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TECHNICAL SPECIFICATION

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Contents

Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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1   Scope

The present document is part of a series of documents that specify charging functionality and charging management in 3GPP networks. The 3GPP core network charging architecture and principles are specified in TS 32.240 [1], which provides an umbrella for other charging management TSs that specify:

-    the content of the CDRs per domain / subsystem / service (offline charging);

-    the content of real-time charging messages per domain / subsystem / service (online charging);

-    the functionality of online and offline charging for those domains / subsystems / services;

-    the interfaces that are used in the charging framework to transfer the charging information (i.e. CDRs or charging events).

The complete document structure for these TSs is defined in TS 32.240 [1].

The present document specifies the converged offline and online charging description for the 5G Data Connectivity domain based on the functional stage 2 description in TS 23.501 [200], TS 23.502 [201] and TS 23.503 [202].

This charging description includes the converged offline and online charging architecture and scenarios specific to the 5G Data Connectivity domain, as well as the mapping of the common 3GPP charging architecture specified in TS 32.240 [1] onto the 5G Data Connectivity domain.

It further specifies the structure and content of the CDRs for offline charging, and the charging events for converged online and offline charging. The present document is related to other 3GPP charging TSs as follows:

-    The common 3GPP charging architecture is specified in TS 32.240 [1].

-    The parameters, abstract syntax and encoding rules for the CDRs are specified in TS 32.298 [51].

-    A transaction based mechanism for the transfer of CDRs within the network is specified in TS 32.295 [54].

-    The file based mechanism used to transfer the CDRs from the network to the operator's billing domain (e.g. the billing system or a mediation device) is specified in TS 32.297 [52].

-    The services, operations and procedures of charging, using Service Based Interface are specified in TS 32.290 [57].

-    The charging service of 5G system is specified in TS 32.291 [58].

All references, abbreviations, definitions, descriptions, principles and requirements, used in the present document, that are common across 3GPP TSs, are defined in TR 21.905 [100]. Those that are common across charging management in 3GPP networks/domains, services or subsystems are provided in the umbrella TS 32.240 [1] and are copied into clause 3 of the present document for ease of reading. Finally, those items that are specific to the present document are defined exclusively in the present document.

2   References

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

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

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

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

[1]   3GPP TS 32.240: "Telecommunication management; Charging management; Charging architecture and principles".

[2] - [50]	Void.
[51]	3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) parameter description".
[52]	3GPP TS 32.297: "Telecommunication management; Charging management; Charging Data Record (CDR) file format and transfer".
[53]	Void.
[54]	3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".
[55-56]	Void.
[57]	3GPP TS 32.290: "Telecommunication management; Charging management; 5G system; Services, operations and procedures of charging using Service Based Interface (SBI)".
[58]	3GPP TS 32.291: " Telecommunication management; Charging management; 5G system; Charging service, stage 3".
[59] - [99]	Void.
[100]	3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
[101]	3GPP TS 22.115: "Service aspects; Charging and billing".
[102]	3GPP TS 22.261: "Service requirements for next generation new services and markets".
[103] - [199]	Void
[200]	3GPP TS 23.501:"System Architecture for the 5G System".
[201]	3GPP TS 23.502:"Procedures for the 5G System".
[202]	3GPP TS 23.503:"Policy and Charging Control Framework for the 5G System; Stage 2".
[203]	3GPP TS 23.316: "Wireless and wireline convergence access support for the 5G System (5GS)".
[204] - [299]	Void
[300] - [399]	Void.
[400] - [499]	Void.
[500] - [599]	Void.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [100] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [100].

3.2 Symbols

For the purposes of the present document, the following symbols apply:

Bd	Reference point for the CDR file transfer from the 5G Data connectivity CGF to the BD.
Ga	Reference point for CDR transfer between a CDF and the CGF.
Nchf	Service based interface exhibited by CHF.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [100] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [100].

5GC	5G Core Network
5GS	5G System
ABMF	Account Balance Management Function
AF	Application Function
AMF	Access and Mobility Management Function
ATSSS	Access Traffic Steering, Switching, Splitting
AUSF	Authentication Server Function
BD	Billing Domain
CCS	Converged Charging System
CDF	Charging Data Function
CGF	Charging Gateway Function
CHF	Charging Function
CP	Control Plane
CTF	Charging Trigger Function
DNN	Data Network Name
FBC	Flow Based Charging
GPSI	Generic Public Subscription Identifier
GUAMI	Globally Unique AMF Identifier
MA	Multi-Access
MPTCP	Multi-Path TCP Protocol
N3IWF	Non-3GPP InterWorking Function
NE	Network Element
NEF	Network Exposure Function
NF	Network Function
NRF	Network Repository Function
NSSF	Network Slice Selection Function
OCF	Online Charging Function
OCS	Online Charging System
PCC	Policy and Charging Control
PCF	Policy Control Function
PEI	Permanent Equipment Identifier
QBC	QoS flow Based Charging
QFI	QoS Flow Identifier
SDF	Service Data Flow
SMF	Session Management Function
SSC	Session and Service Continuity
SUPI	Subscription Permanent Identifier
TNAN	Trusted Non-3GPP Access Network
TNAP	Trusted Non-3GPP Access Point
UDM	Unified Data Management
UDR	Unified Data Repository
UPF	User Plane Function

4 Architecture considerations

4.1 High-level 5G System architecture

4.1.1 Non-roaming reference architecture

Figure 4.1.1.1 shows the 5G System high level architecture as defined in TS 23.501 [200] for 5G data connectivity, in the service-based representation for Control Plane (CP) Network Functions.
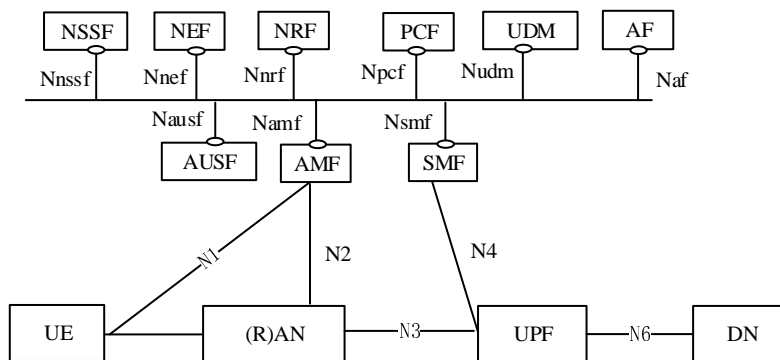
Figure 4.1.1.1: 5G System architecture

4.1.2 Roaming Home Routed reference architecture

Figure 4.1.2.1 shows the 5G System high level Roaming Home Routed architecture as defined in TS 23.501 [200] for 5G data connectivity, in the service-based representation for Control Plane (CP) Network Functions.
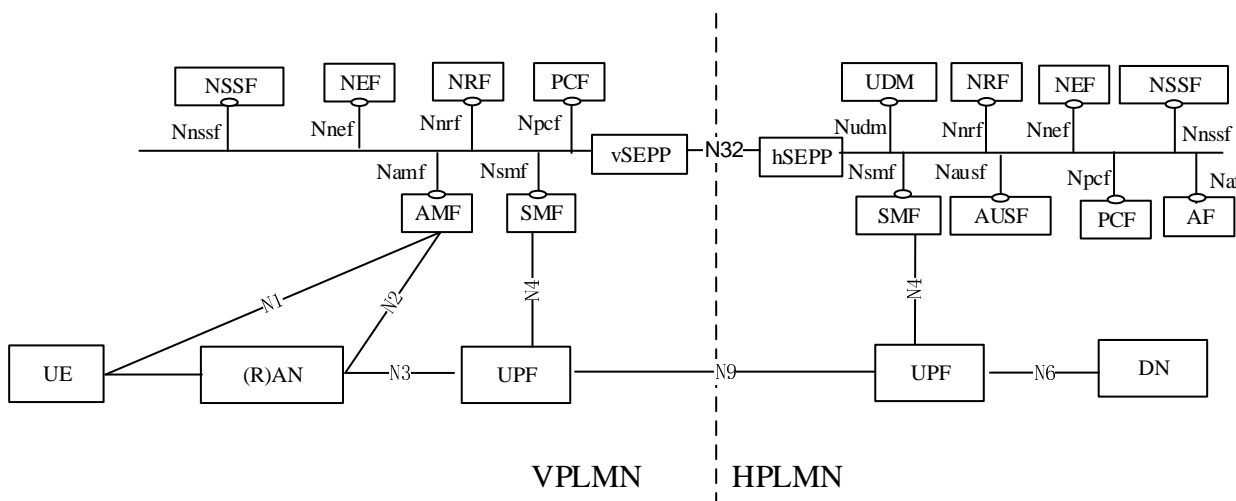
Figure 4.1.2.1: Roaming 5G System architecture - home routed scenario in service-based interface representation

4.1.3 Interworking with EPC architecture

Figure 4.1.3.1 shows the non-roaming architecture for interworking between 5GS and EPC/E-UTRAN as defined in TS 23.501 [200] for 5G data connectivity.
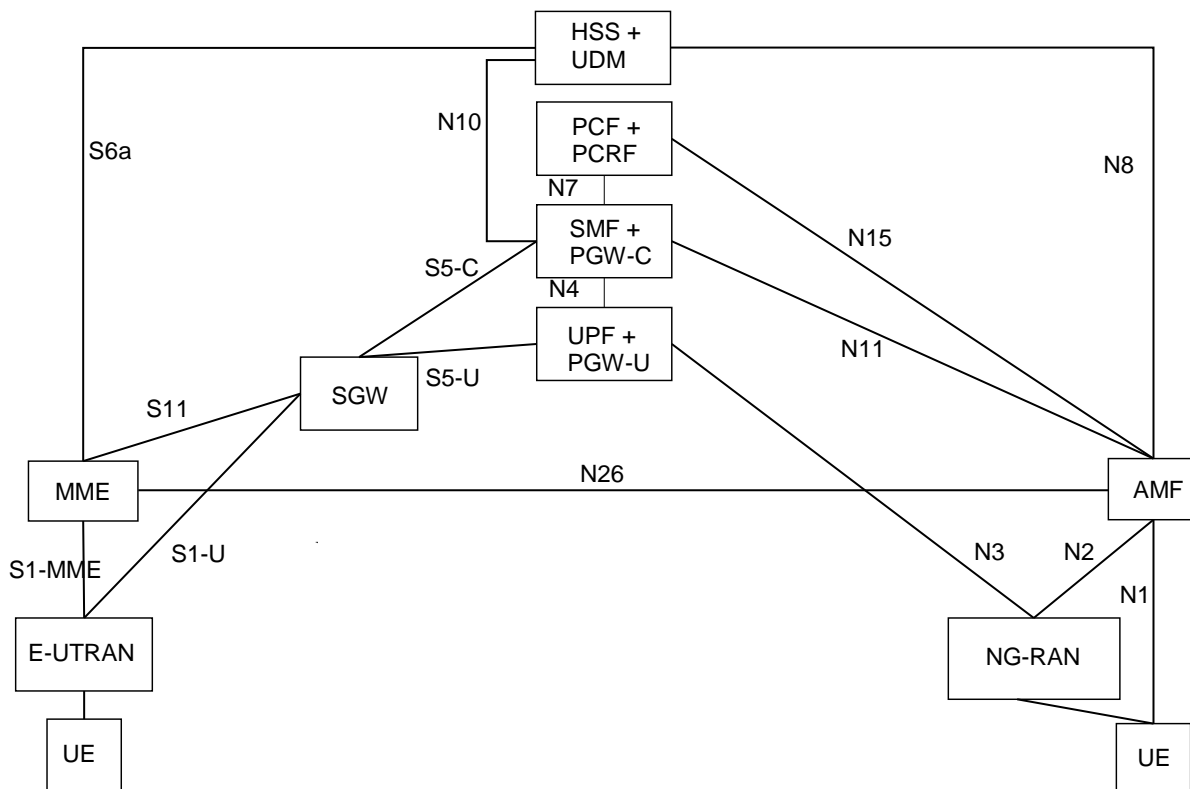
Figure 4.1.3.1: Non-roaming architecture for interworking between 5GS and EPC/E-UTRAN

NOTE: N26 interface is an inter-CN interface between the MME and 5GS AMF in order to enable interworking between EPC and the NG core. Support of N26 interface in the network is optional for interworking.

4.1.4 Architecture reference for Non-3GPP Accesses

Figure 4.1.4.1 shows the non-roaming architecture for Non-3GPP Accesses as defined in TS 23.501 [200] for 5G data connectivity.
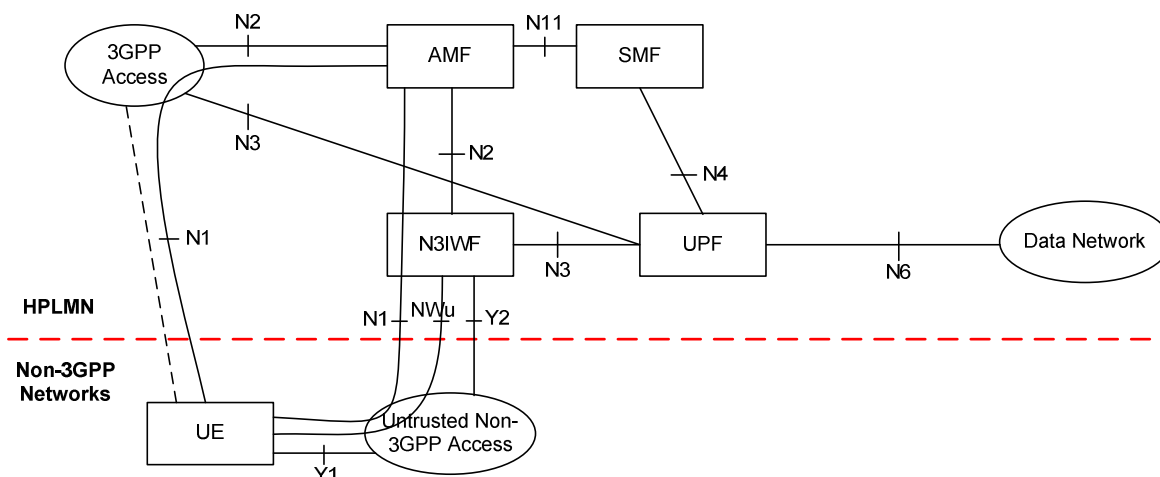
Figure 4.1.4.1: Non-roaming architecture for Untrusted Non-3GPP Accesses

This reference architecture supports service based interfaces for AMF, SMF and other NFs not represented in the figure.

Figure 4.1.4.2 shows the non-roaming architecture for 5G Core Network with trusted non-3GPP access as defined in TS 23.501 [200] for 5G data connectivity.
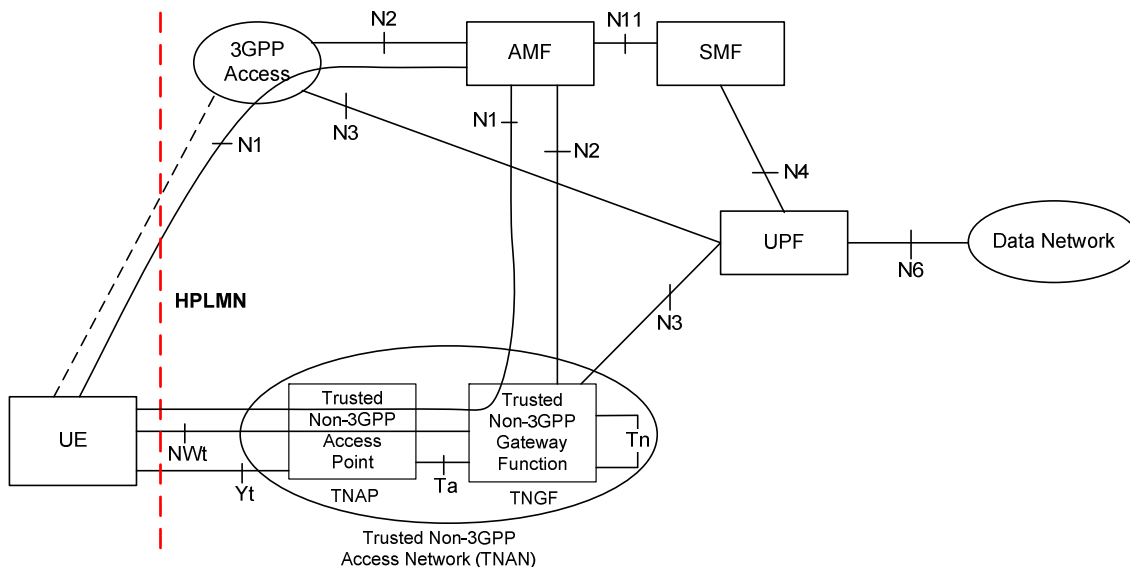
Figure 4.1.4.2: Non-roaming architecture for 5G Core Network with trusted non-3GPP access

The UE is connected to the 5G Core Network over non-3GPP access. This reference architecture supports service based interfaces for AMF, SMF and other NFs not represented in the figure.

4.1.5 Architecture for deployments topologies with specific SMF Service Areas

4.1.5.1 Non-roaming architecture with an I-SMF insertion without ULCL/BP

Figure 4.1.5.1 shows the 5G System high level non-roaming architecture, as defined in TS 23.501 [200], with an I-SMF insertion to the PDU Session without UL-CL/BP, using reference point representation.
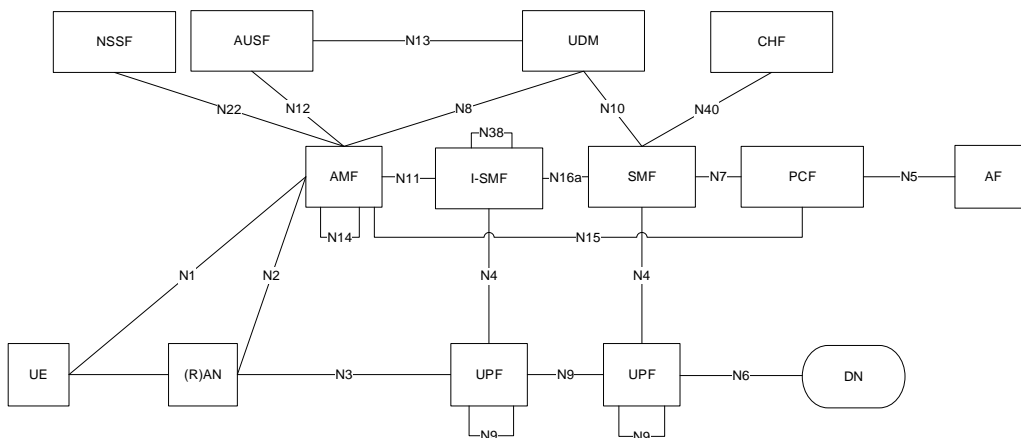
Figure 4.1.5.1: Non-roaming architecture with I-SMF insertion to the PDU Session in reference point representation, with no UL-CL/BP

4.1.5.2 Non-roaming architecture with an I-SMF insertion with ULCL/BP

Figure 4.1.5.2 shows the 5G System high level non-roaming architecture, as defined in TS 23.501 [200], for an I-SMF insertion to the PDU Session with UL-CL/BP, using reference point representation.
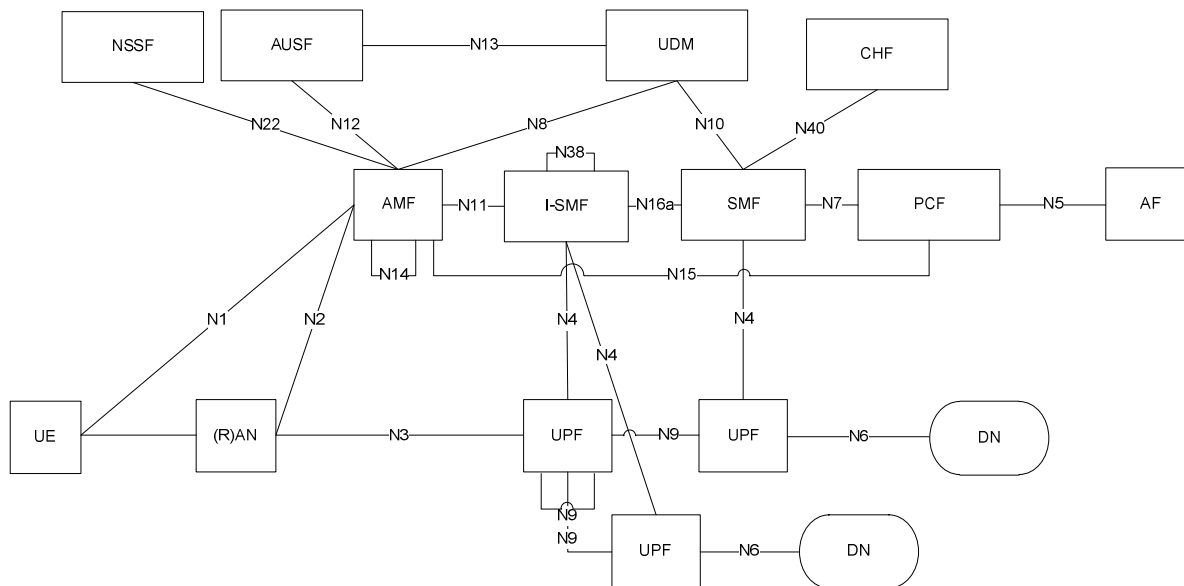
Figure 4.1.5.2: Non-roaming architecture with I-SMF insertion to the PDU Session in reference point representation, with UL-CL/BP

4.1.6 Architecture reference for ATSSS support

The 5G System Architecture references for the support of ATSSS in 5G data connectivity charging are specified in TS 23.501 [200]:

- Non-roaming: Figure 4.2.10-1.

- Roaming with Home-routed architecture - UE registered to the same VPLMN: Figure 4.2.10-2.

- Roaming with Home-routed architecture - UE registered to different PLMNs: Figure 4.2.10-3.

The Hybrid Access architecture of 5G-RG for the support of ATSSS in 5G data connectivity charging is defined in clause 4.1.7.

4.1.7 Architecture reference for Wireline Access network

Figure 4.1.7.1 shows the non- roaming architecture for 5G Core Network for 5G-RG with Wireline 5G Access network and NG RAN as defined in TS 23.501 [200] for 5G data connectivity.
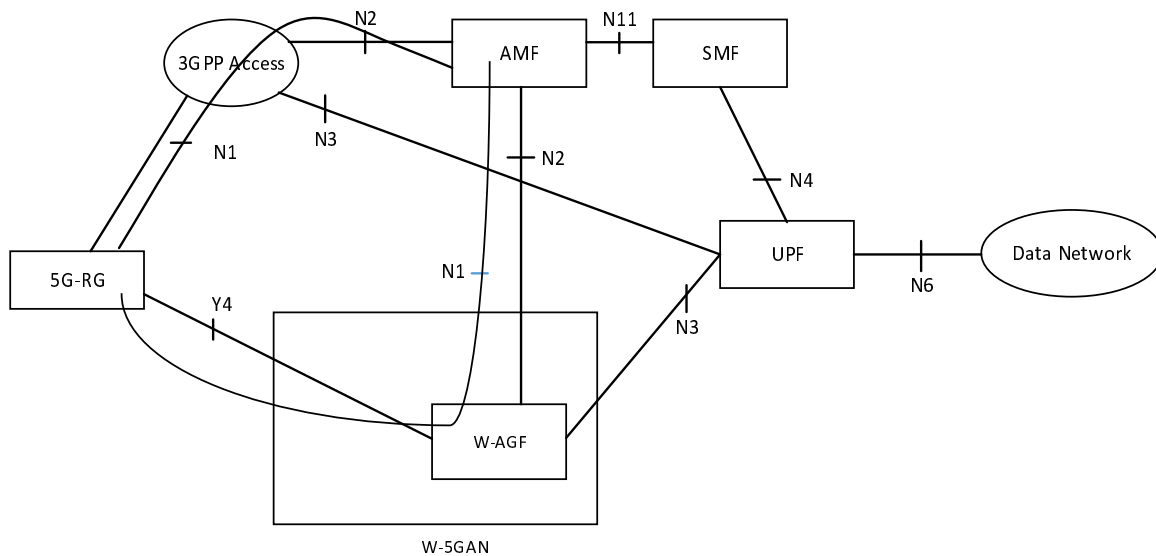
Figure 4.1.7.1: Non- roaming architecture for 5G Core Network for 5G-RG with Wireline 5G Access network and NG RAN

The 5G-RG can be connected to 5GC via W-5GAN, NG RAN or via both accesses. The reference architecture in Figure 4.1.7.1 shows service based interfaces for AMF, SMF and other NFs are not represented in this figure.

Non- roaming architecture for 5G Core Network for FN-RG with Wireline 5G Access network is specified in TS 23.501 [200].

4.2　5G data connectivity domain converged charging architecture

The SMF embedding the CTF, generates charging events towards the CHF for PDU connectivity converged charging or offline only charging.

As described in TS 32.240 [1], the CTF generates charging events towards to the CHF for converged online and offline charging processing. The CDRs generation is performed by the CHF acting as a CDF, which transfers them to the CGF. Finally, the CGF creates CDR files and forwards them to the BD.

If the CGF is external, the CHF acting as a CDF, forwards the CDRs to the CGF across the Ga interface.
If the CGF is integrated, there is only one internal interface between the CHF and the CGF. In this case, the relationship between CHF and CGF is 1:1. An integrated CGF may support the Ga interface from other CDFs.

When an external CGF is used, this CGF may also be used by other, i.e. non-5GCS, network elements, according to network design and operator decision. It should be noted that the CGF may also be an integrated component of the BD – in this case, the Bd interface does not exist and is replaced by a proprietary solution internal to the BD.

Figure 4.2.1 depicts the architectural options for converged charging.
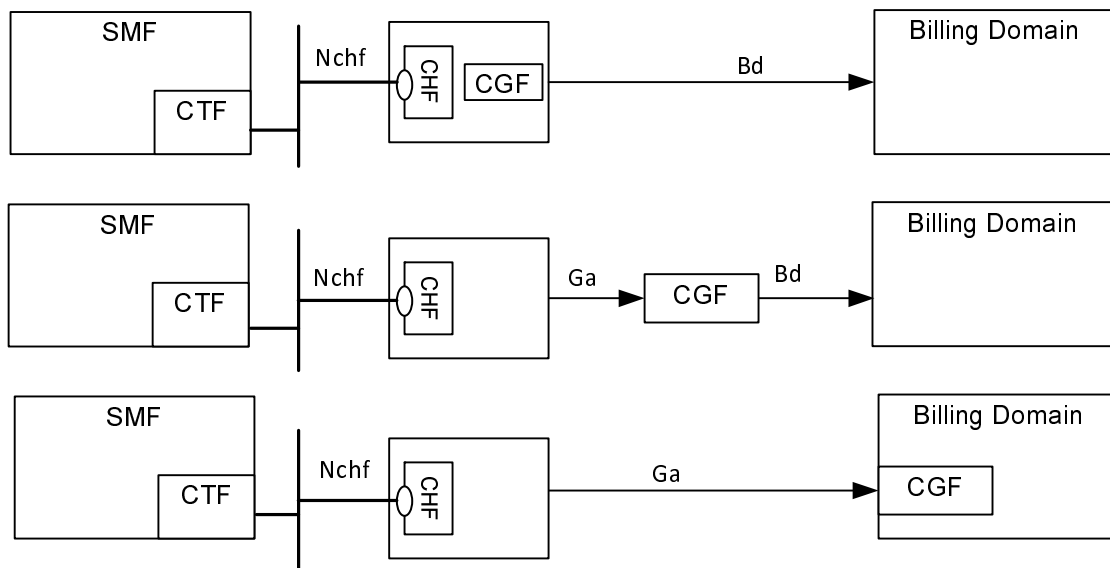
Figure 4.2.1: 5G data connectivity converged charging architecture

Nchf is described in clauses 5.2.1 and 5.2.2, Ga in clause 5.2.4 and Bd in clause 5.2.5.

5   5G data connectivity charging principles and scenarios

5.1   5G data connectivity charging principles

5.1.1   General

The charging functions specified for the 5G data connectivity charging:

-   PDU session in SMF, refer to TS 23.501 [200];

-   service data flows, within PDU session, refer to TS 23.503 [202].

-   QoS flows within PDU session refer to TS 23.501 [200] and TS 23.503 [202].

5.1.2   Requirements

The following are high-level charging requirements specific to the packet domain, derived from the requirements in TS 22.115 [101], TS 22.261 [102], TS 23.501 [200], TS 23.502 [201] and TS 23.503 [202].

-   The SMF shall support converged online and offline charging.

-   The SMF may support offline only charging.

-   The SMF shall support PDU session charging using service based interface.

-   The SMF shall support network slice instance charging.

-   The SMF shall collect charging information per PDU session for UEs served under 3GPP access and non-3GPP access (untrusted non-3GPP access, trusted non-3GPP access and wireline).

- Every PDU session shall be assigned a unique identity number for billing purposes per PLMN. (i.e. the Charging Id).

- Data volumes on both the uplink and downlink directions shall be counted separately. The data volumes shall reflect the data as delivered to and forwarded from the user.

- The charging mechanisms shall provide the date and time information when the PDU session starts.

- The SMF shall be capable of handling the Charging Characteristics. Charging Characteristics can be specific to a subscription or subscribed DNN.

- The SMF may be capable of identifying data volumes, elapsed time or events for individual service data flows (flow based charging). One PCC rule identifies one service data flow.

- SMF shall allow reporting of the service or the detected application usage per rating group or per combination of the rating group and service id. This reporting level can be activated per PCC rule.

- The quota management shall be per rating group per PDU session.

- If there are multiple UPFs for one PDU session, the quota management may be one for all UPFs or separate per UPF and the usage and charging information reporting per UPF.

- The SMF shall support charging for PDU Session types of IP, Ethernet and Unstructured.

- In Home Routed scenario, the SMF shall collect charging information per PDU session and, based on Home Operator policy and agreement between Home and Visit Operators, shall be able to collect charging information per Qos Flow for in-bound and out-bound roamers in Home Routed scenario.

- For interworking between 5GS and EPC, the dedicated PGW-C + SMF shall collect charging information using the same mechanisms as the SMF.

- The SMF shall support PDU session charging when the PDU session is served by both I-SMF and SMF.

- The SMF shall support charging for MA PDU Connectivity Service over 3GPP access and non-3GPP access.

- The SMF in VPLMN and in HPLMN shall support charging for MA PDU Connectivity Service in roaming Home Routed scenario with UE registered to the same VPLMN for 3GPP access and non-3GPP access.

  - The SMF in HPLMN shall support charging for MA PDU Connectivity Service in roaming Home Routed scenario with UE registered in different PLMNs.

5.1.3   Charging information

Charging information in the 5GC domain network is collected for each UE by the SMFs. PDU session charging allows the SMF to collect and categorize per UE per UPF per PDU session, charging information related to data volumes.

The SMF shall collect the following charging information for converged online and offline charging:

- usage of the access and core network resources: the charging information shall describe the amount of data delivered to and forwarded from the UE;

- usage duration: duration of PDU session is counted as the time interval from PDU session establishment to PDU session release;

- user: the charging information shall provide the actual UE addresses used by the user for the PDU session;

- data network: the charging information shall describe the data network addresses with a level of accuracy as determined by the DNN;

- usage of the external data networks: the charging information shall describe the amount of data sent and received to and from the external data network. External networks can be identified by the DNN;

- start time: identifying the time when the PDU session was started;

- user location: HPLMN, VPLMN, inside/outside presence reporting area, plus optional higher-accuracy location information.

The service data flows categorization is achieved by rating group or combination of the rating group and service id: i.e. based on the level of reporting defined per PCC rule, counting per rating group or combination of the rating group and service id. According to TS 23.503 [202], flow based charging shall support different charging models per PCC rule. These charging models may be based on volume, time and/or on number of events matching a specific service data flow template in PCC rule.

For service data flows defined for FBC, the SMF shall collect the following charging information:

- the information described above for PDU session;

- the amount of data transmitted in uplink and downlink directions categorized by rating group or combination of the rating group and service id when volume based charging applies;

- the duration of service data flows is counted and categorized by rating group or combination of the rating group and service id when time based charging applies;

- the number of events and corresponding time stamps categorized by rating group or combination of the rating group and service id when event based charging applies.

Within the PDU session the SMF shall collect the charging information for service data flows per UPF, categorized by rating group or combination of the rating group and service id.

Within the PDU session for local traffic offload scenarios with I-SMF insertion, the SMF shall collect the charging information for service data flows per I-SMF and categorized by rating group or combination of the rating group and service id.

Editor's note: To have I-UPF as well as PSA2 UPF for the I-SMF controlled UPF is FFS.

The user can be identified by a Generic Public Subscription Identifier (GPSI) and/or a 5G Subscription Permanent Identifier (SUPI). For wireline access, SUPI may be used to identify subscriber via wireline network as specified in clause 5.9.2 of TS 23.501 [200].

5.1.4   Charging Identifier

Charging identifier is created to allow correlation of charging information.

For the SMF the charging identifier is assigned per PDU session including the case of I-SMF insertion. At each PDU session establishment, i.e. assignment of a new PDU session id, a new PDU session specific SMF Charging Identifier is generated at the first SMF that processes the PDU session initiating request. This SMF Charging Identifier shall be unique within the SMF and is then used in all subsequent messages for that PDU session. The Charging Identifier shall be used throughout the PDU session's lifetime once assigned. In case of inter-system changes or handovers of PDU session, the Charging Identifier is preserved as long as the PDU session Identifier is preserved.

For EPS handover 5GS in Home routed scenario, the Charging Identifier will be generated by PGW-C+SMF in HPLMN and transferred to the SMF in VPLMN, if the V-SMF has already generated the Charging Identifier, the value shall be replaced by Home Provided Charging Id generated by H-SMF.

5.1.5   PCC rules and charging

5.1.5.1   PCC rules and chargeable events

PCC rules can be activated, deactivated and modified at any time during the PDU session lifetime. The following attribute can be modified by the PCF in a dynamic PCC rule active in the SMF: Charging key, Service identifier, Sponsor Identifier, Application Service Provider Identifier, Measurement method and reporting level. The QoS Flow binding mechanism employed by the SMF upon operations on PCC rules, may result in QoS Flows establishment, modification, or release. This is specified in TS 23.503 [202].

Activities on PCC rules are not chargeable events. However, change of charging rule in PCC rules will lead to chargeable events "start of service data flow" and when this is the last service data flow for the original PCC rule, "termination of service data flow".

The charging key (i.e. Rating group) is a piece of information used to request online charging quotas as defined in TS 23.503 [202].

5.1.5.2 Specific PCC rules scenarios

The capability of SMF to support Application Based Charging is achieved with appropriate PCC rules activation in the SMF. Such PCC Rule shall be defined with service data flow template including an Application Identifier for the application which needs to be detected, enforced and charged. Application detection mechanism in SMF is defined in TS 23.503 [202].

5.1.5.3 PCC rules - MA PDU session

As specified with PCC Rule definition in clause 6.3.1 TS 23.503 [202], during MA PDU session handling by the SMF, PCC Rules can be activated with a MA PDU session control information attribute including an optional rating group for Non-3GPP access, in addition to the rating group included in the PCC rule description.

When the MA PDU session control information in a PCC Rule includes a separate rating group for Non-3GPP access, it shall be used by the SMF for the SDF traffic carried via non-3GPP access. The PCC Rule rating group shall be used for the SDF traffic carried via 3GPP access, and all other charging related attributes in the PCC rule shall be the used for both accesses.

When the MA PDU session control information in a PCC Rule does not include any rating group for Non-3GPP access, the PCC Rule rating group shall be used by the SMF for the SDF traffic carried via both accesses (i.e. 3GPP access and non-3GPP access).

5.1.6 Session and Service Continuity modes

For any scenario of SSC modes specified in TS 23.501 [200], one charging Id shall correspond to a single PDU session ID.

As a result from such SSC mode, a new charging Id is generated by the SMF for the new PDU session Id, and the charging session associated to the old PDU session Id is released.

This behaviour applies to the following scenario:

- PDU session anchor UPF relocation, in SSC mode 2;

- PDU session anchor UPF relocation in SSC mode 3 with multiple PDU Sessions.

5.1.7 UE Presence in Presence Reporting Area (PRA)

During charging session lifetime , the CHF may provide the Presence Reporting Area identifier to be activated for Core Network pre-configured Presence Reporting Area(s) and additionally all of PRA Identifier(s) and list(s) of its elements for UE-dedicated Presence Reporting Area(s) and provision the "Change of UE presence in Presence Reporting Area(s)" re-authorization trigger to the SMF to request the reporting of Change of UE presence in Presence Reporting Area. After such trigger is enabled, SMF shall close the current count, open a new count with the initial status of UE presence in the PRA(s). In case of quota management is required, a Charging Data Response [Update] including the initial status is sent. UE presence status in the PRA(s) describes whether the UE is entering or leaving Presence Reporting Area (s) and if the corresponding Presence Reporting Area(s) is set to inactive by the serving node.

The CHF may modify the list of PRA Identifier(s) by providing the new Presence Reporting Area(s) or by removing existing Presence Reporting Area(s) or modify the list(s) of Presence Reporting Area elements by providing the updated Presence Reporting Area.

The CHF may remove the re-authorization trigger of change of UE presence in Presence Reporting Area as defined in subclause 5.2.1.2, if previously activated.

5.1.8 CHF selection

The CHF selection, i.e. CHF address determination, by the SMF is done at the PDU session establishment, this selection shall be based on the following and with this priority order (highest to lowest):

- CHF address(es) provided by the PCF for the PDU session.

- UDM provided charging characteristics.

- NRF based discovery.

- SMF locally provisioned charging characteristics.

This means that if there are PCF provided CHF address(es) these shall be used, otherwise if the UDM provides charging characteristics these shall be used. If neither of these results in CHF address(es) the NRF can be used to discover CHF instance(s), and as a last resource the SMF locally provisioned charging characteristics shall be used.

When NRF is used for the CHF selection, and the PDU session charging method indicates "offline only" for the PDU session, CHF instance(s) supporting "offline only" charging service instances may be selected.

5.1.9 Roaming

5.1.9.1 General

Based on roaming agreements between the V-PLMN and the H-PLMN, in Home Routed scenario, for each UE roaming in VPLMN:

- The SMF in VPLMN (V-SMF) shall be able to collect charging information per QoS Flow within a PDU session when UE is determined as an in-bound roamer, for CDR generation in VPLMN.

- The SMF in HPLMN (H-SMF) shall be able to collect charging information per QoS Flow within a PDU session when UE is determined as an out-bound roamer, for CDR generation in HPLMN.

This charging information collection mechanism is achieved under Roaming QoS flow Based Charging (QBC) performed by each PLMN, based on a set of charging parameters exchanged between the V-SMF and the H-SMF on a per PDU session basis.

The main parameters exchanged at PDU session establishment are:

- The Charging Id which also includes the VPLMN PLMN ID, assigned by the V-SMF and transferred to the H-SMF in the HPLMN.

- Optionally, the "Roaming Charging Profile" negotiated between the VPLMN and the HPLMN.

The parameters exchanged during the PDU session handover from EPS to 5GS:

- The Home Provided Charging Id which includes the Charging Id assigned by the H-SMF to the original PDU session over EPS and transferred by the H-SMF to the V-SMF. This Home Provided Charging Id shall be used by the V-SMF replacing the existing Charging Id.

- Optionally, the "Roaming Charging Profile" negotiated between the VPLMN and the HPLMN on 5GS side.

In roaming Home routed PDU session, upon V-SMF change:

- intra-PLMN V-SMF change: Home Provided Charging Id, "Roaming Charging Profile" and CHF address are transferred from the old V-SMF to the new V-SMF.

- inter-PLMN V-SMF change: The Home Provided Charging Id is transferred from the old V-SMF to the new V-SMF.

- The "Roaming Charging Profile" is optionally exchanged between the new V-SMF and the H-SMF as for a PDU session establishment.

5.1.9.2 CHF selection

In roaming Home routed scenario, at PDU session establishment, the CHF selection mechanism specified in clause 5.1.8 applies to:

- The V-SMF for CHF selection in VPLMN, with the following differences:

    - CHF address(es) selection mechanisms based on PCF and UDM are not applicable.

    - when charging characteristics is used it will be based on local configuration;

- when NRF is used, the V-CHF can be selected based on UE identified as in-bound roamer and the PLMN Id of the H-PLMN;

- The H-SMF for CHF selection in HPLMN, with the following difference: when NRF is used, the H-CHF can be selected based on UE identified as out-bound roamer and the PLMN Id of the V-PLMN.

In roaming Home routed PDU session, upon V-SMF change:

- intra-PLMN V-SMF change: CHF address supplied by the old V-SMF shall be used.

- inter-PLMN V-SMF change: CHF selection mechanism as per V-SMF CHF selection in VPLMN at PDU session establishment.

5.1.10   Data Volume Reporting for Secondary RAT usage

Volume reporting for Secondary RAT usage is an optional capability in the SMF that provides usage reporting functionality when a Secondary RAT is used by NG-RAN. Use of Secondary RAT refers to options supported by NG-RAN with dual radio accesses, per NG-RAN definition in TS 23.501 [200]. This is valid for both HPLMN and VPLMN.

The following principles are used:

- The reporting of Secondary RAT Data Volume is controlled by the NG-RAN.

- The uplink and downlink data volumes for the Secondary RAT are reported (from NG-RAN to 5G Core) on a per QoS Flow basis and per time interval (controlled by NG-RAN). The report contains Secondary RAT (e.g. E-UTRA) resources used for transport of user data and indicated separately for uplink and downlink per QoS Flow and per time interval. The time interval used for the measurements reported (from NG-RAN) may be partitioned to indicate usage that occurred before respectively after an absolute time (that occurs while measurement for secondary RAT usage report is ongoing).

- The reporting (performed by NG-RAN) in association with UE-related control signaling and via standalone reporting is internally triggered by NG-RAN.

   NOTE: Volumes for the secondary RAT are reported to the CHF in addition to, and uncorrelated from volumes of reported usage, which are undifferentiated between primary and secondary RAT. Considering both volumes would imply the same traffic to be counted twice.

5.1.11   Charging method and Charging service selection

A PDU session charging method indicating "offline only", can be assigned to a PDU session, to indicate a charging method applicable at PDU session level.

When there is no PDU session charging method indicating "offline only" associated to a PDU session, for each PCC Rule:

- if indicated for this PCC Rule, the required charging method applies;

- otherwise (i.e. no required charging method is indicated for this PCC Rule), the default charging method applies.

In this case, the converged charging service will be invoked by the SMF at the PDU session establishment.

When a PDU session charging method indicates "offline only" for a PDU session, offline charging method applies to all the PCC Rules activated during the PDU session. In this case, at the PDU session establishment, the SMF can select between the converged charging service or the offline only charging service based on Operator policy.

This PDU session charging method can be received from PCF by the SMF or configured in the SMF charging characteristics.

5.1.12   Emergency PDU session handling

Volume reporting for Emergency PDU Sessions is a capability in the SMF that provides usage reporting functionality when a session is setup to provide emergency services.

The following principles are used:

- The reporting of Emergency PDU sessions is controlled by the SMF.

- The uplink and downlink data volumes for Emergency PDU Session are reported.

- It includes either or both of an unauthenticated SUPI and a PEI (especially applicable in the case where there is a UE without a UICC).

5.1.13   Support of deployments topologies with specific SMF Service Areas

Depending on scenario, a PDU Session in non-roaming case is either served by a single SMF or served by an SMF and an I-SMF, specified in the clause 5.34 of TS 23.501 [200].When a PDU Session is served by both an SMF and an I-SMF, the SMF is the NF Consumer that has the interfaces towards CHF for I-SMF for the case of an I-SMF insertion, relocation or removal.

For the following case with the I-SMF involved, the SMF shall collect the charging information and report to CHF:

- PDU session establishment, modification and release;

- PDU Session message flows for N2 based handover procedure, with I-SMF insertion/change/removal;

- PDU Session message flows for Xn based handover procedure, with I-SMF insertion/change/removal;

- PDU Session message flows for Service Request, with I-SMF insertion/change/removal

- branching point or UL CL controlled by I-SMF.

5.2   5G data connectivity converged online and offline charging scenarios

5.2.1   Basic principles

5.2.1.1   General

Converged charging may be performed by the SMF interacting with CHF using Nchf specified in TS 32.290 [57] and TS 32.291 [58]. In order to provide the data required for the management activities outlined in TS 32.240 [1] (Credit-Control, accounting, billing, statistics etc.), the SMF shall be able to perform converged charging for each of the following:

- Charging data related to PDU session;

- Charging data related to service data flows within the PDU session.

Converged charging includes quota management and usage reporting.

The SMF shall be able to report charging events to CDF for CDR generation.

The SMF shall be able to perform convergent charging by interacting with CHF, for charging data related to PDU sessions. The Charging Data Request and Charging Data Response are exchanged between the SMF and the CHF, based on SCUR scenarios specified in TS 32.290 [57]. The Charging Data Request is issued by the SMF towards the CHF when certain conditions (chargeable events) are met.

The quota management is always per rating group, reporting level can be either per rating group or per combination of the rating group and service id, which is defined per PCC rule.

Converged charging uses centralized or decentralized unit determination and centralized rating scenarios for session based convergent charging specified in TS 32.290 [57].

The charging information collected per PDU session includes the network slice instance the PDU session belongs to.

The contents and purpose of each charging event that triggers interaction with CHF, as well as the chargeable events that trigger them, are described in the following sub-clauses.

The SMF initiates a charging session with Charging Date Request/Response [Initial], updates the charging session with Charging Date Request/Response [Update], and terminates the charging session with Charging Date Request/Response [Termination].

A detailed formal description of the converged charging parameters defined in the present document is to be found in TS 32.291 [58].

A detailed formal description of the CDR parameters defined in the present document is to be found in TS 32.298 [51].

In order to avoid a charging session remaining inactive for a long period of time, upon expiry of the Unit Count Inactivity Timer, the charging session may be terminated by the SMF sending Charging Data Request [Termination], indicating the PDU session shall continue and the CHF can expect a later Charging Data Request [Initial] request for the same PDU session with the original Charging ID and new session identifier. The SMF may send its locally configured value of the Unit Count Inactivity Timer to the CHF. The CHF may respond with a new Unit Count Inactivity Timer for use in the SMF.

5.2.1.2   Applicable Triggers in the SMF

5.2.1.2.1   General

When a charging event is issued towards the CHF, it includes details such as Subscriber identifier (e.g. SUPI), Charging-id, etc. and also containers identifying the volume count (separated for uplink and downlink traffic), with charging condition change information.

Each trigger condition (i.e. chargeable event) defined for the 5G data connectivity converged charging functionality, is specified with the associated behaviour when they are met.

Two categories of chargeable events are identified:

-    immediate report: chargeable events for which, when occurring, the current counts are closed and sent together with the charging data generated by the SMF towards the CHF in a Charging Data Request. New counts are started by the SMF.

-    deferred report: chargeable events for which, when occurring, the current counts are closed and stored together with the charging data generated by the SMF. The stored counts will be sent to the CHF in next a Charging Data Request. New counts are started by the SMF

When a PDU session starts, and the converged charging is activated, the SMF invokes a Charging Data Request [Initial] towards the CHF to get authorization to start. The SMF is optionally provided in the Charging Data Response [Initial], with a set of chargeable event triggers to be enabled, and the associated category (i.e. immediate or deferred report).

When provided, these triggers override the default triggers in the SMF, they remain active until they are updated or disabled by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

A set of chargeable events are based on trigger thresholds and default ones can be configured in Charging Characteristics which are described in Annex A.
The SMF is optionally provided in the Charging Data Response [Initial], with trigger thresholds which override the default ones configured in the Charging Characteristics selected by the SMF for the PDU session. They remain active until they are updated by subsequent Charging Data Response [Update] from the CHF or the PDU session is terminated.

5.2.1.2.2   Flow Based Charging (FBC) triggers

The set of chargeable events and associated category, which shall be supported by the SMF as the default, is specified in the sub-clause 5.2.1.4 for Flow Based Charging.

Two level of triggers can be supplied by the CHF:

-    Triggers associated to the PDU session.

-    Triggers associated to a rating group within the PDU session.

The set of triggers along with their category (i.e. immediate or deferred report) and level (i.e. per PDU session or per rating group), which can be supplied by the CHF to the SMF for 5G data connectivity converged charging or offline only charging are detailed in the sub-clause 5.2.1.4 for Flow Based Charging.

5.2.1.2.2 QoS flow Based Charging (QBC) triggers

The set of chargeable events and associated category, which shall be supported by the SMF as the default for QoS flow Based Charging, when applicable, is specified in the sub-clause 5.2.1.6.

Two level of triggers can be supplied by the CHF:

- Triggers associated to the PDU session.

- Triggers associated to a QoS Flow within the PDU session.

The set of triggers along with their category (i.e. immediate or deferred report) and level (i.e. per PDU session or per QoS Flow), which can be supplied by the CHF to the SMF for 5G data connectivity converged charging are detailed in the sub-clause 5.2.1.6 for QBC.

When QBC is used in the context of roaming, the set of triggers, their associated category, and trigger thresholds, compose the "Roaming Charging Profile", which governs the SMF charging data generation, synchronously between the V-SMF and the H-SMF when shared.

5.2.1.3 PDU session charging

Converged charging allows the SMF to collect charging information related to data volumes sent to and received by the UE/MS per user per PDU session. The user can be identified by SUPI.

If PDU session specific converged charging is supported, this is achieved by FBC charging, with specific rating group/service identifier, see clause 5.2.1.4.

5.2.1.4 Flow Based Charging (FBC)

For FBC charging, the SMF categorizes the service data flows within PDU session data traffic by rating group and / or combination of the rating group and service id. The level of the reporting and charging method is defined per PCC rule. Details of this functionality are specified in TS 23.503 [202] and TS 32.240 [1].

NOTE: The SMF can only include one QoS Information occurrence per combination of rating group/service id. This implies if an operator wishes to be able to separate usage according to 5QI and ARP for the same charging method, they will need to ensure that service data flows having different 5QI and ARP do not have the same:

- rating group in cases where rating reporting is used;

- rating group/service id where rating group/service id reporting is used.

When a service data flow is governed by a PCC Rule indicated with "Online" charging method, quota management is required before service delivery for controlling this service data flow to be able to start or continue. There is also a special case of "Online" where the SMF may allow traffic to start before quota management.

When a service data flow is governed by a PCC Rule indicated with "Offline" charging method, quota management is not required for this service data flow. Usage reporting is required for this service data flow without affecting the delivery.

According to TS 23.503 [202], FBC shall support different charging models per PCC rule. These charging models may be based on volume and/or time and on number of events matching a specific service data flow template in PCC rule. When a chargeable event occurs for which quota needs to be requested by the SMF to the CHF, the type of requested quota may depend on measurement method configured for the PCC rule.

In general, the charging of a service data flow shall be linked to the PDU session under which the service data flow has been activated.

The amount of data counted shall be the user plane payload at the UPF separated between UL and DL.

For PDU session specific charging, time metering shall start when PDU session is activated.

Table 5.2.1.4.1 summarizes the set of default trigger conditions and their category which shall be supported by the SMF. For "immediate report" category, the table also provides the corresponding Charging Data Request [Initial, Update, Termination] message sent from SMF towards the CHF.

Table 5.2.1.4.1: Default Trigger conditions in SMF

Trigger Conditions	Trigger level	Converged Charging default category	Offline only charging default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immed reporting" category
Start of PDU Session.	PDU session	Immediate	Immediate	Not Applicable	Not Applicable	Charging Data Request [Initial]
Start of the Service data flow and no charging session exists.	RG	Immediate	Immediate	No	No	
Change of Charging conditions						
QoS change	PDU session/ RG	Deferred	Deferred	Yes	Yes	
GFBR guaranteed status change	RG	Deferred	Deferred	Yes	Yes	
User Location change	PDU session/ RG	Deferred	Deferred	Yes	Yes	
Serving Node change	PDU session/ RG	Deferred	Deferred	Yes	Yes	
Change of UE presence in Presence Reporting Area(s)	PDU session/ RG	Deferred	Deferred	Yes	Yes	
Change of 3GPP PS Data off Status	PDU session/ RG	Deferred	Deferred	Yes	Yes	
Tariff time change	PDU session/ RG	Deferred	Deferred	No	No	
UE time zone change	PDU session/ RG	Immediate	Deferred	Yes	Yes	
PLMN change	PDU session/ RG	Immediate	Deferred	Yes	Yes	Charging Data Request [Update]
RAT type change	PDU session/ RG	Immediate	Deferred	Yes	Yes	
Session-AMBR change	PDU session	Immediate	Deferred	Yes	Yes	
Addition of UPF	PDU Session/RG	Immediate	Deferred	Yes	Yes	
Removal of UPF	PDU session/RG	Immediate	Deferred	Yes	Yes	
Insertion of I-SMF	PDU Session	Deferred	Deferred	Yes	Yes	
Re-allocation of I-SMF	PDU Session	Deferred	Deferred	Yes	Yes	
Removal of I-SMF	PDU Session	Deferred	Deferred	Yes	Yes	
Handover cancel	PDU session	Immediate	Deferred	Yes	Yes	
Handover start	PDU session	Immediate	Deferred	Yes	Yes	
Handover complete	PDU session	Immediate	Deferred	Yes	Yes	
Limit per PDU session						
Expiry of data time limit per PDU session	PDU session	Immediate	Immediate	No	Yes	
Expiry of data volume limit per PDU session	PDU session	Immediate	Immediate	No	Yes	
Expiry of data event limit per PDU session	PDU session	Immediate	Immediate	No	Yes	

Expiry of limit of number of charging condition changes	PDU session	Immediate	Immediate	No	Yes
Limit per Rating group					
Expiry of data time limit per rating group	RG	Deferred	Deferred	Yes	Yes
Expiry of data volume limit per rating group	RG	Deferred	Deferred	Yes	Yes
Expiry of data event limit per rating group	RG	Deferred	Deferred	Yes	Yes
Quota management					
Time threshold reached	RG	Immediate	Not applicable	No	Yes
Volume threshold reached	RG	Immediate	Not applicable	No	Yes
Unit threshold reached	RG	Immediate	Not applicable	No	Yes
Time quota exhausted	RG	Immediate	Not applicable	No	Yes
Volume quota exhausted	RG	Immediate	Not applicable	No	Yes
Unit quota exhausted	RG	Immediate	Not applicable	No	Yes
Expiry of quota validity time	RG	Immediate	Not applicable	No	Yes
Expiry of quota holding time	RG	Immediate	Not applicable	No	Yes
Re-authorization request by CHF	RG	Immediate	Not applicable	No	No
Start of service data flow, in case no valid quota for this rating group	RG	Immediate	Not applicable	No	No
Others					
Termination of service data flow - last service data flow under a given Rating Group.	RG	Immediate	Immediate	No	No
Management intervention	PDU session	Immediate	Immediate	No	No
Expiry of Unit Count Inactivity Timer	PDU session	Immediate	Not applicable	No	Yes
End of PDU session	PDU session	Immediate	Immediate	No	No
CHF response with session termination	PDU session	Immediate	Not applicable	No	No
Abort request is received from the CHF	PDU session	Immediate	Immediate	No	No

Charging Data Request [Termination]

The default "Limit" trigger conditions, are trigger thresholds configured in the Charging Characteristics applied to the PDU session. It shall be possible for the CHF to override these default triggers when providing Charging Data Response [Initial], either to disable the triggers, or to enable triggers new thresholds value.

When the traffic is counted in more than one UPF, the CHF overrides these default triggers of volume limit for the all UPFs.

For converged charging, the following details of chargeable events and corresponding actions in the SMF are defined in Table 5.2.1.4.2:

Table 5.2.1.4.2: Chargeable events and their related actions in SMF

Table 5.2.1.4.2: Chargeable events and their related actions in SMF

Chargeable event	Conditions	SMF action
Start of PDU session		Charging Data Request [Initial] with a possible request quota for later use
Start of service data flow	If quota management is required, and valid quota for this rating group does not exist	Charging Data Request [Update] with a request quota with a possible amount of quota.
	If service identifier level reporting is required by the PCC rule	Start new counts with time stamps for the combination of the rating group and service id
	If rating group level reporting is required by the PCC rule	Start new counts with time stamps for the rating group
	If sponsored connectivity level reporting is required by the PCC rule	Start new counts with time stamps for the combination of the rating group, sponsor identity and application service provider identity
	If charging resource, i.e. charging session, for the PDU session does not exist	Charging Data Request [Initial] with a possible request quota
Termination of service data flow	If service identifier level reporting is required by the PCC rule and this is the last service data flow for this combination of the rating group and service id	Close the counts with time stamps
	If rating group level reporting is required by the PCC rule and this is the last service data flow utilizing that specific rating group	Close the counts with time stamps
	If sponsored connectivity level reporting is required by the PCC rule and this was the last active service data flow for this combination of rating group, sponsor identity and application service provider identity	Close the counts with time stamps
Expiry of the Unit Count Inactivity Timer for the PDU session		Charging Data Request [Termination], indicating that charging session is terminated, and the PDU session is still active May include the configured Unit Count Inactivity Timer value
End of PDU session in the SMF		Charging Data Request [Termination] Close the counts with time stamps
Quota specific chargeable events (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization, expiry of quota holding time)		Charging Data Request [Update] with a possible request quota Close the counts and start new counts with time stamps
Change of charging condition in the SMF (e.g. QoS change, Session-AMBR change, user location change, Radio access type change, PLMN change, Serving Node change, UE Time Zone change, change of UE presence in Presence Reporting Area(s), change of 3GPP PS Data Off status, handover cancel, GFBR guaranteed status change)	If the corresponding trigger is enabled	Close the counts and start new counts with time stamps for all active service data flows
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Handover start	If the corresponding trigger is enabled	Start new counts with time stamps for all active service data flows.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update] with a possible request quota.
Handover complete	If the corresponding trigger is enabled	Close the counts with time stamps for all active service data flows.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Addition of UPF	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update] with a request quota with a possible amount of quota.
Tariff time change		Close the counts and start new counts with time stamps

Chargeable event	Conditions	SMF action
CHF response with session termination (e.g. Not Applicable), abort request		Charging Data Request [Termination] Close the counts with time stamps
Removal of a UPF	If quota management is being performed and quota is granted per each UPF	Charging Data Request [Update] Close the counts with time stamps for the removed UPF
	If quota management is being performed and quota is shared between UPFs	Close the counts with time stamps for the removed UPF
	If there is no quota management performed	Close the counts with time stamps for the removed UPF
Insertion of I-SMF	If the corresponding trigger is enabled	Close the counts with time stamps for all active service data flows in SMF, open new accounts for all active service data flows with I-SMF information.
	If the corresponding trigger is enabled and the category is set to "immediate reporting" with quota management is being performed and quota is granted per each UPF	Charging Data Request [Update]. Close the counts with time stamps for all active service data flows usage report in SMF, open new accounts for all active service data flows with I-SMF information.
	If the corresponding trigger is enabled and the category is set to "immediate reporting", with quota management is being performed and quota is shared between UPFs	Charging Data Request [Update]. Close the counts with time stamps for all active service data flows usage report in SMF, open new accounts for all active service data flows with I-SMF information.
	If the corresponding trigger is enabled and the category is set to "immediate reporting", without quota management	Charging Data Request [Update]. Close the counts with time stamps for all active service data flows usage report in SMF, open new accounts for all active service data flows with I-SMF information.
Removal of I-SMF	If quota management being performed and quota is granted per each UPF	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF
	If quota management being performed and quota is shared between UPFs	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF
	If there is no quota management performed	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF
Change of I-SMF	If quota management being performed and quota is granted per each UPF	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF, open active traffic flows' counts for the new I-SMF
	If quota management being performed and quota is shared between UPFs	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF, open active traffic flows' counts for the new I-SMF
	If there is no quota management performed	Charging Data Request [Update]. Close the counts with time stamps for the removed I-SMF, open active traffic flows' counts for the new I-SMF
Expiry of time limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Start new counts with time stamps
Expiry of data volume limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Open a new service data container
Expiry of data event limit per rating group		Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If any matching service data flow is still active	Open a new service data container
Expiry of data event limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps

Chargeable event	Conditions	SMF action
Expiry of time limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Expiry of data volume limit per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Expiry of a limit of number of charging condition changes per PDU session		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps
Management intervention		Charging Data Request [Update] Close the counts with time stamps
	If the PDU session is still active	Start new counts with time stamps

When event based charging applies, the first occurrence of an event matching a service data flow template in PCC rule shall be considered as the start of a service.

How the termination of service data flows is detected, is specified in TS 23.503 [202]. Termination of the service data flow itself does not trigger Charging Data Request [Update].

The CDR generation mechanism processed by the CHF upon receiving Charging Data Request [Initial, Update, Termination] issued by the SMF for these chargeable events, is specified in clause 5.2.3.

5.2.1.5 SSC Mode and Triggers

In case of SSC Mode1, the chargeable events are Change of charging condition in the SMF.

In case of SSC Mode2 and SSC Mode3 PDU session Anchor with multiple PDU session, the chargeable events are Start of PDU session and End of PDU session.

There are two cases related to quota management when the granted quota is volume for multiple UPFs and per Operator's policy, the traffic is counted in more than one UPF:

- Quota shared by UPFs means that SMF manages the shared quota consumption per RG for multiple UPFs and reports the total quota consumed to CHF;

- Quota granted for each UPF means that the CHF manages the quota granted for each UPF and SMF manages and reports the quota consumption per UPF.

For configurations involving multiple UPFs and Operator's policy is to count the traffic in a single UPF (e.g. BP), the quota is granted to the SMF for this single UPF per RG for the whole traffic.

The following scenarios describe configurations in which the traffic is counted in more than one UPF:

In case of SSC mode 3 PDU Session Anchor with IPv6 Multi-homed PDU Session,

- The addition of UPF2 and BP (Change the part of traffic from UPF1 to UPF2):

  - if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota;

  - if quota shared by UPFs, SMF requests UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remaining quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

- The removal of UPF1and BP:

  - In case the quota management and quota granted for each UPF, UPF1 reports final counts to SMF, SMF triggers the chargeable event of Remove the UPF to report final counts from UPF1;

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1. SMF sends counts from UPF1 and UPF2 to the CHF together in next Charging Data Request.

  - In case without the quota management or offline only charging, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request. In case of Addition of additional PDU Session Anchor and Branching Point or UL CL:

- The addition of UPF2 and BP (Change the part of traffic from UPF1 to UPF2):

  - if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota for Rating group;

  - if quota shared by UPFs, SMF indicates UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remain quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

In case of Removal of additional PDU Session Anchor and Branching Point or UL CL:

- The removal of UPF1 and BP (Change traffic from UPF1 to UPF2):

  - In case the quota management and quota granted for each UPF, UPF1 report final counts to SMF, SMF triggers chargeable event of Remove the UPF to report final counts from UPF1;

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1 and re-allocates the remain quota to UPF2. SMF sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

  - In case without the quota management or offline only charging,, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.In case of Change of additional PDU Session Anchor for IPv6 multi-homing or UL CL and Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session.

- The additional of UPF2 (Change the part of traffic from UPF1 to UPF2):

  - if quota granted for each UPF, SMF triggers the chargeable event of Start of SDF for UPF2 to request the quota for Rating group;

  - if quota shared by UPFs, SMF indicates UPF1 report usage of quota, caches the usage from UPF1 and re-allocates the remain quota to UPF2 and UPF1(if needed). When the granted quota from CHF is used up, the SMF reports total usage of quota to CHF.

- The removal of UPF1:

  - In case the quota management and quota granted for each UPF, UPF1 report final counts to SMF, SMF triggers chargeable event of Remove the UPF to report final counts from UPF1.

  - In case the quota management and quota shared by UPFs, UPF1 report final counts to SMF, SMF caches the final count from UPF1 and re-allocates the remain quota to UPF2. SMF sends counts from UPF1 and UPF2 to the CHF together in next Charging Data Request.

  - In case without the quota management or offline only charging, UPF1 report final count to SMF, SMF caches the final count from UPF1 and sends counts from UPF1 and UPF2 to the CHF together in next a Charging Data Request.

5.2.1.6   QoS flow Based Charging

QoS flow Based Charging allows the SMF to collect charging information related to data volumes per PDU session, categorized per QoS Flow.

The user can be identified by SUPI.

For a given PDU session, QBC shall be performed by the SMF within the same charging session used for Flow Based Charging. For the case where QBC is performed from SMF in VPLMN, Flow Based Charging is not applicable and there is no possibility to have quota management for the PDU Session.

The SMF categorizes the volume within PDU session by QoS Flow identified by QoS Flow Identifier (QFI).

The amount of data counted for the QoS Flow shall be the user plane payload at the UPF.

Table 5.2.1.6.1 summarizes the set of default trigger conditions and their category which shall be supported by the SMF in QBC. For "immediate report" category, the table also provides the corresponding Charging Data Request [Initial, Update, Termination] message sent from SMF towards the CHF.

Table 5.2.1.6.1: Default Chargeable events in SMF for QBC

Chargeable event	Trigger level	Default category	CHF allowed to change category	CHF allowed to enable and disable	Message when "immediate reporting" category
Start of PDU session	PDU session	Immediate	Not Applicable	Not Applicable	Charging Data Request [Initial]
Start of a QoS Flow	QoS Flow	Deferred	Not Applicable	Not Applicable	Charging Data Request [Update]
Change of Charging conditions					
QoS change	QoS Flow	Deferred	Yes	Yes	
GFBR guaranteed status change	QoS Flow	Deferred	Yes	Yes	
User Location change	PDU session	Deferred	Yes	Yes	
Serving Node change	PDU session	Deferred	Yes	Yes	
Change of UE presence in Presence Reporting Area(s)	PDU session	Deferred	Yes	Yes	
Change of 3GPP PS Data off Status	PDU session	Deferred	Yes	Yes	
Tariff time change	PDU session	Deferred	No	No	
UE time zone change	PDU session	Immediate	Yes	Yes	
PLMN change	PDU session	Immediate	Yes	Yes	
RAT type change	PDU session	Immediate	Yes	Yes	
Session-AMBR change	PDU session	Immediate	Yes	Yes	
Addition of UPF	PDU session	Immediate	Yes	Yes	
Removal of UPF	PDU session	Immediate	Yes	Yes	
Handover cancel	PDU session	Immediate	Yes	Yes	
Handover start	PDU session	Immediate	Yes	Yes	
Handover complete	PDU session	Immediate	Yes	Yes	
Limit per PDU session					
Expiry of data time limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of data volume limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of data event limit per PDU session	PDU session	Immediate	Yes	Yes	
Expiry of limit of number of charging condition changes	PDU session	Immediate	Yes	Yes	
Limit per QoS Flow					
Expiry of data time limit per QoS Flow	QoS Flow	Deferred	Yes	Yes	
Expiry of data volume limit per QoS Flow	QoS Flow	Deferred	Yes	Yes	
Others					
End of QoS Flow	QoS Flow	Deferred	Yes	Yes	
Management intervention	PDU session	Immediate	No	No	
End of PDU session	PDU session	Immediate	No	No	Charging Data Request [Termination]
Abort request is received from the CHF	PDU session	Immediate	No	No	

The default "Limit" trigger conditions, are trigger thresholds configured in the Charging Characteristics applied to the PDU session for QBC. It shall be possible for the CHF to override these default triggers when providing Charging Data Response [Initial], either to disable the triggers, or to enable triggers new thresholds value.

For QBC the following details of chargeable events and corresponding actions in the SMF are defined in Table 5.2.1.6.2:

Table 5.2.1.6.2: Chargeable events and their related actions in SMF for QBC

Chargeable event	Conditions	SMF action
Start of PDU session		Charging Data Request [Initial]
Start of a QoS Flow	Start of the QoS Flow associated with the default QoS rule	Charging Data Request [Update].
	Start of a QoS Flow	Start new counts with time stamps.
End of a QoS Flow		Close the counts with time stamps for the QoS flows
End of PDU session		Charging Data Request [Termination] Close the counts with time stamps
Change of charging condition in the SMF (e.g. QoS change, Session-AMBR change, user location change, Radio access type change, PLMN change, Serving Node change, UE Time Zone change, change of UE presence in Presence Reporting Area(s), change of 3GPP PS Data Off status, handover cancel, GFBR guaranteed status change)	If the corresponding trigger is enabled	Close the counts and start new counts with time stamps for all active QoS flows.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Handover start	If the corresponding trigger is enabled	Start new counts with time stamps.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Handover complete	If the corresponding trigger is enabled	Close the counts with time stamps for all active QoS flows.
	If the corresponding trigger is enabled and the category is set to "immediate reporting"	Charging Data Request [Update]
Addition of UPF		Charging Data Request [Update].
Removal of UPF		Close the counts with time stamps for the removed UPF
Expiry of time limit per QoS Flow	If the corresponding trigger is enabled	Close the counts with time stamps.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the QoS Flow is still active	Start new counts with time stamps
Expiry of data volume limit per QoS Flow	If the corresponding trigger is enabled	Close the counts with time stamps
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the QoS Flow is still active	Start new counts with time stamps
Expiry of time limit per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Expiry of data volume limit per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Expiry of a limit of number of charging condition changes per PDU session	If the corresponding trigger is enabled	Close the counts with time stamps for all QoS flows.
	If the category is set to "immediate reporting"	Charging Data Request [Update]
	If the PDU session is still active	Start new counts with time stamps for all active QoS flows
Management intervention		Charging Data Request [Update] Close the counts with time stamps for all QoS Flows
	If the PDU session is still active	Start new counts with time stamps
Abort		Charging Data Request [Termination] Close the counts with time stamps

The CDR generation mechanism processed by the CHF upon receiving Charging Data Request [Initial, Update, Termination] issued by the SMF for these chargeable events in QBC, is specified in clause 5.2.3.

5.2.1.7 Roaming QoS flow Based charging (QBC)

When QoS flow Based Charging specified in 5.2.1.6 is used in a context of roaming, a "Roaming Charging Profile" is defined to allow, when shared, QBC synchronized between both PLMNs and includes:

- The set of chargeable events as per Table 5.2.1.6.1 and associated category.

- The set of thresholds for chargeable events based on trigger thresholds.

- An indication on whether the "Default partial record" or the "Individual partial record" mechanism per clause 5.2.3, is used by CHF.

A default "Roaming Charging Profile" is specified for the SMF and comprises:

- The set of chargeable events and associated category specified as the default per Table 5.2.1.6.1.

- The default set of thresholds configured in the Charging Characteristics for QBC.

- The "Default partial record" mechanism indicated as the one used by CHF.

In the VPLMN, at PDU session establishment or PDU session transfer from a different VPLMN, the default "Roaming Charging Profile" in the new V-SMF may optionally be overridden by a new "Roaming Charging Profile" supplied by the CHF in the Charging Data Response [Initial] with:

- updated set of chargeable events and associated category.

- updated thresholds for chargeable events based on trigger thresholds.

- the selected partial record mechanism ("Default partial record" or "Individual partial record").

This updated "Roaming Charging Profile" is transferred from the new V-SMF to the H-SMF and may be acknowledged or replaced by the HPLMN selected "Roaming Charging Profile" to be used by the new V-SMF.

In the HPLMN, at PDU session establishment or V-SMF change for a PDU session, the "Roaming Charging Profile", when received by the H-SMF from the new V-SMF, may be updated by the CHF in the HPLMN in the Charging Data Response [Initial] to H-SMF. This HPLMN CHF selected "Roaming Charging Profile" is used by the H-SMF and transferred towards the VPLMN.

The "Roaming Charging Profile" resulting from the exchange between the VPLMN and HPLMN at PDU session establishment shall remain unchanged during the PDU session lifetime, unless there is a V-SMF change.

At each V-SMF change in Home routed scenario, the "Roaming Charging Profile" may be renegotiated between the VPLMN and HPLMN and shall remain unchanged during the PDU session lifetime with the actual V-SMF.

The capability specified in clause 5.2.1.2.1 for the CHF to be able to update the triggers after the PDU session is established for a given VPLMN shall not be applicable for Roaming QBC.

5.2.1.8 Termination action

The termination action applies only in case of online charging, i.e. quota management is active. It indicates the action, which the UPF should perform when no quota is granted. A packet for a specific rating group is subject to a termination action in the following cases:

- Zero units have been granted;

- The final granted units have been used;

- Quota limit reached;

- End user service rejected;

- End user service denied;

- Rating failed.

The defined termination actions include:

- Allowing the packets to pass through;

- Dropping the packets;

- The SMF Default Termination Action;

- The re-direction of packets to an application server (e.g. defined in the termination action).

    NOTE   Such a re-direction may trigger a new charging session to be initiated.

A Default Termination Action for all rating groups, for which no quota is granted and there is no specific termination action, shall be pre-configured in the SMF according to operator's policy. For instance, the default behaviour may consist of allowing packets of any terminated service to pass through the UPF.

The CHF may provide a termination action for each rating group. Any previously provided termination action may be overwritten by the CHF. A termination action remains valid and shall be applied by the SMF until all the corresponding PCC rules are removed.

5.2.1.9   Sponsored data connectivity charging

The Sponsor Identifier and Application Service Provider Identifier are provided for sponsored data connectivity to the PCF from the AF, according to TS 23.503 [215].

The Sponsor Identifier and Application Service Provider Identity may be included in PCC rules with "offline" charging method from the PCF to the SMF. In this case, charging information collected by the SMF includes the Sponsor Identity and the Application Service Provider Identity. Correlation of charging information from multiple users per sponsor and/or application service provider can then be based on Sponsor Identity and Application Service Provider Identity.

5.2.1.10   Branching point or UL CL controlled by I-SMF

The interaction between I-SMF and SMF for the support of traffic offload by UPF controlled by the I-SMF is specified in the clause 5.34.6 TS 23.501[200].

There are two cases related to quota management when the granted quota is volume for multiple UPFs and per Operator's policy for the scenarios, i.e.Addition, Removal and Change of PDU Session Anchor (PSA2), Branching Point or UL CL controlled by I-SMF, the traffic is counted in more than one UPF:

- Quota shared by UPFs (PSA)

- Quota granted for each UPF (PSA)

In the scenario UL CL/BP controlled by I-SMF, the I-SMF forwards traffic usage information of UPF (PSA2) to the SMF as specified clause 5.34.4 and clause 5.34.5 in TS 23.501 [200].

5.2.1.11   CHF-Controlled Quota Management

Quota management process is initiated by NF consumer, e.g. SMF, for service data flows handled with the online charging method for a given Rating Group. For the provision of the service to the end user, NF consumer requests quota from CHF via Charging Data Request messages [Initial / Update]. CHF-Controlled Quota Management in this context allows CHF to suspend/resume the quota management process for that Rating Group within a PDU session.

When an NF consumer issues a Charging Data Request [Initial / Update] CHF may decide to authorize the service and suspend the quota management for that Rating Group. This means that: the service is authorized without granted units and that all quota management triggers for that Rating Group within a PDU session are ignored by the NF consumer. Usage will continue to be reported via the remaining default active triggers. It is the sole responsibility of CHF to activate other applicable triggers if additional reporting is needed.

When an NF consumer issues a Charging Data Request [Update] in which a given Rating Group has quota management previously suspended, CHF may decide to resume quota management for that Rating Group. This means that all previously set quota management triggers for that Rating Group are considered by the NF consumer and granted units are reconfigured by the CHF.

CHF may want to resume quota management at any time, for this Re-authorization mechanisms can be used to trigger NF consumer to subsequently issue a Charging Data Request [Update].Procedures enabling CHF-Controlled Quota Management to suspend/resume the quota management are described in TS 32.290 [57].

5.2.2 Message flows

5.2.2.1 General

The flows in the present document specify the interaction between the SMF and the CHF for 5G data connectivity converged charging functionality, in different scenarios, based on TS 23.501 [200] and TS 23.502 [201] procedures and flows.

This interaction is based on Charging Data Request /Response specified in TS 32.290 [57], exchanged between the SMF embedding the CTF and the CHF.

As a general principle, the steps in the figures for the message flows below correspond to the steps of figures in TS 23.502 [201], which is the reference. This document specifies the charging specific extension part.

5.2.2.2 PDU session charging from SMF

5.2.2.2.1 General

The subclause below describes PDU session charging in non-roaming scenarios.

5.2.2.2.2 PDU session establishment

The following figure 5.2.2.2.1 describes a PDU session establishment charging, based on figure 4.3.2.2.1.1 TS 23.502 [202] description:
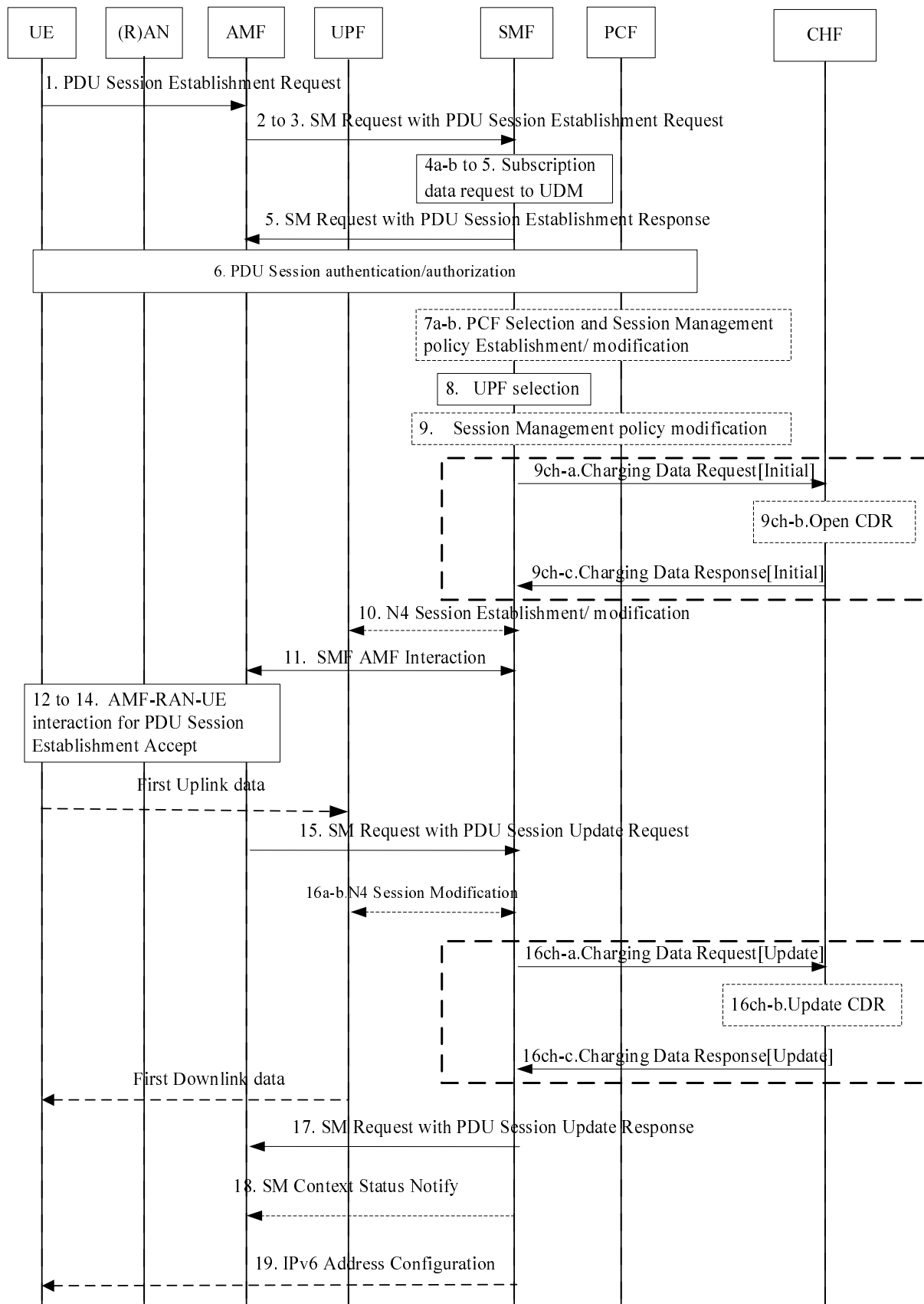
Figure 5.2.2.2.2.1: PDU session establishment

8. The SMF selects an SSC mode for the PDU Session and also selects one or more UPFs.

9. The SMF may perform a Session Management Policy Modification procedure to report some event to the PCF that has previously subscribed.

9ch-a. The SMF creates a Charging Id for the PDU session, and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the PDU session which is triggered by start of PDU session charging event.

9ch-b. The CHF opens CDR for this PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response[Initial] to the SMF.

15. AMF to SMF: SM Request (N2 SM information).

[16a-b]. N4 session Modification.

16ch-a. This step may occur in case "start of service data flow" needs quota from CHF, for the SMF to request quota.

16ch-b. The CHF updates CDR for this PDU session.

16ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

NOTE 1: The steps from 16ch-a to 16ch-c for quota request from CHF are not applicable for offline only charging.

17. SM Request with PDU session Update Response to AMF.

18. SMF sends SM Context Status Notify to AMF.

19. In case of PDU Type IPv6, IPv6 Address Configuration.

5.2.2.3   PDU session charging SSC Mode 1 from SMF

5.2.2.3.1   General

The subclause below describes PDU session SSC mode 1 charging in non-roaming scenarios.

5.2.2.3.2   PDU session charging SSC Mode 1

The following figure 5.2.2.3.2.1 describes a PDU session SSC mode 1 charging, based on clause 5.6.9.2.1 TS 23.501 [201] description:
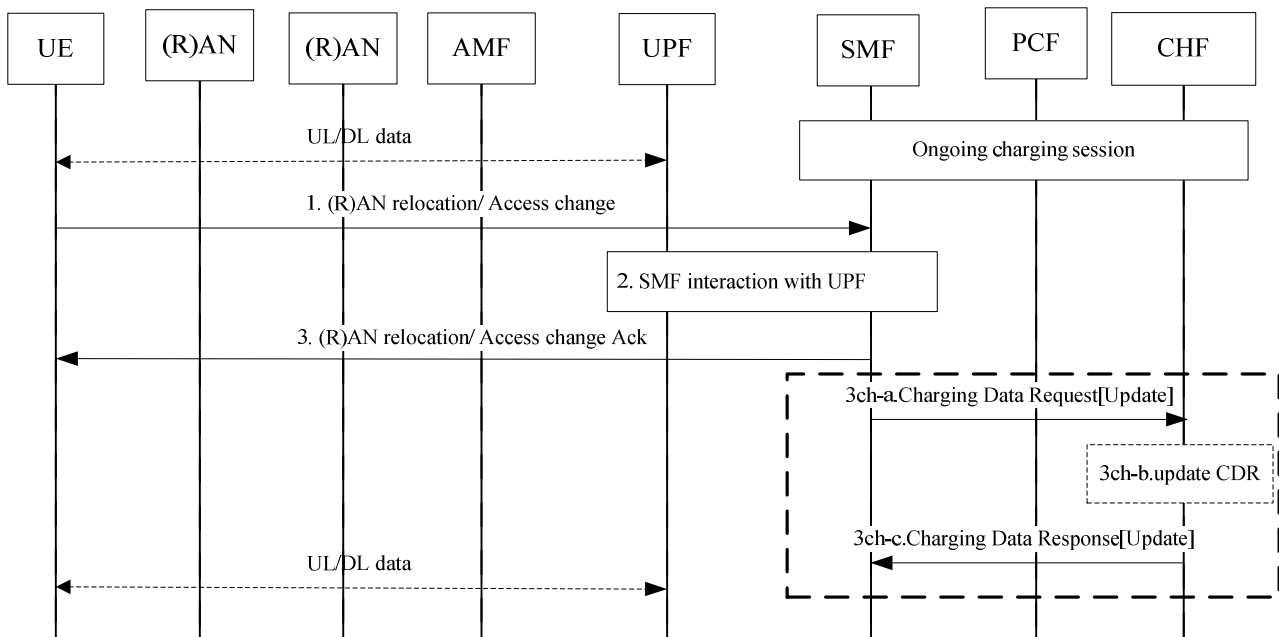
Figure 5.2.2.3.2.1: PDU session anchor relocation in SSC mode 1

Ongoing charging interaction associated with the established PDU session (UPF).

1. A (R)AN relocation is performed.

2. The SMF determines that the serving UPF needs to be maintained and interacts with the UPF for the path switch to the new (R)AN access.

3. the SMF acknowledges the path switch to the new (R)AN.

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for reporting the charging information User location information/ Access Technology Type Information.

3ch-b. The CHF updates the CDR.

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.4   PDU session Charging SSC Mode 2 from SMF

5.2.2.4.1   General

The subclause below describes PDU session charging for change the PDU Session Anchor serving a PDU Session of SSC mode 2

5.2.2.4.2   PDU session Charging SSC Mode 2

The following figure 5.2.2.4.2.1 describes a PDU session anchor relocation in SSC mode 2 charging, based on figure 4.3.5.1.1 TS 23.502 [201] description:
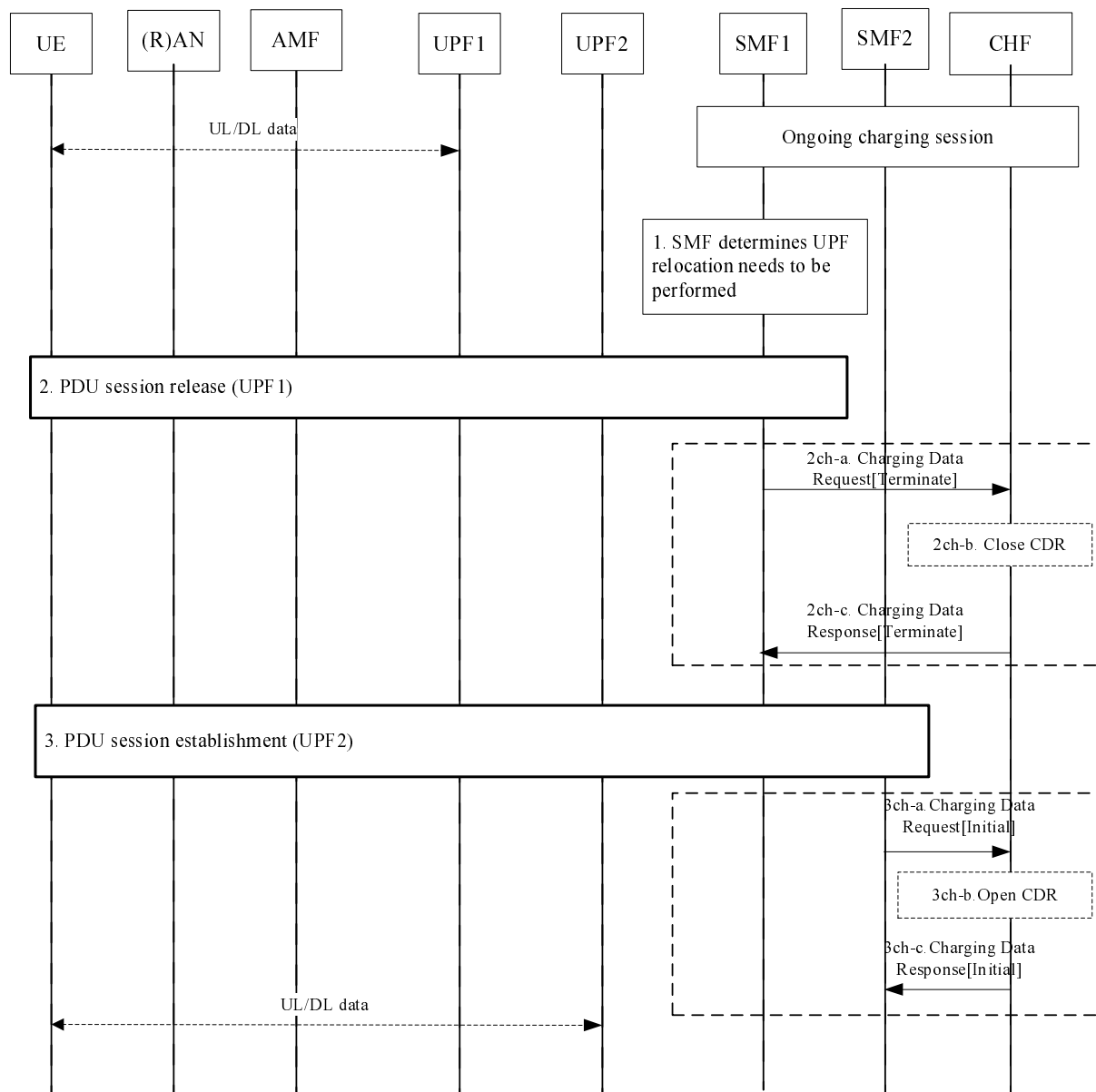
Figure 5.2.2.4.2.1: PDU session anchor relocation in SSC mode 2 with single PDU session anchor

Ongoing charging session associated with the established PDU session (UPF1)

2. PDU session release procedure (UPF1).

2ch-a. The SMF1 sends Charging Data Request[Termination] to the CHF for terminating the charging associated with old PDU session in UPF1.

2ch-b. The CHF closes the CDR for old PDU session in UPF1.

2ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the SMF1.

3. PDU session establishment procedure (UPF2).

3ch-a. The SMF2 creates a Charging Id for new PDU session ID in UPF2 and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the new PDU session which is triggered by start of PDU session charging event.

3ch-b. The CHF opens CDR for new PDU session in UPF2.

3ch-c. The CHF acknowledges by sending Charging Data Response[initial] to the SMF2.

NOTE: If the same SMF1 is re-selected is step 3, the same steps 3ch-a to b apply to SMF1

5.2.2.5 PDU session Charging SSC Mode 3 from SMF

5.2.2.5.1 General

The subclause below describes PDU session charging for change the PDU Session Anchor serving a PDU Session of SSC mode 3.

5.2.2.5.2 PDU session Charging SSC Mode 3

The following figure 5.2.2.5.2.1 describes a PDU session anchor relocation in SSC with mode 3 multiple PDU sessions and SMF reallocation, based on figure 4.3.5.2.1 TS 23.502 [201] description:
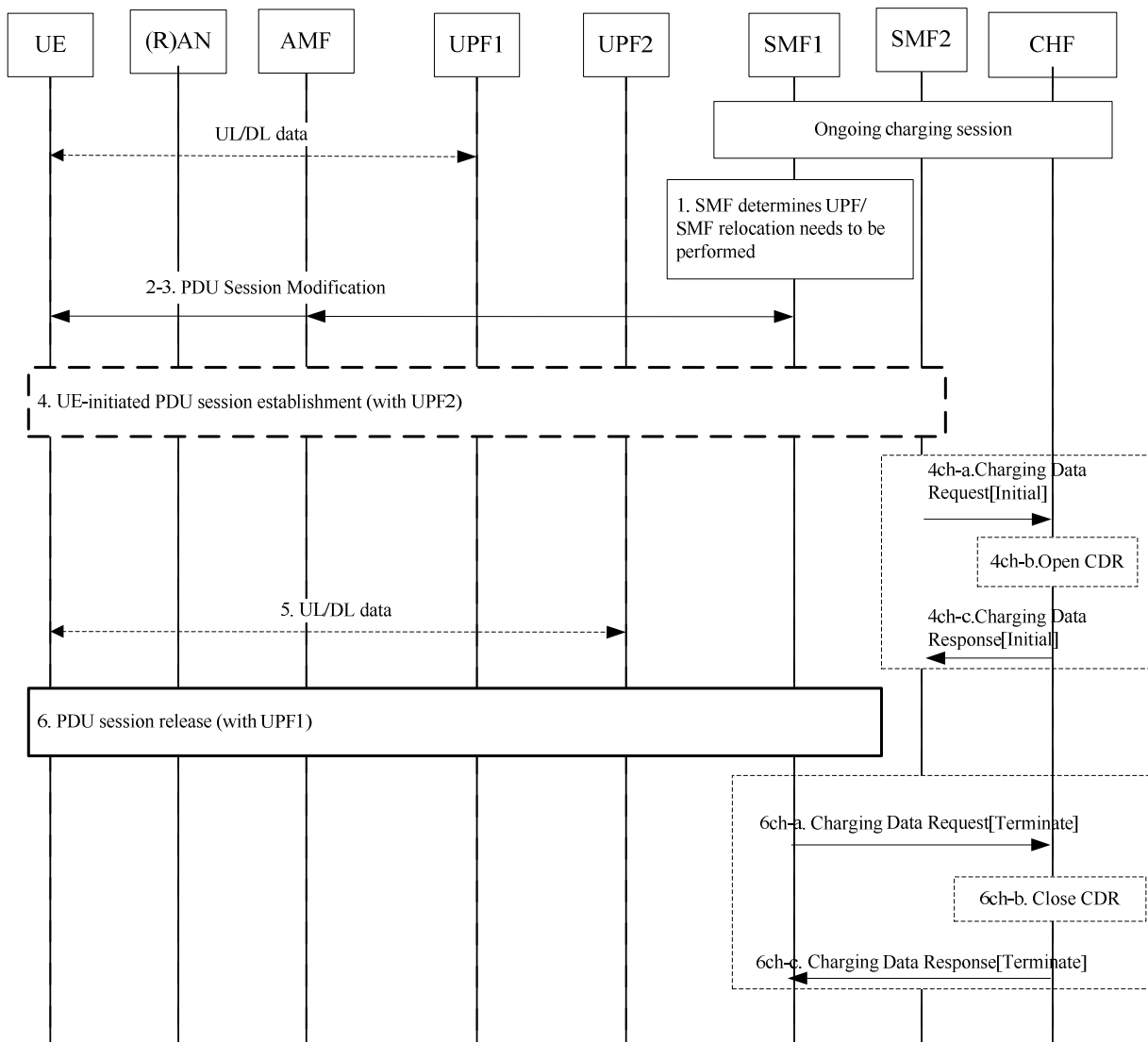
Figure 5.2.2.5.2.1: PDU session anchor relocation in SSC mode 3 with multiple PDU sessions – SMF reallocation

Ongoing charging interaction associated with the established PDU session (with UPF1).

4. UE initiates PDU session establishment procedure with UPF2..

4ch-a. The SMF2 creates a Charging Id for new PDU session ID with UPF2 and sends Charging Data Request[initial] to CHF for authorization for the subscriber to start the new PDU session (with UPF2) which is triggered by start of PDU session charging event.

4ch-b. The CHF opens CDR for new PDU session in UPF2.

4ch-c. The CHF acknowledges by sending Charging Data Response[initial] to the SMF2.

6. Old PDU session for UPF1 release.

6ch-a. The SMF1 sends Charging Data Request[Termination] to the CHF for terminating the charging associated with old PDU session in UPF1.

6ch-b. The CHF closes the CDR for old PDU session in UPF1.

6ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the SMF1.

5.2.2.6 PDU session Charging SSC Mode 3 IPv6 Multi Homed from SMF

5.2.2.6.1 General

The subclause below describes PDU session charging for service continuity with SSC mode 3 using the multi-homed PDU Session.

5.2.2.6.2 PDU session Charging SSC Mode 3 IPv6 Multi Homed

The following figure 5.2.2.6.2.1 describes a PDU session anchor relocation in SSC mode 3 with IPv6 Multi homed PDU Session charging, based on figure 4.3.5.3.1 TS 23.502 [201] description:
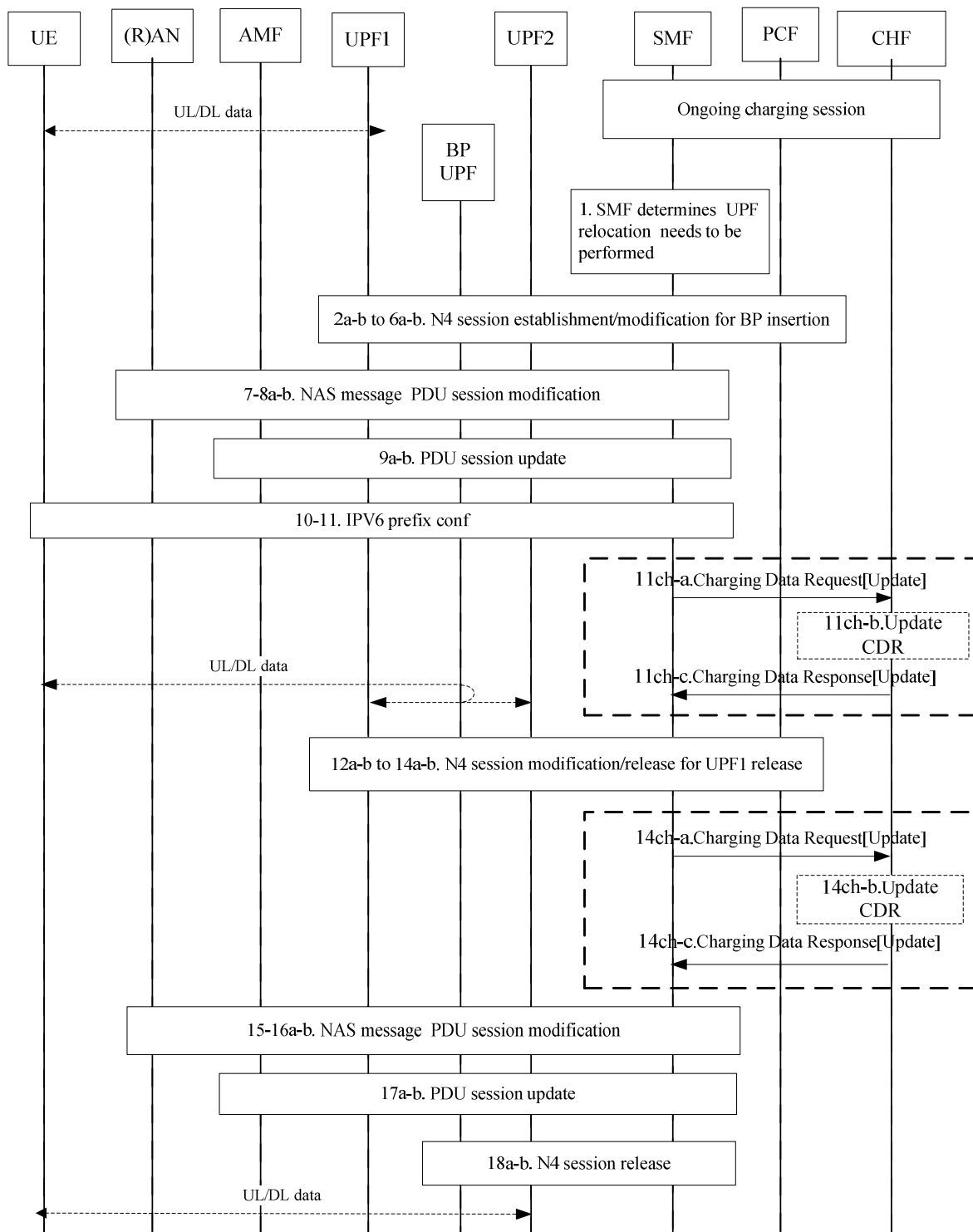
Figure 5.2.2.6.2.1: PDU session anchor relocation in SSC mode 3 with IPv6 Multi homed PDU Session

Ongoing charging interaction associated with the established PDU session (UPF1).

Traffic starts at UPF2.

11ch-a. The SMF sends Charging Data Request[Update] to the CHF for request quota for UPF2 which is triggered by start of service data flow charging event, if quota management per UPF.

11ch-b. The CHF updates CDR for this PDU session

11ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

[12a-b to 13a-b]   The SMF releases the UE's old IPv6 prefix (IP@1), and releases the path between BP UPF and UPF1.

13ch-a. The SMF sends Charging Data Request[Update] to the CHF for usage reporting for UPF1 which is triggered by termination of service data flow charging event, if quota management per UPF.

13ch-b. The CHF updates CDR for this PDU session.

13ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

In this scenario, the PDU session Id is maintained during the whole procedure.

5.2.2.7 Addition of additional PDU Session Anchor and Branching Point or UL CL

The following figure 5.2.2.7.1 describes the charging procedure to add a PDU Session Anchor and a Branching Point or UL CL for an established PDU Session, based on figure 4.3.5.4.1 TS 23.502[201].
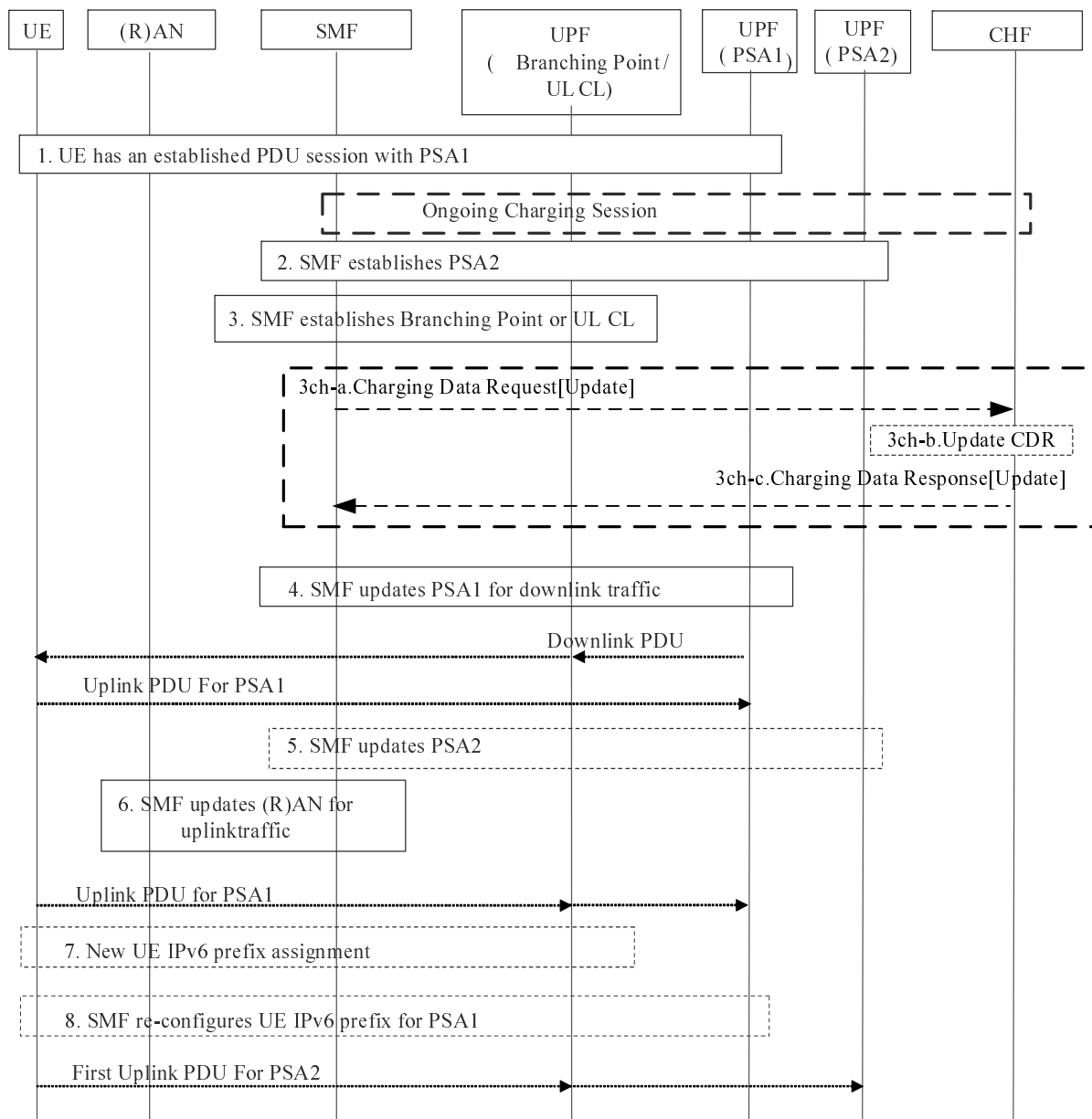
Figure 5.2.2.7.1: Addition of additional PDU Session Anchor and Branching Point or UL CL

Ongoing charging interaction associated with the established PDU session (UPF).

3. The SMF establishes the Branching Point (in case of IPv6 multi-homing) or a UL CL for the PDU Session.

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of UPF (PSA 2) if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of UPF (PSA 2).

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.8 Removal of additional PDU Session Anchor and Branching Point or UL CL

The following figure 5.2.2.8.1 describes charging procedure to remove a PDU Session Anchor and (optionally) remove Branching Point or UL CL for an established PDU Session, based on figure 4.3.5.5.1 TS 23.502[201].
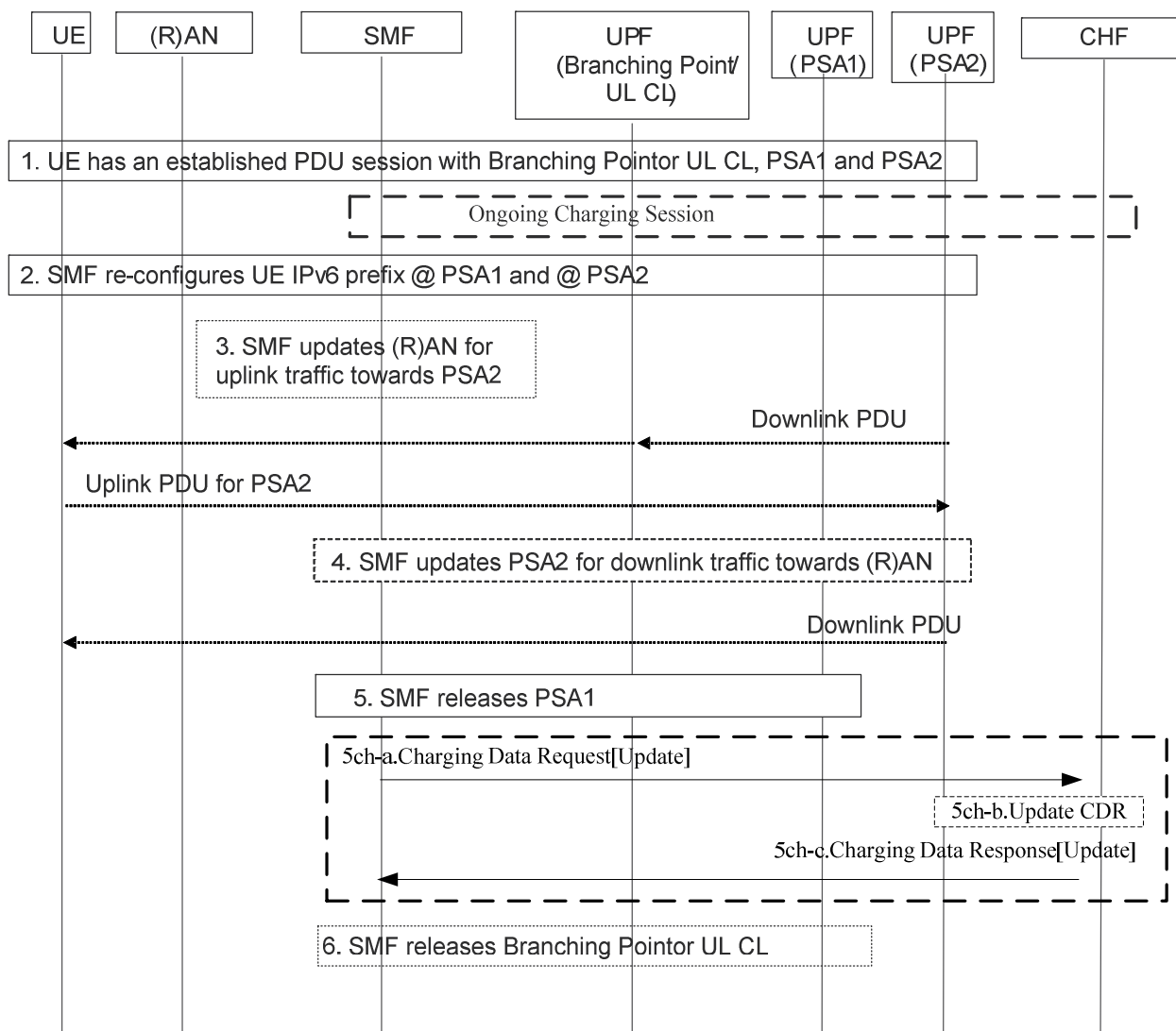
Figure 5.2.2.8.1: Removal of additional PDU Session Anchor and Branching Point or UL CL

Ongoing charging interaction associated with the established PDU session (UPF).

5. The SMF releases via N4 the PSA1.

5ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of UPF (PSA 1) if quota management is granted per UPF by trigger "Removal of UPF".

5ch-b. The CHF updates the CDR for the charging information of UPF (PSA 1).

5ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

6. If steps 4 and 5 were executed, the SMF releases the Branching Point / UL CL.

5.2.2.9 Change of additional PDU Session Anchor for IPv6 multi-homing or UL CL

The following figure 5.2.2.9.1 charging procedure to establish a new additional PDU Session Anchor (i.e., PSA2) and conditionally releases the existing additional PDU Session Anchor (i.e. PSA1), while modifying IPv6 multi-homing or UL CL rule in the same Branching Point or UL CL under controlled by the same SMF abased on figure 4.3.5.6.1 TS 23.502[201].
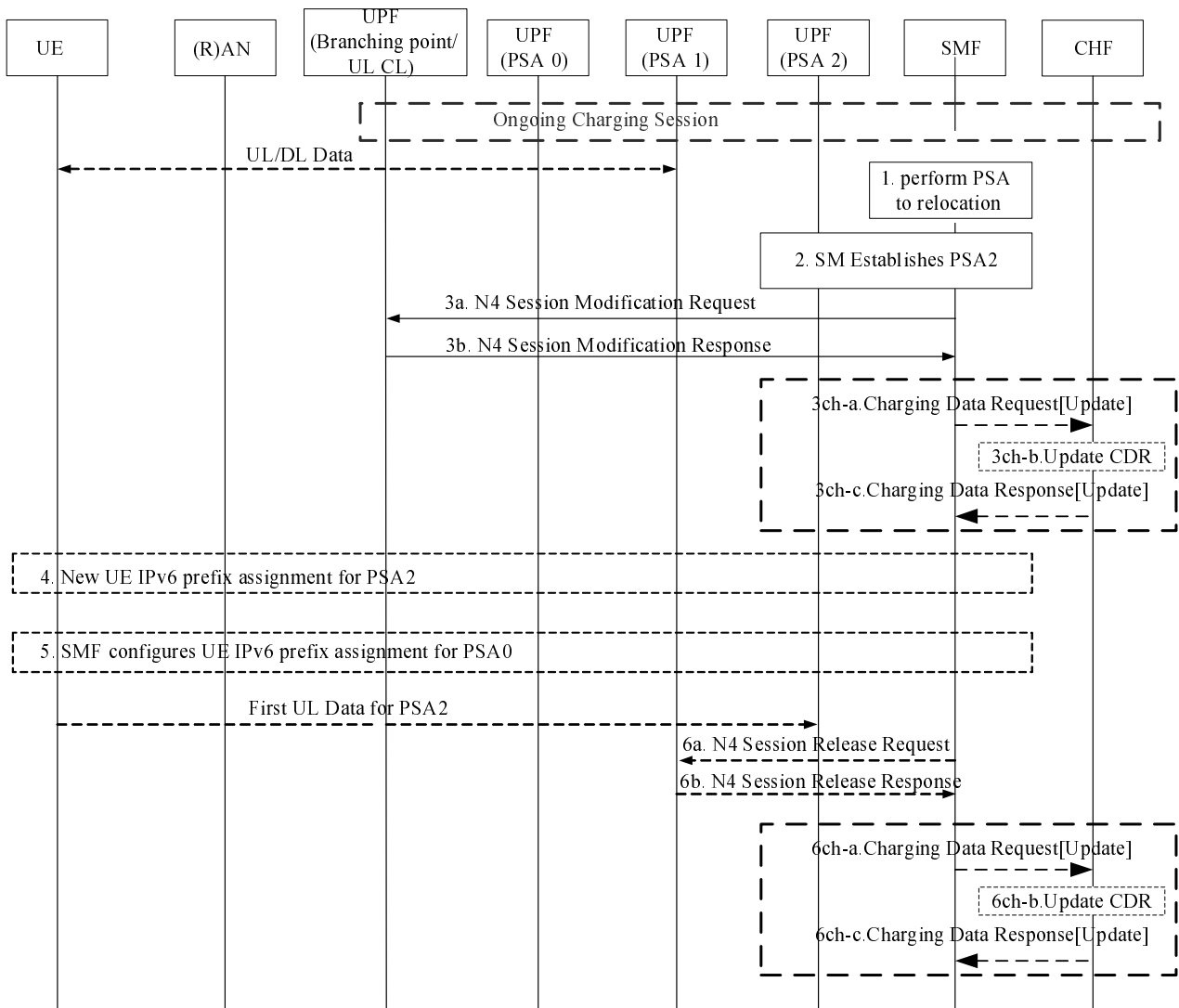
Figure 5.2.2.9.1: Change of additional PSA for a PDU Session in IPv6 multi-homing or UL CL case

Ongoing charging interaction associated with the established PDU session (UPF).

3a-b.   The SMF exchange the N4 message toBranching Point or UL CL .

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of UPF (PSA 2) if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of UPF (PSA 2).

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

6a-b.   Step 6 occurs only if the Branching Point or UL CL does not have any traffic filter on the PDU Session which forwards a traffic flow to PSA1.

6ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of UPF (PSA 1) if quota management is granted per UPF by trigger "Removal of UPF".

6ch-b. The CHF updates the CDR for the charging information of UPF (PSA 1).

6ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.10   Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session

The following figure 5.2.2.10.1 describe the charging procedure to change the Branching Point or the UL CL and additional PSA serving a PDU Session for a UE triggered by SMF ((just an example call flow triggered by Xn based handover) based on figure 4.3.5.7.1 TS 23.502[201].
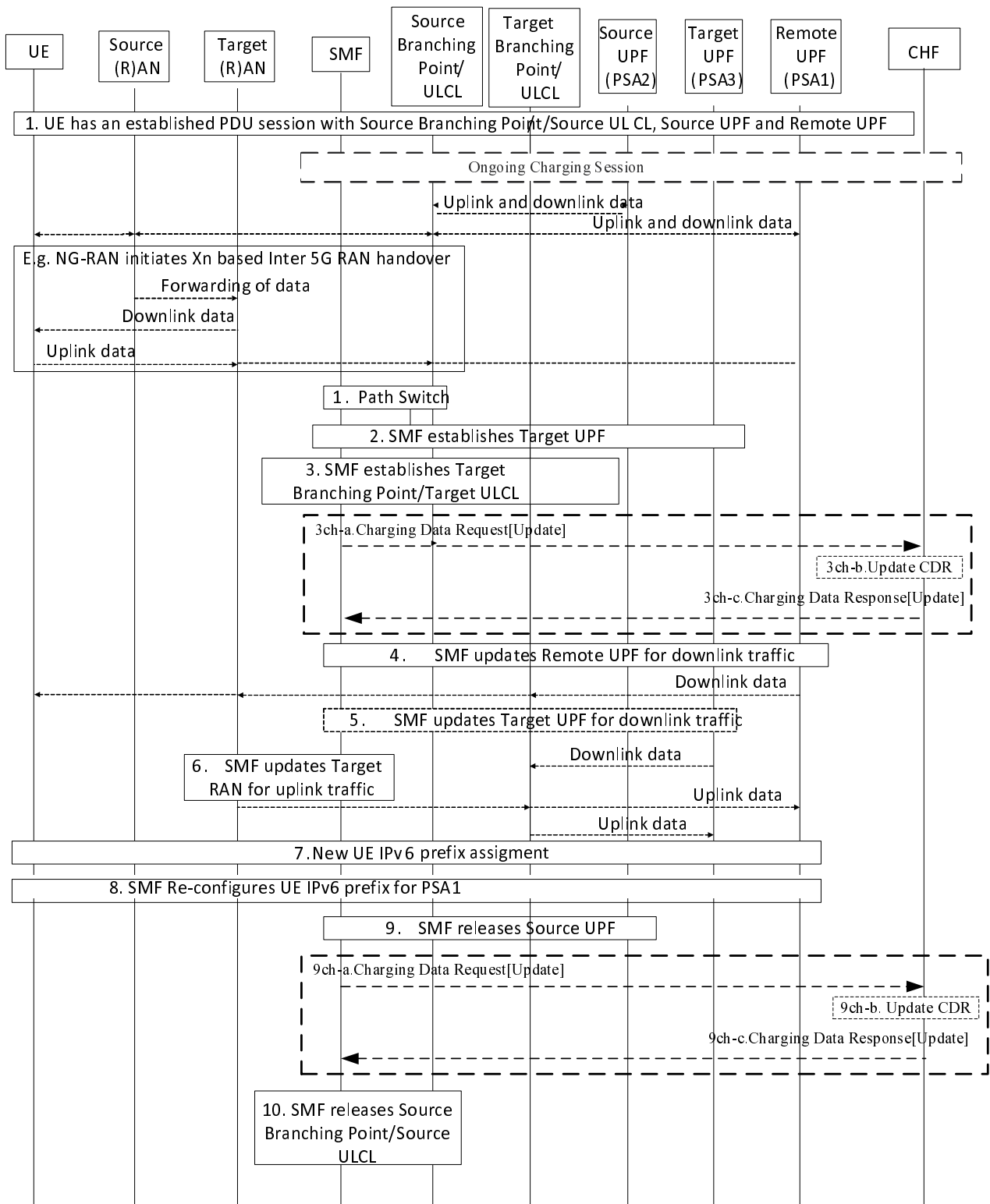
Figure 5.2.2.10.1: Simultaneous change of Branching Point or UL CL and additional PSA for a PDU Session

Ongoing charging interaction associated with the established PDU session (UPF).

3ch-a. The SMF sends Charging Data Request[Update] to the CHF for the additional of Target UPF if quota management is granted per UPF by trigger "Addition of UPF".

3ch-b. The CHF updates the CDR for the charging information of Target UPF.

3ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

9. The SMF releases PSA2.

9ch-a. The SMF sends Charging Data Request[Update] to the CHF for the removal of Source UPF if quota management is granted per UPF by trigger "Removal of UPF".

9ch-b. The CHF updates the CDR for the charging information of Source UPF.

9ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the SMF.

5.2.2.11 PDU session charging for interworking with EPC

5.2.2.11.1 General

In order to interwork with EPC, the N26 interface is introduced as an inter-CN interface between the MME in EPC and 5GS AMF in order to enable provide seamless session continuity for single registration mode UE for inter-system change in the clause 5.17.2.2 TS 23.501[201].

PCF + PCRF, PGW-C + SMF and UPF + PGW-U are dedicated for interworking between 5GS and EPC, which are optional and are based on UE MM Core Network Capability and UE subscription in the clause 4.3 TS 23.501 [201]. The procedures for interworking with EPS based on N26 interface are specified in clause 4.11.1 TS 23.502 [201].

When 5GS and EPC interworking, interaction between the PGW-C + SMF and CHF is using the same interface as for interaction between SMF and CHF.

When a UE establishes a PDU session with PGW-C+SMF in EPS or 5GS, a charging session is established for the PDU session to support 5GS and EPS interworking as follows:

- When a UE is served by EPC, a charging session is established between the PGW-C+SMF and CHF via Nchf interface for EPC online charging and offline charging if 5GS interworking indication from SGW indicates that the UE supports 5G and the PDU session is not restricted to interworking with 5GS by user subscription.

- When a UE is served by 5GS, a charging session is established between the PGW-C+SMF and CHF via Nchf interface for 5GS converged online and offline charging.

- When a UE is served by EPC, the PGW-C+SMF acts as the PGW and a charging session is established via Gy interface for EPC online charging and Gz interface for offline charging if 5GS interworking is not supported.

The chargable events for 5GS and EPC interworking are handover cancel, handover start and handover complete.

The triggers for 5GS and EPC interworking may be enabled or disabled, the PGW-C+SMF will interact with charging system as the following:

- If the trigger for interworking is enabled and the category is set to "immediate reporting", the PGW-C+SMF will report usage in source network and/or request quota for target network.

- If the trigger for interworking is enabled and the category is set to "defered reporting", the PGW-C+SMF will close the count in source network and start a new count in target network, and continue to consume the quota in target network. The source access specific triggers will no more be applicable in the PGW-C+SMF, the target access specific triggers will apply instead.

- If the trigger for interworking is disabled, the PGW-C+SMF will record usage for both source and target network accesses into common count, and consumes the same quota in source and target network. The source access specific triggers will no more be applicable in the PGW-C+SMF, the target access specific triggers will apply instead.

5.2.2.11.2　　5GS to EPS handover using N26 interface

The following figure 5.2.2.11.2.1 describes a PDU session charging handover from 5GS to EPS when N26 is supported, based on figure 4.11.1.2.1.1 TS 23.502 [201] description:
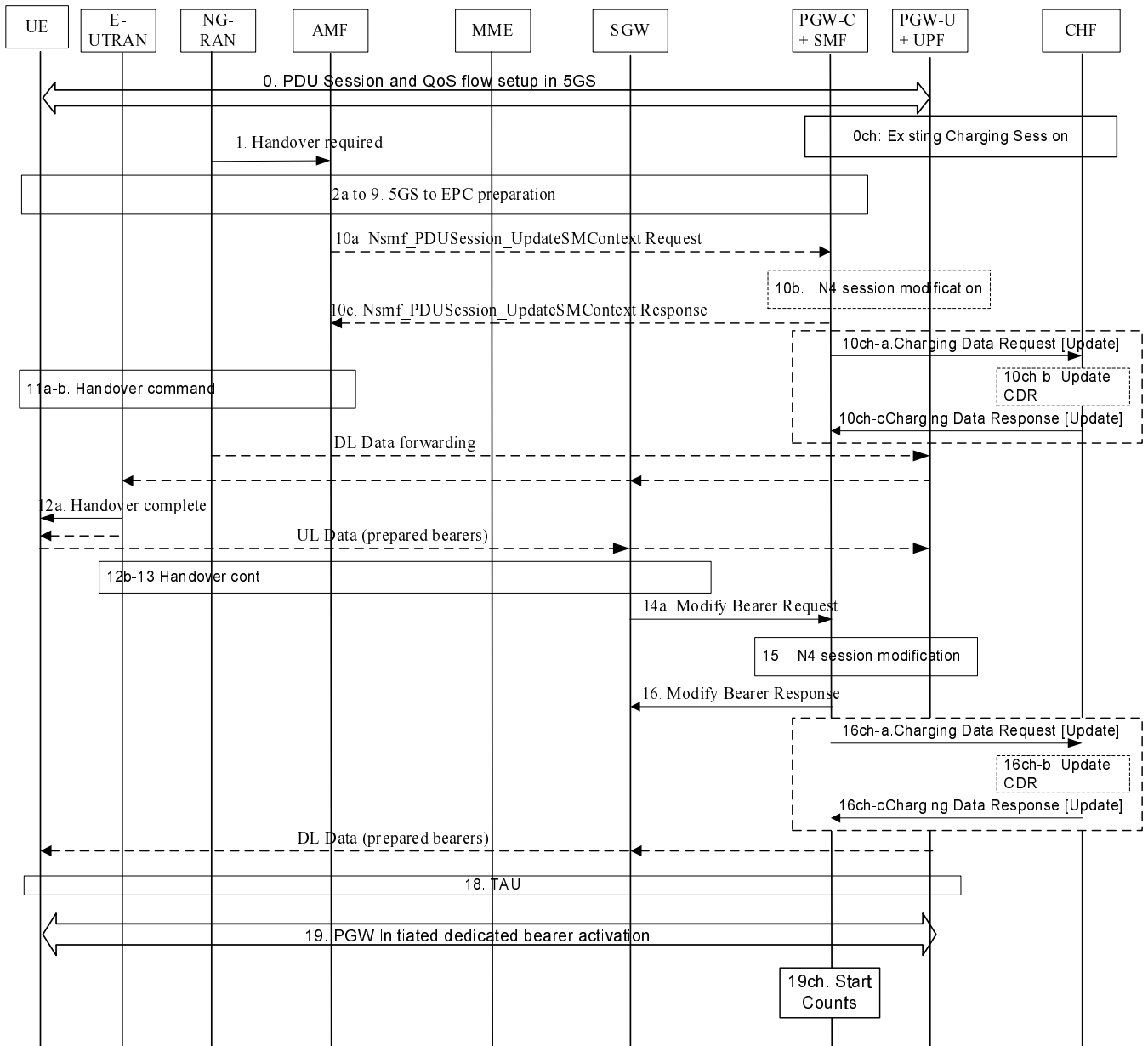
Figure 5.2.2.11.2.1: PDU session charging: 5GS to EPS handover using N26

0.　A PDU session is established in 5GS with multiple QoS Flows.

0ch. A charging session between the PGW-C+SMF and CHF exists for this PDU session.

10c. PDU session update response to AMF.

10ch-a. This step occurs if steps 10a-c occurred. All counts are closed and a Charging Data Request [Update] is sent to CHF, if required by "Handover start" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

16. User Plane path switch for the default bearer and the dedicated GBR bearers between the UE and PGW-U+UPF via SGW.

16ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF, if required by "RAT type change" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

16ch-b. The CHF updates CDR for this PDU session.

16ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

19. Dedicated bearer activation procedure for non-GBR QoS flows initiated by PGW-C+SMF.

19ch. Needed counts are started on start of service data flows of corresponding non-GBR Qos Flows.

### 5.2.2.11.3	EPS to 5GS handover using N26 interface

The following figures 5.2.2.11.3.1 and 5.2.2.11.3.2 describe a PDU session charging handover from EPS to 5GS when N26 is supported, based on figures 4.11.1.2.2.2.1 and 4.11.1.2.2.3.1 TS 23.502 [201] description:
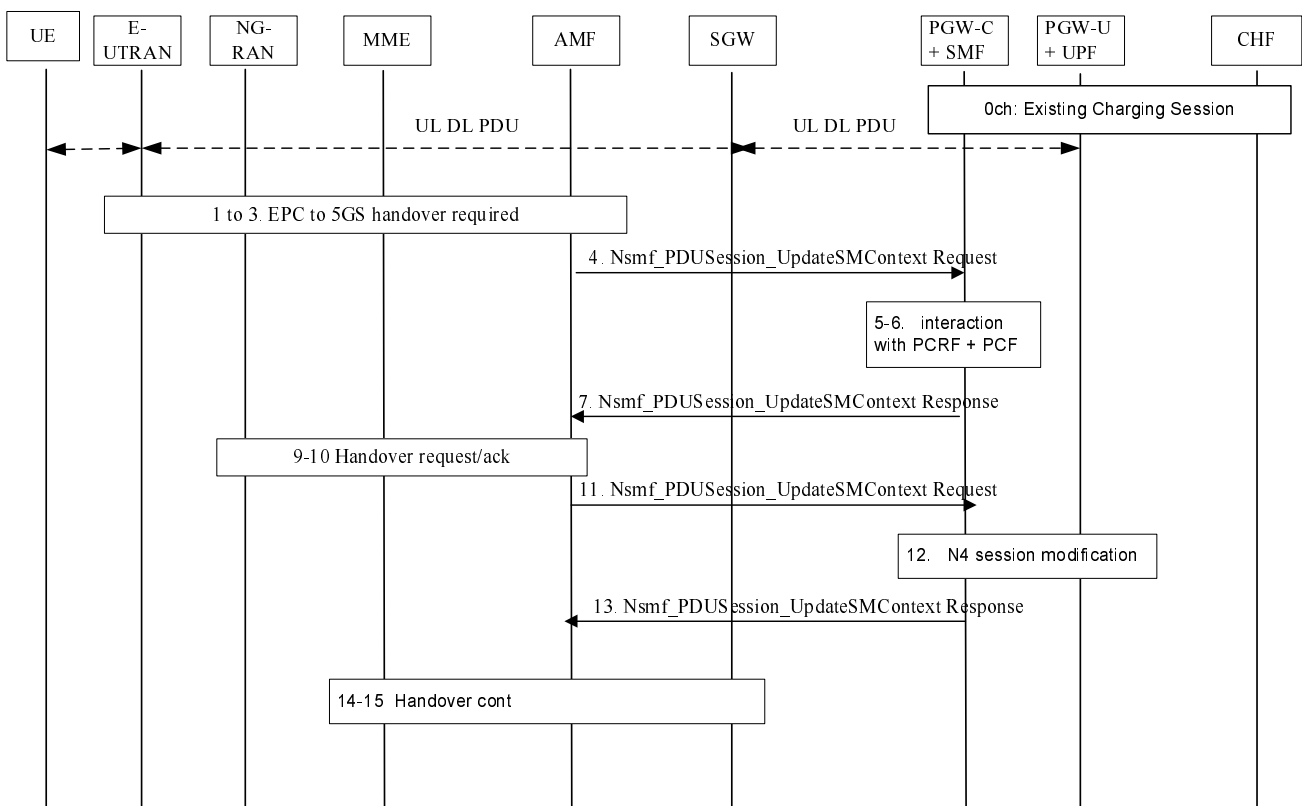
Figure 5.2.2.11.3.1: PDU session charging: EPS to 5GS handover using N26 - preparation

0. If the UE supports 5G and the PDU session is not restricted to interworking with 5GS by user subscription, the PGW-C+SMF is aware that 5GS interworking is supported. A PDU session is established in EPC with default bearer and dedicated bearers. Association between the EPS bearer and the corresponding 5G QoS Rules is stored by the PGW-C+SMF.

0ch. A charging session between the PGW-C+SMF and CHF exists for this PDU session with multiple QoS Flows associated to the default bearer and dedicated bearers.
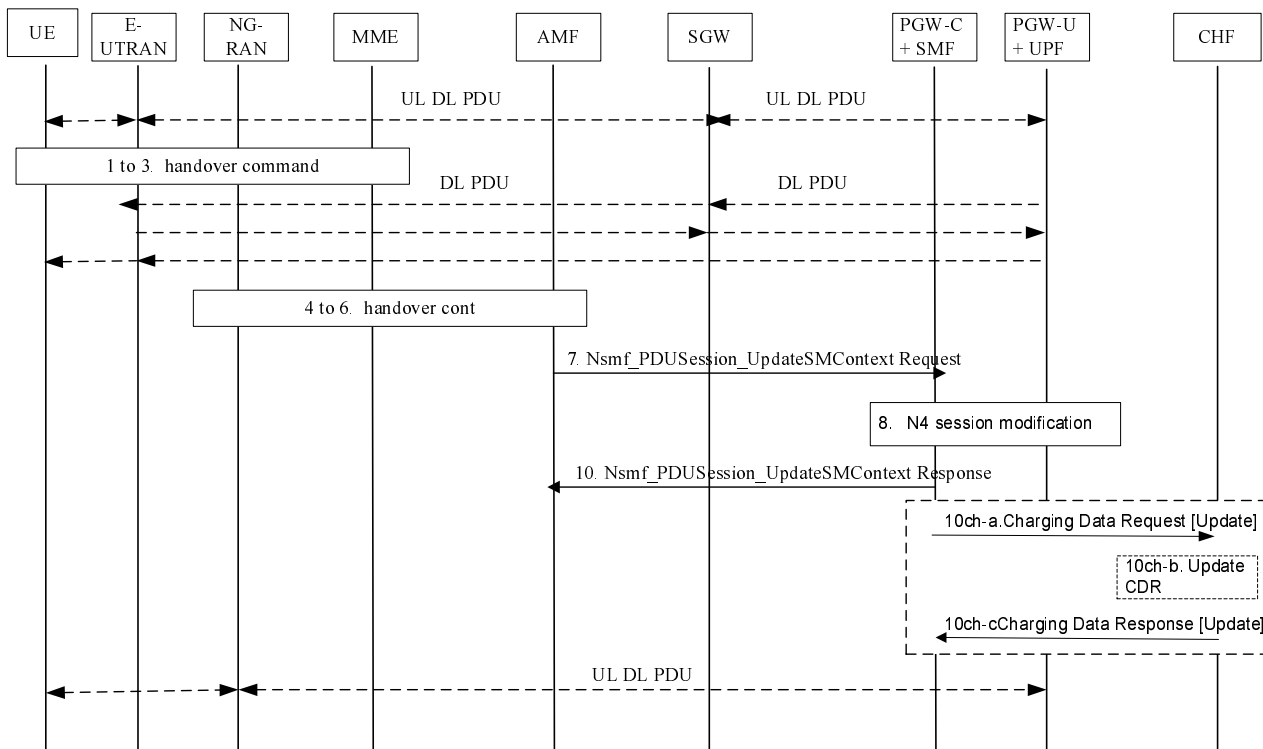
Figure 5.2.2.11.3.2: PDU session charging: EPS to 5GS handover using N26 - execution

10ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF, if required by "RAT type change" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the PGW-C+SMF.

5.2.2.11.4   Handover Cancel

The following figures 5.2.2.11.4.1 describe a PDU session charging handover cancel, based on clause 4.11.1.2.3 TS 23.502 [201] description:
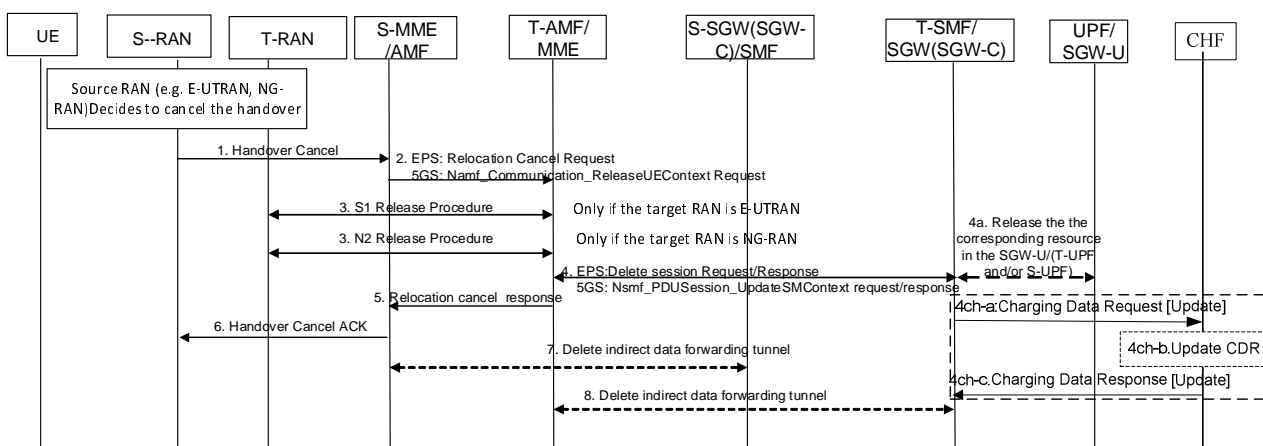
Figure 5.2.2.11.4.1: PDU session charging: Handover Cancel

4.   Based on the Relocation Cancel Indication, the target CN node (MME or AMF) deletes the session resources established during handover preparation phase in SGW(SGW-C and SGW-U)/(SMF and UPF).

4ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF which triggered by "Handover cancel", New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

4ch-b. The CHF updates CDR for this PDU session.

4ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.7. If indirect forwarding tunnel is setup during handover preparation phase then cancellation of handover triggers the source CN node to release the temporary resources used for indirect forwarding.

8. If indirect forwarding tunnel is setup during handover preparation phase then cancellation of handover triggers the target CN node to release the temporary resources used for indirect forwarding.

5.2.2.11.5   EPS to 5GS mobility without N26 interface

The following figures 5.2.2.11.5.1 describe a PDU session charging handover from EPS to 5GS without N26 support, based on clause 4.11.2.3 TS 23.502 [201] description:
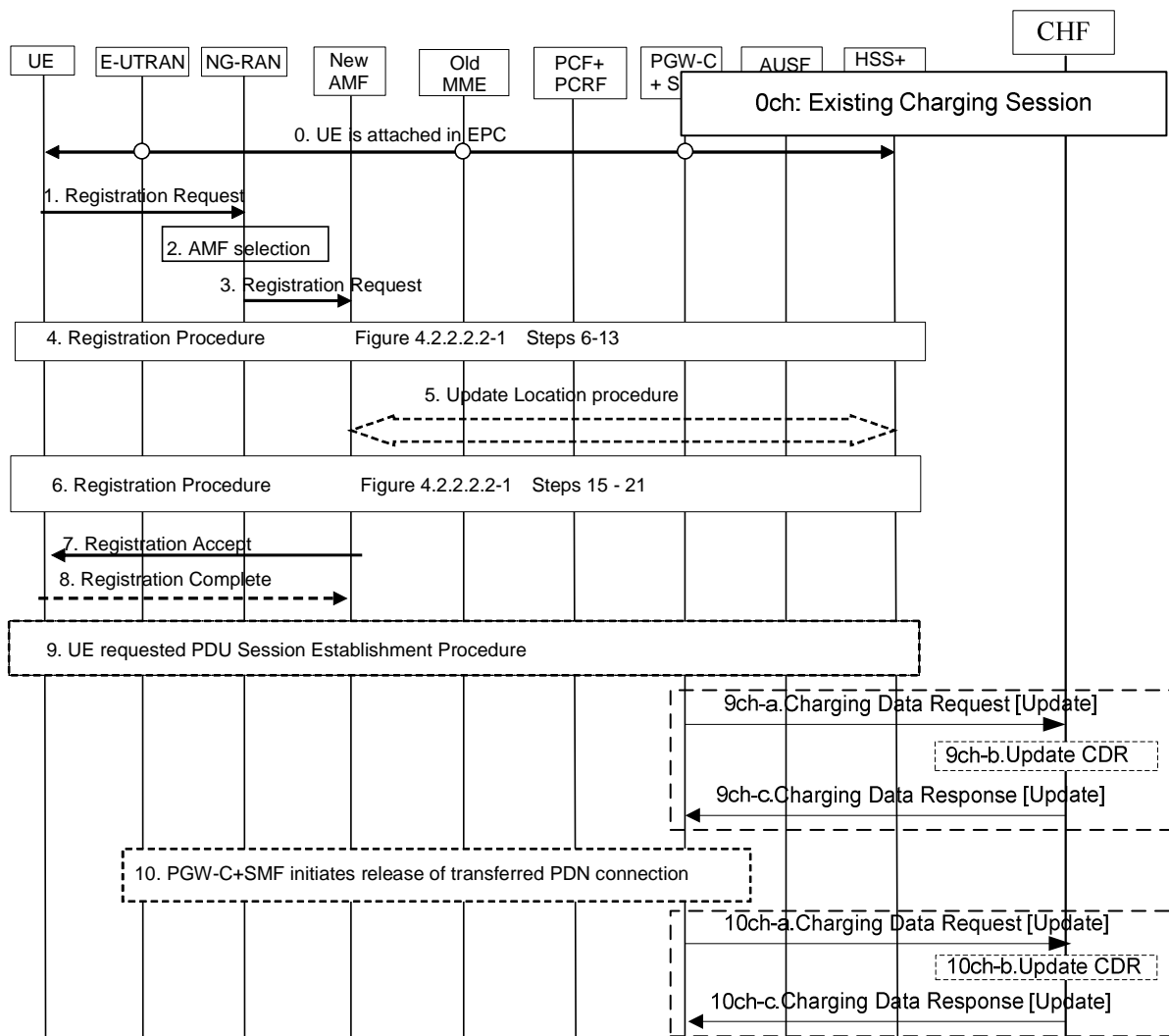
Figure 5.2.2.11.5.1: PDU session charging: EPS to 5GS mobility without N26

0. The UE is attached in EPC.

1-8.   UE initiate registration procedure to the 5GS and indicates that it is moving from EPC.

9. UE requested PDU Session Establishment.

9ch-a. a Charging Data Request [Update] is sent to CHF which is trigged by Handover start charging event, New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

9ch-b. The CHF updates CDR for this PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

10. The PGW-C+SMF performs release of the resources in EPC for the PDN connections(s) transferred to 5GS by performing the PDN GW initiated bearer deactivation procedure.

10ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF which is trigged by Handover complete charging event.

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

5.2.2.11.6 5GS to EPS mobility without N26 interface

The following figures 5.2.2.11.6.1 describe a PDU session charging handover from 5GS to EPS without N26 support, based on clause 4.11.2.2 TS 23.502 [201] description:
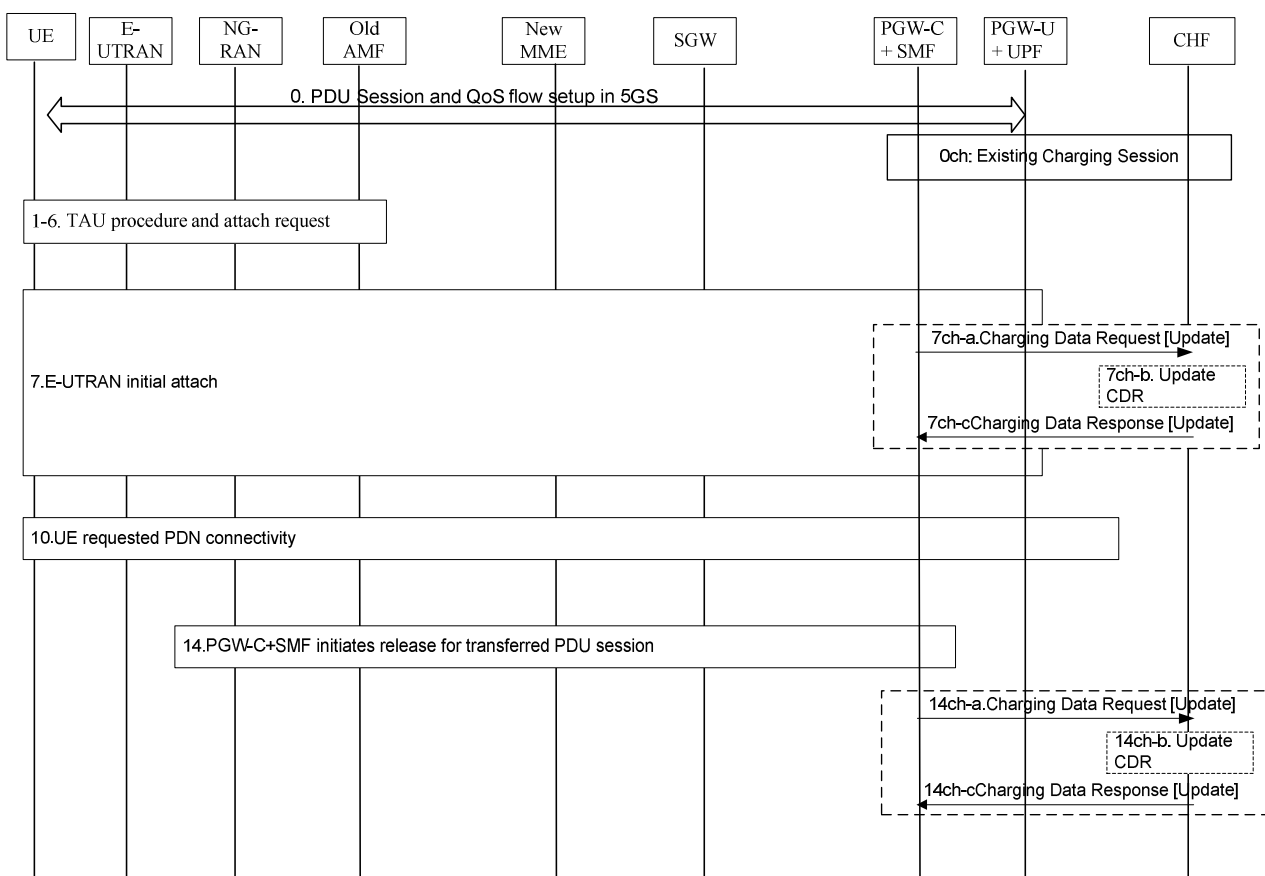
Figure 5.2.2.11.6.1: PDU session charging: 5GS to EPS mobility without N26

0.   UE is registered in 5GS.

1-6. TAU procedure is triggered to start for E-UTRAN initial attach.

7.   UE initiate E-UTRAN Initial Attach procedure to the EPS and indicates that it is moving from 5GS.

7ch-a. a Charging Data Request [Update] is sent to CHF which is triggered by Handover start charging event. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

7ch-b. The CHF updates CDR for this PDU session.

7ch-c.The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

10. If the UE has remaining PDU Sessions in 5GS which it wants to transfer to EPS and maintain the same IP address/prefix, the UE performs the UE requested PDN Connectivity Procedure.

14. The PGW-C+SMF initiates release of the PDU Session(s) in 5GS transferred to EPS.

14ch-a. All counts are closed and a Charging Data Request [Update] is sent to CHF which is triggered by Handover complete charging event.

14ch-b. The CHF updates CDR for this PDU session.

14ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

5.2.2.11.7 EPS to 5GS handover for roaming in Home routed scenario

The following figure 5.2.2.11.7.1 describes a PDU session charging handover from EPS to 5GS for roaming in Home routed scenario, focusing on the charging id generation mechanism.
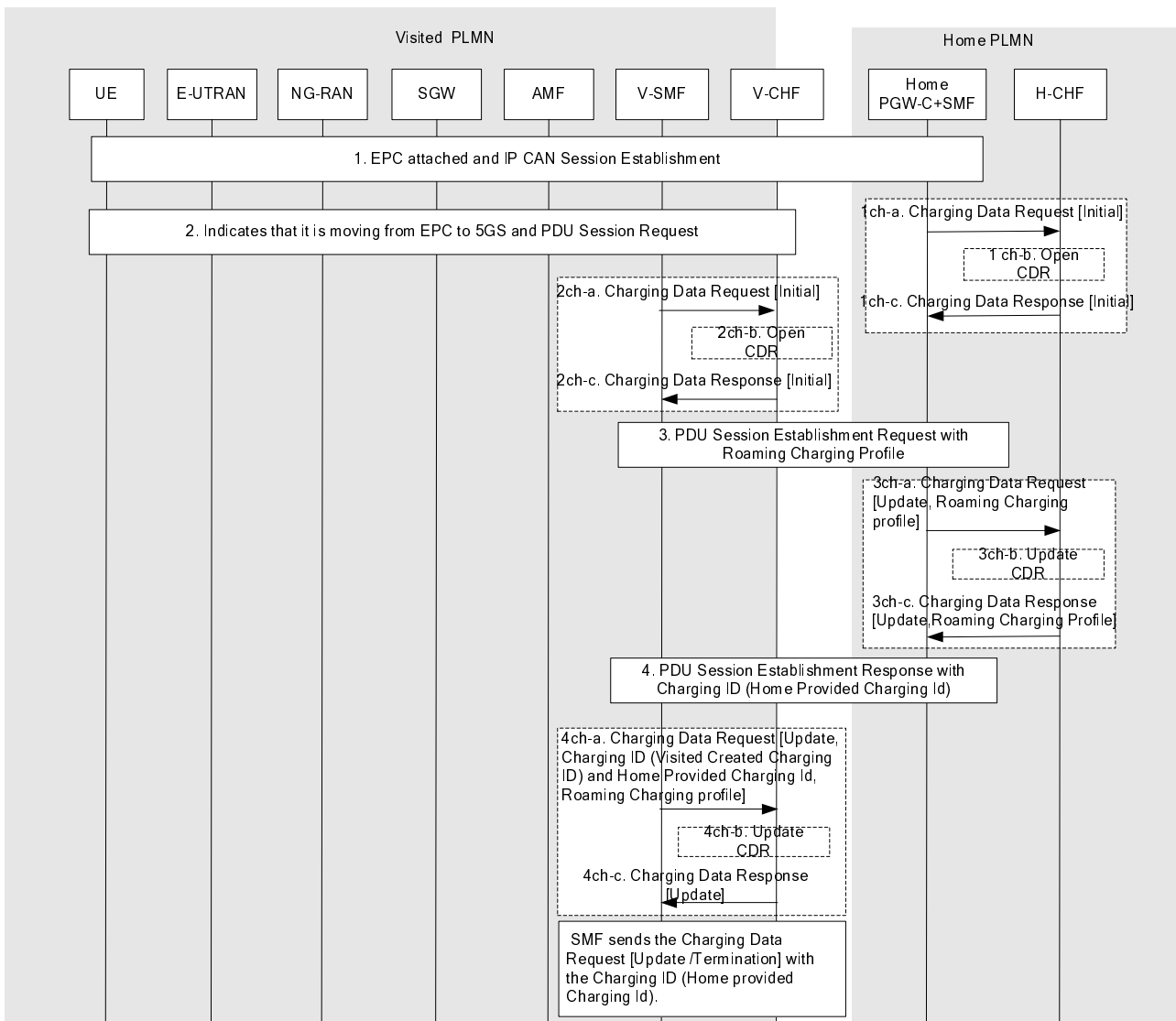
Figure 5.2.2.11.7.1: EPS to 5GS mobility without N26 in Home-Routed Roaming

1. The UE is attached in EPC and initiates a new IP-CAN session.

1ch-a. A Charging Data Request [Initial] is sent to CHF via PGW-C+SMF in HPLMN. The charging ID is generated by PGW-C +SMF in HPLMN.

1ch-b. The H-CHF opens a CDR 1ch-c. The H-CHF acknowledges by sending Charging Data Response [Initial] to the PGW-C+SMF.

2. UE initiates registration procedure to the 5GS and indicates that it is moving from EPC. UE requests PDU Session Establishment.

2ch-a. SMF in VPLMN creates a charging ID (Visited created Charging Id) for the PDU session and sends the Charging Data Request [Initial] to CHF in VPLMN

2ch-b. The CHF in VPLMN opens a CDR.

2ch-c. The CHF in VPLMN acknowledges by sending Charging Data Response [Initial] to the SMF and optionally supplies a "Roaming Charging Profile" to the V-SMF which override the default one.

3. UPF selection and V-SMF sends the PDU session establishement request to H-SMF.

3ch-a. A Charging Data Request [Update] is sent to CHF in HPLMN, indicating the "Roaming Charging Profile" received from the VPLMN.

3ch-b. The CHF in HPLMN updates the CDR.

3ch-c. The CHF in HPLMN acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF and supplies the HPLMN selected "Roaming Charging Profile" to the PGW-C+SMF.

4. H-SMF sends the PDU session establishment response with charging Id (Home provided Charging ID).

4ch-a. A Charging Data Request [Update] is sent to CHF in VPLMN, with the "Roaming Charging Profile", charging ID (Visited created Charging Id) and Home provided Charging ID.

4ch-b. The CHF updates the CDR.

4ch-c. The CHF acknowledges by sending Charging Data Response [Update].

NOTE: The charging ID in V-SMF has the value of Home provided charging ID.

Editor' Note: which parameter is used on step 4 to convey the home provided charging ID is ffs.

5.2.2.12 PDU session charging for roaming in Home routed scenario

5.2.2.12.1 General

The subclauses below describe PDU session charging for roaming in Home routed scenario focusing on roaming QBC procedures between SMF and a CHF in respective PLMNs.

In H-PLMN, PDU session charging for FBC between H-SMF and a H-CHF occurring within the same charging session is not reflected.

5.2.2.12.2 PDU session establishment

The following figure 5.2.2.12.2.1 describes a PDU session charging establishment in roaming Home routed scenario based on figure 4.3.2.2.2.1 TS 23.502 [201] description:
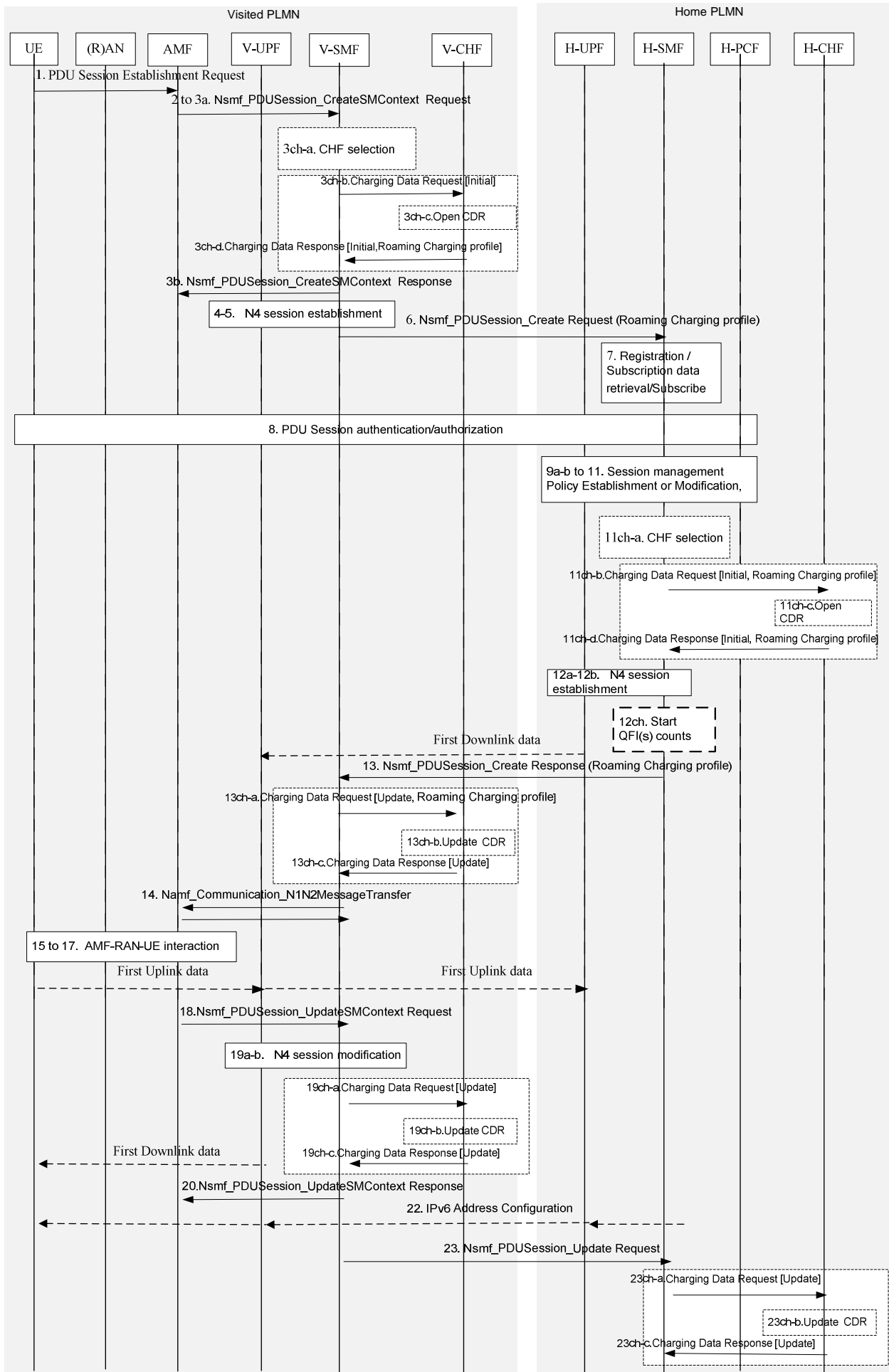
Figure 5.2.2.12.2.1: PDU session charging: establishment roaming Home Routed

1-3a. UE initiates a new PDU session. V-SMF and H-SMF selection by the AMF.

3ch-a. The UE is identified as a roamer (PLMN ID of the received SUPI is different from VPLMN PLMN ID), the CHF is selected accordingly.

3ch-b. A Charging Data Request [Initial] is sent to CHF, indicating "in-bound roamer".

3ch-c. The CHF opens a CDR (indicating "in-bound roamer")

3ch-d. The CHF acknowledges by sending Charging Data Response[Initial] to the SMF and optionally supplies a "Roaming Charging Profile" to the V-SMF which overrides the default one.

10. UPF selection.

11. If dynamic PCC is deployed, SM policy association modification.

11ch-a. Based on UE is identified as roaming in a different PLMN, the CHF is selected accordingly.

11ch-b. A Charging Data Request [Initial] is sent to CHF, indicating "out-bound roamer", with the "Roaming Charging Profile" received from the VPLMN.

11ch-c. The CHF opens a CDR (indicating "out-bound roamer").

11ch-d. The CHF acknowledges by sending Charging Data Response[Initial] to the H-SMF and supplies the HPLMN selected "Roaming Charging Profile" (either the same as the one received from VPLMN, either its own selected) to the H-SMF.

[12a-b]. The SMF initiates an N4 Session Establishment procedure with the selected UPF.

12ch. Counts per QFI are started.

13. Nsmf_PDUSession_Create Response from H-SMF to V-SMF

13ch-a. Based on "received PDU session conditions" trigger, a Charging Data Request [Update] is sent to CHF with charging information received from H-SMF, which includes the HPLMN selected "Roaming Charging Profile" and counts per QFI are started.

13ch-b. The CHF updates the CDR.

13ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

19a-b. N4 session modification.

19ch-a. Counts per rejected QFI(s) are closed. A Charging Data Request [Update] is sent to CHF to report if needed.

19ch-b. The CHF updates the CDR.

19ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

23. Nsmf_PDUSession_UpdateRequest from V-SMF to H-SMF. The rejected QFI(s) are notified to H-SMF.

23ch-a. Counts per rejected QFI(s) are closed. A Charging Data Request [Update] is sent to CHF to report if needed.

23ch-b. The CHF updates the CDR.

23ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the H-SMF.

5.2.2.12.3 PDU session modification

The following figure 5.2.2.12.3.1 describes a PDU Session Modification procedure, home-routed roaming scenario based on figure 4.3.3.3.1 TS 23.502 [201] description:
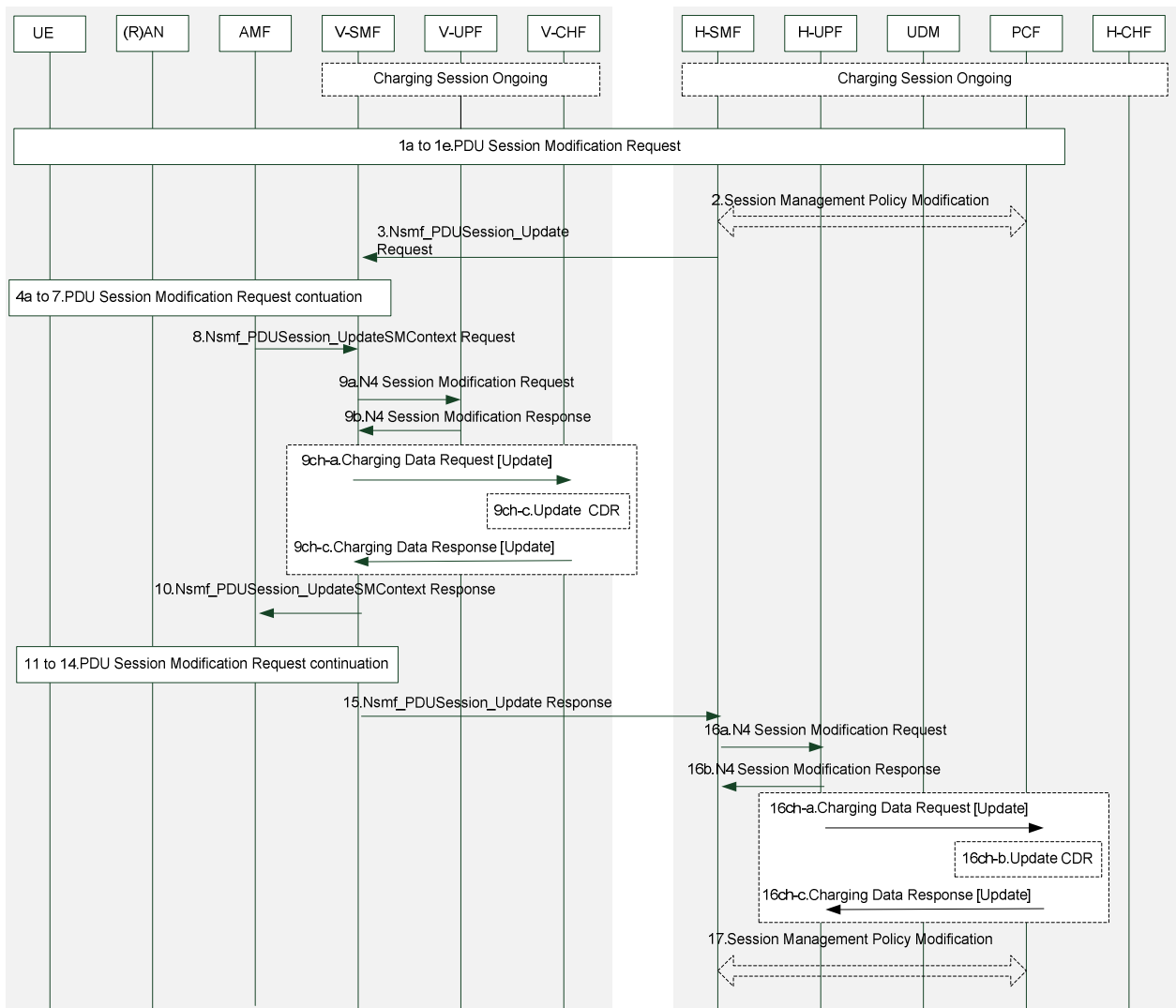
Figure 5.2.2.12.3.1: UE or network requested PDU Session Modification (for home-routed roaming scenario)

9ch-a. A Charging Data Request [Update] is sent to V-CHF with charging information received from V-SMF, if needed and new counts per QFI are started.

9ch-b. The CHF updates the CDR.

9ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the V-SMF.

16ch-a. A Charging Data Request [Update] is sent to H-CHF with charging information received from H-SMF, if needed, and new counts per QFI are started.

16ch-b. The CHF updates the CDR.

16ch-c. The CHF acknowledges by sending Charging Data Response[Update] to the H-SMF.

5.2.2.12.4 PDU session release

The following figure 5.2.2.8.4.1 describes a PDU session charging release in roaming Home routed scenario based on figure 4.3.4.3.1 TS 23.502 [201] description:
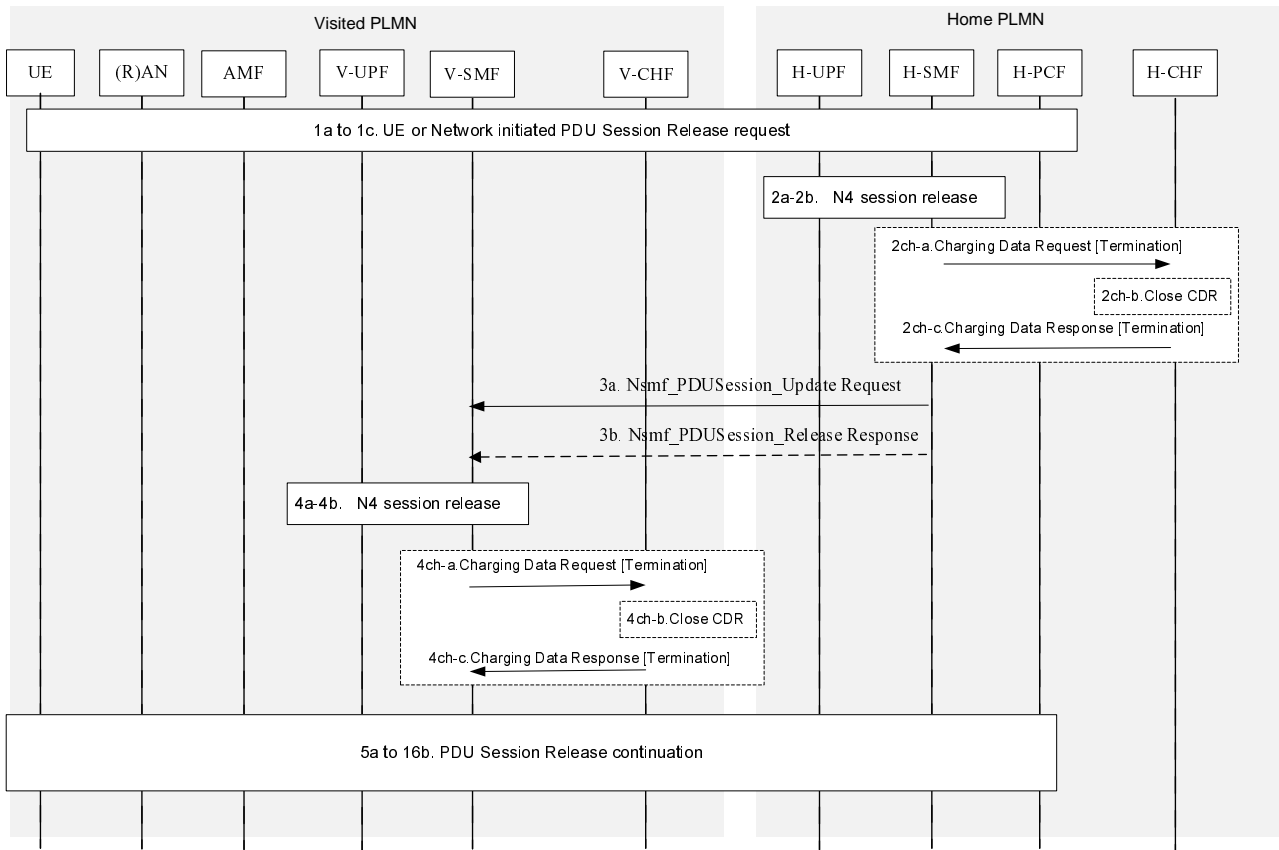
Figure 5.2.2.12.4.1: PDU session charging: release roaming Home Routed

2a-2b. N4 session release between H-SMF and H-UPF.

2ch_a. A Charging Data Request [Termination] is sent to CHF with the set of QFI(s) counts.

2ch-b. The CHF closes the CDR

2ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the H-SMF.

4a-4b. N4 session release between V-SMF and V-UPF.

4ch-a. A Charging Data Request [Termination] is sent to CHF with the set of QFI(s) counts.

4ch-b. The CHF closes the CDR

4ch-c. The CHF acknowledges by sending Charging Data Response[Termination] to the V-SMF.

5.2.2.13   PDU session charging - non-3GPP access

5.2.2.13.1   General

After UE registration to 5GC via an non-3GPP access network, a PDU session can be established via this non-3GPP access. For following scenarios, the PDU session establishment via untrusted non-3GPP access network is specified in clause 4.12 of TS 23.502 [201] and the PDU session establishment via trusted non-3GPP access network is specified in clause 4.12a of TS 23.502 [201]:

- UE initiated PDU session establishment;

- Handover of a PDU Session from 3GPP access to untrusted non-3GPP access;

- Service Request procedures via Untrusted non-3GPP Access specified in clause 4.12.4.5 of TS 23.502 [201];

- Service Request procedures via Trusted non-3GPP Access specified in clause 4.12.4a.5 of TS 23.502 [201].

Handover procedure of a PDU Session between 3GPP access and non-3GPP access is achieved by PDU Session Establishment over source access followed by PDU Session Release over the target access for respective N2 Resources Release. The PDU Session ID, IP address/prefix, and SSC mode are maintained during the move.

PDU session over Untrusted non-3GPP Access release and Trusted non-3GPP Access release are specified in clause 4.12.7 and clause 4.12a.7 of TS 23.502 [201].

5.2.2.13.2 PDU session establishment

5.2.2.13.2.1 PDU session establishment via an untrusted non-3GPP access network

The following figure 5.2.2.13.2.1 describes a PDU session charging establishment via an untrusted non-3GPP access network scenario based on figure 4.12. 5.1 in TS 23.502 [201] description:
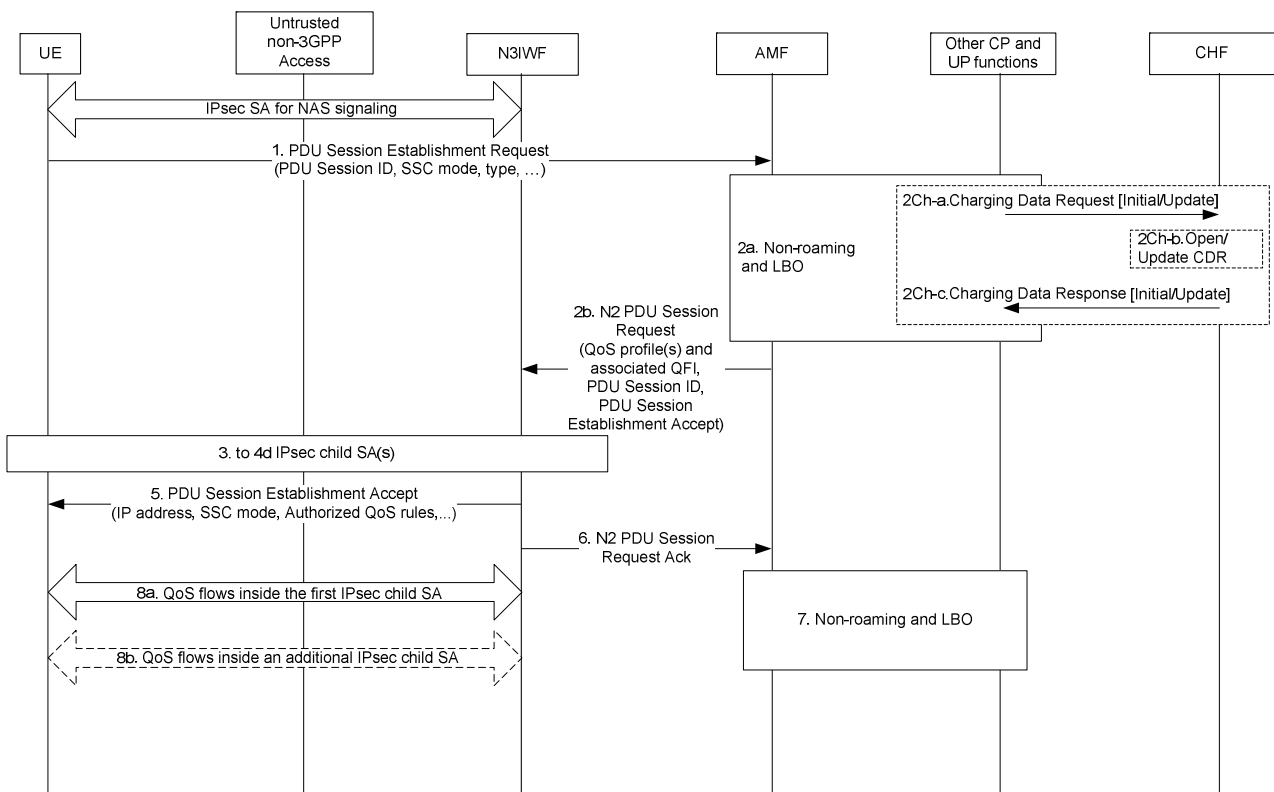
Figure 5.2.2.13.2.1: PDU Session establishment via untrusted non-3GPP access

[2ch-a to 2ch-c]. Two cases:

- In case of "Initial request" the same steps as steps 7ch-a to 7ch-c in figure 5.2.2.2.1 apply, for initial SMF interaction with CHF, with Charging Data Request [Initial].

- In case of "Existing PDU Session" the "radio access type change" trigger may apply for SMF interaction with CHF, with Charging Data Request [Update].

5.2.2.13.2.2 PDU session establishment via Trusted Non-3GPP access network

After the UE registers to 5GC via trusted non-3GPP access network, the UE may request a PDU Session establishment by using the same procedure as the one specified in clause 5.2.2.13.2.1 for untrusted non-3GPP access, with the following modifications:

- The N3IWF in Figure 5.2.2.13.2.1 should be substituted with a TNGF and the Untrusted non-3GPP access should be substituted with a Trusted non-3GPP Access Point (TNAP).

    - Charging Data Request [Initial/Update] contains RAT type and user location specifics to trusted non-3GPP.

    - The TNGF may send a TNGF Identities parameter to AMF inside an N2 Uplink NAS Transport message. The TNGF Identities parameter contains a list of identifiers (i.e. FQDNs or IP addresses) of N3 terminations supported by the TNGF. If received by the AMF, it shall forward it to the SMF, which may use it as input to UPF selection.

5.2.2.13.3   PDU session modification

5.2.2.13.3.1   PDU session modification via an untrusted non-3GPP access network

The following figure 5.2.2.13.3.1 describes a PDU session charging modification via an untrusted non-3GPP access network scenario based on figure 4.12.16.1 in TS 23.502 [201] description:
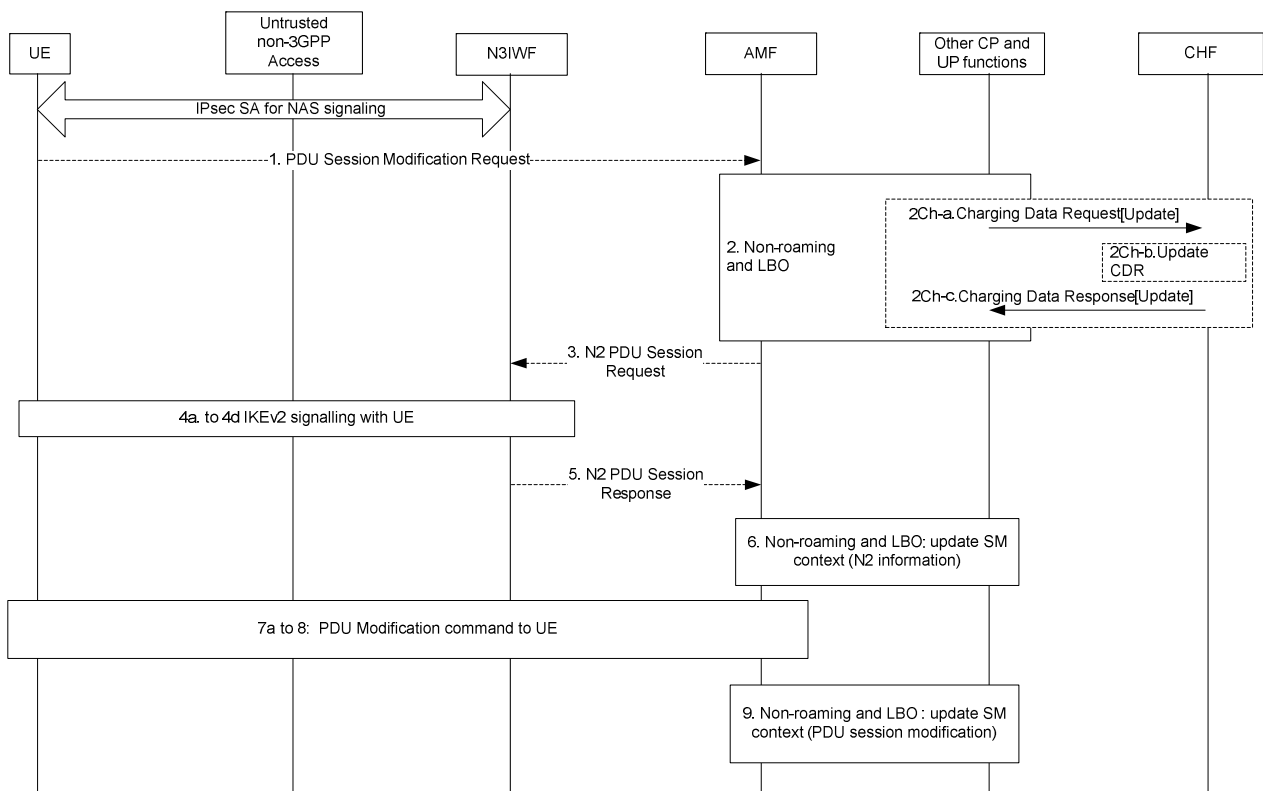
Figure 5.2.2.13.3.1: PDU Session modification via untrusted non-3GPP access

[2ch-a to 2ch-c]: Interaction between SMF and CHF triggered by the modification applied to the PDU session (e.g. QoS handling).

5.2.2.13.3.2   PDU session modification via Trusted Non-3GPP access network

The UE or network requested PDU Session Modification procedure via trusted non-3GPP access network is the same procedure as the one specified in clause 5.2.2.13.3.1 for untrusted non-3GPP access, with the following modifications:

- The N3IWF in Figure 5.2.2.13.3.1 should be substituted with a TNGF and the Untrusted non-3GPP access should be substituted with a Trusted non-3GPP Access Point (TNAP).

- Interaction between SMF and CHF triggered by the modification contains RAT type and user location specifics to trusted non-3GPP.

5.2.2.13.4 PDU session release

5.2.2.13.4.1 PDU session release via an untrusted non-3GPP access network

The following figure 5.2.2.13.4.1 describes a PDU session charging release via an untrusted non-3GPP access network scenario based on figure 4.12.17.1 in TS 23.502 [201] description:
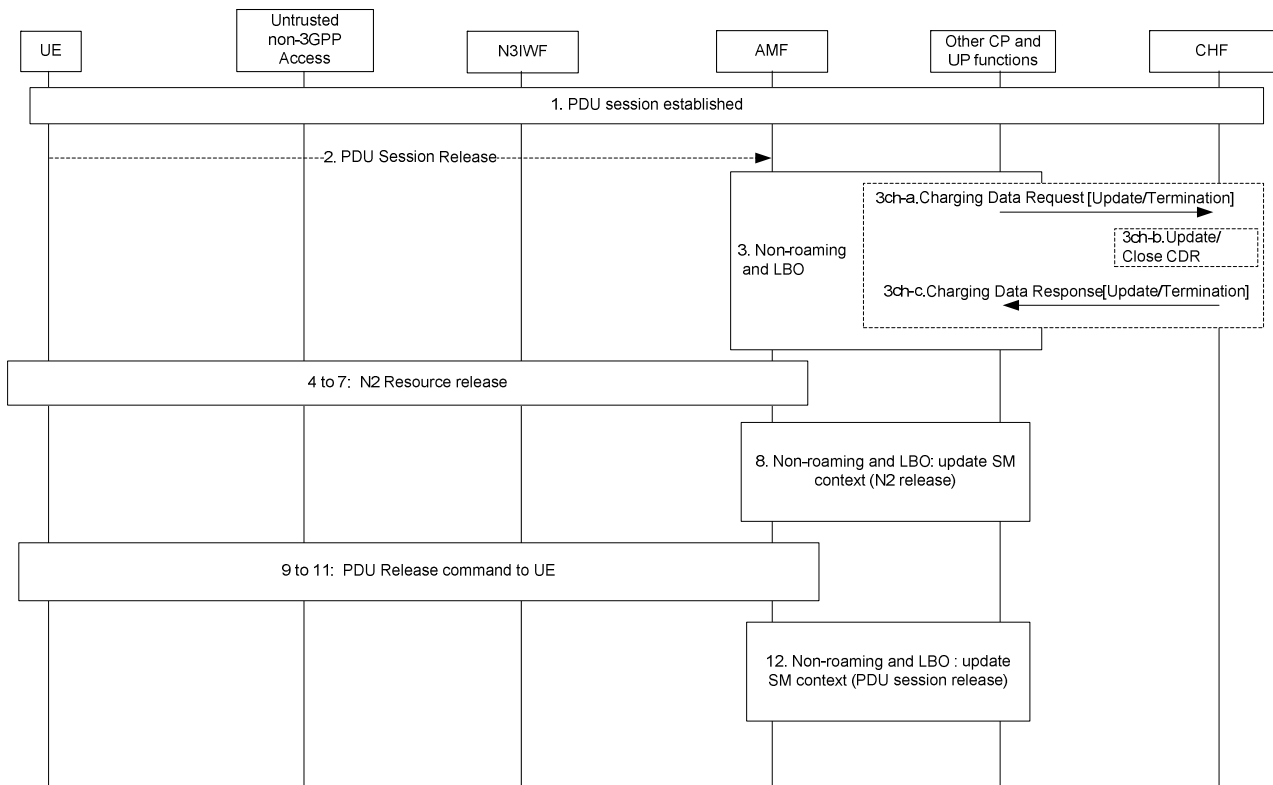
Figure 5.2.2.13.4.1: PDU Session release via untrusted non-3GPP access

[3cha-3chb]. Two cases:

- In case the PDU session needs to be released, SMF interaction with CHF for release, with Charging Data Request [Termination].

- In case of handover from non-3GPP access to 3GPP access, SMF may interacts with CHF, with Charging Data Request [Update].

NOTE 1: the "radio access type change" trigger, if enabled, applied during the PDU session establishment over the 3GPP access which was performed prior to this PDU session release over non-3GPP access.

5.2.2.13.4.2 PDU session release via Trusted Non-3GPP access network

The UE or the network can release a PDU Session via a trusted non-3GPP access network as specified in clause 5.2.2.13.4.1 for the untrusted non-3GPP access with the following modifications:

- The untrusted non-3GPP access is substituted by a trusted non-3GPP access point (TNAP).

- The N3IWF is substituted by the TNGF.

5.2.2.14 PDU session served by I-SMF and SMF

5.2.2.14.1 General

When the I-SMF is inserted, re-allocated, or removed in a PDU Session as specified in TS 23.501 [200], the SMF may report the charging information to the CHF.

When the I-SMF with UL CL/BP is inserted based on information received from SMF, the I-SMF forwards traffic usage information to the SMF as specified in TS 23.501 [200].

When the V-SMF is changed for a Home Routed PDU Session as specified in TS 23.502 [201], the H-SMF may report the charging information to the H-CHF.

5.2.2.14.2 PDU session establishment with I-SMF insertion

The following figure 5.2.2.14.2.1 describes a PDU session establishment charging, for the case where the service area of the selected SMF does not include the location where the UE camps, based on TS 23.502 [201] figure 4.3.2.2.2, where the V-SMF and V-UPF are replaced by I-SMF and I-UPF, and H-SMF and H-UPF are replaced by SMF and UPF (PSA) respectively:
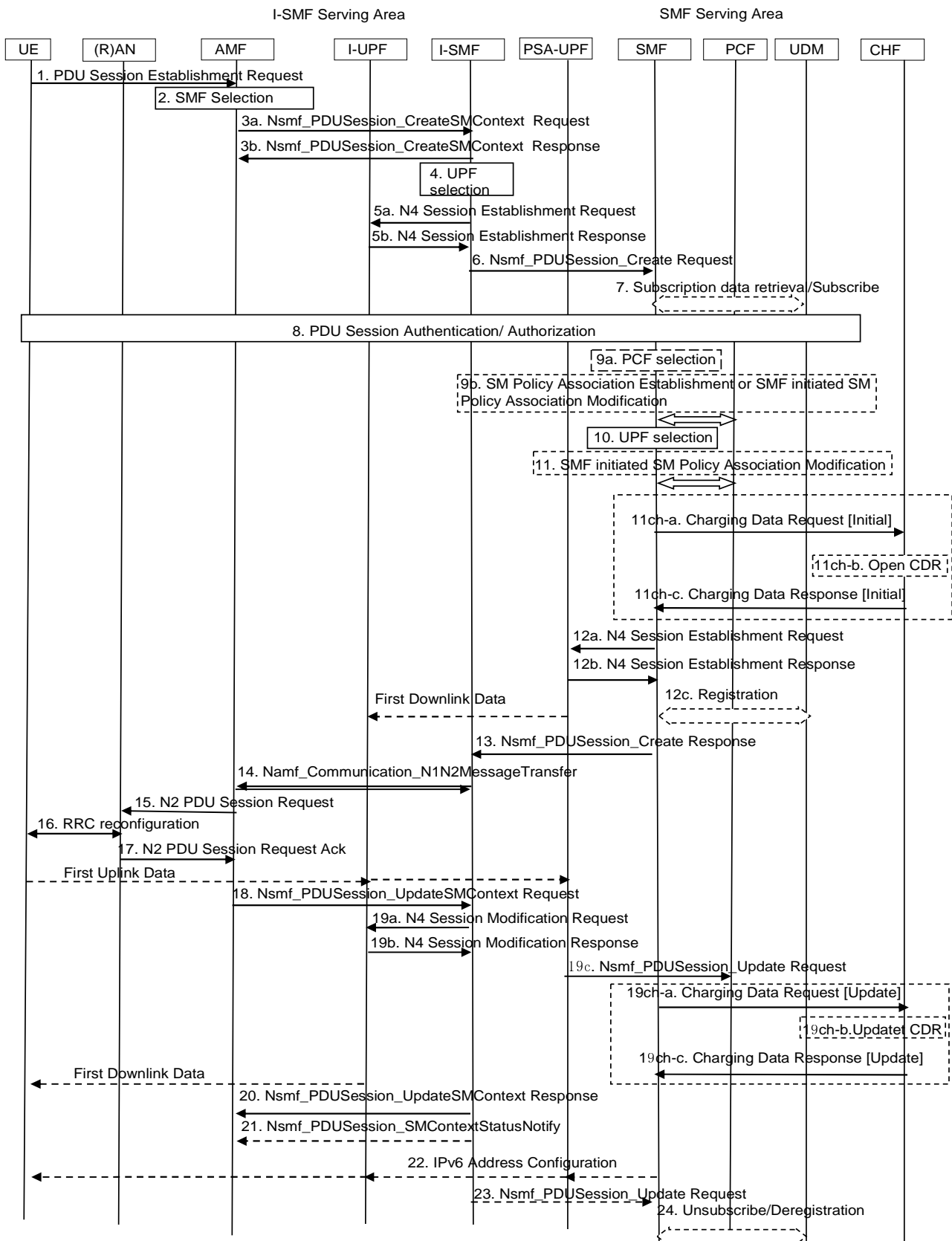
Figure 5.2.2.14.2.1: UE-requested PDU Session Establishment with I-SMF insertion

2. The AMF selects SMF and I-SMF upon SMF serving area cannot cover UE location.

5a. I-SMF selects one or more UPFs.

11. The SMF may perform a Session Management Policy Modification procedure to report some event to the PCF that has previously subscribed.

11ch-a. The SMF creates a Charging Id for the PDU session, and sends Charging Data Request [initial] including I-SMF information to CHF for authorization for the subscriber to start the PDU session which is triggered by start of PDU session charging event.

11ch-b. The CHF opens CDR for this PDU session.

11ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

14. AMF to SMF: SM Request (N2 SM information).

[19a-b]. N4 session Modification.

19c, I-SMF notify SMF on N4 information with Traffic usage reporting.

19ch-a. This step may occur in case "start of service data flow" needs quota from CHF, for the SMF to request quota for both own and I-SMF usage.

19ch-b. The CHF updates CDR for this PDU session.

19ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

NOTE 1: The steps from 19ch-a to 19ch-c for quota request from CHF are not applicable for offline only charging.

20. SM Request with PDU session Update Response to AMF.

21. SMF sends SM Context Status Notify to AMF.

22. In case of PDU Type IPv6, IPv6 Address Configuration.

NOTE 2: I-SMF controlling both I-UPF and PSA2 UPF upon local traffic offload scenarios, can enforce usage report and/or quota management for PSA2 UPF.

5.2.2.14.3 PDU Session modification procedure with I-SMF involved

The following figure 5.2.2.14.3-1 describes a PDU Session modification charging message flow, for the case where the service area of the selected SMF does not include the location where the UE camps, with simplified I-SMF with UE and Serving Network message flows , based on TS 23.502 [201] figure 4.3.3.3-1, where the V-SMF and V-UPF are replaced by I-SMF and I-UPF, and H-SMF and H-UPF are replaced by SMF and UPF (PSA) respectively:
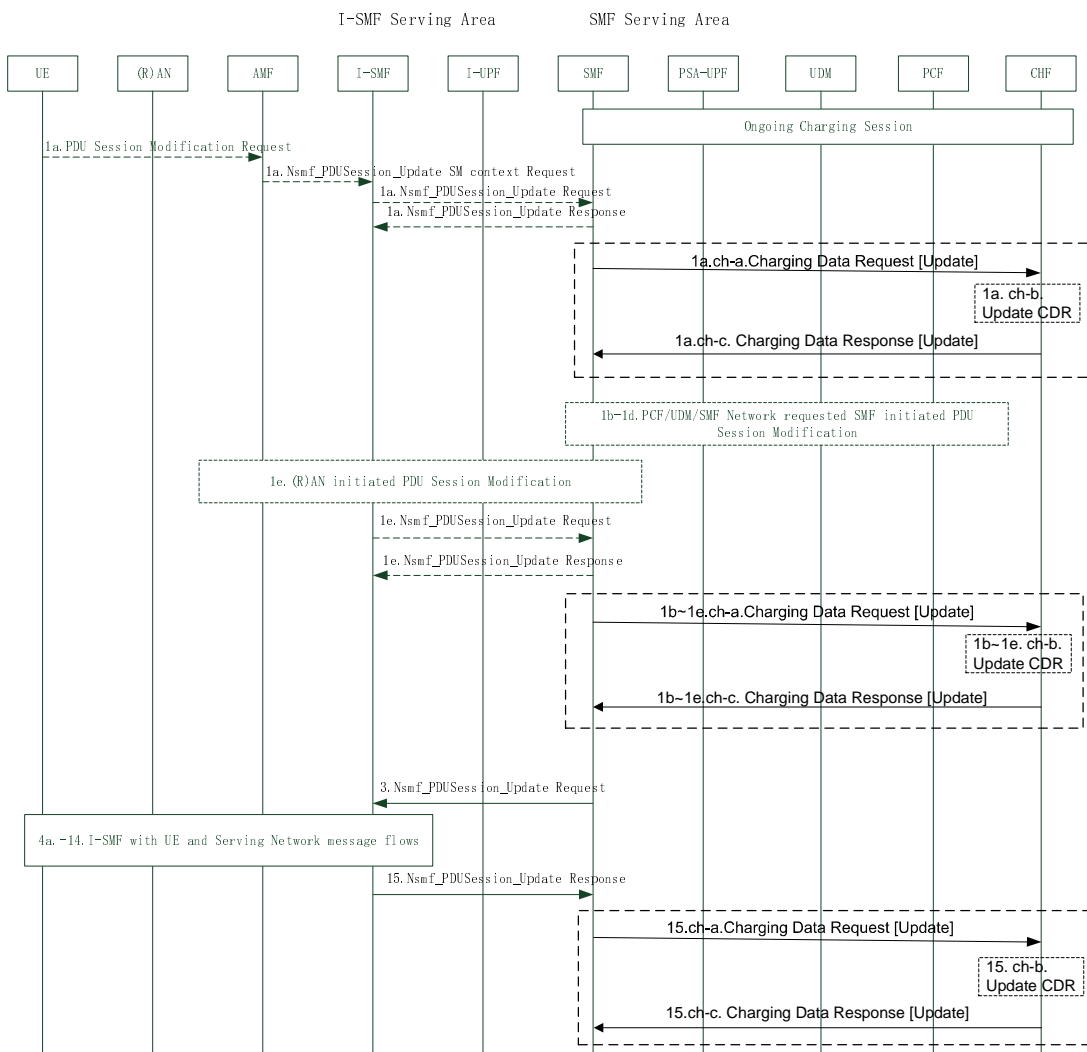
Figure 5.2.2.14.3-1: UE or network requested PDU Session Modification charging with I-SMF involved

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session.

1a. UE or serving network AMF requested PDU Session Modification Request to I-SMF, I-SMF invokes a Nsmf_PDUSession_Update Request message to SMF, including User Location Information, QoS information and I-SMF information. SMF accept with Nsmf_PDUSession_Update_Response message to I-SMF.

1a.ch-a. All counts are closed in SMF and a Charging Data Request [Update] message with PDU Session related triggers including I-SMF information is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

1a.ch-b. The CHF updates CDR for this PDU session.

1a.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

1b~1d. With PCF initiated SM Policy Association Modification or UDM updated the subscription data or SMF decided to modify PDU Session triggers, SMF starts SMF requested PDU Session Modification procedures.

1e. (R)AN initiated PDU Session Modification Request to I-SMF, I-SMF invokes a Nsmf_PDUSession_Update Request message to SMF, including User Location Information, QoS information with indication of QoS flow released and I-SMF information. SMF accept with Nsmf_PDUSession_Update_Response message to I-SMF.

1b~1e.ch-a. All counts are closed in SMF and a Charging Data Request [Update] message with PDU Session related triggers including I-SMF information is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

1b~1e.ch-b. The CHF updates CDR for this PDU session.

1b~1e.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

3. With SMF initiated QoS flows modification procedure, SMF invokes a Nsmf_PDUSession_Update Request message to I-SMF.

4~14. I-SMF interacting with UE and Serving Network message flows, including the QoS rule(s) and QoS Flow level QoS parameters operations.

15. I-SMF invokes a Nsmf_PDUSession_Update Response message to SMF, including User Location Information, QoS flow information and I-SMF information.

15.ch-a. All counts are closed in SMF and a Charging Data Request [Update] message with PDU Session related triggers including I-SMF information is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

15.ch-b. The CHF updates CDR for this PDU session.

15.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

5.2.2.14.4 PDU Session release procedure with I-SMF involved

The following figure 5.2.2.14.4-1 describes a PDU session release charging message flow, for the case where the service area of the selected SMF does not include the location where the UE camps, with simplified I-SMF with UE and Serving Network message flows , based on TS 23.502 [201] figure 4.3.4.3-1, where the V-SMF and V-UPF are replaced by I-SMF and I-UPF, and H-SMF and H-UPF are replaced by SMF and UPF (PSA) respectively.
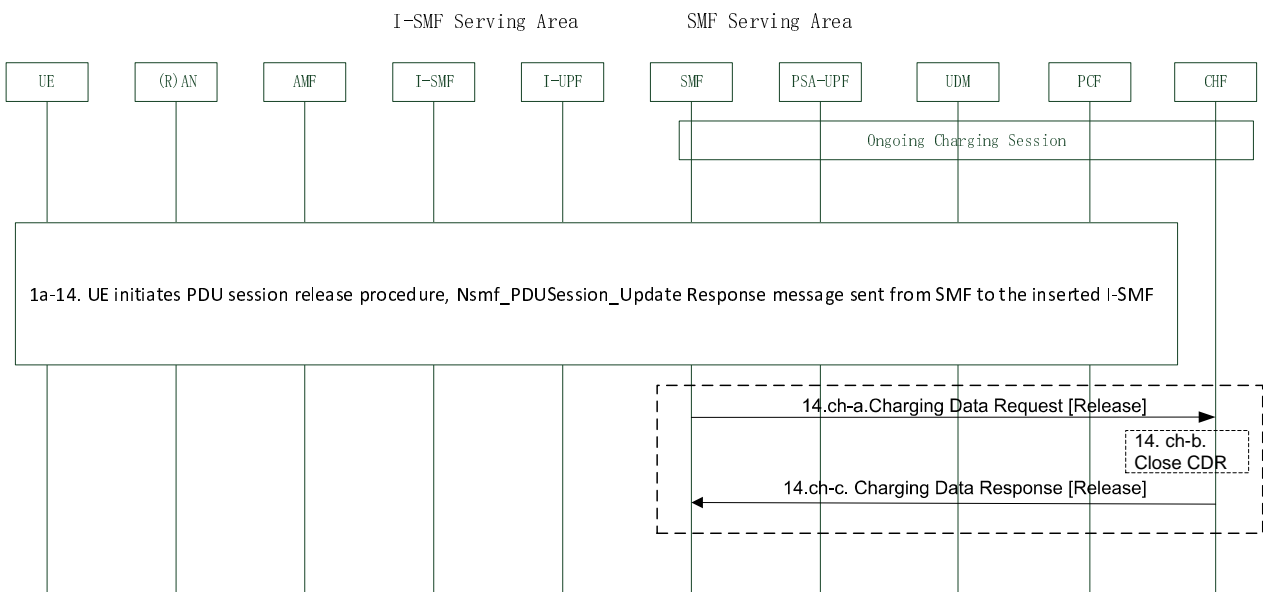
Figure 5.2.2.14.4-1: UE or network requested PDU Session release charging with I-SMF involved

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session.

1a-14. UE initiates PDU session release procedure, finally with Nsmf_PDUSession_Update Response message sent from SMF to the inserted I-SMF.

14.ch-a. All counts are closed in SMF and a Charging Data Request [Release] message including I-SMF information is sent to CHF, with usage reporting.

14.ch-b. The CHF close CDR for this PDU session.

14.ch-c. The CHF acknowledges by sending Charging Data Response [Release] message to the SMF.

5.2.2.14.5 PDU Session procedures with I-SMF insertion/change/removal

PDU Session procedures with I-SMF insertion/change/removal, including below three figures described procedures covering Service Request, N2 based handover and Xn based handover.

The following figure 5.2.2.14.5-1 describes PDU session charging message flows, for the Service Request cases where

- the UE moves from SMF service area to new I-SMF service area, a new I-SMF is inserted (i.e. I-SMF insertion); or

- the UE moves from old I-SMF service area to new I-SMF service area, the I-SMF is changed (i.e. I-SMF change); or

- the UE moves from I-SMF service area back to SMF service area, the I-SMF is removed (i.e. I-SMF removal).

with simplified UE with 5GS message flows, based on TS 23.502 [201] figure 4.23.4.3-1, for I-SMF insertion, change, removal respectively, and specifies the corresponding charging message flow between SMF and CHF.
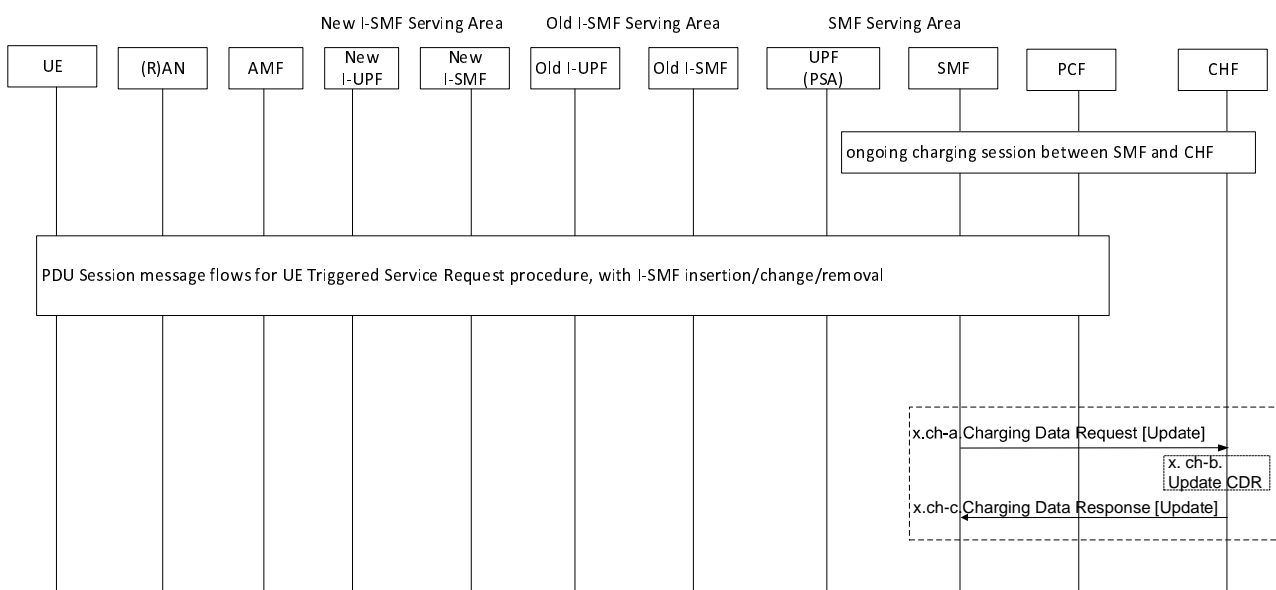
Figure 5.2.2.14.5-1: PDU Session charging message flows for UE Triggered Service Request procedure with I-SMF insertion/change/removal

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session.

PDU Session message flows for UE Triggered Service Request procedure, with I-SMF insertion/change/removal triggers charging message flows as below:

- I-SMF insertion message flows, upon UE moves from SMF service area to I-SMF service area, finally with Nsmf_PDUSession_Create Response message sent from SMF to the inserted I-SMF (Detail message flows refer to TS 23.502,4.23.4.3-1 step 3 to 8c), or finally with Nsmf_PDUSession_Update Response message sent from SMF to the inserted I-SMF (Detail message flows refer to TS 23.502 [201],4.23.4.3-1 step 18 to 20c).

- I-SMF change message flows, upon UE moves from old SMF service area to new I-SMF service area, finally with Nsmf_PDUSession_Update Response message sent from SMF to the inserted new I-SMF (Detail message flows refer to TS 23.502 [201],4.23.4.3-1 step 3 to 8c, or step 18 to 20c).

- I-SMF removal message flows, upon UE moves from I-SMF service area back to SMF service area, finally SMF send Nsmf_PDUSession_CreateSMContext Response message to AMF (Detail message flows refer to TS 23.502,4.23.4.3-1 step 10 to 16), or SMF send Nsmf_PDUSession_UpdateSMContext Response message to AMF (Detail message flows refer to TS 23.502 [201], 4.23.4.3-1 step 22 to 25)

x.ch-a. All counts are closed in SMF, and a Charging Data Request [Update] message including I-SMF information and "insertion/change/removal of I-SMF" trigger is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

x.ch-b. The CHF updates CDR for this PDU session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

NOTE 1: x in figure 5.2.2.14.5-1, refer to the last step number in the detail message flows. For I-SMF insertion or I-SMF change, x refers to 8c or 20c. For I-SMF removal, x refers to 16 or 25.

The following figure 5.2.2.14.5-2 describes PDU session charging message flows, for N2 based handover, with I-SMF insertion, change, removal.
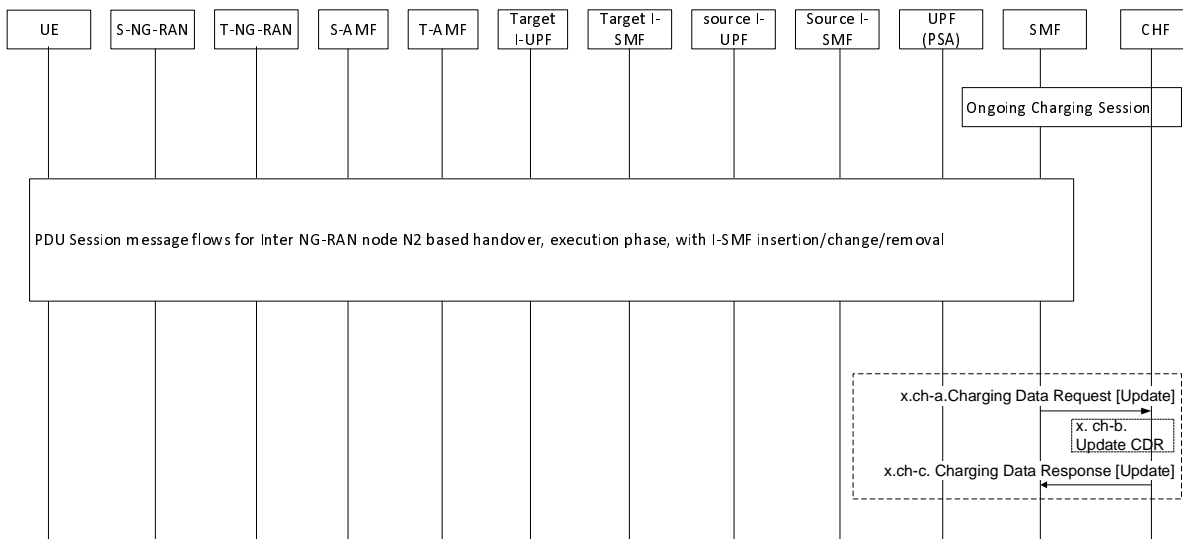
Figure 5.2.2.14.5-2: PDU Session charging message flows for Inter NG-RAN node N2 based handover, execution phase, with I-SMF insertion/change/removal

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session between SMF and CHF.

PDU Session message flows for Inter NG-RAN node N2 based handover procedure, with I-SMF insertion/change/removal triggers charging message flows as below:

- I-SMF insertion message flows, for N2 based handover, refer to TS 23.502 [201], 4.23.7.3.3-1 step 2 to 8.

- I-SMF Change message flows, for N2 based handover, refer to TS 23.502 [201], 4.23.7.3.3-1 step 2 to 8,

- I-SMF Removal message flows, for N2 based handover, refer to TS 23.502 [201], 4.23.7.3.3-1 step 10 to 14.

x.ch-a. All counts are closed in SMF with the I-SMF, and a Charging Data Request [Update] message including I-SMF information and "insertion/change/removal of I-SMF" trigger is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

x.ch-b. The CHF updates CDR for this PDU session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

NOTE 2: x in figure 5.2.2.14.5-2, refer to the last step number in the detail message flows. For I-SMF insertion or I-SMF change, x refers to 8. For I-SMF removal, x refers to 14.

The following figure 5.2.2.14.5-3 describes PDU session charging message flows, for Xn based handover, with I-SMF insertion, change, removal.
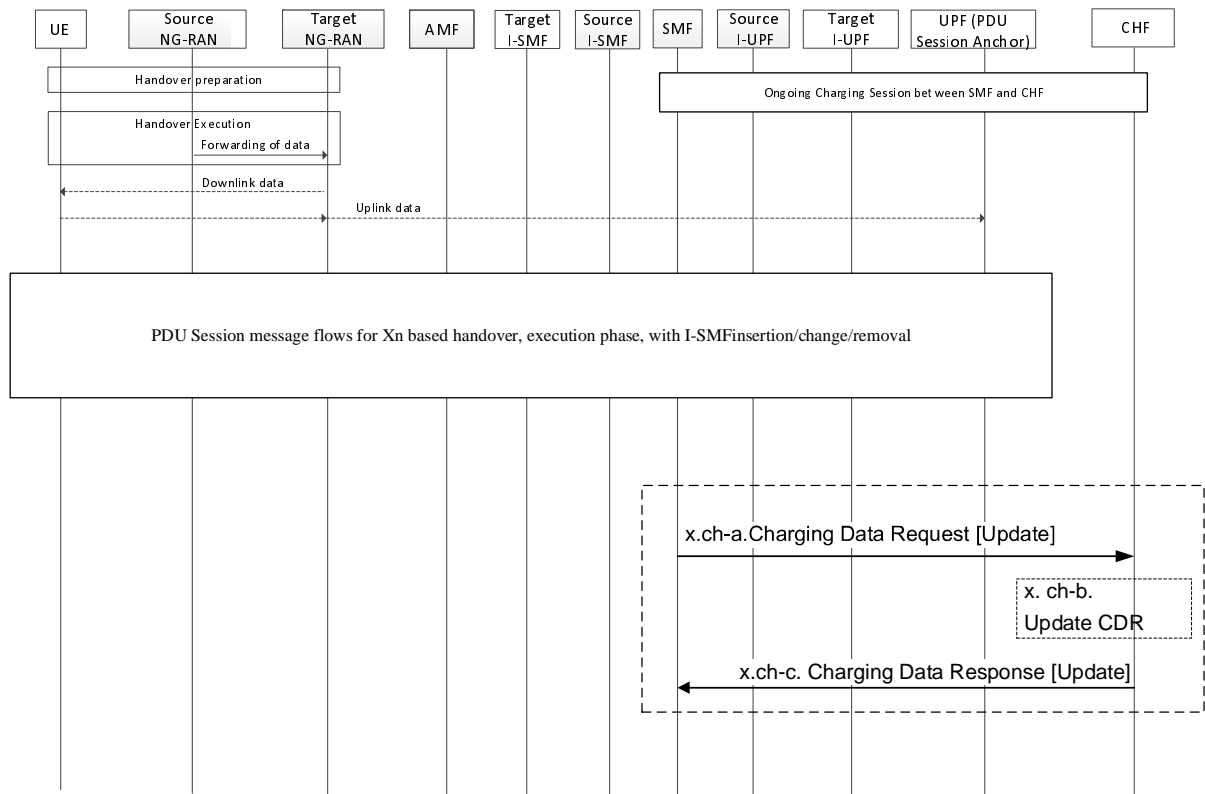
Figure 5.2.2.14.5-3: PDU Session charging message flows for Xn based handover, execution phase, with I-SMFinsertion/change/removal

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session between SMF and CHF.

PDU Session message flows for X2 based handover procedure, with I-SMF insertion/change/removal triggers charging message flows as below:

- I-SMF insertion message flows, for Xn based handover, refer to TS 23.502 [201], 4.23.11.2-1 step 1 to 9.

- I-SMF Change message flows, for Xn based handover, refer to TS 23.502 [201], 4.23.11.3-1 step 1 to 9,

- I-SMF Removal message flows, for Xn based handover, refer to TS 23.502 [201], 4.23.11.4-1 step 1 to 8.

x.ch-a. All counts are closed in SMF with the I-SMF, and a Charging Data Request [Update] message including I-SMF information and "insertion/change/removal of I-SMF" trigger is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the SMF.

x.ch-b. The CHF updates CDR for this PDU session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the SMF.

NOTE 3:   x in figure 5.2.2.13.5-3, refer to the last step number in the detail message flows. For I-SMF insertion or I-SMF change, x refers to 9. For I-SMF removal, x refers to 8.

5.2.2.14.6   5GS to EPS handover using N26 interface with I-SMF removal

When 5GS to EPS handover using N26 interface in idle mode, procedure in TS 23.502 [201] clause 4.23.12.2 is applicable.

When 5GS to EPS handover using N26 interface in active mode, procedure in TS 23.502 [201] clause 4.23.12.6 is applicable.

Upon UE moves from I-SMF service area to EPS service area, with both RAT Type change and I-SMF removal triggered, PGW-C+SMF and CHF will conduct below charging procedures:

x.ch-a. All counts are closed in PGW-C+SMF with a Charging Data Request [Update] message including I-SMF information and both "RAT Type change" and "removal of I-SMF" triggers are sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

x.ch-b. The CHF updates CDR for this PDU session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the PGW-C+SMF.

NOTE 1: x refers to the last message step number with I-SMF removal in the detail message flows in TS 23.502 [201] clause 4.23.12.2 or clause 4.23.12.6.

5.2.2.14.7 EPS to 5GS handover using N26 interface with I-SMF insertion

When EPS to 5GS handover using N26 interface in idle mode, procedure in TS 23.502 [201] clause 4.23.12.3 is applicable.

When EPS to 5GS handover using N26 interface in active mode, procedure in TS 23.502 [201] clause 4.23.12.7 is applicable.

Upon UE moves from EPS service area to I-SMF service area, with both RAT Type change and I-SMF insertion triggered, PGW-C+SMF and CHF conduct below charging procedures:

x.ch-a. All counts are closed in PGW-C+SMF with a Charging Data Request [Update] message including I-SMF information and both "RAT Type change" and "insertion of I-SMF" triggers are sent to CHF, if required by immediate report category trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

x.ch-b. The CHF updates CDR for this PDU session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] message to the PGW-C+SMF.

NOTE 1: x refers to the last message step number with I-SMF insertion in the detail message flows in TS 23.502 [201] clause 4.23.12.3 or clause 4.23.12.7.

5.2.2.14.8 Addition/removal/change of PSA and UL CL or BP controlled by I-SMF

This clause is based on TS 23.502 clause 4.23.9.1, 4.23.9.2 and 4.23.9.3 procedures, describes simplified procedures of addition/removal/change of PSA and UL CL or BP controlled by I-SMF, adding with charging message flow:
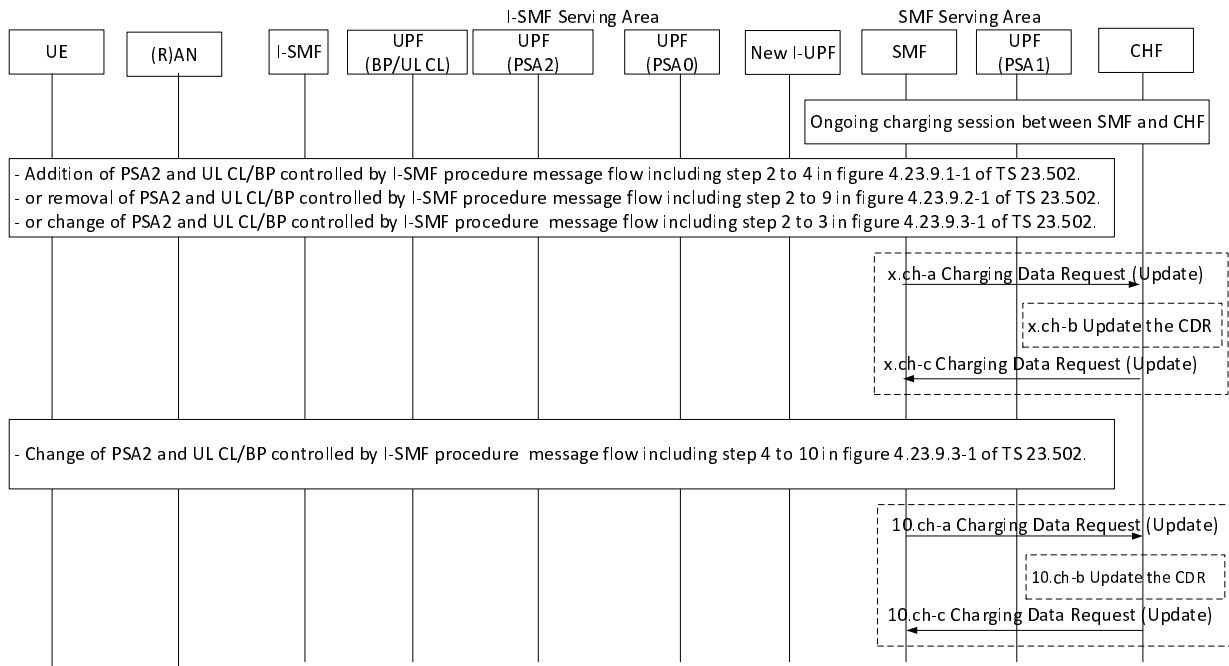
Figure 5.2.2.14.8-1: Addition/removal/change of PSA and UL CL or BP controlled by I-SMF

PDU Session served by both I-SMF and SMF has been established, with the ongoing Charging session.

PDU Session message flows with addition/removal/change of I-SMF controlled addition/removal/change of PSA and UL CL/BP with charging message flows as below:

- Addition of PDU Session Anchor (PSA2) for UL CL/BP controlled by I-SMF message flows, refer step 2 to step 4 described in figure 4.23.9.1-1 of TS 23.502[201].

- Removal of PDU Session Anchor (PSA2) for UL CL/BP controlled by I-SMF message flows, refer step 2 to step 9 described in figure 4.23.9.2-1 of TS 23.502[201].

- Change of PDU Session Anchor (PSA0 to PSA2) for UL CL/BP controlled by I-SMF message flows, refer step 2 to step 3 and step 4 to step 10 described in figure 4.23.9.3-1 of TS 23.502[201].

x.ch-a. All counts are closed in SMF for I-SMF controlled local PSA traffic, and a Charging Data Request [Update] message including I-SMF information and "addition/removal of UPF" trigger is sent to CHF, if required by immediate report category trigger. New counts and time stamps for all addition of PSA active service data flows are started in the SMF.

x.ch-b The CHF updates the CDR for this PDU Session.

x.ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

NOTE 1: x in figure 5.2.2.14.8-1, refer to the last step number in the detail message flows. For addition of PDU Session Anchor (PSA2), x refers to 4. For removal of PDU Session Anchor (PSA2), x refers to 9. For addition of PDU Session Anchor (PSA2) during change of PSA2, x refers to 3.

Removal of PDU Session Anchor (PSA0) for UL CL/BP controlled by I-SMF message flows, refer step 4 to step 10 described in figure 4.23.9.3-1 of TS 23.502[201].

10.ch-a. All counts are closed in SMF for I-SMF controlled the PSA0 traffic, and a Charging Data Request [Update] message including I-SMF information and "removal of UPF" trigger is sent to CHF, if required by immediate report category trigger.

10.ch-b The CHF updates the CDR for this PDU Session.

10.ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

NOTE 2: steps 10.ch-a to 10.ch-c are only applied in Change of PDU Session Anchor (PSA0 to PSA2) procedure.

5.2.2.14.9 Roaming Home routed PDU session - inter-PLMN V-SMF change

The following figure 5.2.2.14.9.1 describes the Home Routed PDU Session case in which the UE moves out of V-SMF service area in the serving PLMN to a new PLMN V-SMF service area, based on figure 4.23.4.3-1 of TS 23.502 [201], with I-SMF replaced by V-SMF in I-SMF change scenario:
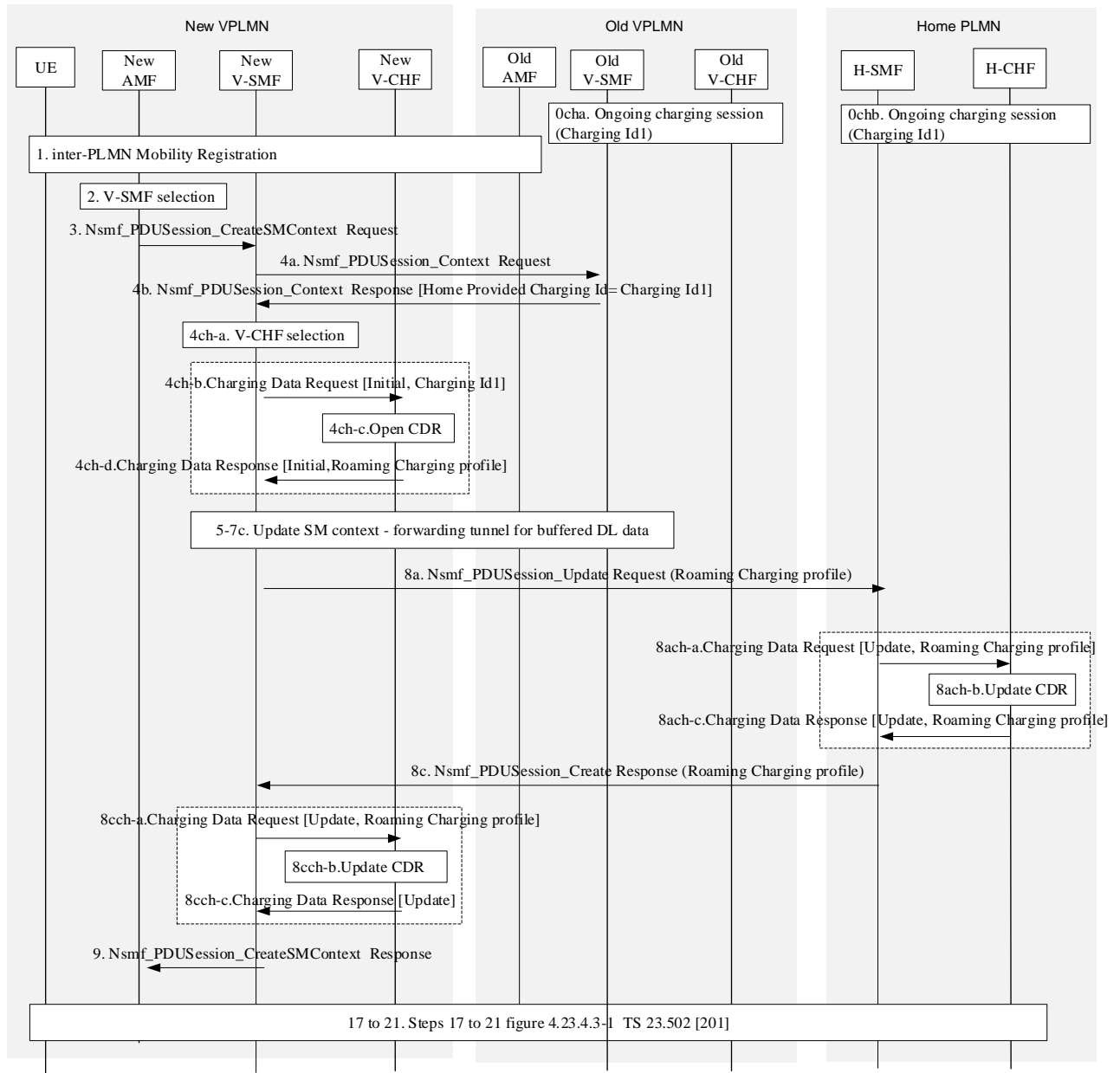
Figure 5.2.2.14.9.1: Roaming Home routed PDU session inter-PLMN V-SMF change

0cha: Ongoing charging session in old VPLMN for UE served by old V-SMF, using Charging Id1.

0chb: Ongoing charging session for HPLMN for UE served by old V-SMF, using Charging Id1.

1-2. UE moves into a different PLMN, and the new AMF determines the new V-SMF based on service area.

3- 4b. SM Context retrieval by new V-SMF from the old V-SMF. The Home Provided Charging Id containing Charging Id1 value is conveyed to the new V-SMF.

4ch-a. The UE is identified as a roamer, the CHF is selected accordingly.

4ch-b. A Charging Data Request [Initial] is sent to V-CHF, indicating "in-bound roamer", with charging Id = Charging Id1 contained in the Home Provided Charging Id received on step 4b.

4ch-c. The V-CHF opens a CDR (indicating "in-bound roamer").

4ch-d. The V-CHF acknowledges by sending Charging Data Response [Initial] to the V-SMF and optionally supplies a "Roaming Charging Profile" to the V-SMF which overrides the default one.

5-7c.   Refer steps 5 to 7c in Figure 4.23.4.3-1 of TS 23.502 [201].

8a. Nsmf_PDUSession_Update Request from new V-SMF towards the H-SMF with the "Roaming Charging Profile".

8ach-a. A Charging Data Request [Update] is sent to H-CHF in HPLMN, indicating the V-SMF change and "Roaming Charging Profile" received from the VPLMN.

8ach-b. The H-CHF in HPLMN updates the CDR.

8ach-c. The H-CHF in HPLMN acknowledges by sending Charging Data Response [Update] to the H-SMF and supplies the HPLMN selected "Roaming Charging Profile" for this VPLMN.

8c. Nsmf_PDUSession_Create Response from H-SMF to new V-SMF with the "Roaming Charging Profile".

8cch-a. A Charging Data Request [Update] is sent to V-CHF with charging information received from H-SMF, which includes the HPLMN selected "Roaming Charging Profile".

8cch-b. The V-CHF updates the CDR.

8cch-c. The V-CHF acknowledges by sending Charging Data Response [Update] to the V-SMF.

9, 17-21. Refer steps 9 and 17 to 21 in Figure 4.23.4.3-1 of TS 23.502 [201].

5.2.2.14.10   Roaming Home routed PDU session - intra-PLMN V-SMF change

The following figure 5.2.2.14.10.1 describes the Home Routed PDU Session case in which the UE moves out of V-SMF service area in the serving PLMN to a new V-SMF service area in the serving PLMN, based on figure 4.23.4.3-1 of TS 23.502 [201], with I-SMF replaced by V-SMF in I-SMF change scenario:
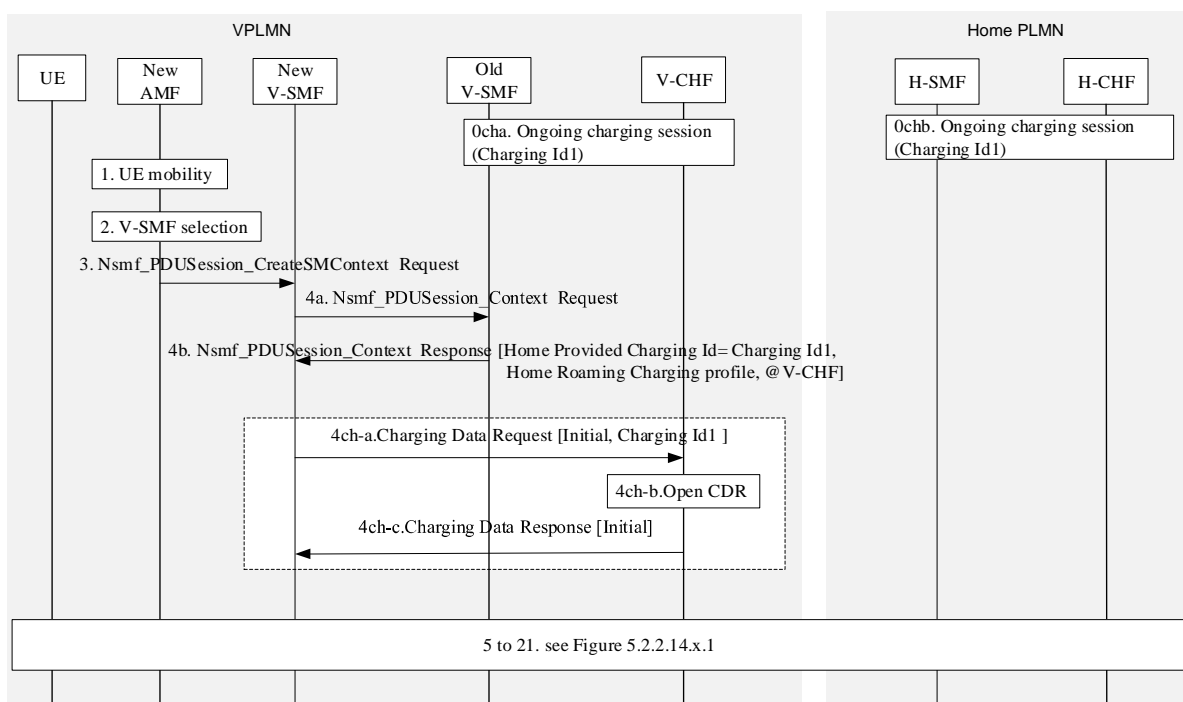
Figure 5.2.2.14.10.1: Roaming Home routed PDU session intra-PLMN V-SMF change

0cha and Ochb: same as in Figure 5.2.2.14.10.1

1-2. UE moves out of the old V-SMF service area, and the new AMF determines the new V-SMF service area in the same VPLMN.

3- 4b. SM Context retrieval by new V-SMF from the old V-SMF. The Home Provided Charging Id containing Charging Id1 value, the "Home Roaming Charging Profile", and the V-CHF address, are conveyed to the new V-SMF.

4ch-a. A Charging Data Request [Initial] is sent to V-CHF, indicating "in-bound roamer", with charging Id containing the Home Provided Charging Id (i.e. Charging Id1) received on step 4b.

NOTE: Since the same V-CHF is used, the Home Roaming Charging Profile to be used is already known by the V-CHF

4ch-b. The V-CHF opens a CDR (indicating "in-bound roamer").

4ch-c. The V-CHF acknowledges by sending Charging Data Response [Initial] to the V-SMF.

5-21. Same steps as in Figure 5.2.2.14.10.1, except the "Roaming Charging Profile" is not renegotiated, i.e.not contained in steps 8a, 8ach-a, 8ach-c, 8c and 8cch-a.

5.2.2.15   PDU session charging from SMF - ATSSS

5.2.2.15.1   General

This clause specifies PDU session charging for a MA PDU session as defined in TS 23.501 [200].

The flows are based on message flows specified in clause 4.22 TS 23.502 [201],

5.2.2.15.2   UE requested MA PDU session establishment

The following figure 5.2.2.15.2.1 describes charging procedure for MA PDU Session establishment requested by UE, based on figure 5.2.2.2.2.1 description with the following differences identified in clause 4.22.2.1 TS 23.502 [202]:
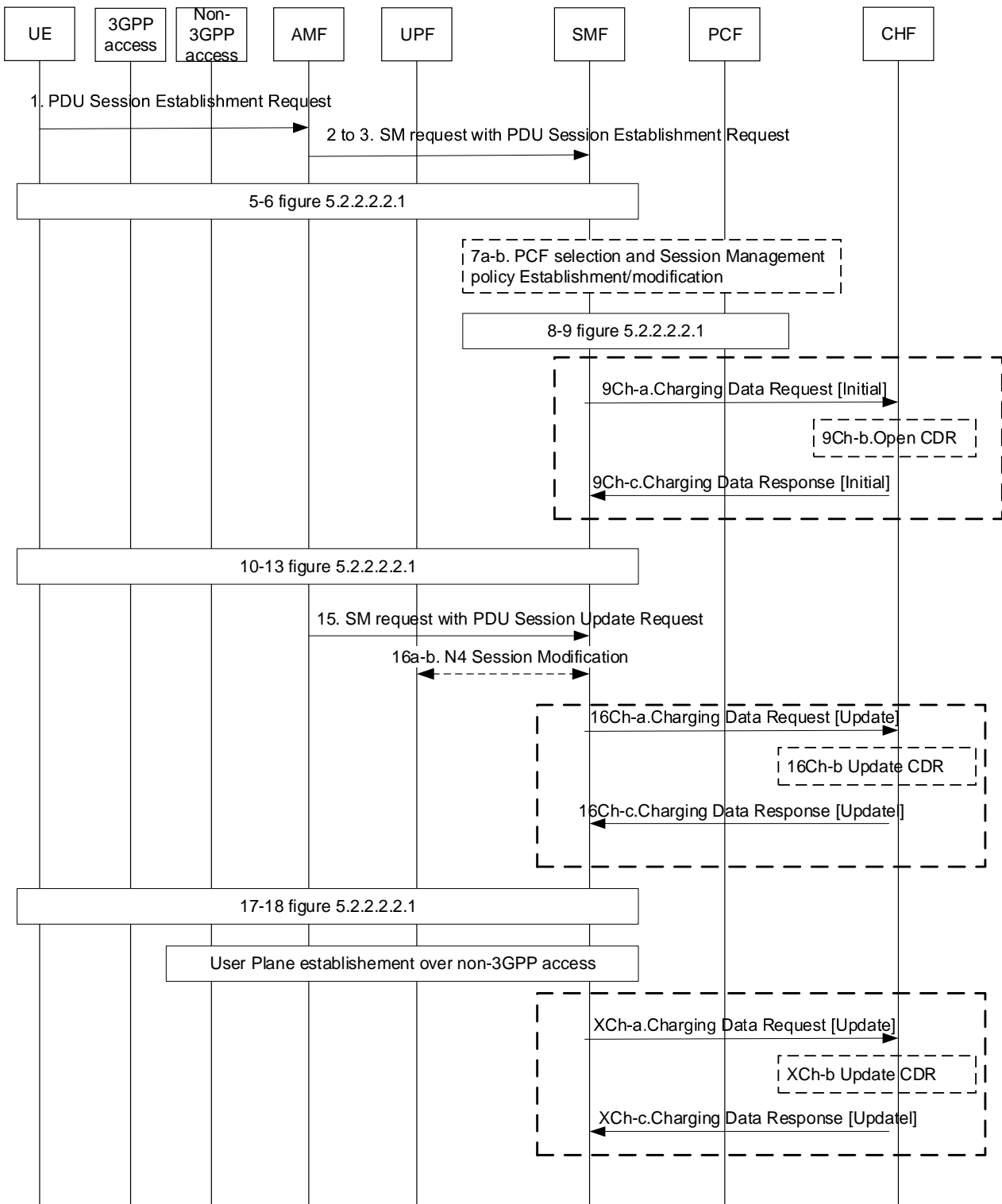
Figure 5.2.2.15.2.1: UE Requested MA PDU session establishment

- The UE is registered in both 3GPP access and non-3GPP access, and UE PDU Session Establishment Request message is sent over the 3GPP access.

1. PDU Session Establishment Request is indicated with "MA PDU Request" and ATSSS Capability (e.g. an "MPTCP Capability" and/or an "ATSSS-LL Capability").

2-3.   The AMF informs the SMF that the request is for a MA PDU Session and indicates the UE is registered over both accesses.

7a-b. PCC Rules supplied by PCF contain ATSSS policy control information, optionally with a dedicated non-3GPP access rating group. From these PCC Rules, the SMF derives ATSSS rules for uplink and N4 rules for downlink for controlling the traffic steering, switching and splitting.

9ch-a. The SMF sends Charging Data Request [initial] indicating "MA PDU session requested by UE" to CHF for authorization for the subscriber to start the MA PDU session.

9ch-b. The CHF opens CDR for this MA PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

10-13. Procedure based on ATSSS policy and SMF derived both N4 Rules and ATSSS rules to UE.

16ch-a. This step may occur in case "start of service data flow" over 3GPP needs quota from CHF for appropriate rating group, the SMF sends Charging Data Request [Update] for requesting quota.

16ch-b. The CHF updates CDR for this MA PDU session.

16ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

After step 18 in figure 5.2.2.2.2.1, if the SMF was informed in step 2 that the UE is registered over both accesses, the SMF initiates the establishment of user-plane resources over non-3GPP access via AMF. After the user plane is established with the non-3GPP access:

Xch-a. The SMF sends Charging Data Request [Update]. This step may occur in case following chargeable events need quota from CHF for appropriate rating group, or if required by "immediate reporting" category:

- "start of SDF additional access" over non-3GPP.

- "start of service data flow" over non-3GPP or 3GPP.

Xch-b. The CHF updates CDR for this MA PDU session.

Xch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

In the scenario where the PDU Session Establishment Request message for the MA PDU session is sent over the non-3GPP access, and the user plane over the non-3GPP access is established before the user plane over 3GPP:

16ch-a. This step may occur in case "start of service data flow" over non-3GPP needs quota from CHF for appropriate rating group, or if required by "immediate reporting" category

Xch-a. This step may occur in case following chargeable events need quota from CHF for appropriate rating group, or if required by "immediate reporting" category:

- "start of SDF additional access" over 3GPP.

- "start of service data flow" over non-3GPP or 3GPP.

5.2.2.15.3   UE requested PDU session establishment with Network Modification to MA PDU Session

The following flow describes the charging procedure for a single access PDU session establishment by ATSSS-capable UE and the 5GC network decides to convert to a Multi-Access PDU (MA PDU) Session, based on figure 5.2.2.2.2.1 description with the following differences identified in clause 4.22.3 TS 23.502 [202]:

- The UE is registered in both 3GPP access and non-3GPP access and sends a PDU Session Establishment Request message over the 3GPP access.

1. PDU Session Establishment Request may include "MA PDU Network-Upgrade Allowed" indication and its ATSSS Capability.7. The single-access PDU Session requested by the UE is converted into a MA PDU Session by SMF based on "MA PDU Network-Upgrade Allowed" indication, and PCC Rules are supplied by PCF containing ATSSS policy control information optionally with a dedicated non-3GPP access rating group.

9ch-a. The SMF sends Charging Data Request [initial] indicating "MA PDU session requested by Network modification" to CHF.

9ch-b. The CHF opens CDR for this MA PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

Steps after step 10 in clause 5.2.2.15.2 apply.

5.2.2.15.4 UE Requested PDU Session Establishment with Network Modification to MA PDU Session - roaming in Home routed scenario

The charging procedure for single access PDU session establishment requested by ATSSS-capable UE and converted to a Multi-Access PDU (MA PDU) Session by the 5GC network in roaming Home routed scenario, is based on figures in clause 5.2.2.15.X. and description in clause 4.22.3 TS 23.502 [202].

5.2.2.15.4.1 UE registered to the same VPLMN over 3GPP access and non-3GPP access

The charging procedure for UE registered to the same VPLMN over 3GPP access and non-3GPP access is based on figure 5.2.2.15.X.1.1 with differences identified in clause 4.22.3 TS 23.502 [202]:

- The UE is registered to the same VPLMN over 3GPP access and non-3GPP access, and UE PDU Session Establishment Request message is sent over the 3GPP access.

1-3a. UE PDU Session Establishment Request may include "MA PDU Network-Upgrade Allowed" indication and its ATSSS Capability. This indication may be conveyed by AMF to V-SMF.

6. The V-SMF provides the "MA PDU Network-Upgrade Allowed" indication to H-SMF, if received from AMF together with an indication whether the UE is registered over both accesses.

9a-b. The single-access PDU Session received by H-SMF with "MA PDU Network-Upgrade Allowed" indication is converted into a MA PDU Session. PCC Rules are supplied by PCF containing ATSSS policy control information optionally with a non-3GPP access dedicated rating group.

11ch-a to c. Same steps as in figure 5.2.2.12.2.1 with Charging Data Request [Initial] indicating "MA PDU session requested by the Network".

5.2.2.15.5 UE requested MA PDU session establishment - roaming in Home routed scenario

5.2.2.15.5.1 General

The charging procedure for MA PDU Session establishment requested by UE in roaming Home routed scenario is based on figure 5.2.2.12.2.1 and description in clause 4.22.2.2 TS 23.502 [202].

5.2.2.15.5.2 UE registered to the same VPLMN over 3GPP access and non-3GPP access

The following figure 5.2.2.15.5.2.1 describes charging procedure for MA PDU session charging establishment requested by UE in roaming Home routed scenario for UE registered to the same VPLMN over 3GPP access and non-3GPP access:
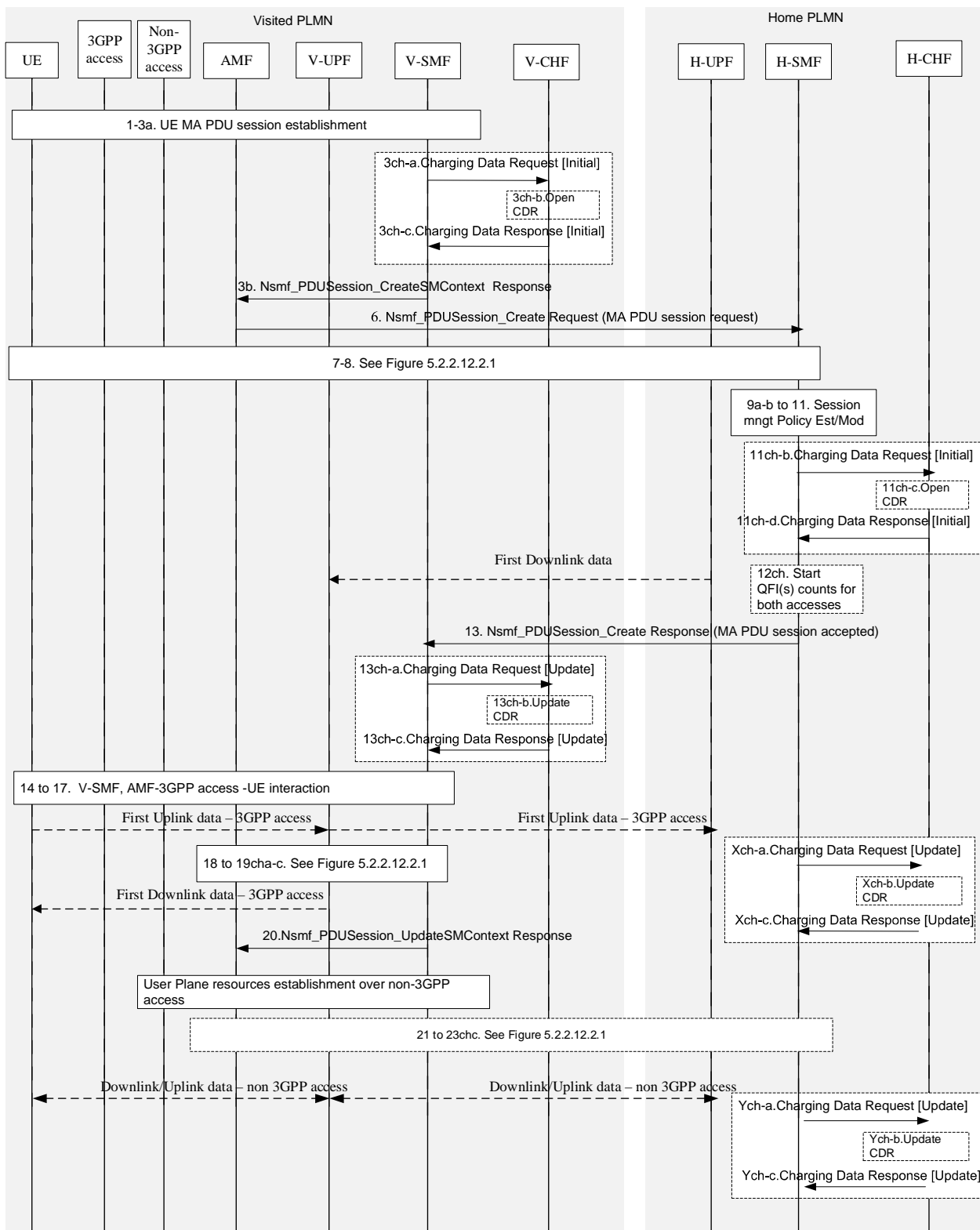
Figure 5.2.2.15.5.2.1: UE requested MA PDU session - Roaming Home Routed - same VPLMN

- The UE is registered to the same VPLMN over 3GPP access and non-3GPP access, and UE PDU Session Establishment Request message is sent over the 3GPP access.

1-3a. UE initiates a new PDU session indicated with "MA PDU Request" and ATSSS Capability. Selection by the AMF of V-SMF which supports MA PDU sessions. The AMF indicates to V-SMF that the UE is registered over both accesses

3ch-a to 3ch-d. Same steps as in figure 5.2.2.12.2.1.

6. The V-SMF informs the H-SMF that the request is for a MA PDU Session and the UE is registered over both accesses.

9a-b. PCC rules are supplied by H-PCF containing MA PDU session control information based on currently used list of Access Type(s) and RAT Type(s). The H-SMF initiates the establishment of user-plane resources over non-3GPP access and derives the ATSSS rules for the UE and the N4 rules for the H-UPF.

11ch-a to c. Same steps as in figure 5.2.2.12.2.1 with Charging Data Request [Initial] indicating "MA PDU session requested by UE".

12ch. Counts per QFI are started for both 3GPP and non-3GPP accesses.

13. Nsmf_PDUSession_Create Response from H-SMF to V-SMF with "MA PDU session Accepted" indication.

13ch-a to c. Same steps as in figure 5.2.2.12.2.1. Counts per QFI are started for both 3GPP and non-3GPP accesses.

14-19b. Procedure in the VPLMN for 3GPP access and based on H-SMF derived ATSSS rules to UE for the MA PDU session.

Xch-a. The H-SMF sends Charging Data Request [Update]. This step may occur in case "start of service data flow" chargeable event over 3GPP, when required by "immediate reporting" category.

Xch-b. The H-CHF updates CDR for this MA PDU session.

Xch-c. The H-CHF acknowledges by sending Charging Data Response [Update] to the V-SMF.

After the user plane resources are established over non-3GPP access in VPLMN, and traffic goes through between VPLMN and HPLMN over non-3GPP access:

Ych-a. The H-SMF sends Charging Data Request [Update] to H-CHF. This step may occur in case "start of service data flow " chargeable event over non-3GPP, when required by "immediate reporting" category.

Ych-b. The H-CHF updates CDR for this MA PDU session.

Ych-c. The H-CHF acknowledges by sending Charging Data Response [Update] to the V-SMF.

5.2.2.15.6 EPS interworking

5.2.2.15.6.1 5GS to EPS handover using N26 interface

The charging procedure for MA PDU Session 5GS to EPS handover using N26 interface scenario is based on figure 5.2.2.11.2.1 description with the differences identified in clause 4.22.6.2.1 TS 23.502 [202]:

0ch. A charging session between the PGW-C+SMF and CHF exists for the MA PDU Session with multiple QoS Flows over 3GPP access and non-3GPP access.

16ch-a. MA PDU session moved to EPS: All counts affected by the MA PDU session move to EPS are closed and a Charging Data Request [Update] is sent to CHF, if required by "RAT type change" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF.

MA PDU Session Release procedure over non-3GPP access triggered by PGW-C+SMF: All counts affected by the release of non-3GPP access are closed by "Termination of service data flow" trigger.

5.2.2.15.6.2 5GS to EPS mobility without N26 interface

The charging procedure for MA PDU Session 5GS to EPS mobility without using N26 interface scenario is based on figure 5.2.2.11.6.1 description with the differences identified in clause 4.22.6.2.5 TS 23.502 [202]:

0. UE is registered in 5GS and MA PDU Session is over both 3GPP and non-3GPP accesses.

10. E-UTRAN Initial attach procedure:

10ch-a. MA PDU Session is moved to EPS: All counts affected by the MA PDU session move to EPS are closed and a Charging Data Request [Update] is sent to CHF, if required by "Handover start" trigger. New counts and time stamps for all active service data flows are started in the PGW-C+SMF

10ch-b. The CHF updates CDR for this PDU session.

10ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+SMF.

The PGW-C + SMF triggers the MA PDU Session Release procedure over non-3GPP access: All counts affected by the release of non-3GPP access are closed by "Termination of service data flow" trigger.

14. The PGW-C+SMF initiates release of the 5GS MA PDU Session(s) transferred to EPS.

5.2.2.15.7 Hybrid Access with Multi-Access PDU Session connectivity over NG-RAN and W-5GAN

The following flow describes the charging procedure for MA PDU Session establishment over NG-RAN and W-5GAN requested by 5G-RG, based on figure 5.2.2.15.2.1 description with the following differences identified in clause 4.12.2 TS 23.316 [203]:

- The UE is replaced by 5G-RG.

- Non-3GPP access(es) is specifically referred to wireline access.

When PDU Session Establishment Request message is sent over the 3GPP access (i.e. NG-RAN), or sent over the non-3GPP access (i.e. W-5GAN):

9ch-a. The SMF sends Charging Data Request [initial] to CHF for authorization for the 5G-RG to start the MA PDU session.

9ch-b. The CHF opens CDR for this MA PDU session.

9ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

5.2.2.15.8 Hybrid Access with multi-access connectivity over E-UTRAN/EPC and W-5GAN

The following flow describes the charging procedure for MA PDU Session establishment over E-UTRAN/EPC and W-5GAN requested by 5G-RG using EPC interworking procedures, based on clause 4.12.3 TS 23.316 [203]:
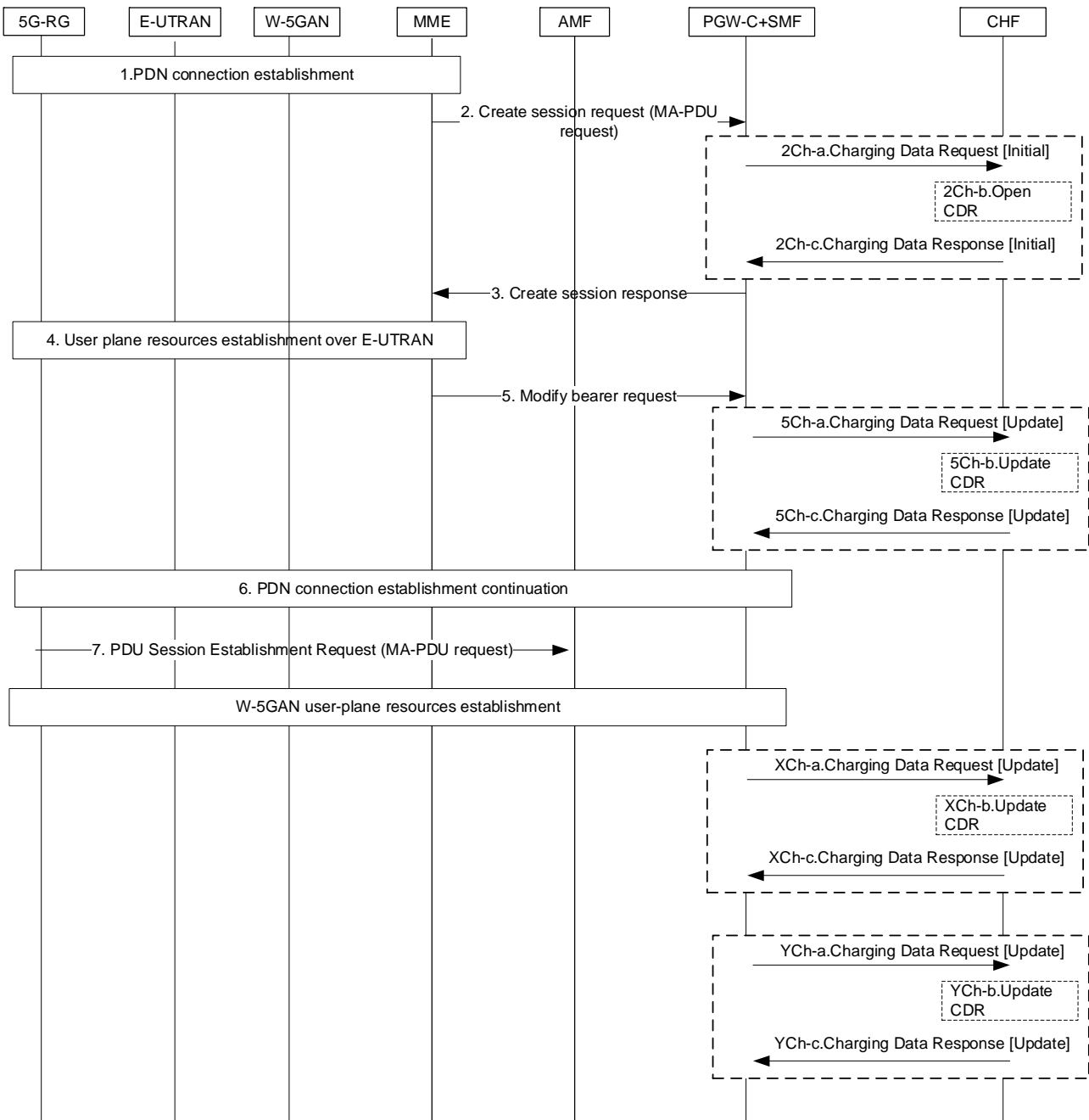
Figure 5.2.2.15.8.1: MA PDU session establishment requested by 5G-RG via EPC

- The 5G-RG is registered in EPC.

1. 5G-RG initiates PDN Connection establishment via E-UTRAN, indicating the PDN Connection is requested to be associated with a MA PDU Session and its "ATSSS-LL Capability".

2. Create session request in EPC to the selected PGW-C+SMF with the indication the PDN Connection is requested to be associated with a MA PDU Session.

2ch-a. The PGW-C+ SMF sends Charging Data Request [initial] indicating "MA PDU session requested" to CHF for authorization for the 5G-RG to use the PDN connection for a MA PDU session.

2ch-b. The CHF opens CDR for this PDN connection.

2ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the PGW-C+ SMF.

3. Create session response indicating the request for using the PDN Connection for MA-PDU Session is accepted.

4-5. User Plane resources establishment for E-UTRAN

5ch-a. This step may occur in case "start of service data flow" over 3GPP needs quota from CHF for appropriate rating group, the PGW-C+ SMF sends Charging Data Request [Update] for requesting quota.

5ch-b. The CHF updates CDR for this PDN connection.

5ch-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+ SMF.

6. PDN connection establishment continuation

7. 5G-RG sends a PDU Session Establishment Request indicating "MA PDU Request" to establish W-5GAN user-plane resources.

When the user plane is established with W-5GAN (X corresponds to step 16a-b of figure 5.2.2.2.2.1 for the W-5GAN):

Xch-a. The PGW-C+ SMF sends Charging Data Request [Update]. This step may occur if required by "addition of access" trigger.

Xch-b. The CHF updates CDR for this MA PDU session.

Xch-c. The CHF acknowledges by sending Charging Data Response [Update] to the SMF.

After the user plane is established:

Ych-a. The PGW-C+ SMF sends Charging Data Request [Update]. This step may occur in case "start of service data flow" chargeable event needs quota from CHF for appropriate rating group, or if required by "immediate reporting" category.

Ych-b. The CHF updates CDR for this MA PDU session.

Ych-c. The CHF acknowledges by sending Charging Data Response [Update] to the PGW-C+ SMF.

In the scenario where the MA PDU Session is requested via 5GC/W-5GAN, the 5G-RG is registered to EPC and user-plane resources are added on 3GPP access over EPC, the following applies:

MA PDU session establishment via 5GC/W-5GAN per figure 5.2.2.15.2.1 until step 18 with PDU Session Establishment Request message for the MA PDU session sent over W-5GAN (i.e. non-3GPP access).

After step 18 of figure 5.2.2.2.2.1, the 5G-RG sends a PDN Connection Establishment Request via E-UTRAN, indicating "handover" and "MA PDU Request".

When the user plane is established with E-UTRAN over EPC:

Xch-a. The PGW-C+ SMF sends Charging Data Request [Update]. This step may occur if required by "addition of access" trigger.

After the user plane is established with E-UTRAN over EPC:

Ych-a. This step may occur in case "start of service data flow" chargeable event needs quota from CHF for appropriate rating group, or if required by "immediate reporting" category.

5.2.2.16 PDU session charging – wireline access

5.2.2.16.1 General

After registration management procedures to 5GC via wireline access network, a PDU session can be established via this wireline access, as specified in TS 23.316 [203] for different scenarios:

- 5G-RG connected via NR-RAN and W-5GAN;

- FN-RG connected via W-5GAN.

5.2.2.16.2   5G-RG Requested PDU Session Establishment via W-5GAN

The following figure 5.2.2.16.2.1 describes charging when 5G-RG requests a PDU session establishment via W-AGF.
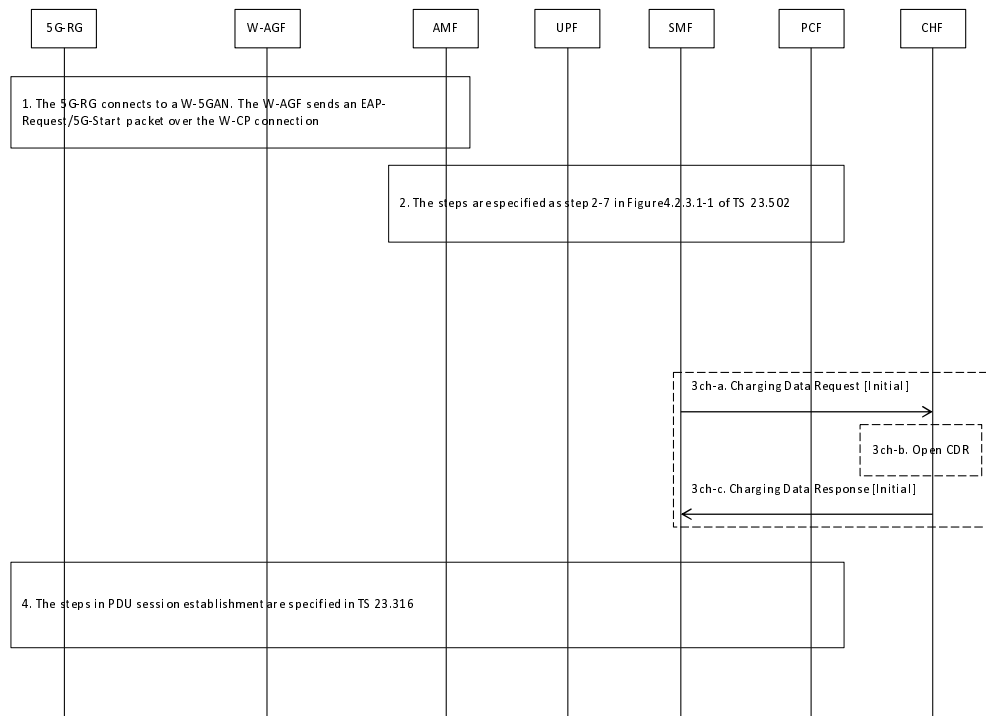
1) The 5G-RG connects to a W-5GAN and the W-AGF sends an EAP-Request/5G-Start packet over the W-CP connection as described in clause 7.3.1.1 in TS 23.316 [203].

2) The steps are specified as step 2-7 in clause 4.3.2.1 of TS 23.502 [202].

3ch-a. The SMF creates a Charging Id for the PDU session, and sends Charging Data Request [Initial] to CHF for authorization for the subscriber information via wireline network to start the PDU session which is triggered by start of PDU session charging event.

3ch-b. The CHF opens CDR for this PDU session.

3ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

4) The steps of PDU session establishment are specified in clause 7.3.1.1 of TS 23.316 [203].

5.2.2.16.3   FN-RG related PDU Session Establishment via W-5GAN

The following figure 5.2.2.16.3.1 describes charging when FN-RG requests a PDU session establishment via W-AGF. As described in clause 7.3.4 in TS 23.316 [203], after the registration procedure is completed, the W-AGF may establish PDU session(s) on behalf of the FN-RG.
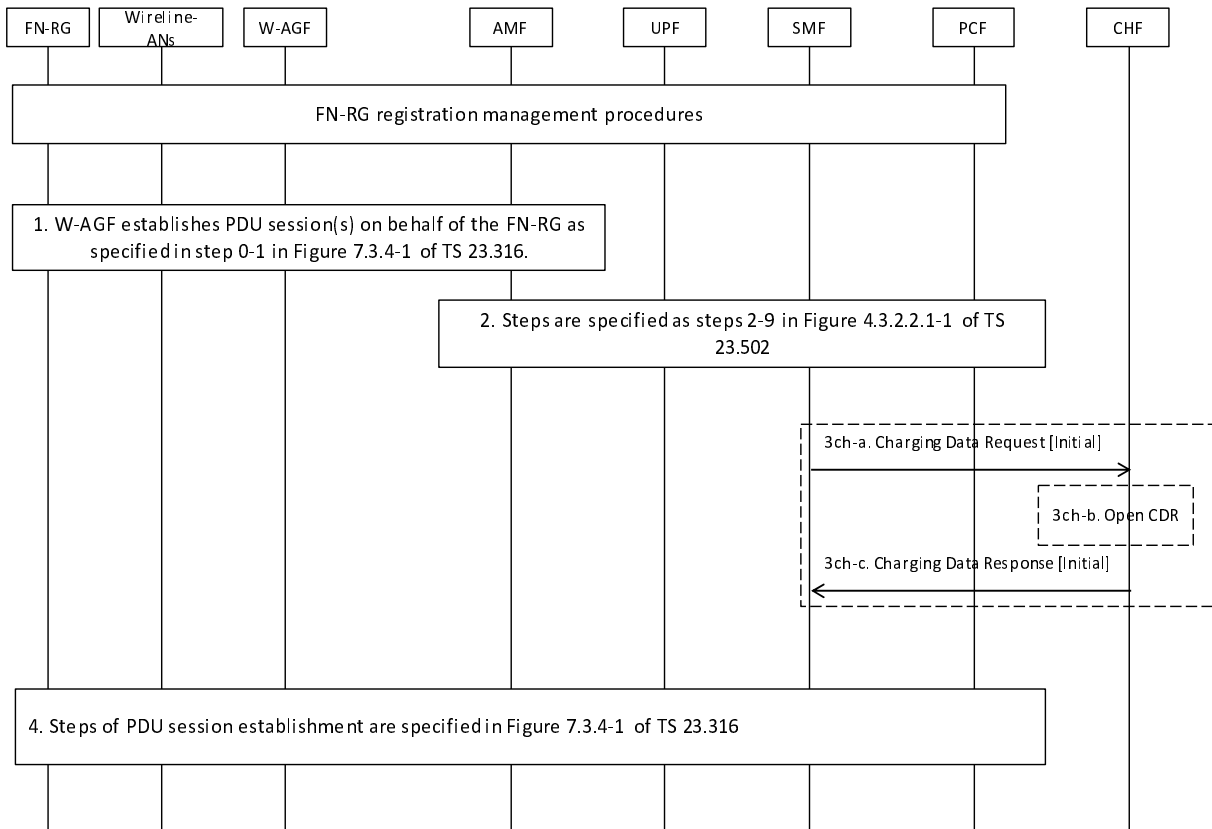
Figure 5.2.2.16.3.1: charging when FN-RG requests a PDU session establishment via W-AGF

1) After the registration procedure is completed, the W-AGF may establish PDU session(s) on behalf of the FN-RG as described in clause 7.3.4 in TS 23.316 [203].

2) The steps are specified as step 2-9 in clause 4.3.2.2.1 of TS 23.502 [202].

3ch-a. The SMF creates a Charging Id for the PDU session, and sends Charging Data Request [Initial] to CHF for authorization for the subscriber identified under wireline network to start the PDU session which is triggered by start of PDU session charging event.

3ch-b. The CHF opens CDR for this PDU session.

3ch-c. The CHF acknowledges by sending Charging Data Response [Initial] to the SMF.

4) The steps of PDU session establishment are specified in clause 7.3.4 of TS 23.316 [203].

5.2.2.16.4 Handover procedure

5.2.2.16.4.1 5G RG handover of a PDU Session procedure from W-5GAN access to 3GPP access

Following figure 5.2.2.16.4.1.1 describes charging when 5G-RG handover of a PDU Session procedure from W-5GAN access to 3GPP access.
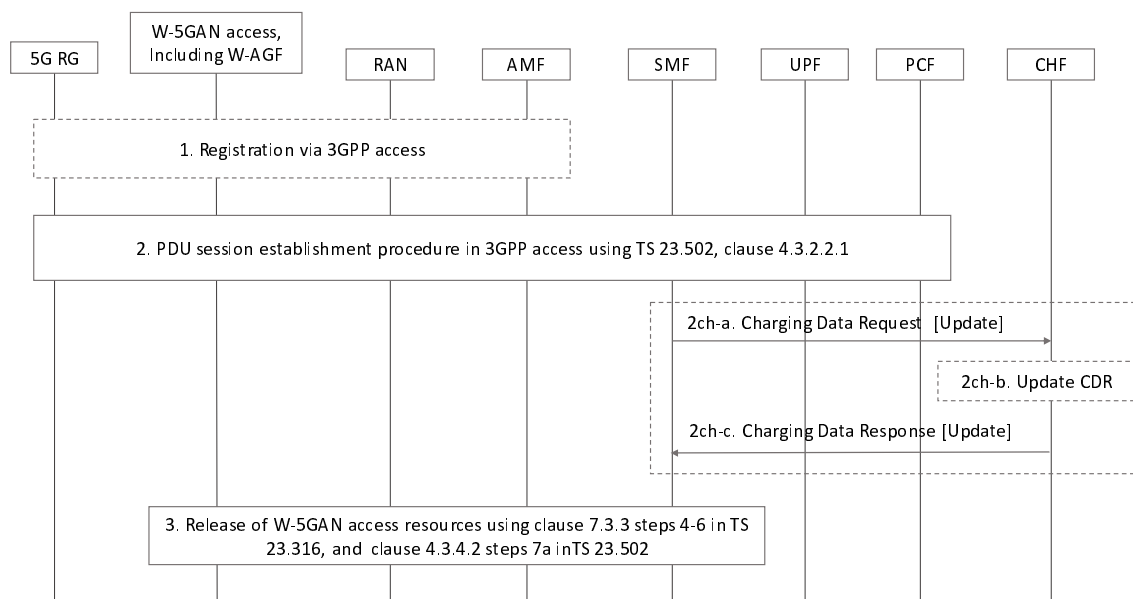
Figure 5.2.2.16.4.1.1: Handover of PDU session from W-5GAN access to 3GPP access

As described in clause 7.6.2.1 in TS 23.316 [203], the handover of a PDU session from W-5GAN access to 3GPP access is as following.

1-2)   The steps are described in clause 7.6.2.1 in TS 23.316 [203], 5G-RG peforms registeration via 3GPP access and PDU session establishmeng procedure.

2ch-a-c. SMF may interact with CHF with Charging Data Request [Update].

NOTE: The access network change trigger, if enabled, applied during the PDU session establishment via the 3GPP access network before SMF executes the release of W-5GAN access resource.

3. The step that the SMF executes the release of resources in W-5GAN access is same as step 3 as described in clause 7.6.3.1 of TS 23.316 [203].

Editor's note: If the trigger used in 5G-RG handover is same as the trigger for handover from non-3GPP access to 3GPP access in clause 5.2.2.13.4 is FFS.

5.2.2.16.4.2   5G RG handover of a PDU Session procedure from 3GPP to W-5GAN access

Following figure 5.2.2.16.4.2.1 describes charging when 5G-RG handover of a PDU Session procedure from 3GPP to W-5GAN access.
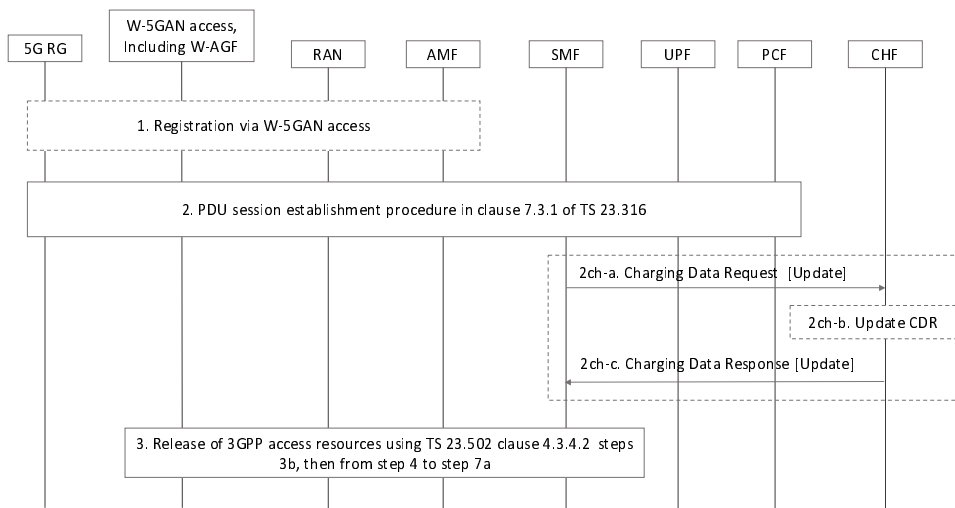
Figure 5.2.2.16.4.2.1: Handover of a PDU Session procedure from 3GPP to W-5GAN access

As described in clause 7.6.3.2 in TS 23.316 [203], the handover of a PDU session from 3GPP access to W-5GAN access is as following.

1) The 5G-RG initiates Reigistration procedure via W-5GAN as defined in clause 7.2.1.1 of TS 23.316 [203].

2) The 5G-RG performs PDU Session Establishment procedure via W-5GAN access as described in 7.6.3.2 of TS 23.316 [203].

   2ch-a-c. SMF may interact with CHF with Charging Data Request [Update].

NOTE: The access network change trigger, if enabled, applied during the PDU session establishment via the W-5GAN before SMF performs the release of 3GPP access resource.

3) The step that the SMF executes the release of resource via 3GPP access is same as step 3 as described in clause 7.6.3.2 of TS 23.316 [203].

Editor's note: If the trigger used in 5G-RG handover is same as the trigger for handover from non-3GPP access to 3GPP access in clause 5.2.2.13.4 is FFS.

5.2.3   CDR generation

5.2.3.1   Introduction

The CHF CDRs for PDU session charging and roaming QBC are generated by the CHF to collect charging information that they subsequently transfer to the Charging Gateway Function (CGF).

The following clauses describe in detail the conditions for opening, adding information to, and closing the CHF CDR.

5.2.3.2   Triggers for CHF CDR

5.2.3.2.1   General

A PDU session charging CHF CDR is used to collect charging information related to the PDU session data information for a UE in Flow Based Charging. Multiple service data flow containers per PDU session can be added in the CHF CDR by the CHF, upon receiving a Charging Data Request including new counts as defined in subclause 5.2.1.1.

A CHF CDR shall be opened when the CHF receives Charging Data Request[Initial].

As an alternative to the default CHF behaviour, the "Individual Partial record" mechanism can be used based on Operator's policy configured in the CHF. In this case a new CDR shall be opened for each Charging Data Request[Initial, Update, Termination], charging information shall be added and the CDR shall then be closed. The Sequence Number will be incremented for each Charging Data Request[Initial, Update, Termination] received by the CHF.

5.2.3.2.2 Triggers for CHF CDR charging information addition

When the CHF receives Charging Data Request[Update], with the change conditions identified in Table 5.2.3.2.2.1 the charging information shall be added in the PDU session charging CHF CDR, and the CDR shall remain open, as the default supported mechanism.

Table 5.2.3.2.2.1: Triggers for CHF CDR charging information addition

Trigger Conditions	Applicable for converged charging	Applicable for offline only charging
Change of Charging conditions		
QoS change	Yes	Yes
User Location change	Yes	Yes
Serving Node change	Yes	Yes
Change of UE presence in Presence Reporting Area(s)	Yes	Yes
Change of 3GPP PS Data off Status	Yes	Yes
Handover cancel	Yes	Yes
Handover start	Yes	Yes
Limit per Rating Group		
Expiry of data time limit per RG	Yes	Yes
Expiry of data volume limit per RG	Yes	Yes
Expiry of data event limit per RG	Yes	Yes
Quota management triggers		
Time threshold reached	Yes	No
Volume threshold reached	Yes	No
Unit threshold reached	Yes	No
Time quota exhausted	Yes	No
Volume quota exhausted	Yes	No
Unit quota exhausted	Yes	No
Expiry of quota validity time	Yes	No
Re-authorization request by CHF	Yes	No

In case the "Individual Partial record" mechanism is enabled, the Table 5.2.3.2.2.1 is not applicable. The charging information consists of a set of containers, which are added as "List of Multiple Unit Usage" parameter of the CHF CDR. Each container identifies the configured counts (volume separated for uplink and downlink, elapsed time or number of events) per rating group or combination of the rating group and service id, associated with the changed charging conditions.

5.2.3.2.3 Triggers for CHF CDR partial record closure

When the CHF receives Charging Data Request [Update],with the change conditions identified in Table 5.2.3.2.3.1, the charging information shall be added in the PDU session charging CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number, as the default supported mechanism.

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Table 5.2.3.2.3.1: Triggers for CHF CDR partial record closure

Trigger Conditions
Change of Charging conditions
UE time zone change
PLMN change
RAT type change
DNN-AMBR change
Removal of UPF
Insertion_of_ISMF
Change_of_ISMF
Removal_of_ISMF
Handover complete
Management intervention
Addition of access
Removal of access
Limit per PDU session
Expiry of data time limit per PDU session
Expiry of data volume limit per PDU session
Expiry of data event limit per PDU session
Expiry of limit of number of charging condition changes

In case the "Individual Partial record" mechanism is enabled, the Table 5.2.3.2.3.1 is not applicable.

5.2.3.2.4 Triggers for CHF CDR closure

When the CHF receives Charging Data Request[Termination], the charging information shall be added in the PDU session charging CHF CDR and the CDR shall be closed.

5.2.3.3 Triggers for CHF CDR for roaming QBC

5.2.3.3.1 General

A Roaming QBC CHF CDR is used to collect charging information related to Roaming QBC in V-SMF, and the PDU session charging CHF CDR is used to collect charging information related to Roaming QBC in H-SMF. QoS flow containers per PDU session can be added in the CHF CDRs by the CHF, upon receiving a Charging Data Request.

The charging information received from the CHF consists of a set of containers, which are added as "List Multiple QFI container" parameter of the CHF CDRs. Each container identifies the configured counts (volume separated for uplink and downlink, elapsed time) per QoS Flow, associated with the changed charging conditions.

A roaming CHF CDR shall be opened when the CHF receives Charging Data Request[Initial] indicating "in-bound roamer".

5.2.3.3.2 Triggers for CHF CDR charging information addition for roaming QBC

When the CHF receives Charging Data Request[Update], with the change conditions identified in Table 5.2.3.3.2.1 the charging information shall be added in the CHFCDR, and the CDR shall remain open, as the default supported mechanism.

Table 5.2.3.3.2.1: Triggers for CHF CDR charging information addition for roaming QBC

Trigger Conditions
Change of Charging conditions
QoS change
User Location change
Serving Node change
Change of UE presence in Presence Reporting Area(s)
Change of 3GPP PS Data off Status
Limit per QoS Flow
Expiry of data time limit per QoS Flow
Expiry of data volume limit per QoS Flow
Others
End of QoS Flow

In case the "Individual partial record" mechanism is enabled, this sub-clause is not applicable.

5.2.3.3.3   Triggers for CHF CDR partial record closure for roaming QBC

When the CHF receives Charging Data Request[Update] with the change conditions identified in Table 5.2.3.3.1, the charging information shall be added in the CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number, as the default supported mechanism.

Table 5.2.3.3.3.1: Triggers for CHF CDR partial record closure for roaming QBC

Trigger Conditions
Change of Charging conditions
UE time zone change
PLMN change
RAT type change
DNN-AMBR change
Removal of UPF
Management intervention
Limit per PDU session
Expiry of data time limit per PDU session
Expiry of data volume limit per PDU session
Expiry of data event limit per PDU session
Expiry of limit of number of charging condition changes

In case the "Individual partial record" mechanism is enabled, the Table 5.2.3.3.3.1 is not relevant: instead, the charging information shall be added in the CHF CDR, before the CDR is closed and a subsequent CHF CDR shall be opened with an incremented Sequence Number for each Charging Data Request[Update] received by the CHF.

5.2.3.3.4   Triggers for roaming QBC CHF CDR closure

When the CHF receives Charging Data Request[Termination], the charging information shall be added in the roaming QBC CHF CDR and the CDR shall be closed.

5.2.4   Ga record transfer flows

In 5G, both fully qualified partial CDRs (FQPC) and reduced partial CDRs (RPC), as specified in TS 32.240 [1] may be supported on the Ga interface. In line with TS 32.240 [13], the support of FQPCs is mandatory, the support of RPCs is optional. For further details on the Ga protocol application refer to TS 32.295 [54].

5.2.5   Bd CDR file transfer

In 5G, both fully qualified partial CDRs (FQPC) and reduced partial CDRs (RPC), as specified in TS 32.240 [1] may be supported on the Bd interface. In line with TS 32.240 [13], the support of FQPCs is mandatory, the support of RPCs is optional. For further details on the Bd protocol application refer to TS 32.297 [52].

6. Definition of charging information

6.1 Data description for 5G data connectivity charging

6.1.1 Message contents

6.1.1.1 General

The Charging Data Request and Charging Data Response are specified in TS 32.290 [57] and include charging information. The Charging Data Request can be of type [Initial, Update, Termination].

Table 6.1.1.1.1 describes the use of these messages for converged charging.

Table 6.1.1.1.1: Converged charging messages reference table

Message	Source	Destination
Charging Data Request	SMF	CHF
Charging Data Response	CHF	SMF

The following clauses describe the different fields used in the Charging Data messages and the category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1].

6.1.1.2 Charging Data Request message

Table 6.1.1.2.1 illustrates the basic structure of a Charging Data Request message from the SMF as used for 5G data connectivity converged charging.

Table 6.1.1.2.1: Charging Data Request message contents

Information Element	Category for converged charging	Category for offline only charging	Description
Session Identifier	O$_C$	O$_C$	Described in TS 32.290 [57]
Subscriber Identifier	O$_M$	M	Described in TS 32.290 [57] In case SUPI is not present (for emergency service), the User Equipment Info in table 6.2.1.2.1. shall be present for identifying the user.
NF Consumer Identification	M	M	Described in TS 32.290 [57]
NF Functionality	M	O$_C$	Described in TS 32.290 [57]
NF Name	O$_C$	O$_C$	Described in TS 32.290 [57]
NF Address	O$_C$	O$_C$	Described in TS 32.290 [57]
NF PLMN ID	O$_C$	O$_C$	Described in TS 32.290 [57]
Invocation Timestamp	M	M	Described in TS 32.290 [57]
Invocation Sequence Number	M	M	Described in TS 32.290 [57]
Retransmission Indicator	O$_C$	O$_C$	Described in TS 32.290 [57]
Notify URI	O$_C$	O$_C$	Described in TS 32.290 [57]
Service Specification Information	O$_C$	O$_C$	Described in TS 32.290 [57]
Supported Features	O$_C$	-	This field indicates the features supported by the NF consumer.
Triggers	O$_C$	O$_C$	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
Multiple Unit Usage	O$_C$	O$_C$	Described in TS 32.290 [57] This field is not applicable to QBC.
Rating Group	M	M	Described in TS 32.290 [57]
Requested Unit	O$_C$	-	Described in TS 32.290 [57]
Used Unit Container	O$_C$	O$_C$	Described in TS 32.290 [57]
Triggers	O$_C$	O$_C$	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
PDU Container Information	O$_C$	O$_C$	This field holds the 5G data connectivity PDU session container specific information described in clause 6.2.
UPF ID	O$_C$	O$_C$	This field holds the UPF identifier used to identify the UPF. These fields shall only be included when either quota is requested per UPF, or used units are reported per UPF
PDU Session Charging Information	O$_M$	O$_M$	This field holds the 5G data connectivity specific information described in clause 6.2.
Roaming QBC information	O$_M$	O$_M$	This field holds the roaming QBC specific information defined in clause 6.2.1.4 This field is not applicable to FBC.

6.1.1.3 Charging data response message

Table 6.1.1.3.1 illustrates the basic structure of a Charging Data Response message from the CHF as used for 5G data connectivity converged charging.

Table 6.1.1.3.1: Charging Data Response message contents

Information Element	Category for converged charging	Category for offline only charging	Description
Session Identifier	O$_C$	O$_C$	Described in TS 32.290 [57]
Invocation Timestamp	M	M	Described in TS 32.290 [57]
Invocation Result	O$_C$	M	Described in TS 32.290 [57]
Invoation Result Code	O$_C$	M	Described in TS 32.290 [57]
Failed Parameter	O$_C$	O$_C$	Described in TS 32.290 [57]
Failure Handling	O$_C$	O$_C$	Described in TS 32.290 [57]
Invocation Sequence Number	M	M	Described in TS 32.290 [57]
Session Failover	O$_C$	O$_C$	Described in TS 32.290 [57]
Supported Features	O$_C$	-	This field indicates the features supported by the NF consumer.
Multiple Unit Information	O$_C$	O$_C$	Described in TS 32.290 [57] This field is not applicable to QBC.
Result Code	O$_C$	O$_C$	Described in TS 32.290 [57]
Rating Group	M	M	Described in TS 32.290 [57]
UPF ID	O$_C$	O$_C$	This field holds the UPF identifier used for quota granted per UPF by CHF
Granted Unit	O$_C$	-	Described in TS 32.290 [57]
Validity Time	O$_C$	-	Described in TS 32.290 [57]
Final Unit Indication	O$_C$	-	Described in TS 32.290 [57]
Time Quota Threshold	O$_C$	-	Described in TS 32.290 [57]
Volume Quota Threshold	O$_C$	-	Described in TS 32.290 [57]
Unit Quota Threshold	O$_C$	-	Described in TS 32.290 [57]
Quota Holding Time	O$_C$	-	Described in TS 32.290 [57]
Triggers	O$_C$	O$_C$	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
Triggers	O$_C$	O$_C$	This field is described in TS 32.290 [57] and holds the 5G data connectivity specific triggers described in clause 5.2.1.
PDU Session Charging Information	O$_M$	O$_M$	This field holds the 5G data connectivity specific information described in clause 6.2.
Roaming QBC Information	O$_M$	O$_M$	This field holds the roaming QBC specific information defined in clause 6.2.1.4 This field is not applicable to FBC.

6.1.2 Ga message contents

6.1.3 CDR description on the B$_d$ interface

6.1.3.1 General

This clause describes the CDR content and format generated for 5G data connectivity - PDU session charging.

The following tables provide a brief description of each CDR parameter. The category in the tables is used according to the charging data configuration defined in clause 5.4 of TS 32.240 [1]. Full definitions of the CDR parameters, sorted by the name in alphabetical order, are provided in TS 32.298 [51].

6.1.3.2 PDU session charging CHF CDR data

If enabled, CHF CDRs for PDU session charging shall be produced for each PDU session. In roaming Home routed scenario, the PDU session charging CHF CDR shall cover both Flow based Charging and Qos flow Based Charging (QBC) from H-SMF.

The fields of PDU session charging CHF CDR are specified in table 6.1.3.2.1.

Table 6.1.3.2.1: PDU session charging CHF record data

Field	Category	Description
Record Type	M	CHF record.
Recording Network Function ID	O_M	This field holds the name of the recording entity, i.e. the CHF id.
Subscriber Identifier	O_M	This field holds the Subscription Permanent Identifier (SUPI) of the served party. This fields should be present except for emergency session. The detail of SUPI is specified in clause 5.9.2 of TS 23.501 [200]
NF Consumer Information	M	This field holds the information of the SMF that used the charging service.
NF Functionality	M	This field contains the function of the node (i.e. SMF)
NF Name	O_C	This field holds the name of the SMF used.
NF Address	O_C	This fields holds the IP Address of the SMF used.
NF PLMN ID	Oc	This field holds the PLMN identifier (MCC MNC) of the SMF.
List of Multiple Unit Usage	O_M	This field holds a list of changes in charging conditions for all service data flows within this PDU session.This list is categorized per rating group or per combination of rating group and service id or per combination of rating group, sponsor identity and application service provider identity. In addition, usage is differentiated between with and without quota management. Each change is time stamped. Charging conditions are used to categorize traffic volumes, elapsed time and number of events, such as per tariff period.
Rating Group	O_M	This filed holds the rating group.
Used Unit Container	O_C	This field holds the used units and information connected to the reported units.
Service Identifier	O_C	This field holds the Service Identifier.
Quota management Indicator	O_M	This field holds an indicator on whether the used units are with or without quota management.
Triggers	O_C	This field holds the reason for closing the used unit container.
Trigger Timestamp	O_C	This field holds the timestamp of the trigger.
Time	O_C	This field holds the amount of used time.
Total Volume	O_C	This field holds the amount of used volume in both uplink and downlink directions.
Uplink Volume	O_C	This field holds the amount of used volume in uplink direction.
Downlink Volume	O_C	This field holds the amount of used volume in downlink direction.
Service Specific Unit	O_C	This field holds the amount of used service specific units.
Event Time Stamps	O_C	This field holds the timestamps of the event reported in the Service Specific Units, if the reported units are event based.
Rating Indicator	Oc	This field indicates if the units have been rated or not.
Local Sequence Number	M	This field holds the container sequence number.
PDU Container Information	O_C	This field holds the 5G data connectivity specific information defined in clause 6.2.1.3.
UPF ID	O_C	This field holds the UPF identifier used to identify the UPF when reporting the usage for the UPF.
Record Opening Time	M	Time stamp when the PDU session is activated in the SMF or record opening time on subsequent partial records.
Duration	M	This field holds the duration of this record.
Record Sequence Number	C	Partial record sequence number, only present in case of partial records.
Cause for Record Closing	M	The reason for the release of the record.
Diagnostics	O_M	This field holds a more detailed reason for the release of the PDU session, when a single cause is applicable.
Local Record Sequence Number	O_M	Consecutive record number created by the CDF. The number is allocated sequentially including all CDR types.
Record Extensions	O_C	A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information defined in clause 6.2.1.2.
Roaming QBC information	O_C	This field holds the roaming QBC specific information defined in clause 6.2.1.4, when applicable.

6.1.3.3 Roaming QBC CHF CDR data

If enabled, CHF CDRs for Roaming QBC shall be produced in VPLMN for each PDU session established for an in-bound roamer. The fields of Roaming QBC CHF CDR are specified in table 6.1.3.3.1.

Table 6.1.3.3.1: Roaming QBC CHF record data

Field	Category	Description
Record Type	M	CHF record.
Recording Network Function ID	O_M	This field holds the name of the recording entity, i.e. the CHF id.
Subscriber Identifier	M	This field holds the 5G Subscription Permanent Identifier (SUPI) of the served party, if available.
NF Information	O_C	This field holds the information of the V-SMF that used the charging service.
NF Functionality	M	This field contains the function of the node.
NF Name	O_C	This field holds the name of the V-SMF used.
NF Address	O_C	This fields holds the IP Address of the V-SMF used.
NF PLMN ID	Oc	This field holds the PLMN identifier (MCC MNC) of the V-SMF.
Record Opening Time	M	Time stamp when the PDU session is activated in the SMF or record opening time on subsequent partial records.
Duration	M	This field holds the duration of this record.
Record Sequence Number	C	Partial record sequence number, only present in case of partial records.
Cause for Record Closing	M	The reason for the release of the record.
Diagnostics	O_M	This field holds a more detailed reason for the release of the PDU session, when a single cause is applicable.
Local Record Sequence Number	O_M	Consecutive record number created by the CHF. The number is allocated sequentially including all CDR types.
Record Extensions	O_C	A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
PDU Session Charging Information	O_M	This field holds the 5G data connectivity specific information defined in clause 6.2.1.2.
Roaming QBC Information	O_M	This field holds the 5G data connectivity Roaming QBC specific information defined in clause 6.2.1.4

6.2 5G data connectivity charging specific parameters

6.2.1 Definition of 5G data connectivity charging information

6.2.1.1 General

The Charging Information parameter used for 5G data connectivity charging is provided in the following sub-clauses.

6.2.1.2   Definition of PDU session charging information

PDU session specific charging information used for 5G data connectivity charging is provided within the PDU session charging Information.

The detailed structure of the PDU Session Charging Information can be found in table 6.2.1.2.1.

Table 6.2.1.2.1: Structure of PDU Session Charging Information

Information Element	Category	Description
Charging Id	O_M	This field holds the Charging Id for PDU session.
Home Provided Charging Id	O_C	This field holds the Charging Id generated by H-SMF.This field is only applicable in V-SMF in the home routed roaming scenario for EPS to 5GS interworking.
User Information	O_M	Group of user information.
User Identifier	O_C	This field contains the identification of the user (i.e. GPSI).
User Equipment Info	O_C	This field holds the identification of the terminal (i.e. PEI, MAC Address) It is used for identifying the user in case SUPI is not present during emergency service. The detail identification of the wireline access is specified in clause 4.7.7 of TS 23.316 [203].
unauthenticatedFlag	O_C	This field indicates the served SUPI is not authenticated.
Roamer In Out	O_C	This field holds an indication if the roamer is in-bound or out-bound. This field is present only if UE is identified as a roamer.
User Location Info	O_C	This field indicates details of where the UE is currently located (access-specific user location information). For MA PDU session, this field holds the user location associated to the 3GPP access
MA PDU Non 3GPP User Location info	O_C	This field holds the user location associated to the non 3GPP access for MA PDU session.
User Location Time	O_C	The NTP time at which the UE was last known to be in the location. For MA PDU session, this field holds the user location time associated to the 3GPP access.
MA PDU Non 3GPP User Location Time	O_C	This field holds the user location time associated to the non 3GPP access for MA PDU session.
UE Time Zone	O_C	This field holds the Time Zone of where the UE is located, if available where the UE currently resides.
Presence Reporting Area Information	O_C	This field contains part of the Presence Reporting Area Information of UE as defined in TS 23.501[200], comprising the Presence Reporting Area identifier(s) and an indication on whether the UE is inside or outside the Presence Reporting Area, if available.
PDU Session Information	M	Group of PDU session information.
PDU Session ID	M	This field holds identifier of PDU session.
Network Slice Instance Identifier	O_M	This field holds network slice information the PDU session belongs to.
PDU Type	O_M	This field holds the type of PDU session.
PDU Address	O_C	Group of UE IP address.
PDU Ipv4 Address	O_C	This field holds the IP Address of the served SUPI allocated for PDU session, i.e. IPv4 address.
PDU IPv6 Address with Prefix	O_C	This field holds the IP Address of the served SUPI allocated for PDU session, i.e. IPv6 prefix.
PDU Address prefix length	O_C	PDP/PDN Address prefix length of an IPv6 typed Served PDU Address. The field needs not available for prefix length of 64 bits.
IPv4 Dynamic Address Flag	O_C	This field indicates whether served PDP/PDN address for IPv4 is dynamically allocated. This field is missing if address is static.
IPv6 Dynamic Address Flag	O_C	This field indicates whether served PDP/PDN address for IPv6 is dynamically allocated. This field is missing if address is static.
SSC Mode	O_C	This field holds SSC mode of PDU session.
MA PDU session information	O_C	This field holds information associated to the MA PDU session.
MA PDU session indicator	O_C	This field indicates the PDU session is a MA PDU session requested by the UE or requested by Network modification based ATSSS capabilities provided by the UE and the Network.
ATSSS capability	O_C	This field holds the ATSSS capability supported by the MA PDU session
SUPI PLMN ID	O_C	This field holds PLMN ID of the SUPI.
Serving Network Function ID	O_C	Group of serving Network Function identifier

Serving Network Function Functionality	M	This field holds the functionality of the Serving Network Function: i.e. AMF, SMF, SGW, I-SMF. When this field holds "AMF" then it is related to AMF in the same PLMN as the SMF consuming the charging service. When this field holds "SMF" then it is related to V-SMF for home routed roaming. This field holds "I-SMF" when a PDU session is served by SMF + I-SMF.
Serving Network Function Name	O$_C$	This field holds the name of the serving Network Function (i.e. AMF).
Serving Network Function Addresses	O$_C$	This field holds the IP Addresses of the Serving Network Function.
Serving Network Function FQDN	O$_C$	This field holds the FQDN the Serving Network Function. When the the Serving Network Function is an AMF, this FQDN is the AMF name as defined in subclause 5.9.5 of 3GPP TS 23.501 [200].
Serving Network Function PLMN ID	O$_C$	This field holds the PLMN ID of the network the Serving Network Function belongs to.
AMF Identifier	O$_C$	This field holds the AMF identifier.
Serving CN PLMN ID	O$_C$	This field holds the serving Core Network Operator PLMN ID selected by the UE if different from SMF PLMN ID.
RAT Type	O$_C$	This field holds the Radio Access Technology (RAT) currently serving the UE. For MA PDU session, this field holds the Radio Access Technology (RAT) associated to the 3GPP access
MA PDU Non 3GPP RAT Type	O$_C$	This field holds the Radio Access Technology (RAT) serving the UE in non 3GPP access for MA PDU session.
Data Network Name Identifier	M	This field contains the identifier of the DNN the user is connected to.
DNN Selection Mode	O$_C$	This field indicates whether the requested DNN corresponds to an explicitly subscribed DNN or to the usage of a wildcard subscription.
Authorized QoS Information	O$_C$	This field holds the authorized QoS applied to PDU session.
Subscribed QoS Information	O$_C$	This field holds the subscribed default QoS for the PDU session.
Authorized Session-AMBR	O$_C$	This field holds the authorized Session-AMBR for the PDU session.
Subscribed Session-AMBR	O$_C$	This field holds the subscribed Session-AMBR for the PDU session.
PDU session start Time	O$_C$	This field holds the timestamp when PDU session starts.
PDU session stop Time	O$_C$	This field holds the timestamp when PDU session terminates.
Diagnostics	O$_C$	This field holds a more detailed reason for the release of the PDU session and complements the "Change Condition" information.
Charging Characteristics	O$_C$	This field holds the Charging Characteristics for this PDU session.
Charging Characteristics Selection Mode	O$_C$	This field holds information about how the "Charging Characteristics" was selected.
3GPP PS Data Off Status	O$_C$	This field holds the 3GPP Data off Status when UE's 3GPP Data Off status is Activated or Deactivated.
Session Stop Indicator	O$_C$	This field indicates to the CHF that the PDU session has been terminated.
Unit Count Inactivity Timer	O$_C$	This field holds the threshold for the time period when no units has been counted by the SMF. It holds either the value configured in SMF, if it is supported, or the value to be used as received from the CHF. A value of zero indicates that this mechanism shall not be used. This field is not applicable to QBC.
RAN Secondary RAT Usage Report	O$_C$	This field holds the secondary RAT usage reported from NG-RAN.
NG RAN Secondary RAT Type	O$_C$	This field holds the value of Secondary RAT Type, as provided by the NG-RAN.
Qos Flows Usage Reports	O$_C$	This field holds a list of containers per QFI with volumes reported, each container is time stamped.
QoS Flow Id	O$_M$	This field holds the QoS flow Identifier (QFI)
Start Timestamp	O$_C$	This field holds the start timestamp of the collected usage.
End Timestamp	O$_C$	This field holds the end timestamp of the collected usage.
Downlink Volume	O$_C$	This field holds the amount of used volume in downlink direction.
Uplink Volume	O$_C$	This field holds the amount of used volume in uplink direction.

6.2.1.3 Definition of PDU Container information

Used Unit Container, described in table 6.1.1.2.1, specific charging information used for 5G data connectivity charging is provided within the PDU Container Information described in table 6.2.1.3.1.

Table 6.2.1.3.1: Structure of PDU Container Information

Information Element	Category	Description
Time of First Usage	O$_C$	This field holds the Timestamp when the first transmitted IP packet of the service data flow matching the current used unit container
Time of Last Usage	O$_C$	This field holds the Timestamp when the last transmitted IP packet of the service data flow matching the current used unit container
QoS Information	O$_C$	This field holds the QoS applied during the service data container interval
QoS Characteristics	O$_C$	This field holds the QoS characteristics applied for QoS information. It is only be used when the non-standardized 5QI is present in QoS information.
AF Charging Identifier	O$_C$	An identifier, provided from the AF, may be used to correlate the measurement for the Charging key/Service identifier values in this PCC rule with application level reports.
User Location Information	O$_C$	This field holds the user location during the used unit container interval
UE Time Zone	O$_C$	This field holds the Time Zone of where the UE is located, during the used unit container interval.
Presence Reporting Area Information	O$_C$	This field holds the Presence Reporting Area Information of UE during the used unit container interval.
Serving Network Function ID	O$_C$	Serving Network Function identifier.
RAT Type	O$_C$	This field holds the RAT type during the used unit container interval. For MA PDU session, this field holds the RAT type associated to the access which activated the rating group.
Sponsor Identity	O$_C$	This field holds the identifier of the sponsor when sponsored data connectivity is used
Application Service Provider Identity	O$_C$	This field holds the identifier of the application service provider that is delivering a service to the end user.
Charging Rule Base Name	O$_C$	This field holds the reference to group of PCC rules predefined at the SMF
3GPP PS Data Off Status	O$_C$	This field holds the 3GPP Data off Status during the used unit container interval
MA PDU Steering functionality	O$_C$	This field holds the Steering functionality used during the used unit container interval when MA PDU session
MA PDU Steering mode	O$_C$	This field holds the Steering mode used during the used unit container interval when MA PDU session.

6.2.1.4 Definition of roaming QBC information

Roaming QBC specific charging information used for 5G data connectivity charging is provided within the Roaming QBC Information.

The detailed structure of the Roaming QBC Information can be found in table 6.2.1.4.1.

Table 6.2.1.4.1: Structure of Roaming QBC Information

Information Element	Category	Description
Multiple QFI container	O_C	This field holds a list of QFI containers. It may have multiple occurrences
Triggers	O_C	This field holds the reason for closing the QFI unit container.
Trigger Timestamp	O_C	This field holds the timestamp of the trigger.
Time	O_C	This field holds the amount of used time.
Total Volume	O_C	This field holds the amount of used volume in both uplink and downlink directions.
Uplink Volume	O_C	This field holds the amount of used volume in uplink direction.
Downlink Volume	O_C	This field holds the amount of used volume in downlink direction.
Local Sequence Number	M	This field holds a QFI data container sequence number
QFI Container information	O_C	This field holds the QFI data container information defined in clause 6.2.1.5
UPF ID	O_C	This field holds the UPF identifier used to identify the UPF when reporting the usage for the UPF.
Roaming Charging Profile	O_C	This field holds the Roaming Charging Profile associated to the PDU session for roaming QBC.
Trigger	O_C	This field holds the trigger applicable to QBC. This field has multiple occurrences
Trigger type	O_C	This field holds the chargeable event defined in table 5.2.1.6.1.
Trigger category	O_C	This field holds the trigger category (i.e. immediate or deferred reporting)
Time Limit	O_C	This field holds the limit value in seconds when the trigger type is "Expiry of data time limit"
Volume Limit	O_C	This field holds the limit value in octets when the trigger type is "Expiry of data volume limit"
Max Number of charging condition changes	O_C	This field holds the limit value when the trigger type is "Expiry of limit of number of charging condition changes"
Partial record method	O_C	This field holds the method uses by the CHF for partial record closure: default or Individual.

6.2.1.5 Definition of QFI Container information

QFI Container information, defined in table 6.2.1.4.1, specific charging information used for 5G data connectivity QBC charging is provided within the QFI Container Information described in table 6.2.1.5.1.

Table 6.2.1.4.1: Structure of QFI Container Information

Information Element	Category	Description
QoS Flow Id	M	This field holds the QoS flow Identifier (QFI)
Time of First Usage	O_C	This field holds the Timestamp when the first transmitted IP packet of the service data flow matching the current QFI data container
Time of Last Usage	O_C	This field holds the Timestamp when the last transmitted IP packet of the service data flow matching the current QFI data container
QoS Information	O_C	This field holds the QoS applied during the QFI data container interval
QoS Characteristics	O_C	This field holds the QoS characteristics applied for QoS information. It is only be used when the non-standardized 5QI is present in QoS information.

Information Element	Category	Description
User Location Information	O_C	This field holds the user location during the QFI data container interval
UE Time Zone	O_C	This field holds the Time Zone of where the UE is located, during the QFI data container interval
Presence Reporting Area Information	O_C	This field holds the Presence Reporting Area Information of UE during the QFI data container interval.
RAT Type	O_C	This field holds the RAT type during the QFI data container interval
Report Time	M	This field holds the Timestamp when the QFI data container was closed
Serving Network Function ID	O_C	Group of serving Network Function identifier.
3GPP PS Data Off Status	O_C	This field holds the 3GPP Data off Status during the QFI data container interval

6.2.2 Detailed message format for converged charging

The following clause specifies per Operation Type the charging data that are sent by SMF for 5G data connectivity converged charging or offline only charging.

The Operation Types are listed in the following order: I (Initial)/U (Update)/T (Termination)/E (Event). Therefore, when all Operation Types are possible it is marked as IUTE. If only some Operation Types are allowed for a node, only the appropriate letters are used (i.e. IUT or E) as indicated in the table heading. The omission of an Operation Type for a particular field is marked with "-" (i.e. IU-E). Also, when an entire field is not allowed in a node the entire cell is marked as "-".

Table 6.2.2.1 defines the basic structure of the supported fields in the *Charging Data* Request message for 5G data connectivity converged charging or offline only charging.

Table 6.2.2.1: Supported fields in *Charging Data Request* message

| Information Element | Functionality of SMF | FBC | QBC | FBC | QBC |
| | Charging Service | Converged Charging | Converged Charging | Offline Only Charging | Offline Only Charging |
	Supported Operation Types	I/U/T/E	I/U/T/E	I/U/T/E	I/U/T/E
Session Identifier		-UT-	-UT-	-UT-	-UT-
Subscriber Identifier		IUT-	IUT-	IUT-	IUT-
NF Consumer Identification		IUT-	IUT-	IUT-	IUT-
Invocation Timestamp		IUT-	IUT-	IUT-	IUT-
Invocation Sequence Number		IUT-	IUT-	IUT-	IUT-
Retransmission Indicator		IUT-	IUT-	IUT-	IUT-
Notify URI		IU-	IU-	IU-	IU-
Supported Features		IU-	IU-	-	-
Service Specification Information		IUT-	IUT-	IUT-	IUT-
Triggers		-UT-	-UT-	-UT-	-UT-
Multiple Unit Usage		IUT-	-	IUT-	-
Rating Group		IUT-	-	IUT-	-
Requested Unit		IU--	-	-	-
Used Unit Container		-UT-	-	-UT-	-
Triggers		-UT-	-	-UT-	-
PDU Container Information		-UT-	-	-UT-	-
UPF ID		IUT-	IUT-	IUT-	IUT-
PDU Session Charging Information		IUT-	IUT-	IUT-	IUT-
Charging Id		IUT-	IUT-	IUT-	IUT-
Home Provided Charging Id		-UT-	-UT-	-UT-	-UT-
User Information		IUT-	IUT-	IUT-	IUT-
User Location Info		IUT-	IUT-	IUT-	IUT-
MA PDU Non 3GPP User Location Info		IUT-	IUT-	IUT-	IUT-
UE Time Zone		IUT-	IUT-	IUT-	IUT-
Presence Reporting Area Information		-UT-	-UT-	-UT-	-UT-
PDU Session Information		IUT-	IUT-	IUT-	IUT-
PDU Session ID		IUT-	IUT-	IUT-	IUT-
Network Slice Instance Identifier		IUT-	IUT-	IUT-	IUT-
PDU Type		IUT-	IUT-	IUT-	IUT-
PDU Address		IUT-	IUT-	IUT-	IUT-
SSC Mode		IUT-	IUT-	IUT-	IUT-
MA PDU session information		IUT-	IUT-	IUT-	IUT-
SUPI PLMN ID		IUT-	IUT-	IUT-	IUT-
Serving Network Function ID		IUT-	IUT-	IUT-	IUT-
Serving CN PLMN ID		IUT-	IUT-	IUT-	IUT-
RAT Type		IUT-	IUT-	IUT-	IUT-
MA PDU Non 3GPP RAT Type		IUT-	IUT-	IUT-	IUT-
Data Network Name Identifier		IUT-	IUT-	IUT-	IUT-
DNN Selection Mode		IUT-	IUT-	IUT-	IUT-
Authorized QoS Information		IUT-	IUT-		
Subscribed QoS Information		IUT-	IUT-		
Authorized Session-AMBR		IUT-	IUT-		
Subscribed Session-AMBR		IUT-	IUT-		
PDU session start Time		I---	I---	I---	I---
PDU session stop Time		--T-	--T-	--T-	--T-
Diagnostics		--T-	--T-	--T-	--T-
Charging Characteristics		IUT-	IUT-	IUT-	IUT-
Charging Characteristics Selection Mode		IUT-	IUT-	IUT-	IUT-
3GPP PS Data Off Status		IUT-	IUT-	IUT-	IUT-
Session Stop Indicator		--T-	--T-	--T-	--T-
Unit Count Inactivity Timer		IU--	-	IU--	-
RAN Secondary RAT Usage Report		-UT-	-UT-	-UT-	-UT-
Roaming QBC information		-	IUT-	-	IUT-
Multiple QFI container		-	IUT-	-	IUT-
UPF ID		-	IUT-	-	IUT-
Roaming Charging Profile		-	IU--	-	IU--

Table 6.2.2.2 defines the basic structure of the supported fields in the *Charging Data* Response message for 5G data connectivity converged charging or offline only charging.

Table 6.2.2.2: Supported fields in *Charging Data Response* message

| Information Element | Functionality of SMF | FBC | QBC | FBC | QBC |
| | Charging Service | Converged Charging | Converged Charging | Offline Only Charging | Offline Only Charging |
	Supported Operation Types	I/U/T/E	I/U/T/E	I/U/T/E	I/U/T/E
Session Identifier		I---	I---	I---	I---
Invocation Timestamp		IUT-	IUT-	IUT-	IUT-
Invocation Result		IUT-	IUT-	IUT-	IUT-
Invocation Sequence Number		IUT-	IUT-	IUT-	IUT-
Session Failover		IU--	IUT-	IU--	IUT-
Supported Features		IU--	IU--	-	-
Triggers		IU--	IU--	IU--	IU--
Multiple Unit information		IU--	-	IU--	-
Result Code		IU--	-	IU--	-
Rating Group		IU--	-	IU--	-
UPF ID		IU--	-	IU--	-
Granted Unit		IU--	-	-	-
Validity Time		IU--	-	-	-
Final Unit Indication		IU--	-	-	-
Time Quota Threshold		IU--	-	-	-
Volume Quota Threshold		IU--	-	-	-
Unit Quota Threshold		IU--	-	-	-
Quota Holding Time		IU--	-	-	-
Triggers		IU--	-	IU--	-
PDU Session Charging Information		IU--	IU--	IU--	IU--
Charging Id		-	-	-	-
Home Provided Charging Id		-	-	-	-
User Information		-	-	-	-
User Location Info		-	-	-	-
MA PDU Non 3GPP User Location info		-	-	-	-
UE Time Zone		-	-	-	-
Presence Reporting Area Information		IU--	IU--	IU--	IU--
PDU Session Information		-	-	-	-
PDU Session ID		-	-	-	-
Network Slice Instance Identifier		-	-	-	-
PDU Type		-	-	-	-
PDU Address		-	-	-	-
SSC Mode		-	-	-	-
MA PDU session information		-	-	-	-
SUPI PLMN ID		-	-	-	-
Serving Network Function ID		-	-	-	-
Serving CN PLMN ID		-	-	-	-
RAT Type		-	-	-	-
MA PDU Non 3GPP RAT Type		-	-	-	-
Data Network Name Identifier		-	-	-	-
DNN Selection Mode		-	-	-	-
Authorized QoS Information		-	-	-	-
Subscribed QoS Information		-	-	-	-
Authorized Session-AMBR		-	-	-	-
Subscribed Session-AMBR		-	-	-	-
PDU session start Time		-	-	-	-
PDU session stop Time		-	-	-	-
Diagnostics		-	-	-	-
Charging Characteristics		-	-	-	-
Charging Characteristics Selection Mode		-	-	-	-
Charging Rule Base Name		-	-	-	-
3GPP PS Data Off Status		-	-	-	-
Session Stop Indicator		-	-	-	-
Unit Count Inactivity Timer		IU--	-	-	-
RAN Secondary RAT Usage Report		-	-	-	-
Roaming QBC information		-	IU--	-	IU--
Multiple QFI container		-	-	-	-
UPF ID		-	-	-	-

Roaming Charging Profile	-	IU--	-	IU--

6.2.3 Formal 5G data connectivity charging parameter description

6.2.3.1 5G data connectivity CHF CDR parameters

The detailed definitions, abstract syntax and encoding of the PDU session charging and Roaming QBC CHF CDRs parameters are specified in TS 32.298 [51].

6.2.3.2 5G data connectivity resources attributes

The detailed definitions of resources attributes used for 5G data connectivity charging are specified in TS 32.291 [58].

Annex A (normative): Charging Characteristics

A.1 General

A subscriber may have Charging Characteristics assigned to his subscription and/or his subscribed DNNs. Default Charging Characteristics may also be pre-provisioned on the SMF.

During UE PDU session establishment, when the SMF retrieves subscription data from the UDM, if a subscribed Charging Characteristics for the requested DNN is identified, it may override the SMF pre-provisioned Charging Characteristics.

The Charging Characteristics parameter consists of a string of 16 bits designated as Behaviours (B), freely defined by Operators, as shown in TS 32.298 [51]. Each bit corresponds to a specific charging behaviour which is configured on a per operator basis, and pointed when bit is set to "1" value.

A charging behaviour is defined as an association to a specific usage design:

One usage may consist of a set of trigger profiles associated to the PDU session in converged charging as described in the Table A.1 example:

Table A.1: Example of Charging Characteristics behaviours for SMF

| Behaviour index | PDU session charging | | | | | | | | | |
	Default charging method	PDU session charging method	Charging service	Primary and Secondary CHF addresses	Active	Time Limit Per PDU session	Vol Limit Per PDU session	Change Cond. Per PDU session	Tariff times	…
0	Online	-	Converged charging	URI 1 URI 2	Yes	10 min	1Mb	2	0-7, 7-12	…
1	Offline	-	Converged charging	URI 1 URI 2	Yes	15 min	5Mb	3	0-24	…
2	Online	-	Converged charging	URI 1 URI 2	Yes	30 min	2Mb	2	0-7, 7-12	…
3		Offline only	Offline only charging	URI 1 URI 2	Yes	15 min	1MB	-1	-0-24	…
4	-	Offline only	Converged charging	URI 1 URI 2	No	15 min	1MB	1	0-24	…
…	…			…	…	…	…	…	…	…

Associated to the behaviour, the following may also be configured:

- the CHF addresses to be used by the SMF;

- the "Default charging method" (online or offline) to be used as the default one for every PCC rules of the PDU Session;

- the PDU session charging method indicating whether the charging method for the PDU session is "offline only".

- charging service.

The "Default charging method",PDU session charging method and CHF addresses configured in the applicable Charging Characteristics behaviour, are superseded by "Default charging method", PDU session charging method and CHF addresses supplied by the PCF if any, during SMF interaction with the PCF at PDU session establishment, as described in TS 23.503 [202].

Annex B (normative):
Interworking

B.1   General

This clause specifies the EPS and 5GS interworking.

This clause describes only the additions in respect the main body clause 6 for 5G Data Connectivity Charging.

B.2   Definition of charging information for interworking

B.2.1   Data description for interworking with EPC

B.2.1.1   Message contents

The Charging message as described in clause 6.1.1 shall apply to the PGW-C+SMF for interworking with EPC scenario.

When UE is connected to PGW-C+SMF via EPC and interworking with 5GS is supported, the information and mechanism included in clause 6.1.1 and TS 32.290[57] is supported.

Editor's Note: The full Annex is still FFS.

B.2.1.2   Ga message contents

B.2.1.3   CDR description on the Bd interface

The CDR description defined in clause 6.1.3.2 is used for interworking with EPC scenario.

B.2.2   Interworking charging specific parameters

B.2.2.1   Definition of Interworking charging information

The charging information defined in clause 6.2.1 is used for interworking with EPC scenario.

The specific information used for PS charging when UE is connected to P-GW+SMF via EPC is provided within the PDU session charging Information, as defined in clause 6.2.1.2, with the following difference:

Table B.2.2.1.X-1: Charging Information additional field

Information Element	Category	Description
multipleQFIcontainer	O_C	This field holds the containers associated to a charging condition change on an IP-CAN bearer. This is included when triggers conditions are met (Qos change, tariff time change ...). It may occur several times.

B.2.2.2   Detailed message format for Interworking charging

The message format defined in clause 6.2.2 is used for interworking with EPC scenario.

The supported fields in table 6.2.2.1 for the converged charging message shall apply to the P-GW+SMF for the applicable fields, with the difference that SMF is replaced by P-GW+SMF, and the table B.2.2.2-1 describes the reuse and extension of Multiple QFI Container for interworking.

Table B.2.2.2-1: Reuse the MultipleQFIContainer fields for Interworking

Information Element for 5G Data connectivity	Information Element for Interworking	Corresponding to 32.298 [51]
Multiple QFI Container	Yes	Traffic data volumes
Triggers	Yes	Change condition
Trigger Timestamp	Yes	Change Time
Time	No	-
Total Volume	No	-
Uplink Volume	Yes	Data Volume Uplink
Downlink Volume	Yes	Data Volume Downlink
Local Sequence Number	No	-
QFI Container Information	Yes	-
QFI	No	-
Time of First Usage	No	-
Time of Last Usage	No	-
QoS Information	Yes	EPC QoS Information
User Location Information	Yes	User Location Information
UE Time Zone	No	-
Presence Reporting Area Information	Yes	Presence Reporting Area Status
RAT Type	Yes	RAT Type
Serving Network Function ID	No	-
3GPP PS Data Off Status	No	-
-	3GPP Charging Id	Charging Id
-	Enhanced Diagnostics	Enhanced Diagnostics
-	Diagnostics	Diagnostics
-	No	UWAN User Location Information
-	No	User CSG information
-	No	Access Availability Change Reason
-	No	Related Change of Charging Condition
-	No	CP CIoT EPS optimisation indicator
-	No	Serving PLMN Rate Control

B.2.2.3 Formal Interworking charging parameter description

The CHF CDR parameters and resources attributes defined in clause 6.2.3 is used for interworking with EPC scenario.

Annex C (informative):
Change history

Change history
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2018-09	SA#81					Upgrade to change control version	15.0.0
2018-12	SA#82	SP-181057	0001	1	F	Correction on the User Information	15.1.0
2018-12	SA#82	SP-181057	0002	1	F	Clarification of Charging Characteristics in roaming	15.1.0
2018-12	SA#82	SP-181057	0003	1	F	Clarification of CHF selection	15.1.0
2018-12	SA#82	SP-181057	0004	1	F	Clarification of Charging Identifier	15.1.0
2018-12	SA#82	SP-181057	0029	-	F	Correction on flows for alignment with TS 23.502	15.1.0
2018-12	SA#82	SP-181057	0007	1	F	Allow updating of Notify URI	15.1.0
2018-12	SA#82	SP-181057	0008	1	F	Correction of Invocation result at http ok	15.1.0
2018-12	SA#82	SP-181057	0009	1	F	Correction of Online non-blocking handling	15.1.0
2018-12	SA#82	SP-181057	0010	1	F	Correction of UPF Id definition	15.1.0
2018-12	SA#82	SP-181057	0011	1	F	Correction of Serving Network Function ID definition	15.1.0
2018-12	SA#82	SP-181057	0012	1	F	Correction of Unused Quota Timer naming	15.1.0
2018-12	SA#82	SP-181057	0013	1	B	Introduction Data Volume Reporting for Option 4&7	15.1.0
2018-12	SA#82	SP-181057	0014	1	F	Complete flows alignment with TS 23.502	15.1.0
2018-12	SA#82	SP-181057	0015	1	F	PRA Charging Clarification	15.1.0
2018-12	SA#82	SP-181057	0016	1	F	Add missing clause on formal description	15.1.0
2019-03	SA#83	SP-190115	0030	-	F	Correction of category for subscriber identifier	15.2.0
2019-03	SA#83	SP-190116	0035	1	F	Correction of NF Consumer Information	15.2.0
2019-03	SA#83	SP-190116	0044	1	F	Correct definition of Individual Partial record mechanism	15.2.0
2019-03	SA#83	SP-190115	0046	1	F	Correction of QoS Information	15.2.0
2019-03	SA#83	SP-190115	0047	1	F	Correction of user information	15.2.0
2019-03	SA#83	SP-190115	0048	1	F	Correction of serving network function	15.2.0
2019-03	SA#83	SP-190115	0049	1	F	Correction of Trigger Conditions for FBC	15.2.0
2019-03	SA#83	SP-190115	0050	1	F	Remove Quota Consumption Time	15.2.0
2019-03	SA#83	SP-190112	0033	1	B	Addition of the Triggers for Interworking	16.0.0
2019-03	SA#83	SP-190112	0034	1	B	Addition of the Message flow for Interworking	16.0.0
2019-03	SA#83	SP-190127	0035	1	B	Add offline only charging	16.0.0
2019-03	SA#83	SP-190127	0036	1	B	Add offline only charging for SMF	16.0.0
2019-03	SA#83	SP-190127	0038	1	B	Add offline only charging CDR generation	16.0.0
2019-03	SA#83	SP-190127	0039	1	B	Add description of charging information for offline only charging	16.0.0
2019-03	SA#83	SP-190127	0040	1	B	Add offline only charging for flow based charging	16.0.0
2019-03	SA#83	SP-190127	0041	1	B	Add offline only charging for QoS flow based charging	16.0.0
2019-03	SA#83	SP-190127	0043	2	B	Add offline only charging triggers for SSC modes	16.0.0
2019-03	SA#83	SP-190127	0045	1	B	Add Offline charging service procedures.	16.0.0
2019-03	SA#83	SP-190127	0051	1	B	Add offline only charging for CHF selection	16.0.0
2019-06	SA#84	SP-190381	0057	1	B	Clarify the charging session for interworking	16.1.0
2019-06	SA#84	SP-190381	0058	1	B	Add the quota management for Interworking	16.1.0
2019-06	SA#84	SP-190381	0059	1	B	Definition of charging information for interworking with EPC	16.1.0
2019-06	SA#84	SP-190382	0060	1	B	Add detailed message format for offline charging	16.1.0
2019-06	SA#84	SP-190382	0062	1	B	CHF selection in offline only	16.1.0
2019-06	SA#84	SP-190382	0065	1	D	Correction of missing SDF abbreviation	16.1.0
2019-06	SA#84	SP-190383	0066	-	A	Correction of Start of a QoS Flow trigger	16.1.0
2019-09	SA#85	SP-190757	0067	1	B	Clarification for EPC interworking triggers	16.2.0
2019-09	SA#85	SP-190757	0068	-	B	EPC interworking call flow correction	16.2.0
2019-09	SA#85	SP-190757	0070	1	B	Modify the Charging id	16.2.0
2019-09	SA#85	SP-190757	0071	1	B	Message flow for 5GS and EPC interworking in Home routed scenario	16.2.0
2019-09	SA#85	SP-190757	0072	1	B	Definition of charging information for interworking with EPC	16.2.0
2019-09	SA#85	SP-190758	0073	1	B	Introduce offline only determination by SMF	16.2.0
2019-09	SA#85	SP-190759	0074	1	A	Correction of Serving Node change	16.2.0
2019-09	SA#85	SP-190759	0076	1	F	Correction of Termination action	16.2.0
2019-09	SA#85	SP-190757	0082	1	B	Clarification on RAT Type change	16.2.0
2019-09	SA#85	SP-190759	0083	1	A	Add the selection model in PDU session information	16.2.0
2019-09	SA#85	SP-190759	0086	1	A	Coordination of information element category	16.2.0
2019-09	SA#85	SP-190759	0087	-	A	Correction of PDU session charging information definition	16.2.0
2019-09	SA#85	SP-190759	0090	1	F	Correction of AF Charging Identifier naming	16.2.0
2019-12	SA#86	SP-191155	0107	-	A	Add the Service specification Information	16.3.0
2019-12	SA#86	SP-191159	0108	1	F	Add the Qos Characteristics	16.3.0
2019-12	SA#86	SP-191155	0109	1	A	Add the QNC support	16.3.0
2019-12	SA#86	SP-191155	0110	1	A	Correction of PCC rules description	16.3.0
2019-12	SA#86	SP-191155	0111	-	A	Correction of UPF ID in CHF CDR data	16.3.0
2019-12	SA#86	SP-191155	0113	1	A	Clarification of sponsored data connectivity charging	16.3.0
2019-12	SA#86	SP-191155	0114	1	A	Correction of Unit Count Inactivity Timer	16.3.0
2019-12	SA#86	SP-191167	0115	1	B	Add charging requirement for I-SMF	16.3.0
2019-12	SA#86	SP-191167	0116	1	B	Add charging principle for I-SMF	16.3.0
2019-12	SA#86	SP-191167	0117	1	B	Add charging trigger conditions for I-SMF	16.3.0
2019-12	SA#86	SP-191167	0118	1	B	Add I-SMF PDU session charging information	16.3.0
2019-12	SA#86	SP-191151	0121	1	F	Correction of Interworking flow	16.3.0

2019-12	SA#86	SP-191155	0122	-	F	Correction of Container definition	16.3.0
2019-12	SA#86	SP-191159	0123	1	F	Correction of QoS Based Charging description	16.3.0
2019-12	SA#86	SP-191159	0124	1	F	Definition of Emergency Session handling	16.3.0
2019-12	SA#86	SP-191177	0126	1	F	Missing default trigger for Offline only	16.3.0
2019-12	SA#86	SP-191167	0127	1	B	Adding ETSUN architecture with I-SMF insertion	16.3.0
2019-12	SA#86	SP-191167	0129	1	B	Adding I-SMF in 5G data connectivity charging information	16.3.0
2019-12	SA#86	SP-191167	0132	1	B	Adding I-SMF in PDU Session Charging message flow	16.3.0
2019-12	SA#86	SP-191167	0133	1	B	PDU Session modification procedure with I-SMF involved	16.3.0
2019-12	SA#86	SP-191167	0134	1	B	PDU session release procedure with I-SMF involved	16.3.0
2019-12	SA#86	SP-191167	0135	1	B	PDU Session procedures with I-SMF insertion/change/removal	16.3.0
2019-12	SA#86	SP-191151	0139	1	F	Correction of handover triggers	16.3.0
2019-12	SA#86	SP-191167	0142	1	B	Adding I-SMF triggers related actions in SMF	16.3.0
2019-12	SA#86	SP-191167	0144	1	B	Add CDR trigger condition for change of I-SMF	16.3.0
2019-12	SA#86	SP-191167	0145	1	B	Add charging ID assigned by SMF with I-SMF	16.3.0
2019-12	SA#86	SP-191156	0153	1	A	Correction of Unit Count Inactivity Timer	16.3.0
2019-12	SA#86	SP-191156	0154	1	A	Alignment of Rating Indicator	16.3.0
2019-12	SA#86	SP-191156	0155	1	A	Clarify on limit for multiple UPFs	16.3.0
2019-12	SA#86	SP-191156	0156	1	A	Clarify on the triggers for time and volume	16.3.0
2019-12	SA#86	SP-191167	0160	1	B	Adding I-SMF controlled UPF triggers per RG level	16.3.0
2019-12	SA#86	SP-191156	0162	1	A	Correction of charging rule base name	16.3.0
2020-03	SA#87E	SP-200170	0140	2	B	5GS to EPS handover using N26 interface with I-SMF	16.4.0
2020-03	SA#87E	SP-200170	0141	2	B	EPS to 5GS handover using N26 interface with I-SMF	16.4.0
2020-03	SA#87E	SP-200170	0167	1	B	Introduction of V-SMF change in Roaming HR - principles	16.4.0
2020-03	SA#87E	SP-200179	0168	1	B	Introduction of ATSSS architecture reference and charging requirements	16.4.0
2020-03	SA#87E	SP-200179	0169	1	B	Introduction of MA PDU session and PCC Rules	16.4.0
2020-03	SA#87E	SP-200179	0170	1	B	Introduction of ATSSS flows	16.4.0
2020-03	SA#87E	SP-200179	0172	1	B	Introduction of V-SMF change in Roaming HR - flows	16.4.0
2020-03	SA#87E	SP-200179	0182	2	B	Add the branching point or UL CL controlled by I-SMF	16.4.0
2020-03	SA#87E	SP-200164	0185	1	B	Add 5WWC charging requirements	16.4.0
2020-03	SA#87E	SP-200164	0186	1	B	Add 5WWC charging requirements	16.4.0
2020-03	SA#87E	SP-200164	0188	1	B	Add procedure for 5G-RG scenario	16.4.0
2020-03	SA#87E	SP-200164	0189	2	B	Add procedure for FN-RG scenario	16.4.0
2020-03	SA#87E	SP-200164	0190	2	B	Add description on identifier in a PDU session for 5G RG and FN RG	16.4.0
2020-03	SA#87E	SP-200170	0200	2	B	Addition/removal/change of PSA2 and UL CL or BP controlled by I-SMF	16.4.0
2020-03	SA#87E	SP-200170	0203	1	B	Remove Editor's note of PDU Session establishment with I-SMF insertion	16.4.0
2020-03	SA#87E	SP-200182	0204	3	B	Introduce CHF-Controlled Quota Management	16.4.0
2020-07	SA#88E	SP-200484	0212	1	F	Add the Retransmission Indicator	16.5.0
2020-07	SA#88E	SP-200505	0214	1	B	Add description on charging information	16.5.0
2020-07	SA#88E	SP-200505	0215	1	B	Add procedure for 5G-RG handover	16.5.0
2020-07	SA#88E	SP-200506	0217	1	F	Correction of Charging Identifier definition	16.5.0
2020-07	SA#88E	SP-200495	0218	2	B	Introduction of MA PDU session information	16.5.0
2020-07	SA#88E	SP-200495	0219	1	B	Clarify ATSSS when same rating group for 3GPP and non-3GPP	16.5.0
2020-07	SA#88E	SP-200495	0220	-	B	Introduction of ATSSS Roaming Home Routed Network requested	16.5.0
2020-07	SA#88E	SP-200495	0221	1	B	Introduction of ATSSS Roaming Home Routed UE requested	16.5.0
2020-07	SA#88E	SP-200495	0222	-	B	Introduction of ATSSS EPS interworking	16.5.0
2020-07	SA#88E	SP-200507	0223	1	F	Correction of Serving Network Function Functionality for I-SMF	16.5.0
2020-07	SA#88E	SP-200495	0224	-	B	Introduction of architecture reference for ATSSS Hybrid access	16.5.0
2020-07	SA#88E	SP-200495	0225	-	B	Introduction of flows for ATSSS Hybrid access NG-RAN and W-5GAN	16.5.0
2020-07	SA#88E	SP-200495	0226	-	B	Introduction of flows for ATSSS Hybrid access EPC and W-5GAN	16.5.0
2020-07	SA#88E	SP-200495	0227	1	B	Introduction of non-3GPP access information for MA PDU session	16.5.0
2020-07	SA#88E	SP-200495	0228	-	B	Introduction of ATSSS triggers and CDR handling	16.5.0
2020-07	SA#88E	SP-200495	0229	1	B	Introduction of MA PDU information in detailed messages	16.5.0
2020-07	SA#88E	SP-200485	0230	1	F	Correct the PDU address	16.5.0
2020-07	SA#88E	SP-200505	0232	1	B	Add Trusted non-3GPP access related charging requirements	16.5.0
2020-07	SA#88E	SP-200508	0233	1	B	Settings of Supported Features for CHFCQM	16.5.0
2020-07	SA#88E	SP-200485	0234	1	F	Correcting of PDU session information in charging data response	16.5.0

History

Document history		
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