ PCC session is established.

6. The PGW sends a `CCR-Initial` message to the OCS. The `CCR-Initial` message includes the rule space for the PDN connection.

7. The OCS responds with a `CCA-Initial` message to the PGW, and a credit control session is set up.

8. To authorize the UE device for PDN access, the PGW sends an `AA-Request` (AAR) message to the 3GPP AAA server.

9. The 3GPP AAA server responds with an `AA-Answer` (AAA) message to the PGW.

10. If a RADIUS accounting server is configured for the APN, the PGW sends an `Accounting-Request (Start)` message to the RADIUS server.

11. The RADIUS server responds with an `Accounting-Response` message to the PGW to indicate the start of the accounting session for the PDN connection.

12. The PGW sends a `Create Session Response` message to the TWAN, including the IP address allocated for the UE.

A GTP-U tunnel is created between the TWAN and the PGW for the payload traffic between the trusted WLAN access network and the EPS network.

After the initial attach, the additional PDN connections can be created following the same procedure as above.

If a `Create Session Request` message received is in conflict with an existing PDN connection, the EPG deletes the existing PDN connection. The received `Create Session Request` message is silently discarded, and the EPG waits for the peer node to retransmit the message. When the retransmitted `Create Session Request` message is received, the EPG establishes the new PDN connection.

Note: The PGW supports multiple simultaneous PDN connections for each UE over the GTP-based S2a interface but only one per APN.

5.2 TWAN-Initiated PDN Connection Deletion

When the UE device terminates the PDN connection, the TWAN initiates a PDN connection deletion procedure. Figure 21 shows the signalling between the TWAN and the PGW during the PDN connection deletion procedure.

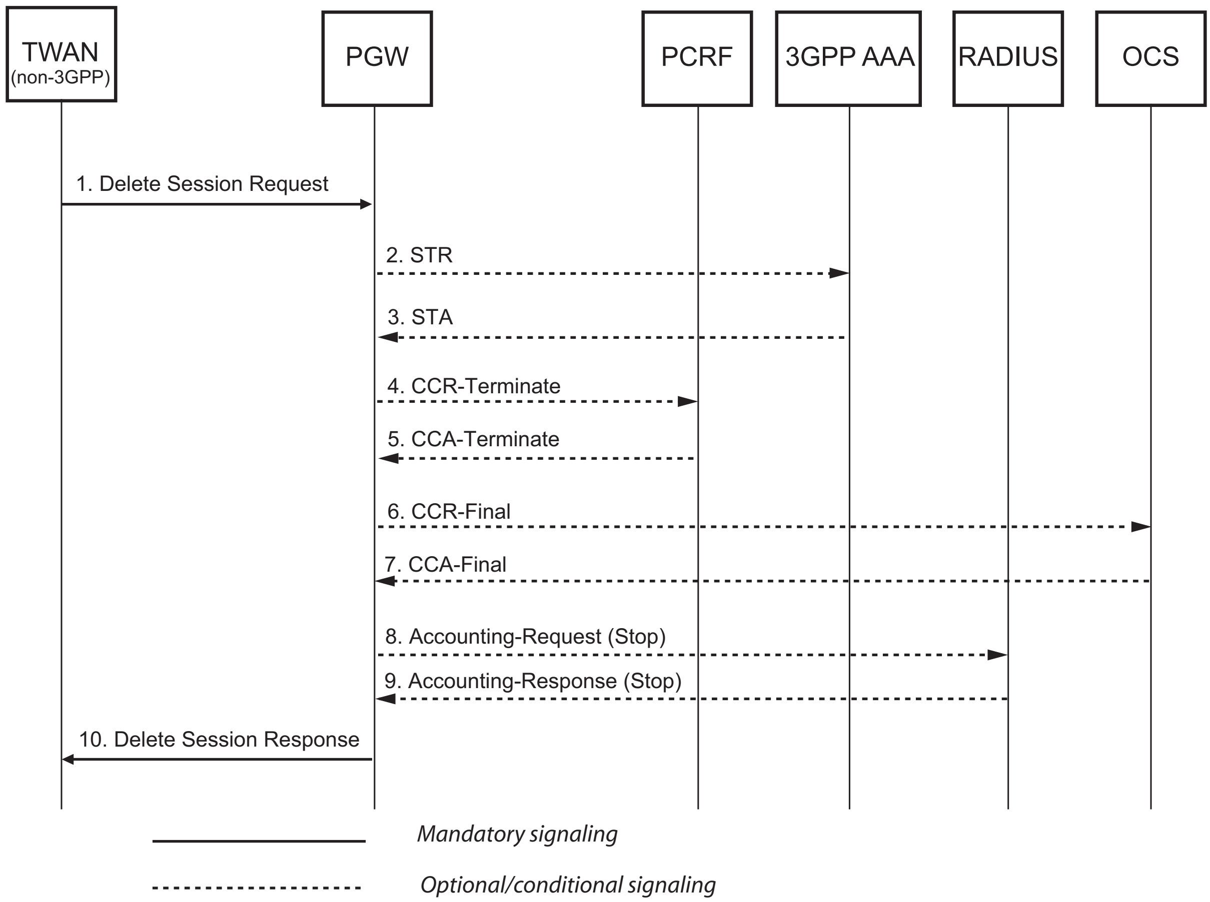

Figure 21 Signalling during the TWAN-Initiated PDN Connection Deletion Procedure

The TWAN-initiated PDN connection deletion procedure involves the following steps:

1. The TWAN sends an `Delete Session Request` message the PGW.

2. The PGW sends a `Session Termination Request` (STR) message to the 3GPP AAA server to terminate the session.

3. The 3GPP AAA server responds with a `Session Termination Answer` (STA) message to the PGW.

4. To terminate the Gx+ PCC session, the PGW sends a `CCR-Terminate` message to the PCRF.

5. The PCRF responds with a `CCA-Terminate` message to the PGW.

6. To terminate the credit control session, the PGW sends a `CCR-Final` message to the OCS.

7. The OCS responds with a `CCA-Final` message to the PGW.

8. To terminate the accounting session, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server.

9. The RADIUS server responds with an `Accounting-Response` message to the PGW.

10. The PGW sends a `Delete Session Response` message to the TWAN.

The PDN connection is terminated and the GTP-U tunnel is removed.

5.3 PGW-Initiated PDN Connection Deletion

The PGW-initiated PDN disconnection is triggered by any of the following events:

— CLI initiated termination

— Manual APN shutdown

— PCRF initiated IP-CAN session termination procedure with a `RAR` message

The CLI `terminate-idle-session-start` command can be used to delete only idle sessions on the PGW. For more information on terminating idle sessions see Section 3.12 on page 22.

Figure 22 shows the signalling between the TWAN and the PGW during a PGW-initiated PDN connection deletion procedure.

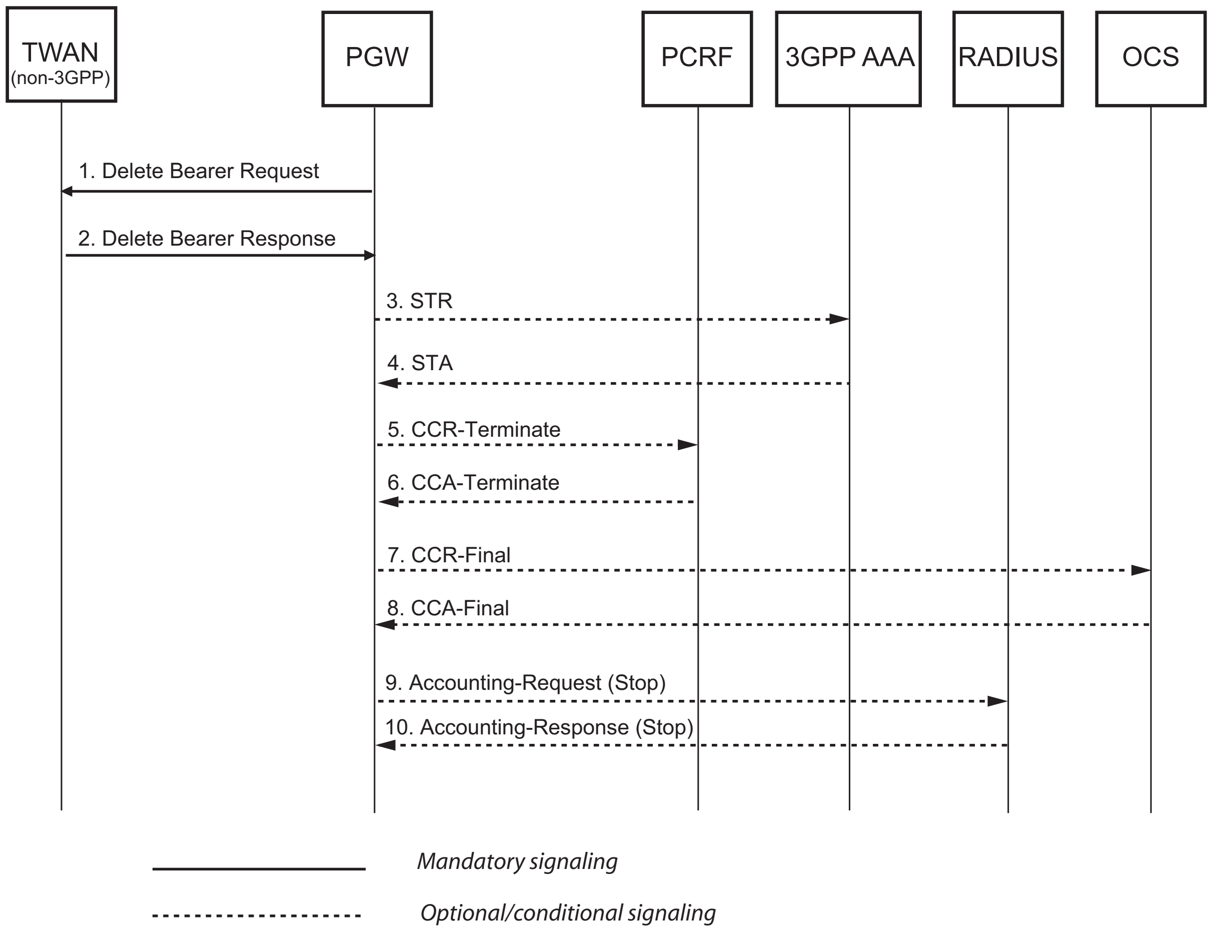

Figure 22 Signalling during the PGW-Initiated PDN Connection Deletion Procedure

The PGW-initiated PDN connection deletion procedure involves the following steps:

1. The PGW receives a trigger to start a PDN disconnection. The PGW sends a `Delete Bearer Request` message to the TWAN.

2. The TWAN deletes the bearer contexts related to the `Delete Bearer Request`, and sends a `Delete Bearer Response` to the PGW.

3. The PGW sends an `STR` message to the 3GPP AAA server to terminate the session.

4. The 3GPP AAA server responds with a `STA` message to the PGW.

5. To terminate the Gx+ PCC session, the PGW sends a `CCR-Terminate` message to the PCRF.

6. The PCRF responds with a `CCA-Terminate` message to the PGW.

7. To terminate the credit control session, the PGW sends a `CCR-Final` message to the OCS.

8. The OCS responds with a `CCA-Final` message to the PGW.

9. To terminate the accounting session, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server.

10. The RADIUS server responds with an `Accounting-Response` message to the PGW.

The PDN connection is terminated and the GTP-U tunnel is removed.

6 Session Management over the PMIPv6-Based S2a Interface

Session management procedures between the MAG and the PGW are detailed in the following sections.

6.1 PDN Connection Creation

Creation of a PMIPv6 PDN connection is initiated by the MAG and is implemented through the PGW for a UE device in a CDMA2000 network. The connection is created by exchanging PBU and PBA messages between the MAG and the PGW, see Figure 23.

Exchange of these messages establishes two binding list entries: the BCE in the PGW, and the Binding Update List Entry in the MAG.

In the exchange of the PBU and PBA messages, the MAG allocates the downlink GRE key and the PGW allocates the uplink GRE key. These keys are used for the encapsulation of the PDN connection's user data, downlink traffic and uplink traffic.

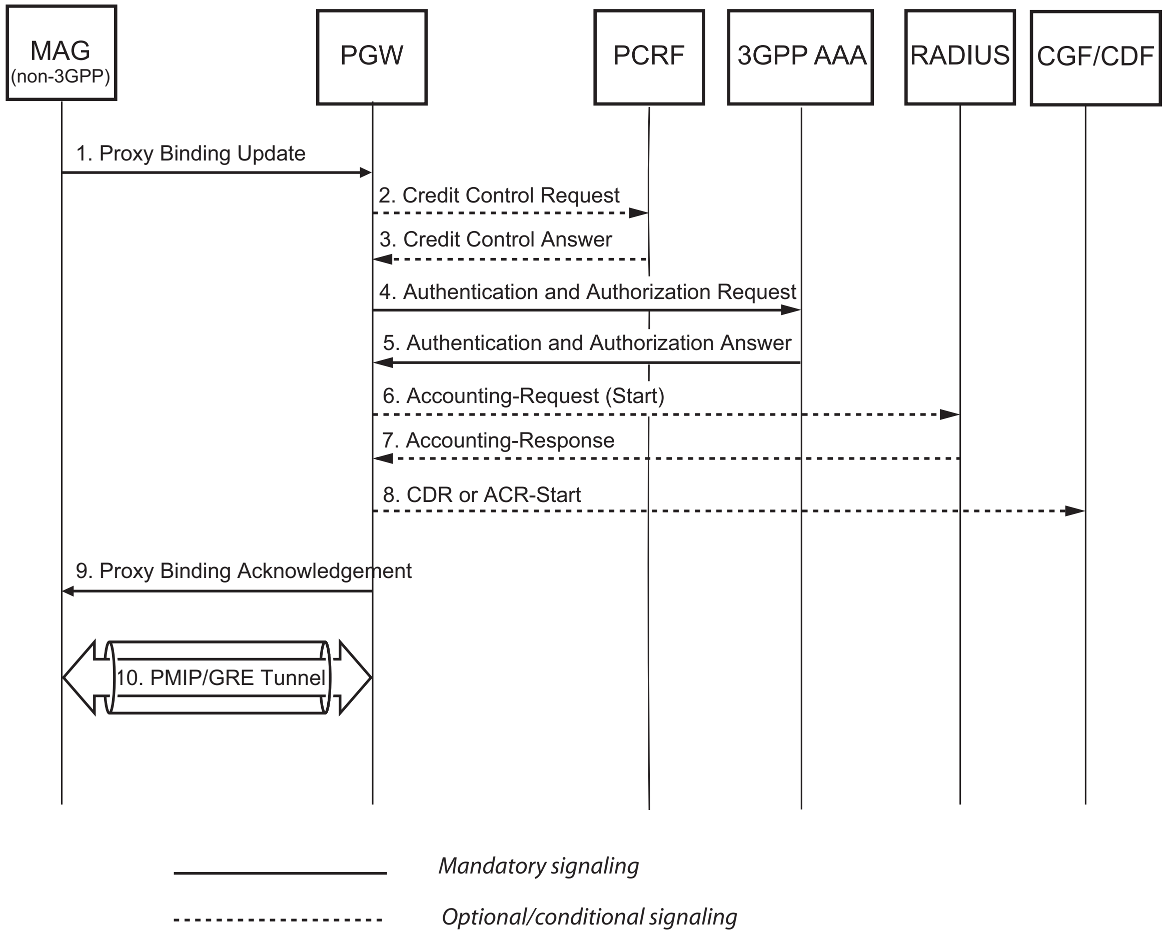

Figure 23 PDN Connection Creation Procedure

A MAG Initiated PDN Connection Creation procedure involves the following steps:

1. The MAG prepares and sends a PBU message with Lifetime greater than zero to the selected PGW to create a PDN connection, and waits for response. The PBU includes the APN for the UE device. Optionally if requested by the UE, the PBU includes IPv4 link MTU in the PCO IE.

   Note: The IMS emergency call from CDMA network is not supported. The multiple PDN connection with the same APN over PMIP-based S2a interface is not supported.

2. If PCC is used, the PGW sends a `CCR-Initial` message to the PCRF.

3. The PCRF replies with a `CCA-Initial` message back to the PGW.

4. To authorize the UE device for PDN access, the PGW sends an `AAR` message to the 3GPP AAA server.

5. The 3GPP AAA server responds with an `AAA` message back to the PGW.

6. If a RADIUS accounting server is configured for the APN, the PGW sends an `Accounting-Request (Start)` message to the RADIUS server which includes the MSISDN of the UE.

7. The RADIUS server responds with an `Accounting-Response` message to the PGW.

8. For CDR charging, if suppression of initial partial CDR closure is not configured, the PGW generates an initial partial CDR that only includes static information, and closes the record immediately. For configuration information, refer to Offline Charging Configuration.

   For Rf charging, the PGW sends an `Accounting-Request (ACR) Start` message to the CDF.

9. The PGW sends a PBA message to the MAG.

   The PGW creates a BCE for the requested APN for this UE device. The PGW allocates an IPv4 address, an IPv6 address or both IPv4 and IPv6 addresses, depending on the request from the UE. In case of IPv6 address, the PGW also provide the link-local address. The PDN Type indication will only be set if the requested IP-type is changed from the allocated IP-type.

   The PGW also saves the downlink GRE key from the MAG, and allocates an uplink GRE key to send to the MAG in the PBA message.

   If the IPv4 link MTU in PCO IE is requested by the UE, the PGW sends the MTU size based on the following:

   — If an APN MTU size is configured, the PGW sends the configured APN MTU size.

   — If no APN MTU size is configured, the PGW sends the configured PGW MTU size.

10. A GRE tunnel is created between the MAG and the PGW for the payload traffic between the CDMA2000 network and the EPS network.

The GRE tunnel is maintained as long as the EPS session exists. It is removed through any of the PDN Connection Deletion procedures, initiated by the MAG or the PGW, see Section 6.3 on page 76 or Section 6.4 on page 78.

If a received PBU message is in conflict with an existing PMIPv6 PDN connection, the EPG deletes the existing PMIPv6 PDN connection. If the PBU message comes from the same MAG as the one for existing PMIPv6 PDN connection, no BRI is sent to MAG. If it comes from a different MAG, BRI is sent to the old MAG, which initiates the existing PMIPv6 PDN connection. The received PBU message is silently discarded, and the EPG waits for the peer node to retransmit the message. When the retransmitted PBU message is received, the EPG establishes the new PDN connection.

If a received `Create Session Request` message is in conflict with an existing PDN connection, the EPG deletes the existing PDN connection. The received

`Create Session Request` message is silently discarded, and the EPG waits for the peer node to retransmit the message. When the retransmitted `Create Session Request` message is received, the EPG establishes the new PDN connection.

6.2 PDN Connection Lifetime Extension

The MAG assigns each PDN connection at creation a predefined connection time, called BCE Lifetime, controlled by a timer. The PGW checks that the BCE Lifetime value is within the limits specified in the PGW configuration.

The MAG monitors the lifetime for the PDN connections that are about to time out, and sends a PBU message to the PGW to extend the BCE Lifetime before a PDN connection times out in the PGW.

Figure 24 shows the signalling between the MAG and the PGW during a Lifetime Extension procedure.

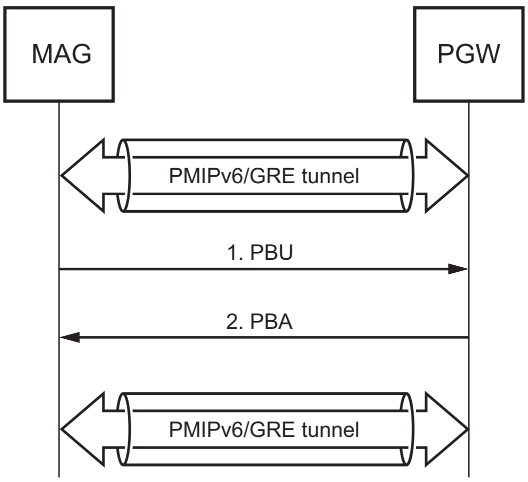

Figure 24 PDN Connection Lifetime Extension Procedure

A PDN Connection Lifetime Extension procedure involves the following steps:

1. The MAG decides to prolong the lifetime of an existing PDN connection and sends a PBU message with a new lifetime value for the PDN connection to the PGW.

2. The PGW updates the BCE with the new lifetime and responds to the MAG with a PBA message with the granted lifetime value.

The GRE tunnel remains.

6.3 MAG-Initiated PDN Connection Deletion

When the UE device terminates the PDN connection, the MAG initiates a PDN Connection Deletion procedure. Figure 25 shows the signalling between the MAG and the PGW during the PDN Connection Deletion procedure.

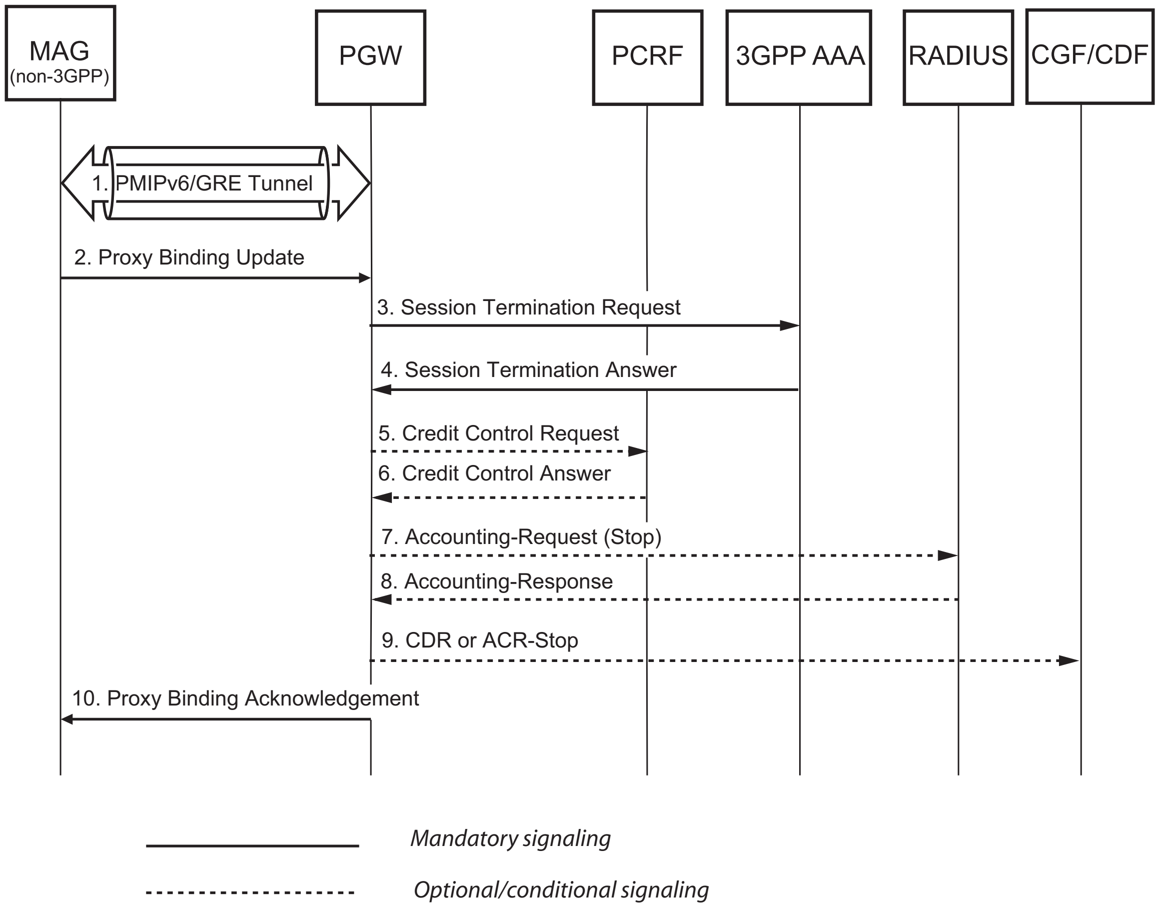

Figure 25 MAG-Initiated PDN Connection Deletion Procedure

A MAG initiated PDN Connection Deletion procedure involves the following steps:

1. The UE or the MAG initiates a disconnection of the PMIPv6/GRE tunnel between the MAG and the PGW.

2. The MAG sends a PBU message with Lifetime=`0` to the PGW.

3. The PGW starts the configurable BCE delete timer and stops the Lifetime supervision timer. When the `deleteTimer` expires, the PGW sends an STR message to the 3GPP AAA server to terminate the session.

4. The 3GPP AAA server responds with a `Session Termination Answer` (STA) message to the PGW.

5. If the PCC is used, the PGW sends a `Credit-Control Request` (CCR-Terminate) message to the PCRF.

6. The PCRF responds with a `Credit-Control Answer` (CCA-Terminate) successful message.

7. If RADIUS accounting is activated for the APN, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server configured for the APN.

8. The PGW receives an `Accounting-Response` message from the RADIUS server configured for the APN.

9. For CDR-based charging, the PGW closes the CDR and the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer.

   For Rf charging, the PGW sends an `ACR Stop` message to the CDF.

10. The PGW looks up the BCE, deletes the binding and all resources allocated for this PDN connection, and sends a `PBA` message to the MAG.

The GRE tunnel for payload is disabled, and the PDN connection is terminated after the BCE delete timer has expired and the BCE is removed.

6.4 PGW-Initiated PDN Connection Deletion

The PGW-initiated PDN disconnection is triggered by any of the following events:

- PDN connection lifetime expiration
- CLI initiated termination
- Intra non-3GPP PDN Connection handover (termination towards the Source MAG)
- LTE-to-non-3GPP PDN Connection handover
- PCRF initiated IP-CAN Session Termination procedure with a RAR message
- RADIUS disconnect
- Manual APN shutdown

Then, the PGW must inform the MAG that the BCE related to the UE device is about to be deactivated and that the MAG should remove the resources related to the PDN connection.

The CLI `terminateIdleSessionStart` command can be used to delete only idle sessions on the PGW. For more information on terminating idle sessions see Section 3.12 on page 22.

Figure 26 shows the signalling between the PGW and the MAG during this procedure.

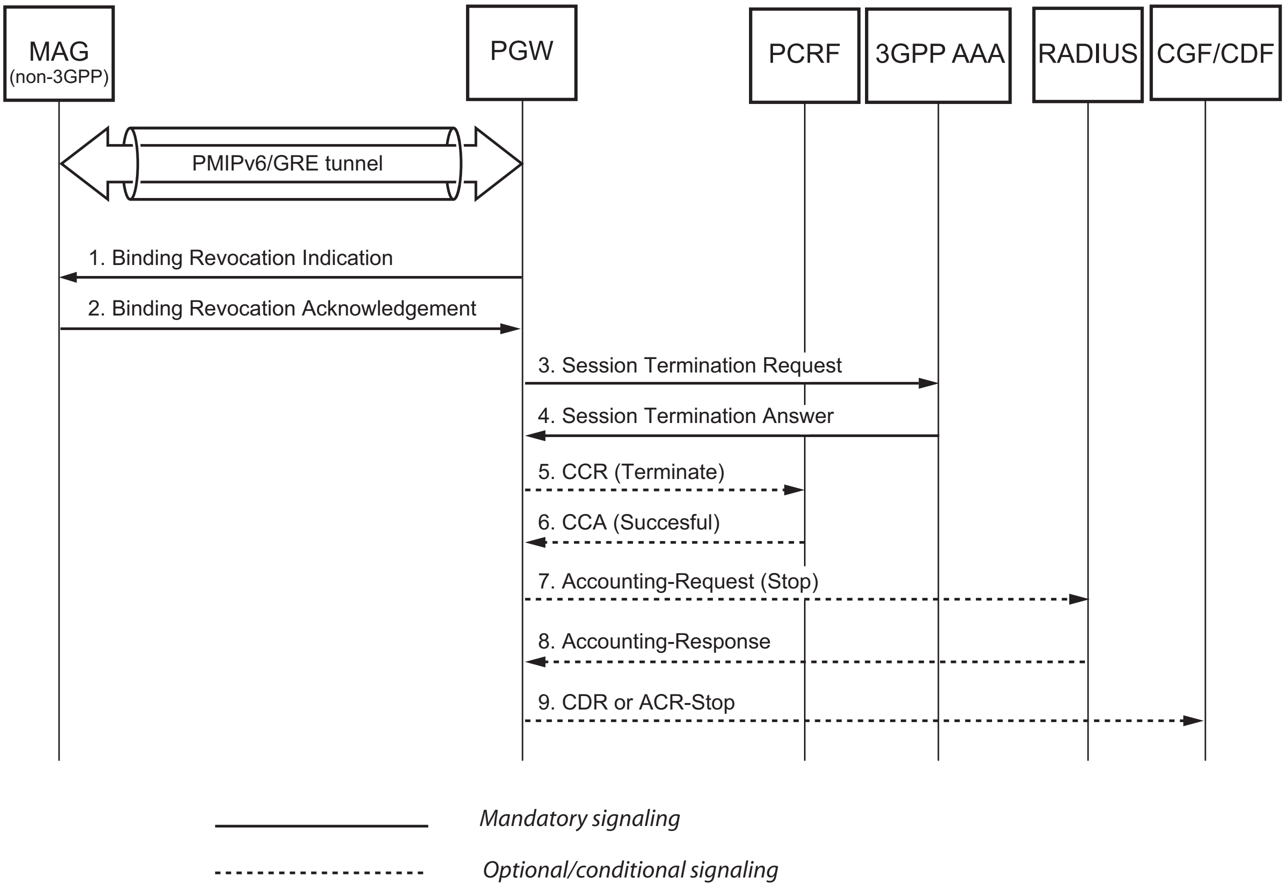

Figure 26 PGW-Initiated PDN Connection Deletion Procedure

The PGW-initiated PDN Connection Deletion procedure involves the following steps:

1. The PGW sends a `Binding Revocation Indication` (BRI) message to the MAG, and clears the BCE related to the UE device.

   Note: If the deletion is due to Intra non-3GPP handover, the PGW does not delete the BCE and keeps the PMIPv6/GRE tunnel.

2. The MAG deletes the binding, removes the PMIPv6/GRE tunnel and sends a `Binding Revocation Acknowledgement` (BRA) message to the PGW.

   If no BRA is received, the PGW resends the BRI message after the BRI timer has expired. This timer doubles the time between BRI message retransmission for each retransmission, and the PGW continues to resend the BRI message until a BRA message is received, or until the configured maximum number of resent BRI messages (`bri retries`) is fulfilled.

   Note: The remaining steps are not performed if the PGW-initiated PDN disconnection is triggered by intra non-3GPP handover.

3. The PGW sends an STR message to the 3GPP AAA server to terminate the session.

4. The 3GPP AAA server responds with a `Session Termination Answer` (STA) message to the PGW.

5. If the PCC is used, the PGW sends a `Credit-Control Request` (CCR-Terminate) message to the PCRF.

   If the PGW-initiated PDN disconnection is triggered by IRAT handover to 3GPP (LTE), the PCC session towards the PCRF is kept and the `CCR-terminate` message is not sent to the PGW.

6. The PCRF responds with a `Credit-Control Answer` (CCA-Terminate) successful message.

   This message is not applicable if the PGW-initiated PDN disconnection is triggered by IRAT handover to 3GPP (LTE).

7. If RADIUS accounting is activated for the APN, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server configured for the APN.

8. The PGW receives an `Accounting-Response` message from the RADIUS server configured for the APN.

9. For CDR-based charging, the PGW closes the CDR and the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer.

   For Rf charging, the PGW sends an `ACR Stop` message to the CDF.

The BCE is removed, the PMIPv6/GRE tunnel is removed, and all allocated resources are released.

Note: The PGW ignores signalling messages received from the MAG for the PDN connection during the PGW-Initiated PDN Connection Deletion.

6.5 Path Management

Path Management is implemented, which means that the MAG or the PGW initiates the heartbeat exchange to test reachability status of the remote peer.

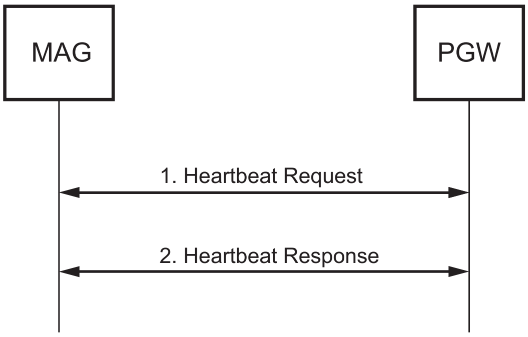

Figure 27 PMIPv6 Path Management Procedure

When the bi-directional PMIPv6 tunnel is established between the MAG and the PGW, the MAG or the PGW checks that the remote peer is reachable by sending messages at regular intervals, configurable in the MAG and the PGW.

The PMIPv6 Path Management procedure involves the following steps:

1. The MAG or the PGW sends a `Heartbeat Request` message to the PGW or the MAG. Each `Heartbeat Request` message contains a sequence number that is incremented monotonically.

2. The PGW or the MAG checks that the sequence number is included in the received `Heartbeat Request` message, and includes it in the `Heartbeat Response` message sent to the MAG or the PGW. The restart counter is returned in the message.

For a detailed description of the PMIPv6 Heartbeat mechanism, refer to the SoC with 3GPP TS 29.275.

7 Session Management over the S2b Interface

Session management over the S2b interface is handled through the ePDG and the PGW.

For more information about the S2b interface, refer to S2b Interface Description.

7.1 PDN Connection Creation

Creation of a PDN connection is initiated by the ePDG and is implemented through the PGW for a UE device in an untrusted WLAN access network. The connection is created by exchanging `Create Session Request` and `Create Session Response` messages between the ePDG and the PGW. Figure 28 shows the signalling between the ePDG and the PGW during the PDN connection creation procedure.

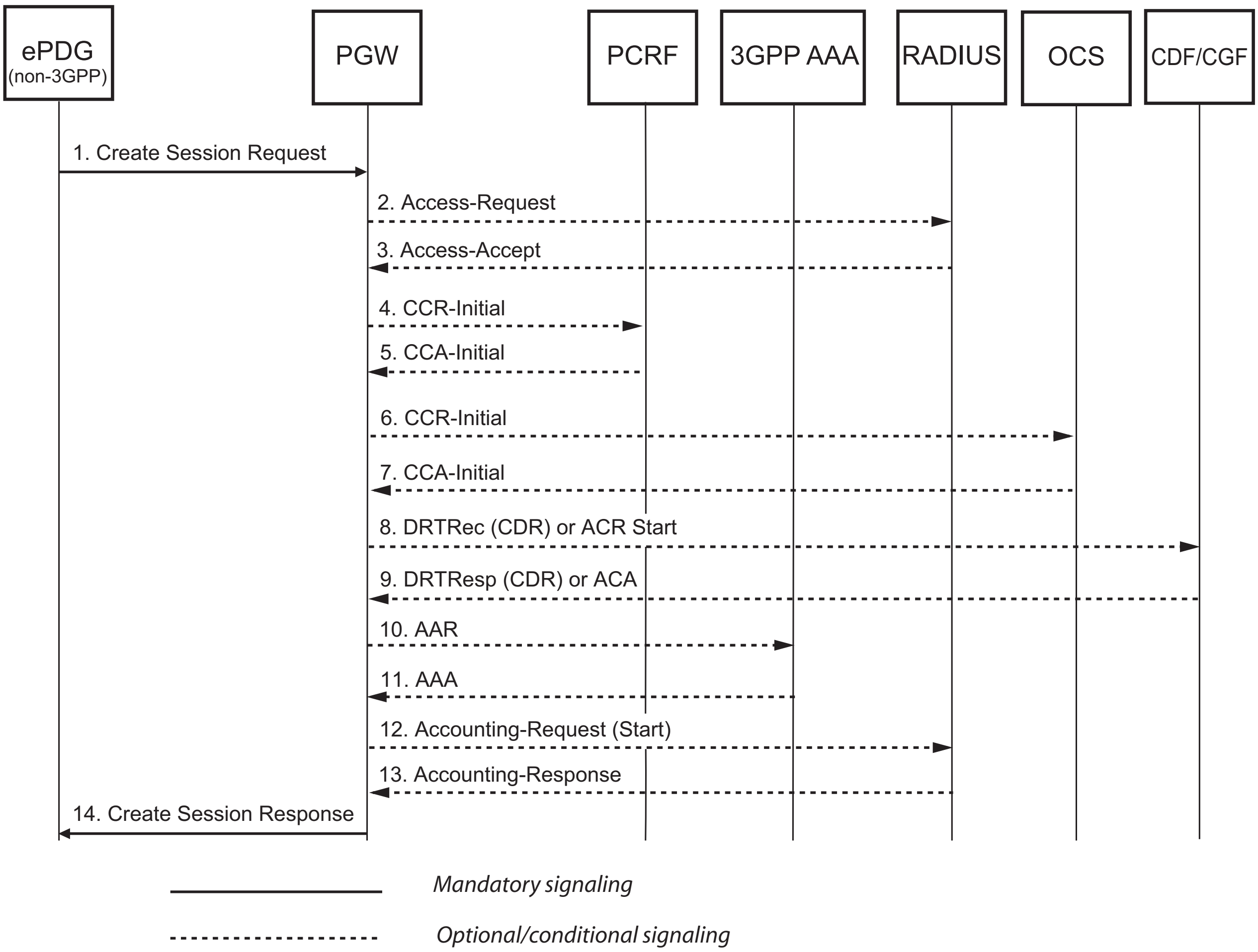

Figure 28 Signalling during the PDN Connection Creation Procedure

An ePDG-initiated PDN connection creation procedure involves the following steps:

1. The ePDG sends a `Create Session Request` message to the PGW, and waits for response. The request includes the IMSI of the UE, an APN selected by the ePDG, PDN type (IPv4, IPv6, or IPv4v6), and QoS information. The RAT type indicates `WLAN`. Optionally, the request includes IPv4 link MTU in the PCO or APCO IE.

   Note: If the request includes both PCO and APCO IEs, only PCO is handled.

The PGW selects an APN according to Section 3.5.1 on page 13, and performs admission control based on resource availability. The PGW then assigns an IP address to the UE according to the description in Section 3.13 on page 25.

Note: The PGW supports the emergency call setup if no S6b or S6bAuth profile exists under this emergency APN.

Note: The multiple PDN connection with the same APN over S2b interface is not supported.

2. The PGW sends authentication information to the RADIUS authentication server in the `Access-Request` message to request access for the PDN connection.

3. The RADIUS server responds with an `Access-Accept` message.

4. If PCC is deployed, the PGW sends a `CCR-Initial` message to the PCRF.

5. The PCRF responds with a `CCA-Initial` message to the PGW, and a Gx+ PCC session is established.

6. The PGW sends a `CCR-Initial` message to the OCS. The `CCR-Initial` message includes the rule space for the PDN connection.

7. The OCS responds with a `CCA-Initial` message to the PGW, and a credit control session is set up.

8. For CDR charging using GTP', the `Data Record Transfer Request` is sent but for FTP the CDR is stored to disk.

   For CDR charging, If suppression of initial partial CDR closure is not configured, the PGW generates an initial partial CDR that only includes static information, and closes the record immediately. For configuration information, refer to Offline Charging Configuration. For Rf charging, the PGW sends an `ACR Start` message to the CDF.

9. For CDR charging using GTP', the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP. For Rf charging, the CDF responds with an `Accounting Answer (ACA)` message to the PGW.

10. To authorize the UE device for PDN access, the PGW sends an `AAR` message to the 3GPP AAA server.

11. The 3GPP AAA server responds with an `AAA` message to the PGW.

12. If a RADIUS accounting server is configured for the APN, the PGW sends an `Accounting-Request (Start)` message to the RADIUS server.

13. The RADIUS server responds with an `Accounting-Response` message to the PGW to indicate the start of the accounting session for the PDN connection.

14. The PGW sends a `Create Session Response` message to the ePDG, including the IP address allocated for the UE. If the IPv4 link MTU in the PCO or APCO IE is requested by the UE, the PGW sends the MTU size based on the following:

    — If an APN MTU size is configured, the PGW sends the configured APN MTU size.

    — If no APN MTU size is configured, the PGW sends the configured PGW MTU size.

A GTP-U tunnel is created between the ePDG and the PGW for the payload traffic between the untrusted WLAN access network and the EPS network.

If a received `Create Session Request` message is in conflict with an existing PDN connection, the EPG deletes the existing PDN connection. The received `Create Session Request` message is silently discarded, and the EPG waits for the peer node to retransmit the message. When the retransmitted `Create Session Request` message is received, the EPG establishes the new PDN connection.

After the initial attach, the additional PDN connections can be created following the same procedure as above.

Note: The PGW supports multiple simultaneous PDN connections for each UE over the S2b interface but only one per APN.

7.2 PDN Connection Modification

This section describes the activation, modification, or deactivation of dedicated bearers.

7.2.1 Dedicated Bearer Activation

A default bearer is established during the attach procedure. Any additional bearer that is established for the same PDN connection is referred to as a dedicated bearer. Dedicated bearers are established with the Dedicated Bearer Activation procedure. Signalling during this procedure is shown in Figure 29.

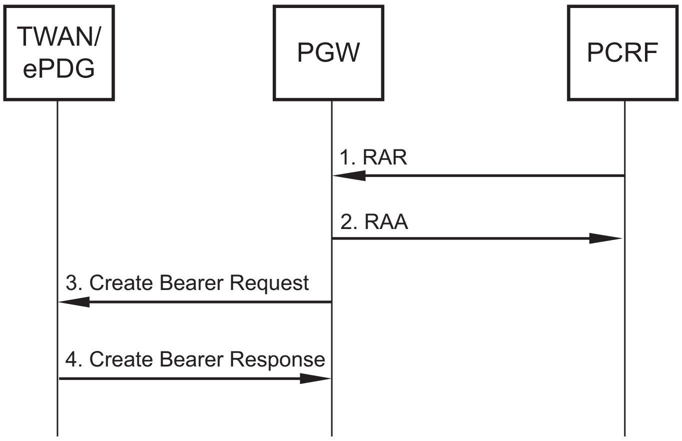

Figure 29 Signalling During a Dedicated Bearer Activation Procedure

The dedicated bearer activation procedure consists of the following steps:

1. If Policy and Charging Control (PCC) is deployed, the PCRF initiates a PCC Session Modification procedure by sending an `RAR` message.

2. The PGW responds with an `RAA` message to the PCRF.

3. The PGW sends a `Create Bearer Request` message to the TWAN/ePDG. This message includes the following information:

   — Linked Bearer Identity (LBI)

   — EPS Bearer ID

   — TFT

   — `S2b-U PGW F-TEID`

   — Bearer Level QoS

   — Charging Id

4. The TWAN/ePDG acknowledges the bearer activation by sending a `Create Bearer Response` message to the PGW. This message includes the following information:

   — Cause

   — EPS Bearer ID

   — `S2b-U ePDG F-TEID`

   — `S2b-U PGW F-TEID`

7.2.2 Bearer Modification

A bearer modification procedure is used in cases when different bearer parameters need to be modified. Parameters can be modified, for instance, as a result of PCRF-triggered PCC rule modification.

Signalling during a bearer modification procedure is shown in Figure 30.

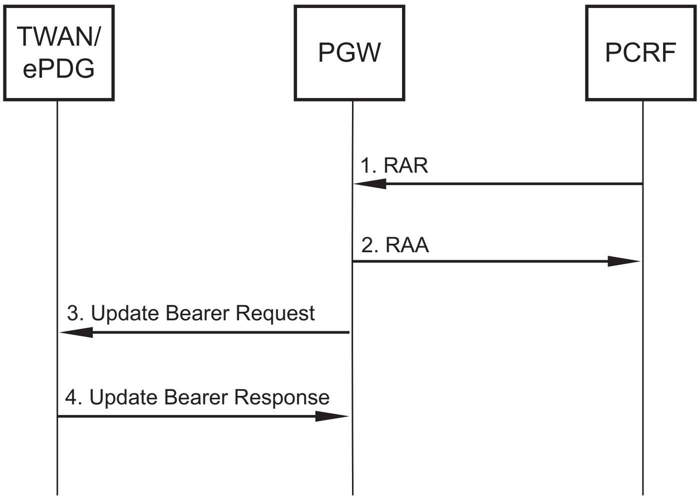

Figure 30 Signalling During a Bearer Modification Procedure

A bearer modification procedure involves the following steps:

1. If PCC is deployed, the PCRF initiates a PCC session modification procedure by sending an RAR message.

2. The PGW responds with an RAA message to the PCRF.

3. The PGW sends an `Update Bearer Request` message to the TWAN/ePDG. This message includes the following information:

   — EPS bearer ID

   — TFT

   — Bearer Level QoS (optional)

   — APN-AMBR

4. The TWAN/ePDG responds with an `Update Bearer Response` message to the PGW. This message contains the following information:

   — Cause

   — EPS bearer ID

7.2.3 Bearer Deletion

This section describes the procedure during bearer deletion. Signalling during this procedure is shown in Figure 31.

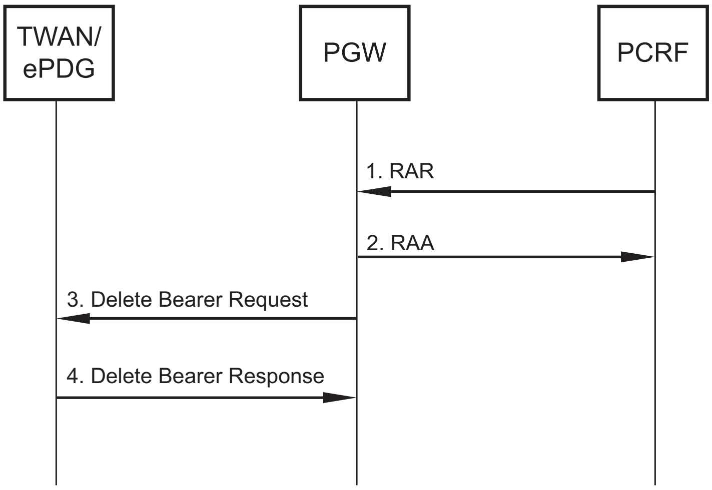

Figure 31 Signalling During a Dedicated Bearer Deletion Procedure

1. If PCC is deployed, the PCRF initiates a PCC session deletion procedure by sending an `RAR` message to the PGW.

2. The PGW responds with an `RAA` message to the PCRF.

3. The PGW sends a `Delete Bearer Request` message to the TWAN/ePDG. This message includes the following information:

   — Cause

   — EPS Bearer ID

4. The TWAN/ePDG responds with a `Delete Bearer Response` message to the PGW.

7.3 ePDG-Initiated PDN Connection Deletion

When the UE device terminates the PDN connection, the ePDG initiates a PDN connection deletion procedure. Figure 32 shows the signalling between the ePDG and the PGW during the PDN connection deletion procedure.

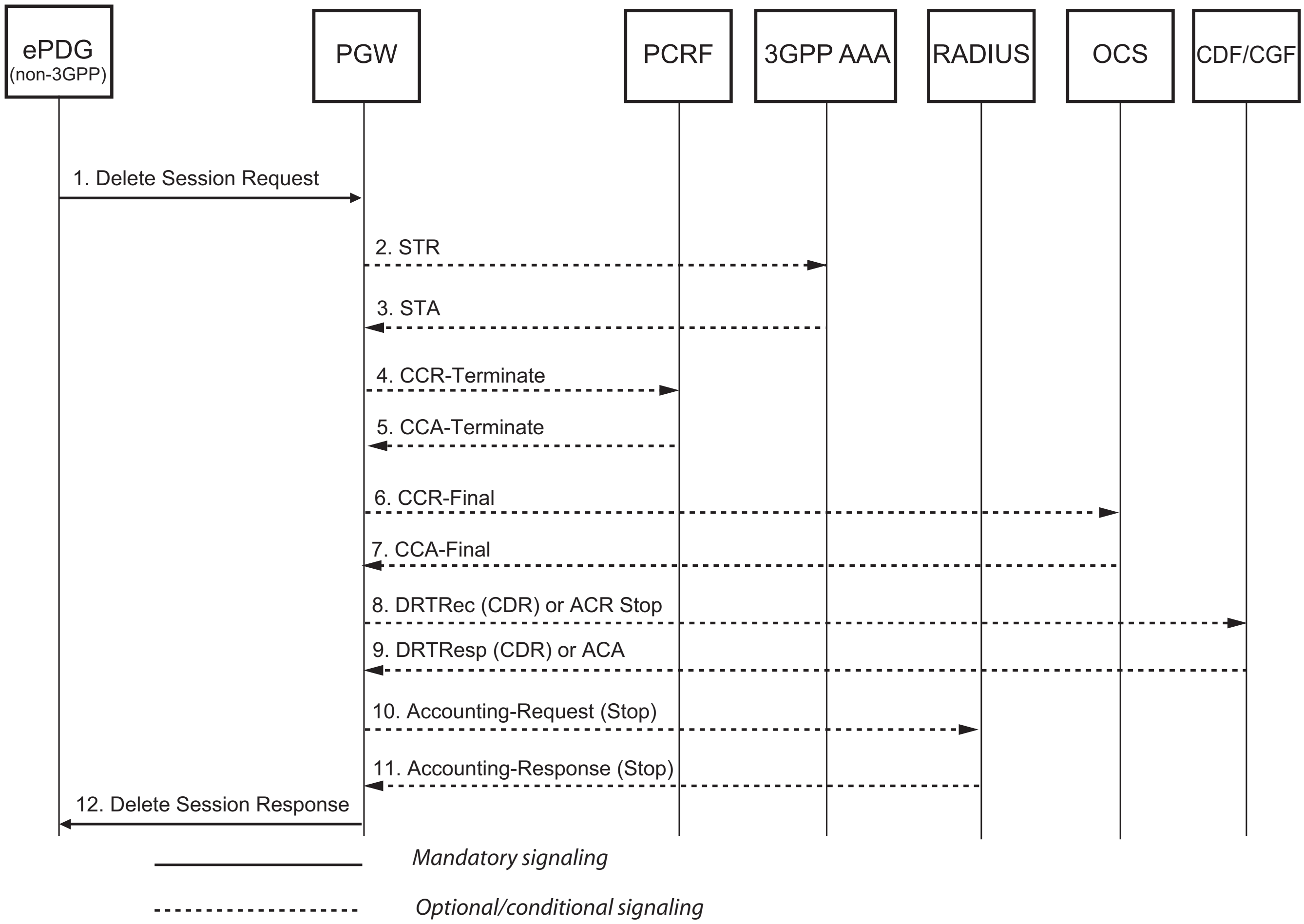

Figure 32 Signalling during the ePDG-Initiated PDN Connection Deletion Procedure

The ePDG-initiated PDN connection deletion procedure involves the following steps:

1. The ePDG sends a `Delete Session Request` message the PGW.

2. The PGW sends an `STR` message to the 3GPP AAA server to terminate the session.

3. The 3GPP AAA server responds with a `STA` message to the PGW.

4. To terminate the Gx+ PCC session, the PGW sends a `CCR-Terminate` message to the PCRF.

5. The PCRF responds with a `CCA-Terminate` message to the PGW.

6. To terminate the credit control session, the PGW sends a `CCR-Final` message to the OCS.

7. The OCS responds with a `CCA-Final` message to the PGW.

8. For CDR charging using GTP', the `Data Record Transfer Request` is sent. For CDR charging using FTP, the PGW closes the CDR and the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer. For Rf charging, the PGW sends an `ACR Stop` message to the CDF.

9. For CDR charging using GTP', the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP. For Rf charging, the CDF responds with an `Accounting Answer (ACA)` message to the PGW.

10. To terminate the accounting session, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server.

11. The RADIUS server responds with an `Accounting-Response` message to the PGW.

12. The PGW sends a `Delete Session Response` message to the ePDG.

The PDN connection is terminated and the GTP-U tunnel is removed.

7.4 PGW-Initiated PDN Connection Deletion

The PGW-initiated PDN disconnection is triggered by any of the following events:

— CLI initiated termination

— Manual APN shutdown

— PCRF initiated IP-CAN session termination procedure with a `RAR` message

The `terminate-idle-session-start` action command can be used to delete only idle sessions on the PGW. For more information on terminating idle sessions see Section 3.12 on page 22.

Figure 33 shows the signalling between the ePDG and the PGW during a PGW-initiated PDN connection deletion procedure.

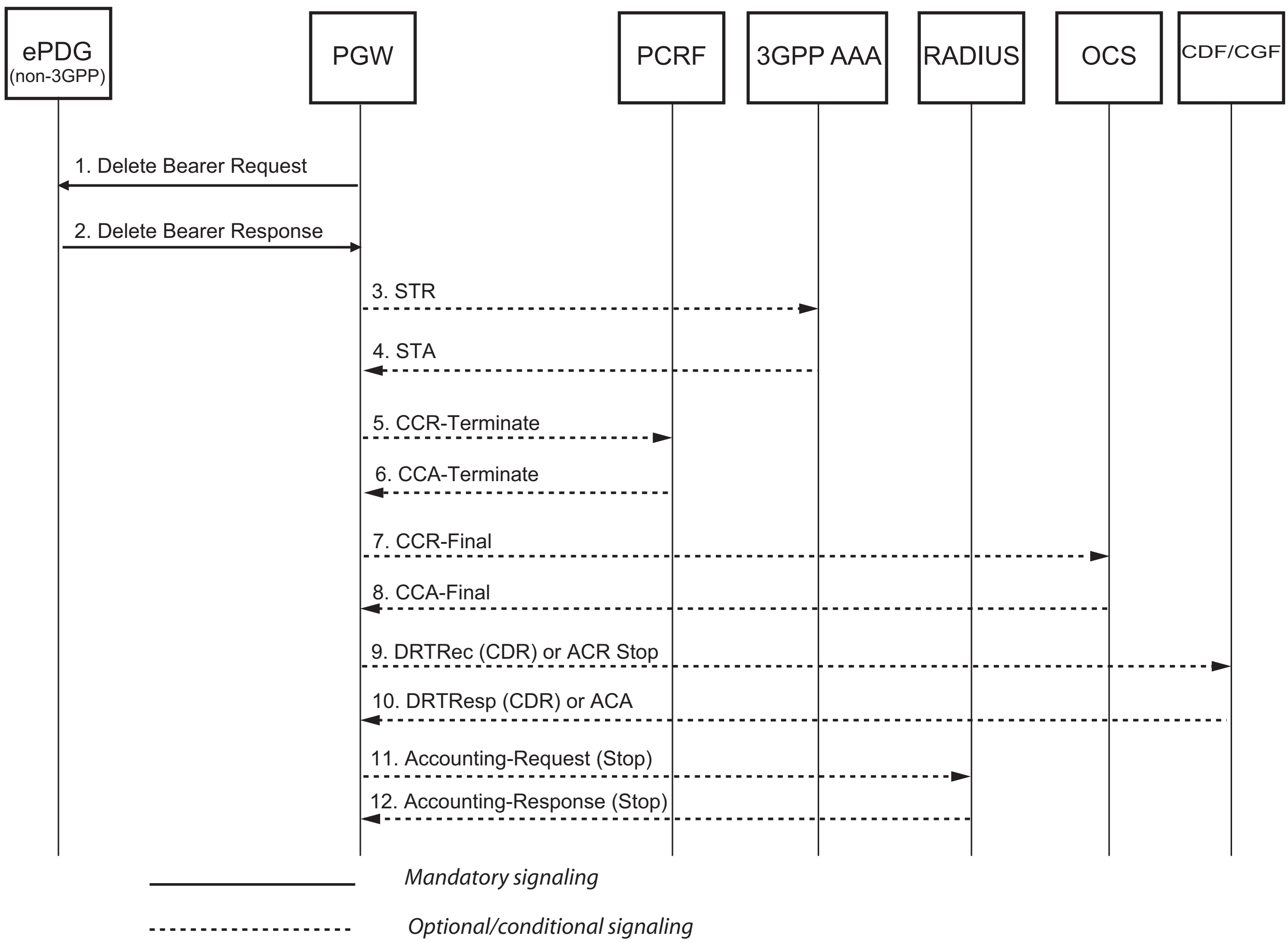

Figure 33 Signalling during the PGW-Initiated PDN Connection Deletion Procedure

The PGW-initiated PDN connection deletion procedure involves the following steps:

1. The PGW receives a trigger to start a PDN disconnection. The PGW sends a `Delete Bearer Request` message to the ePDG.

   Note: For the authenticated emergency session, when the inactivity timer is expired, the session is deleted. Therefore, Ericsson recommends to configure the inactivity timer to a high value to use emergency call in the S2b interface. For information about configuring the inactivity timer, refer to IMS Emergency Session Configuration.

2. The ePDG deletes the bearer contexts related to the `Delete Bearer Request`, and sends a `Delete Bearer Response` to the PGW.

3. The PGW sends an `STR` message to the 3GPP AAA server to terminate the session.

4. The 3GPP AAA server responds with a `STA` message to the PGW.

5. To terminate the Gx+ PCC session, the PGW sends a `CCR-Terminate` message to the PCRF.

6. The PCRF responds with a `CCA-Terminate` message to the PGW.

7. To terminate the credit control session, the PGW sends a `CCR-Final` message to the OCS.

8. The OCS responds with a `CCA-Final` message to the PGW.

9. For CDR charging using GTP', the `Data Record Transfer Request` is sent. For CDR charging using FTP, the PGW closes the CDR and the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer. For Rf charging, the PGW sends an `ACR Stop` message to the CDF.

10. For CDR charging using GTP', the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP. For Rf charging, the CDF responds with an `Accounting Answer (ACA)` message to the PGW.

11. To terminate the accounting session, the PGW sends an `Accounting-Request (Stop)` message to the RADIUS server.

12. The RADIUS server responds with an `Accounting-Response` message to the PGW.

The PDN connection is terminated and the GTP-U tunnel is removed.

8 Session Management over the S11 Interface

Session management over the S11 interfaces is handled through the SGW to the PGW.

The user plane can be established over the following:

— The S1-U interface to the eNodeB.

— The S11-U interface to the MME: When S11-U Control Plane CIoT EPS Optimisation is requested, the MME sends the `S11-U MME F-TEID` and the `S11 Tunnel Flag`.

For information on EPS, refer to Ericsson Packet Core Network Overview.

8.1 PDN Connection Creation

The mandatory signalling in the EPS network during a PDN connection and default bearer creation procedure is shown in Figure 34.

For details on the messages sent between the SGW and the PGW, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

Note: SGW refers to Ericsson SGWs in this document. The behavior can be different in case of an external SGW.

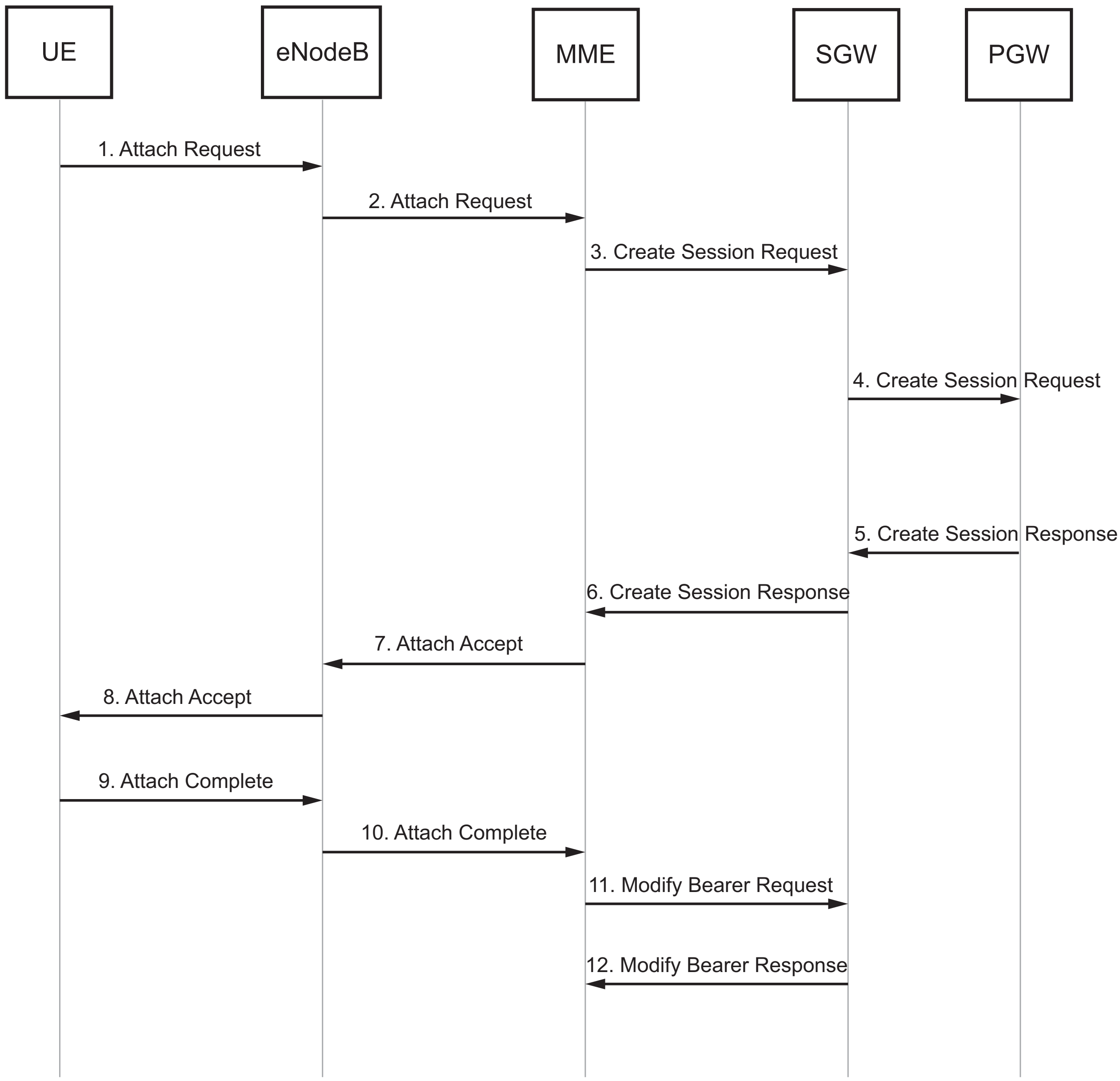

Figure 34 Signalling during the PDN Connection Creation Procedure

The PDN connection creation procedure consists of the following steps:

1. The UE sends an `Attach Request` message to an eNodeB.

2. The eNodeB forwards the `Attach Request` message to an MME.

3. The MME sends a `Create Session Request` message to the SGW. The request includes the IMSI of the UE, the IMEI of the UE, an APN selected by the user or MME, and QoS information. The request also includes the MME TEID for signalling traffic. Optionally, the request includes IPv4 link MTU in the PCO IE received from the UE.

If MME requests the S11-U, then it sends the `S11-U MME F-TEID` and `S11-U Tunnel Flag`. The MME may also add the Control Plane Only PDN Connection Indication (CPOPCI). The SGW records this in its CDRs and forwards it to the PGW.

Note: The UE may perform an emergency attach from an unauthenticated user, so the `Create Session Request` message may include:

— Only IMEI, no IMSI

— IMEI, IMSI and the IMSI Unauthenticated Flag

If the EPG receives a `Create Session Request` with a valid IMSI and an indication flag that is set to unauthenticated, the EPG uses the IMEI as the identifier instead of the IMSI.

If the EPG receives a `Create Session Request` with an IMEI but not an IMSI, then the UE device is allowed to perform an emergency attach.

If the EPG receives a new `Create Session Request` (with TEID `0`) for the same IMEI and EBI, but with an unauthenticated IMSI, then the existing session is removed first.

The SGW allocates S5/S8 F-TEID for the control plane and the user plane.

If configured to perform charging, the SGW also chooses a charging characteristic profile and saves the information necessary for charging generation (such as the IMSI and MSISDN).

Extended PCO Support Indication (EPCOSI) flag is set to 1 on the S11 interface by the MME if the UE and the MME support ePCO.

4. The SGW sends the `Create Session Request` message to the PGW. The request includes PCO or ePCO IE. If the received `Create Session Request` message is in conflict with an existing PDN connection, the SGW sends a `Delete Session Request` message before the `Create Session Request` message to the PGW to terminate the existing session before creating the new session.

   The PGW selects an APN according to Section 3.5.1 on page 13, and performs admission control based on resource availability. The PGW then assigns an IP address to the UE according to the description in Section 3.13 on page 25.

   Communication with an external RADIUS system is possible for RADIUS authentication, end-user IP address allocation, and accounting services. A DHCP server can be used instead of a RADIUS server for the end-user IP address allocation. One or two IP addresses are assigned depending on the PDP type or PDN type.

If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Create Session Request`.

If PGW receives the CPOPCI, then the PGW records this in its CDRs.

If the PGW receives a `Create Session Request` message from an SGW, that conflicts with an existing PDN connection initiated by a different SGW, the PGW sends a `Delete Bearer Request` message to the latter SGW to terminate the existing session, before creating the new session.

EPCOSI flag is set to 1 on the S5/S8 interface by the SGW if the SGW supports ePCO and MME has set the EPCOSI flag to 1.

5. The PGW sends a `Create Session Response` message as a response to the SGW. This step, and Step 4, leads to a GTP-U tunnel establishment in the uplink and downlink directions between the SGW and PGW.

   If configured to perform charging, the SGW updates the information needed for CDRs (such as PDN address and charging ID) and generates an initial charging record. For more information on charging, refer to Offline Charging.

   If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

   If the IPv4 link MTU in PCO IE is requested by the UE, the PGW sends the MTU size based on the following:

   — If an APN MTU size is configured, the PGW sends the configured APN MTU size.

   — If no APN MTU size is configured, the PGW sends the configured PGW MTU size.

   If the PGW supports ePCO and the EPCOSI flag is set to 1 in the `Create Session Request message`, the PGW sends ePCO to the SGW.

6. The SGW responds with a `Create Session Response` message to the MME.

   The response contains the following:

   — The SGW TEID and IP address for uplink signalling traffic on the S11 interface.

   — The assigned end-user IP address.

   — If S11-U was not requested in Step 3, the SGW uplink IP address and the TEID for use on the S1-U interface.

   — If S11-U was requested in Step 3, the SGW does the following:

   - It includes the SGW uplink IP address and the TEID for use on the S11-U interface.
   - If a separate S11-U logical interface is configured and CPOPCI is not included in Step 3, the SGW additionally includes the SGW uplink IP address and the TEID on S1-U interface.
   - The SGW sets up the GTP-U tunnel to the MME and is ready for uplink or downlink payload. In this case, Step 11 and Step 12 are optional.

7. The MME sends an `Attach Accept` message to the eNodeB.
8. The eNodeB forwards the `Attach Accept` message to the UE.
9. The UE sends an `Attach Complete` message to the eNodeB.
10. The eNodeB forwards the `Attach Complete` message to the MME.
11. The MME sends a `Modify Bearer Request` message to the SGW.

    The request contains the IP address and TEID for downlink user payload to the eNodeB.

    The SGW sets up a GTP-U tunnel over the S1-U interface towards the eNodeB, and connects the eNodeB with the internally established GTP tunnel towards the PGW. This enables uplink and downlink data transfer for the PDN connection.
12. The SGW responds with a `Modify Bearer Response` message to the MME.

The UE can now start sending uplink user payload through the eNodeB and the S1-U interface towards the connected PDN, and the EPG can receive downlink user payload from the PGW and forward it through the S1-U interface towards the UE.

8.2 Session Establishment for a Visiting SGW

When the SGW is in the home domain, the PGW handles the charging. However, in roaming cases, when the SGW is in the visiting domain, the S5/S8 interface is used to connect to the home PGW and the visiting SGW generates an SGW-CDR. For more information on SGW-CDRs, refer to CDR Format for the SGW.

The SGW initiates SGW-CDR during the establishment of the session, as described in Section 8.1 on page 93, after the reception of the `Create Session Request` message.

— SGW chooses the Charging Characteristic and charging profile

— SGW saves the information needed for CDR (such as IMSI, MSISDN, Time Zone, ULI)

— SGW allocates S5/S8 F-TEID for the control plane and the user plane

Then, upon receiving the `Create Session Response` message:

— SGW saves the information needed for CDR (such as PDN address, charging ID)

The SGW then creates an SGW-CDR.

8.3 Additional PDN Connection Creation

Signalling during the Additional PDN Connection Creation procedure is shown in Figure 35. This procedure allows UE to request connections to additional PDNs, using the same or different PGWs.

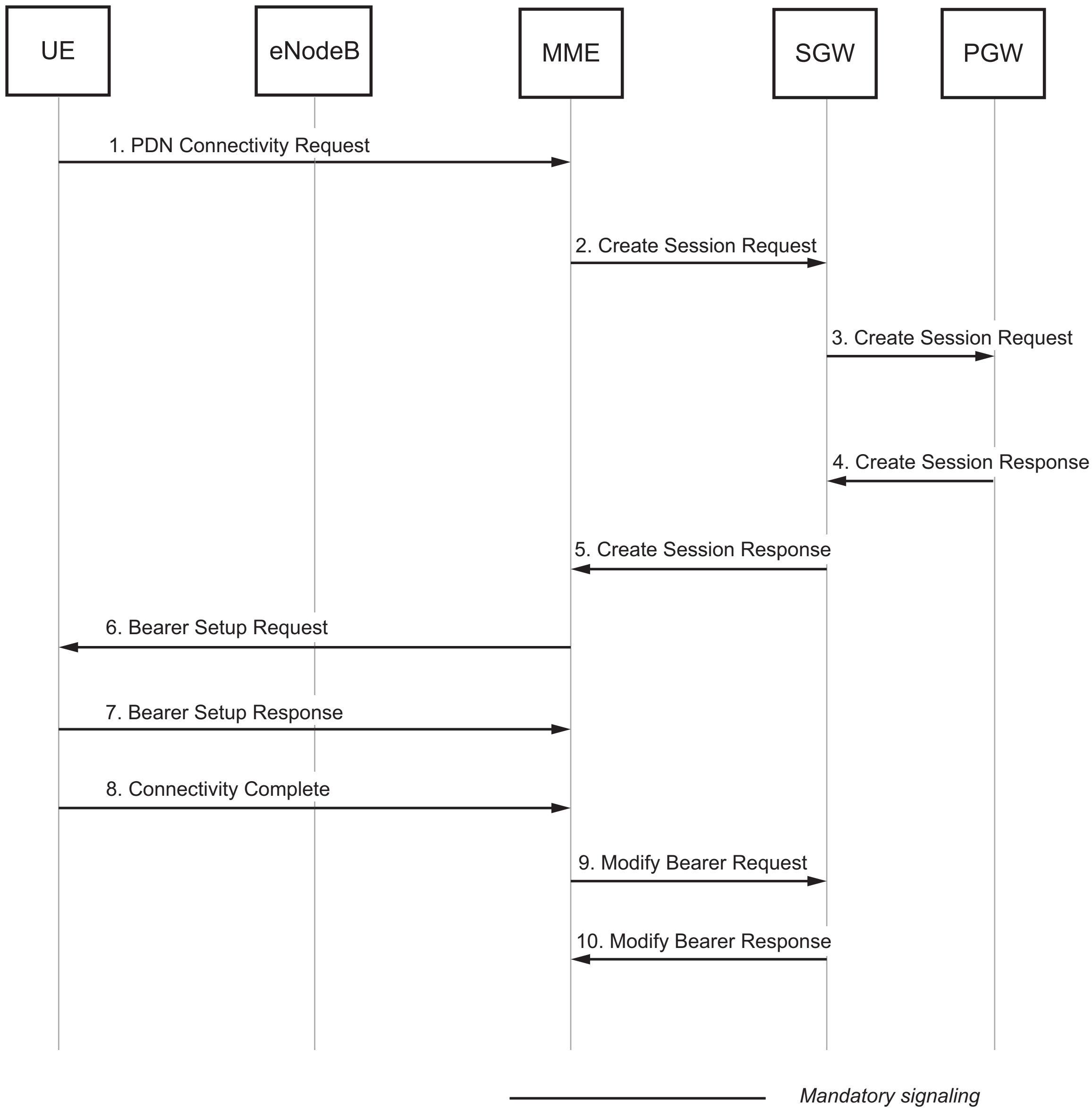

Figure 35 Signalling during the Additional PDN Connection Creation Procedure

The PDN connection creation procedure consists of the following steps:

1. The UE sends an `PDN Connectivity Request` message, containing the requested APN, to the MME.
2. The MME sends a `Create Session Request` message to the SGW.

   The request includes the IMSI of the UE, an APN selected by the user or MME, and QoS information. The request also includes the MME Tunnel Endpoint Identifier (TEID) for signalling traffic.

   The SGW allocates S5/S8 F-TEID for the control plane and the user plane.

   If configured to perform charging, the SGW also chooses a charging characteristic profile and saves the information necessary for charging generation (such as the IMSI and MSISDN).
3. The SGW sends the `Create Session Request` message to the PGW.

   The PGW selects an APN according to Section 3.5.1 on page 13, and performs admission control based on resource availability. The PGW then assigns an IP address to the UE according to the description in Section 3.13 on page 25.

   Communication with an external RADIUS system is possible for RADIUS authentication, end-user IP address allocation, and accounting services. A DHCP server can be used instead of a RADIUS server for the end-user IP address allocation. One or two IP addresses are assigned depending on the PDP type or PDN type.

   If configured to perform PGW Pause Charging, a request to enable the SGW to use PGW Pause charging for the PDN connection is included in the `Create Session Request`.
4. The PGW sends a `Create Session Response` message as a response to the SGW.

   This step, and Step 3, lead to a GTP-U tunnel establishment in the uplink and downlink directions between the SGW and PGW

   If configured to perform charging, the SGW updates the information needed for CDRs (such as PDN address and charging ID) and generates an initial charging record. For more information on charging, refer to Offline Charging.

   If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.
5. The SGW responds with a `Create Session Response` message to the MME.

   The response contains the SGW TEID and IP address for uplink signalling traffic on the S11 interface, the SGW uplink IP address and TEID for use on the S1-U interface, and the assigned end-user IP address.

6. The MME sends a `Bearer Setup Request` to the UE through the eNodeB.

7. The UE sends a `Bearer Setup Response` to the MME through the eNodeB.

8. The UE sends the `PDN Connectivity Complete` message to the MME through the eNodeB.

9. The MME sends a `Modify Bearer Request` message to the SGW.

   The request contains the IP address and TEID for downlink user payload to the SGW.

   The SGW sets up a GTP-U tunnel over the S1-U interface towards the eNodeB, and connects the eNodeB with the internally established GTP tunnel towards the PGW. This enables uplink and downlink data transfer for the PDN connection.

10. The SGW responds with a `Modify Bearer Response` message to the MME.

If the PGW receives a `Create Session Request` message for an existing bearer, the PGW does the following:

1. It buffers the received `Create Session Request` message.

2. It internally deletes the existing bearer or the entire session if it is a default bearer.

3. It creates a new session by handling the buffered `Create Session Request` message.

Note: The existing bearer can only be a Gn/Gp or S5/S8 bearer.

Note: The PGW detects the collision of the incoming request and the existing bearer when both of the following conditions are satisfied:

- The IMSI of the incoming request is equal to the IMSI of the existing bearer.

- The EBI of the incoming request is equal to the EBI or the NSAPI of the existing bearer.

If a `Create Session Request` message is received for an existing bearer while a transaction for the bearer is in progress, the PGW silently discards the request and deletes the bearer corresponding to the existing bearer. The PGW waits for the peer node to retransmit the `Create Session Request` message, and establishes a new PDN connection when it receives the retransmitted message.

The UE can now start sending uplink user payload through the eNodeB and the S1-U interface towards the connected PDN, and the EPG can receive downlink user payload from the PDN and forward it through the S1-U interface towards the UE.

8.4 PDN Connection Modification

This section describes the activation, modification, or deactivation of dedicated bearers

8.4.1 Dedicated Bearer Activation

A default bearer is established during the attach procedure. During this procedure, the UE is assigned IP addresses and packet data resources to communicate with a PDN. Any additional bearer that is established for the same PDN connection is referred to as a dedicated bearer. Dedicated bearers are established with the Dedicated Bearer Activation procedure. Signalling during this procedure is shown in Figure 36.

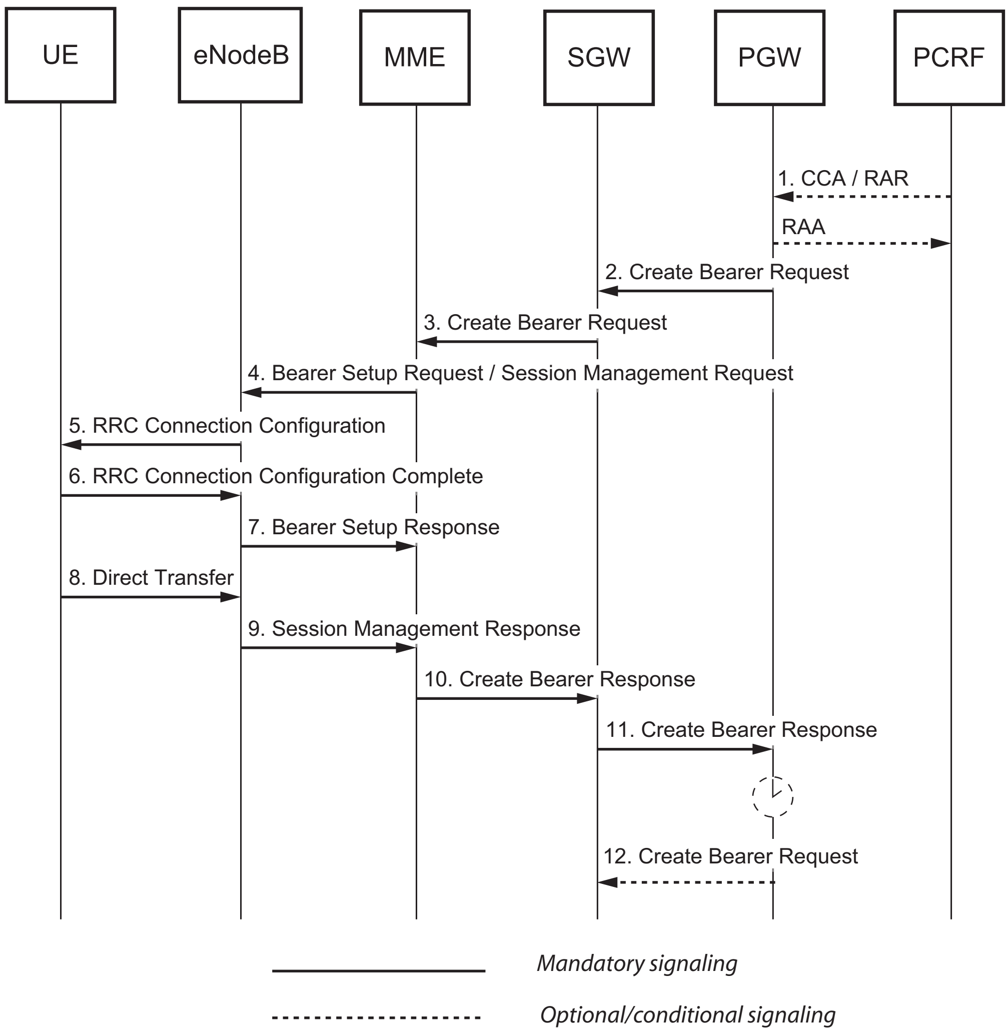

Figure 36 Signalling during a Dedicated Bearer Activation procedure

The dedicated bearer activation procedure consists of the following steps:

1. If Policy and Charging Control (PCC) is deployed the PCRF initiates a PCC Session Modification procedure by sending a `CCA` message with request type Update or a `RAR` message. The message includes the following information:

   — Allocation Retention Priority (ARP)

   — QoS Class Identifier (QCI)

   — If a `RAR` message was sent from the PCRF, the PGW sends a `Re-Authorization Answer` (`RAA`) message to the PCRF.

2. The PGW sends the `Create Bearer Request` message to the SGW including the Linked EPS Bearers ID (LBI), which is the EPS Bearers ID (EBI) for the default bearer.

3. The SGW forwards a `Create Bearer Request` message to the MME. Each dedicated bearer contains the following information:

   — An empty EBI

   — SGW F-TEID over the S1-U interface

   — GTP-U F-TEIDs over the S5/S8 interface

4. The MME sends a `Bearer Setup Request/Session Management Request` message to the eNodeB.

5. The eNodeB forwards the `Non Access Stratum` message in an `RRC Connection Reconfiguration` message to the UE.

6. The UE acknowledges the radio bearer activation with a `RRC Connection Reconfiguration Complete` message to the eNodeB.

7. The eNodeB acknowledges the bearer activation by sending a `Bearer Setup Response` message to the MME.

8. The UE NAS layer builds a `Session Management Response` including EBI. The UE then sends a `Direct Transfer` message to the eNodeB.

9. The eNodeB sends an Uplink NAS Transport `Session Management Response` message to the MME.

10. The MME acknowledges bearer activation by sending a `Create Bearer Response` message to the SGW.

11. The SGW acknowledges the bearer activation by sending a `Create Bearer Response` message to the PGW.

    If configured to perform charging, and if the bearer creation was successful, the SGW begins collecting charging data.

12. If the PGW receives a `Create Bearer Response` message from the SGW, containing cause code 110 (`Temporarily rejected due to handover procedure in progress`), the PGW starts the

temporaryRejectionGuardTimer. When the timer expires, the PGW re-initiates the bearer creation procedure by sending the Create Bearer Request as in Step 2. The number of times the PGW retries the Create Bearer Request message is configurable. For information on how to configure the timer value and the number of retries, refer to GTP Interface Configuration.

Note: The cause code Temporarily rejected due to handover procedure in progress indicates that the MME has temporarily rejected the bearer creation procedure due to an ongoing handover, TAU, or RAU procedure.

The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid message of one of the following messages:

- Delete Session Request
- Modify Bearer Command
- Modify Bearer Request
- Modify Bearer Request for SGW relocation
- Proxy Binding Update for handover to the MAG
- Re-Authorization Request
- Update PDP Context Request for handover to the SGSN

After processing the message, the PGW re-initiates the bearer creation procedure at Step 2, except if the received message was one of the following messages:

- Delete Session Request
- Proxy Binding Update for handover to the MAG
- Re-Authorization Request for removing the PCC rules that triggered the creation procedure
- Update PDP Context Request for handover to the SGSN if the SGSN does not support network-initiated secondary PDP contexts

If the PGW has not reached the maximum number of retry times, the PGW ignores the Access Network Information report parameters (ULI and UE Time Zone) in the Create Bearer Response message which contains the cause code Temporarily rejected due to handover procedure in progress even if NetLoc is enabled on the EPG. For more information about NetLoc, refer to Policy Control.

8.4.2 Bearer Modification

A bearer modification procedure is used in cases when different bearer parameters need to be modified. Parameters can be modified, for instance, as a result of handover from GSM and WCDMA networks to LTE.

8.4.2.1 Bearer Modification Without Bearer QoS Update

Bearer modification without bearer QoS update is used to update the Traffic Flow Template (TFT) for dedicated bearer, or to modify the APN-AMBR. Signalling during a bearer modification procedure without bearer QoS update is shown in Figure 37.

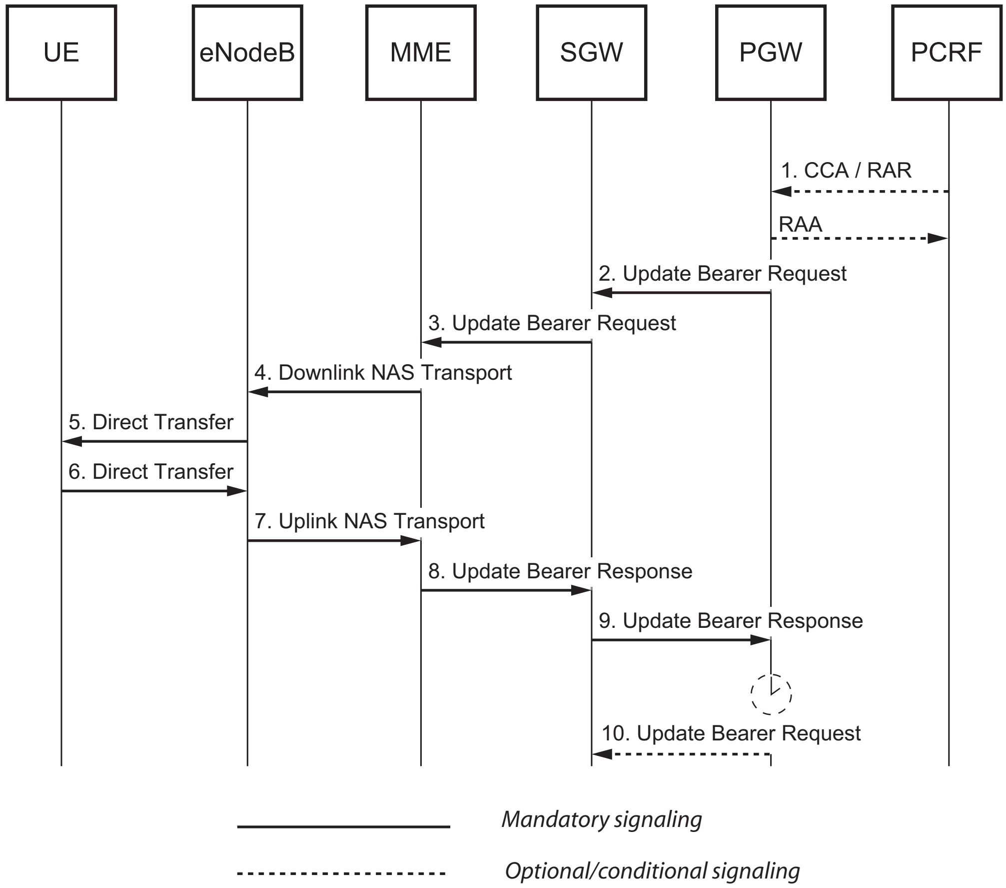

Figure 37 Signalling during a bearer modification procedure without bearer QoS Update

A bearer modification procedure without bearer QoS update involves the following steps:

1. The PCRF initiates a PCC session modification procedure by sending a `CCA` message with request type Update or an `RAR` message.

— If an RAR message is sent from the PCRF, the PGW applies the policy decision included in the message. The PGW responds with an RAA message to the PCRF.

2. The PGW sends an `Update Bearer Request` message to the SGW. This message includes the following information:

   — EBI for the bearer to be modified

   — TFT

   — APN-AMBR

     • LBI

3. The SGW forwards the `Update Bearer Request` message to the MME.

4. The MME sends a `Downlink NAS Transport` message to the eNodeB.

5. The eNodeB forwards the NAS message in a `Direct Transfer`message to the UE.

6. The UE responds with a `Direct Transfer` message to the eNodeB.

7. The eNodeB acknowledges the update with an `Uplink NAS Transport` message to the MME.

8. The MME acknowledges the bearer modification by sending an `Update Bearer Response` message to the SGW.

9. The SGW forwards the bearer modification with an `Update Bearer Response` message to the PGW.

10. If the PGW receives an `Update Bearer Response` from the SGW with a `Cause value` of 110 in the `Cause` IE, the PGW starts the `temporary-rejection-guard-timer` timer. After the timer expires, the PGW re-initiates the bearer modification procedure by sending the `Update Bearer Request` as in Step 2. The number of times the PGW retries the `Update Bearer Request` message is also configurable in the PGW. For information on configuring the timer and number of retries, refer to GTP Interface Configuration.

    The `Cause` IE in the response message indicates the acceptance, or the reason for rejection of the corresponding request message.

Note: A Cause value of 110 indicates that the MME has temporarily rejected the bearer modification procedure due to an ongoing handover, Tracking Area Update (TAU), or Routing Area Update (RAU) procedure.

The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid Modify Bearer Request or Modify Bearer Command and after processing the message the PGW re-initiates the bearer modification procedure at step 2.

The PGW ignores the Access Network Information report parameters (ULI and UE Time Zone) in the Update Bearer Response message which contains a Cause value 110 even if NetLoc is enabled on the EPG. For detailed information about NetLoc, refer to Policy Control.

8.4.2.2 Bearer Modification With Bearer QoS Update

Bearer modification with bearer QoS Update is used to update the QoS parameters for an active default or dedicated bearer. Signalling during a bearer modification procedure with bearer QoS update is shown in Figure 38.

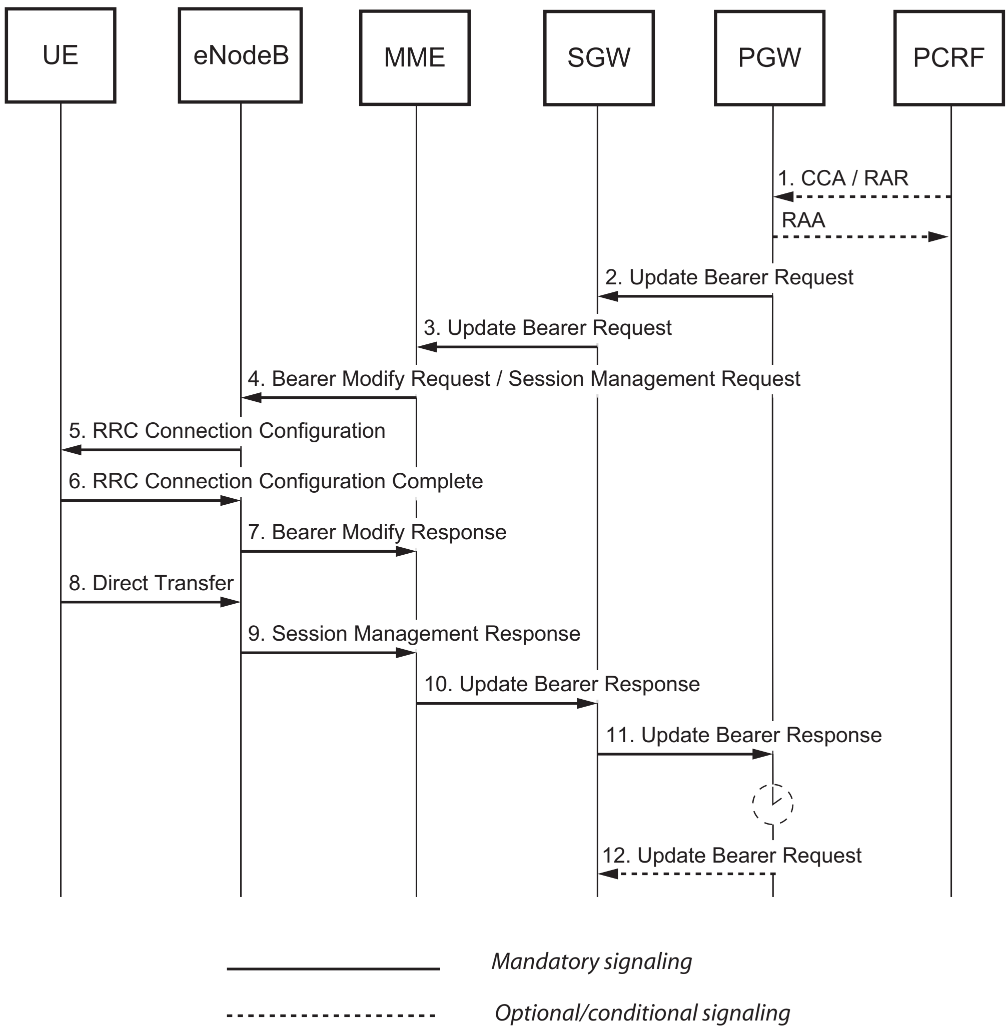

Figure 38 Signalling during a bearer modification procedure with bearer QoS update

A bearer modification procedure with bearer QoS update involves the following steps:

1. The PCRF initiates a PCC session modification procedure by sending a `CCA` message with request type Update or a `RAR` message. The message includes the following information:

   — TFT

   — APN-AMBR

   — If a `RAR` message was sent from the PCRF, the PGW applies the policy decision included in the message. The PGW responds with a `RAA` message to the PCRF.

2. The PGW sends an `Update Bearer Request` message to the SGW. This message includes the new QoS parameter and includes the following information:

- EBI for the bearer to be modified
- EPS Bearer QoS
- TFT
- APN-AMBR

3. The SGW forwards the `Update Bearer Request` message to the MME.
4. The MME and sends a `Downlink NAS Transport` message to the eNodeB.
5. The eNodeB forwards the NAS message in a `RRC Connection Reconfiguration` message to the UE.
6. The UE responds with a `RRC Connection Reconfiguration Complete` message to the eNodeB.
7. The eNodeB acknowledges the update with a `Bearer Modify Response` message to the MME.
8. The UE NAS layer builds a session management response and sends `Direct Transfer` message to the eNodeB.
9. The eNodeB sends the `Session Management Response` message to the MME.
10. The MME acknowledges the bearer modification by sending an `Update Bearer Response` message to the SGW.
11. The SGW forwards the bearer modification with an `Update Bearer Response` message to the PGW.
12. If the PGW receives an `Update Bearer Response` from the SGW with a `Cause value` of `110` in the `Cause` IE, the PGW starts the `temporary-rejection-guard-timer` timer. After the timer expires, the PGW re-initiates the bearer modification procedure by sending the `Update Bearer Request` as in Step 2. The number of times the PGW retries the `Update Bearer Request` message is also configurable in the PGW. For information on configuring the timer and number of retries, refer to GTP Interface Configuration.

    Note: A `Cause value` of `110` indicates that the MME has temporarily rejected the bearer modification procedure due to an ongoing handover, TAU, or RAU procedure.

    The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid `Modify Bearer Request` or `Modify Bearer Command` and after processing the message the PGW re-initiates the bearer modification procedure at step 2.

The PGW ignores the Access Network Information report parameters (ULI and UE Time Zone) in the `Update Bearer Response` message which contains a Cause value 110 even if NetLoc is enabled on the EPG. For detailed information about NetLoc, refer to Policy Control.

8.4.2.3 Intruding Signal

If the PGW is waiting to receive an Update Bearer Response message, but receives a Delete Session Request message, the PGW prioritizes Delete Session Request without waiting for the Update Bearer Response.

If the PGW is waiting to receive an Update Bearer Response message, but receives a Create Session Request message, the PGW prioritizes Create Session Request without waiting for the Update Bearer Response.

If the PGW is waiting to receive an Update Bearer Response message, but receives a Create PDP Context Request message, the PGW prioritizes Create PDP Context Request without waiting for the Update Bearer Response.

Note: If the EPG receives an Update Bearer Response for the aborted procedure, the EPG ignores that response.

8.4.3 Bearer Deletion

Bearer deletion can be initiated by the PGW or the MME. Dedicated bearers are activated and deactivated depending on the service that is used. This section describes procedures that are involved during bearer deletion.

8.4.3.1 MME-Initiated Dedicated Bearer Deactivation

This section describes the MME-initiated deactivation of dedicated bearers. Signalling during this procedure is shown in Figure 39.

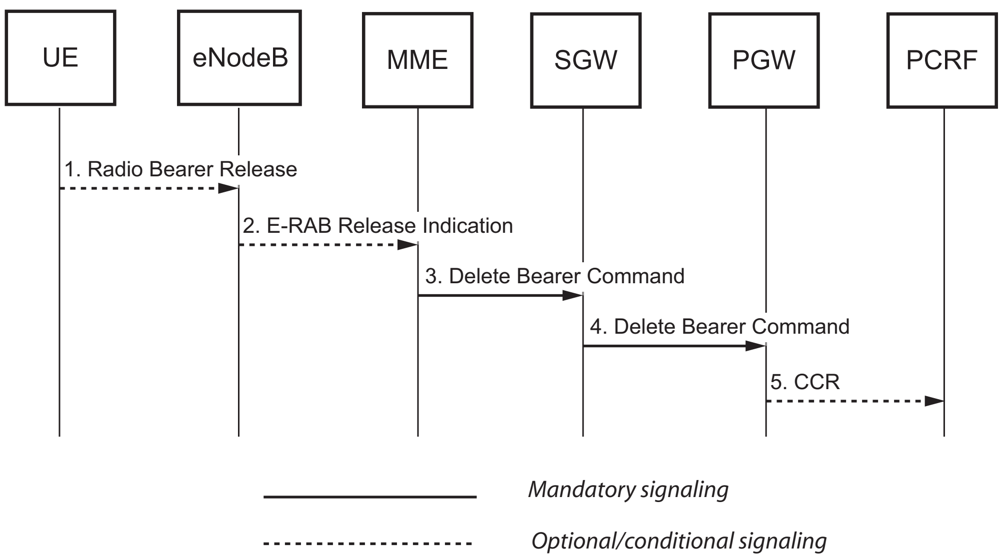

Figure 39 Signalling during an MME-initiated Dedicated Bearer Deactivation procedure

1. The UE deletes the bearer contexts related to the released radio bearers. An MME initiated detach request triggers paging when the UE is in idle state.

2. When the eNodeB releases radio bearers it sends an indication of bearer release to the MME.

3. The MME sends the `Delete Bearer Command` message to the SGW.

4. The SGW forwards the `Delete Bearer Command` message to the PGW.

   If configured to perform charging, the SGW closes the final charging record.

5. The PGW sends a `CCR` message with request type Update to the PCRF.

This procedure triggers the PGW initiated Bearer Deletion procedure. For more information, see Section 8.4.3.2 on page 110.

8.4.3.2 PGW-Initiated Bearer Deletion

This section describes PGW-initiated deletion of default and dedicated bearers. Signalling during this procedure is shown in Figure 40.

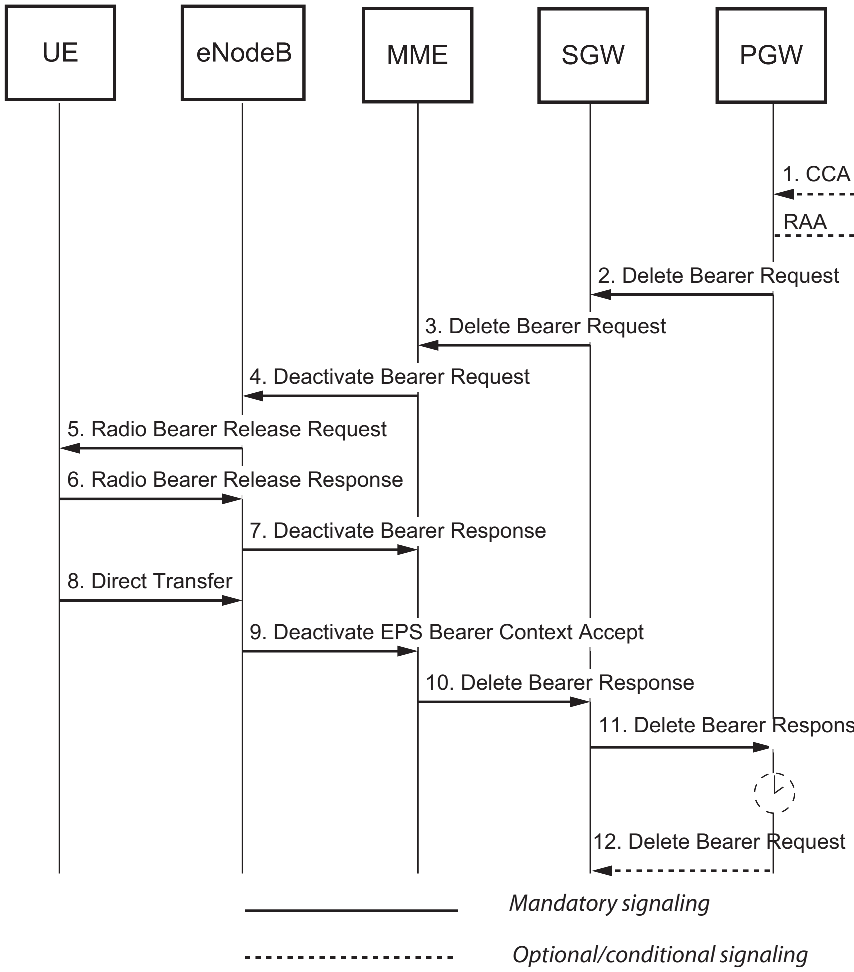

Figure 40 Signalling during a PGW-initiated Bearer Deletion procedure

1. If PCC is deployed, the PCRF initiates a PCC session modification procedure by sending a `CCA` message with request type Update or an `RAR` message to the PGW.

   — If an `RAR` message was sent from the PCRF, the PGW applies the policy decision included in the message, and responds with an `RAA` message to the PCRF.

2. The PGW sends a `Delete Bearer Request` message to the SGW, including one or more EBIs for the bearers to be deleted.

3. The SGW forwards the `Delete Bearer Request` message to the MME.

4. The MME sends a `Deactivate Bearer Request` message to the eNodeB.

5. The eNodeB forwards the NAS message to the UE in the `Radio Bearer Release Request` message.

6. The UE sends the `Radio Bearer Release Response` message to the eNodeB.

7. The eNodeB acknowledges the bearer deactivation and sends the `Deactivate Bearer Response` message to the MME.

8. The UE NAS layer builds a `Deactivate EPS Bearer Context Accept` message including EBI. The UE then sends a `Direct Transfer` message to the eNodeB.

9. The eNodeB sends an `Uplink NAS Transport Deactivate EPS Bearer Context Accept` message to the MME.

10. The MME acknowledges the bearer deactivation by sending a `Delete Bearer Response` message to the SGW.

11. The SGW forwards the `Delete Bearer Response` message to the PGW.

12. If the PGW receives a `Delete Bearer Response` from the SGW with a `Cause value of 110` in the `Cause IE`, the PGW starts the `temporary-rejection-guard-timer`.

    The PGW sets the locally configured Guard Timer and makes a new attempt when the timer elapses. The PGW re-initiates this procedure by sending the `Delete Bearer Request` as in Step 2 with a new GTP Sequence Number.

    The number of times the PGW retries the `Delete Bearer Request` can be configured in the PGW. For more information on configuring the timer and number of retries, refer to GTP Interface Configuration.

    Due to the mobility procedure, the second `Delete Bearer Request` might address a new node.

    A Cause value of 110 indicates that the MME/S4-SGSN has temporarily rejected the bearer deletion procedure due to an ongoing hand over, TAU, or RAU procedure.

    The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid interfering message of following type:

    — Modify Bearer Request

    — Delete Bearer Command

    — Create Session Request

    — Update PDP Context Request

    — Delete Session Request

Note: The PGW removes the charging rules before sending the `Delete Bearer Request`, which results in following:

— The uplink payload received on the bearer will be dropped

— The downlink payload will be dropped unless it matches with other installed charging rule. In that case it will be forwarded on the bearer associated with that charging rule

8.5 HSS-Initiated Subscribed QoS Modification

This section describes the HSS-initiated subscribed QoS modification. Signalling during this procedure is shown in Figure 41.

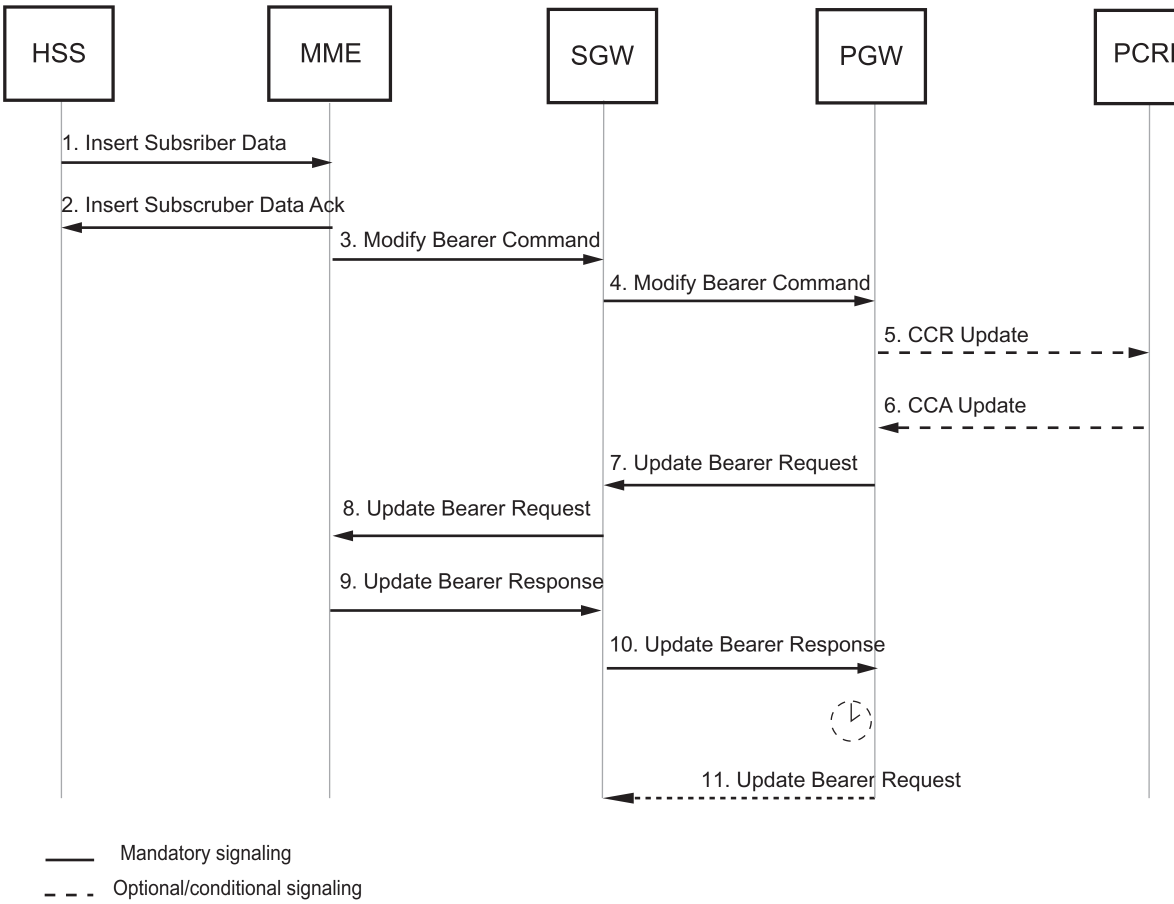

Figure 41 Signalling during an HSS-Initiated Subscribed QoS Modification Procedure

1. The HSS sends an `Insert Subscriber Data` message to the MME. This message contains the subscription data, including EPS bearer QoS and subscribed APN-AMBR.

2. The MME updated the subscription data and then responds with an `Insert Subscriber Data Ack` message to the HSS.

3. If the `Bearer Level QoS`, or the subscribed `APN-AMBR`, or both are updated, the MME sends a `Modify Bearer Command` message for each PDN connection to the SGW.

4. The SGW forwards the `Modify Bearer Command` message to the PGW.

5. If Gx is enabled and the `QOS_CHANGE` event trigger is subscribed and matched, the PGW performs admission control and sends a `CCR Update` message to the PCRF.

6. As a response to the `CCR Update` message, the PCRF sends a `CCA Update` message to the PGW.

7. As the response to each `Modify Bearer Command` message, the PGW sends an `Update Bearer Request` message to the SGW with the selected `APN-AMBR` and the `Bearer Level QoS`. The `Bearer Level QoS` is only present when it is different from the previously-authorized `Bearer Level QoS`.

8. The SGW forwards the `Update Bearer Request` message to the MME.

9. The MME responds with an `Update Bearer Response` message to the SGW.

10. The SGW forwards the `Update Bearer Response` message to the PGW.

11. If the PGW receives an `Update Bearer Response` from the SGW with a `Cause value` of 110 in the `Cause` IE, the PGW starts the `temporary-rejection-guard-timer` timer. After the timer expires, the PGW resends the `Update Bearer Request` message.. The number of times the PGW retries the `Update Bearer Request` message is configurable in the PGW. For information on configuring the timer and number of retries, refer to GTP Interface Configuration.

    The `Cause` IE in the response message indicates the acceptance, or the reason for rejection of the corresponding request message.

    Note: A `Cause value` of 110 indicates that the MME has temporarily rejected the bearer modification procedure due to an ongoing handover, Tracking Area Update (TAU), or Routing Area Update (RAU) procedure.

    The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid `Modify Bearer Request` or `Modify Bearer Command` and after processing the message the PGW re-initiates the bearer modification procedure at step 2.

8.6 S1 and S11-U Release

The signalling when the UE switches from connected to idle state is shown in Figure 42.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

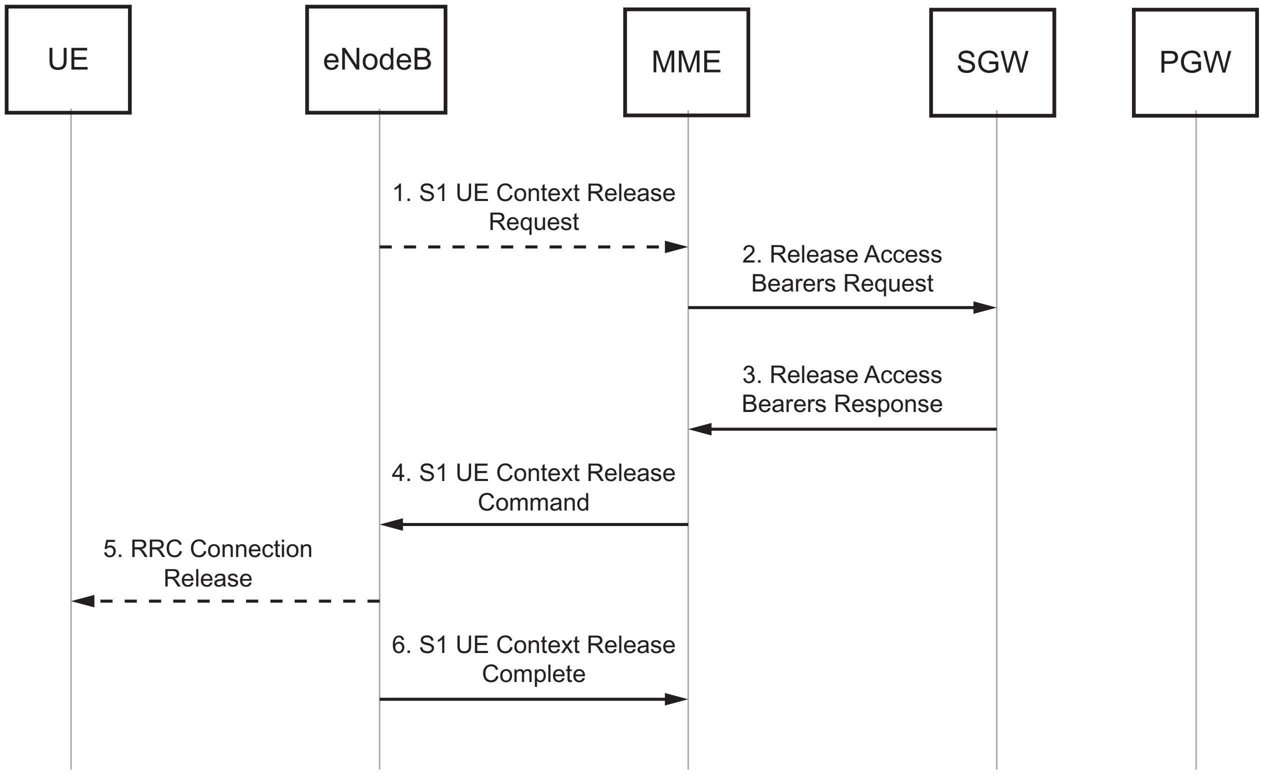

Figure 42 Signalling during the S1 Release Procedure

Note: The same procedure is used by MME and SGW to release the S11-U downlink GTP-U tunnels.

The S1 release procedure consists of the following steps:

1. If the release is initiated by the eNodeB, the eNodeB sends an `S1 UE Context Release Request` message to the MME.
2. The MME sends a `Release Access Bearers Request` message to the SGW.

   The SGW releases all the downlink GTP-U tunnels to the eNodeB or MME when S11-U is used and starts buffering user traffic directed to the idle UE.
3. The SGW responds with a `Release Access Bearers Response` message to the MME.
4. The MME releases the S1 interface by sending an `S1 UE Context Release Command` message to the eNodeB.
5. If the Radio Resource Control (RRC) connection is not already released, the eNodeB sends an `RRC Connection Release` message to the UE in acknowledged mode. This leads to release of radio bearers between the UE and eNodeB.
6. The eNodeB confirms the S1 Release by returning an `S1 UE Context Release Complete` message to the MME.

8.7 Service Request

This section describes the procedures that cause the UE to switch from the idle to the connected state.

8.7.1 UE-Triggered Service Request

The signalling when the UE switches from idle to connected state is shown in Figure 43.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

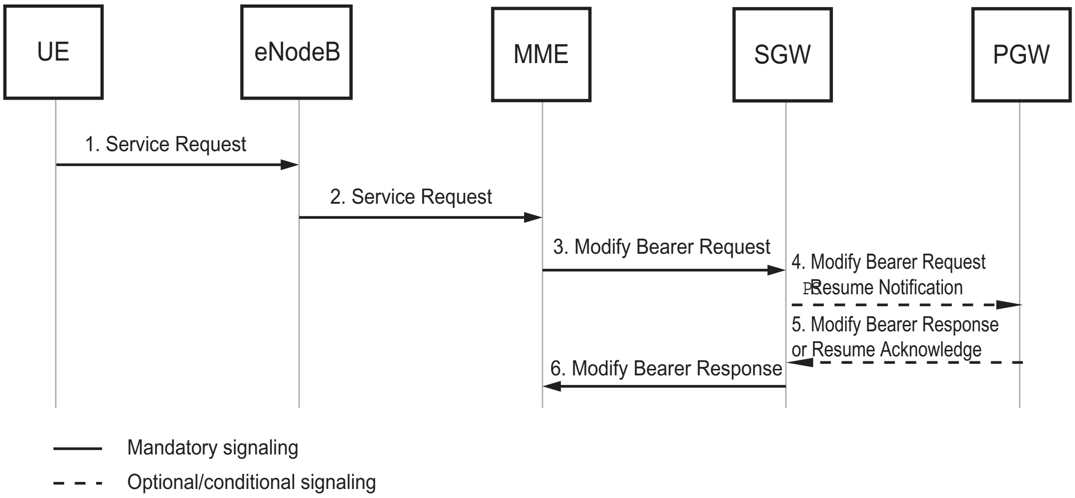

Figure 43 Signalling during the UE-Triggered Service Request Procedure

The UE-triggered service request procedure consists of the following steps:

1. The UE sends a `Service Request` message to the eNodeB.

2. The eNodeB forwards the `Service Request` message to the MME, which returns the SGW IP address and TEID or the MME IP address and TEID if Control Plane CIoT Optimisation is used.. The IP address and TEID are used by the eNodeB for uplink user payload towards the SGW or MME. The eNodeB also establishes the radio bearer between the UE and the eNodeB.

3. The MME sends one `Modify Bearer Request` message per PDN connection to the SGW. The message contains the IP address and TEID for downlink user payload to the eNodeB or MME for the EPS bearer to be modified. The SGW uses this information to establish or re-establish the GTP-U tunnel towards the eNodeB or MME.

   When MME requests the S11-U, it will send its `S11-U F-TEID` and the `S11-U Tunnel Flag`, else it will send the `S1-U eNodeB F-TEID`.

Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

4. The SGW forwards the `Modify Bearer Request` message to the PGW in cases, for example, the ULI is included in the message. If there is no need to send the `Modify Bearer Request` message and the PDN connection is in the Suspended state, the SGW sends the `Resume Notification` message to the PGW.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling, refer to GTP Interface Configuration.

5. The PGW responds with a `Modify Bearer Response` or `Resume Acknowledge` message to the SGW.

6. The SGW responds with a `Modify Bearer Response` message to the MME. Depending if the MME requested the S11-U or S1-U in step 3 the SGW will send `S11-U F-TEID` or `S1-U F-TEID` to the MME.. The uplink and downlink data transfer for the PDN connection is now re-enabled. If the PDN connection is in the suspended state, the SGW resumes the PDN connection.

   Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

8.7.2 Network-Triggered Service Request

The signalling when the network is paging the UE to switch from the idle to connected state is shown in Figure 44.

For details on the messages sent between the MME and SGW, refer to S11 Interface Description.

If the EPG acts as a combined SGW and PGW, the SGW and the PGW communicate over an internal interface.

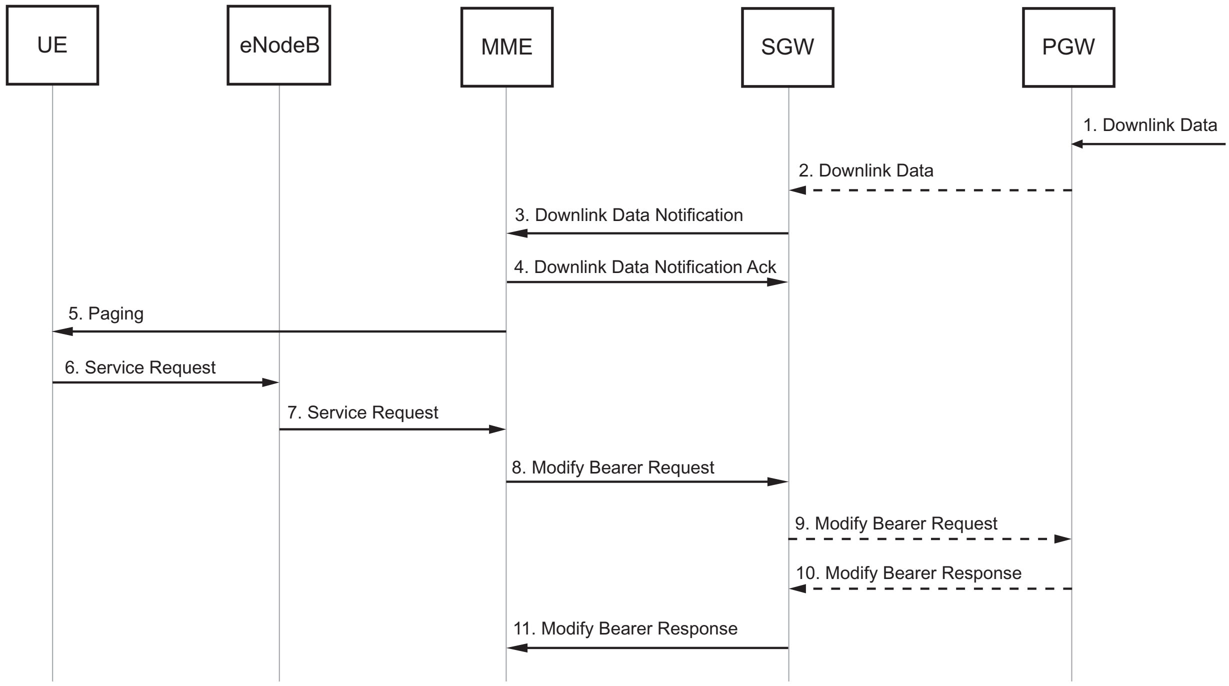

Figure 44 Signalling during the Network-Triggered Service Request Procedure

The network-triggered service request procedure consists of the following steps:

1. The PGW receives downlink data from a PDN sent to the UE in idle state.
2. The PGW forwards the data to the SGW.

   The SGW buffers the downlink data for the established PDN connection, and identifies the MME serving the UE.
3. The SGW sends a `Downlink Data Notification` message to the MME.
4. The MME responds with a `Downlink Data Notification Acknowledge` message to the SGW.

Note: For UEs in Extended Discontinuous Reception (eDRX) or Power Saving Mode (PSM), the MME calculates and sends the `DL Buffering Duration` IE and the optional `DL Buffering Suggested Packet Count` IE in a `Downlink Data Notification Acknowledge` message to the SGW. The SGW stores a new value for the `DL Data Buffer Expiration Time` based on the `DL Buffering Duration`. The SGW does not send `Downlink Data Notification` messages during the `DL Buffering Duration`.

The SGW buffers downlink packet according to the `DL Buffering Suggested Packet Count` IE if this IE is included. A maximum of 512 packets per bearer can be buffered per bearer. For more information about the packet buffering capacity, refer to EPG Characteristics.

When the `DL Buffering Duration` IE is set to infinity and the `DL Buffering Suggested Packet Count` IE is set to `0`, the SGW does not trigger the `Downlink Data Notification` message to MME anymore. The SGW clears the buffered payload and discards all new incoming payload.

5. The MME starts paging the UE.

6. The UE responds to the paging and sends a service request to the eNodeB.

7. The eNodeB forwards the service request to the MME, which returns the SGW IP address and TEID or the MME IP address and TEID, if the Control Plane CIoT Optimisation is used. These are used by the eNodeB for uplink user payload towards the SGW or MME. The eNodeB also establishes the radio bearer between the UE and eNodeB.

8. The MME sends a `Modify Bearer Request` message, per PDN connection to the SGW. The message contains the IP address and TEID for downlink user payload to the eNodeB or MME for the EPS bearer to be modified. SGW uses this information to establish or to re-establish the GTP-U tunnel towards the eNodeB or MME.

   When MME requests the S11-U, it sends its `S11-U F-TEID` and the `S11-U Tunnel Flag`, else it will send the `S1-U eNodeB F-TEID`.

   Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

9. The SGW forwards the `Modify Bearer Request` message to the PGW in cases, for example, the ULI is included in the message.

Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

10. The PGW responds with a `Modify Bearer Response` message to the SGW.

11. The SGW responds with a `Modify Bearer Response` message to the MME.

    If `S11 Tunnel Flag` is included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S11-U F-TEID`.

    If `S11 Tunnel Flag` is not included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S1-U F-TEID`.

    Depending on this the uplink and downlink data transfer for the PDN connection is now re-enabled.

    Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

8.8 Establishing S1-U while S11-U Is Being Used

Both the UE and the MME can initiate the procedure to establish the session with the S1-U interface while S11-U interface is being used. The UE is connected and the data is transferred between the MME and SGW using the S11-U interface.

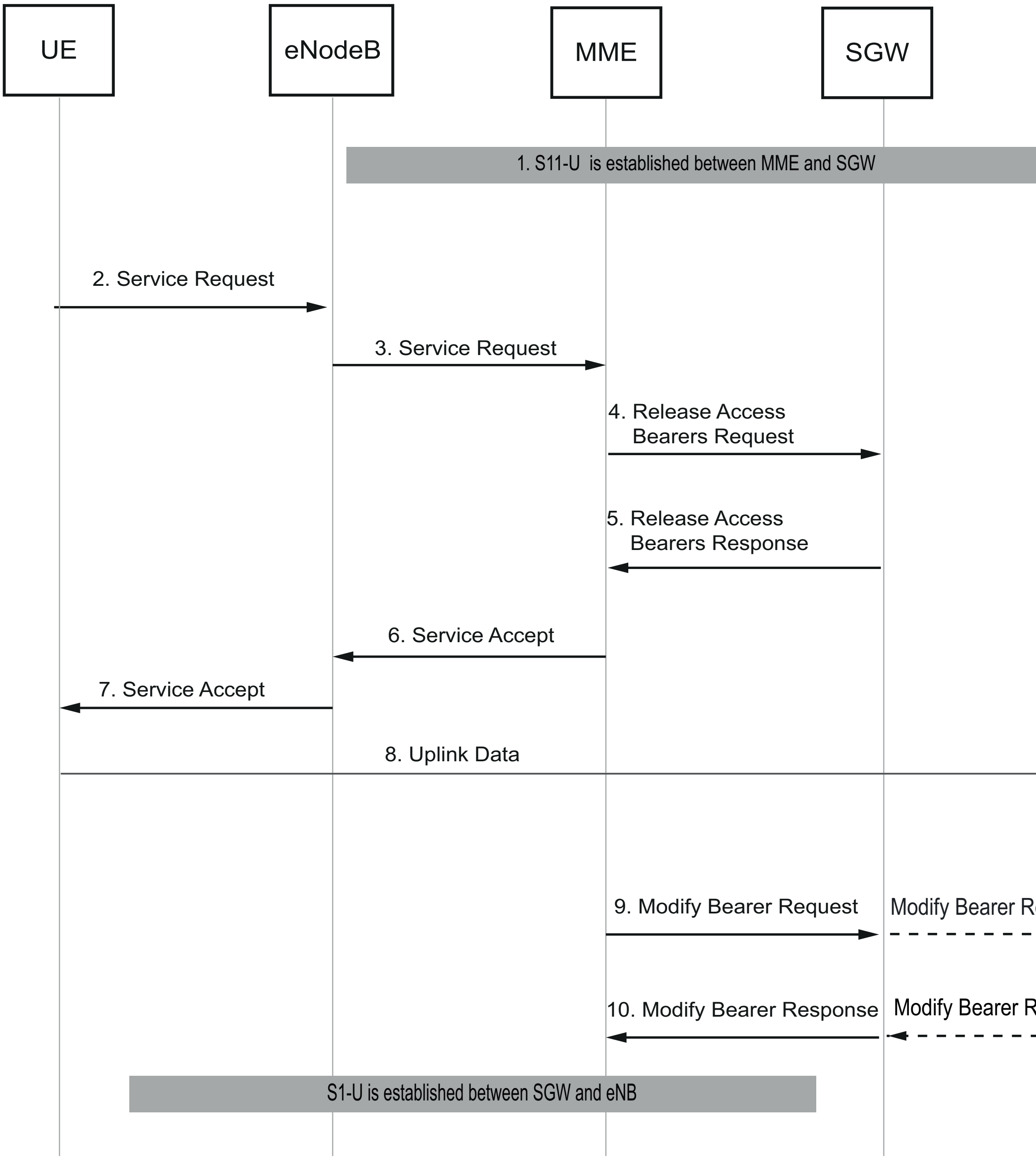

Figure 45 Establishing the S1-U Interface while S11-U Interface Is Being Used.

The procedure of establishing the S1-U while S11-U is in use consists of the following steps:

1. The UE sends and the data over the eNodeB.

2. The UE sends a `Service Request` message to the eNodeB.

3. The eNodeB forwards the `Service Request` message to the MME.

Note: If MME initiates the procedure then step 2 and step 3 are not used.

4. The MME sends a `Release Access Bearers Request` message to the SGW.

   The MME can alternatively send a `Modify Bearer Request` containing the `S1-U F-TEID` to the eNodeB for the EPS bearer to be modified as described in step 9.

   The SGW releases the S11-U bearer and responds with `Modify Bearer Response` message containing the `S1-U F-TEID`. The uplink and downlink transfer is established through the S1-U.

5. The SGW responds with a `Release Access Bearers Response` and releases all the downlink GTP-U tunnels and starts buffering the downlink data.

   The downlink data triggers the Network Triggered Service Request procedure.

   For more information, see Section Network-Triggered Service Request.

6. The MME sends the SGW IP address and the TEID to the eNodeB. The SGW IP address and the TEID are used by the eNodeB for uplink user payload toward the SGW.

7. The eNodeB also establishes the radio bearer between the UE and the eNodeB.

8. The UE sends the uplink data through the eNodeB, the SGW, and the PGW.

9. The MME sends one `Modify Bearer Request` message per PDN connection to the SGW. The message contains the IP address and the TEID for downlink user payload to the eNodeB for the EPS bearer to be modified. The SGW uses this information to establish the GTP-U tunnel toward the eNodeB.

   Note: The MME may send a `Modify Access Bearers Request` message to the SGW. The `Modify Access Bearers Request` messages are sent according to the standards described in 3GPP TS.23.401 and 3GPP TS 29.274.

   If the SGW has PGW pause charging activated, then SGW sends a `Modify Bearer Request` to deactivate PGW pause charging on the PDN connection, and to resume charging the PGW. The PGW responds with a `Modify Bearer Response` and informs the SGW that pause charging was deactivated by the PGW.

10. The SGW responds to the MME with a `Modify Bearer Response` message containing the `S1-U F-TEID`. The downlink data transfer for the PDN connection is re-enabled.

8.9 Non-IP PDN Connection Creation

The signalling of the non-IP PDN connection creation procedure is shown in Figure 46.

For details on the messages sent between the SGW and the PGW, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

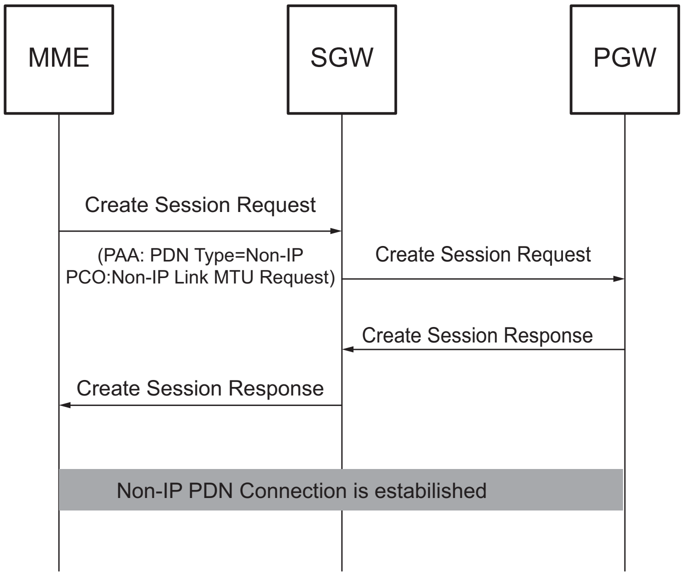

Figure 46 Non-IP PDN Connection Creation

The Non-IP PDN connection creation procedure consists of the following steps. The UE requests a session with PDN-Type: Non-IP.

1. The MME sends the `Create Session Request` message to the SGW.

2. The SGW forwards the `Create Session Request` message to the PGW.

   Depending on the APN configuration, the PGW allocates an IPv4 or IPv6 address to the session which is used as the end point for the IP tunnel to the Application Server on the Gi/SGi interfaces.

   For more details on APN configuration, refer to APN Configuration.

3. The PGW responds to the UE with a `Create Session Response` message.

   Note: The PAA IE does not include the PDN address. The SGW and PGW use the PDN Type in the PAA IE as the correct value. The PGW cannot change the PDN type.

4. The SGW forwards the `Create Session Response` to the MME.

   The SGW releases and sets up the user plane tunnels towards MME as in the normal S1-U procedure.

8.10 PDN Connection Termination

This section describes the procedures that terminate PDN connections.

8.10.1 Detach or PDN Disconnection

The detach and PDN disconnection procedures can be initiated by any of the following:

- The UE
- The MME/S4-SGSN
- The HSS

The signalling is described in Figure 47.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

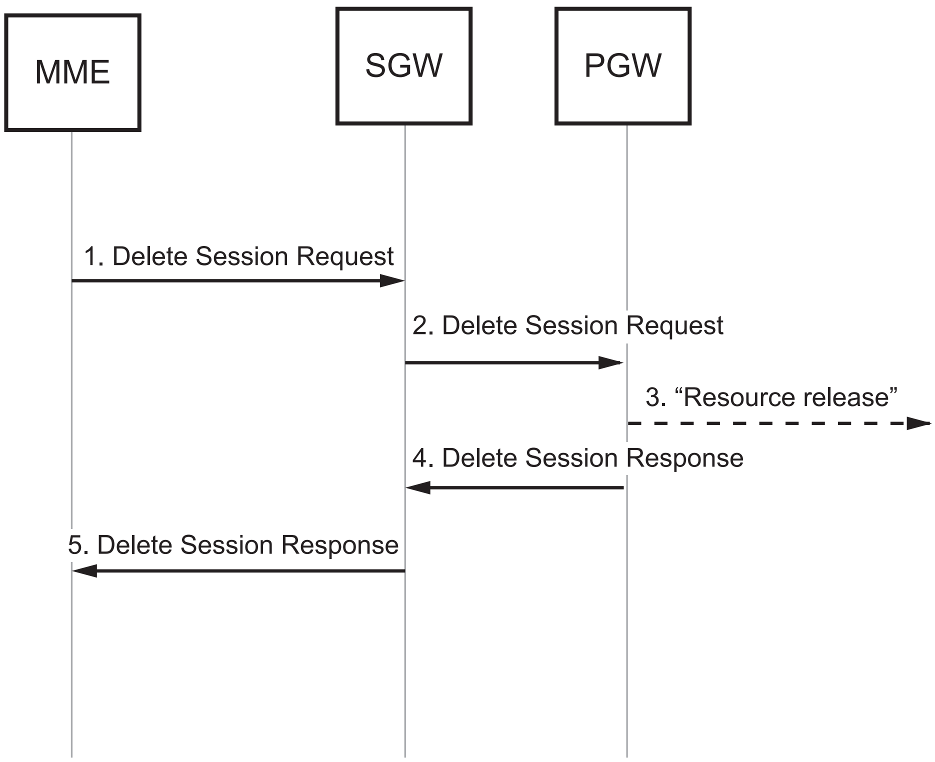

Figure 47 Signalling During the UE-, MME-, or HSS-Initiated Detach Procedure

The UE-, MME, or HSS-initiated detach procedure consists of the following steps:

1. The MME sends a `Delete Session Request` message to the SGW for each PDN connection to be disconnected.

2. The SGW sends a `Delete Session Request` message to the PGW.

3. The PGW initiates the release of any reserved resources associated with the PDN connection toward external communicating nodes such as RADIUS and DHCP servers.

4. The PGW sends a `Delete Session Response` message to the SGW for each `Delete Session Request`. GTP-C and GTP-U tunnels used for communication between the SGW and the PGW are released.

5. The SGW responds with a `Delete Session Response` message to the MME.

   If configured to perform charging, the SGW closes the final charging record. The cause in the record indicates `Normal Release`.

   The SGW terminates the PDN connection and removes the GTP-U tunnel toward the eNodeB. When the last PDN connection is removed the SGW also removes the GTP-C tunnel over the S11/S4 interface.

8.10.2 PGW-Initiated PDN Disconnection

The signalling during a PGW-initiated PDN disconnection is shown in Figure 48.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

The `terminate-idle-session-start` action command can be used to delete only idle sessions on the PGW. For more information on terminating idle sessions see Section 3.12 on page 22.

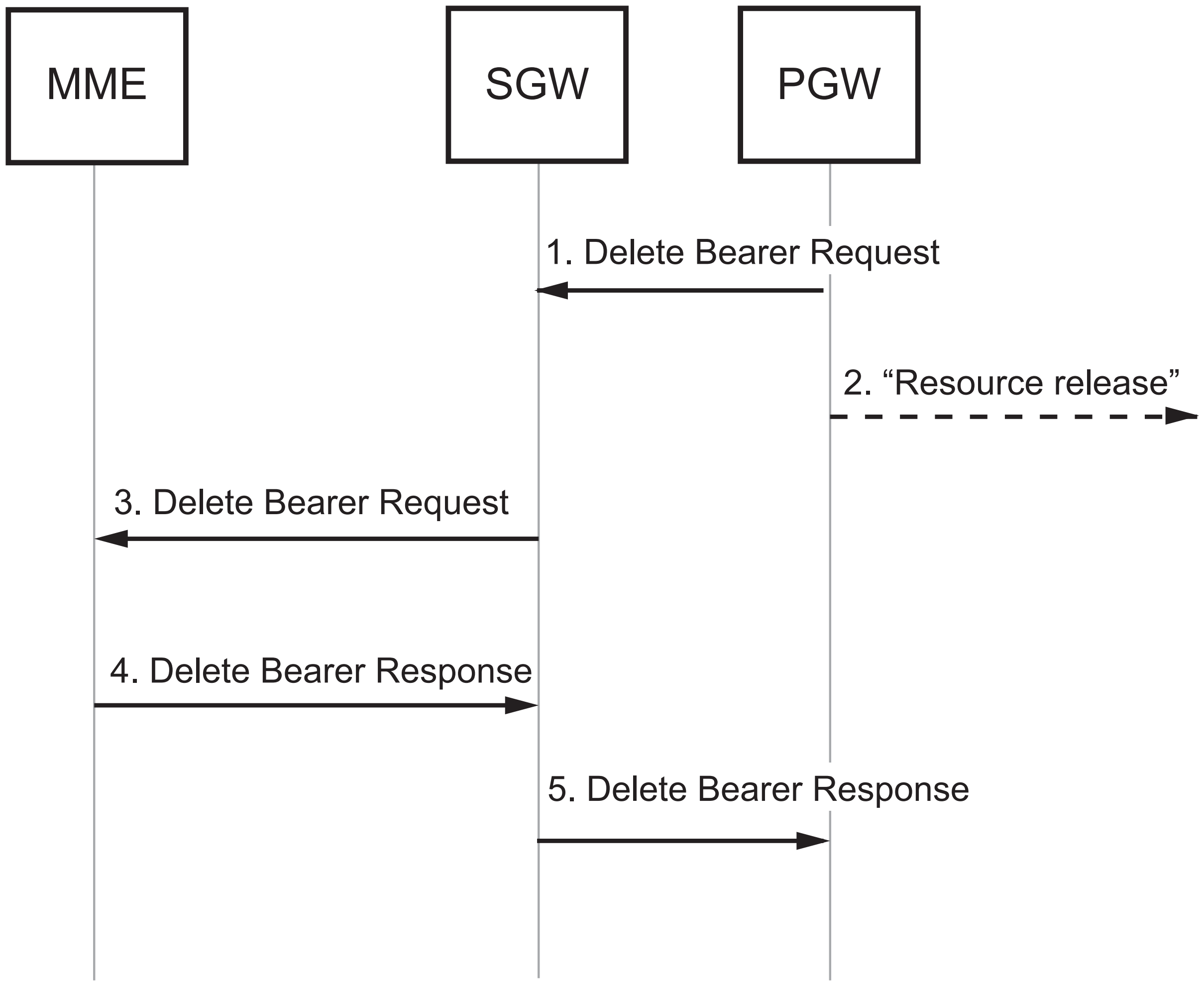

Figure 48 Signalling during a PGW-Initiated PDN Disconnection

The PGW-initiated PDN disconnection consists of the following steps:

1. The PGW receives a trigger to start a PDN disconnection. The trigger can be PGW internal due to operator intervention or fault. The trigger can also be initiated by communicating external nodes. The PGW sends a `Delete Bearer Request` message to the SGW, and the LBI is included. If this PDN Disconnection procedure is manually triggered by CLI, the `Delete Bearer Request` message can be configured to include the `Reactivation requested` cause code. This cause code requires UE to reactivate the PDN connection for the corresponding APN. For more information about how to include the `Reactivation requested` cause code, refer to GTP Interface Configuration.

2. The PGW initiates the release of any reserved resources associated with the PDN connection towards external communicating nodes such as RADIUS and DHCP servers.

3. The SGW sends the `Delete Bearer Request` message to the MME. The SGW removes the S1-U tunnel.

4. The MME responds with a `Delete Bearer Response` message to the SGW.

5. The SGW deletes the bearer context related to the deactivated PDN connection and sends a `Delete Bearer Response` to the PGW.

   If configured to perform charging, the SGW closes the final charging record. The cause in the record indicates `Normal Release`.

During graceful shutdown, the `Reactivation requested` cause code is always included in the `Delete Bearer Request` message. See Section 3.12 on page 22 for information on terminating idle sessions.

8.10.2.1 PCRF-Initiated Disconnection

The PCRF can initiate a disconnection procedure. For more detailed information, refer to Gx+ Interface Description.

8.10.3 SGW-Initiated PDN Disconnection

The signalling during the SGW-initiated PDN disconnection procedure is shown in Figure 49.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

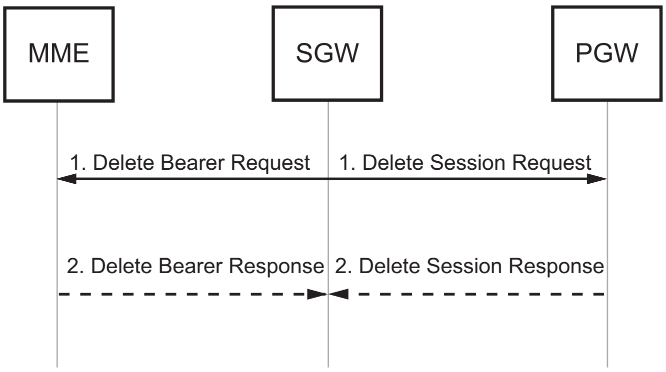

Figure 49 Signalling during an SGW-Initiated PDN Disconnection

The SGW-initiated PDN disconnection consists of the following steps:

1. The SGW receives a trigger to start a PDN disconnection. The SGW sends a `Delete Bearer Request` message to the MME and a `Delete Session Request` to the PGW. If this PDN Disconnection procedure is manually triggered by CLI, the `Delete Bearer Request` message can be configured to include the `Reactivation requested` as the cause value.

   The SGW continues to send `Delete Bearer Request` and `Delete Session Request` signals simultaneously until all PDN connections have been disconnected.

The SGW sends the requests to each UE device without pausing between PDN connections. The SGW does not wait for response messages before sending the next requests.

2. The MME responds with a `Delete Bearer Response` message to the SGW. The PGW sends a `Delete Session Response` message to the SGW.

During graceful shutdown, the `Reactivation requested` cause code is always included in the `Delete Bearer Request` message. See Section 3.12 on page 22 for information on terminating idle sessions.

8.11 Session Termination for Visiting SGW

The SGW closes the SGW-CDR upon the termination of the session as described in Section 8.10 on page 123, after the reception of the `Delete Session Response` message.

Upon receiving the `Delete Session Response` message, the SGW closes the SGW-CDR.

— SGW closes the CDRs with `Normal Release`.

— `listofvolumecontainer` is closed with `Record Closure`.

8.12 PGW Pause Charging

The SGW supports PGW pause charging. The majority of signal flows are included in existing signal flows, however PGW Pause Charging Start for both full and flushed buffers are specific to pause charging.

For a description of PGW pause charging, see Section 3.21 on page 37.

For more information on configuring PGW pause charging, refer to PGW Pause Charging Configuration.

8.12.1 PGW Pause Charging Start - Full Buffer

The signalling during an SGW-initiated pause of charging in the PGW due to a full buffer is shown in Figure 50.

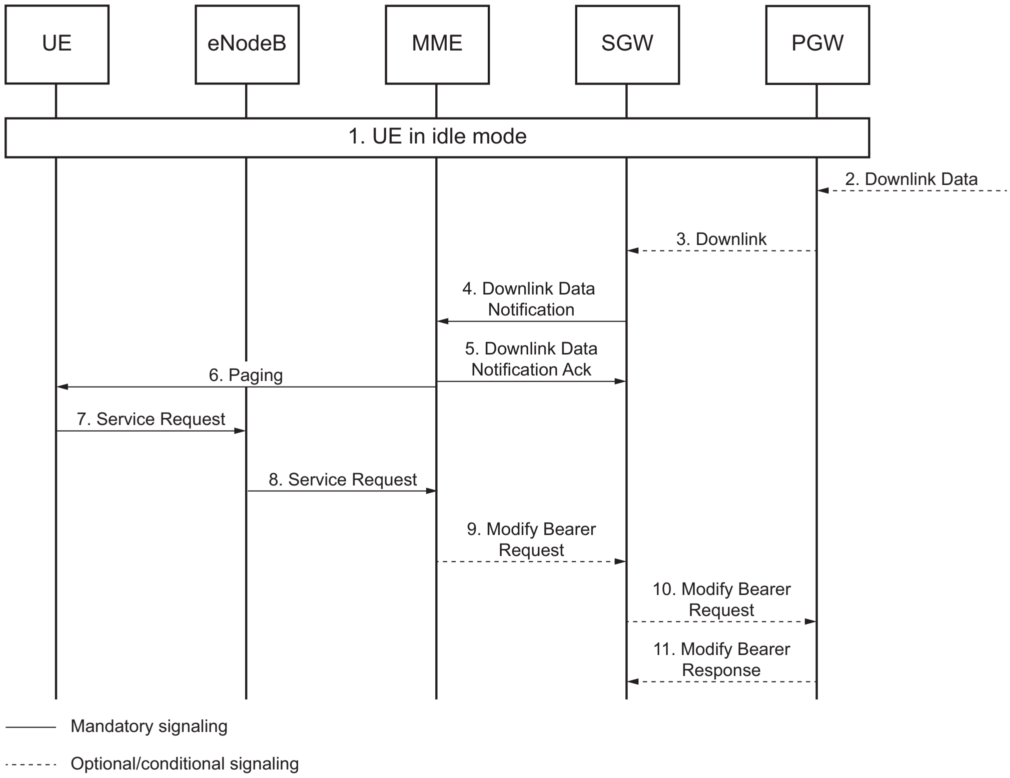

Figure 50 Signalling during Full Buffer Initiated PGW Pause Charging

PGW pause charging initiation due to full buffer can only occur when the UE is in idle state.

The PGW pause charging signal flow consists of the following steps:

1. The UE goes into idle state.

2. The PGW receives downlink data from a PDN sent to the UE in idle state.

3. The PGW forwards the data to the SGW.

   The SGW starts buffering the downlink data for the established PDN connection, and identifies the MME serving the UE.

4. The SGW sends a `Downlink Data Notification` message to the MME.

5. The MME responds with a `Downlink Data Notification Acknowledge` message to the SGW.

6. The MME starts paging the UE.

7. The UE sends a `Service Request` to the eNodeB.

8. The eNodeB forwards the Service Request to the MME.

9. The MME sends a Modify Bearer Request message to the SGW.

   If the Modify Bearer Request is not received by the SGW, the payload buffer starts to fill. Once the buffer is full, the Bytes_Loss_for_PDN and Packets_Loss_for_PDN counters increment according to the number of bytes or packets that are unsuccessful thereafter. When either the bytes-loss-threshold or the packets-loss-threshold is reached, the SGW sends a Modify Bearer Request message to the PGW indicating that the PGW pauses charging for the PDN connection - as described in Step 10, where the signal flow continues.

   If the Modify Bearer Request is successful, the flow ends at this step.

   The PGW continues to forward downlink data received from a PDN to the SGW in order to trigger paging of a UE in idle mode, even if the buffer is full.

10. The SGW sends a Modify Bearer Request message, which includes a request to activate pause charging, to the PGW.

11. The PGW responds with a Modify Bearer Response message to the SGW and charging is paused for the PDN connection.

8.12.2 PGW Pause Charging Start - Flushed Buffer

The signalling during an SGW-initiated pause of charging in the PGW due to a flushed buffer is shown in Figure 51.

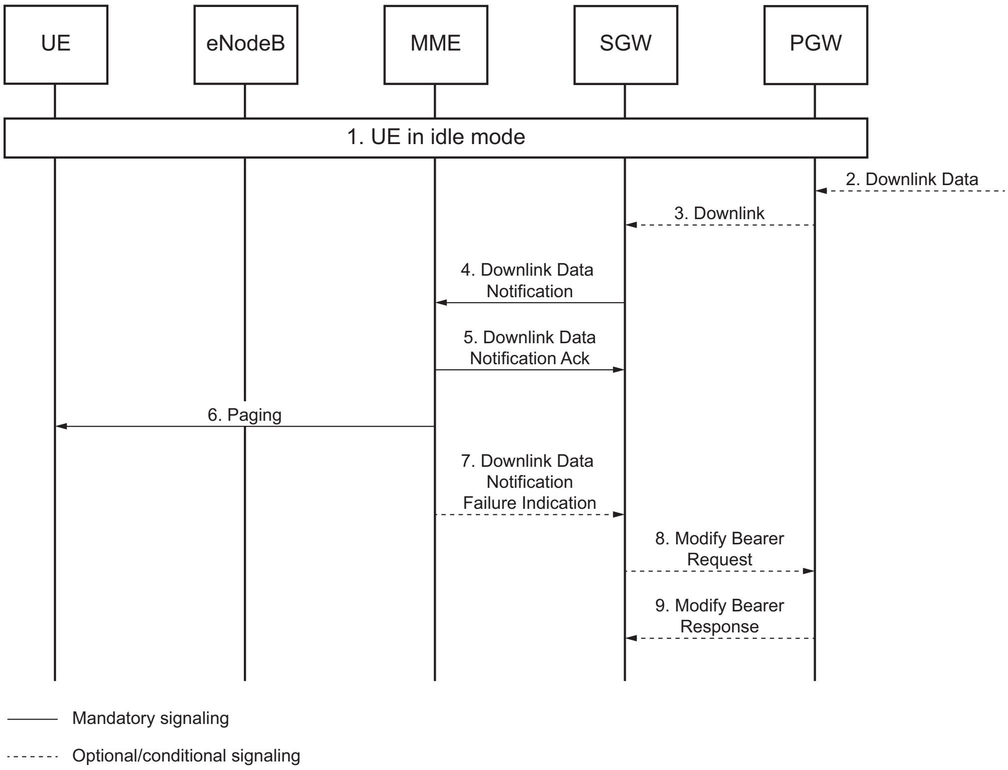

Figure 51 Signalling during Flushed Buffer Initiated PGW Pause Charging

The PGW pause charging signal flow consists of the following steps:

1. The UE goes into idle state.

2. The PGW receives downlink data from a PDN sent to the UE in idle state.

3. The PGW forwards the data to the SGW.

   The SGW starts buffering the downlink data for the established PDN connection, and identifies the MME serving the UE.

4. The SGW sends a `Downlink Data Notification` message to the MME.

5. The MME responds with a `Downlink Data Notification Acknowledge` message to the SGW.

6. The MME starts paging the UE.

   If the paging is unsuccessful, the flow continues with Step 7.

   If the paging is successful, the flow ends at this step.

7. The MME sends a `Downklink Data Notification Failure Indication` message to the SGW.

   The payload buffer is flushed and the `Bytes_Loss_for_PDN` and `Packets_Loss_for_PDN` counters increase by the number of bytes or packets that had been held in the buffer. When either the `bytes-loss-threshold` or the `packets-loss-threshold` is reached, the SGW sends a `Modify Bearer Request` message to the PGW indicating that the PGW pauses charging for the PDN connection - as described in Step 8, where the signal flow continues.

   If the thresholds are not reached, the flow ends at this step.

   The PGW continues to forward any downlink data received from a PDN to the SGW in order to trigger paging of a UE in idle mode, even if the buffer is full.

8. The SGW sends a `Modify Bearer Request` message, which includes a request to activate pause charging, to the PGW.

9. The PGW responds with a `Modify Bearer Response` message to the SGW and charging is paused for the PDN connection.

8.13 Inter-MME Paging

If an idle UE moves into an area of a new MME, the new MME can initiate paging of the UE. After sending a `Downlink Data Notification` message to the old MME, and if the SGW receives a `Modify Bearer Request` or a `Modify Access Bearer Request` message for a TAU from a new MME, the SGW resends a `Downlink Data Notification` message to the new MME. The inter-MME paging procedure is shown in Figure 52.

For information on how to configure inter-MME paging, refer to Paging Configuration.

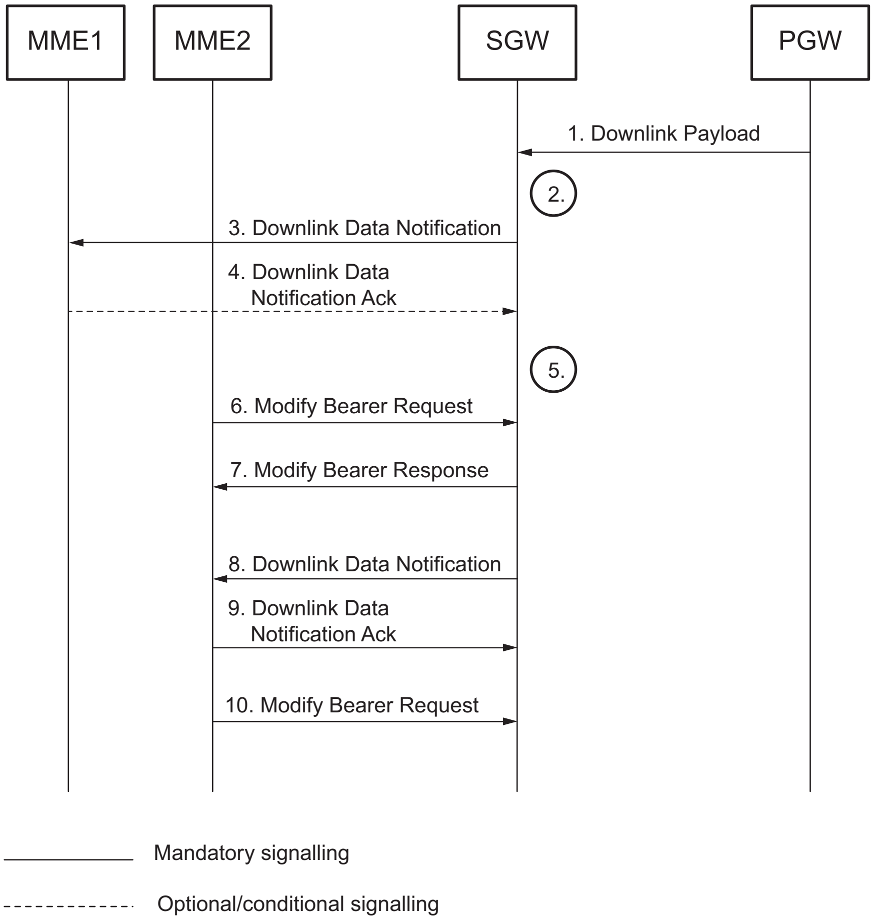

Figure 52 Inter-MME Paging

1. The PGW sends payload to the SGW.
2. The SGW buffers the payload.
3. The SGW sends a `DDN` message to the MME.
4. The MME responds with a `Downlink Data Notification Ack` to the SGW.
5. The SGW does not receive an expected `Modify Bearer Request` from the MME because the UE has moved to the new MME.
6. The new MME sends a `Modify Bearer Request` without an S1/S11-U F-TEID to the SGW.
7. The SGW sends a `Modify Bearer Response` to the new MME and the resending timer starts.
8. The resending timer expires and the SGW resends a `DDN` message to the new MME.
9. The new MME responds with a `Downlink Data Notification Ack` to the SGW.

10. The new MME sends a `Modify Bearer Request` with an S1/S11-U F-TEID to the SGW.

9 Session Management over the S4 Interface

Session management over the S4 interface is handled through the PGW and SGW.

The user plane can be established over the following:

- The S4-U interface for GSM users
- The S4-U interface for WCDMA users when Direct Tunnel is not used
- The S12 interface for WCDMA users when Direct Tunnel is used

Note:

- In all figures in this section, RAN refers to an RNC or a BSC.
- The steps in the shadow region are optional and they occur only when Direct Tunnel is used.

9.1 PDN Connection Creation

The signalling during a PDN connection creation is shown in Figure 53.

For details on the messages sent between the SGSN and the SGW, refer to S4 Interface Description.

For details on the message sent between the eNodeB/RNC and the SGW, refer to S1-U and S12 Interface Description.

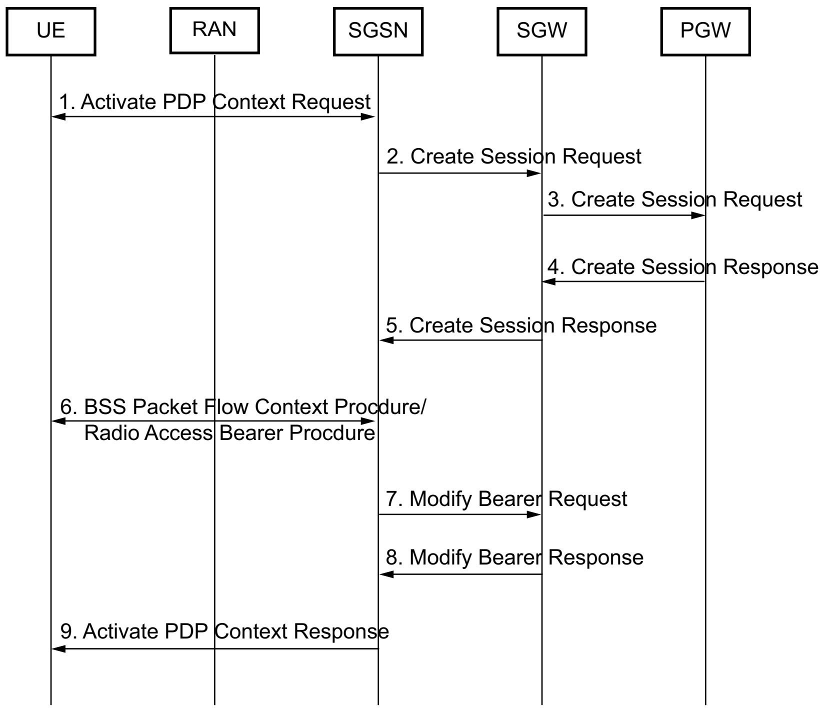

Figure 53 Signalling during a PDN Connection Creation Procedure

1. The UE sends an `Activate PDP Context Request` message to the SGSN. In addition to the requested QoS, the message contains a PDP address including the PDP type (IPv4, IPv6 or IPv4v6), the optional APN requested, and PCOs.

2. The SGSN sends a `Create Session Request` message to the SGW. Each request includes the following information:

   — IMSI of the UE

   — APN selected by the user or the SGSN

   — QoS information

   — SGSN IP address and TEID for the signalling traffic is used

   — SGSN IP address and TEID for the user plane traffic, if Direct Tunnel is not applicable, or not to be used

   — PCO received from the UE (optional). The PCO is transparent to the SGSN.

   — Direct Tunnel Flag (DTF). If DTF is set to 1, Direct Tunnel is to be used.

3. The SGW updates the `Create Session Request` message and sends it to the PGW. If the received `Create Session Request` message is in conflict with an existing PDN connection, the SGW sends a `Delete Session Request` message before the `Create Session Request` message to the PGW to terminate the existing session before creating the new session.

The PGW selects an APN according to Section 3.5.1 on page 13, and performs admission control based on resource availability. The PGW then assigns an IP address to the UE according to the description in Section 3.13 on page 25. Communication with an external RADIUS system is possible for RADIUS authentication, end-user IP address allocation, and accounting services. A DHCP server can be used instead of a RADIUS server for the end-user IP address allocation. One or two IP addresses are assigned depending on the PDP type or PDN type.

4. The PGW responds with a `Create Session Response` message to the SGW. This step, together with Step 3, leads to a GTP-U tunnel establishment on the uplink and downlink between the SGW and PGW.

5. The SGW updates the `Create Session Response` message and sends it to the SGSN. The response message includes the following SGW F-TEIDs:

   — For the control plane over the S4-C interface

   — For the user plane over the S12 interface if DTF is set to 1 in Step 2

   — For the user plane over the S4-U interface if DTF is not received or is set to `0` in Step 2

   If configured to perform charging, the SGW begins collecting charging data.

6. In A/Gb mode, the SGSN initiates the BSS Packet Flow Context (PFC) procedure. In Iu mode, the SGSN initiates the RAB procedure.

7. The SGSN sends the `Modify Bearer Request` message to the SGW. The request includes the following information:

   — `S4-U SGSN F-TEID` if Direct Tunnel is not used

   — `S12 RNC F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

8. The SGW acknowledges the `Modify Bearer Request` message by sending the `Modify Bearer Response` message to the SGSN. The SGW can then send its buffered downlink packets.

9. The SGSN sends an `Activate PDP Context Accept` message to the UE.

9.2 Bearer and PDN Connection Modification

The section describe the PCRF-initiated PDN modification and PGW-initiated modification.

9.2.1 PCRF-Initiated Modification

A PCRF-Initiated modification can result in modification of the default bearer, and can also result in activation, modification, or deletion of dedicated bearers. Refer to Policy Control for information when activation, modification, or deletion of dedicated bearer is performed.

9.2.1.1 Dedicated Bearer Activation

The signalling during a dedicated bearer activation procedure is shown in Figure 54.

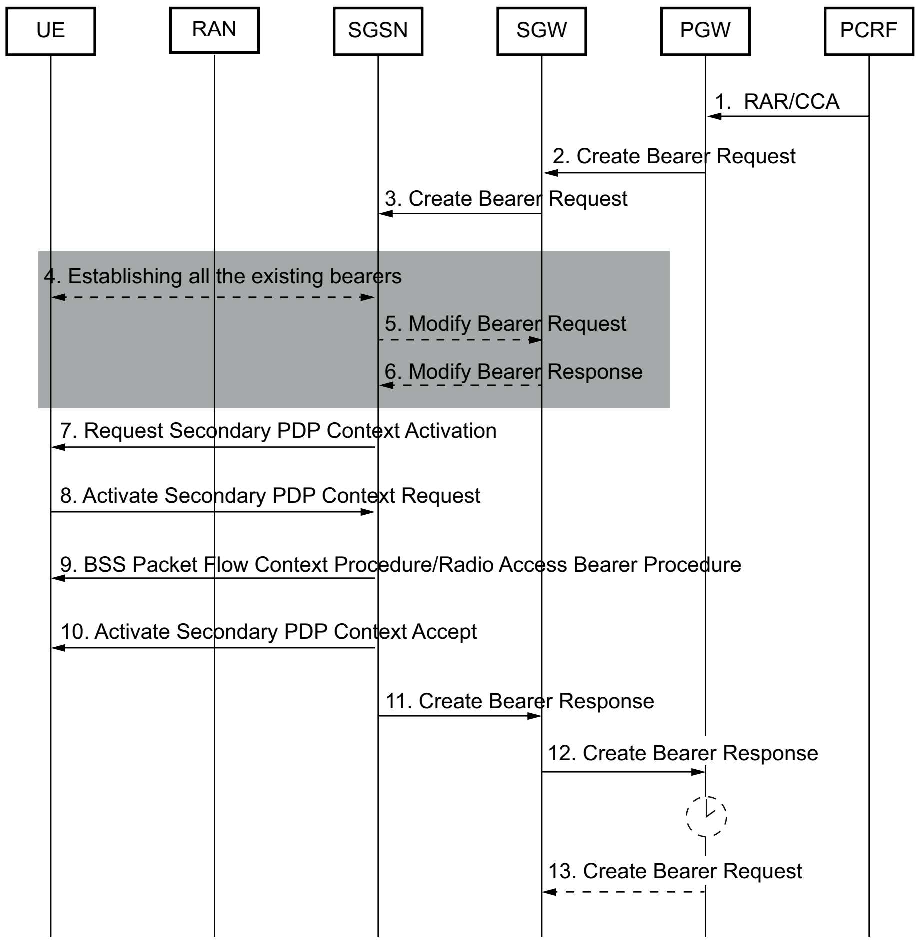

Figure 54 Signalling during a Dedicated Bearer Activation Procedure

Note: Steps 4, 5, and 6 occur only when the UE state is in PMM-idle and when the SGSN decides to establish all existing bearers.

1. If PCC is deployed, the PCRF initiates a PCC session modification procedure by sending a `CCA` message or a `RAR` message. If a `RAR` message is sent from the PCRF, the PGW applies the policy decision included in the message. The PGW responds with a `RAA` message to the PCRF.

   For information on how to initiate the dedicated bearer activation, refer to Policy Control.

2. The PGW sends a `Create Bearer Request` message to the SGW.

3. The SGW updates the `Create Bearer Request` message and sends it to the SGSN. Each dedicated bearer includes the following information:

   — Linked Bearer Identity (LBI)

   — An empty EBI

   — `S4-U SGW F-TEID` if the DTF stored in the SGW is `0` (non Direct Tunnel)

   — `S12 SGW F-TEID` if the DTF stored in the SGW is 1 (Direct Tunnel)

4. The SGSN sends the `Modify Bearer Request` message to the SGW. The request includes the following information:

   — `S4-U SGSN F-TEID` if Direct Tunnel is not used

   — `S12 RNC F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

5. The SGW updates the address for the user plane and TEID for downlink data and returns a `Modify Bearer Response` message to the SGSN. The response includes the following information:

   — `S4-U SGW F-TEID` if Direct Tunnel is not used

   — `S12 SGW F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

6. In Iu mode, RAB setup is done by the RAB assignment procedure. In A/Gb mode, the SGSN can execute BSS PFC procedures The step works only when the SGSN establishes all the existing bearers.

7. The SGSN sends a `Request Secondary PDP Context Activation` message to the UE.

8. The UE responds with an `Activate Secondary PDP Context Request` message to the SGSN.

9. In A/Gb mode, the SGSN initiates the BSS PFC procedure. In Iu mode, the SGSN initiates the RAB procedure.

10. The SGSN sends an `Activate Secondary PDP Context Accept` message to the UE.

11. The SGSN sends the `Create Bearer Response` message to the SGW. The message including the following information:

    — `S12 RNC F-TEID` if the SGSN decides to set up Direct Tunnel

    — `S4-U SGSN F-TEID` if the SGSN decides not to set up Direct Tunnel

    The SGW then updates the Direct Tunnel information based on the received downlink F-TEID:

- S12 RNC F-TEID indicates that Direct Tunnel is set up
- S4-U SGSN F-TEID indicates that Direct Tunnel is not set up

The SGSN can return SGW F-TEID with the same interface type as the type in the Create Bearer Request message or return SGW F-TEID with interface type depending on whether Direct Tunnel is established or not. The SGW accepts either of the following SGW-F-TEID values: S12 SGW F-TEID or S4 SGW F-TEID.

12. The SGW updates the Create Bearer Response message and sends it to the PGW.

    If configured to perform charging, and if the bearer creation was successful, the SGW begins collecting charging data.

13. If the PGW receives a Create Bearer Response message from the SGW, containing cause code 110 (Temporarily rejected due to handover procedure in progress), the PGW starts the temporary-rejection-guard-timer. When the timer expires, the PGW re-initiates the bearer creation procedure by sending the Create Bearer Request message as in Step 2. The number of times the PGW retries to send the Create Bearer Request message is configurable. For information on how to configure the timer value and the number of retries, refer to GTP Interface Configuration.

Note: The cause code `Temporarily rejected due to handover procedure in progress` indicates that the MME has temporarily rejected the bearer creation procedure due to an ongoing handover, TAU, or RAU procedure.

The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid message of one of the following messages:

- `Delete Session Request`
- `Modify Bearer Command`
- `Modify Bearer Request`
- `Modify Bearer Request` for SGW relocation
- `Proxy Binding Update` for handover to the MAG
- `Re-Authorization Request`
- `Update PDP Context Request` for handover to the SGSN

After processing the message, the PGW re-initiates the bearer creation procedure at Step 2, except if the received message was one of the following messages:

- `Delete Session Request`
- `Proxy Binding Update` for handover to the MAG
- `Re-Authorization Request` for removing the PCC rules that triggered the creation procedure
- `Update PDP Context Request` for handover to the SGSN if the SGSN does not support network-initiated secondary PDP contexts

If the PGW has not reached the maximum number of retry times, the PGW ignores the Access Network Information report parameters (ULI and UE Time Zone) in the `Create Bearer Response` message which contains the cause code `Temporarily rejected due to handover procedure in progress` even if NetLoc is enabled on the EPG. For more information about NetLoc, refer to Policy Control.

9.2.1.2 Bearer Modification

A bearer modification procedure can be performed without a bearer QoS update (that is, when TFT or APN-AMBR or both are to be modified) or with a bearer QoS update. The signalling during PCRF-initiated bearer modification procedure is shown in Figure 55.

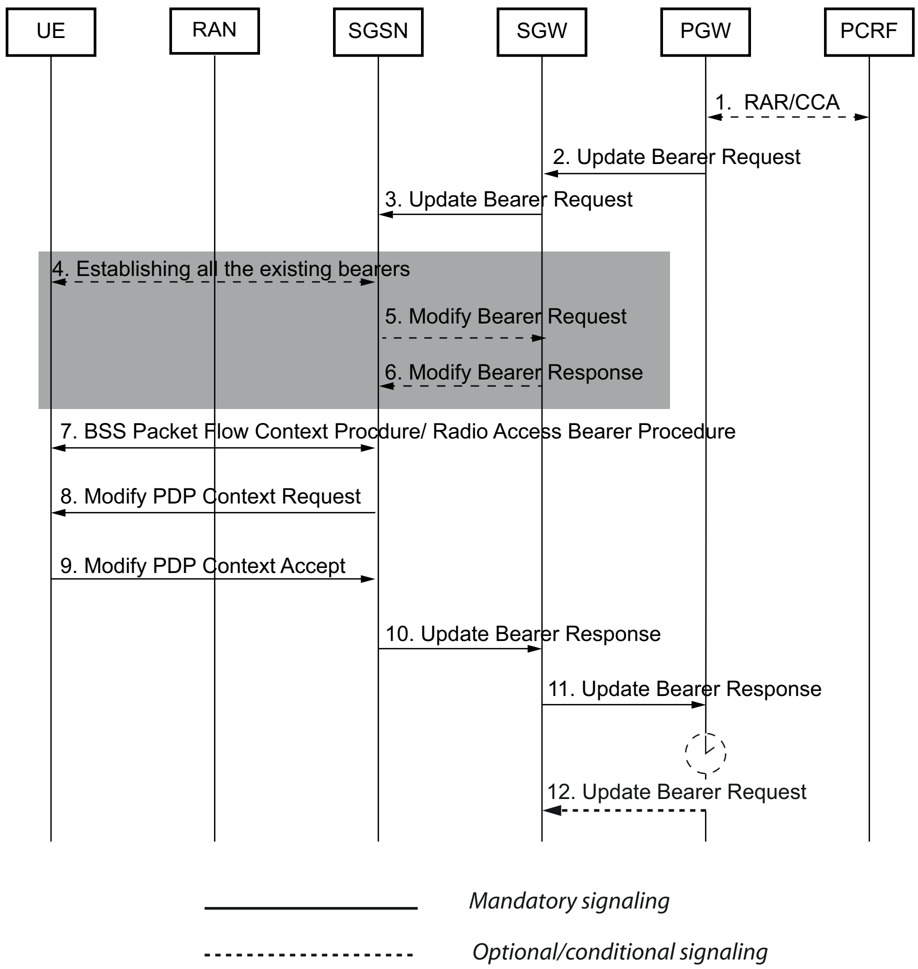

Figure 55 Signalling during a Bearer Modification Procedure

Note: Steps 4, 5, and 6 occur only when the UE state is in PMM-idle and when the SGSN decides to establish all existing bearers.

1. If PCC is deployed, the PCRF initiates a PCC session modification procedure by sending a `CCA` message with request type Update or a `RAR` message. If a `RAR` message is sent from the PCRF, the PGW applies the policy decision included in the message. The PGW responds with a `RAA` message to the PCRF.

   For information on when to initiate the bearer modification, refer to Policy Control.

2. The PGW sends an `Update Bearer Request` message to the SGW. The message includes the following information:

   — EBI for the bearer to be modified

   — Bearer QoS (included if bearer QoS is to be updated)

   — TFT (optional)

— APN-AMBR (mandatory)

Note: If neither Bearer QoS nor TFT is included, the bearer ID should refer to the default bearer.

3. The SGW updates the `Update Bearer Request` message and sends it to the SGSN.

4. The SGSN sends the `Modify Bearer Request` message to the SGW. The request includes the following information:

   — `S4-U SGSN F-TEID` if Direct Tunnel is not used

   — `S12 RNC F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

5. The SGW updates the address for the user plane and TEID for downlink data and returns a `Modify Bearer Response` message to the SGSN. The response includes the following information:

   — `S4-U SGW F-TEID` if Direct Tunnel is not used

   — `S12 SGW F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

6. In Iu mode, RAB setup is done by the RAB assignment procedure. In A/Gb mode, BSS PFC procedures can be executed. The step works only when the SGSN establishes all the existing bearers.

7. In A/Gb mode, the SGSN initiates the BSS PFC procedure. In Iu mode, the SGSN initiates the RAB procedure.

8. The SGSN sends a `Modify PDP Context Request` message to the UE.

9. The UE acknowledges the PDP context modification with a `Modify PDP Context Accept` message to the SGSN.

10. The SGSN acknowledges the bearer modification by sending an `Update Bearer Response` message to the SGW. The response includes the following information:

    — `S4-U SGSN F-TEID` if Direct Tunnel is not used

    — `S12 RNC F-TEID` if Direct Tunnel is used

    — DTF (set to value 1 if Direct Tunnel is used)

11. The SGW acknowledges the bearer modification by forwarding the `Update Bearer Response` message to the PGW.

12. If the PGW receives an `Update Bearer Response` from the SGW `Cause value` of `110` in the `Cause` IE, the PGW starts the

temporary-rejection-guard-timer timer. After the timer expires, the PGW re-initiates the bearer modification procedure by sending the Update Bearer Request as in Step 2. The number of times the PGW retries the Update Bearer Request message is also configurable in the PGW. For information on configuring the timer and number of retries, refer to GTP Interface Configuration.

Note: A Cause value of 110 indicates that the S4-SGSN has temporarily rejected the bearer modification procedure due to an ongoing handover, TAU, or RAU procedure.

The PGW can receive and handle other messages when the guard timer is running. However, the PGW stops the guard timer after receiving a valid Modify Bearer Request or Modify Bearer Command and after processing the message the PGW re-initiates the bearer modification procedure at step 2.

The PGW ignores the Access Network Information report parameters (ULI and UE Time Zone) in the Update Bearer Response message which contains a Cause value 110 even if NetLoc is enabled on the EPG. For detailed information about NetLoc, refer to Policy Control.

9.2.1.3 Dedicated Bearer Deletion

The signalling during a dedicated bearer deletion procedure is shown in Figure 56.

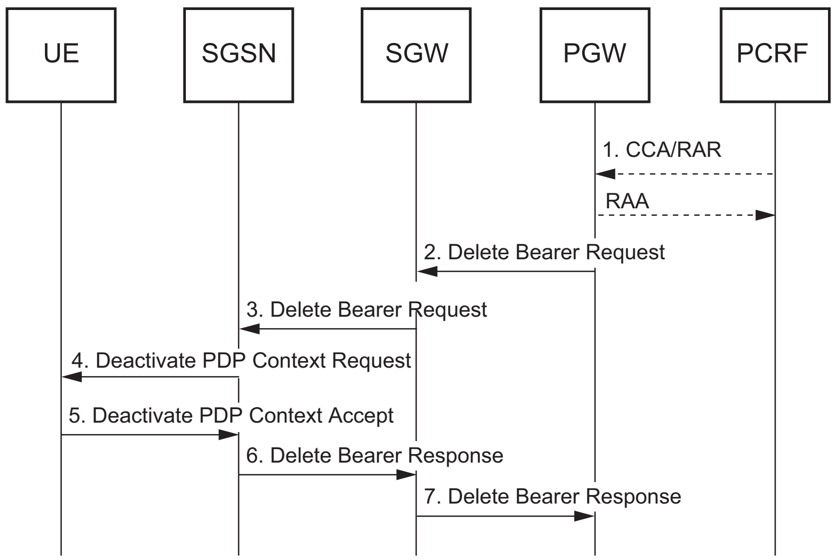

Figure 56 Signalling during a Dedicated Bearer Deletion Procedure

1. If PCC is deployed, the PCRF initiates a PCC session modification procedure by sending a CCA message with request type Update or a RAR message. If a RAR message was sent from the PCRF, the PGW applies the policy decision included in the message. The PGW responds with a RAA message to the PCRF.

For information when to initiate the dedicated bearer deletion, refer to Policy Control.

2. The PGW sends a `Delete Bearer Request` message to the SGW including one or more EBIs for the dedicated bearers to be deleted.

3. The SGW forwards the `Delete Bearer Request` message to the SGSN.

4. The SGSN sends a `Deactivate PDP Context Request` message to the UE.

5. The UE acknowledges the PDP context deactivation with a `Deactivate PDP Context Accept` message to the SGSN.

6. The SGSN sends a `Delete Bearer Response` message to the SGW.

7. The SGW forwards the `Delete Bearer Response` message to the PGW

   If configured to perform charging, the SGW closes the charging record for that bearer. For more information, refer to Offline Charging.

9.2.2 PGW-Initiated Modification

The PGW can initiate a bearer modification based on the local policy. For details, refer to Step 2 through Step 11 on Page 142.

9.3 Bearer Deletion and PDN Connection Deactivation

This section describes the following scenarios:

- PGW-initiated bearer deletion and PDN connection deactivation
- SGSN-initiated and UE-Initiated PDN connection deactivation
- SGSN-initiated and UE-Initiated PDN bearer deactivation
- PCRF-initiated bearer deactivation and PDN connection deactivation

9.3.1 PGW-Initiated Bearer Deletion and PDN Connection Deactivation

The signalling during a PGW-Initiated bearer deletion and PDN connection deactivation procedure is shown in Figure 57.

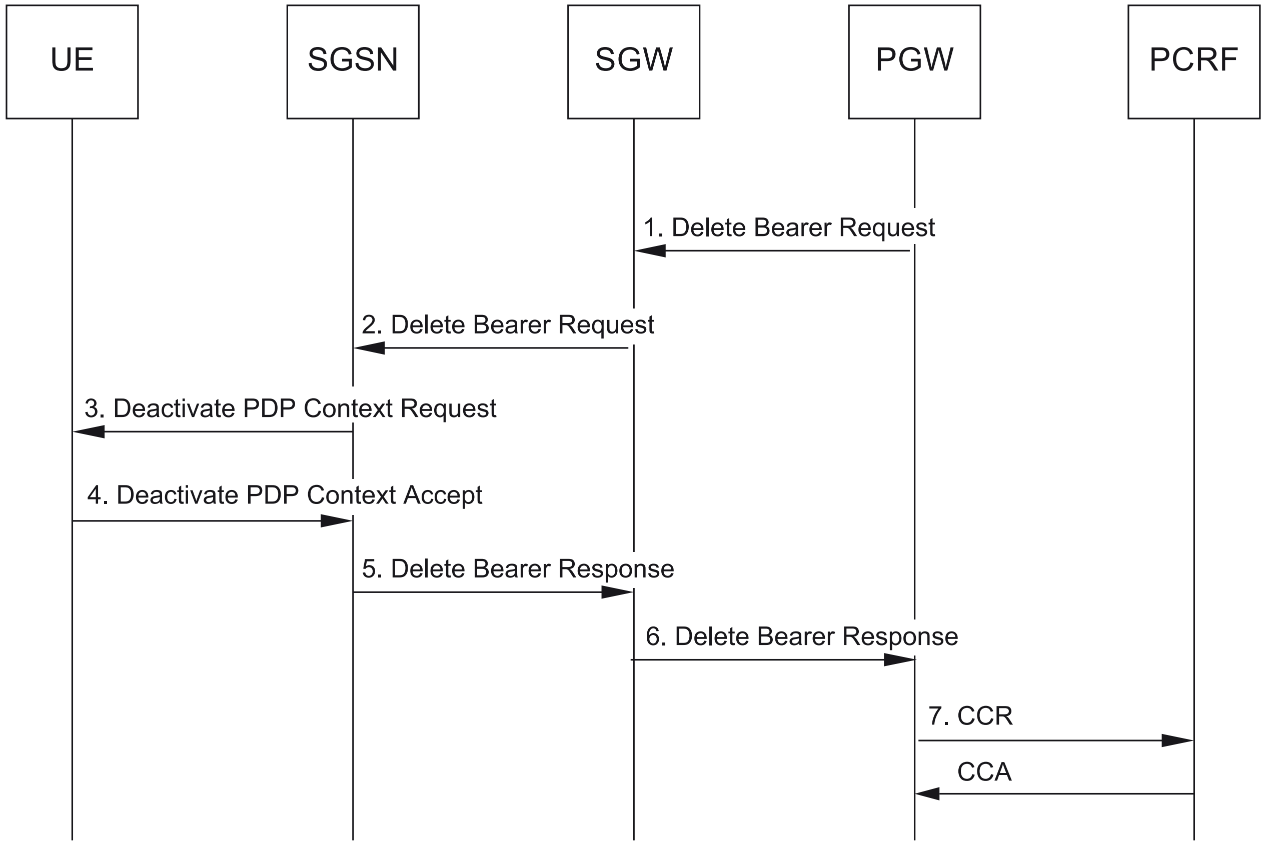

Figure 57 Signalling during a PGW-Initiated Bearer Deletion and PDN Connection Deactivation Procedure

1. The PGW sends a `Delete Bearer Request` message to the SGW. If the bearer(s) to be deleted is (are) a dedicated bearer(s), the message includes all the EBIs for the bearer(s) to be deleted. If all the bearers are to be deleted, that is, the PDN connection is to be deactivated, the LBI is included.

2. The SGW forwards the `Delete Bearer Request` message to the SGSN.

3. The SGSN sends a `Deactivate PDP Context Request` message to the UE. If there is more than one PDP context established and all the PDP contexts are to be deleted, the `Tear Down Indicator` IE is set to 1 in the message.

4. The UE responds with a `Deactivate PDP Context Accept` message to the SGSN.

5. The SGSN sends a `Delete Bearer Response` message to the SGW.

6. The SGW forwards the `Delete Bearer Response` message to the PGW.

   If configured to perform charging, the SGW closes the final charging record.

7. If the PDN connection is to be deactivated, the PGW sends a `CCR` message with request type Terminate to the PCRF. There can be a single of multiple dedicated bearers. If a dedicated bearer is to be deleted, the PGW sends a

CCR message with request type Update to the PCRF to indicate that the PCC rules previously installed on the dedicated bearer are inactive . The PCRF responds with a CCA message to the PGW.

The terminate-idle-session-start action command can be used to delete only idle sessions on the PGW. For more information on terminating idle sessions see Section 3.12 on page 22.

9.3.2 SGW-Initiated PDN Disconnection

This section describes the SGW-initiated termination of PDN connections for UE devices that are in idle state.

The SGW sends a Delete Bearer Request with Reactivation Requested as the cause value to the SGSN, and a Delete Session Request to the PGW.

For each PDN connection within the UE device, the SGW sends the Delete Bearer Request and Delete Session Request signals simultaneously. The SGW sends the requests for each UE device without pausing between PDN connections. The SGW does not wait for response messages before sending the next requests.

If the MME tries to reconnect deleted PDN connections before the last PDN connection has been deleted, the request is rejected by the SGW.

See Section 3.12 on page 22 for more information on terminating idle sessions.

9.3.3 SGSN-Initiated and UE-Initiated PDN Connection Deactivation

The signalling during an SGSN-initiated and UE-initiated PDN connection deactivation procedure is shown in Figure 58. The Step 1 in the procedure is only applicable to UE-initiated PDN connection deactivation. The SGSN-Initiated PDN connection deactivation procedure starts from the Step 2.

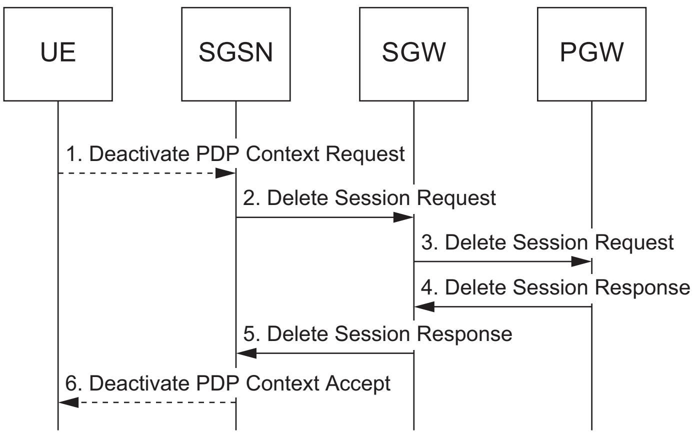

Figure 58 Signalling during a SGSN-Initiated and UE-Initiated PDN Connection Deactivation Procedure

1. The UE sends a `Deactivate PDP Context Request` message to the SGSN. The `Tear Down Indicator` IE is set to 1 in the message, if more than one PDP context has been established.

2. The SGSN sends a `Delete Session Request` message to the SGW.

3. The SGW forwards the `Delete Session Request` message to the PGW.

4. The PGW responds with a `Delete Session Response` message to the SGW.

5. The SGW forwards the `Delete Session Response` message to the SGSN.

   If configured to perform charging, the SGW closes the final charging record.

6. The SGSN sends a `Deactivate PDP Context Accept` message to the UE.

9.3.4 SGSN-Initiated and UE-Initiated Bearer Deactivation

The signalling during a SGSN-initiated and UE-initiated bearer deactivation procedure is shown in Figure 59. Step 1 in the procedure is only applicable for UE-initiated bearer deactivation. The SGSN-Initiated bearer deactivation procedure starts from Step 2.

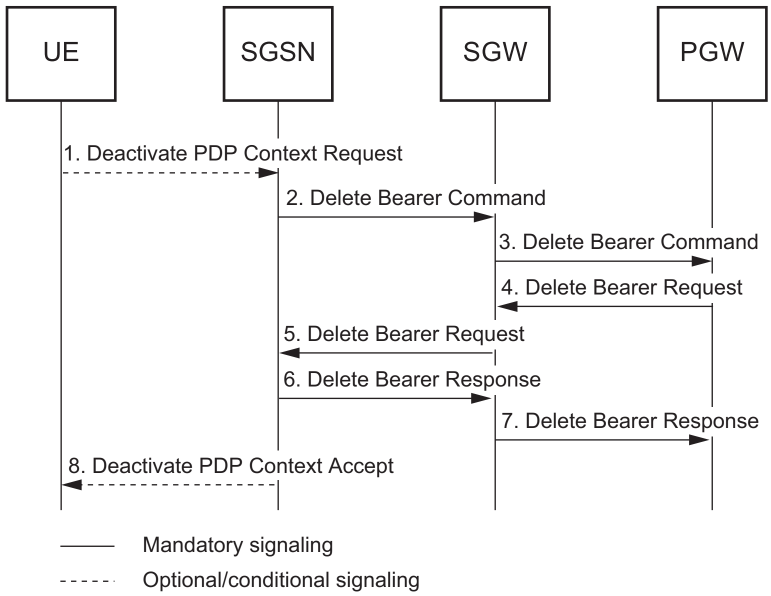

Figure 59 Signalling during a SGSN-Initiated and UE-Initiated Bearer Deactivation Procedure

1. The UE sends a `Deactivate PDP Context Request` message to the SGSN. Tear down Indicator is set to `0` or not included in the message.

2. The SGSN sends a `Delete Bearer Command` message to the SGW.

3. The SGW forwards the `Delete Bearer Command` message to the PGW.

4. The PGW responds with the `Delete Bearer Request` message to the SGW.

5. The SGW forwards a `Delete Bearer Request` message to the SGSN.

6. The SGSN sends a `Delete Bearer Response` message to the SGW.

7. The SGW forwards the `Delete Bearer Response` message to the PGW.

   If configured to perform charging, the SGW closes the final charging record.

8. The SGSN sends a `Deactivate PDP Context Accept` message to the UE.

9.3.5 PCRF-Initiated Bearer Deactivation and PDN Connection Deactivation

For dedicated bearer deactivation triggered by the PCRF, refer to Section 9.2.1.3 on page 144. For PCRF-initiated PDN connection deactivation, Session-Release-Cause is included in RAR from PCRF to the PGW. Delete Bearer Request includes the LBI. For details, refer to Section 9.3.1 on page 145.

9.4 Service Request

This section describes the service request scenarios using the S4 interface.

— UE-initiated service request

— Network-requested service request

9.4.1 UE-Initiated Service Request

The signalling during a UE-initiated service request procedure using the S4 interface is shown in Figure 60.

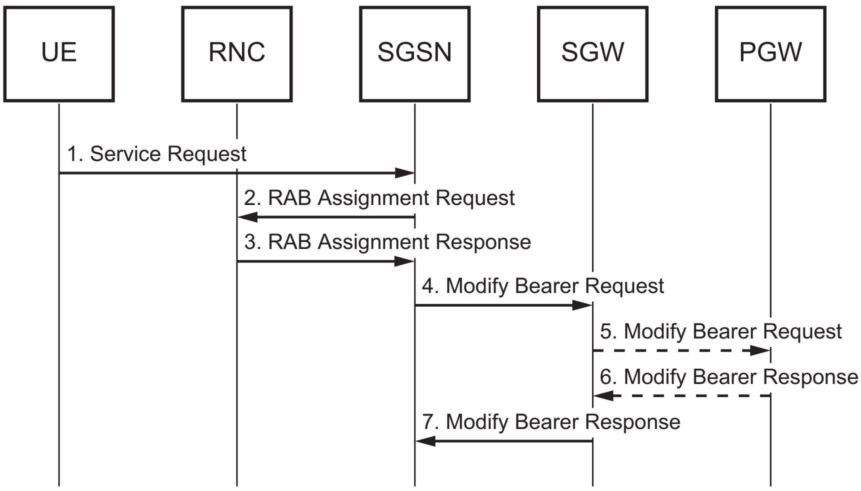

Figure 60 Signalling during a UE-Initiated Service Request Procedure Using S4 Interface

1. The UE sends a `Service Request` to the SGSN.

2. The SGSN sends an `RAB Assignment Request` message to the RNC.

3. The RNC responds with an `RAB Assignment Response` message to the SGSN.

4. The SGSN sends the `Modify Bearer Request` message to the SGW. The request includes the following information:

   — `S4-U SGSN F-TEID` if Direct Tunnel is not used

   — `S12 RNC F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

5. The SGW sends the `Modify Bearer Request` message to the PGW in cases, for example, when ULI is included.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

6. The PGW responds with a `Modify Bearer Response` message to the SGW.

7. The SGW sends the `Modify Bearer Response` message to the SGSN.

9.4.2 Network-Triggered Service Request

This section assumes the user plane does not exist between the SGW and the SGSN. If the user plane exists, the downlink packets received in the SGW are sent directly to the S4-SGSN, which causes the SGSN to initiate paging.

The signalling during a network-triggered service request procedure is shown in Figure 61.

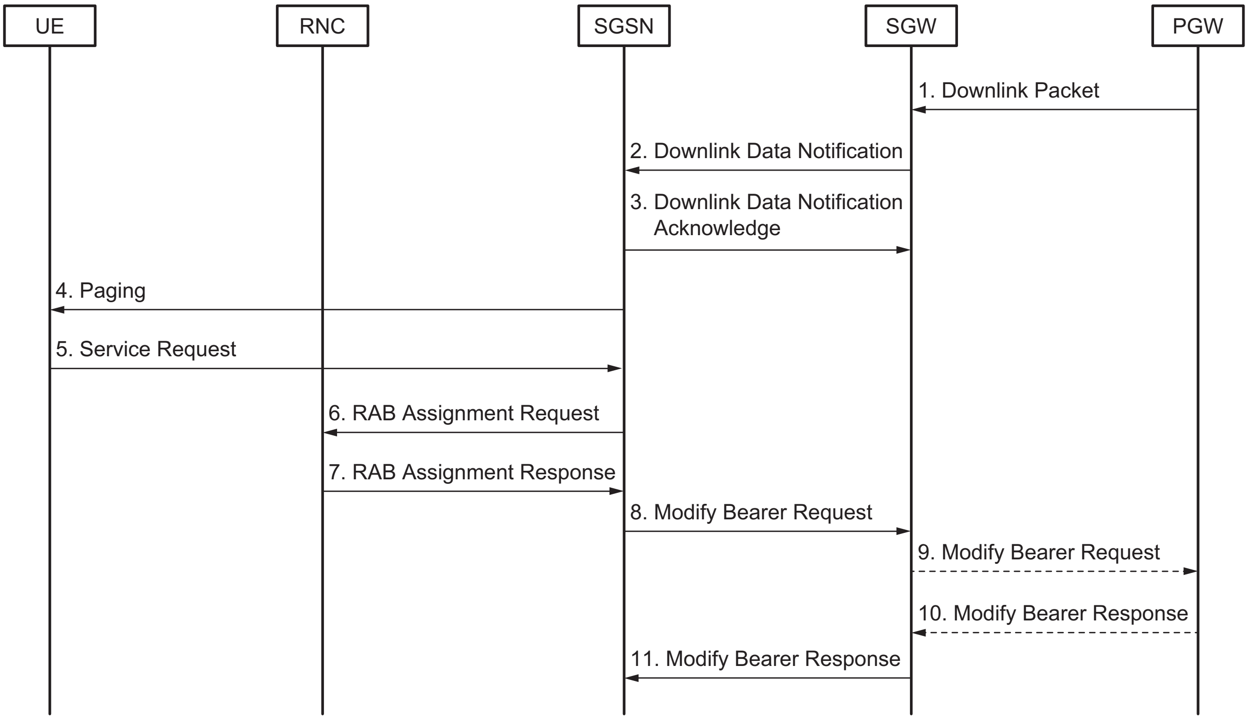

Figure 61 Signalling during a Network-Triggered Service Request Procedure Using the S4 Interface

1. The PGW sends downlink packets to the SGW.

2. The SGW sends a `Downlink Data Notification` message to the SGSN.

3. The SGSN responds with a `Downlink Data Notification Acknowledge` message to the SGW.

Note: For UEs in eDRX or PSM, the SGSN calculates and sends the `DL Buffering Duration` IE and the optional `DL Buffering Suggested Packet Count` IE in a `Downlink Data Notification Acknowledge` message to the SGW. The SGW stores a new value for the `DL Data Buffer Expiration Time` based on the `DL Buffering Duration`. The SGW does not send `Downlink Data Notification` messages during the `DL Buffering Duration`.

The SGW buffers downlink packet according to the `DL Buffering Suggested Packet Count` IE if this IE is included. A maximum of 512 packets per bearer can be buffered per bearer. For more information about the packet buffering capacity, refer to EPG Characteristics.

When the `DL Buffering Duration` IE is set to infinity and the `DL Buffering Suggested Packet Count` IE is set to `0`, the SGW does not trigger the `Downlink Data Notification` message to SGSN anymore. The SGW clears the buffered payload and discards all new incoming payload.

4. The SGSN starts paging the UE.

5. The UE responds with a `Service Request` message to the SGSN.

6. The SGSN sends an `RAB Assignment Request` message to the RNC.

7. The RNC responds with an `RAB Assignment Response` message to the SGSN.

8. The SGSN sends the `Modify Bearer Request` message to the SGW. The request includes the following information:

   — `S4-U SGSN F-TEID` if Direct Tunnel is not used

   — `S12 RNC F-TEID` if Direct Tunnel is used

   — DTF (set to value 1 if Direct Tunnel is used)

9. The SGW sends a `Modify Bearer Request` message to the PGW, if, for example, the ULI is included.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

10. The PGW responds with a `Modify Bearer Response` message to the SGW.

11. The SGW sends the `Modify Bearer Response` message to the SGSN.

9.5 Iu release and RAN Release

9.5.1 Iu Release

The signalling during a Iu release procedure is shown in Figure 62.

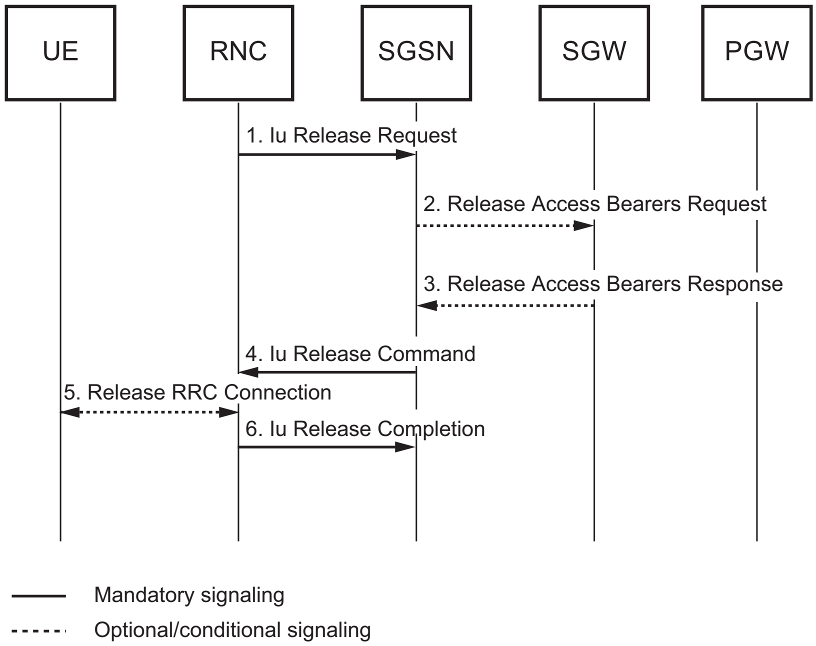

Figure 62 Signalling during an Iu Release Procedure Using S4 Interface

The Iu release procedure using the S4 interface consists of the following steps:

1. The RNC sends an `Iu Release Request` to the SGSN.
2. The SGSN can send a `Release Access Bearers Request` message to the SGW.
3. The SGW responds with a `Release Access Bearers Response` message to the SGSN.
4. The SGSN sends an `Iu Release Command` message to the RNC.
5. The RNC initiates the release of `RRC` connection towards the UE.
6. The RNC sends the `Iu Release Completion` to the SGSN.

9.5.2 RAB Release

The signalling during a RAB release procedure is shown in Figure 63.

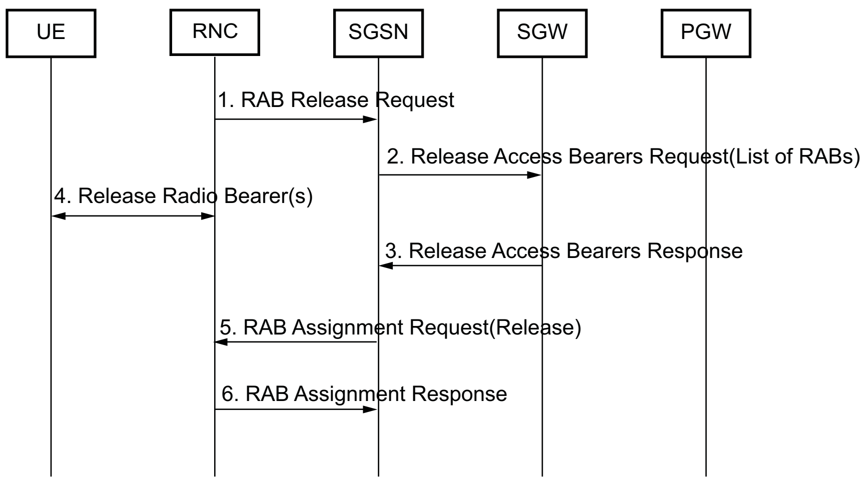

Figure 63 Signalling during a RAB Release Procedure Using S4 Interface

The RAB release procedure using the S4 interface consists of the following steps:

1. The RNC sends an `RAB Release Request` to the SGSN.

2. If Direct Tunnel was established, the SGSN sends a `Release Access Bearers Request` message to the SGW. The message includes the list of RABs. The SGW removes RNC' IP address and TEID.

   Note: In the list of RABs, some bearers are released and some are not. Those RABs not released in the SGW are called preserved bearers. If downlink packets are received on the preserved bearer, the `Downlink Data Notification` is triggered.

3. The SGW responds with a `Release Access Bearers Response` message to the SGSN.

4. If the radio bearers are still present, the radio bearers are released.

5. The SGSN sends a `RAB Assignment Request` to the RNC. For each RAB to be released, the request includes RAB ID and release cause.

6. The RNC sends an `RAB Assignment Response` to the SGSN.

10 Session Management Mobility

This section describes the supported mobility procedures for the EPG. Some of the basic scenarios are illustrated with sequence diagrams.

The UE accesses the network through GSM, WCDMA, and LTE.

10.1 Intra GERAN and UTRAN Mobility

This section describes the supported mobility scenarios within GERAN and UTRAN. The scenarios supported are separated for idle and connected mode.

10.1.1 Routing Area Update

If the UE is in idle mode, a Routing Area Update (RAU) procedure is performed.

This section describes the following RAU scenarios in the SGSN:

— Using the S4 Interface, old SGSN using the Gn/Gp Interface

— Using the Gn/Gp Interface, old SGSN using the S4 Interface

— Using the S4 Interface, old SGSN using the S4 Interface - with or without SGW relocation

10.1.1.1 RAU in SGSN Using the S4 Interface, Old SGSN Using Gn/Gp Interface

The signalling during an RAU procedure in SGSN using the S4 Interface, old SGSN using the Gn/Gp interface is shown in Figure 64.

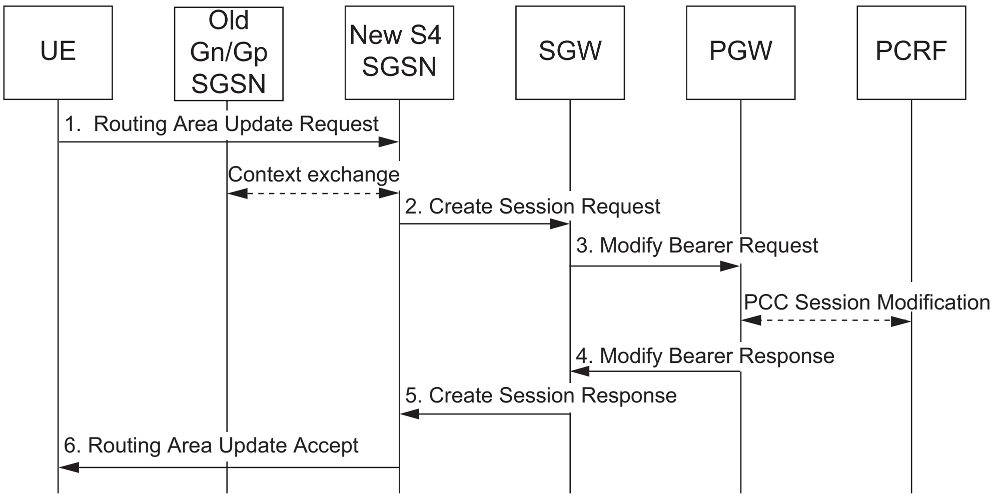

Figure 64 Signalling during an RAU Procedure in SGSN Using the S4 Interface - Old SGSN Using the Gn/Gp Interface

1. The UE sends a `Routing Area Update Request` message to the new S4-SGSN.

2. The new S4-SGSN sends a `Create Session Request` message to the SGW. The OI flag is set to 1. The SGSN F-TEID for the control plane is included. The request can also contain DTF. If DTF is set to 1, Direct Tunnel is to be used and user plane F-TEID is not included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The SGW sends a `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

5. The SGW responds with a `Create Session Response` message to the new S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

6. The new S4-SGSN sends a `Routing Area Update Accept` to the UE.

10.1.1.2 RAU in SGSN Using the Gn/Gp Interface, Old SGSN Using the S4 Interface

The signalling during an RAU procedure in SGSN using the Gn/Gp Interface with the old SGSN using the S4 interface is shown in Figure 65.

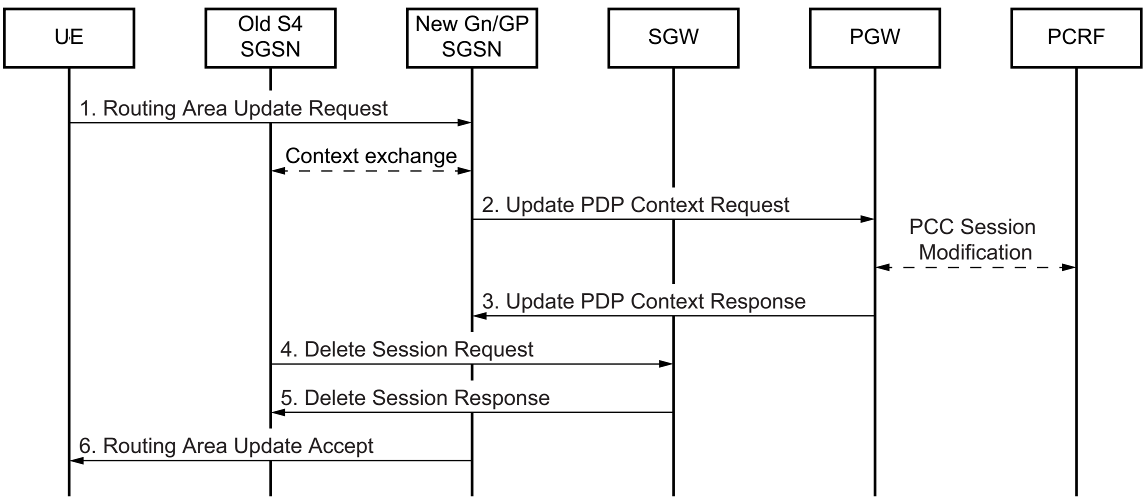

Figure 65 Signalling during an RAU Procedure in SGSN Using the Gn/Gp Interface, Old SGSN Using the S4 Interface

1. The UE sends a `Routing Area Update Request` message to the new Gn/Gp SGSN.

2. The new Gn/Gp SGSN sends an `Update PDP Context Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

3. The PGW responds with an `Update PDP Context Response` message to the new Gn/Gp SGSN.

4. The S4-SGSN sends a `Delete Session Request` to the SGW. The SI flag is set to 1. The OI flag is not included or included but set to `0`.

5. The SGW responds with a `Delete Session Response` message to the S4-SGSN.

6. The new Gn/Gp SGSN sends a `Routing Area Update Accept` message to the UE.

10.1.1.3 RAU in SGSN Using the S4 Interface, Old SGSN Using the S4 Interface - RAU with SGW Relocation

The signalling during a RAU procedure in SGSN using the S4 Interface with the old SGSN using the S4 interface with SGW relocation is shown in Figure 66.

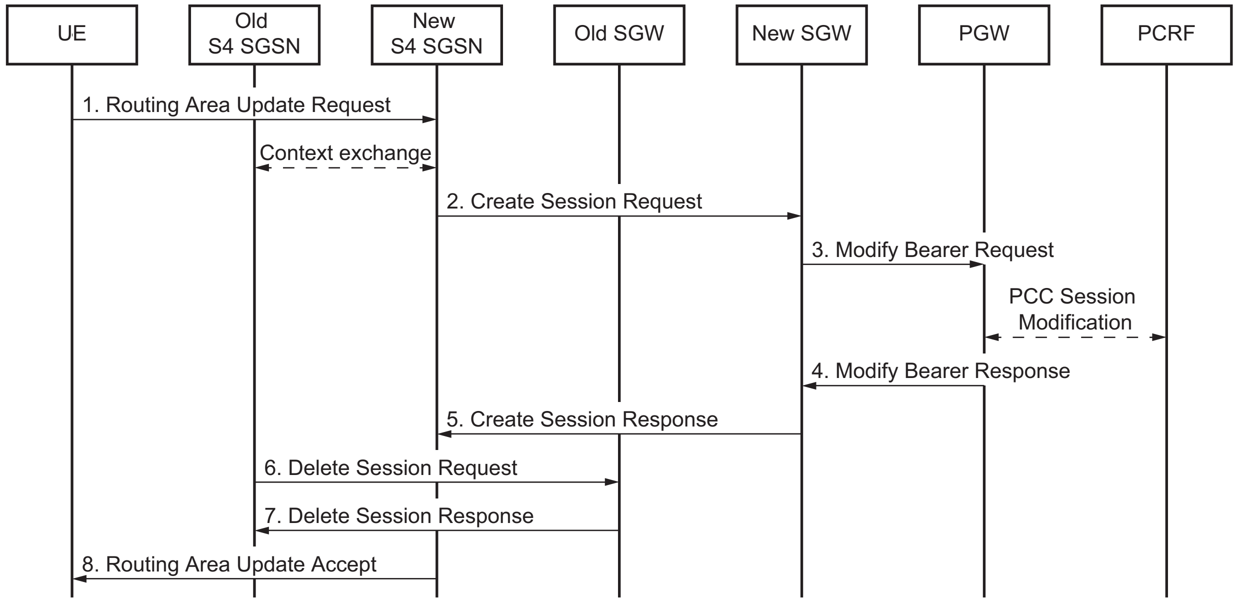

Figure 66 Signalling during an RAU Procedure in SGSN Using the S4 Interface, Old SGSN Using the S4 Interface with SGW Relocation

1. The UE sends a `Routing Area Update Request` to the new S4-SGSN.

2. The new S4-SGSN sends a `Create Session Request` to the new SGW. The OI flag is set to 1. The request can also contain DTF. If DTF is set to 1, Direct Tunnel is to be used and user plane F-TEID is not included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The new SGW sends a `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

4. The PGW responds with a `Modify Bearer Response` message to the new SGW.

5. The new SGW sends a `Create Session Response` to the new S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

   If configured to perform charging, the new SGW begins collecting charging data.

6. The old S4-SGSN sends a `Delete Session Request` to the old SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

7. The old SGW responds with a `Delete Session Response` to the old S4-SGSN.

If configured to perform charging, the old SGW closes the final charging record.

8. The new S4-SGSN sends a `Routing Area Update Accept` to the UE.

10.1.1.4 RAU in SGSN Using the S4 Interface, Old SGSN Using the S4 Interface - RAU without SGW Relocation

The signalling during an RAU procedure in SGSNs without SGW relocation using the S4 Interface is shown in Figure 67.

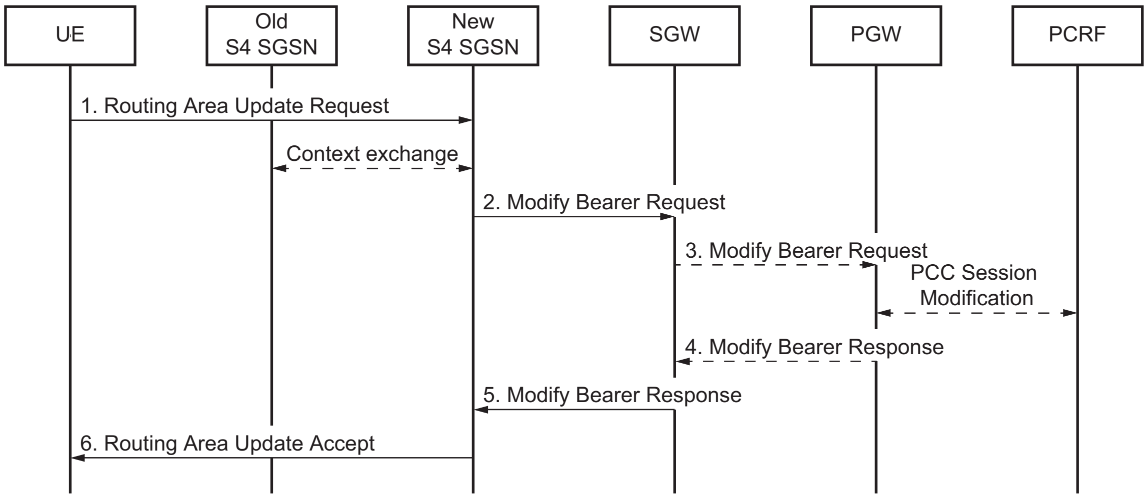

Figure 67 Signalling during a RAU Procedure in SGSNs without SGW Relocation Using the S4 Interface

1. The UE sends a `Routing Area Update Request` message to the new S4-SGSN.

2. The new S4-SGSN sends a `Modify Bearer Request` message to the SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is to be used and no user plane F-TEID is included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The SGW sends the `Modify Bearer Request` message to the PGW in cases, for example, when the RAT type is changed.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

5. The SGW sends the `Modify Bearer Response` message to the new S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

6. The new S4-SGSN sends a `Routing Area Update Accept` message to the UE.

10.1.2 Handover or SRNS Relocation

If the UE is in connected mode, a handover or SRNS relocation procedure is performed, if allowed by the radio network.

This section describes the following handover or relocation scenarios:

— From the SGSN using the Gn/Gp Interface to SGSN using the S4 Interface

— From the SGSN using the S4 Interface to SGSN using the Gn/Gp Interface

— In the SGSN or between SGSNs using the S4 Interface - with or without SGW Relocation

— Enhanced SRNS Relocation - with or without SGW relocation

10.1.2.1 Handover or Relocation from SGSN Using the Gn/Gp Interface to SGSN Using the S4 Interface

The signalling during a handover or relocation from SGSN using the Gn/Gp interface to SGSN using the S4 interface is shown in Figure 68.

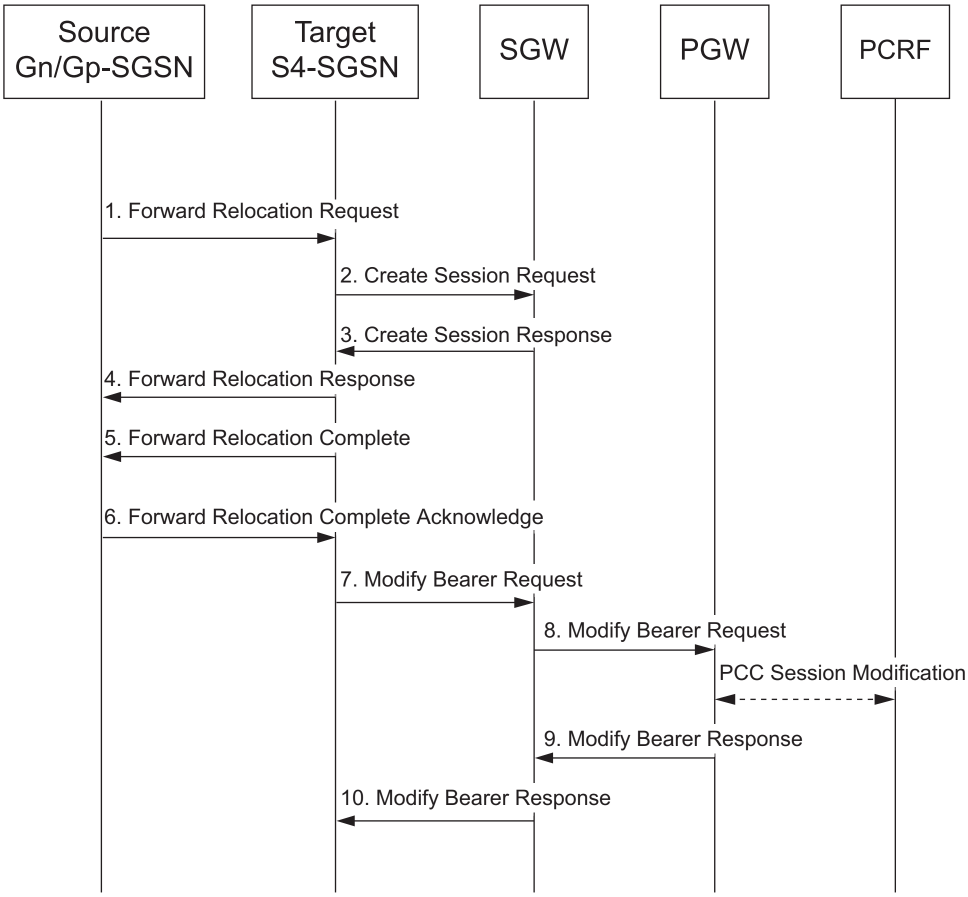

Figure 68 Signalling during a Handover or Relocation from SGSN using the Gn/Gp Interface to SGSN Using the S4 Interface

1. Upon reception of `Handover Required` message or `Relocation Required` message from the source radio network, the source Gn/Gp SGSN sends an `Forward Relocation Request` message to the target S4-SGSN.

2. The target S4-SGSN sends a `Create Session Request` message to the SGW. The OI flag is set to `0` or not included. The request also contains DTF. If DTF is set to 1, Direct Tunnel is to be used and user plane F-TEID is not included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The SGW responds with a `Create Session Response` message to the target S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

4. The target S4-SGSN requests that the radio bearer be established. Once it is established, the target S4-SGSN sends a `Forward Relocation Response` message to the source Gn/Gp SGSN.

5. When the target S4-SGSN receives the information that the radio network is complete with handover or relocation, the target S4-SGSN sends a `Forward Relocation Complete` message to the source Gn/Gp SGSN.

6. The source Gn/Gp SGSN sends a `Forward Relocation Complete Acknowledge` to the target S4-SGSN.

7. The target S4-SGSN sends a `Modify Bearer Request` message to the SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If direct tunnel is not applicable or not established, `S4-U SGSN F-TEID` is included.

8. The SGW updates and sends the `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

9. The PGW sends a `Modify Bearer Response` message to the SGW.

10. The SGW updates and sends the `Modify Bearer Response` message to the target S4-SGSN. If DTF is set to `0` in Step 7, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 7, `S12 SGW F-TEID` is returned.

10.1.2.2 Handover or Relocation from SGSN Using the S4 Interface to SGSN Using the Gn/Gp Interface

The signalling during a handover or relocation from SGSN using the S4 interface and SGSN using the Gn/Gp interface is shown in Figure 69.

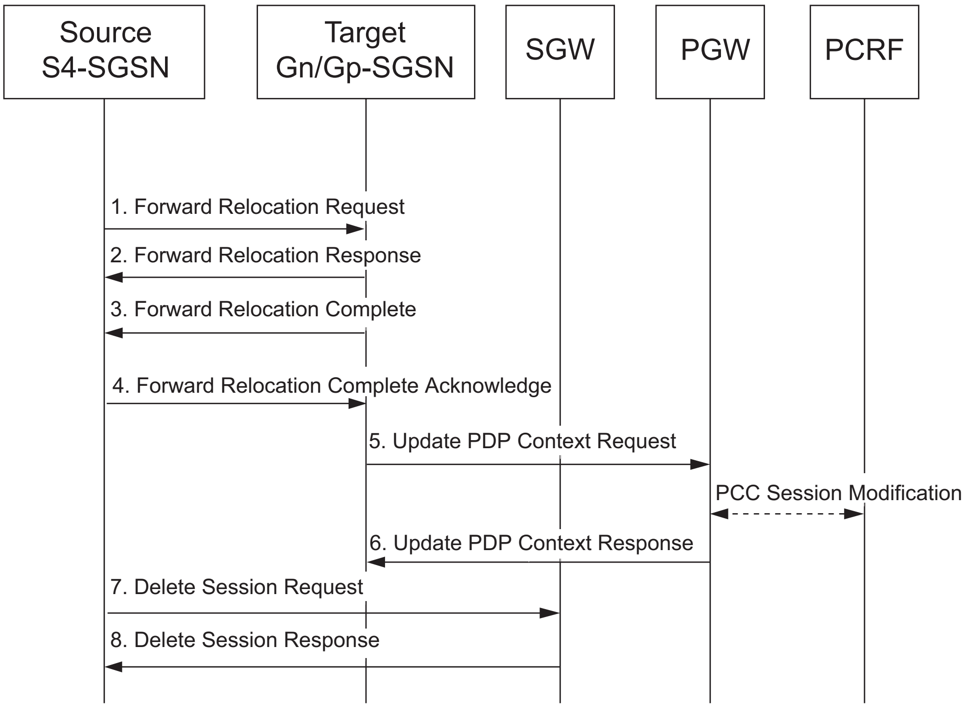

Figure 69 Signalling during a Relocation from SGSN Using the S4 Interface and SGSN Using the Gn/Gp Interface

1. Upon reception of `Handover Required` message or `Relocation Required` message from the source radio network, the source S4-SGSN sends a `Forward Relocation Request` message to the target Gn/Gp SGSN.

2. The target Gn/Gp SGSN requests that the radio bearer be established. Once it is established, the target Gn/Gp SGSN responds with a `Forward Relocation Response` message to the source S4-SGSN.

3. When the target Gn/Gp SGSN receives the information that the radio network is complete with handover or relocation, the target Gn/Gp SGSN sends a `Forward Relocation Complete` message to the source S4-SGSN.

4. The source S4-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target Gn/Gp SGSN.

5. The target Gn/Gp SGSN sends an `Update PDP Context Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

6. The PGW responds with an `Update PDP Context Response` message to the SGW.

7. The source S4-SGSN sends a `Delete Session Request` message to the SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

8. The SGW responds with a `Delete Session Response` message to the source S4-SGSN.

10.1.2.3 Handover or Relocation between SGSNs Using the S4 Interface - with SGW Relocation

The signalling during Handover or relocation between SGSNs using the S4 interface with SGW relocation is shown in Figure 70.

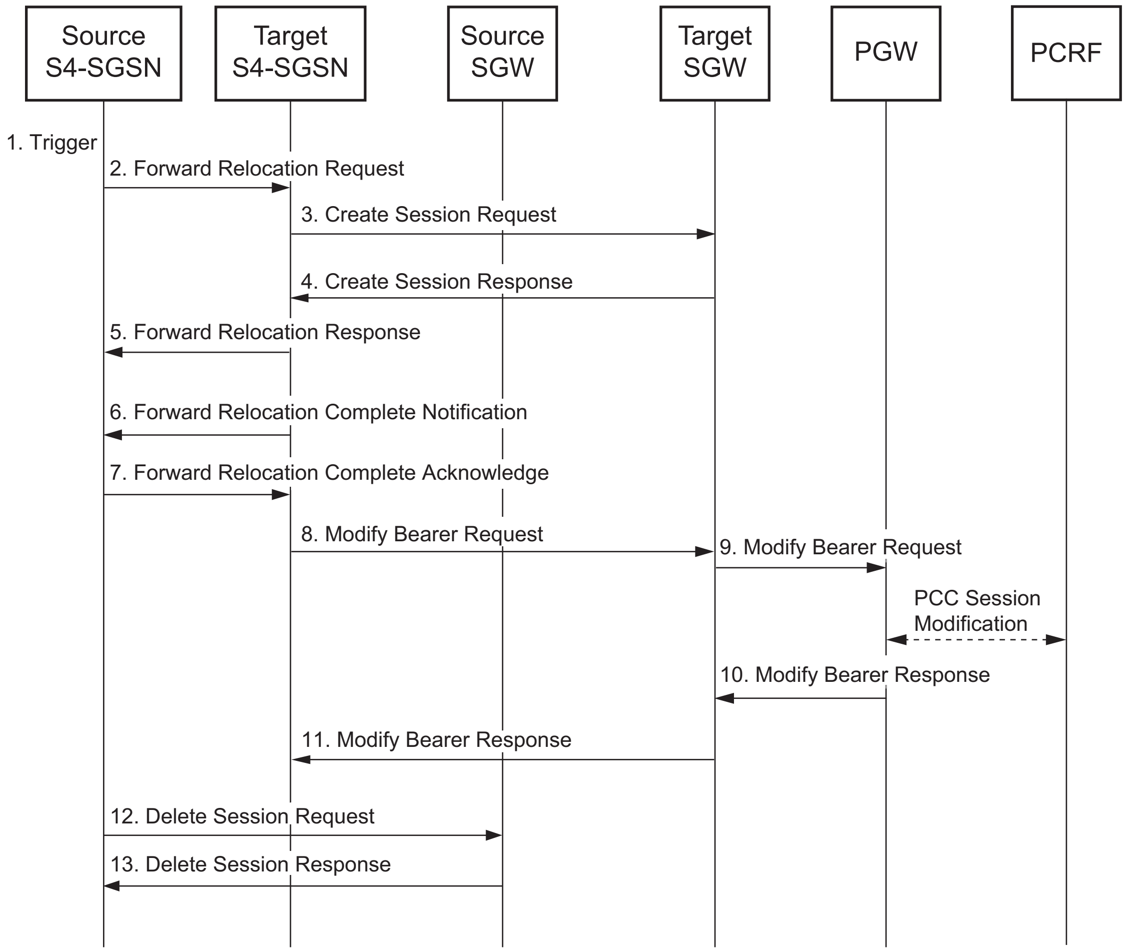

Figure 70 Signalling during a Handover or Relocation between SGSNs Using the S4 Interface - with SGW Relocation

1. The handover procedure is triggered in the source S4-SGSN.

2. Upon reception of `Handover Required` message or `Relocation Required` message from the source radio network, the source S4-SGSN sends a `Forward Relocation Request` message to the target S4-SGSN.

3. The target S4-SGSN sends a `Create Session Request` message to the target SGW. The OI flag is set to `0` or not included. The request can also contain DTF. If DTF is set to 1, Direct Tunnel is to be used and user plane F-TEID is not included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

4. The target SGW responds with a `Create Session Response` message to the target S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

   If configured to perform charging, the target SGW begins collecting charging data.

5. The target S4-SGSN requests that the radio bearer be established. Once it is established, the target S4-SGSN sends a `Forward Relocation Response` message to the source S4-SGSN.

6. When the target S4-SGSN receives the information that the radio network is complete with handover or relocation, the target S4-SGSN also sends a `Forward Relocation Complete Notification` message to the source S4-SGSN.

7. The source S4-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target S4-SGSN.

8. The target S4-SGSN sends a `Modify Bearer Request` message to the target SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If direct tunnel is not applicable or not established, `S4-U SGSN F-TEID` is included.

9. The target SGW updates the `Modify Bearer Request` message and sends it to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

10. The PGW responds with a `Modify Bearer Response` message to the target SGW.

11. The target SGW updates the `Modify Bearer Response` message and sends it to the target S4-SGSN. If DTF is set to `0` in Step 8, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 8, `S12 SGW F-TEID` is returned.

12. The source S4-SGSN sends a `Delete Session Request` to the source SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

13. The source SGW responds with a `Delete Session Response` to the source S4-SGSN.

    If configured to perform charging, the source SGW closes the final charging record.

10.1.2.4 Handover or Relocation between SGSNs Using S4 - without SGW Relocation

The signalling during a Handover or relocation between SGSNs using S4 without SGW relocation is shown in Figure 71.

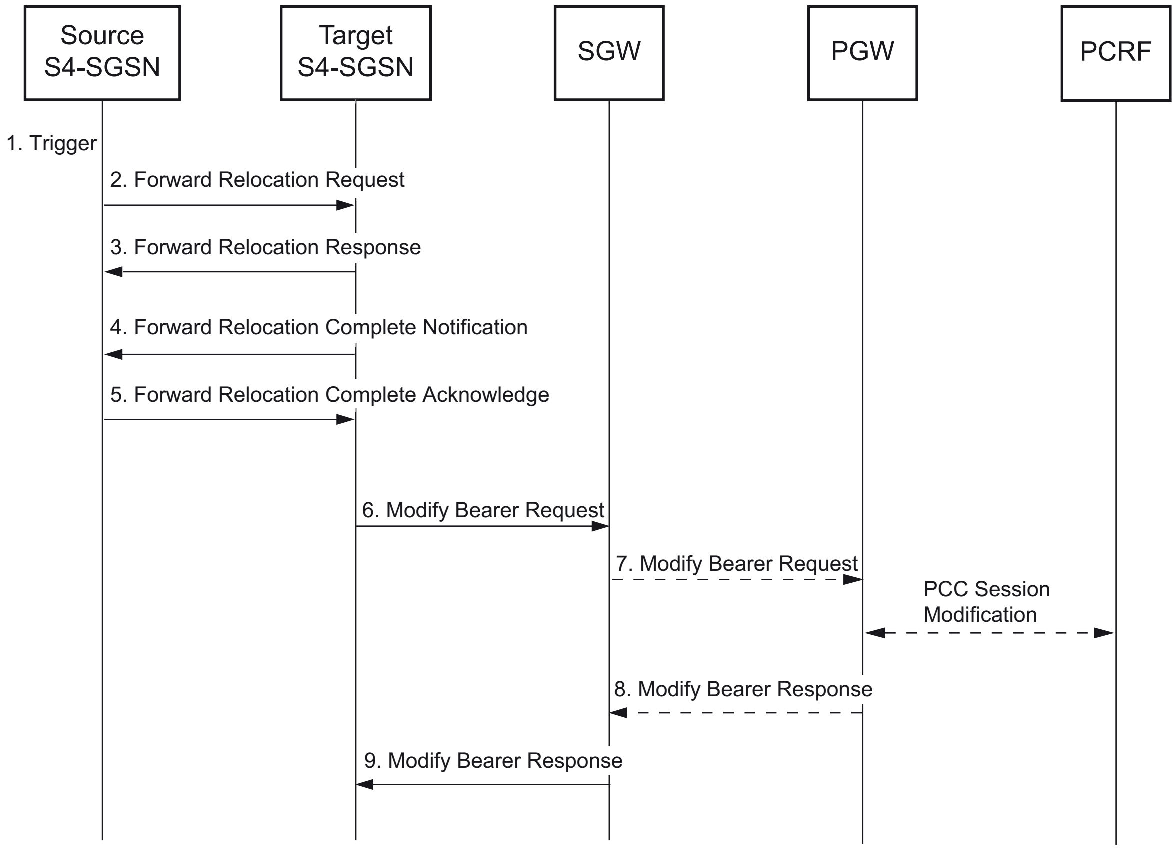

Figure 71 Signalling during a Relocation between SGSNs using the S4 Interface - without SGW Relocation

1. The handover procedure is triggered in the source S4-SGSN.

2. Upon reception of `Handover Required` message or `Relocation Required` message from the source radio network, the source S4-SGSN sends a `Forward Relocation Request` message to the target S4-SGSN.

3. The target S4-SGSN requests that the radio bearer be established. Once it is established, the target S4-SGSN responds with a `Forward Relocation Reponse` message to the source S4-SGSN.

4. When the target S4-SGSN receives the information that the radio network is complete with handover or relocation, the target S4-SGSN sends a `Forward Relocation Complete Notification` message to the source S4-SGSN.

5. The source S4-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target S4-SGSN.

6. The target S4-SGSN sends a `Modify Bearer Request` message to the SGW in cases, for example, when the RAT type is changed. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If direct tunnel is not applicable or not established, `S4-U SGSN F-TEID` is included.

7. The SGW sends a `Modify Bearer Request` message to the PGW, if, for example, the RAT Type is changed, or the ULI is included.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

8. The PGW responds with a `Modify Bearer Response` message to the SGW.

9. The SGW forwards the `Modify Bearer Response` message to the target S4-SGSN. If DTF is set to `0` in Step 6, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 6, `S12 SGW F-TEID` is returned.

10.1.2.5 Enhanced SRNS Relocation - with SGW Relocation

The signalling during an enhanced SRNS relocation with SGW relocation is shown in Figure 72.

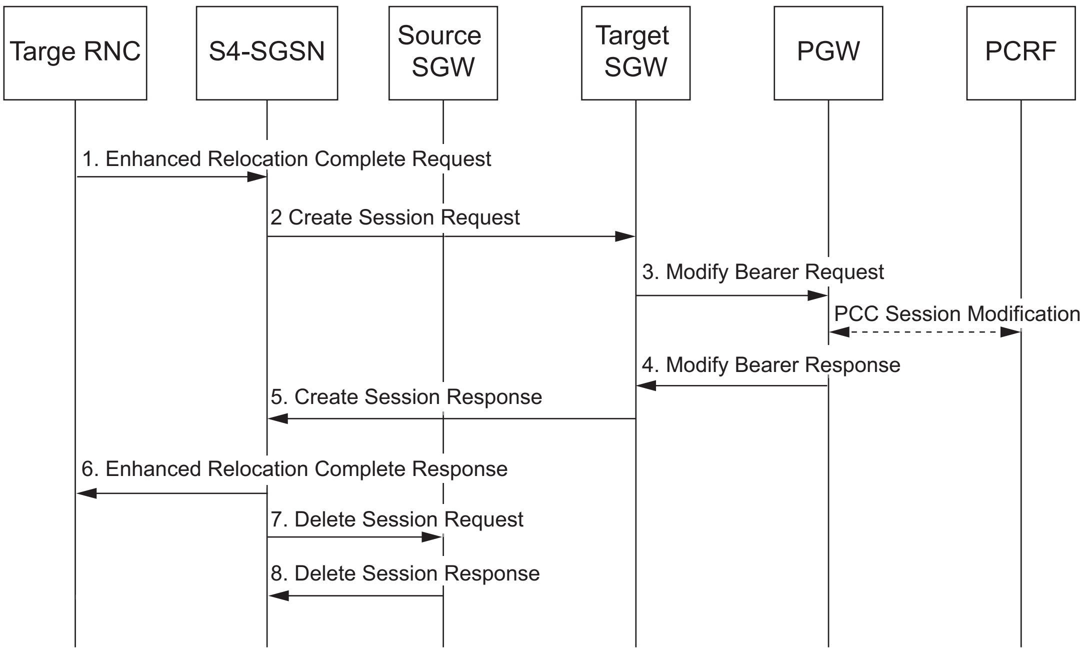

Figure 72 Signalling during a Enhanced SRNS Relocation - with SGW Relocation

1. The target RNC sends an `Enhanced Relocation Complete Request` message to the S4-SGSN.

2. The S4-SGSN sends a `Create Session Request` message to the target SGW. OI flag is set to 1. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If Direct Tunnel is not established, `S4-U SGSN F-TEID` is included.

3. The target SGW sends a `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

4. The PGW responds with a `Modify Bearer Response` message to the target SGW.

5. The target SGW sends a `Create Session Response` message to the S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

   If configured to perform charging, the target SGW begins collecting charging data.

6. The S4-SGSN sends an `Enhanced Relocation Complete Response` message to the target RNC.

7. The S4-SGSN sends a `Delete Session Request` to the source SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

8. The source SGW responds with a `Delete Session Response` message to the S4-SGSN.

   If configured to perform charging, the source SGW closes the final charging record.

10.1.2.6 Enhanced SRNS Relocation - without SGW Relocation

The signalling during an enhanced SRNS relocation without SGW relocation is shown in Figure 73.

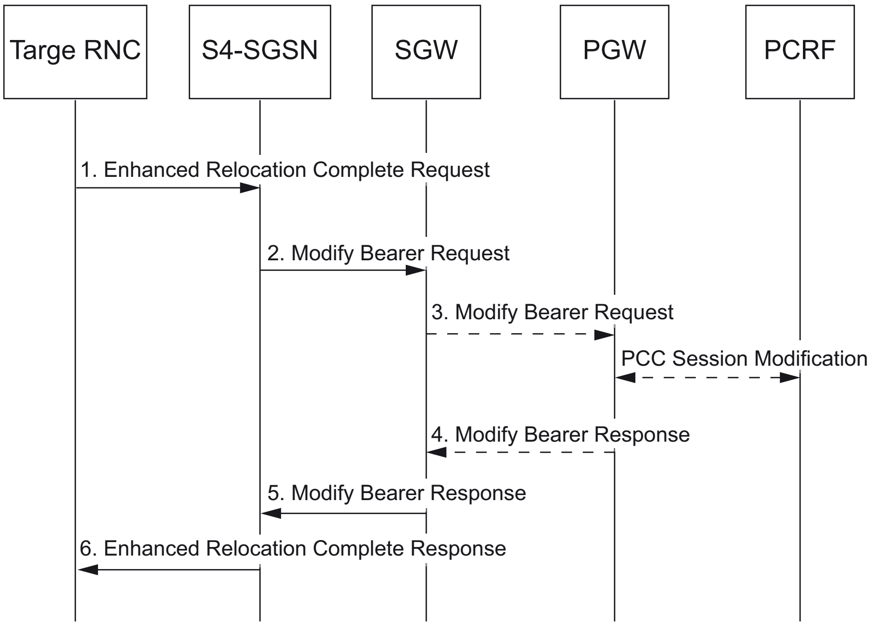

Figure 73 Signalling during an Enhanced SRNS Relocation - without SGW Relocation

1. The target RNC sends an `Enhanced Relocation Complete Request` message to the S4-SGSN.

2. The S4-SGSN sends a `Modify Bearer Request` message to the SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If Direct Tunnel is not established, `S4-U SGSN F-TEID` is included.

3. The SGW forwards the `Modify Bearer Request` message to the PGW in cases, for example, when ULI is included.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

5. The SGW forwards the `Modify Bearer Response` message to the S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

6. The S4-SGSN sends an `Enhanced Relocation Complete Response` message to the target RNC.

10.2 Inter RAT Access Mobility

The following sections describe the Routing Area Update and the Tracking Area Update that involve mobility between LTE and GSM or WCDMA systems.

Note: The Inter RAT mobility to and from NB-IOT is not supported.

10.2.1 Routing Area Update

The signalling during a Routing Area Update (RAU) procedure from LTE to GSM or WCDMA systems is shown in Figure 74.

The target SGSN uses the Gn interface to communicate with the PGW.

This procedure is supported for both when the UE is in idle state and connected state.

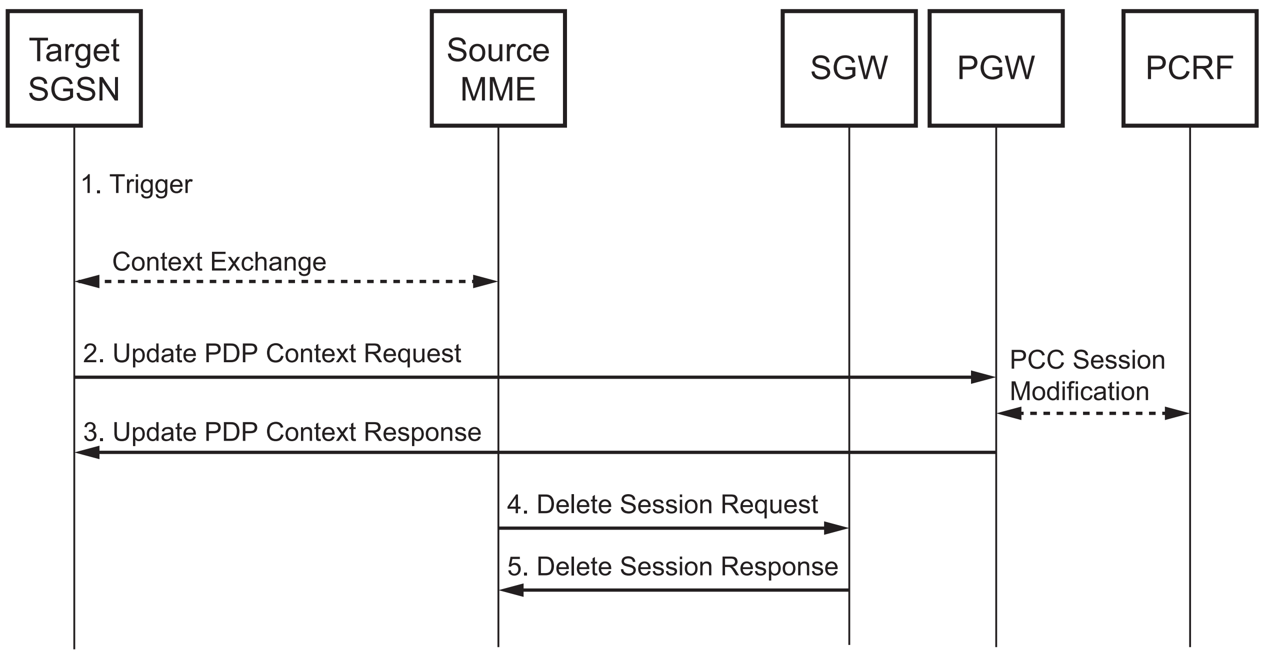

Figure 74 Signalling during RAU Procedure from LTE to GSM or WCDMA Systems

The RAU procedure consists of the following steps:

1. The UE initiates the RAU.

   The target SGSN and the source MME exchange `SGSN Context` messages.

2. The target SGSN sends an `Update PDP Context Request` message to the PGW. The request includes target SGSN IP-addresses and TEIDs for control plane and user plane, NSAPI, and QoS parameters.

Note: If the `Update PDP Context Request` message does not contain any RAT type IE, and there is no RAT type configured corresponding to the SGSN IP address, the PGW uses the default RAT type as the current RAT type. If the default RAT type is not configured or configured as `keep-value`, PGW uses the previous RAT type as the current RAT type. For more information, see Section 3.19 on page 36.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

3. Based on the received message, the PGW updates the corresponding PDP context and sends an `Update PDP Context Response` message back to the target SGSN.

4. The source MME sends a `Delete Session Request` message to the SGW. This clears the EPS bearer context in the SGW.

   If the SGW receives a `Delete Session Request` message addressed to a TEID that is not recognized by the SGW, the message is rejected.

   The SI flag and the OI flag are included in the `Delete Session Request` message. These flags are set to **`one`** or to **`zero`** by the source MME. The SI flag set to **`one`** indicates that all PDN connections should be deleted in the SGW; the SI flag set to **`zero`** means that only the PDN connection pointed out by the LBI should be deleted. The OI flag set to **`one`** indicates that the SGW should signal to the PGW to delete the same PDN connections; the OI flag set to **`zero`** means that no signalling to the PGW should be done.

   If the received `Delete Session Request` message contains the flags SI=1 and OI=1, then the SGW rejects the request by sending a `Delete Session Response` message.

   If the received `Delete Session Request` message contains the flags SI=0 and OI=0, then the following cases exist:

   — If the LBI for the default bearer is included in the message, the SGW deletes the PDN connection pointed out by the LBI and sends a `Delete Session Response` message with acceptance response cause value back to the source MME.

   — If the received `Delete Session Request` message does not contain the LBI, the SGW rejects the request by sending a `Delete Session Response` message back to the source MME.

5. Normally, the SGW clears the EPS bearer context and sends a `Delete Session Response` back to the source MME.

   If configured to perform charging, the SGW closes the final charging record.

10.2.2 RAU with MME to S4-SGSN Interaction - without SGW Relocation

The signalling during an RAU procedure with MME interaction without SGW relocation is shown in Figure 75.

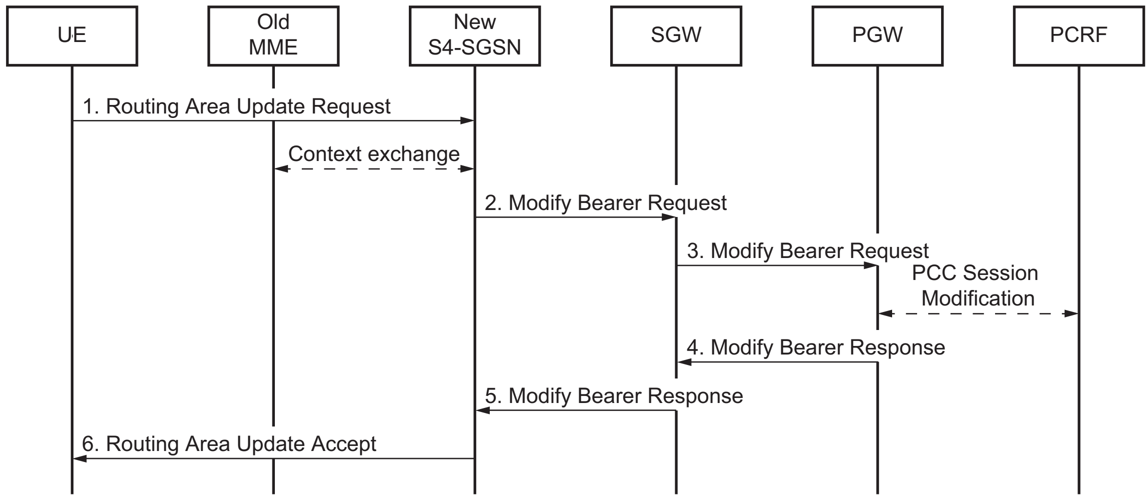

Figure 75 Signalling during an RAU Procedure with MME interaction without SGW Relocation

1. The UE sends a `Routing Area Update Request` message to the new S4-SGSN.

2. The new S4-SGSN sends a `Modify Bearer Request` message to the SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is to be used and no user plane F-TEID is included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The SGW sends the `Modify Bearer Request` message to the PGW.

   If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

   If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

   If the UE does not indicate support for network-initiated dedicated bearers at UE initial attach or UE-requested PDN connectivity, all existing dedicated bearers are deleted. For details, refer to Policy Control.

5. The SGW forwards the `Modify Bearer Response` message to the new S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

If the PDN connection is in the Suspended state, the SGW resumes the suspended PDN connection.

6. The new S4-SGSN sends a `Routing Area Update Accept` message to the UE.

10.2.3 RAU with MME to S4-SGSN Interaction - with SGW Relocation

The signalling during an RAU procedure with MME interaction with SGW relocation is shown in Figure 76.

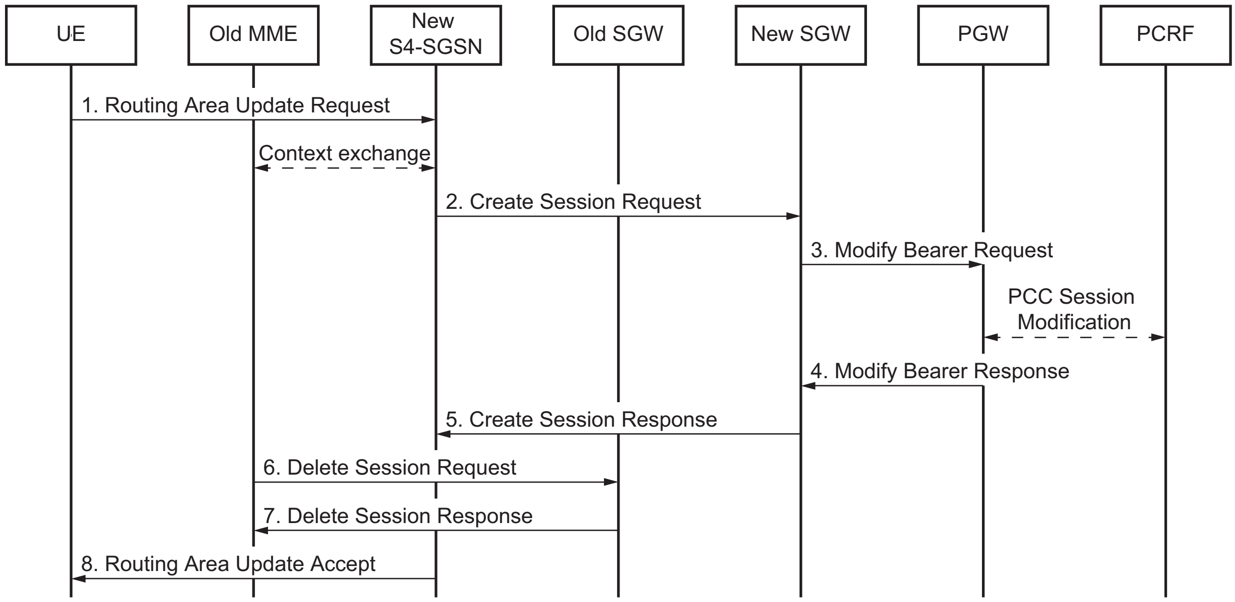

Figure 76 Signalling during an RAU Procedure with MME interaction with SGW Relocation

1. The UE sends a `Routing Area Update Request` to the new S4-SGSN.

2. The new S4-SGSN sends a `Create Session Request` message to the new SGW. The OI flag is set to 1. The request also contains DTF. If DTF is set to 1, Direct Tunnel is to be used and no user plane F-TEID is included. If DTF is not included or included but set to value `0`, `S4-U SGSN F-TEID` can be included.

3. The new SGW sends a `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

4. The PGW responds with a `Modify Bearer Response` message to the new SGW.

If the UE did not indicate support for network-initiated dedicated bearers at UE initial attach or UE-requested PDN connectivity, all existing dedicated bearers are deleted. For details, refer to Policy Control.

5. The new SGW sends a `Create Session Response` to the new S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

   If configured to perform charging, the new SGW begins collecting charging data.

6. The old MME sends a `Delete Session Request` to the old SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

7. The old SGW responds with a `Delete Session Response` to the old MME.

   If configured to perform charging, the old SGW closes the final charging record.

8. The new S4-SGSN sends a `Routing Area Update Accept` to the UE.

10.2.4 Inter RAT Handover from MME to Gn-SGSN

The signalling during an Inter RAT Handover from MME to Gn-SGSN is shown in Figure 77.

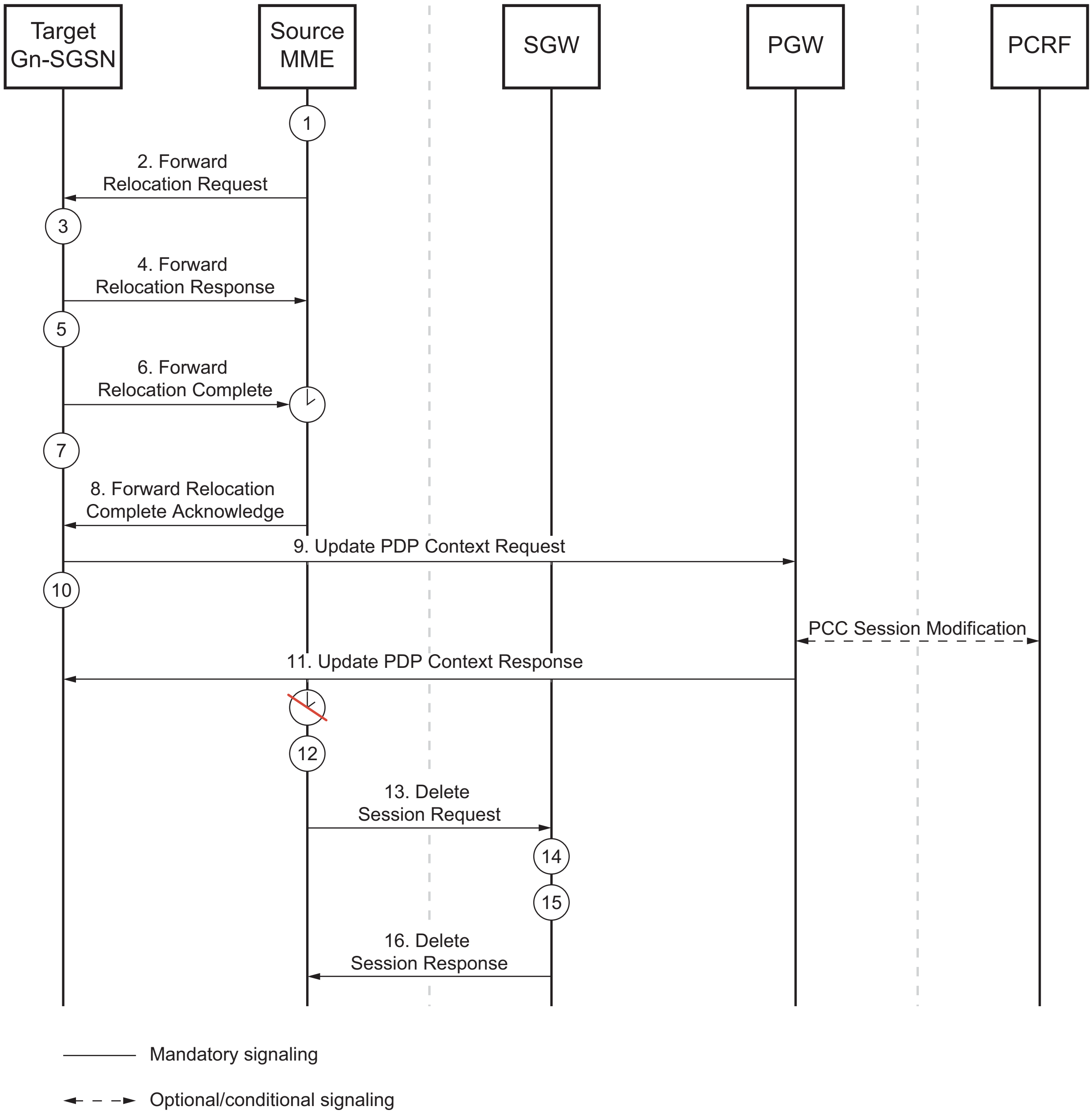

Figure 77 Signalling during an Inter RAT Handover from MME to Gn-SGSN

1. The source MME maps the EPS bearer parameters to PDP contexts.

2. The source MME sends a `Forward Relocation Request` message, including the PGW TEIDs, to the target Gn-SGSN.

3. The target Gn-SGSN allocates resources for the transmission of user data.

4. The target Gn-SGSN sends a `Forward Relocation Response` message to the source MME.

5. The target Gn-SGSN completes the relocation.

6. The target Gn-SGSN sends a `Forward Relocation Complete` message to the source MME.

In the source MME, the timer for releasing resources starts when it receives the `Forward Relocation Complete` message.

7. The target Gn-SGSN starts forwarding uplink data.

8. The source MME sends a `Forward Relocation Complete Acknowledge` message to the target Gn-SGSN.

9. The target Gn-SGSN sends an `Update PDP Context Request` message to the PGW to switch the user plane to the SGSN.

   Note: If the `Update PDP Context Request` message does not contain any RAT type IE, and there is no RAT type configured corresponding to the SGSN IP address, the PGW uses the default RAT type as the current RAT type. If the default RAT type is not configured or configured as `keep-value`, PGW uses the previous RAT type as the current RAT type. For more information, see Section 3.19 on page 36.

10. The target Gn-SGSN starts forwarding downlink data.

If PCC is deployed, the PGW may initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

11. The PGW sends an `Update PDP Context Response` message, including the Charging ID, to the target Gn-SGSN.

In the source MME, the timer for releasing resources expires.

12. The source MME deletes the EPS bearer resources.

13. The source MME sends a `Delete Session Request` message to the SGW.

14. The SGW stops forwarding uplink and downlink data.

15. The SGW deletes the EPS bearer resources.

16. The SGW sends a `Delete Session Response` message to the source MME.

10.2.5 Inter RAT Handover from Gn-SGSN to MME

The signalling during an Inter RAT Handover from MME to Gn-SGSN is shown in Figure 78.

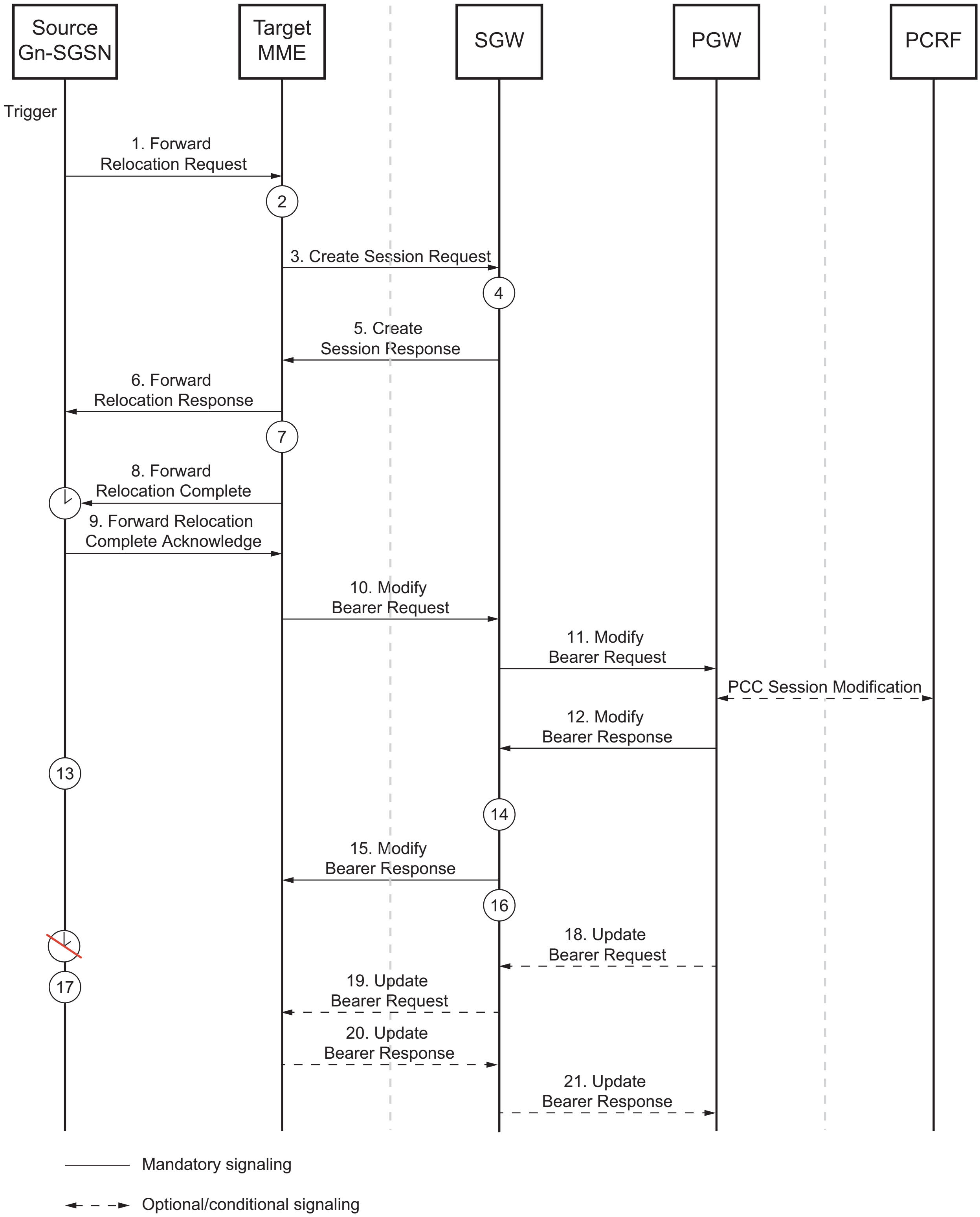

Figure 78 Signalling during an Inter RAT Handover from Gn-SGSN to MME

1. The source Gn-SGSN sends a `Forward Relocation Request` message to the target MME.

2. The target MME maps the PDP context parameters to EPS bearers and selects an SGW.

3. The target MME sends a `Create Session Request` to the SGW.

4. The SGW allocates EPS bearer resources.

5. The SGW sends a `Create Session Response` message to the target MME.

6. The target MME sends `Forward Relocation Response` to source Gn-SGSN.

7. The target MME completes the relocation.

8. The target MME sends a `Forward Relocation Complete` message to the source Gn-SGSN.

In the source Gn-SGSN, the timer for releasing resources starts when it receives the `Forward Relocation Complete` message.

9. The source Gn-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target MME.

10. The target MME sends an `Modify Bearer Request` message, including the eNodeB TEIDs, to the SGW.

11. The SGW sends a `Modify Bearer Request` to the PGW to switch the user plane to the SGW.

    If PCC is deployed, the PGW may initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

    If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

    If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Modify Bearer Request`.

12. The PGW sends a `Modify Bearer Response` message, including the identity of the default bearer and the Charging ID, to SGW.

    If the PGW is configured to perform, and can support pause charging, the `Modify Bearer Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

13. The source Gn-SGSN stops forwarding data.

14. The SGW starts forwarding downlink data.

15. The SGW sends a `Modify Bearer Response` message, including the identity of the default bearer, to the target MME.

16. The SGW starts forwarding uplink data.

In the source Gn-SGSN, the timer for releasing resources expires.

17. The source Gn-SGSN deletes the PDP context resources.

18. If the QoS is changed as part of the handover, or if the QCI for a bearer is greater than 9, the PGW sends an `Update Bearer Request`, including the QoS for the bearer, to the SGW.

19. The SGW sends an `Update Bearer Request` to the MME.

20. The MME sends an `Update Bearer Response` to the SGW.

21. The SGW sends an `Update Bearer Response` to the PGW.

10.2.6 Inter RAT Handover from MME to S4-SGSN - without SGW Relocation

The signalling during an Inter RAT Handover from MME to S4-SGSN without SGW Relocation is shown in Figure 79.

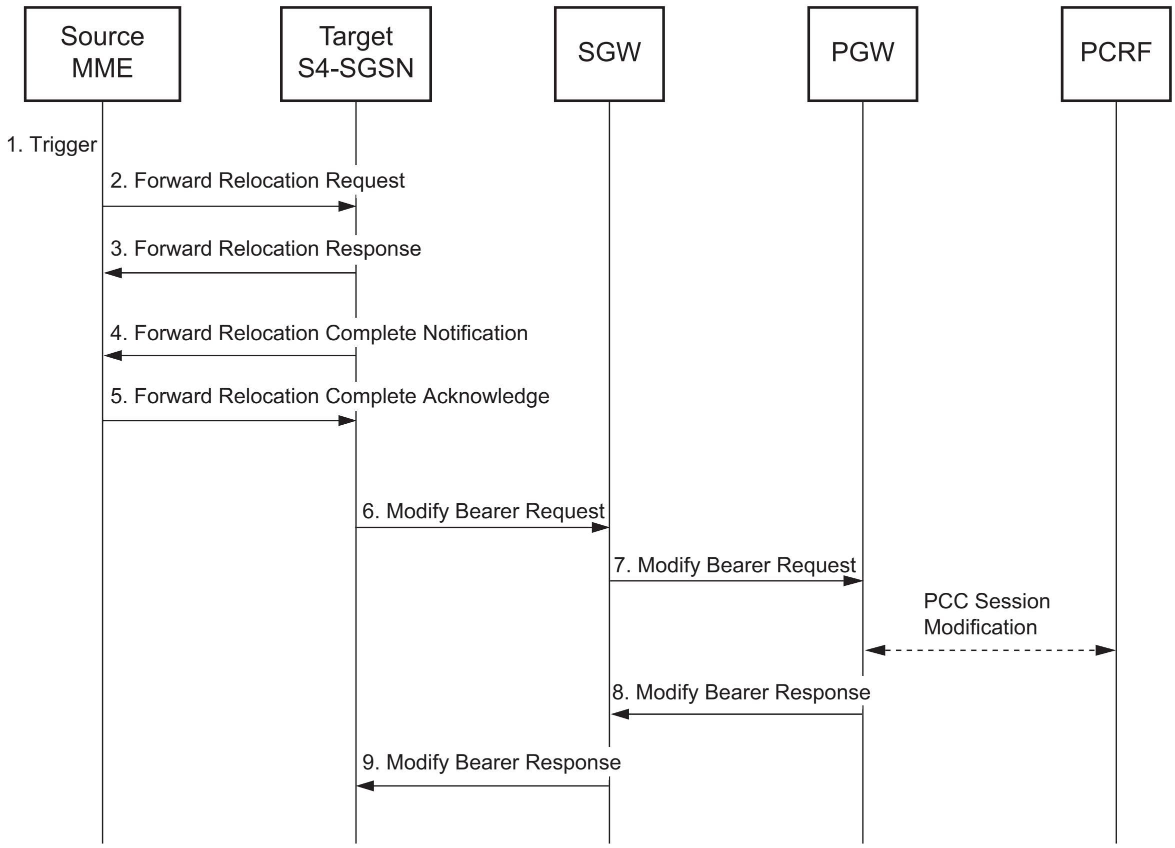

Figure 79 Signalling during an Inter RAT Handover from MME to S4-SGSN without SGW Relocation

1. The handover procedure is triggered in the source MME.

2. When the source MME receives a `Handover Required` message from the source radio network, the source MME sends a `Forward Relocation Request` message to the target S4-SGSN.

3. The target S4-SGSN requests that the radio bearer be established. Then, the target S4-SGSN responds by sending a `Forward Relocation Reponse` message to the source MME.

4. When the target S4-SGSN receives the information that the radio network is complete with handover, the target S4-SGSN sends a `Forward Relocation Complete Notification` message to the source MME.

5. The source MME sends a `Forward Relocation Complete Acknowledge` message to the target S4-SGSN.

6. The target S4-SGSN sends a `Modify Bearer Request` message to the SGW in cases. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If direct tunnel is not applicable or not established, `S4-U SGSN F-TEID` is included.

7. The SGW sends the `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

8. The PGW responds with a `Modify Bearer Response` message to the SGW.

If the UE did not indicate support for network-initiated dedicated bearers at UE initial attach or UE-requested PDN connectivity, all existing dedicated bearers are deleted. For details, refer to Policy Control.

9. The SGW forwards the `Modify Bearer Response` message to the target S4-SGSN.If DTF is set to `0` in Step 6, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 6, `S12 SGW F-TEID` is returned.

10.2.7 Inter RAT Handover from MME to S4-SGSN - with SGW Relocation

The signalling during an Inter RAT Handover procedure from MME to S4-SGSN with SGW relocation is shown in Figure 80.

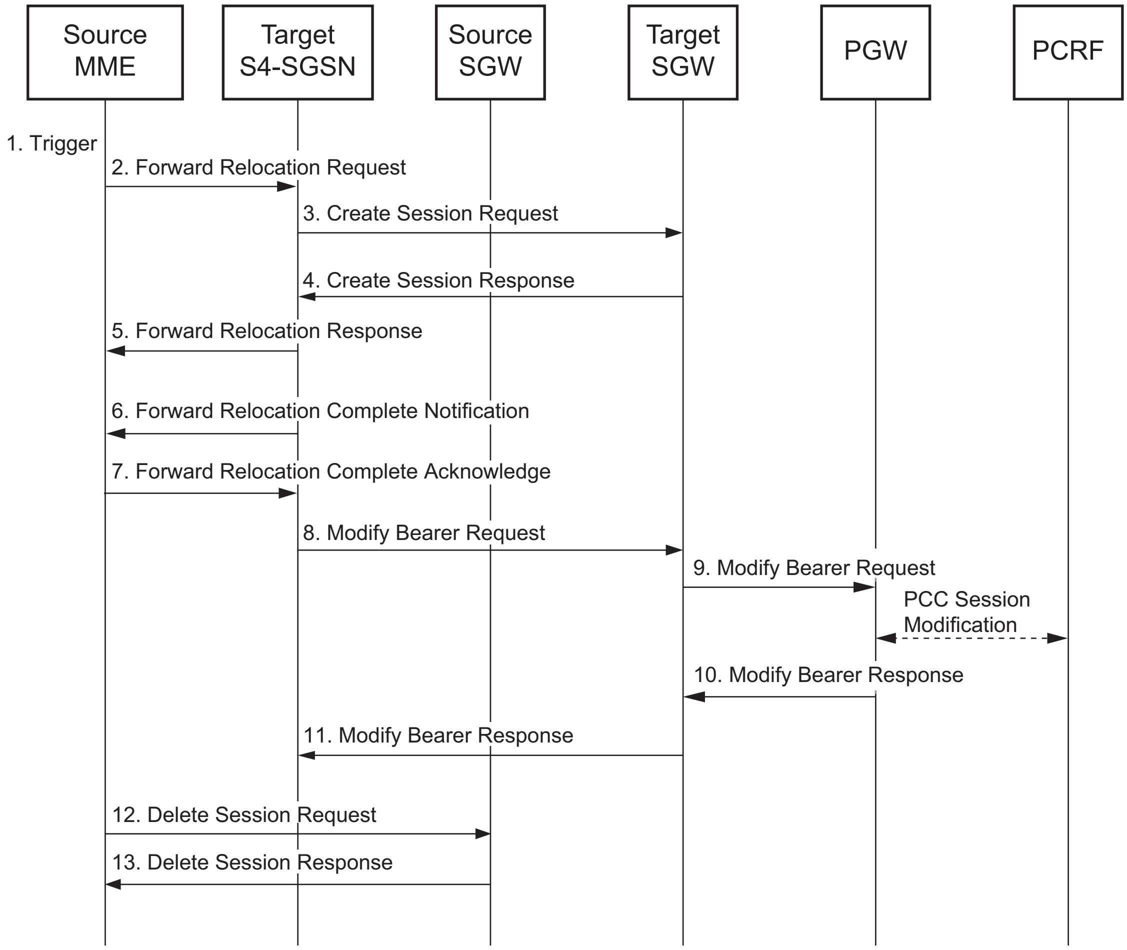

Figure 80 Signalling during an Inter RAT Handover from MME to S4-SGSN with SGW Relocation

1. The handover procedure is triggered in the source MME.

2. When the source MME receives a `Handover Required` message from the source radio network, the source MME sends a `Forward Relocation Request` message to the target S4-SGSN.

3. The target S4-SGSN sends a `Create Session Request` message to the target SGW. The OI flag is set to `0` or not included. The request also contains DTF. If DTF is set to 1, Direct Tunnel is established and `S12 RNC F-TEID` is included. If direct tunnel is not applicable or not established, `S4-U SGSN F-TEID` is included.

4. The target SGW responds with a `Create Session Response` message to the target S4-SGSN. If DTF is set to `0` in Step 2, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 2, `S12 SGW F-TEID` is returned.

   If configured to perform charging, the target SGW begins collecting charging data.

5. The target S4-SGSN requests that the radio bearer is established. Then, the target S4-SGSN sends a `Forward Relocation Response` message to the source MME.

6. When the target S4-SGSN receives the information that the radio network completes handover, then the target S4-SGSN sends a `Forward Relocation Complete Notification` message to the source MME.

7. The source MME sends a `Forward Relocation Complete Acknowledge` message to the target S4-SGSN.

8. The target S4-SGSN sends a `Modify Bearer Request` message to the target SGW. The request also contains DTF. If DTF is set to 1, Direct Tunnel is to be used.

9. The target SGW updates the `Modify Bearer Request` message and sends it to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

10. The PGW responds with a `Modify Bearer Response` message to the target SGW.

If the UE does not indicate support for network-initiated dedicated bearers at UE initial attach or UE-requested PDN connectivity, all existing dedicated bearers are deleted. For details, refer to Policy Control.

11. The target SGW updates the `Modify Bearer Response` message and sends it to the target S4-SGSN. If DTF is set to `0` in Step 8, `S4-U SGW F-TEID` is returned. If DTF is set to 1 in Step 8, `S12 SGW F-TEID` is returned.

12. The source MME sends a `Delete Session Request` to the source SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

13. The source SGW responds by sending a `Delete Session Response` to the source MME.

    If configured to perform charging, the source SGW closes the final charging record.

10.2.8 Inter RAT Handover from S4-SGSN to MME - without SGW Relocation

The signalling during an Inter RAT Handover from S4-SGSN to MME without SGW Relocation is shown in Figure 81.

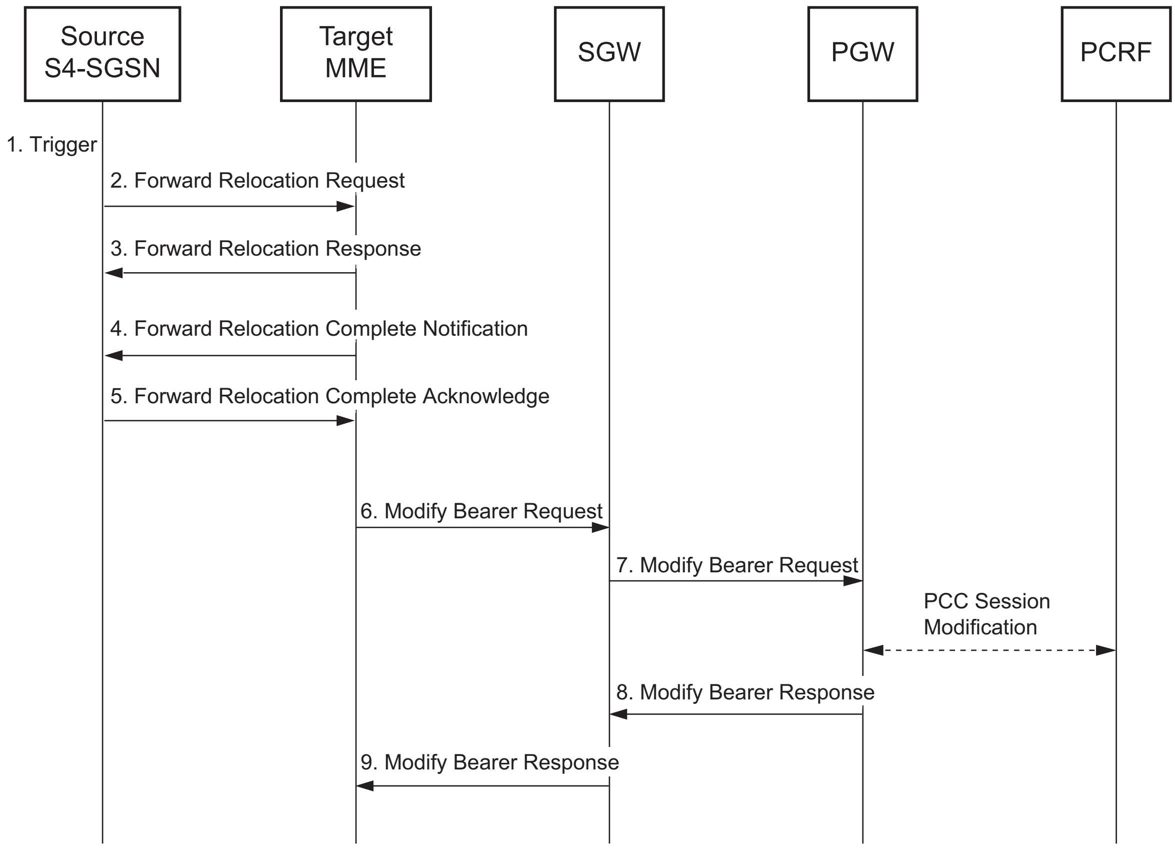

Figure 81 Signalling during an Inter RAT Handover from S4-SGSN to MME without SGW Relocation

1. The handover procedure is triggered in the source S4-SGSN.

2. When the source S4-SGSN receives a `Handover Required` message or `Relocation Required` message from the source radio network, the source S4-SGSN sends a `Forward Relocation Request` message to the target MME.

3. The target MME requests that the radio bearer be established. Then, the target MME responds by sending a `Forward Relocation Reponse` message to the source S4-SGSN.

4. When the target MME receives the information that the radio network is complete with handover or relocation, the target MME sends a `Forward Relocation Complete Notification` message to the source S4-SGSN.

5. The source S4-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target MME.

6. The target MME sends a `Modify Bearer Request` message to the SGW in cases, for example, when the RAT type is changed.

Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

7. The SGW forwards the `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

8. The PGW responds by sending a `Modify Bearer Response` message to the SGW.

9. The SGW forwards the `Modify Bearer Response` message to the target MME.

Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

10.2.9 Inter RAT Handover from S4-SGSN to MME - with SGW Relocation

The signalling during an Inter RAT Handover procedure from S4-SGSN to MME - with SGW relocation is shown in Figure 82.

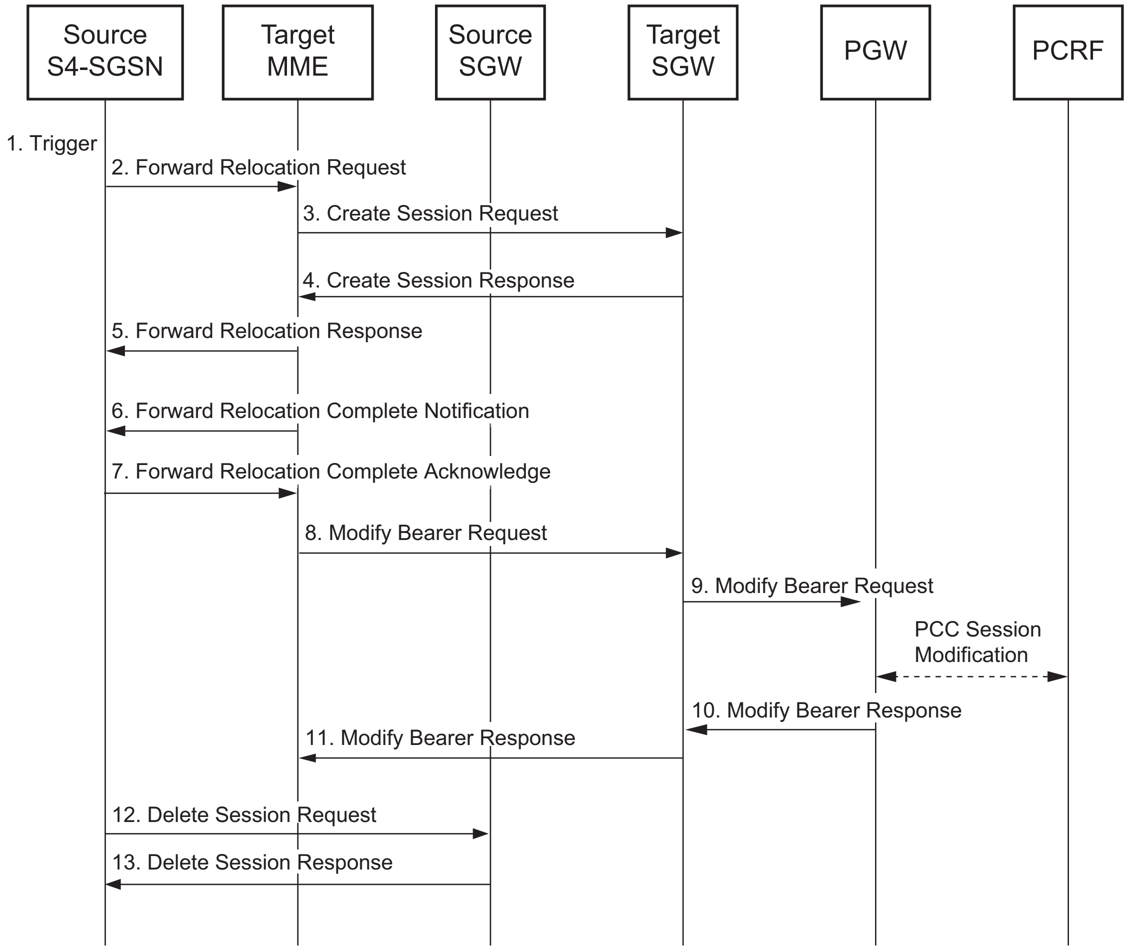

Figure 82 Signalling during an Inter RAT Handover from S4-SGSN to MME with SGW Relocation

1. The handover procedure is triggered in the source S4-SGSN.

2. When the source S4-SGSN receives a `Handover Required` message or `Relocation Required` message from the source radio network, the source S4-SGSN sends a `Forward Relocation Request` message to the target MME.

3. The target MME sends a `Create Session Request` message to the target SGW. The OI flag is set to `0` or not included.

4. The target SGW responds with a `Create Session Response` message to the target MME.

   If configured to perform charging, the target SGW begins collecting charging data.

5. The target MME requests that the radio bearer is established. Then, the target MME sends a `Forward Relocation Response` message to the source S4-SGSN.

6. When the target MME receives the information that the radio network has completed the handover or relocation, then the target MME sends a `Forward Relocation Complete Notification` message to the source S4-SGSN.

7. The source S4-SGSN sends a `Forward Relocation Complete Acknowledge` message to the target MME.

8. The target MME sends a `Modify Bearer Request` message to the target SGW.

9. The target SGW updates the `Modify Bearer Request` message and sends it to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

10. The PGW responds with a `Modify Bearer Response` message to the target SGW.

11. The target SGW updates the `Modify Bearer Response` message and sends it to the target MME.

12. The source S4-SGSN sends a `Delete Session Request` message to the source SGW. The OI flag is set to `0` or not included. The SI flag is set to 1.

13. The source SGW responds by sending a `Delete Session Response` message to the source S4-SGSN.

    If configured to perform charging, the source SGW closes the final charging record.

10.2.10 Tracking Area Update

The signalling during a TAU procedure from GSM or WCDMA to LTE system is shown in Figure 83.

This procedure is supported only if the UE is in idle state.

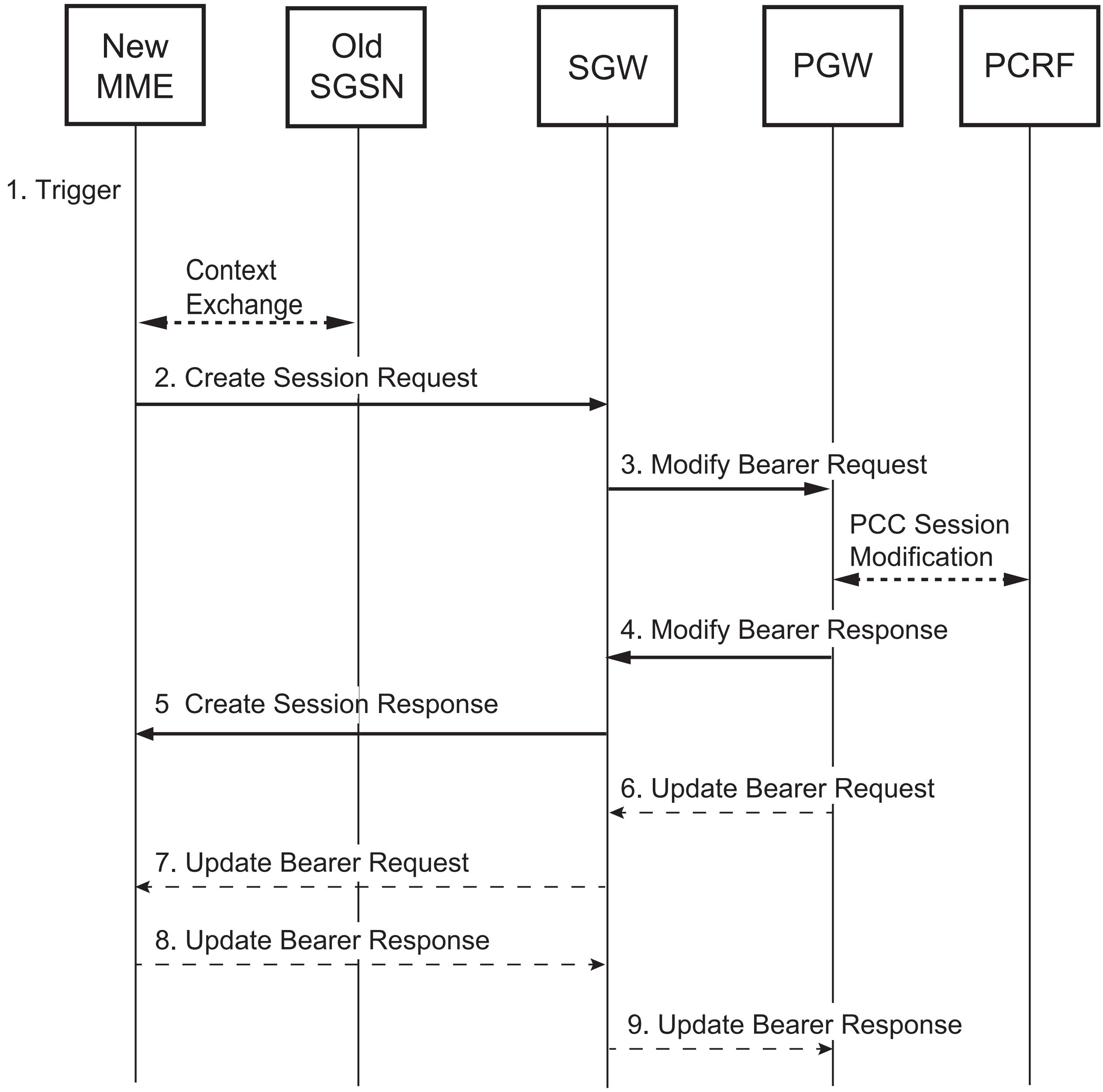

Figure 83 Signalling during TAU procedure from GSM, or WCDMA to LTE System

The TAU procedure from GSM or WCDMA to LTE system consists of the following steps:

1. The UE initiates the TAU procedure. The UE is in idle state.

   The target MME and the source SGSN exchange `SGSN Context` messages. The target MME relocates the SGW.

2. The target MME sends a `Create Session Request` message to the SGW. The message contains, for example, RAT type, bearer context to be created, IMSI, IMEI, and F-TEID for the target MME. The MME maps the primary PDP

context to the default EPS bearer; it also maps the QoS parameters of the PDP context to the EPS bearer QoS parameters.

3. The SGW sends a `Modify Bearer Request` message to the PGW. The message contains for example and F-TEID for the target SGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

   If the PGW receives an invalid `Modify Bearer Request` message, the PGW rejects the request and sends a `Modify Bearer Response` message with an appropriate reject cause. For more information on reject causes, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

5. The SGW sends a `Create Session Response` message to the target MME.

6. If the QoS is changed as part of the handover, or if the QCI for a bearer is greater than 9, the PGW sends an `Update Bearer Request`, including the QoS for the bearer, to the SGW.

7. The SGW sends an `Update Bearer Request` to the MME.

8. The MME sends an `Update Bearer Response` to the SGW.

9. The SGW sends an `Update Bearer Response` to the PGW.

10.2.11 TAU with S4-SGSN interaction without SGW relocation

The signalling that occurs during a signalling during a TAU procedure from old S4-SGSN to new MME without SGW relocation in Figure 84.

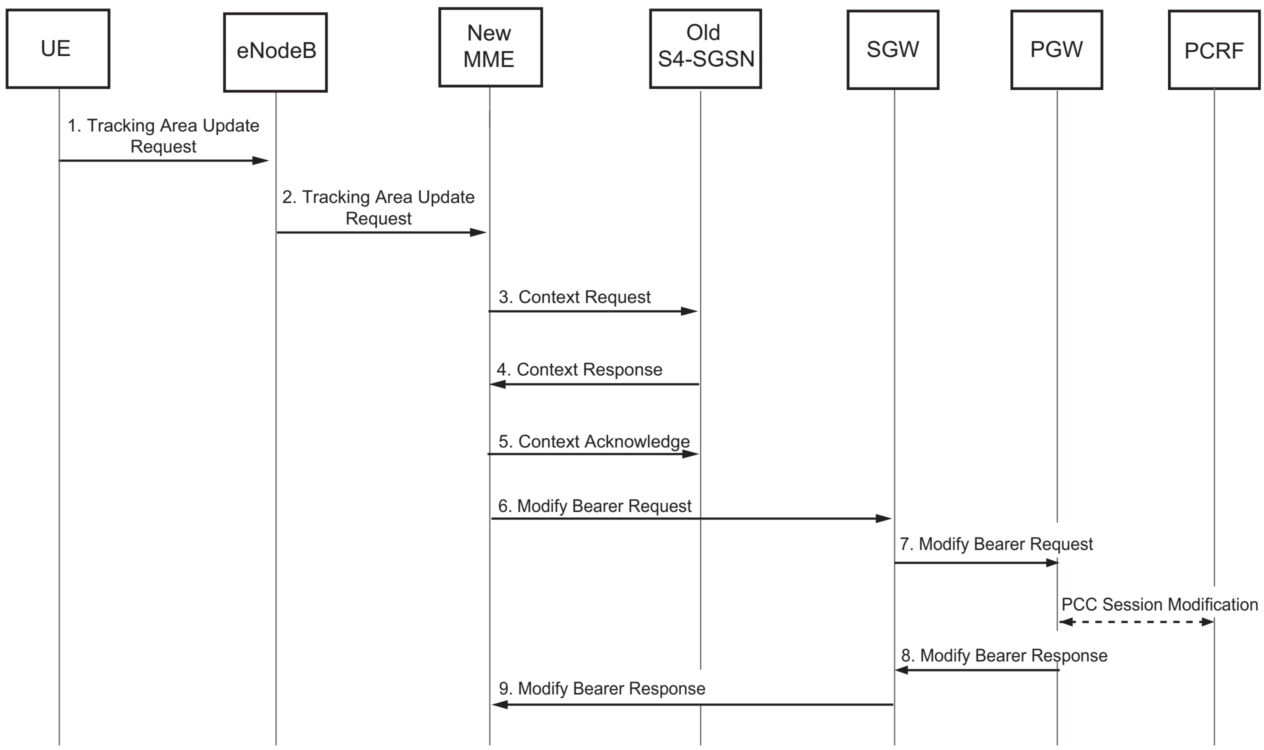

Figure 84 Signalling During a TAU procedure with S4-SGSN interaction without SGW relocation

1. The UE sends a `Tracking Area Update Request` message to the eNodeB.

2. The eNodeB sends a `Tracking Area Update Request` message to the new MME.

3. The new MME sends a `Context Request` message to the old S4-SGSN.

4. The old S4-SGSN responds with a `Context Response` message to the new MME.

5. The new MME sends a `Context Acknowledge` message to the old S4-SGSN.

6. The new MME sends a `Modify Bearer Request` message to the SGW. The message contains the IP address and TEID of the new MME, and the GTPv2-C tunnel endpoint of the new MME.

   Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

7. The SGW sends a `Modify Bearer Request` message to the PGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

8. The PGW sends a `Modify Bearer Response` message to the SGW.

9. The SGW responds with a `Modify Bearer Response` message to the new MME.

   Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

10.2.12 TAU with S4-SGSN interaction with SGW relocation

The signalling that occurs during a TAU procedure interacting from old S4-SGSN to new MME with SGW relocation is shown in Figure 85.

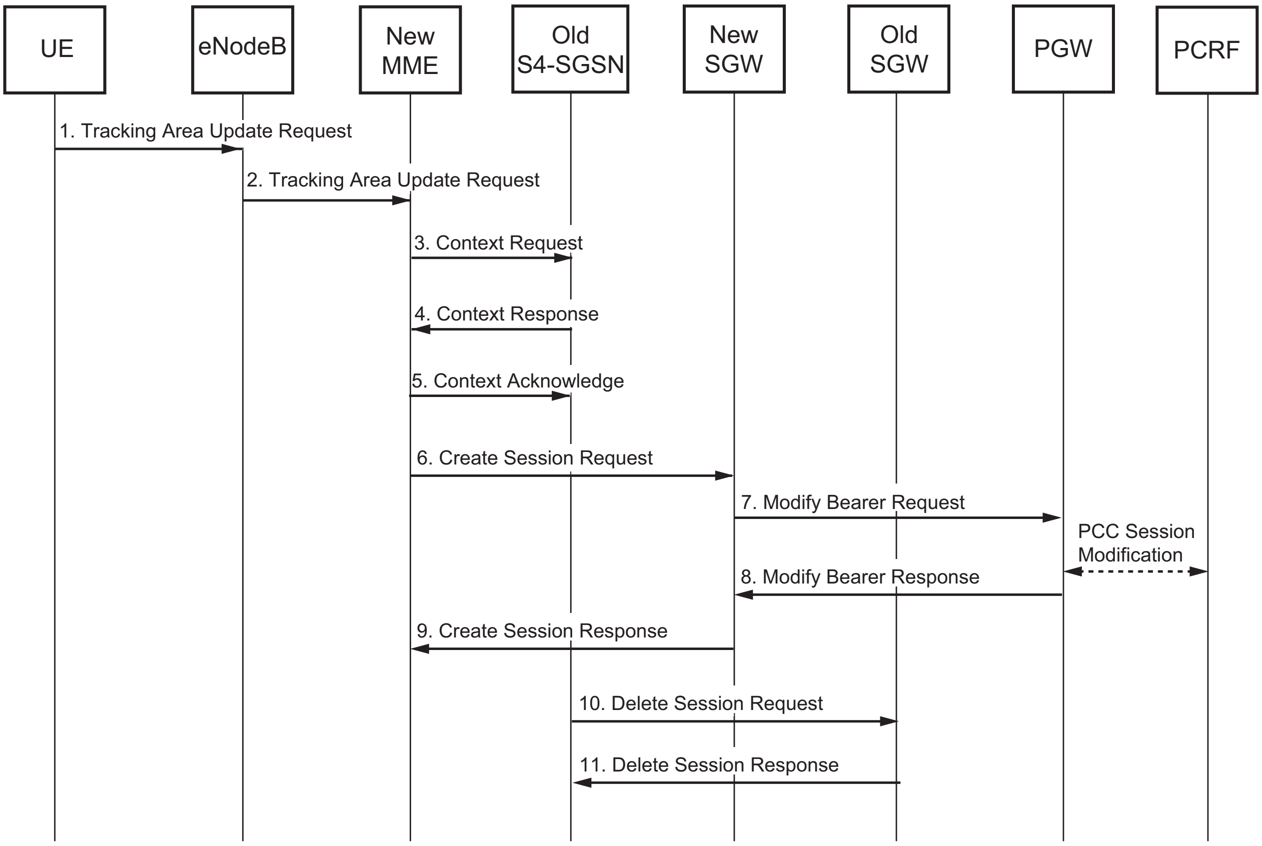

Figure 85 Signalling during a TAU procedure with S4-SGSN interaction with SGW relocation

1. The UE sends a `Tracking Area Update Request` message to the eNodeB.

2. The eNodeB sends a `Tracking Area Update Request` message to the new MME.

3. The new MME sends a `Context Request` message to the old S4-SGSN.

4. The old S4-SGSN responds with a `Context Response` message to the new MME.

5. The new MME sends a `Context Acknowledge` message to the old S4-SGSN.

6. The new MME sends a `Create Session Request` message to the new SGW. The message contains RAT type, bearer context, IMSI and control plane F-TEID. The new SGW establishes a PDN connection.

7. The new SGW sends a `Modify Bearer Request` message to the PGW. The message contains RAT type and F-TEID for the control plane and user plane from the new SGW.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

If the selected BCM was changed during the mobility, any existing dedicated bearers might be removed, or the creation of new dedicated bearers might be initiated. For more information, see Section 10.8 on page 240.

8. The PGW responds with a `Modify Bearer Response` message to the new SGW.

9. The new SGW sends a `Create Session Response` message to the new MME.

   If configured to perform charging, the new SGW begins collecting charging data.

10. The old S4-SGSN sends a `Delete Session Request` message to the old SGW. This deletes the EPS bearer context in the old SGW. The OI flag is set to `0` and the SI flag is set to `1`.

11. The old SGW deletes the EPS bearer context and then sends a `Delete Session Response` message back to the old S4-SGSN.

    If configured to perform charging, the old SGW closes the final charging record.

10.3 Intra E-UTRAN Mobility

This section describes the supported mobility scenarios within E-UTRAN, also known as intra E-UTRAN mobility. The scenarios supported are listed below.

Note: The following mobility scenarios are also applicable for NB-IoT RAT type sessions.

- S1-based handover - No SGW change, with or without MME change
- S1-based handover - With SGW relocation
- S1-based handover - With MME and SGW relocation

- X2-based handover - Without SGW relocation
- X2-based handover - With SGW relocation
- Tracking Area Update (TAU) - No SGW change, with or without MME change
- TAU - With SGW relocation; with or without MME change

Note: The reception of GTP messages and Modify Bearer Requests can trigger RADIUS accounting-related updates.

10.3.1 S1-Based Handover - No SGW Change

The S1-based handover procedure is used when the UE in connected state moves to a cell covered by another eNodeB. The associated MME can be same or different. The signalling during an S1-based handover procedure without an MME or SGW change is shown in Figure 86.

For details on the messages sent between the MME and SGW, refer to S11 Interface Description.

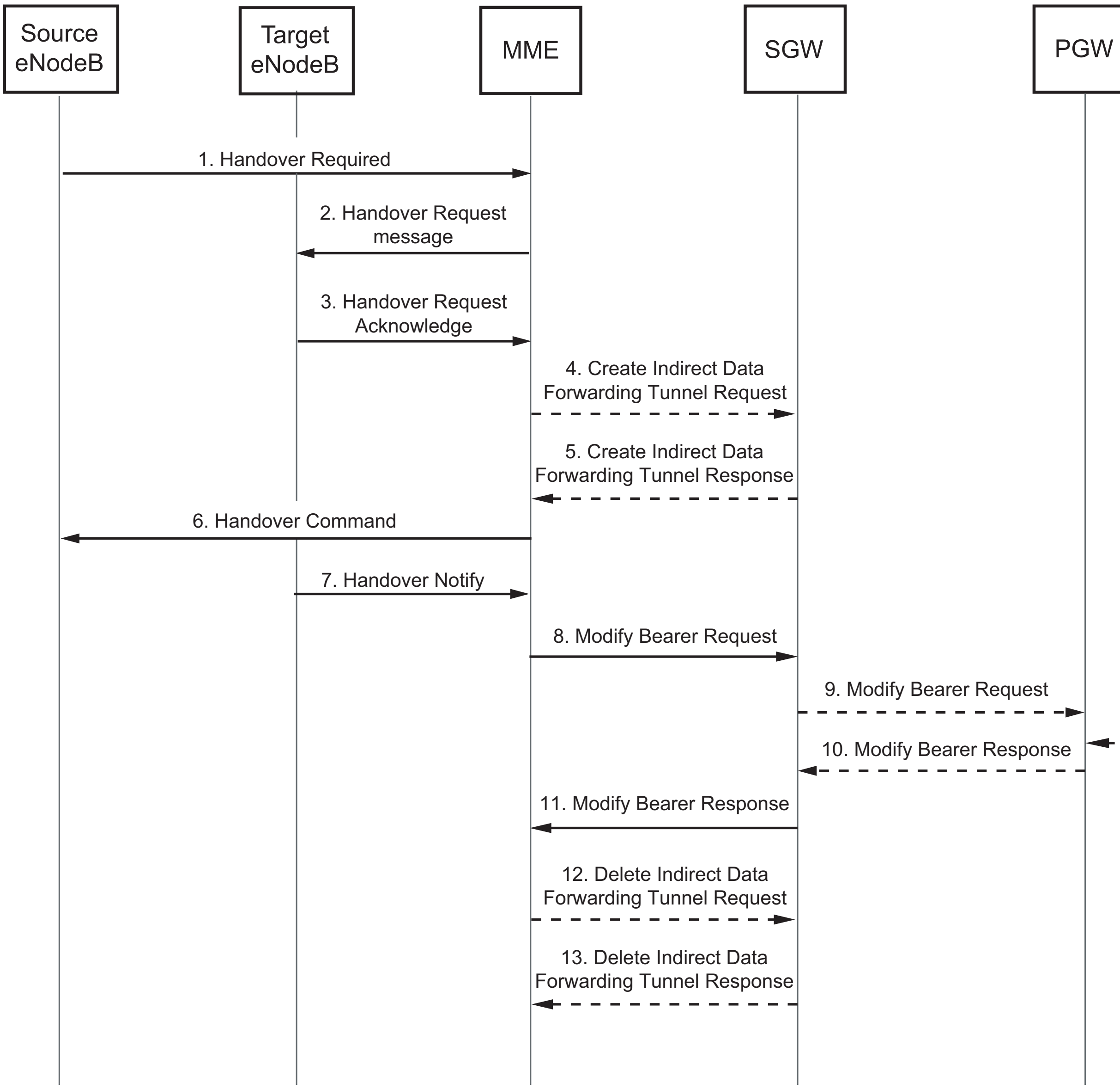

Figure 86 Signalling during an S1-Based Handover Procedure

The S1-based handover procedure consists of the following steps:

1. The source eNodeB sends a `Handover Required` message to the MME.
2. The MME sends a `Handover Request` message to the target eNodeB.
3. The target eNodeB responds with a `Handover Request Acknowledge` message to the MME.
4. Optionally, the MME sends a `Create Indirect Data Forwarding Tunnel Request` to the SGW.

5. If step 4 is performed, the SGW sends a `Create Indirect Data Forwarding Tunnel Response` message to the MME.

   Note: For information on enabling indirect data forwarding, refer to GTP Interface Configuration.

6. The MME sends a `Handover Command` message to the source eNodeB.

   The source eNodeB requires the UE to send further uplink user payload to the target eNodeB. The source eNodeB also forwards any received downlink user payload to the target eNodeB over the X2 interface, if it is present.

7. The target eNodeB sends a `Handover Notify` message to the MME.

8. The MME sends a `Modify Bearer Request` message to the SGW. The message includes the GTP-U tunnel endpoint towards the new eNodeB used for downlink user payload.

   Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

9. The SGW sends a `Modify Bearer Request` message to the PGW, if the ULI, UE Time Zone, or Serving Network is included.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

10. The PGW responds with a `Modify Bearer Response` message to the SGW.

11. The SGW responds with a `Modify Bearer Response` message to the MME. The SGW sends an end marker packet to the source eNodeB, and stops sending downlink user payload to the source eNodeB. The SGW starts sending downlink user payload to the target eNodeB.

    Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

12. Optionally, the MME sends a `Delete Indirect Data Forwarding Tunnel Request` to the SGW.

13. If step 12 is performed, the SGW sends a `Delete Indirect Data Forwarding Tunnel Response` message to the MME.

10.3.2 S1-Based Handover - With SGW Relocation

The S1-based handover with SGW relocation procedure is used when the UE moves from one cell to a cell in another eNodeB and the SGW is relocated.

The signalling during an S1-based handover with SGW relocation is shown in Figure 87.

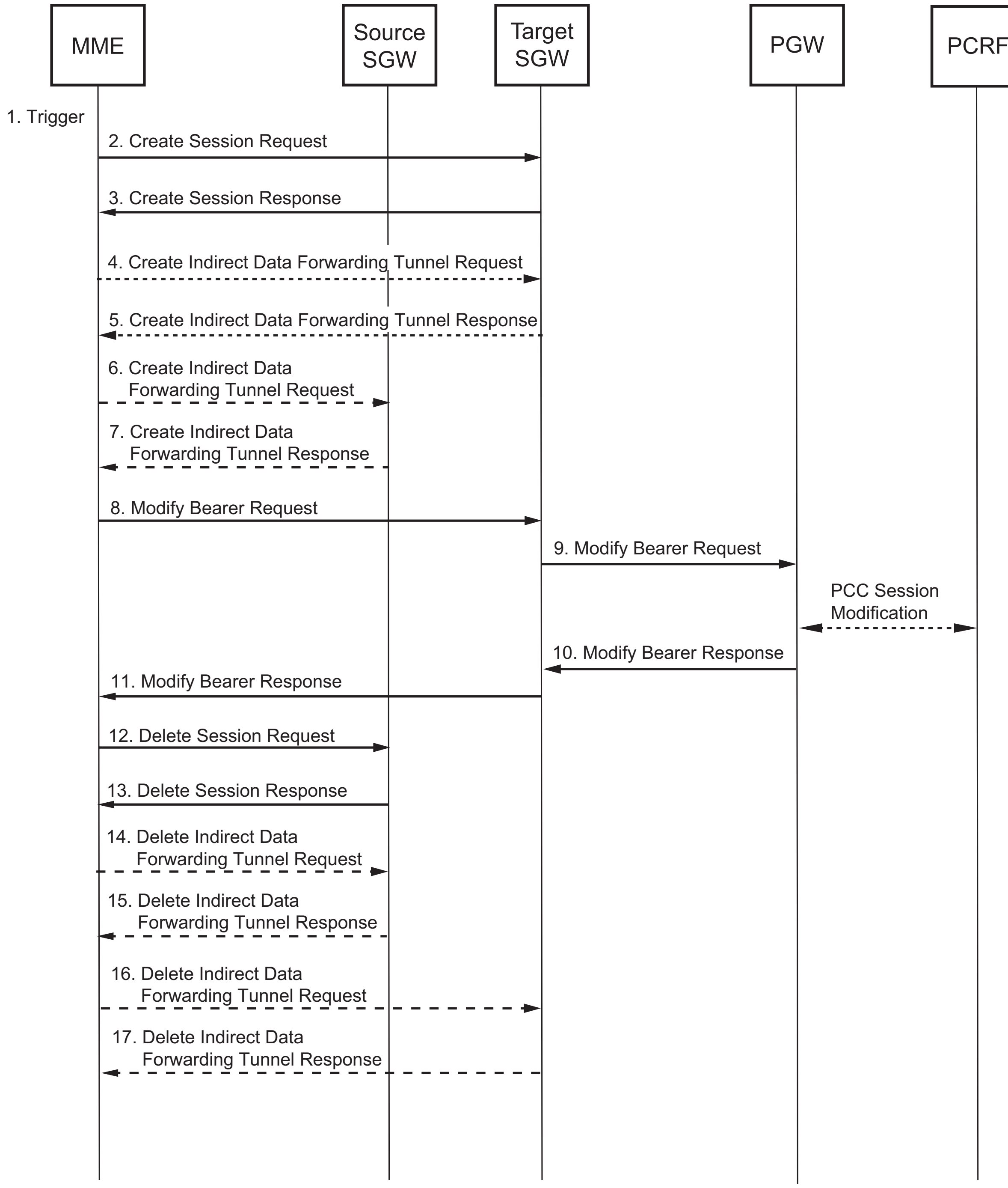

Figure 87 Signalling during an S1-based Handover Procedure with SGW Relocation

The S1-based handover procedure with SGW change consists of the following steps:

1. The handover procedure is triggered when the source eNodeB decides to initiate an S1-based handover to the target eNodeB.

2. The MME sends a `Create Session Request` to the target SGW.
3. The target SGW sends a `Create Session Response` back to the MME.
4. Optionally, the MME sends a `Create Indirect Data Forwarding Tunnel Request` to the target SGW.
5. If step 4 is performed, the target SGW sends a `Create Indirect Data Forwarding Tunnel Response` message to the MME.
6. Optionally, the MME sends a `Create Indirect Data Forwarding Tunnel Request` to the source SGW.
7. If step 6 is performed, the source SGW sends a `Create Indirect Data Forwarding Tunnel Response` message to the MME.

   Note: For information on enabling indirect data forwarding, refer to GTP Interface Configuration.

8. The MME sends a `Modify Bearer Request` message to the target SGW.
9. The target SGW sends a `Modify Bearer Request` message to the PGW.

   If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Modify Bearer Request`.

10. The PGW responds with a `Modify Bearer Response` message to the target SGW.

    The PGW stops sending downlink user data to the source SGW. The PGW indicates the end of transmission by sending an end marker packet to the source SGW. Then the PGW starts sending downlink user data to the target SGW.

    If the PGW receives an invalid `Modify Bearer Request`, the PGW rejects the request and sends a `Modify Bearer Response` with an appropriate reject cause. For more information on reject causes, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

    If the PGW is configured to perform, and can support pause charging, the `Modify Bearer Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

11. The target SGW sends a `Modify Bearer Response` to the MME.

    If configured to perform charging, the target SGW begins collecting charging data.

12. The MME sends a `Delete Session Request` message to the source SGW. This clears the EPS bearer context in the source SGW.

    If the source SGW receives a `Delete Session Request` message addressed to a TEID that is not recognized by the source SGW, the message is rejected.

    The Scope Indication (SI) flag and the Operation Indication (OI) flag are included in the `Delete Session Request` message. These flags are set to **`one`** or to **`zero`** by the MME.

    The different flag values indicate the following:

    — The SI flag set to **`one`** indicates that all PDN connections should be deleted in the source SGW.

    — The SI flag set to **`zero`** indicates that only the PDN connection pointed out by the LBI should be deleted.

    — The OI flag set to **`one`** indicates that the source SGW should signal to the PGW to delete the same PDN connections.

    — The OI flag set to **`zero`** indicates that no signalling to the PGW should be done.

    If the received `Delete Session Request` message contains the flags SI=1 and OI=1, then the source SGW rejects the request by sending a `Delete Session Response` message.

    If the received `Delete Session Request` message contains the flags SI=`0` and OI=`0`, then the following cases exist:

    — If the LBI for the default bearer is included in the message, the source SGW deletes the PDN connection pointed out by the LBI and sends a `Delete Session Response` message with acceptance response cause value back to the MME.

    — If the received `Delete Session Request` message does not contain the LBI, the source SGW rejects the request by sending a `Delete Session Response` message back to the MME.

13. Normally, the source SGW clears the EPS bearer context and sends a `Delete Session Response` back to the MME.

    If configured to perform charging, the source SGW closes the final charging record.

14. Optionally, the MME sends a `Delete Indirect Data Forwarding Tunnel Request` to the source SGW.

15. If step 14 is performed, the source SGW sends a `Delete Indirect Data Forwarding Tunnel Response` message to the MME.

16. Optionally, the MME sends a `Delete Indirect Data Forwarding Tunnel Request` to the target SGW.

17. If step 16 is performed, the target SGW sends a `Delete Indirect Data Forwarding Tunnel Response` message to the MME.

10.3.3 S1-Based Handover with MME and SGW Relocation

The S1-based handover with MME and SGW relocation procedure is used when the UE moves from one cell to a cell covered by another eNodeB, and both the MME and SGW are relocated.

The signalling during an S1-based handover with MME and SGW relocation is shown in Figure 88.

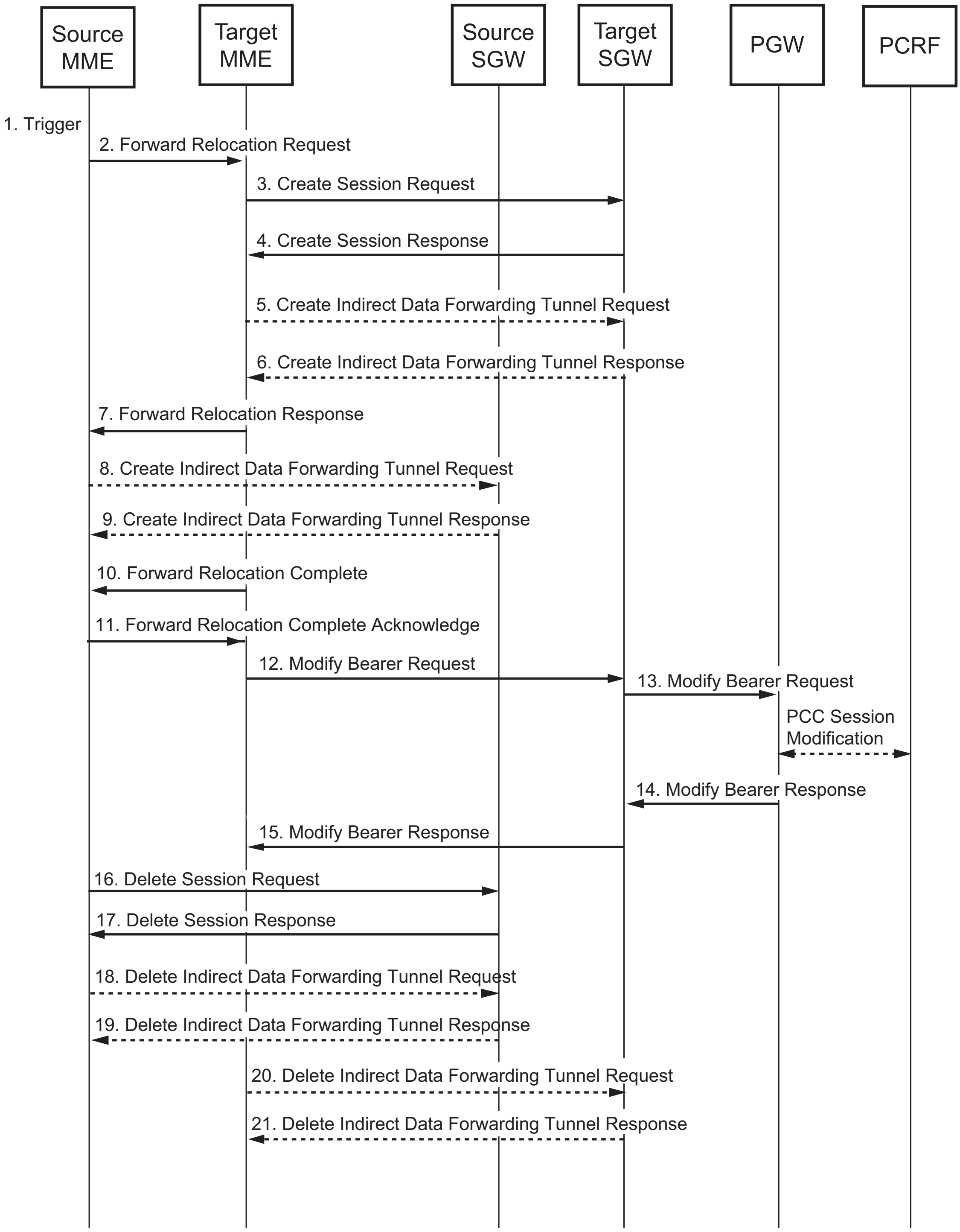

Figure 88 Signalling during an S1-based Handover Procedure with MME and SGW Relocation

The S1-based handover procedure with MME and SGW relocation consists of the following steps:

1. The handover procedure is triggered when the source eNodeB decides to initiate an S1-based handover to the target eNodeB.

2. The source MME sends a `Forward Relocation Request` to the target MME.

3. The target MME sends a `Create Session Request` to the target SGW. The message contains EPS bearer context with PGW addresses and TEIDs.

4. The target SGW sends a `Create Session Response` back to the target MME. The target MME then sends a `Handover Request` message to the target eNodeB.

5. Optionally, the target MME sends a `Create Indirect Data Forwarding Tunnel Request` to the target SGW.

6. If step 5 is performed, the target SGW sends a `Create Indirect Data Forwarding Tunnel Response` message to the MME.

   Note: For information on enabling indirect data forwarding, refer to GTP Interface Configuration.

7. The target MME sends a `Forward Relocation Response` to the source MME. The message contains Cause, Target to Source transparent container, SGW change indication, EPS Bearer Setup Result, addresses and TEIDs.

8. Optionally, the source MME sends a `Create Indirect Data Forwarding Tunnel Request` to the source SGW.

9. If step 8 is performed, the source SGW sends a `Create Indirect Data Forwarding Tunnel Response` message to the MME.

10. The target MME sends a `Forward Relocation Complete Notification` message to the source MME.

11. The source MME sends a `Forward Relocation Complete Acknowledge` message to the target MME.

12. The target MME sends a `Modify Bearer Request` message to the target SGW. The message contains eNodeB address and TEID allocated to the target eNodeB for downlink traffic on S1-U for the accepted EPS bearers.

13. The target SGW sends a `Modify Bearer Request` message to the PGW.

    If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

    If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Modify Bearer Request`.

14. The PGW responds with a `Modify Bearer Response` message to the target SGW.

The PGW stops sending downlink user data to the source SGW, and indicates the ending of transmission by sending an end marker packet to the source SGW. The PGW starts sending downlink user data to the target SGW.

If the PGW receives an invalid `Modify Bearer Request` message, the PGW rejects the request and sends a `Modify Bearer Response` message with an appropriate reject cause. For more information on reject causes, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

15. The target SGW sends a `Modify Bearer Response` to the target MME.

    If configured to perform charging, the target SGW begins collecting charging data.

16. The source MME sends a `Delete Session Request` message to the source SGW. This clears the EPS bearer context in the source SGW.

    If the source SGW receives a `Delete Session Request` message addressed to a TEID that is not recognized by the source SGW, the message is rejected.

    The SI flag and the OI flag are included in the `Delete Session Request` message. These flags are set to **`one`** or to **`zero`** by the MME.

    The different flag values indicate the following:

    — The SI flag set to **`one`** indicates that all PDN connections should be deleted in the source SGW.

    — The SI flag set to **`zero`** indicates that only the PDN connection pointed out by the LBI should be deleted.

    — The OI flag set to **`one`** indicates that the source SGW should signal to the PGW to delete the same PDN connections.

    — The OI flag set to **`zero`** indicates that no signalling to the PGW should be done.

    If the received `Delete Session Request` message contains the flags SI=1 and OI=1, then the source SGW rejects the request by sending a `Delete Session Response` message.

    If the received `Delete Session Request` message contains the flags SI=0 and OI=0, then the following cases exist:

    — If the LBI for the default bearer is included in the message, the source SGW deletes the PDN connection pointed out by the LBI and sends a `Delete Session Response` message with acceptance response cause value back to the MME.

- If the received `Delete Session Request` message does not contain the LBI, the source SGW rejects the request by sending a `Delete Session Response` message back to the MME.

17. Normally, the source SGW clears the EPS bearer context and sends a `Delete Session Response` message back to the source MME.

    If configured to perform charging, the source SGW closes the final charging record.

18. Optionally, the MME sends a `Delete Indirect Data Forwarding Tunnel Request` to the source SGW.

19. If step 18 is performed, the source SGW sends a `Delete Indirect Data Forwarding Tunnel Response` message to the MME.

20. Optionally, the MME sends a `Delete Indirect Data Forwarding Tunnel Request` to the target SGW.

21. If step 20 is performed, the target SGW sends a `Delete Indirect Data Forwarding Tunnel Response` message to the MME.

10.3.4 X2-Based Handover - No SGW Change

The X2-based handover procedure is used when the UE in connected state moves to a cell in another eNodeB and an X2 interface exists between the eNodeBs involved. Furthermore, the X2 interface is used for both handover-related control signalling and for downlink user payload forwarding between the source and target eNodeB. The signalling during an X2-based handover procedure is shown in Figure 89. No MME change takes place as part of this procedure.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

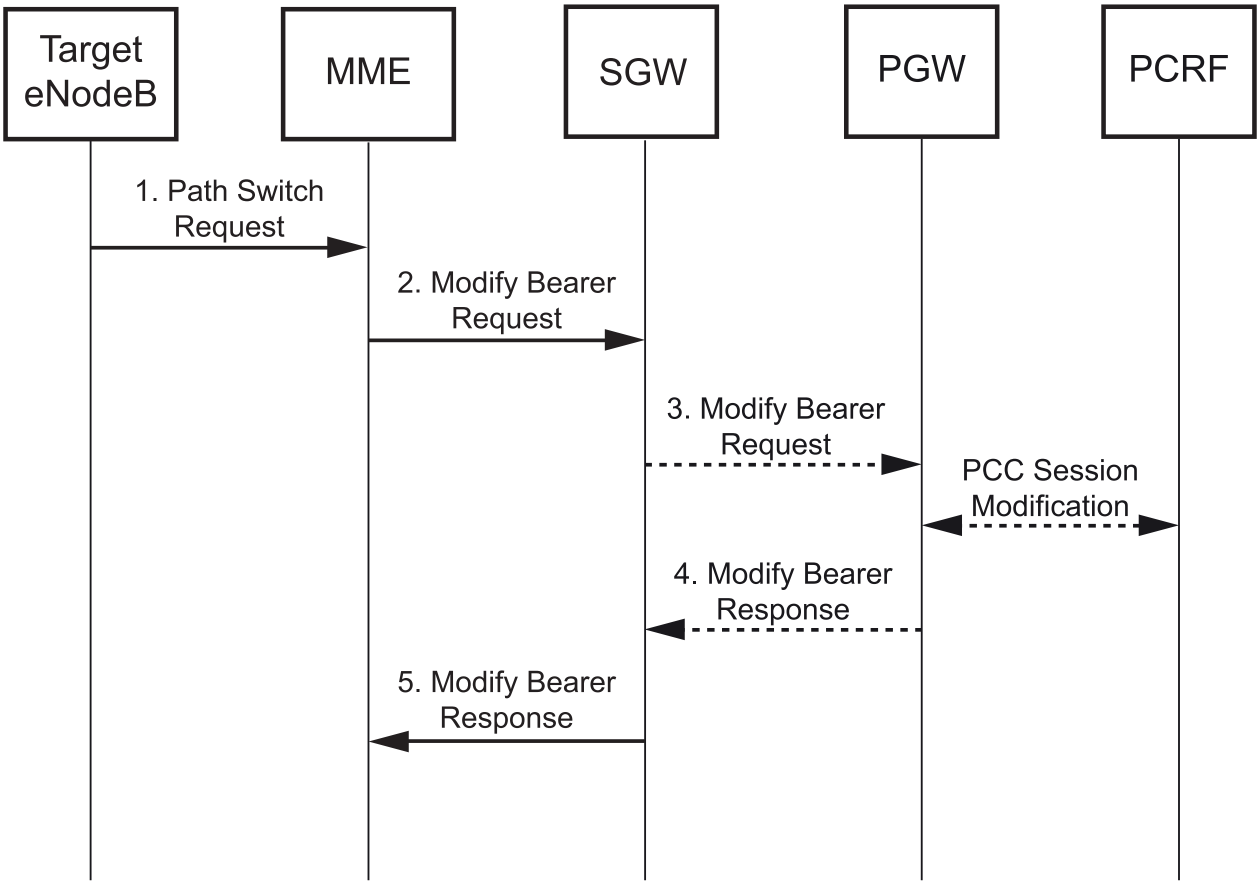

Figure 89 Signalling during an X2-Based Handover

As part of the X2-based handover procedure, the source eNodeB forwards downlink user payload to the target eNodeB. The X2-based handover procedure consists of the following steps:

1. The target eNodeB sends a `Path Switch Request` message to the MME.
2. The MME sends a `Modify Bearer Request` message to the SGW. The message includes the GTP-U tunnel endpoint towards the new eNodeB for downlink packet sending.

   Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

3. The SGW sends a `Modify Bearer Request` message to the PGW, if the ULI, UE Time Zone, or Serving Network is included.

Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

Note: Once the SGW receives the downlink GTP-U tunnel of the target eNodeB from the `Modify Bearer Request` message, the SGW sends an end marker packet to the source eNodeB and stops sending downlink user payload to the source eNodeB. The SGW starts sending downlink user payload to the target eNodeB.

4. The PGW responds with a `Modify Bearer Response` message to the SGW.

5. The SGW responds with a `Modify Bearer Response` message to the MME.

   Note: The SGW may send a `Modify Access Bearers Response` message to the MME. Modify Access Bearers Response messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

10.3.5 X2-Based Handover with SGW Relocation

The X2-based handover procedure with SGW relocation can be used when the UE in connected state moves from one cell to a cell in another eNodeB and there exists an X2-interface between the eNodeBs involved. The MME determines that the source SGW cannot continue to serve the UE and relocates the SGW.

The signalling during an X2-based handover with SGW relocation is shown in Figure 90.

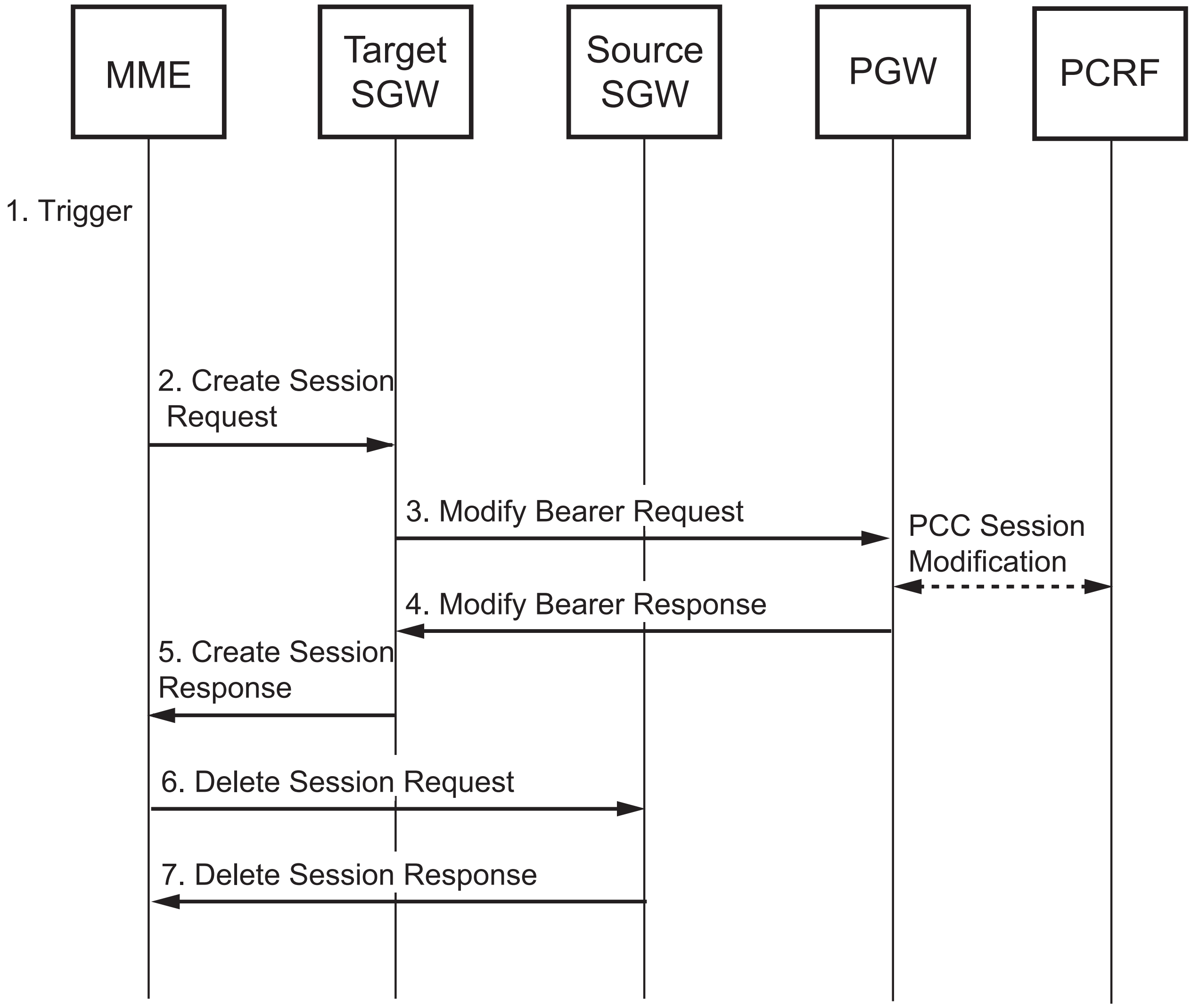

Figure 90 Signalling during an X2-based Handover with SGW Relocation

The X2-based handover with SGW relocation consists of the following steps:

1. The handover is triggered by the target eNodeB. The eNodeB sends a `Path Switch Request` message to the MME with information that the UE has changed cells.

   The MME determines that the source SGW cannot continue to serve the UE and relocates the SGW.

2. The MME sends a `Create Session Request` message to the target SGW. The message contains, for example, RAT type, bearer context to be created, IMSI, and F-TEID for the MME. The MME decides also whether to include the ULI IE in the message or not. The target SGW starts to establish a PDN connection.

3. The target SGW sends a `Modify Bearer Request` message to the PGW. The message contains, for example, the F-TEID for the target SGW. The ULI IE is included in the message if it is present in step 2.

   If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Modify Bearer Request`.

4. The PGW responds with a `Modify Bearer Response` message to the target SGW.

   If the PGW receives an invalid `Modify Bearer Request` message, the PGW rejects the request and sends a `Modify Bearer Response` message with an appropriate reject cause. For more information on reject causes, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

   If the PGW is configured to perform, and can support pause charging, the `Modify Bearer Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

5. The target SGW sends a `Create Session Response` message to the MME.

   If configured to perform charging, the target SGW begins collecting charging data.

6. The MME sends a `Delete Session Request` message to the source SGW. This clears the EPS bearer context in the source SGW.

   If the source SGW receives a `Delete Session Request` message addressed to a TEID that is not recognized by the source SGW, the message is rejected.

   The SI flag and the OI flag are included in the `Delete Session Request` message. These flags are set to **`one`** or to **`zero`** by the MME.

   The different flag values indicate the following:

   — The SI flag set to **`one`** indicates that all PDN connections should be deleted in the source SGW.

   — The SI flag set to **`zero`** indicates that only the PDN connection pointed out by the LBI should be deleted.

   — The OI flag set to **`one`** indicates that the source SGW should signal to the PGW to delete the same PDN connections.

   — The OI flag set to **`zero`** indicates that no signalling to the PGW should be done.

If the received `Delete Session Request` message contains the flags SI=1 and OI=1, then the source SGW rejects the request by sending a `Delete Session Response` message.

If the received `Delete Session Request` message contains the flags SI=0 and OI=0, then the following cases exist:

— If the LBI for the default bearer is included in the message, the source SGW deletes the PDN connection pointed out by the LBI and sends a `Delete Session Response` message with acceptance response cause value back to the MME.

— If the received `Delete Session Request` message does not contain the LBI, the source SGW rejects the request by sending a `Delete Session Response` message back to the MME.

7. Normally, the source SGW deletes the EPS bearer context and sends a `Delete Session Response` back to the MME.

   If configured to perform charging, the source SGW closes the final charging record.

10.3.6 TAU with MME Relocation - No SGW Change

A TAU procedure with MME relocation occurs when the UE detects that it has entered a new TA that is not allocated by the present MME. A change of MME takes place. The signalling during a TAU procedure with MME relocation is shown in Figure 91.

For details on the messages sent between the MME and the SGW, refer to S11 Interface Description.

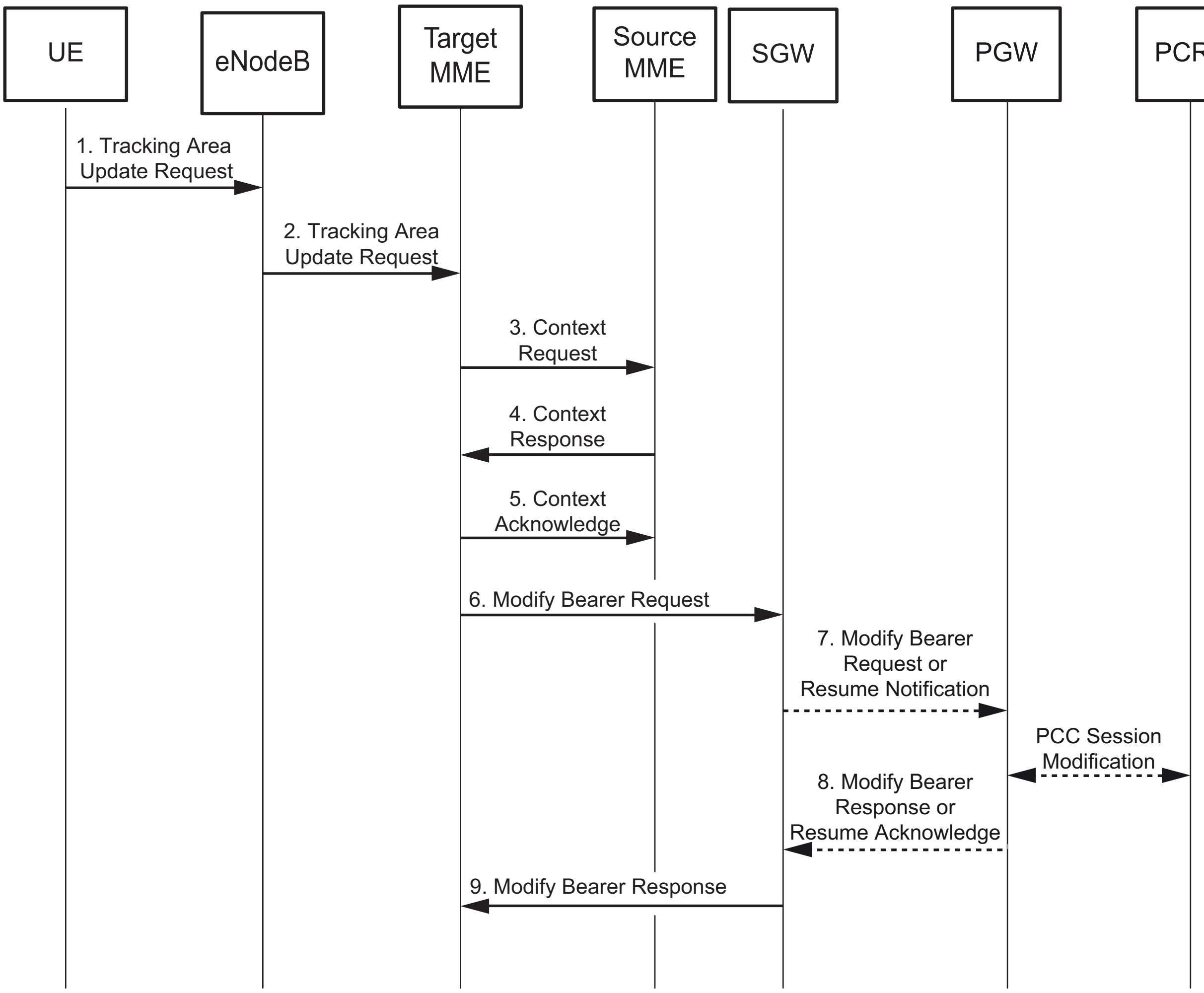

Figure 91 Signalling during a TAU Procedure with MME Relocation

The TAU procedure with MME relocation consists of the following steps:

1. The UE sends a `Tracking Area Update Request` message to the eNodeB.

2. The eNodeB sends a `Tracking Area Update Request` message to the target MME.

3. The target MME sends a `Context Request` message to the source MME.

4. The source MME responds with a `Context Response` message to the target MME.

5. The target MME sends a `Context Acknowledge` message to the source MME.

6. The target MME sends a `Modify Bearer Request` message to the SGW. The message contains the IP address and TEID of the target MME, and the GTPv2-C tunnel endpoint towards the new MME is updated.

Note: The MME may send a `Modify Access Bearers Request` message to the SGW. Modify Access Bearers Request messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

7. The SGW forwards the `Modify Bearer Request` message to the PGW in cases, for example, the ULI is included in the message. If there is no need to send the `Modify Bearer Request` message and the PDN connection is in the Suspended state, the SGW sends the `Resume Notification` message to the PGW.

   Note: When reducing S5/S8 signalling is enabled, the SGW forwards a `Modify Bearer Request` message only when a changed Serving Network IE or UE Time Zone IE is received from the MME. For information on reducing S5/S8 signalling refer to GTP Interface Configuration.

If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

8. The PGW responds with a `Modify Bearer Response` or `Resume Acknowledge` message to the SGW.

9. The SGW responds with a `Modify Bearer Response` message to the target MME. If the PDN connection is in the Suspended state, the SGW resumes the PDN connection and starts buffering user traffic directed to the idle UE.

   If `S11 Tunnel Flag` is included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S11-U F-TEID`.

   If `S11 Tunnel Flag` is not included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S1-U F-TEID`.

   Note: The SGW sends a `Modify Access Bearers Response` message to the MME. The `Modify Access Bearers Response` messages are sent according to the situations described in 3GPP TS.23.401 and the 3GPP TS 29.274.

10.3.7 TAU with SGW Relocation

A TAU procedure with SGW relocation occurs when the UE detects that it has entered a new TA that is not in the TAI list that the UE registered with the network. A change of SGW takes place. The MME is relocated if the new TA is not allocated by the present MME.

The signalling during a TAU procedure with SGW relocation is shown in Figure 92.

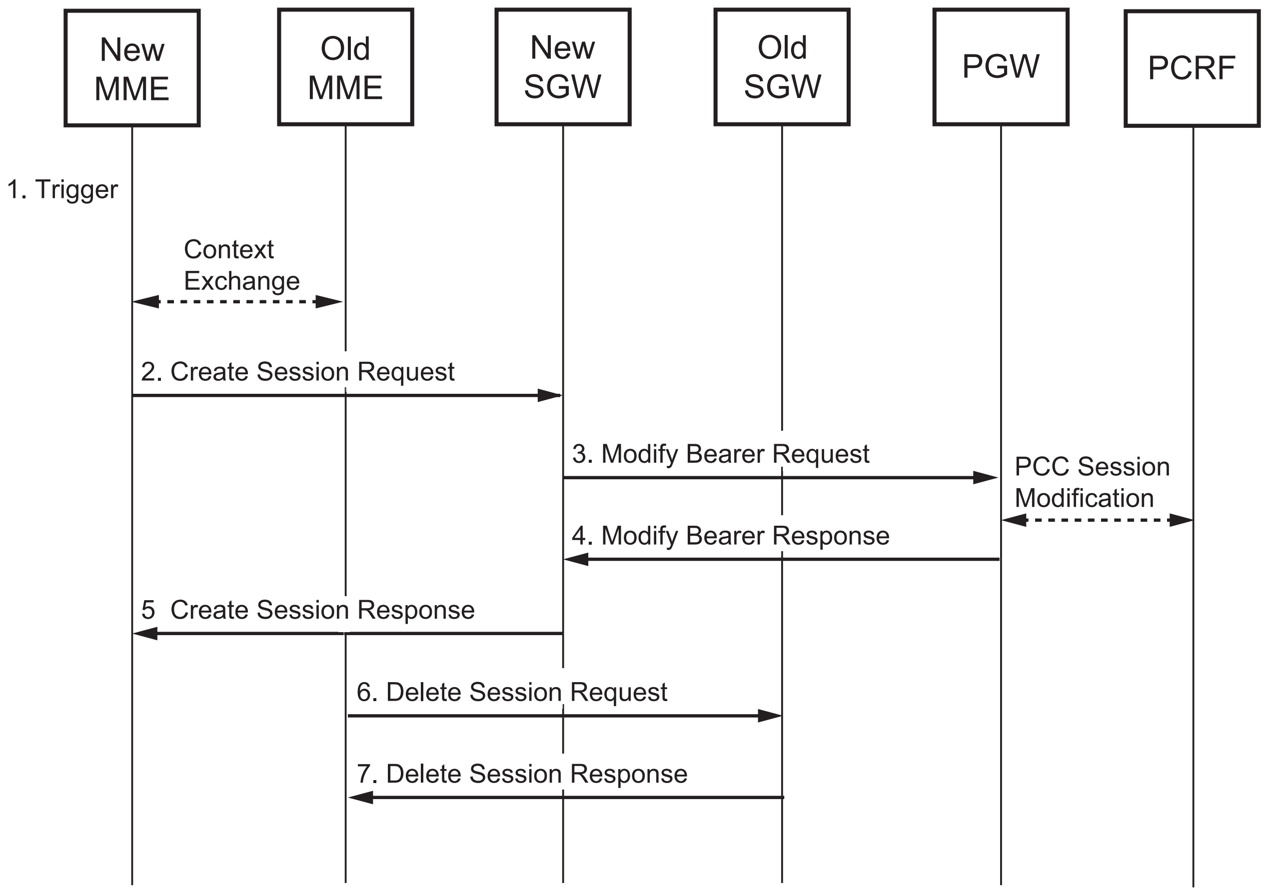

Figure 92 Signalling During a TAU Procedure with SGW Relocation

The TAU procedure consists of the following steps:

1. The UE initiates the TAU procedure.

   If a relocation of MME has taken place, then the target MME and the source MME exchange `Context` messages.

   The MME determines that the source SGW cannot continue to serve the UE and relocates the SGW.

   Note: In the described scenario, a relocation of MME has taken place which gives a target MME and a source MME. If an MME relocation has not occurred, then the signalling concerns just one MME, that is, step 2, 5, 6, and 7 begin or end at the same MME.

2. The target MME sends a `Create Session Request` message to the target SGW. The message contains for example, RAT type, bearer context to be created, IMSI, IMEI, and F-TEID for target MME. The target SGW starts to establish a PDN connection.

   In case of S11-U request the MME adds the CPOPCI. The SGW will record this in its CDRs.

3. The target SGW sends a `Modify Bearer Request` message to the PGW. The message contains, for example, an F-TEID for the target SGW.

   If PCC is deployed, the PGW can initiate a PCC session modification procedure. For more information, see Section 10.7 on page 238.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Modify Bearer Request`.

4. The PGW responds with a `Modify Bearer Response` message to the target SGW.

   If the PGW receives an invalid `Modify Bearer Request` message, the PGW rejects the request and sends a `Modify Bearer Response` message with an appropriate reject cause. For more information on reject causes, refer to SGW S5/S8 Interface Description and PGW S5/S8 Interface Description.

   If the PGW is configured to perform, and can support pause charging, the `Modify Bearer Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging, see Section 3.21 on page 37.

   If `S11 Tunnel Flag` is included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S11-U F-TEID`.

   If `S11 Tunnel Flag` is not included in the`Modify Bearer Request` message from the MME, the SGW responds with an `S1-U F-TEID`.

5. The target SGW sends a `Create Session Response` message to the target MME.

   If configured to perform charging, the target SGW begins collecting charging data.

6. The source MME sends a `Delete Session Request` message to the source SGW. This clears the EPS bearer context in the source SGW.

   If the source SGW receives a `Delete Session Request` message addressed to a TEID that is not recognized by the source SGW, the message is rejected.

   The SI flag and the OI flag are included in the `Delete Session Request` message. These flags are set to **`one`** or to **`zero`** by the source MME.

   The different flag values indicate the following:

   — The SI flag set to **`one`** indicates that all PDN connections should be deleted in the source SGW.

   — The SI flag set to **`zero`** indicates that only the PDN connection pointed out by the LBI should be deleted.

- The OI flag set to **one** indicates that the source SGW should signal to the PGW to delete the same PDN connections.

- The OI flag set to **zero** indicates that no signalling to the PGW should be done.

If the received `Delete Session Request` message contains the flags SI=1 and OI=1, then the source SGW rejects the request by sending a `Delete Session Response` message.

If the received `Delete Session Request` message contains the flags SI=0 and OI=0, then the following cases exist:

- If the LBI for the default bearer is included in the message, the source SGW deletes the PDN connection pointed out by the LBI and sends a `Delete Session Response` message with acceptance response cause value back to the source MME.

- If the received `Delete Session Request` message does not contain the LBI, the source SGW rejects the request by sending a `Delete Session Response` message back to the source MME.

7. The source SGW deletes the EPS bearer context and sends a `Delete Session Response` message back to the source MME.

   If configured to perform charging, the source SGW closes the final charging record.

10.4 Trusted Non-3GPP (CDMA2000) Access Mobility

Note: In this section the trusted non-3GPP network refers specifically to a CDMA2000 access network.

Trusted non-3GPP access mobility occurs when a UE device moves between LTE and CDMA2000 networks, or within the CDMA2000 network. Mobility is achieved using the following procedures:

- Intra trusted non-3GPP PDN connection handover
- E-UTRAN to trusted non-3GPP PDN connection handover
- Trusted non-3GPP to E-UTRAN PDN connection handover

10.4.1 Intra Trusted Non-3GPP PDN Connection Handover

When the UE device moves within the trusted non-3GPP network (CDMA2000), the mobility data of the UE is handed over from one MAG (source) to another MAG (target). The target MAG sends a PBU including the APN to the PGW to update the BCE for the PDN connection of the UE device (for example, to update the BCE with target MAG's IP address as the new MAG). The PGW confirms the update by sending a PBA to the target MAG.

The signalling during an intra trusted non-3GPP handover procedure is shown in Figure 93.

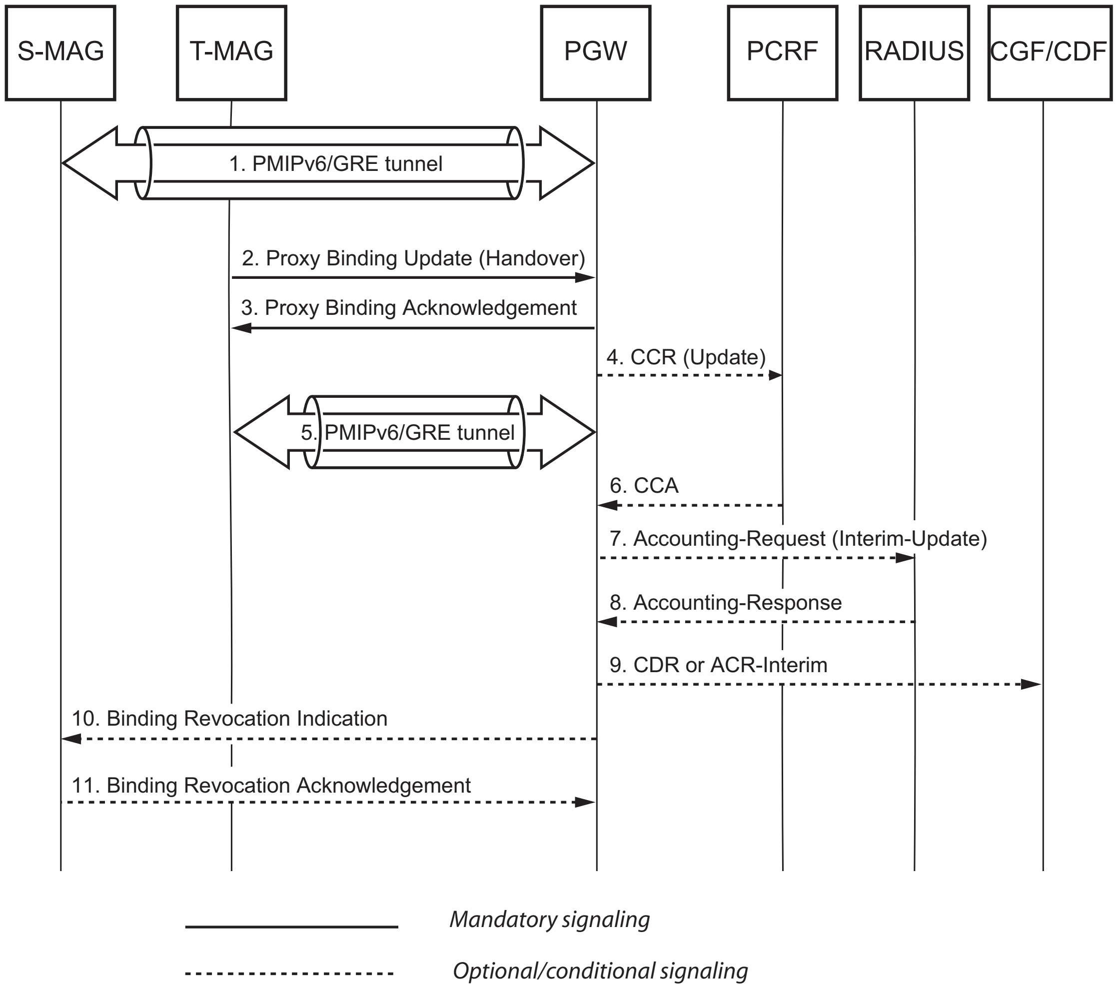

Figure 93 Intra Non-3GPP PDN Connection Handover Procedure

An intra trusted non-3GPP handover procedure involves the following steps:

1. The UE moves within the CDMA2000 network and causes a MAG relocation, but the GRE tunnel is maintained until the PGW has updated the BCE.

2. The target MAG sends a PBU message to the PGW including the `Handoff Indicator=3`, which indicates a handover, or `Handoff Indicator=4`, which indicates unknown state.

   If the `Handoff Indicator=3`, the PGW reuses the already allocated IP address stored in the BCE.

   If the `Handoff Indicator=4` and the BCE is not pending for removal, the PGW waits until one of the following occurs before reusing the BCE:

   — The `BCE reuseTimer` expires.

— A deregistration PBU message is received from the source MAG before the `BCE reuseTimer` expires.

For information on configuring the BCE `reuse-timer`, refer to PMIPv6-Based S2a Interface Configuration.

3. The PGW updates the BCE for the UE device and confirms the handover by a PBA message to the target MAG.

4. If PCC is used and if there is an Event Trigger provisioned by the PCRF, the PGW sends a `CCR-Update` message to the PCRF.

5. The GRE tunnel for payload is established between the target MAG and the PGW.

6. The PCRF (if used) replies with a `CCA-Update` message back to the PGW.

7. If a RADIUS accounting server is configured for the APN, the PGW sends an `Accounting-Request (Interim-Update)` message to the RADIUS server.

8. The RADIUS server responds with an `Accounting-Response` message to the PGW.

9. For CDR-based charging, the PGW closes the CDR with `Cause for Record Closing` set to `Serving Node Change` if the configured serving node change limit `(sgsn-change-limit)` has reached. The CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer.

   For Rf charging, the PGW generates the `ACR interim` message with the `Change-Condition` AVP set to `Serving Node Change` if the configured serving node change limit `(sgsn-change-limit)` has reached.

   To configure the serving node change limit, refer to Offline Charging Configuration.

10. If the `BCE reuseTimer` has already expired and a deregistration PBU has not been received from the source MAG, the PGW sends a BRI message to the source MAG to remove the connection towards the source MAG.

11. The source MAG deletes the binding, removes the PMIPv6/GRE tunnel and sends a BRA message to the PGW. For detailed information on PGW-initiated PDN Connection Deletion procedure, see Section 6.4 on page 78.

10.4.2 E-UTRAN to Trusted Non-3GPP PDN Connection Handover

When the UE device moves from the LTE access network to a CDMA2000 access network, a PDN connection creation is initiated by the MAG. The MAG sends a Handover PBU message to the PGW. The PGW creates the BCE for the PDN connection, and confirms the UE handover from the LTE to the CDMA2000 access network by sending a PBA message to the MAG. Then the GRE tunnel for the payload is established and the communication switched over to this tunnel.

Note: In case of PMIPv6 PDN Connection handover (non-3GPP to LTE or LTE to non-3GPP), the old authorized APN-AMBR and QCI used before the handover is used until the PCRF updates the APN-AMBR and QCI in a `CCA-update` or `RAR` message. Existing dedicated bearers and default bearer become invalid if the RAT type changes from LTE to HRPD and eHRPD.

The signalling during a handover from LTE network to non-3GPP access network is shown in Figure 94.

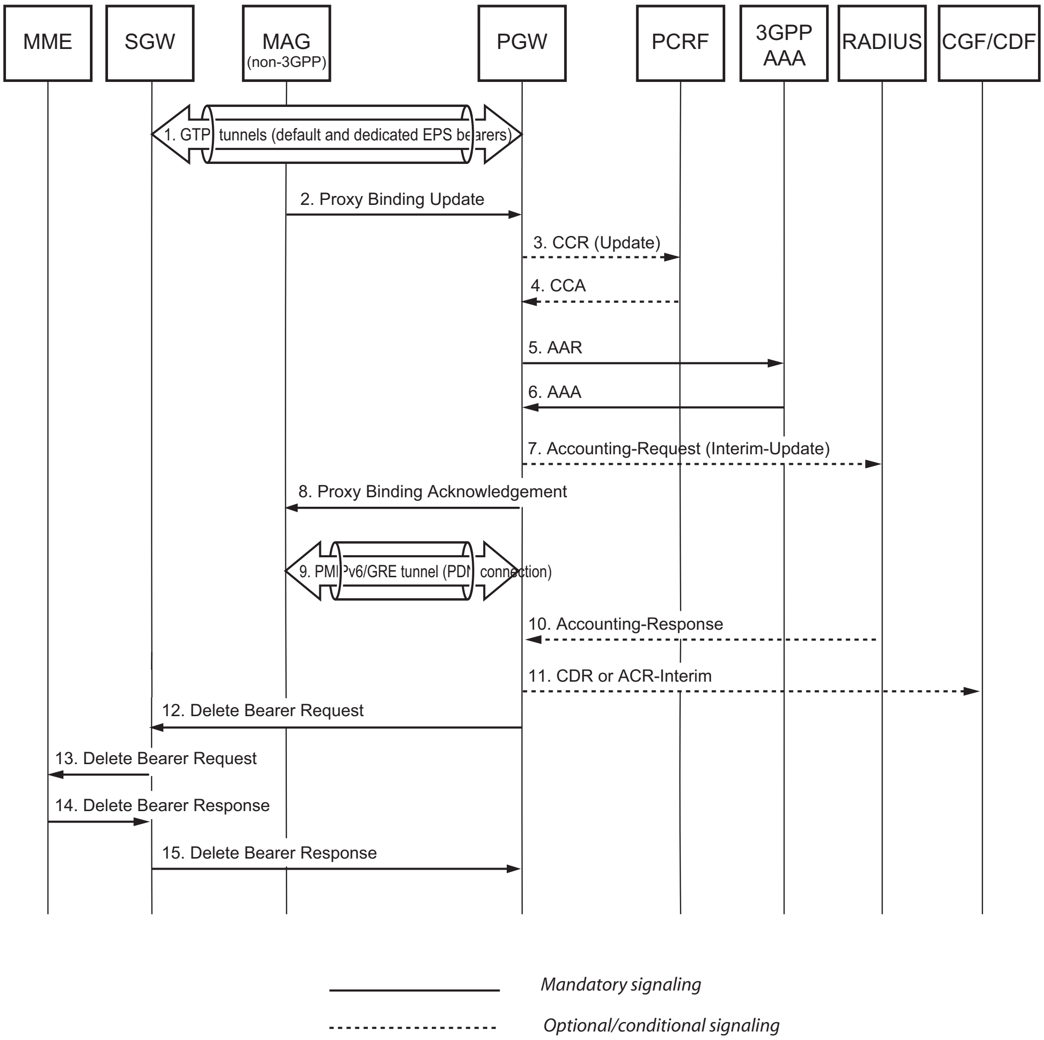

Figure 94 Handover Procedure from LTE to Non-3GPP Access Networks

A Handover procedure from an LTE to a CDMA2000 access network involves the following steps:

1. The UE device is located in the LTE access network, and there is a GTP-C tunnel for signalling and a GTP-U tunnel for payload between the SGW and the PGW.

2. When the UE device enters the CDMA2000 access network, the MAG sends a PBU message to the PGW, to inform about a UE device that has changed RAT type and needs to establish the PDN connection on the PMIPv6-based S2a interface. The Handoff Indicator is either 2 or 4 in the PBU message.

   If an IPv6 Home Network Prefix was assigned to the UE on the E-UTRAN side, the PGW provides a unique link-local address to the MAG.

3. If PCC is deployed, the PGW sends a CCR-Update message to the PCRF.

   The PGW installs the dynamic PCC rules of the dedicated EPS bearers on the PMIPv6-based S2a PDN connection.

4. The PGW receives the CCA message from the PCRF as a response to the sent CCR message. The old authorized APN-AMBR that was used before the handover is used until the PCRF updates the APN-AMBR in a CCA-Update message or RAR message. The QoS is downgraded when moving from an LTE network to a non-3GPP network.

5. The PGW sends an AAR message to the 3GPP AAA server to authorize the UE device for PDN access.

6. The 3GPP AAA server responds with an AAA message back to the PGW.

7. If a RADIUS accounting server is configured for the APN, the PGW sends an Accounting-Request (Interim-Update) message to the RADIUS server.

8. The PGW creates the BCE stored for the UE device, and confirms the IRAT handover by a PBA message to the MAG.

9. The PGW switches the payload to the newly established PMIPv6/GRE tunnel over the PMIPv6-based S2a interface.

   The payload on the default and dedicated EPS bearers is switched to the PMIPv6-based S2a PDN connection.

10. The RADIUS server responds with an Accounting-Response message to the PGW.

11. For CDR-based charging, the PGW closes the CDR with Cause for Record Closing set to RAT Change. The CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer.

    For Rf charging, the PGW generates the ACR interim message with the Change-Condition AVP set to RAT Change.

12. The PGW sends a Delete Bearer Request message to the SGW to remove the GTP-U tunnel for the UE device. The LBI is set to the default bearer and the Cause is set to RAT changed from 3GPP to non-3GPP.

13. The SGW sends a Delete Bearer Request message to the MME.

14. The MME sends a Delete Bearer Response message to the SGW.

15. The SGW deletes the bearer context related to the deactivated PDN connection and sends a `Delete Bearer Response` message back to the PGW.

10.4.3 Trusted Non-3GPP to E-UTRAN PDN Connection Handover

The PDN connection for a UE device located in a CDMA2000 network has established a GRE tunnel between the MAG and the PGW for payload transport.

When the UE device moves from the CDMA2000 network to the LTE network, the MME detects the handover from the non-3GPP access. Therefore, the MME creates a session with the same APN using the same PGW for the UE device as used in the PDN connection from the CDMA2000 network. Then the SGW sends a handover message to the PGW, and GTP-C and GTP-U tunnels are established.

The signalling during a handover from CDMA2000 network to LTE network is shown in Figure 95.

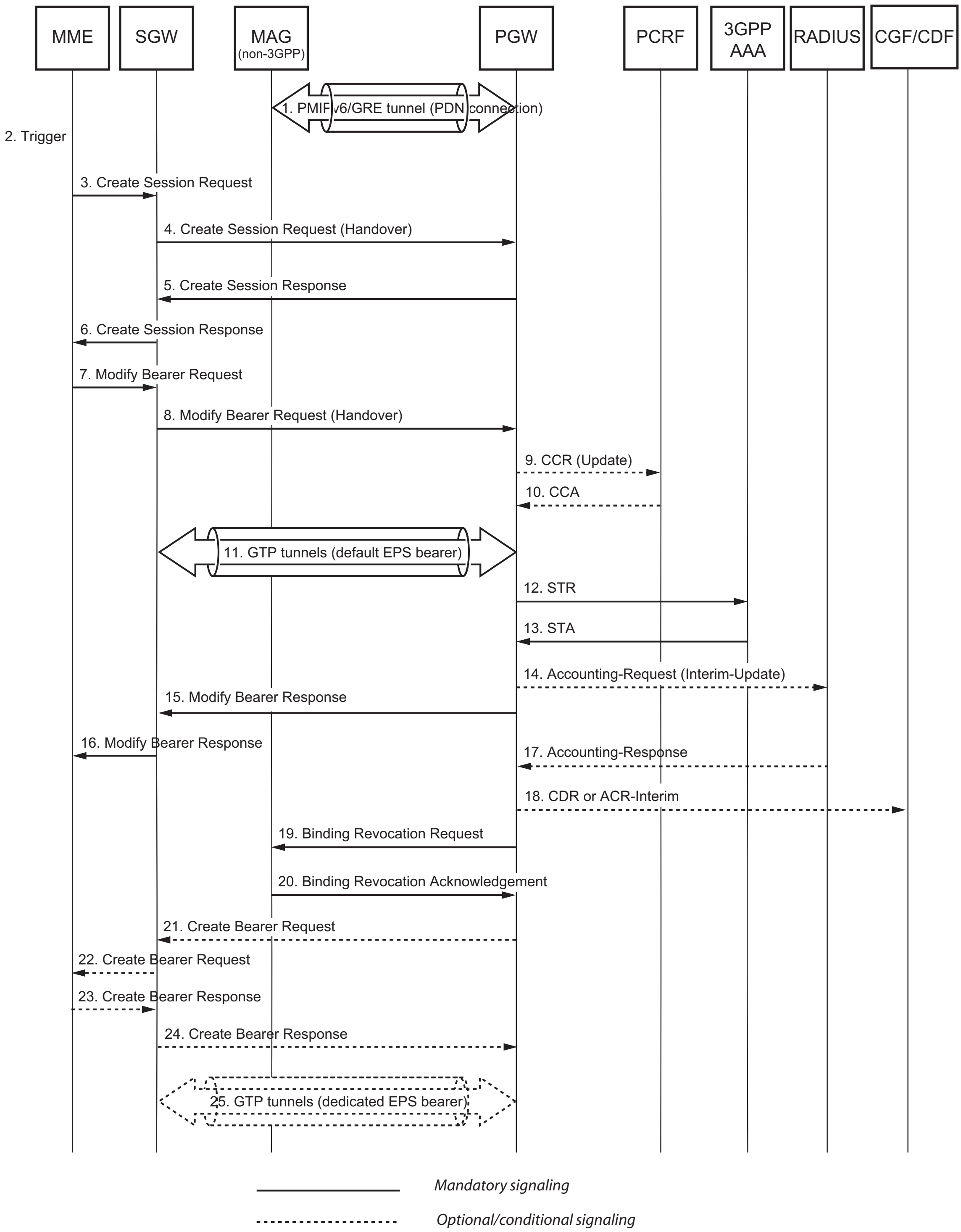

Figure 95 Handover Procedure from Non-3GPP to LTE Access Networks

A Handover procedure from a non-3GPP to an LTE access network involves the following steps:

1. The UE moves from the CDMA2000 network to the LTE network, but the GRE tunnel is maintained until the PGW has updated the PDN connection.
2. A handover is triggered by the UE initiating a PDN connection.
3. The MME sends a `Create Session Request` message with handover indication to the SGW.
4. The SGW allocates a local TEID for the control plane tunnel over the S5/S8 GTP-C interface and for the user plane tunnel over the S5/S8 GTP-U interface. The SGW sends a `Create Session Request` message with handover indication to the PGW.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Create Session Request`.
5. The PGW sends a `Create Session Response` message to the SGW.

   If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging see Section 3.21 on page 37.
6. The SGW sends a `Create Session Response` message to the MME.
7. The MME sends a `Modify Bearer Request` message with `Handover Indication` to the SGW.
8. The SGW forwards the `Modify Bearer Request` message with `Handover Indication` to the PGW.
9. If PCC is deployed, the PGW sends a `CCR-Update` message to the PCRF. The QoS is upgraded when moving from a CDMA2000 network to an LTE network.
10. The PCRF responds with a `CCA` message to the PGW.
11. The PGW switches the payload to the newly established GTP-U tunnel over the S5/S8 interface.

    The payload on the PMIPv6-based S2a PDN connection is switched to the default EPS bearer.
12. The PGW sends an `STR` message to the 3GPP AAA server to terminate the session.
13. The 3GPP AAA server responds with an `STA` message to the PGW.
14. If a RADIUS accounting server is configured for the APN, the PGW sends an `Accounting-Request (Interim-Update)` message to the RADIUS server.
15. Without waiting for the response from the RADIUS server, the PGW sends a `Modify Bearer Response` message to the SGW to confirm the PDN connection handover to the LTE network.

16. The SGW sends a `Modify Bearer Response` back to the MME.

17. The RADIUS server responds with an `Accounting-Response` message to the PGW.

18. For CDR-based charging, the PGW closes the CDR with `Cause for Record Closing` set to `RAT Change`. The CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer.

    For Rf charging, the PGW generates the `ACR interim` message with the `Change-Condition` AVP set to `RAT Change`.

19. The PGW sends a `BRI` message to the MAG to release all resources connected to the UE device.

20. The MAG clears all allocated resources for the UE and responds with a `BRA` message.

21. If the dynamic PCC rules with QoS parameters were installed on the PMIPv6-based S2a PDN connection before the handover or the new dynamic PCC rules with QoS parameters are included in the `CCA-Update` message from the PCRF, the PGW sends a `Create Bearer Request` message to the SGW to establish the dedicated EPS bearers.

    Note: In case that the PGW did not send a `CCR-Update` message to the PCRF due to no triggering for this, the dedicated bearer cannot be created for the Dynamic PCC rules installed on PMIPv6-based S2a session before handover. The dedicated bearer cannot be created for the new Dynamic PCC rules from the PCRF through the `RAR` message either. Therefore, Ericsson recommends to configure the PCRF with subscribing one of the following event triggers to trigger the `CCR-Update` message to the PCRF after handover.

    — `RAT_CHANGE (2)`

    — `IP_CAN_CHANGE (7)`

22. The SGW forwards the `Create Bearer Request` message to the MME.

23. The MME acknowledges bearer activation by sending a `Create Bearer Response` message to the SGW.

24. The SGW acknowledges bearer activation by sending a `Create Bearer Response` message to the PGW.

25. The PGW switches the user traffic mapped to the default EPS bearer in Step 11 to the corresponding dedicated bearers.

10.5 Trusted Non-3GPP (WLAN) Access Mobility

Trusted non-3GPP access mobility occurs when a UE device moves between LTE network and trusted WLAN access network. Mobility is achieved using the following procedures:

Note: In this section, the trusted non-3GPP access refers specifically to a trusted WLAN access network.

- E-UTRAN to trusted non-3GPP PDN connection handover
- Trusted non-3GPP to E-UTRAN PDN connection handover

10.5.1 E-UTRAN to Trusted Non-3GPP PDN Connection Handover

When a UE device moves from the LTE network to a trusted WLAN access network, the TWAN sends a `Create Session Request` message indicating handover to the PGW. The PGW sends a `Create Session Response` message to the TWAN to confirm the UE handover from the LTE network to the trusted WLAN access network.

The signalling during a handover from LTE network to trusted non-3GPP network is shown in Figure 96.

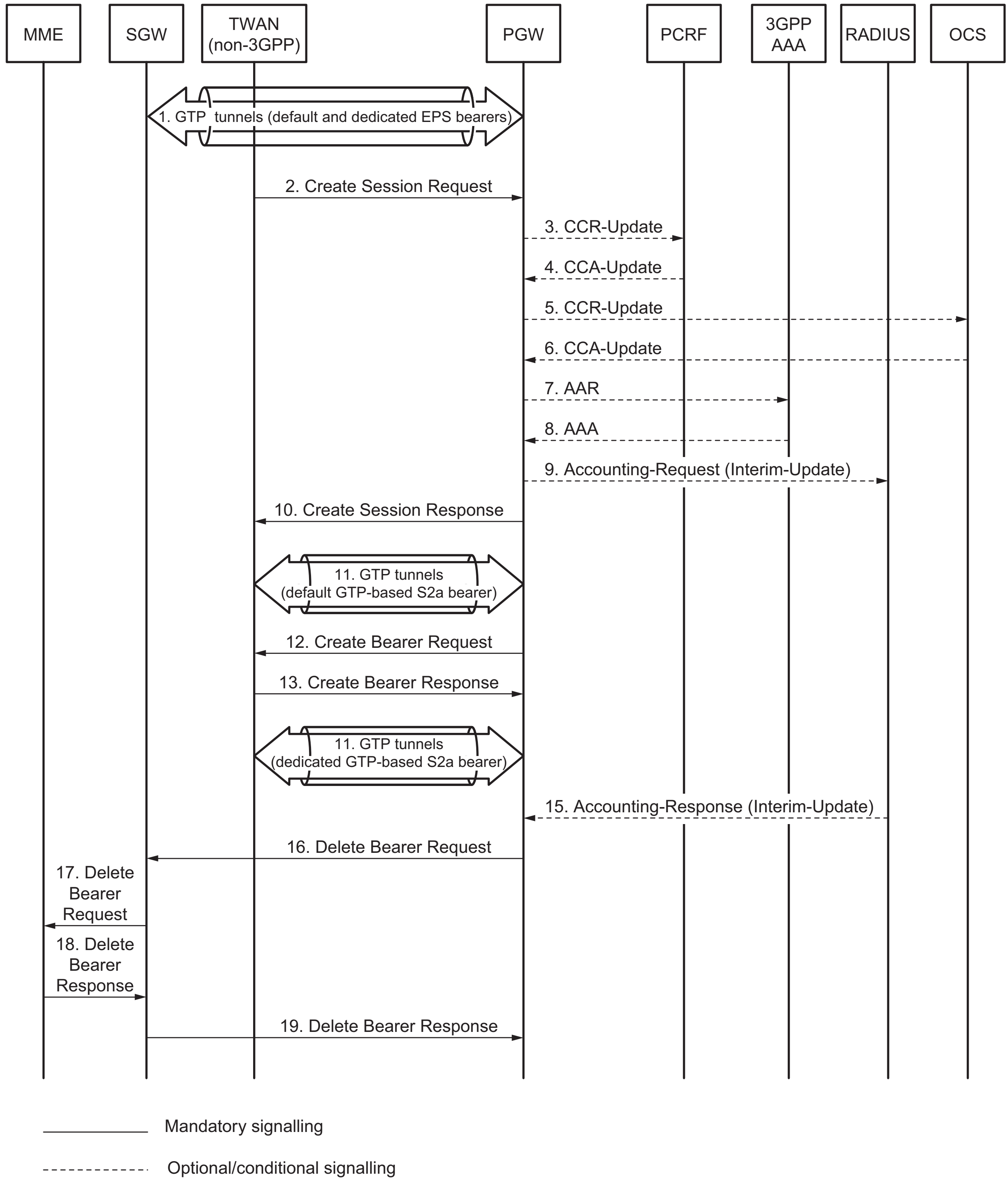

Figure 96 Signalling during Handover Procedure from LTE Network to Trusted Non-3GPP Network

A handover procedure from the LTE network to the trusted WLAN access network involves the following steps:

1. The UE device is located in the LTE network, and there is a GTP-C tunnel for signalling and a GTP-U tunnel for payload between the SGW and the PGW for both default bearer and dedicated bearer.

2. When the UE device enters the trusted WLAN access network, the TWAN sends a `Create Session Request` message to the PGW, to inform about a UE device that has changed RAT type and needs establish the PDN connection on the GTP-based S2a interface. The `Handover Indication` is set to 1 in the `Create Session Request` message.

3. If needed, the PGW sends a `CCR-Update` message to the PCRF to update the Gx+ PCC session.

   The PGW installs the dynamic PCC rules of the EPS dedicated bearers on the default GTP-based S2a bearer.

4. The PCRF responds with a `CCA-Update` message to the PGW.

5. To update the credit control session, the PGW sends a `CCR-Update` message to the OCS.

6. The OCS responds with a `CCA-Update` message to the PGW.

7. To authorize the UE device for PDN access, the PGW sends an `AAR` message to the 3GPP AAA server.

8. The 3GPP AAA server responds with an `AAA` message to the PGW.

9. To update the accounting session, the PGW sends an `Accounting-Request (Interim-Update)` to the RADIUS accounting server.

10. Without waiting for the response from the RADIUS server, the PGW sends a `Create Session Response` message to the TWAN.

11. The PGW switches the payload on the default bearer to the newly established GTP-U tunnel over the GTP-based S2a interface.

    The payload on the default and dedicated 3GPP EPS bearers is switched to the default GTP-based S2a bearer.

12. The PGW sends a `Create Bearer Request` message to the TWAN to establish a dedicated S2a bearer.

13. The TWAN responds with a `Create Bearer Response` message to the PGW.

14. The PGW switches the user traffic mapped to the dedicated S2a bearer.

15. The RADIUS server responds with an `Accounting-Response (Interim-Update)` to the PGW.

16. The PGW sends a `Delete Bearer Request` message to the SGW to remove the old PDN connection for the UE device. The `Cause` IE is set to `RAT changed from 3GPP to Non-3GPP` and the `LBI` IE is included in the `Delete Bearer Request` message.

17. The SGW forwards the `Delete Bearer Request` message to the MME.

18. The MME sends a `Delete Bearer Response` message to the SGW.

19. The SGW deletes the bearer context related to the deactivated PDN connection, and sends the `Delete Bearer Response` message to the PGW.

Note: Dedicated bearer on the GTP-based S2a interface is supported only for trials.

10.5.2 Trusted Non-3GPP to E-UTRAN PDN Connection Handover

When a UE device moves from a trusted WLAN access network to the LTE network, the MME detects the handover from the non-3GPP access. Therefore, the MME creates a session with the same APN using the same PGW for the UE device as used in the PDN connection from the trusted WLAN access network. Then the SGW sends a handover message to the PGW, and GTP-C and GTP-U tunnels are established.

The signalling during a handover from trusted non-3GPP network to LTE network is shown in Figure 97.

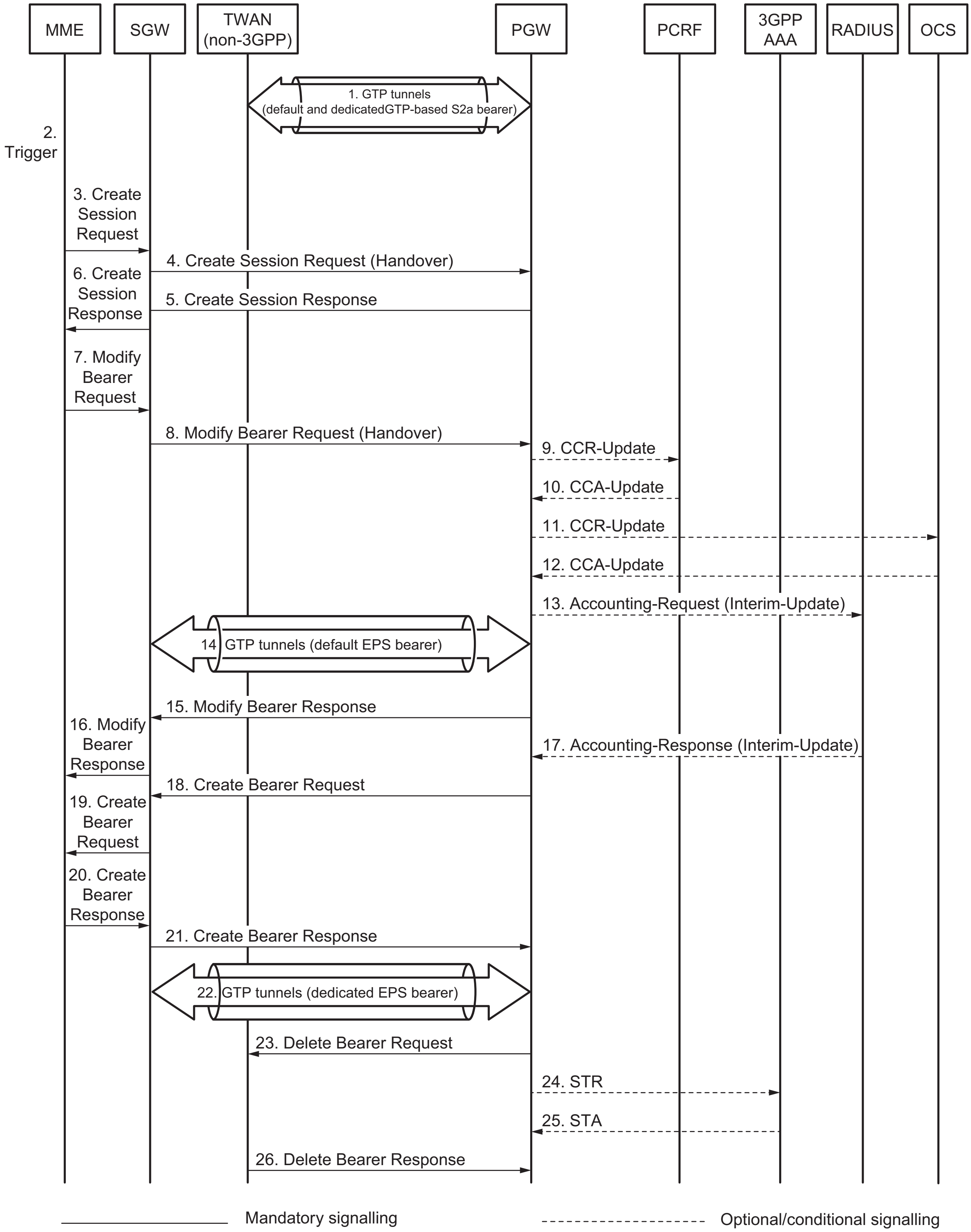

Figure 97 Signalling during Handover Procedure from Trusted Non-3GPP Network to LTE Network

A Handover procedure from the trusted non-3GPP network to the LTE network involves the following steps:

1. The UE is located in the trusted WLAN access network, and there is a GTP-C tunnel for signalling and a GTP-U tunnel for payload between the TWAN and the PGW for both default bearer and dedicated bearer.

2. A handover is triggered when the UE device enters the LTE network.

3. The MME sends a `Create Session Request` message with `Handover Indication` to the SGW.

   The SGW allocates S5/S8 F-TEID for the control plane and user plane.

4. The SGW sends a `Create Session Request` message with `Handover Indication` to the PGW.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Create Session Request`.

5. The PGW responds with a `Create Session Response` message to the SGW.

   The response contains the IP address or the prefix that was assigned to the UE while the UE was connected to the non-3GPP network.

   If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging see Section 3.21 on page 37.

6. The SGW responds with a `Create Session Response` message to the MME.

   The response contains the SGW IP address and TEID for uplink user payload.

7. The MME sends a `Modify Bearer Request` message to the SGW.

   The request contains the eNodeB IP address and TEID for downlink user payload.

8. The SGW sends a `Modify Bearer Request` message to the PGW.

9. If needed, the PGW sends a `CCR-Update` message to the PCRF to update the Gx+ PCC session.

10. The PCRF responds with a `CCA-Update` message.

11. To update credit control session, the PGW sends a `CCR-Update` message to the OCS.

12. The OCS responds with a `CCA-Update` message to the PGW.

13. To update the accounting session, the PGW sends an `Accounting-Request (Interim-Update)` to the RADIUS accounting server.

14. The PGW switches the payload to the newly established GTP-U tunnel over the S5/S8 interface.

    The payload on the default GTP-based S2a bearer is switched to the default 3GPP EPS bearer.

15. Without waiting for the response from the RADIUS server, the PGW sends a `Modify Bearer Response` message to the SGW to confirm the PDN connection handover to the LTE network.

16. The SGW sends a `Modify Bearer Response` to the MME.

17. The RADIUS server responds with an `Accounting-Response (Interim-Update)` to the PGW.

18. The PGW sends a `Create Bearer Request` message to the SGW to establish the dedicated EPS bearers.

19. The SGW forwards the `Create Bearer Request` message to the MME.

20. The MME acknowledges bearer activation by sending a `Create Bearer Response` message to the SGW.

21. The SGW acknowledges the bearer activation by sending a `Create Bearer Response` message to the PGW.

22. The PGW switches the user traffic mapped to the dedicated EPS bearer.

23. The PGW sends a `Delete Bearer Request` message to the TWAN to release all resources connected to the UE device.

24. To terminate the S6b session, the PGW sends an `STR` message to the 3GPP AAA server.

25. The 3GPP AAA server responds with an `STA` message to the PGW.

26. The TWAN releases all allocated resources for the UE, and responds with a `Delete Bearer Response` message.

10.6 Untrusted Non-3GPP (WLAN) Access Mobility

Untrusted non-3GPP access mobility occurs when a UE device moves between LTE network and untrusted WLAN access network. Mobility is achieved using the following procedures:

— E-UTRAN to untrusted non-3GPP PDN connection handover

— Untrusted non-3GPP to E-UTRAN PDN connection handover

Note: During the handover between the LTE network and the Untrusted WLAN access network, if the original PDN Type indicating the IPv4v6 is changed to the IPv4 or IPv6 for PDN connection, the PGW rejects the handover request.

Note: If a non-3GPP PDN connection already exists with the same IMSI and the same APN, the PGW also rejects the handover request.

10.6.1 E-UTRAN to Untrusted Non-3GPP PDN Connection Handover

When a UE device moves from the LTE network to an untrusted WLAN access network, the ePDG sends a `Create Session Request` message indicating handover to the PGW. The PGW sends a `Create Session Response` message to the ePDG to confirm the UE handover from the LTE network to the untrusted WLAN access network.

The signalling during a handover from LTE network to untrusted non-3GPP network is shown in Figure 98.

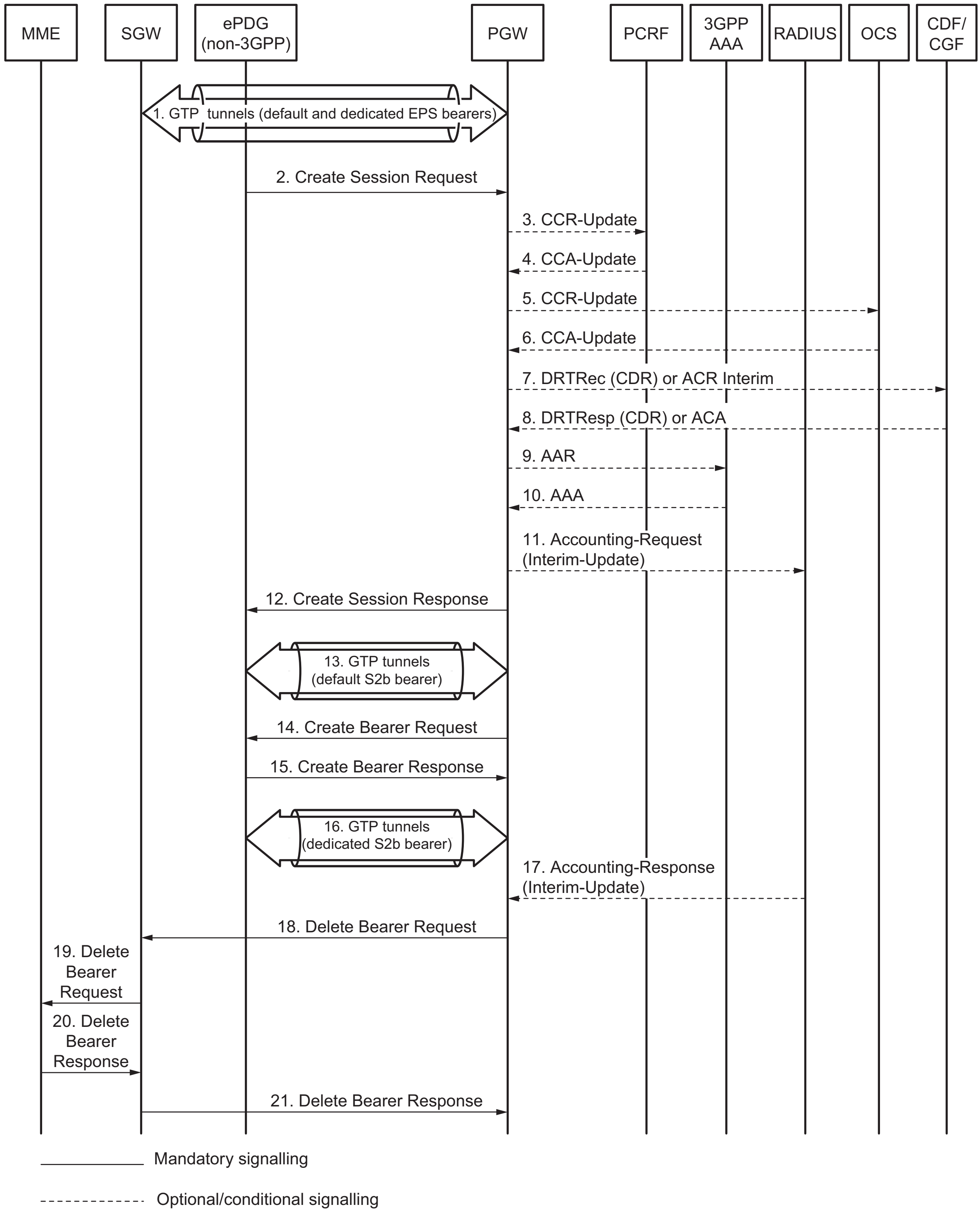

Figure 98 Signalling during Handover Procedure from LTE Network to Untrusted Non-3GPP Network

A handover procedure from the LTE network to the untrusted WLAN access network involves the following steps:

1. The UE device is located in the LTE network, and there is a GTP-C tunnel for signalling and a GTP-U tunnel for payload between the SGW and the PGW.

2. When the UE device enters the untrusted WLAN access network, the ePDG sends a `Create Session Request` message to the PGW, to inform about a UE device that has changed RAT type and needs establish the PDN connection on the S2b interface. The `Handover Indication` is set to 1 in the `Create Session Request` message.

   Note:

   — If there is no existing session in the PGW, the PGW sends a `Create Session Response` message with `Context Not Found` over the S2b interface. If a special handling of the handover request is configured, the PGW silently accepts the handover as a new request. For more information, refer to APN Configuration.

   — If there is an existing session of the same user and same APN but different RAT type, the PGW compares the IP address in the `PDN Address Allocation (PAA)` IE with the previously allocated UE IP address. Three scenarios with different behaviors are described in the following table:

Scenario	Behavior
`PAA IE` with zero IP address	The handover is accepted.
The IP address in `PAA IE` is the same with the previously allocated UE IP address	The handover is accepted.
The IP address in `PAA IE` is different from the previously allocated UE IP address	The handover is rejected with `Context Not Found` and the PGW delete this PDN with an external `Delete Bearer Request` message.

   The IP address inspection in `PAA` IE is done for both LTE to untrusted WIFI and untrusted WIFI to LTE handovers.

3. If PCC is deployed, the PGW sends a `CCR-Update` message to the PCRF to update the Gx+ PCC session.

   The PGW installs the dynamic PCC rules of the EPS dedicated bearers on the default S2b bearer.

4. The PCRF responds with a `CCA-Update` message to the PGW.

5. To update the credit control session, the PGW sends a `CCR-Update` message to the OCS.

6. The OCS responds with a `CCA-Update` message to the PGW.

7. The PGW closes the CDR with `Cause for Record Closing` set to `RAT Change`. For CDR charging using GTP', the `Data Record Transfer Request` is sent. For CDR charging using FTP, the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer. For Rf charging, the PGW generates the `ACR interim` message with the `Change-Condition` AVP set to `RAT Change`.

8. For CDR charging using GTP', the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP. For Rf charging, the CDF responds with an `Accounting Answer (ACA)` message to the PGW.

9. To authorize the UE device for PDN access, the PGW sends an `AAR` message to the 3GPP AAA server.

10. The 3GPP AAA server responds with an `AAA` message to the PGW.

11. To update the accounting session, the PGW sends an `Accounting-Request (Interim-Update)` to the RADIUS accounting server.

12. Without waiting for the response from the RADIUS server, the PGW sends a `Create Session Response` message to the ePDG.

13. The PGW switches the payload to the newly established GTP-U tunnel over the S2b interface.

    The payload on the default and dedicated 3GPP EPS bearers is switched to the default S2b bearer.

14. The PGW sends a `Create Bearer Request` message to the ePDG to establish S2b dedicated bearers.

15. The ePDG responds with a `Create Bearer Response` message to the PGW.

16. The PGW switches the user traffic mapped to the dedicated S2b bearer.

17. The RADIUS server responds with an `Accounting-Response (Interim-Update)` to the PGW.

18. The PGW sends a `Delete Bearer Request` message to the SGW to remove the old PDN connection for the UE device. The `Cause` IE is set to `RAT changed from 3GPP to Non-3GPP` and the `LBI` IE is included in the `Delete Bearer Request` message.

19. The SGW forwards the `Delete Bearer Request` message to the MME.

20. The MME sends a `Delete Bearer Response` message to the SGW.

21. The SGW deletes the bearer context related to the deactivated PDN connection, and sends the `Delete Bearer Response` message to the PGW.

10.6.2 Untrusted Non-3GPP to E-UTRAN PDN Connection Handover

When a UE device moves from an untrusted WLAN access network to the LTE network, the MME detects the handover from the non-3GPP access. Therefore, the MME creates a session with the same APN using the same PGW for the UE device as used in the PDN connection from the untrusted WLAN access network. Then the SGW sends a handover message to the PGW, and GTP-C and GTP-U tunnels are established.

The signalling during a handover from untrusted non-3GPP network to LTE network is shown in Figure 99.

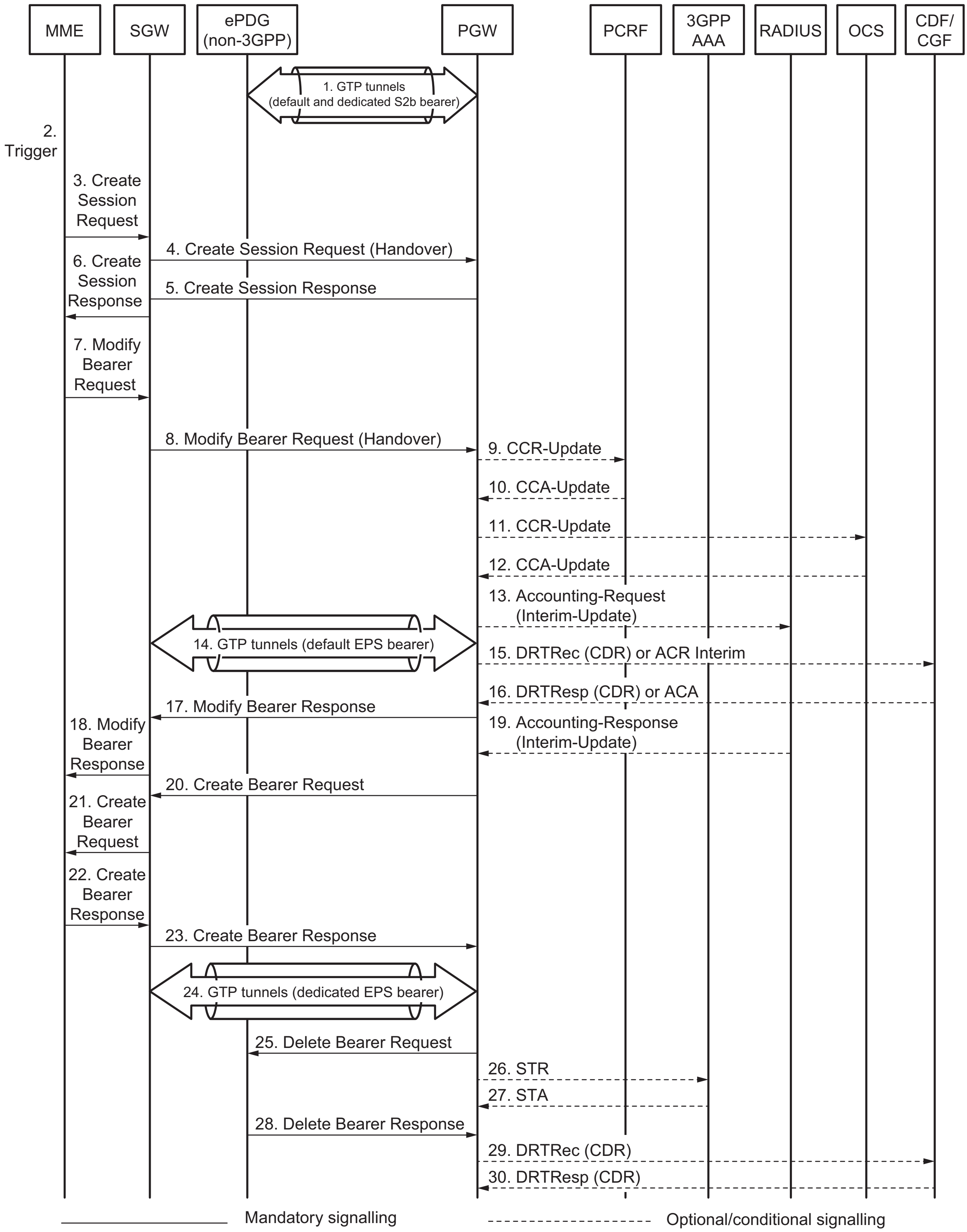

Figure 99 Signalling during Handover Procedure from Untrusted Non-3GPP Network to LTE Network

A Handover procedure from the untrusted non-3GPP network to the LTE network involves the following steps:

1. The UE is located in the untrusted WLAN access network, and there is a GTP-C tunnel for signalling and a GTP-U tunnel for payload between the ePDG and the PGW.

2. A handover is triggered when the UE device enters the LTE network.

3. The MME sends a `Create Session Request` message with `Handover Indication` to the SGW.

   The SGW allocates S5/S8 F-TEID for the control plane and user plane.

4. The SGW sends a `Create Session Request` message with `Handover Indication` to the PGW.

   If configured to perform PGW pause charging, a request to enable the SGW to use PGW pause charging for the PDN connection is included in the `Create Session Request`.

5. The PGW responds with a `Create Session Response` message to the SGW.

   The response contains the IP address or the prefix that was assigned to the UE while the UE was connected to the non-3GPP network.

   If the PGW is configured to perform, and can support pause charging, the `Create Session Response` includes a positive response to the request and PGW pause charging is enabled for the PDN connection. For more information on PGW pause charging see Section 3.21 on page 37.

6. The SGW responds with a `Create Session Response` to the MME.

   The response contains the SGW IP address and TEID for uplink user payload.

7. The MME sends a `Modify Bearer Request` message to the SGW.

   The request contains the eNodeB IP address and TEID for downlink user payload.

8. The SGW sends a `Modify Bearer Request` message to the PGW.

9. If PCC is deployed, the PGW sends a `CCR-Update` message to the PCRF to update the Gx+ PCC session.

10. The PCRF responds with a `CCA-Update` message.

11. To update credit control session, the PGW sends a `CCR-Update` message to the OCS.

12. The OCS responds with a `CCA-Update` message to the PGW.

13. To update the accounting session, the PGW sends an `Accounting-Request (Interim-Update)` to the RADIUS accounting server.

14. The PGW switches the payload to the newly established GTP-U tunnel over the S5/S8 interface.

    The payload on the default S2b bearer is switched to the default 3GPP EPS bearer.

15. The PGW closes the CDR with `Cause for Record Closing` set to `RAT Change`. For CDR charging using GTP', the `Data Record Transfer Request` is sent. For CDR charging using FTP, the CDR is either directly transferred to the charging gateway or stored locally on a CPB for later transfer. If Rf charging is used instead, the PGW generates the `ACR interim` message with the `Change-Condition` AVP set to `RAT Change`.

16. For CDR charging using GTP', the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP. For Rf charging, the CDF responds with an `Accounting Answer (ACA)` message to the PGW.

17. Without waiting for the response from the RADIUS server, the PGW sends a `Modify Bearer Response` message to the SGW to confirm the PDN connection handover to the LTE network.

18. The SGW sends a `Modify Bearer Response` to the MME.

19. The RADIUS server responds with an `Accounting-Response (Interim-Update)` to the PGW.

20. The PGW sends a `Create Bearer Request` message to the SGW to establish the dedicated EPS bearers.

21. The SGW forwards the `Create Bearer Request` message to the MME.

22. The MME acknowledges bearer activation by sending a `Create Bearer Response` message to the SGW.

23. The SGW acknowledges the bearer activation by sending a `Create Bearer Response` message to the PGW.

24. The PGW switches the user traffic mapped to the dedicated EPS bearer.

25. The PGW sends a `Delete Bearer Request` message to the ePDG to release all resources connected to the UE device.

26. To terminate the S6b session, the PGW sends an `STR` message to the 3GPP AAA server.

27. The 3GPP AAA server responds with a `STA` message to the PGW.

28. The ePDG releases all allocated resources for the UE, and responds with a `Delete Bearer Response` message.

29. If CDR is used, for CDR charging using GTP, the `Data Record Transfer Request` is sent. For CDR charging using FTP, the CDR is either directly

transferred to the charging gateway or stored locally on a CPB for later transfer.

30. For CDR charging using GTP, the `Data Record Transfer Response` is received by the PGW and no response is received for CDR charging using FTP.

10.7 PCC Session Modification

This section describes the PCC session modification sub-procedure triggered by the mobility events in Section 10.1 on page 155 to Section 10.3 on page 192. The PCC session modification sub-procedure occurs when one or several events that the PCRF subscribes to, such as RAT change or serving node change, occur. The PGW reports the events together with the changed attributes. In a response, the PCRF can send the updated QoS parameters to the PGW.

The PCC session modification sub-procedure can be triggered over GTPv1-C, see Figure 100, over GTPv2-C, see Figure 101, or over PMIPv6, see Figure 102.

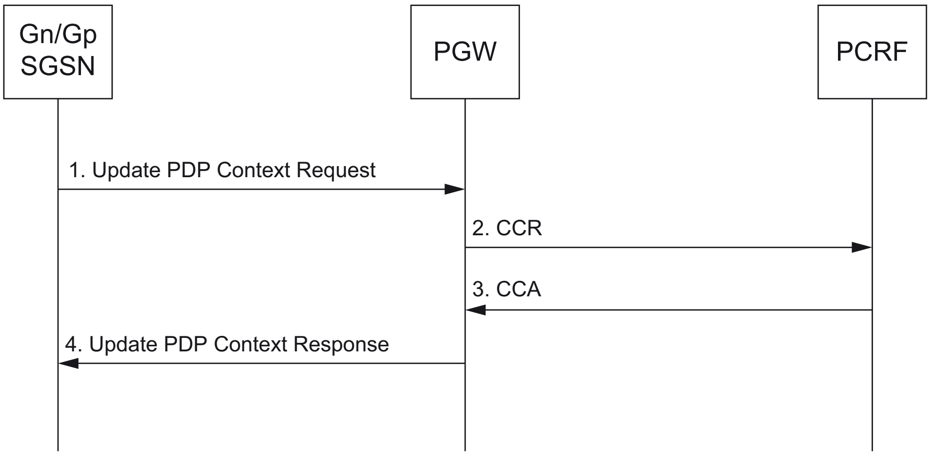

Figure 100 Signalling during a PCC Session Modification over GTPv1-C

The PCC session modification sub-procedure consists of the following steps:

1. The Gn/Gp SGSN sends an `Update PDP Context Request` message to the PGW.

2. The PGW sends a `CCR` message with request type Update to the PCRF.

3. The PCRF sends a `CCA` message with request type Update to the PGW. This message can contain updated QoS parameters.

4. The PGW sends an `Update PDP Context Response` message to the Gn/Gp SGSN.

If the `CCA` message with `Update` request type contains modified QoS parameters, the PGW includes the modified QoS parameters, if accepted by the PGW, in the `Update PDP Context Response` message. For more information about QoS updates, refer to Quality of Service on the GGSN and PGW.

Note: Modified QoS parameters from PCRF can also trigger dedicated bearer activation. For more information, see Section 9.2.1.1 on page 138.

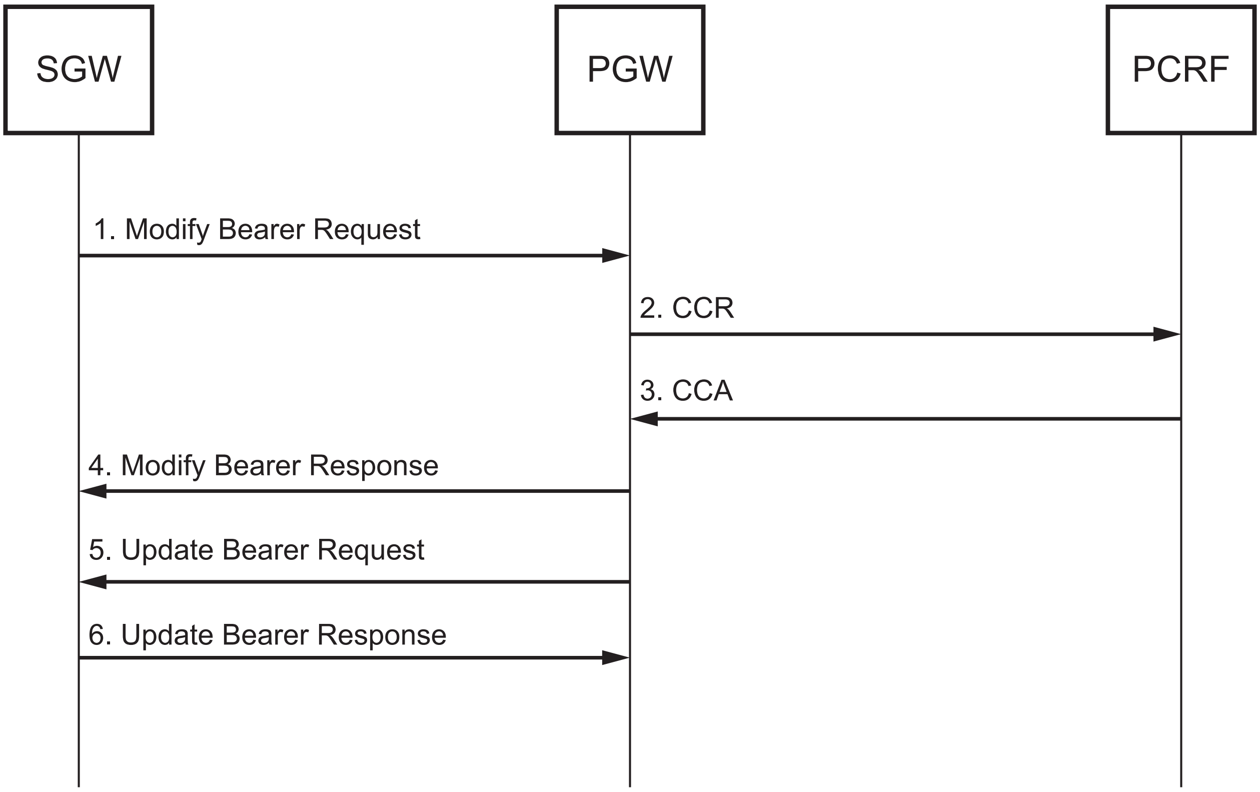

Figure 101 Signalling during a PCC Session Modification over GTPv2-C

The PCC session modification sub-procedure consists of the following steps:

1. The SGW sends a `Modify Bearer Request` message to the PGW.
2. The PGW sends a `CCR` message with request type Update to the PCRF.
3. The PCRF sends a `CCA` message with request type Update to the PGW. This message can contain updated QoS parameters.
4. The PGW sends a `Modify Bearer Response` message to the SGW.
5. If the `CCA` message with request type Update contains modified QoS parameters, the PGW decides to send an `Update Bearer Request` message to the SGW. For more information about QoS updates, refer to Quality of Service on the GGSN and PGW.

   Note: Modified QoS parameters from PCRF can also trigger dedicated bearer activation. For more information, see Section 9.2.1.1 on page 138.

6. The SGW sends an `Update Bearer Response` to the PGW.

The PGW decides the outcome of the QoS update after analyzing the cause codes in the `Update Bearer Response` message. For more information about the cause codes, refer to Policy Control.

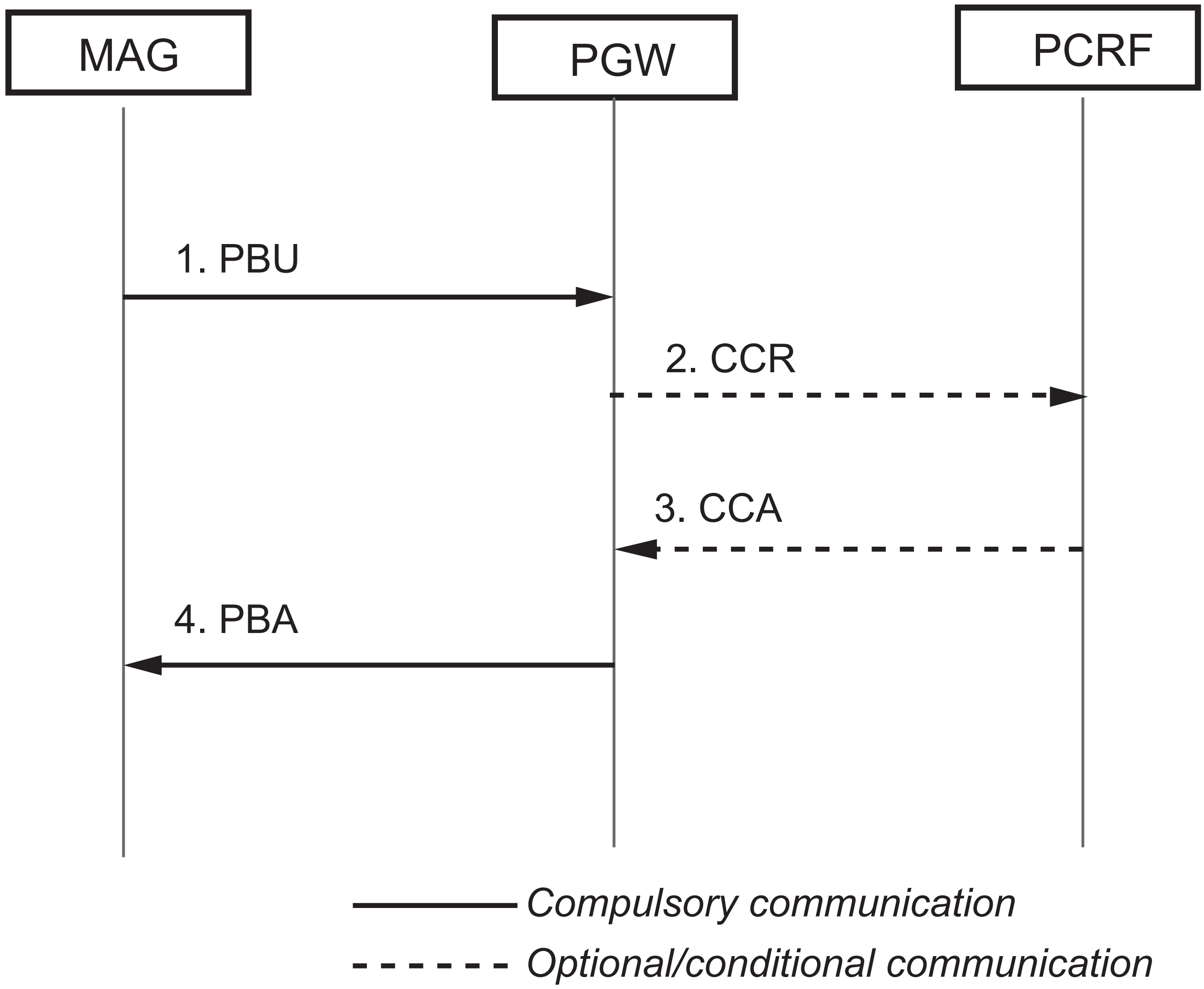

Figure 102 Signalling during a PCC Session Modification over PMIPv6

The PCC session modification sub-procedure consists of the following steps:

1. The MAG sends a `PBU` message to the PGW.
2. The PGW sends a `CCR` message with request type `Update` to the PCRF.
3. The PCRF sends a `CCA` message with request type `Update` to the PGW.
4. The PGW sends a `PBA` message to the MAG.

10.8 Bearer Control Mode Change during Mobility

If, during mobility, the selected BCM for the user session is changed from `UE_NW` to `UE_ONLY`, any already existing dedicated bearers are terminated. Any dynamic PCC rules installed on those bearers are moved to the default bearer. Any predefined PCC rules associated with the dedicated bearers are installed on the default bearer.

If the selected BCM is changed from `UE_ONLY` to `UE_NW`, the PGW initiates the creation of new dedicated bearers if there are any dynamic PCC rules installed on the session with a specified QCI and ARP, or if there are any active predefined PCC rules with an associated service QoS profile. The creation of the dedicated bearers is initiated after the mobility procedure is completed. If the bearer creation based on Service Detection fails, the PGW attempts the creation according to a retry mechanism. For more information about the creation of dedicated bearers, see Section 4.1.3 on page 54 for Gn/Gp access, Section 8.4.1 on page 101 for S11 access, and Section 9.2.1.1 on page 138 for S4 access. For more information about the retry mechanism of bearer creation based on Service Detection failures, refer to Quality of Service on the GGSN and PGW.

11 Network-Triggered Service Restoration Procedure

This section describes the network-triggered service restoration procedure on the SGW.

The network-triggered service restoration procedure is triggered by the following mechanisms:

— Peer monitoring

  When an MME or SGSN is restarted and becomes available, the MME or SGSN sends an incremented restart counter to the SGW. For the signalling procedure when the SGW detects a restarted MME or SGSN, see Section 11.1 on page 243.

— Path management

  When there is no `Echo Response` message from an MME or SGSN after all possible retransmissions, the path to the MME or SGSN is marked as unavailable. For the signalling procedure when the SGW detects that an MME or SGSN is unavailable, see Section 11.2 on page 245.

The SGW detects that the MME or SGSN also supports the network-triggered service restoration procedure when the SGW receives the `Sending Node Features` IE with the `Network-Triggered Service Restoration (NTSR)` feature included in an `Echo Request` or `Echo Response` message.

For information on the path management messages, refer to S4 Interface Description and S11 Interface Description.

For information on configuring the SGW to support network-triggered service restoration procedures, refer to GTP Interface Configuration.

11.1 Service Restoration for a Restarted MME or SGSN

The signalling during the network-triggered service restoration procedure for a restarted MME or SGSN consists of the following steps as shown in Figure 103.

Note: This procedure assumes that MME or SGSN geographical redundancy is enabled.

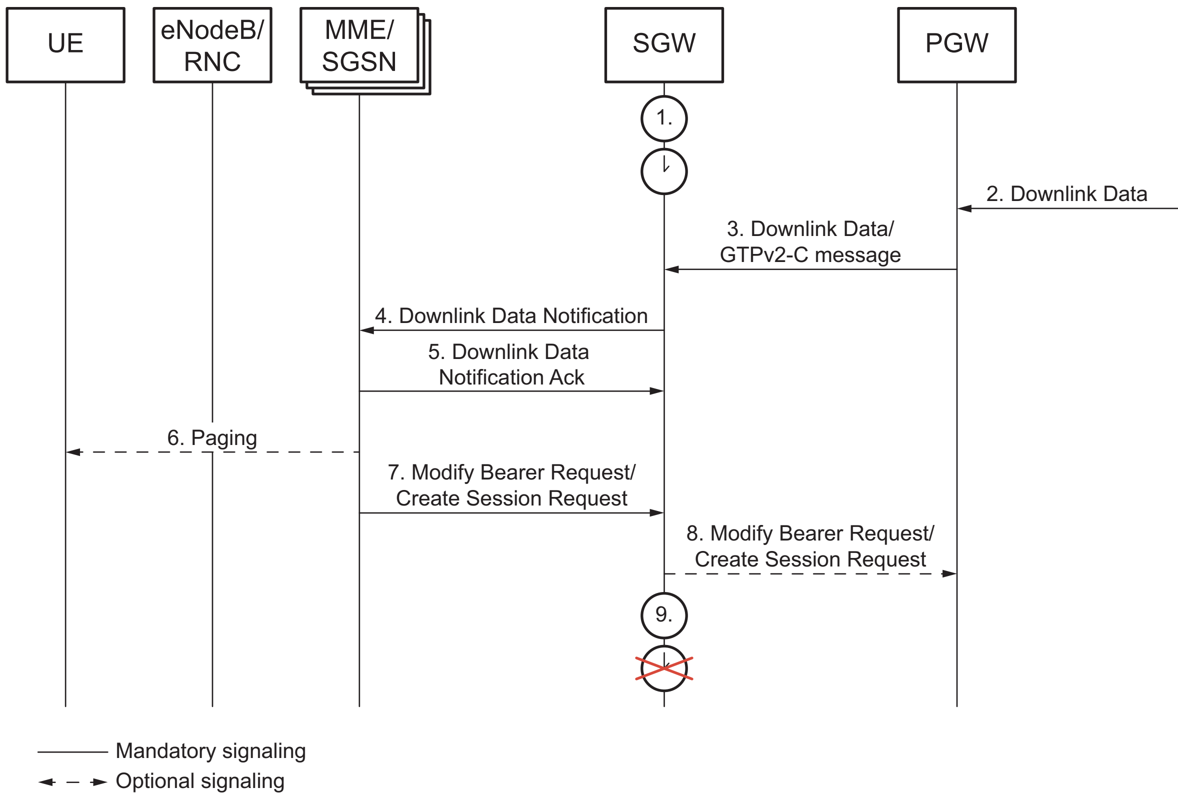

Figure 103 Signalling During the Network-Triggered Service Restoration Procedure for a Restarted MME or SGSN

1. The SGW detects through an incremented restart counter in any applicable message that an MME or SGSN restart has occurred. The SGW marks all PDN connections connected to the restarted MME or SGSN for possible restoration and starts the supervision timer for network-triggered service restoration for all maintained PDN connections.

2. The PGW receives downlink data, which is to be sent to the UE, on a maintained PDN connection.

3. The PGW either forwards the downlink data to the SGW or sends a GTPv2-C signalling message to the SGW.

4. For maintained idle PDN connections, the SGW buffers the downlink data and identifies the MME or SGSN serving the UE. The SGW then sends a `Downlink Data Notification` message with IMSI to the MME or SGSN.

   For GTPv2-C signalling messages, for example a `Create Bearer Request`, the SGW sends a response to the PGW.

5. The MME or SGSN responds with a `Downlink Data Notification Acknowledge` message to the SGW with a cause code `Request accepted`.

The MME or SGSN fetches all the available data for the UE from a backup MME or SGSN in the pool of MMEs or SGSNs.

6. If the MME or SGSN cannot recover the UE data from a backup MME or SGSN or there is no such backup MME or SGSN, that is, when there is no geographical redundancy for MMEs or SGSNs, the MME or SGSN pages the UE with a request to re-attach.

7. After the PDN connection is restored from a backup MME or SGSN, the restarted MME or SGSN sends a `Modify Bearer Request` to the SGW to restore the PDN connection.

   If the restarted MME or SGSN requests the UE to re-attach as optionally shown in Step 6, the UE re-attaches and the MME or SGSN sends a `Create Session Request` to the SGW.

8. Upon receiving a `Modify Bearer Request` message from the MME or SGSN, the SGW may optionally forward the `Modify Bearer Request` message to the PGW to modify the maintained PDN connection. Signalling continues according to legacy behavior for bearer modification.

   If the SGW receives a `Create Session Request` message following a re-attach request, the SGW deletes the old maintained PDN connection and forwards the `Create Session Request` to the PGW to establish a new user session. Signalling continues according to legacy behavior for user session creation.

9. When the supervision timer for network-triggered service restoration expires and bearer deletion due to a peer restart is enabled, the SGW deletes all previously maintained PDN connections locally and externally towards the MME or SGSN and the PGW.

11.2 Service Restoration for an Unavailable MME or SGSN

The signalling during the network-triggered service restoration procedure for when an MME or SGSN becomes unavailable consists of the following steps as shown in Figure 104.

Note: This procedure assumes that geographical redundancy is configured for MMEs or SGSNs, a pool of MMEs or SGSNs is configured on the SGW, and the unavailable MME or SGSN belongs to such a configured pool.

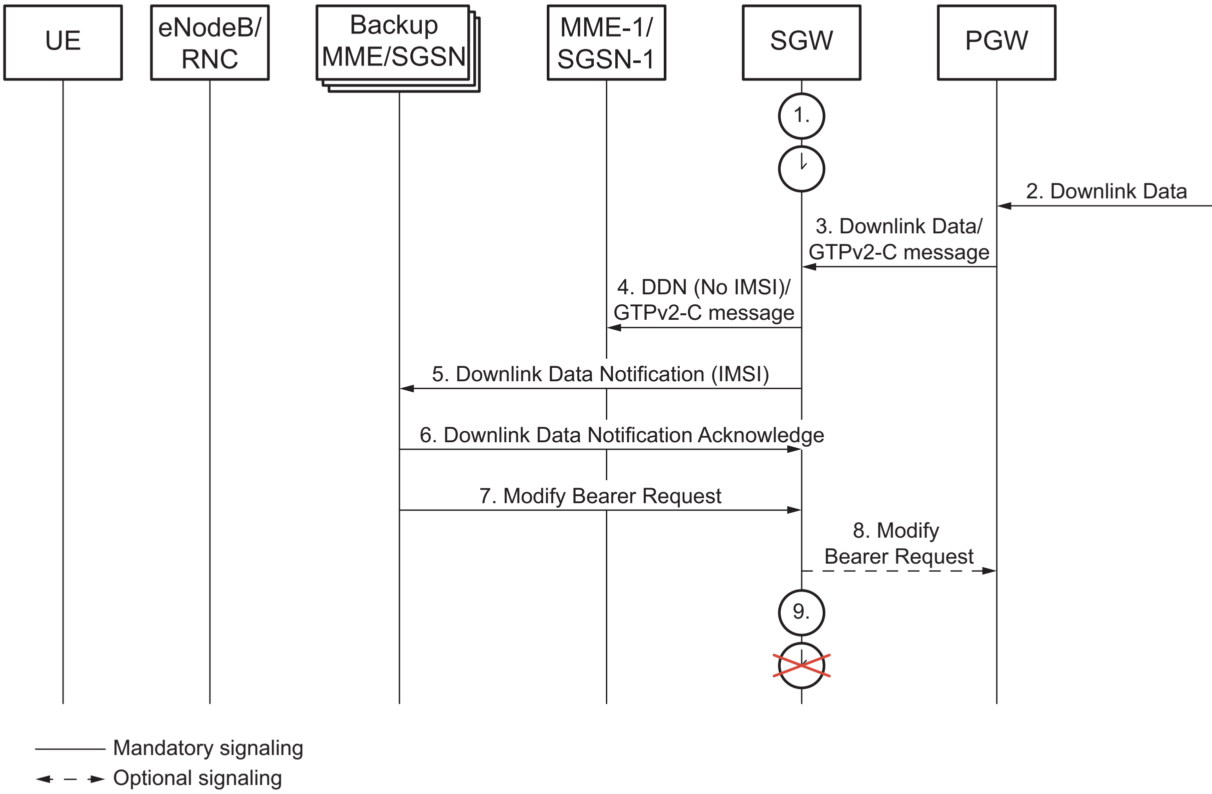

Figure 104 Signalling During the Network-Triggered Service Restoration Procedure for an Unavailable MME or SGSN

1. The SGW detects that an MME or SGSN (**MME-1/SGSN-1**) is unavailable using path management messages. The SGW marks all PDN connections connected to the unavailable MME or SGSN for possible restoration and starts the supervision timer for network-triggered service restoration for all maintained PDN connections.

2. The PGW receives downlink data, which is to be sent to the UE, on a maintained PDN connection.

3. The PGW either forwards the downlink data to the SGW or sends a GTPv2-C signalling message to the SGW.

4. If the SGW receives downlink data for an idle PDN connection, the SGW sends a `Downlink Data Notification` message without IMSI to the unavailable MME or SGSN (**MME-1/SGSN-1**) only once, thereby ignoring the specified **`n3-requests`** value.

   If the SGW receives a GTPv2-C signalling message, the SGW forwards the message, for example a `Create Bearer Request` to the unavailable MME or SGSN (**MME-1/SGSN-1**) only once, thereby ignoring the specified **`n3-requests`** value.

5. If no reply is received from the unavailable MME or SGSN (**MME-1/SGSN-1**), the SGW sends a `Downlink Data Notification` message with IMSI to the next MME or SGSN present in the configured pool in a round-robin fashion. If no response is received to the `Downlink Data Notification` message with IMSI from the backup MME or SGSN after `n3Requests` number of attempts, the SGW tries the next MME or SGSN in the pool, and so on.

   If a pool is not configured, the SGW does not send the `Downlink Data Notification` message with IMSI.

6. A backup MME or SGSN from within the pool responds with a `Downlink Data Notification Acknowledge` message to the SGW with a cause code `Request accepted`.

7. The backup MME or SGSN also sends a `Modify Bearer Request` message to the SGW.

8. Upon receiving a `Modify Bearer Request` message from the backup MME or SGSN, the SGW may optionally forward the `Modify Bearer Request` message to the PGW to modify the maintained PDN connection. Signalling continues according to legacy behavior for bearer modification.

9. If the supervision timer for network-triggered service restoration expires, the MME or SGSN (**MME-1/SGSN-1**) is still unavailable, and bearer deletion due to a path failure is enabled, the SGW deletes all its maintained PDN connections locally.

If the MME or SGSN (**MME-1/SGSN-1**) becomes available while the supervision timer for network-triggered service restoration is still running, the supervision timer is stopped. If the cause of its unavailability was due to a restart, the service restoration procedure is according to Section 11.1 on page 243. If the cause of its unavailability was not due to a restart, the SGW starts a cleanout timer for network-triggered service restoration to allow the MME or SGSN to inform the SGW that some PDN connections are still present in the MME or SGSN. When the cleanout timer expires and bearer deletion due to a path failure is enabled, all remaining sessions, which are still pending restoration, are deleted locally and externally towards the MME or SGSN and the PGW.

Reference List

3GPP Standards

[1] General Packet Radio Service (GPRS), Service Description Stage 2, 3GPP TS 23.060

[2] Architecture Enhancements for Non-3GPP Accesses, 3GPP TS 23.402

[3] General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access, 3GPP TS.23.401

[4] GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface, 3GPP TS 29.060

[5] 3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C), 3GPP TS 29.274

[6] Proxy Mobile IPv6 (PMIPv6) based Mobility and Tunnelling protocols; Stage 3, 3GPP TS 29.275

IETF Standards

[7] Dynamic Host Configuration Protocol, RFC 2131