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Foreword

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1 Scope

The present document is part of a series of Technical Specifications (TSs) specifying charging functionality and charging management in Packet Switched networks (GSM/UMTS, EPS). The 3GPP core network charging architecture and principles are specified in TS 32.240 [1], which provides an umbrella for other charging management documents 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 the charging TSs is defined in TS 32.240 [1].

The present document specifies the offline and online charging description for the Packet Switched (PS) domain based on the functional stage 2 description in TS 23.060 [201], TS 23.401 [208] and TS 23.402 [209].

The offline and online charging description for the PS domain encompasses also fixed broadband access in the convergent scenario deployment (i.e. both the fixed broadband access network and Evolved Packet Core (EPC) owned by a single operator) based on the functional stage 2 description in the corresponding Annex of TS 23.203 [215].

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

It further specifies the structure and content of the CDRs for offline charging, and the charging events for online 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 3GPP Diameter application that is used for PS domain offline and online charging is specified in TS 32.299 [50].

Note that a CAMEL based prepaid function and protocol is also specified for the PS domain (TS 23.078 [206] and TS 29.078 [202]). CAMEL entities and functions are outside the scope of the present document.

All terms, definitions and abbreviations used in the present document, which are common across 3GPP TSs, are defined in TR 21.905 [100]. Those that are common across charging management in PS domains, services or subsystems are provided in the umbrella document 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.

Furthermore, requirements that govern the charging work are specified in TS 22.115 [101].

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] - [9] Void.
- [10] 3GPP TS 32.250: "Telecommunication management; Charging management; Circuit Switched (CS) domain charging".
- [11] – [19] Void.
- [20] 3GPP TS 32.260: "Telecommunication management; Charging management; IP Multimedia Subsystem (IMS) charging".
- [21] - [29] Void.
- [30] 3GPP TS 32.270: "Telecommunication management; Charging management; Multimedia Messaging Service (MMS) charging".
- [31] 3GPP TS 32.271: "Telecommunication management; Charging management; Location Services (LCS) charging".
- [32] void.
- [33] 3GPP TS 32.273: "Telecommunication management; Charging management; Multimedia Broadcast and Multicast Service (MBMS) charging".
- [34] 3GPP TS 32.274: "Telecommunication management; Charging management; Short Message Service (SMS) charging".
- [35] - [49] Void.
- [50] 3GPP TS 32.299: "Telecommunication management; Charging management; Diameter charging application".
- [51] 3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) encoding rules description".
- [52] 3GPP TS 32.297: "Telecommunication management; Charging management; Charging Data Records (CDR) file format and transfer".
- [53] 3GPP TS 32.296: "Telecommunication management; Charging management; Online Charging System (OCS) applications and interfaces".
- [54] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".
- [55] - [99] Void.
- [100] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [101] 3GPP TS 22.115: "Service aspects; Charging and billing".
- [102] - [199] Void.
- [200] 3GPP TS 22.060: "General Packet Radio Service (GPRS); Service description; Stage 1".
- [201] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".
- [202] 3GPP TS 29.078: "Customized Applications for Mobile network Enhanced Logic (CAMEL) Phase X; CAMEL Application Part (CAP) specification".
- [203] 3GPP TS 29.060: "General Packet Radio Service (GPRS); GPRS Tunnelling Protocol (GTP) across the Gn and Gp interface".

- [204] Void.
- [205] 3GPP TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".
- [206] 3GPP TS 23.078: "Customized Applications for Mobile network Enhanced Logic (CAMEL); Phase 4; Stage 2".
- [207] 3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description".
- [208] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".
- [209] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".
- [210] 3GPP TS 29.274: "3GPP Evolved Packet System (EPS); Evolved General Packet Radio Service (GPRS) Tunnelling Protocol for Control plane (GTPv2-C); Stage 3".
- [211] 3GPP TS 29.275: "Proxy Mobile IPv6 (PMIPv6) based Mobility and Tunnelling protocols; Stage 3".
- [212] 3GPP TS 23.261: "IP flow mobility and seamless Wireless Local Area Network (WLAN) offload; Stage 2".
- [213] 3GPP TS 23.272: "Circuit Switched (CS) fallback in Evolved Packet System (EPS); Stage 2".
- [214] Void.
- [215] 3GPP TS 23.203: "Policy and charging control architecture".
- [216] 3GPP TS 29.212: "Policy and Charging Control (PCC); Reference points".
- [217] - [400] Void.
- [401] IETF RFC 3588 (2003): "Diameter Base Protocol".
- [402] IETF RFC 4006 (2005): "Diameter Credit-Control Application".
- [403] - [599] Void.
- [600] Broadband Forum TR-146: "Internet Protocol (IP) Sessions".
- [601] Broadband Forum TR-134: "Broadband Policy Control Framework (BPCF)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions defined in TR 21.905 [100], TS 32.240 [1] and TS 22.060 [200], and the following apply:

2G-/3G-: prefixes 2G- and 3G- refer to functionality that supports only GSM or UMTS, respectively, e.g. 2G-SGSN refers only to the GSM functionality of an SGSN

When the term/prefix is omitted, reference is made independently from the GSM or UMTS functionality.

accounting: process of apportioning charges between the Home Environment, Serving Network and Subscriber.

billing: function whereby CDRs generated by the charging function(s) are transformed into bills requiring payment.

Billing Domain (BD): Part of the operator network, which is outside the core network that receives and processes CDR files from the core network charging functions. It includes functions that can provide billing mediation and billing or other (e.g. statistical) end applications. It is only applicable to offline charging (see "Online Charging System" for equivalent functionality in online charging).

CAMEL: network feature that provides the mechanisms to support operator specific services even when roaming outside HPLMN.

CAMEL subscription information: identifies a subscriber as having CAMEL services.

CDR field Categories: the CDR fields are defined in the present document. They are divided into the following categories:

- **Mandatory (M):** field that shall always be present in the CDR.
- **Conditional (C):** field that shall be present in a CDR if certain conditions are met.
- **Operator Provisionable: Mandatory (O_M):** A field that operators have provisioned to always be included in the CDR.
- **Operator Provisionable: Conditional (O_C):** A field that operators have provisioned to be included in the CDR if certain conditions are met.

chargeable event: activity utilizing telecommunications network resources and related services for:

- user to user communication (e.g. a single call, a data communication session or a short message); or
- user to network communication (e.g. service profile administration); or
- inter-network communication (e.g. transferring calls, signalling, or short messages); or
- mobility (e.g. roaming or inter-system handover); and
- that the network operator may want to charge for.

As a minimum, a chargeable event characterises the resource / service usage and indicates the identity of the involved end user(s).

charged party: user involved in a chargeable event that has to pay parts or the whole charges of the chargeable event, or a third party paying the charges caused by one or all users involved in the chargeable event, or a network operator.

charging: a function within the telecommunications network and the associated OCS/BD components whereby information related to a chargeable event is collected, formatted and transferred in order to make it possible to determine usage for which the charged party may be billed.

Charging Data Record (CDR): A formatted collection of information about a chargeable event (e.g. time of call set-up, duration of the call, amount of data transferred, etc) for use in billing and accounting. For each party to be charged for parts of or all charges of a chargeable event a separate CDR is generated, i.e. more than one CDR may be generated for a single chargeable event, e.g. because of its long duration, or because more than one charged party is to be charged.

charging event: a set of charging information forwarded by the CTF towards the CDF (offline charging) or towards the OCS (online charging). Each charging event matches exactly one chargeable event.

charging function: entity inside the core network domain, subsystem or service that is involved in charging for that domain, subsystem or service.

Credit-Control: mechanism which directly interacts in real-time with an account and controls or monitors the charges, related to the service usage. Credit-Control is a process of: checking if credit is available, credit reservation, deduction of credit from the end user account when service is completed and refunding of reserved credit not used.

domain: part of a communication network that provides network resources using a certain bearer technology.

Fully Qualified Partial CDR (FQPC): partial CDR that contains a complete set of the fields specified in the present document. This includes all the mandatory and conditional fields as well as those fields that the PLMN operator has provisioned to be included in the CDR. The first Partial CDR shall be a Fully Qualified Partial CDR.

GPRS: packet switched bearer and radio services for GSM and UMTS systems.

GSM only: qualifier indicating that this clause or paragraph applies only to a GSM system. For multi-system cases this is determined by the current serving radio access network.

in GSM,....: qualifier indicating that this paragraph applies only to GSM System.

in UMTS,....: qualifier indicating that this paragraph applies only to UMTS System.

inter-system change: change of radio access between different radio access technologies such as GSM and UMTS.

IP-CAN bearer: An IP transmission path of defined capacity, delay and bit error rate, etc. See TS 21.905 [100] for the definition of bearer.

IP-CAN session: The association between a UE represented by an IPv4 address and/or an IPv6 prefix, and UE identity information, if available, and a PDN represented by a PDN ID (e.g. an APN). An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as UE IP addresses are established and announced to the IP network.

middle tier TS: used for the 3GPP charging TSs that specify the domain / subsystem / service specific, online and offline, charging functionality. These are all the TSs in the numbering range from TS 32.250 [10] to TS 32.271 [31], e.g. TS 32.250 [10] for the CS domain, or TS 32.270 [30] for the MMS service. Currently, there is only one "tier 1" TS in 3GPP, which is TS 32.240 [1] that specifies the charging architecture and principles. Finally, there are a number of top tier TSs in the 32.29x numbering range ([50] ff) that specify common charging aspects such as parameter definitions, encoding rules, the common Billing Domain (BD) interface or common charging applications.

near real-time: near real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than one (1) minute.

Non-Seamless WLAN Offload (NSWO) is a capability of routing specific IP flows over the WLAN access without traversing the EPC as defined in clause 4.1.5 of TS 23.402 [209].

offline charging: charging mechanism where charging information **does not** affect, in real-time, the service rendered.

online charging: charging mechanism where charging information can affect, in real-time, the service rendered and therefore a direct interaction of the charging mechanism with bearer/session/service control is required.

Online Charging System (OCS): the entity that performs real-time Credit-Control. Its functionality includes transaction handling, rating, online correlation and management of subscriber account balances.

packet switched domain: domain in which data is transferred between core network elements in packet switched mode.

partial CDR: CDR that provides information on part of a subscriber session. A long session may be covered by several partial CDRs. Two formats are considered for partial CDRs. One that contains all of the necessary fields (FQPC); the second has a reduced format (RPC).

Presence Reporting Area: An area defined within 3GPP Packet Domain for the purposes of reporting of UE presence within that area due to policy control and/or charging reasons. There are two types of Presence Reporting Area: "UE-dedicated Presence Reporting Area", and "Core Network pre-configuration Presence Reporting Area".

Real-time: real-time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than one (1) second.

Reduced Partial CDR (RPC): partial CDRs that only provide mandatory fields and information regarding changes in the session parameters relative to the previous partial CDR. For example, location information is not repeated in these CDRs if the subscriber did not change its location.

settlement: payment of amounts resulting from the accounting process.

Selected IP Traffic Offload (SIPTO): Offload of selected types of IP traffic (e.g. internet traffic) towards a defined IP network close to the UE's point of attachment to the access network. SIPTO is applicable to traffic offload for the macro-cellular access network and for the H(e)NB subsystem.

subscriber: A subscriber is an entity (associated with one or more users) that is engaged in a subscription with a service provider. The subscriber is allowed to subscribe and unsubscribe services, to register a user or a list of users authorized to enjoy these services, and also to set the limits relative to the use that associated users make of these services.

tariff period: part of one (calendar) day during which a particular tariff is applied. Defined by the time at which the period commences (the switch-over time) and the tariff to be applied after switch-over.

tariff: set of parameters defining the network utilization charges for the use of a particular bearer / session / service.

UMTS only: qualifier indicating that this clause or paragraph applies only to a UMTS system. For multi-system cases this is determined by the current serving radio access network.

user: An entity, not part of the 3GPP System that uses network resources by means of a subscription. The user may or may not be identical to the subscriber holding that subscription.

User Equipment (UE): A device allowing a user access to network services. For the purpose of 3GPP specifications the interface between the UE and the network is the radio interface. A UE can be subdivided into a number of domains, the domains being separated by reference points. Currently defined domains are the USIM and ME Domains. The ME Domain can further be subdivided into several components showing the connectivity between multiple functional groups. These groups can be implemented in one or more hardware devices. An example of such connectivity is the TE – MT interface. Further, an occurrence of a User Equipment is an MS for GSM as defined in GSM TS 04.02 (GSM Public Land Mobile Network (PLMN) Access Reference Configuration).

3.2 Symbols

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

| | |
|-----|--|
| A | Interface between an MSC and a BSC |
| Bp | Reference point for the CDR file transfer from the Packet Switched CGF to the BD |
| C | Interface between a HLR and a SMSC |
| D | Interface between a MSC and a HLR |
| E | Interface between a MSC and a SMSC |
| Ga | Reference point between a CDF and the CGF for CDR transfer |
| Gb | Interface between an SGSN and a BSC |
| Gc | Interface between an GGSN and an HLR |
| Gd | Interface between an SMS-GMSC and an SGSN, and between a SMS-IWMSC and an SGSN |
| Ge | Interface between a SGSN and a CAMEL GSM SCF |
| Gf | Interface between an SGSN and an EIR |
| Gi | Interface between the Packet-Switched domain and an external packet data network |
| Gn | Interface between two GSNs within the same PLMN |
| Gp | Interface between two GSNs in different PLMNs |
| Gr | Interface between an SGSN and an HLR |
| Gs | Interface between an SGSN and an MSC/VLR. |
| Gy | Online charging reference point between a PCEF and an OCS |
| Gyn | Online charging reference point between a TDF and an OCS |
| Gz | Offline charging reference point between a PCEF and an OFCS |
| Gzn | Offline charging reference point between a TDF and an OFCS |

| | |
|--------|--|
| Iu | Interface between the 3G SGSN and the UTRAN |
| kbit/s | Kilobits per second. 1 kbit/s = 2 ¹⁰ bits per second |
| Mbit/s | Megabits per second. 1 Mbit/s = 2 ²⁰ bits per second |
| R | Reference point between a non-ISDN compatible TE and MT. Typically this reference point supports a standard serial interface. |
| Rf | Offline charging reference point between a PCN network element and CDF |
| Ro | Online charging reference point between a PCN network element and the OCS |
| Um | Interface between the Mobile Station (MS) and the GSM fixed network part |
| Uu | Interface between the User Equipment (UE) and the UMTS fixed network part |

3.3 Abbreviations

For the purposes of the present document, the abbreviations defined in TR 21.905 [100] and the following apply:

| | |
|-----------|--|
| 3G | 3 rd Generation |
| ABC | Application Based Charging |
| ADC | Application Detection and Control |
| AoC | Advice of Charge |
| APN | Access Point Name |
| ARP | Allocation and Retention Priority |
| BD | Billing Domain |
| CAMEL | Customised Applications for Mobile network Enhanced Logic |
| CCA | Credit-Control-Answer |
| CCR | Credit-Control-Request |
| CDF | Charging Data Function |
| CDR | Charging Data Record |
| CG | Charging Gateway |
| CGF | Charging Gateway Function |
| CI | Cell Identity |
| CS | Circuit Switched |
| CSE | CAMEL Service Environment |
| CSG | Closed Subscriber Group |
| CSG ID | Closed Subscriber Group Identity |
| CTF | Charging Trigger Function |
| DCCA | Diameter Credit-Control Application |
| EPC | Evolved Packet Core |
| ePDG | Evolved Packet Data Gateway |
| EPS | Evolved Packet System |
| ECUR | Event Charging with Unit Reservation |
| E-UTRAN | Evolved Universal Terrestrial Radio Access Network |
| FBC | Flow Based bearer Charging |
| FQPC | Fully Qualified Partial CDR |
| GERAN | GSM EDGE Radio Access Network |
| GGSN | Gateway GPRS Support Node |
| GPRS | General Packet Radio Service |
| GSM | Global System for Mobile communication |
| GTP | GPRS Tunnelling Protocol |
| GTP' | The GPRS protocol used for CDR transport. It is derived from GTP with enhancements to improve transport reliability necessary for CDRs. |
| HeNB | Home eNode B |
| HNB | Home Node B |
| H(e)NB | HNB and HeNB |
| HLR | Home Location Register |
| HPLMN | Home PLMN |
| IEC | Immediate Event Charging |
| IETF | Internet Engineering Task Force |
| IFOM | IP Flow Mobility |
| IHOSS:OSP | Internet Hosted Octet Stream Service: Octet Stream Protocol |
| IMEI | International Mobile Equipment Identity |
| IMSI | International Mobile Subscriber Identity |
| IP | Internet Protocol |

| | |
|-----------|---|
| IP-CAN | IP Connectivity Access Network |
| IPv4 | Internet Protocol version 4 |
| IPv6 | Internet Protocol version 6 |
| ISDN | Integrated Services Digital Network |
| ITU-T | International Telecommunication Union - Telecommunications standardization sector |
| LAC | Location Area Code |
| LR | Location Request |
| M-CDR | Mobility management generated CDR |
| MAPCON | Multi Access PDN Connectivity |
| MCC | Mobile Country Code (part of IMSI) |
| ME | Mobile Equipment |
| MLC | Mobile Location Center |
| MME | Mobility Management Entity |
| MMS | Multimedia Messaging Service |
| MNC | Mobile Network Code (part of IMSI) |
| MO | Mobile Originated |
| MO-LR | Mobile Originated Location Request |
| MS | Mobile Station |
| MSISDN | Mobile Station ISDN number |
| MT | Mobile Terminated |
| MT-LR | Mobile Terminated Location Request |
| NE | Network Element |
| NI | Network Identifier (part of the APN) |
| NI-LR | Network Induced - Location Request |
| NSWO | Non-Seamless WLAN Offload |
| OAM&P | Operation, Administration, Maintenance and Provisioning |
| OCF | Online Charging Function |
| OCS | Online Charging System |
| OI | Operator Identifier (part of the APN) |
| P-GW | PDN Gateway |
| PCC | Policy and Charging Control |
| PCEF | Policy and Charging Enforcement Function |
| PCN | Packet switched Core network Node (SGSN, GGSN, S-GW, P-GW, TDF) |
| PDN | Packet Data Network |
| PDP | Packet Data Protocol (e.g. IP) |
| PDU | Packet Data Unit |
| PGW-CDR | P-GW (enhanced by FBC) generated CDR |
| PLMN | Public Land Mobile Network |
| PMIP | Proxy Mobile IP |
| PPP | Point-to-Point Protocol |
| PRA | Presence Reporting Area |
| PS | Packet Switched |
| QCI | QoS Class Identifier |
| QoS | Quality of Service |
| RAB | Radio Access Bearer |
| RAC | Routing Area Code |
| RANAP | Radio Access Network Application Part |
| RG | Residential Gateway |
| RNC | Radio Network Controller |
| RPC | Reduced Partial CDR |
| SAC | Service Area Code |
| S-CDR | SGSN (IP-CAN bearer) generated CDR |
| S-GW | Serving Gateway |
| SCUR | Session Charging with Unit Reservation |
| SDF | Service Data Flow |
| SGSN | Serving GPRS Support Node |
| SGW-CDR | S-GW (IP-CAN bearer) generated CDR |
| SIPTO | Selected IP Traffic Offload |
| SMS | Short Message Service |
| S-SMO-CDR | SGSN delivered Short message Mobile Originated CDR |
| S-SMT-CDR | SGSN delivered Short message Mobile Terminated CDR |
| TDF | Traffic Detection Function |

| | |
|---------|--|
| TDF-CDR | TDF generated CDR |
| TR | Technical Report |
| TS | Technical Specification |
| TWAG | Trusted WLAN Access Gateway |
| TWAN | Trusted WLAN Access Network |
| UMTS | Universal Mobile Telecommunications System |
| USIM | Universal Subscriber Identity Module |
| UTRAN | UMTS Terrestrial Radio Access Network |

4 Architecture considerations

4.0 General

This clause describes the functional entities involved in the PS domain charging architecture. It also presents the mappings of the ubiquitous offline and online charging architecture specified in TS 32.240 [1] onto physical implementations that are standardized for the 3GPP PS domain.

4.1 High-level EPS architecture

The 3GPP PS domain provides procedures for packet core networks described in TS 23.060 [201], TS 23.401 [208], TS 23.402 [209] and TS 23.272 [213].

For offline charging the following Packet switched Core network Nodes (PCN) may generate accounting metrics sets for PS domain CDRs:

- the SGSN, to record a user's access to PLMN resources, mobility management activities, SMS and LCS usage;
- the S-GW, to record a user's access to PLMN resources;
- the ePDG, to record a user's access to PLMN resources;
- the P-GW, to record a user's access to external networks ;
- the GGSN, to record a user's access to external networks;
- the MME, to record a user's SMS;
- the TDF, to record a user's access to external networks and applications.

The PCNs send the CDRs to the CGF in near real-time. The responsibility of the CGF is to provide non-volatile CDR storage and the Bp interface towards the Billing Domain (BD). Further details on the CGF can be found in TS 32.240 [1] and TS 32.297 [52].

For more information about online charging in PS domains see clause 4.3.

When P-GW provides connectivity to GERAN/UTRAN (P-GW acts as a GGSN) it employs P-GW charging defined in this specification. When the stand-alone GGSN provides connectivity to GERAN/UTRAN, it employs P-GW charging as defined in the present document:

- Stand-alone GGSN offline charging is based on FBC IP-CAN bearer charging data in P-GW;
- Stand-alone GGSN online charging is based on PS Information used for online charging.

4.2 PS domain offline charging architecture

As described in TS 32.240 [1], the CTF (an integrated component in each charging relevant NE) generates charging events and forwards them to the CDF. The CDF, in turn, generates CDRs which are then transferred to the CGF. Finally, the CGF creates CDR files and forwards them to the BD.

If the PCN generating the charging information has an integrated CDF, then the PCN can produce CDRs. The CGF may also be integrated in the PCN, or it may exist as a physically separate entity.

If the CGF is external to the PCN, then the CDF forwards the CDRs to the CGF across the Ga interface.

In this case, the relationship between PCN/CDF and CGF is m:1.

If the CGF is integrated in the PCN, then there is only an internal interface between the CDF and the CGF.

In this case, the relationship between PCN/CDF and CGF is 1:1. An integrated CGF may support the Ga interface from other PCN/CDFs.

If the CDF is external to the PCN, the charging events are transferred from the PCN to the CDF via the Rf interface specified in TS 32.299 [50]. In this case, the relationship between PCN and CDF is m:1.

When an external CGF is used, this CGF may also be used by other, i.e. non-PS, 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 Bp interface does not exist and is replaced by a proprietary solution internal to the BD.

Figure 4.2.1 depicts the architectural options described above.

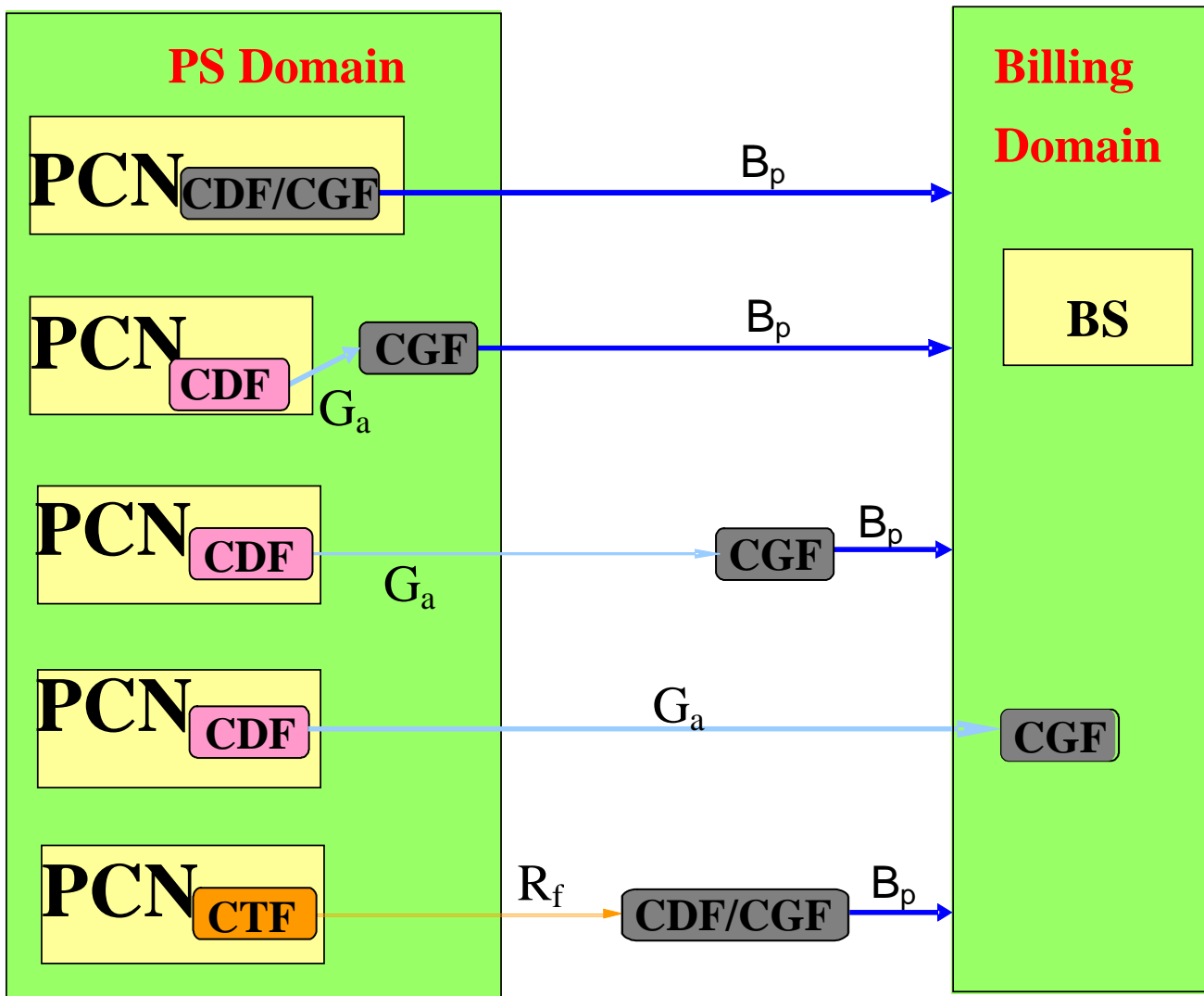


Figure 4.2.1: PS domain offline charging architecture

The P-GW includes a Policy and Charging Enforcement Function (PCEF) to support Flow Based bearer Charging (FBC) functionality; this is not depicted in figure 4.2.1. The Traffic Detection Function (TDF) supports Application Based Charging (ABC) functionality. The Rf, Ga and Bp interfaces include the required functionality, e.g. defined for the Gz/Gzn reference point in TS 23.203 [215]. Refer to clause 5.2.1.3, TS 32.240 [1] and TS 23.203 [215] for further details on FBC.

The PCNs may provide inter-operator charging functionality for Multimedia Broadcast/Multicast Services (MBMS) defined in TS 23.246 [207] and TS 32.273 [33], not for subscriber charging.

It is mandatory to support at least one of the options Rf, Ga or Bp interfaces from the PCN as described in the specification.

NOTE: The Rf interface details are specified for S-GW, ePDG, MME, TDF and P-GW in this release.

4.3 PS domain online charging architecture

PS domain online charging based on SGSN functions is implemented by CAMEL techniques as described in TS 23.078 [206] and TS 29.078 [202], i.e. outside the scope of the 32-series of charging TSs. Note, however, that the CDRs described in the present document contains CAMEL information. This is because some of that information is relevant to offline charging in case of CAMEL control of (part of) the session, and thus needs to be captured in the offline charging information. However, this is not related to the online charging functions for the PS domain.

Mechanisms to enable PS domain online charging from the P-GW with included PCEF and the TDF are specified in the present document, utilising the Ro interface and the associated Diameter application as specified in TS 32.299 [50]. The reason for this alternative solution to CAMEL is that operators may enforce the use of HPLMN P-GWs and TDF in the case of roaming, hence P-GW or TDF service control and charging can be executed in the HPLMN in all circumstances. The P-GW and TDF based PS domain online charging architecture is depicted in figure 4.3.1.

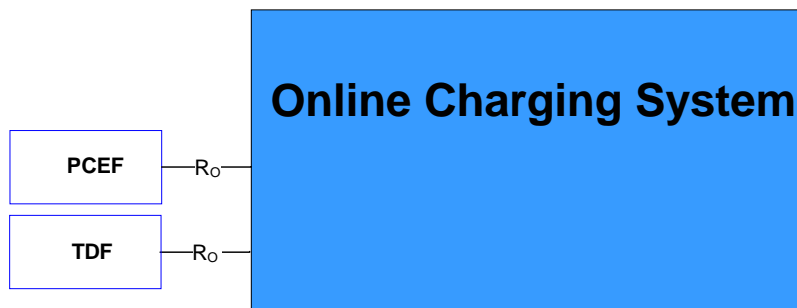


Figure 4.3.1: PS domain online charging architecture

The Ro reference point includes the functionality defined for the Gy reference point (required for the PCEF) and the Gyn reference point (required for the TDF) in TS 23.203 [215]. Refer to clause 5.2.1.3, TS 32.240 [1] and TS 23.203 [215] for further details on FBC.

Details on the interfaces and functions can be found in TS 32.240 [1] for the general architecture components, TS 32.296 [53] for the OCS, and TS 32.299 [50] for the Ro application.

5 PS domain charging principles and scenarios

5.1 PS charging principles

5.1.0 General

The charging functions specified for the PS domain relate to:

- mobility management, refer to TS 23.060 [201];
- SMS transmissions / receptions, refer to TS 23.060 [201] , and TS 23.272 [213];
- IP-CAN bearers, refer to TS 23.060 [201], TS 23.401 [208] and TS 23.402 [209];
- LCS events, refer to TS 32.271 [31];
- individual service data flows (identified by Service data flow filters or application identifier) within a IP-CAN bearer, refer to TS 23.203 [215];
- TDF session, refer to TS 23.203 [215];
- network usage for specific applications within a TDF session, refer to TS 23.203 [215] ;
- MBMS bearer contexts, refer to TS 23.246 [207] and TS 32.273 [33].

5.1.1 Requirements

The following are high-level charging requirements specific to the packet domain, derived from the requirements in TS 22.115 [101], TS 23.060 [201], TS 23.401 [208], TS 23.402 [209] and TS 23.203 [215].

- 1) Every IP-CAN bearer shall be assigned a unique identity number for billing purposes. (i.e. the Charging Id).

NOTE: An IP-CAN session is identified by the unique identity number assigned to the default bearer for the IP-CAN session.

- 2) Data volumes on both the uplink and downlink directions shall be counted separately. The data volumes shall reflect the data as delivered to and from the user. When the P-GW includes PCEF, the data volumes shall also reflect the data as delivered to and from the serving node at the bearer level.
- 3) The charging mechanisms shall provide the duration of the IP-CAN bearer with date and time information.
- 4) The network operator may define a subset of the charging information specified by PS domain charging standards. This means that it shall be possible to configure the PCN for the CDR information generated.
- 5) The PCNs shall be capable of handling the Charging Characteristics. Charging Characteristics can be specific for a subscription, subscribed IP-CAN bearer (i.e. per APN) or per TDF session, see annex A for details.
- 6) The SGSN shall support charging of CAMEL services.
- 7) The SGSN shall support charging for location requests.
- 8) The SGSN may support online charging using CAMEL techniques.
- 9) The P-GW may support online charging using IETF based techniques.
- 10) The P-GW may be capable of identifying data volumes, elapsed time or events for individual service data flows (Flow Based bearer Charging). One PCC rule identifies one service data flow.
- 11) When online charging is used in the P-GW/TDF, the Credit-Control shall be per rating group.
- 12) P-GW/TDF shall allow reporting of the service or detected application /detected application usage per rating group or per combination of the rating group and service id. This reporting level can be activated per PCC/ADC rule.
- 13) The P-GW shall collect charging information for IP -CAN session as it would for one IP-CAN bearer in case of PMIP based connectivity is used.
- 14) Charging support in the SGSN shall apply only for SGSN with Gn/Gp connectivity.
- 15) The data volume shall be counted regardless of whether the subscriber's traffic has been offloaded from the mobile operator's network.

Editor's Notes: This requirement should be rerefined after finalization of the architecture for Selected IP Traffic Offload charging.

- 16) The TDF may support online charging using IETF techniques.
- 17) The TDF shall be capable of identifying data volumes, elapsed time or events for specific applications (ABC).
- 18) The charging mechanisms shall provide the duration of the TDF session with date and time information.

These requirements apply equally to PS domain online charging and offline charging.

5.1.2 Charging information

Charging information in the PS domain network is collected for each MS/UE by the SGSNs, MMEs, S-GWs, ePDG, P-GWs and TDFs, which are serving that MS/UE. The SGSN, S-GW, and ePDG collect charging information for each MS/UE related with the radio network usage, while the P-GW and TDF collect charging information for each MS related with the external data network usage. PCNs also collect charging information on usage of the PS domain network resources. For MBMS, charging information in the PS domain network is collected for each MBMS bearer context.

The following paragraphs list the charging information to be collected by the PCNs for both online and offline charging.

For IP-CAN bearers, the PCNs shall collect the following charging information:

1. usage of the radio interface: the charging information shall describe the amount of data transmitted in MO and MT directions categorized with QoS and user protocols;
2. usage duration: duration of IP-CAN bearer is counted as the time interval from IP-CAN bearer activation to IP-CAN bearer deactivation;
3. usage of the general PS domain resources: the charging information shall describe the usage of other PS domain-related resources and the MSs PS domain network activity (e.g. mobility management);
4. destination and source: the charging information shall provide the actual source addresses used by the subscriber for the IP-CAN bearer. The charging information shall describe the destination addresses with a level of accuracy as determined by the Access Point Name (APN);
5. 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 APN.

NOTE: When charging per IP-CAN session is deployed in the P-GW, the usage of the external data networks is provided only at the session level and not per bearer.

6. location of MS/UE: HPLMN, VPLMN, plus optional higher-accuracy location information.
7. User CSG information: a user consumes network services via a CSG cell or a hybrid cell according to the user CSG information. The charging information shall include CSG ID, access mode and CSG membership indication.
8. User inside/outside of a Presence Reporting Area: the charging information shall include indication on whether the UE is inside or outside of a Presence Reporting Area, and identification of the Presence Reporting Area, and is collected by SGW and PGW

For service data flows defined for FBC, the P-GW shall collect the following charging information:

1. the information described above for IP-CAN bearer charging;
2. the amount of data transmitted in MO and MT directions categorized by rating group or combination of the rating group and service id when volume based charging applies;
3. 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;
4. 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.

For TDF sessions, the TDF shall collect the following charging information:

1. usage duration: duration of TDF session is counted as the time interval from TDF session activation to TDF session deactivation;
2. usage of the general PS domain resources: the charging information shall describe the usage of other PS domain-related resources and the MSs PS domain network activity (e.g. mobility management);
3. destination and source: the charging information shall provide the actual source addresses used by the subscriber for the TDF session. The charging information shall describe the destination addresses with a level of accuracy as determined by the APN;

4. 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 APN.
5. location of MS/UE: HPLMN, VPLMN, plus optional higher-accuracy location information.
6. User CSG information: a user consumes network services via a CSG cell or a hybrid cell according to the user CSG information. The charging information shall include CSG ID, access mode and CSG membership indication.
7. User inside/outside of a Presence Reporting Area: the charging information shall include indication on whether the UE is inside or outside of a Presence Reporting Area, and identification of the Presence Reporting Area.

For application traffic defined for ABC, the TDF shall collect the following charging information:

1. the information described above for TDF session charging;
2. the amount of data transmitted as specific application in MO and MT directions categorized by rating group or combination of the rating group and service identifier when volume based charging applies;
3. the duration of application traffic is counted and categorized by rating group or combination of the rating group and service identifier when time based charging applies;
4. the number of events and corresponding timestamps categorized by rating group or combination of the rating group and service identifier when event based charging applies.

For non-IP-CAN bearer related activities, the SGSN shall collect the following charging information:

1. mobility management actions for GPRS attached UEs/MSs;
2. short messages passing through the SGSN in MO and MT directions;
3. location requests passing through the SGSN, triggered by the UE/MS, by an external source, or by the network.

For MBMS bearer contexts, the PCNs shall collect the following charging information:

1. usage of the radio interface: the charging information shall describe the amount of data transmitted categorized with QoS and MBMS specific information defined in TS 32.273 [33];
2. usage duration: duration of MBMS bearer context is counted as the time interval from the local creation of the MBMS bearer context to the local deletion of the MBMS bearer context;
3. source: the charging information shall provide the source address used by the MBMS bearer service for the MBMS bearer context. The charging information may describe the destination addresses with a level of accuracy as determined by the APN;
4. location information: the charging information shall describe a list of the downstream nodes being sent the MBMS bearer service.

The MME shall collect short messages passing through the MME in MO and MT directions.

5.1.3 Identifiers and correlation

The EPC charging identifier assigned per IP-CAN bearer, is used for correlation purpose within PS domain, as specified in TS 32.240 [1].

Within a PDN connection, the EPS default bearer remains established throughout the lifetime of this PDN connection and is assigned with its "EPS default bearer charging identifier". Other additional IP-CAN bearers (i.e. dedicated bearers) which may be activated and deactivated during this PDN connection, are each assigned with their own "IP-CAN bearer charging identifier". For correlation of charging information for the whole PDN connection, this "EPS default bearer charging identifier" is shared by all these IP-CAN bearers charging sessions activated during this PDN connection, as the "PDN connection charging identifier".

For PMIP based connectivity, an "unique Charging Id" is assigned by the P-GW for the PDN connection (i.e. as it would be one IP-CAN bearer).

For ABC by the TDF:

- in case of GTP based connectivity, an "EPS default bearer charging identifier",
- in case of PMIP based connectivity, an "unique Charging Id"

is assigned by the P-GW and transferred to the TDF via the PCRF for the TDF session.

During handover of a PDN connection between a GTP based connectivity access, and a PMIP based connectivity access for the P-GW (and reversely), the "EPS default bearer charging identifier" and the "unique Charging Id" respectively, are maintained in order to ensure charging continuity for the whole PDN connection over the different accesses.

Upon handover from GTP based connectivity to PMIP based connectivity, the previously assigned "EPS default bearer charging identifier" is used as the "unique Charging Id". Upon handover from PMIP based connectivity to GTP based connectivity, the previously assigned "unique Charging Id" is used as the "EPS default bearer charging identifier".

When multiple simultaneous PDN connections are established for a given APN, each PDN connection is associated with its own "PDN connection charging identifier" or "unique Charging Id" and processed independently from the other PDN connections.

When a "MAPCON capable UE", as defined in TS 23.402 [209], has simultaneous PDN connections through different access networks, each PDN connection is associated with its own "PDN connection charging identifier" or "unique charging Id" over the selected access for the PDN connection. When selective transfer of PDN connections between the different accesses is performed, each PDN connection is transferred, as for a single PDN connection.

When an "IFOM capable UE", as defined in TS 23.402 [209], is simultaneously connected to 3GPP access and WLAN access for different IP flows within the same PDN connection, each service data flow is uniquely identified by a PCC Rule within the PDN connection.

When SIPTO function applies, as defined in TS 23.060 [201] and TS 23.401 [208] the standard charging behaviour for PDN connection activation/deactivation applies on the respective GW.

For inter-level correlation when charging per IP-CAN session is not active, the charging identifier assigned to the specific bearer used for a dynamic PCC rule serves as the PS domain access network charging identifier. For inter-level correlation when Charging per IP-CAN session is active, the charging identifier assigned to the PDN connection serves as the PS domain access network charging identifier assigned to a dynamic PCC rule. Transport of PS domain access network charging identifier to an external application function are specified in TS 29.212 [216].

5.1.4 UE Presence in Presence Reporting Area

UE Presence in Presence Reporting Area (PRA) charging information, as defined in TS 23.401 [208] and TS 23.203 [215], is collected for each UE by S-GWs, P-GWs and TDFs which are serving that UE.

During IP-CAN session establishment, a Presence Reporting Area (PRA) for the PDN connection is determined. The PCRF, when deployed, may provide a Presence Reporting Area (PRA) to the P-GW. The PCRF-selected PRA is then delivered to the TDF and OCS. When the PCRF does not provide a PRA, the OCS may provide the PRA to the P-GW. Only one PRA may be selected per PDN connection. The PCEF shall ignore any "Presence Reporting Area identifier" provided during the lifetime of the IP-CAN session after establishment procedure.

During IP-CAN session establishment, the PCRF, TDF (via PCRF), and OCS may independently subscribe to notifications of whether the UE is entering or leaving a Presence Reporting Area (PRA). At any time during the IP-CAN session, the PCRF, TDF (via PCRF), and OCS may independently subscribe/unsubscribe to these notifications. When subscribed, the UE presence status in the PRA at the time of the subscription, and subsequently whether the UE enters or leaves the PRA, shall be reported by the P-GW or TDF to the OCS for online charging when subscribed by OCS, and by the S-GW, P-GW, and TDF for offline charging.

For offline charging, the initial status of UE presence in the PRA shall be captured in current counts and reported on first charging event. For online charging, this initial status shall be reported *when received by the PCEF if quota have already been requested for the service usage, otherwise this initial status shall be reported on the first quota request.*

5.2 PS domain offline charging scenarios

5.2.1 Basic principles

5.2.1.0 General

In order to provide the data required for the management activities outlined in TS 32.240 [1] (billing, accounting, statistics etc.), the SGSN shall be able to produce CDRs, and the MME, S-GW, ePDG, P-GW and TDF shall be able to produce CDRs or report charging events for CDRs generation by CDF, as specified for each node type in the following:

- Charging data related to IP-CAN bearers in the SGSN (S-CDR), S-GW (SGW-CDR), ePDG (ePDG-CDR) and P-GW (PGW-CDR);
- Charging data related to service data flows in the P-GW (PGW-CDR);
- Charging data related to MM contexts (Mobile Station Mobility Management Data) in SGSN (M-CDR);
- SMS Mobile Originated data (S-SMO-CDR) and SMS Mobile Terminated Data (SMS-SMT-CDR) in the SGSN;
- Charging data related to mobile originated location requests (LCS-MO-CDR), mobile terminated location request (LCS-MT-CDR), and network induced location request (LCS-NI-CDR) passing through the SGSN;
- Charging data related to MBMS bearer contexts (S-MB-CDR, G-MB-CDR, and MBMS-GW-CDR).
- SMS Mobile Originated data (S-SMO-CDR) and SMS Mobile Terminated Data (S-SMT-CDR) in the MME;
- Charging data related to TDF session (TDF-CDR) in the TDF;
- Charging data related to application traffic in the TDF (TDF-CDR).

The contents and purpose of each of these CDRs, as well as the chargeable events that trigger CDR creation, information addition, or closure are described in the following clauses. A detailed formal description of the CDR parameters defined in the present document is to be found in TS 32.298 [51].

When the CDF is implemented as a separate entity (for the MME, S-GW, ePDG, P-GW and TDF), the charging events triggering and contents for CDRs handling by the CDF, are described in clause 5.2.2.

5.2.1.1 IP-CAN bearer charging

SGSN, ePDG, P-GW, and S-GW collect charging information per user per IP-CAN bearer. In case of P-GW is not aware of IP-CAN bearers, i.e. in case of PMIP based connectivity, P-GW collects charging information per IP-CAN session as it would be one IP-CAN bearer. IP-CAN bearer charging allows the PCNs to collect charging information related to data volumes sent to and received by the UE/MS, categorised by the QCI and ARP applied to the IP-CAN bearer. The user can be identified by MSISDN and/or IMSI, while the IP-CAN bearer can be determined by a unique identifier generated by the P-GW when creating a IP-CAN bearer. This identifier is also forwarded to the S-GW/ePDG/SGSN so as to allow correlation of S-GW/ePDG/SGSN IP-CAN bearer CDRs with the matching P-GW CDRs in the BD.

NOTE: The control plane IP address of SGSN or P-GW(acting as GGSN) is the IP address used at Gn/Gp interface. The control plane IP address of S-GW or P-GW is the IP address used at S5/S8 interface. The control plane IP address of ePDG or P-GW is the IP address used at S2b interface.

IP-CAN bearer specific offline charging in P-GW, is achieved by FBC offline charging, with specific rating group/service identifier, see clause 5.2.1.3.

The main collected information items are duration of the IP-CAN bearer and data volume transferred during the lifetime of the IP-CAN bearer. The following chargeable events are defined for SGSN, S-GW and ePDG IP-CAN bearer charging:

- Start of IP-CAN bearer. Upon encountering this event, a new CDR for this IP-CAN bearer is created and the data volume is captured for the IP-CAN bearer.
- End of IP-CAN bearer in the SGSN/S-GW/ePDG. The CDR is closed upon encountering this trigger.
- Tracking Area Update of:
 - Inter-SGSN/inter S-GW. The IP-CAN bearer CDR is closed in SGSN/S-GW upon encountering this trigger.
 - Inter-MME. In S-GW a new MME address is added to CDR upon encountering this trigger.
 - S4-SGSN to MME. In S-GW a new MME address is added to CDR upon encountering this trigger.
 - MME to S4-SGSN. In S-GW a new S4-SGSN address is added to CDR upon encountering this trigger.
- Intersystem change (e.g. change of radio interface from GSM to UMTS or vice versa). This event closes the CDR. A new one is opened if the IP-CAN bearer is still active.
- PLMN change visible in the P-GW. This event closes the CDR. A new one is opened if the IP-CAN bearer is still active.
- MS Timezone change visible in the P-GW. This event closes the CDR. A new one is opened if the IP-CAN bearer is still active.
- Expiry of an operator configured time limit per IP-CAN bearer. This event closes the CDR, and a new one is opened if the IP-CAN bearer is still active.
- Expiry of an operator configured data volume limit per IP-CAN bearer. This event closes the CDR, and a new one is opened if the IP-CAN bearer is still active.
- Change of charging condition in the SGSN: e.g. QoS change, tariff time change, user CSG information change or direct tunnel establishment/removal. When this event is encountered, the current volume count is captured and a new volume count is started.
- Change of charging condition in the S-GW: e.g. QoS change, tariff time change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area. When this event is encountered, the current volume counts are captured and a new volume counts are started.
- Change of charging condition in the ePDG: e.g. QoS change, tariff time change. When this event is encountered, the current volume counts are captured and a new volume counts are started.
- Expiry of an operator configured change of charging condition limit per IP-CAN bearer. This event closes the CDR, and a new one is opened if the IP-CAN bearer is still active.

- Management intervention may also force trigger a chargeable event.

When the CDF is implemented as a separate entity, all these chargeable events defined for IP-CAN bearer, trigger charging events reporting, for CDRs (S-GW, ePDG and P-GW CDRs) to be constructed, enriched or closed by CDF, according to description in clause 5.2.2.

5.2.1.2 MM context charging

The SGSN collects charging information for mobility management actions per attached UE/MS, i.e. per user. The user can be identified by MSISDN and/or IMSI. There can be only one MM context per UE/MS at a time, and only the SGSN is involved. Therefore there is no need for special MM context identifiers. The main information items collected are changes of location pertaining to the UE/MS. The following chargeable events are defined for MM context charging:

- Start of MM context (UE/MS attaches to a SGSN). A new M-CDR is created upon encountering this event.
- End of MM context: explicit or implicit GPRS detach, including SGSN change (inter-SGSN routing area update including intersystem change). This event triggers the closure of the M-CDR.
- Mobility Change, i.e. a change in the Routing Area. The new location information is captured for the M-CDR.
- Expiry of an operator configured time limit. This event triggers the closure of the M-CDR.
- Expiry of an operator configured mobility change limit. This event triggers the closure of the M-CDR.
- Intra-SGSN intersystem change (change of radio interface from GSM to UMTS or vice versa). This event triggers the closure of the M-CDR.

Management intervention may also force trigger a chargeable event.

5.2.1.3 Flow Based bearer Charging (FBC)

IP-CAN bearer charging allows the P-GW to collect charging information related to data volumes sent to and received by the UE/MS, categorised by the QoS applied to the IP-CAN bearer. FBC is supported by the P-GW by the integration of a PCEF. With PCEF, the normal IP-CAN bearer charging is enhanced by the capability to categorise the service data flows within IP-CAN bearer data traffic by rating group or combination of the rating group and service id. I.e., while there is only one uplink and one downlink data volume count per IP-CAN bearer in IP-CAN bearer charging, FBC provides one count per each rating group or combination of the rating group and service id. The level of the reporting is defined per PCC rule. Details of this functionality are specified in TS 23.203 [215] and TS 32.240 [1].

NOTE: The P-GW can only include one QoS Information occurrence per service data container. This implies if an operator wishes to be able to separate usage according to QCI and ARP within their billing system they will need to ensure that services having different QCI 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.

IP-CAN bearer specific offline charging is achieved with IP-CAN bearer specific rating group/service identifier defined in clause 5.3.1.1.

According to TS 23.203 [215], 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. In general the charging of a service data flow shall be linked to the IP-CAN bearer under which the service data flow has been activated. The following chargeable events are defined for FBC:

- Start of IP-CAN bearer. Upon encountering this event, a new PGW-CDR for this context is created.
- Start of service data flow. If service identifier level reporting is required by the PCC rule new counts and time stamps for this combination of the rating group and service id are started. If rating group level reporting is required by the PCC rule needed new counts and time stamps for this rating group are started. The type of counters shall depend on the measurement method configured for the PCC rule. When event based charging applies, the first occurrence of an event matching a service data flow template in PCC rule shall imply that a new count is started. When new events occur, the counter shall be increased. Each event shall be time stamped.
- Termination of service data flow. If service identifier level reporting is required by the PCC rule and this was the last active service data flow for this combination of the rating group and service id or if rating group level reporting is required by the PCC rule and this was the last active service data flow for this rating group, the counters and time stamps are closed and added to the PGW-CDR. For information on how the termination of service data flows is detected, refer to TS 23.203 [72].
- End of IP-CAN bearer in the P-GW. The PGW-CDR is closed upon encountering this trigger.
- Serving node (e.g. SGSN/S-GW/ePDG) change in the P-GW. New SGSN/S-GW/ePDG address is added to PGW-CDR.
- Expiry of an operator configured time limit per IP-CAN bearer. This event closes the PGW-CDR, and a new one is opened if the IP-CAN bearer is still active.
- Expiry of an operator configured time limit per rating group. The counters and time stamps are closed and added to the PGW-CDR. A new service data flow container is opened if any matching service data flow is still active.
- Expiry of an operator configured data volume limit per IP-CAN bearer. This event closes the PGW-CDR, and a new one is opened if the IP-CAN bearer is still active.
- Expiry of an operator configured data volume limit per rating group. The counters and time stamps are closed and added to the PGW-CDR. A new service data flow container is opened if any matching service data flow is still active.
- Expiry of an operator configured data event limit per rating group. The counters and time stamps are closed and added to the PGW-CDR. A new service data flow container is opened if any matching service data flow is still active.
- Change of charging condition: IP-CAN bearer modification (e.g. QoS change, SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area), tariff

time change or failure handling procedure triggering. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all active service data flows are started.

- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change) visible in the P-GW. This event closes the PGW-CDR, and a new one is opened if the IP-CAN bearer is still active.
- PLMN change visible in the P-GW. This event closes the PGW-CDR. A new one is opened if the IP-CAN bearer is still active.
- MS Timezone change visible in the P-GW. This event closes the PGW-CDR. A new one is opened if the IP-CAN bearer is still active.
- SGSN change in the P-GW. New SGSN address is added to PGW-CDR.
- Expiry of an operator configured report of service flow data limit per IP-CAN bearer. This event closes the PGW-CDR, and a new one is opened if the IP-CAN bearer is still active.
- Completion of a time envelope as defined in TS 32.299 [50]. This event closes a service data flow container. Further details are described in clause 5.2.3.4.1 "Triggers for PGW-CDR Charging Information Addition". The need for reporting time envelopes may be statically configured for each rating group or dynamically controlled by online charging.

Management intervention may also force trigger a chargeable event.

Relevant service data flows for a certain IP-CAN bearer are determined when FBC is applied. PCC rules are used for this determination. One PCC rule identifies service data flow to be measured but it can also include certain characteristics related to that service data flow.

PCC rules can be activated, deactivated and modified any time during the IP-CAN bearer lifetime. PCC rule activation, deactivation and modification are not chargeable events. However these PCC rule changes may lead to "start of service data flow" and "termination of service data flow" chargeable events.

A PCC rule can contain e.g.:

- service data flow template (service data flow filters or application identifier) to identify packets belonging to certain service data flow,
- charging method to identify whether online/offline/both/neither charging interface is used,
- measurement method for offline charging to identify whether time/volume/events are measured for this service data flow,
- Charging key (i.e. rating group) for that service data flow,
- service identifier for that service data flow,
- Sponsor Identifier (offline charging only),
- Application Service Provider Identifier (offline charging only),
- application function record information to correlate the measurement with application level reports,
- reporting level for the service data flow (rating group or combination of the rating group and service id),
- precedence to the situations where two or more PCC rules are overlapping.

PCC rules can be:

- pre-defined in P-GW (can be activated either by the PCRF or PCEF itself) or,
- dynamically provisioned and activated by the PCRF over the Gx interface.

This is specified in TS 23.203 [215] and TS 29.212 [216].

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic PCC rule which is active in the PCEF: Charging key, Service identifier, Sponsor Identifier, Application Service Provider Identifier, Measurement method, and Service identifier level reporting. A change of any of this charging information will trigger a

"start of service data flow" chargeable event when a valid counter does not exist corresponding to that changed PCC rule. A change of any of this charging information will trigger a "termination of service data flow" chargeable event when this was the last active service data flow for the counter corresponding to the original PCC rule.

When the CDF is implemented as a separate entity, all these FBC related chargeable events, trigger charging events reporting, for P-GW CDRs to be constructed, enriched or closed by CDF, according to description in clause 5.2.2.

Extended packet inspection can be done in the PCEF with pre-defined PCC rules. The PCEF also have the possibility to output service specific information related to the packet inspection in the CDR.

The capability of P-GW to support ABC is achieved with PCRF providing appropriate PCC rules to the P-GW. 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.

5.2.1.4 SMS charging

The SGSN and the MME collect charging information for each Short Message sent to, or received by, a MS/UE. There are two chargeable events for SMS charging in the SGSN and MME:

- the transfer of a SM through the SGSN and MME in MO direction;
- the transfer of a SM through the SGSN and MME in MT direction.

Management intervention may also force trigger a chargeable event.

5.2.1.5 LCS charging

The SGSN collects charging information for each Location Request for a MS/UE. The following chargeable events are specified for LCS:

- A location request for a MS/UE triggered by that MS/UE (LCS-MO);
- A location request for a MS/UE triggered by an external entity (LCS-MT);
- A location request for a MS/UE triggered by the network (LCS-NI).

Management intervention may also force trigger a chargeable event.

5.2.1.6 MBMS context charging for GPRS

The SGSN and GGSN collects charging information for each MBMS bearer service activated. The following chargeable events are specified for MBMS:

- Start of MBMS bearer context. Upon encountering this event, a new CDR for this MBMS bearer context is created and the data volume is captured for the MBMS bearer context.
- End of MBMS bearer context in the SGSN/GGSN. For the SGSN only, this trigger includes inter-SGSN routing area update (e.g. the last UE using the MBMS bearer context leaves the routing area). The MBMS bearer context CDR is closed upon encountering this trigger.
- Expiry of an operator configured time limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.
- Expiry of an operator configured data volume limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.
- Change of charging condition: tariff time change. When this event is encountered, the current volume count is captured and a new volume count is started.
- Expiry of an operator configured change of charging condition limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.

Management intervention may also force trigger a chargeable event.

5.2.1.6A MBMS context charging for EPS

In EPS, MBMS GW is the function entity which may be stand alone or co-located with other network elements such as BM-SC or combined S-GW/PDN-GW. The MBMS GW collects charging information for each MBMS bearer service activated. The following chargeable events are specified for MBMS:

- Start of MBMS bearer context. Upon encountering this event, a new CDR for this MBMS bearer context is created and the data volume is captured for the MBMS bearer context.
- End of MBMS bearer context in the MBMS GW.
- Expiry of an operator configured time limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.
- Expiry of an operator configured data volume limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.
- Change of charging condition: tariff time change. When this event is encountered, the current volume count is captured and a new volume count is started.
- Expiry of an operator configured change of charging condition limit per MBMS bearer context. This event closes the MBMS bearer context CDR, and a new one is opened if the MBMS bearer context is still active.

Management intervention may also force trigger a chargeable event.

The MBMS control plane function is supported by MME for E-UTRAN access and by SGSN for UTRAN access.

5.2.1.7 IP Flow Mobility (IFOM) charging

An "IFOM capable UE", as defined in TS 23.402 [209], may be simultaneously connected to 3GPP access and WLAN access for different IP flows within the same PDN connection, as described in TS 23.261 [212].

In the P-GW, FBC (as described in clause 5.2.1.3) applies to the corresponding service data flows, carried by appropriate IP-CAN bearer(s) activated for both accesses.

For a PDN connection, charging for each service data flow, is performed within the IP-CAN bearer charging session of the IP-CAN bearer it belongs to, according to its associated PCC Rule.

As described in TS 23.261 [212], the UE may also move one or more IP flow(s) from 3GPP access to WLAN access (and reversely). The transfer of the corresponding service data flow(s) from one access to the other access, results in PCC Rule(s) removed from the IP-CAN bearer(s) of the source access, leading to termination of service data flow", and PCC Rule(s) installed into the IP-CAN bearer(s) of the target access.

For each service data flow, identified by its PCC Rule, this PCC Rule may be provided with a different description depending on the access type where it has to be enforced. In particular, the rating group may differ, as a way to apply charging differentiation per-access type. The charging method, measurement method, reporting level may also potentially be different, in case charging behaviour is not expected to be unified between both domains.

In order to ensure the accurate level of granularity of service data flows charging, the associated PCC Rule shall be defined with the service identifier level reporting.

For the case where dynamic PCC is not deployed, per-access Charging Characteristics and pre-defined PCC Rule(s) in P-GW may be used as a way to apply charging differentiation.

5.2.1.8 Sponsored data connectivity charging

According to TS 23.203 [215] two deployment scenarios exist for sponsored data connectivity. The Sponsor Identifier and Application Service Provider Identifier are provided for sponsored services to the PCRF from the AF over the Rx interface.

In the first scenario the PCRF assigns a service specific Charging Key for a sponsored IP flow. The Charging key is used by the PCEF to generate separate accounting records for offline charging and/or usage data records for online charging for the sponsored flows. Correlation of accounting records and usage data records from multiple users per sponsor and/or application service provider is then performed using the charging key.

In a second scenario the Sponsor Identifier and Application Service Provider Identity is included in PCC-rules from the PCRF to the PCEF. For this scenario the same Charging Key may be used both for IP flows that are sponsored and for flows that are not sponsored. Accounting records generated by the PCEF for offline charging include the Sponsor Identity and the Application Service Provider Identity. Correlation of accounting records from multiple users per sponsor and/or application service provider can then be based on Sponsor Identity and Application Service Provider Identity instead of the Charging Key. Usage reporting for online charging including Sponsor Identity and Application Service Provider Identity has not been specified in this release of the specification. PCC-rules that include a Sponsor Identity and an Application Service Provider Identity should include a Charging Method that indicates offline charging.

5.2.1.9 Application Based Charging (ABC)

5.2.1.9.0 Introduction

For the sub-clauses that follow, a single CDR is defined to handle both TDF session and ABC information when both are to be used. Either TDF session charging, ABC or both may be active as determined by Charging Characteristics. For ABC the opening and closing of CDRs is bound to the TDF session start and end respectively. Many application containers per TDF session can be active simultaneously within the TDF CDR see clause 5.2.3.9.1.

When the CDF is implemented as a separate entity, all of these TDF session and ABC related chargeable events, trigger charging events reporting, for CDRs to be constructed, enriched or closed by CDF, according to clause 5.2.2.

5.2.1.9.1 Charging per application

ABC allows collection of charging information for network usage of application traffic, categorized within the TDF session by rating group or combination of rating group and service identifier. ABC supported by TDF is based on ADC rules. Details of this functionality are specified in TS 23.203 [215].

NOTE: ABC is supported by the P-GW embedding PCEF enhanced with application detection and control functionality as defined in TS 23.203 [215], by mean of appropriate PCC Rules, and therefore specified under FBC clause 5.2.1.3.

According to TS 23.203 [215], ABC shall support different charging models per ADC rule. These charging models may be based on volume and/or time and on number of event matching specific detected application traffic in ADC rule. The following chargeable events are defined for ABC when offline charging is activated:

- Start of TDF session. Upon encountering this event, a new TDF-CDR for this context is created.
- Start of application traffic. If service identifier level reporting is required by the ADC rule, new counts and time stamps for this combination of the rating group and service identifier are started. If rating group level reporting is required by the ADC rule new counts and time stamps for this rating group are started. The type of counters shall depend on the measurement method configured for the ADC rule. When event based charging applies, the first occurrence of an event detected by the pre-defined ADC rules shall imply that a new count is started. When new events occur, the counter shall be increased. Each event shall be time stamped.
- Termination of application traffic. If service identifier level reporting is required by the ADC rule or if rating group level reporting is required by the ADC rule, the counters and time stamps are closed and added to the TDF-CDR.
- End of TDF session in the TDF. The TDF-CDR is closed upon encountering this trigger.
- Expiry of an operator configured time limit for keeping a CDR open. This event closes all counters. The resulting containers are data to the CDR and the CDR is closed. A new CDR is opened if the TDF session is still active.
- Expiry of an operator configured time limit per rating group. The counters and time stamps are closed and added to the TDF-CDR. A new application traffic container is opened if any application related to the rating group is still active.
- Expiry of an operator configured data volume limit per TDF session. This event closes the TDF-CDR, and a new one is opened if the TDF session is still active.
- Expiry of an operator configured data volume limit per rating group. The counters and time stamps are closed and added to the TDF-CDR. A new one is opened if any application related to the rating group is still active.
- Expiry of an operator configured data event limit per rating group. The counters and time stamps are closed and added to the TDF-CDR. A new one is opened if any application related to the rating group is still active.
- Expiry of an operator configured data event limit per TDF session. This event closes the TDF-CDRs, and new one is opened if the TDF session is still active.
- Change of charging condition: TDF session modification (e.g. SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area), tariff time change

or failure handling procedure triggering. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all active applications are started.

- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change) visible in the TDF. This event closes the TDF-CDR, and a new one is opened if the TDF session is still active.
- PLMN change visible in the TDF. This event closes the TDF-CDR. A new one is opened if the TDF session is still active.
- MS Timezone change visible in the TDF. This event closes the TDF-CDR. A new one is opened if the TDF session is still active.
- Completion of a time envelope as defined in TS 32.299 [50]. This event closes an application traffic container. Further details are described in clause 5.2.3.9.2 "Triggers for TDF-CDR Charging Information Addition". The need for reporting time envelopes may be statically configured for each rating group or dynamically controlled by online charging.

Management intervention may also force trigger a chargeable event.

ADC rules can be activated, deactivated and modified any time during the TDF session lifetime. ADC rule activation, deactivation and modification are not chargeable events of ABC. However these rule changes may lead to "start of application traffic" and "termination of application traffic" chargeable events.

Application Detection and Control rule can contain e.g.:

- Application Identifier to identify detected application,
- charging method to identify whether online/offline/both/neither charging interface is used,
- measurement method for online/offline charging to identify whether time/volume/events are measured for this application,
- Charging key (i.e. rating group) for that application,
- service identifier for that application,
- reporting level for the application (rating group or combination of the rating group and Service identifier),
- precedence to the situations where two or more ADC rules are overlapping.

Application Detection and Control rule can be:

- pre-defined in TDF (can be activated by the PCRF) or,
- dynamically provisioned and activated by the PCRF over the Sd interface.

This is specified in TS 23.203 [215] and TS 29.212 [216].

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic ADC rule: Charging key, Service identifier, Measurement method, and Service identifier level reporting. A change of any of this charging information triggers a "start of application traffic" chargeable event when a valid counter does not exist corresponding to that changed ADC rule. A change of any of this charging information triggers a "termination of application traffic" chargeable event when this was the last active application for the counter corresponding to the original ADC rules.

5.2.1.9.2 Charging per TDF session

TDF collects charging information per user per TDF session. TDF session charging allows the TDF to collect charging information related to data volumes sent to and received by the UE/MS for the timeframe since the establishment till the termination of TDF session. The user can be identified by MSISDN and/or IMSI, while the TDF session can be determined by a unique identifier generated by the P-GW (an "EPS default bearer Charging Identifier" for GTP based connectivity or an "unique Charging Id" for PMIP based connectivity) when establishing TDF session.

TDF session specific offline charging in TDF is achieved by ABC offline charging, with a vendor specific rating group/service identifier associated with the TDF session. The main collected information items are duration of the TDF session and data volume transferred during the lifetime of the TDF session. When Charging per TDF session is active, the following chargeable events are defined:

- Start of TDF session. Upon encountering this event, a new TDF-CDR for this context is created.
- End of TDF session in the TDF. The TDF-CDR is closed upon encountering this trigger.
- Expiry of an operator configured time limit for keeping a CDR open. This event closes all counters. The resulting containers are data to the CDR and the CDR is closed. A new CDR is opened if the TDF session is still active.
- Expiry of an operator configured time limit per TDF session. This event closes the CDR, and a new one is opened if the TDF session is still active.
- Expiry of an operator configured data volume limit per TDF session. This event closes the TDF-CDR, and a new one is opened if the TDF session is still active.
- Change of charging condition: TDF session modification (e.g. SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area), tariff time change or failure handling procedure triggering. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all active applications are started.
- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change) visible in the TDF. This event closes the TDF-CDR, and a new one is opened if the TDF session is still active.
- PLMN change visible in the TDF. This event closes the TDF-CDR. A new one is opened if the TDF session is still active.
- MS Timezone change visible in the TDF. This event closes the TDF-CDR. A new one is opened if the TDF session is still active.

Expiry of an operator configured change of charging condition limit per TDF session. This event closes the CDR, and a new one is opened if the TDF session is still active.

NOTE: All the events defined above are a shared events with ABC in clause 5.2.1.9.1 for the single shared CDR.

Management intervention may also force trigger a chargeable event.

5.2.1.10 Charging per IP-CAN session

5.2.1.10.0 General

Charging per IP-CAN session is an optional capability in the P-GW that provides for a consolidated view of the charging information across all bearers in the IP-CAN session. When charging per IP-CAN session is active, the basic principles in this clause apply to the P-GW instead of the principles in clause 5.2.1.1 and clause 5.2.1.3 above.

For the sub-clauses that follow, a single PGW-CDR is defined to handle both types of charging information when both are to be used. When Charging per IP-CAN session is active, either IP-CAN bearer charging, FBC or both may be active as determined by Charging Characteristics.

When the CDF is implemented as a separate entity, all of these IP-CAN bearer and FBC related chargeable events, trigger charging events reporting, for CDRs to be constructed, enriched or closed by CDF, according to description in clause 5.2.2.

5.2.1.10.1 IP-CAN bearer charging

For the purpose of interoperator charging, the P-GW collects charging information per user per IP-CAN bearer. In case the P-GW is not aware of IP-CAN bearers, i.e. in case of PMIP based connectivity, P-GW collects charging information per IP-CAN session as it would be one IP-CAN bearer. IP-CAN bearer charging allows the P-GW to collect charging information related to data volumes sent to and received by the UE/MS, categorised by the QCI and ARP applied to the IP-CAN bearer. The user can be identified by MSISDN and/or IMSI, while the IP-CAN bearer can be determined by a unique identifier generated by the P-GW when creating an IP-CAN bearer. This identifier is forwarded to the S-GW/ePDG/SGSN so as to allow correlation of S-GW/ePDG/SGSN IP-CAN bearer CDRs with the matching P-GW charging information in the BD.

The amount of data counted for the IP-CAN bearer shall be the user plane payload at the tunnelling (e.g. GTP-u, GRE Tunnel) interface. Time metering is started when IP-CAN bearer is activated.

- NOTE 1: The control plane address of the P-GW, together with the unique charging identifier assigned by the P-GW, enables the correlation of charging information. The control plane IP address of SGSN or P-GW (acting as GGSN) is the IP address used at Gn/Gp interface.
 The control plane IP address of S-GW or P-GW is the IP address used at S5/S8 interface.
 The control plane IP address of ePDG or P-GW is the IP address used at S2b interface.

When Charging per IP-CAN session is active and measurements for IP-CAN bearers are captured in the same CDR as FBC measurements, the following chargeable events are defined:

- Start of the default bearer for an IP-CAN session.
 Upon encountering this event, a new CDR for the IP-CAN session is created and the data volume counts (i.e., uplink and downlink) are started and captured for the IP-CAN bearer.

NOTE 2: Start of the default bearer for an IP-CAN session is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- Start of a dedicated bearer for an IP-CAN session.
 Additional volume counts are started and captured for the dedicated bearer.
- End of dedicated bearer in the P-GW.
 The counters and time stamps for the IP-CAN bearer are closed and resulting container added to the CDR.
- End of IP-CAN session (i.e. end of default bearer) in the P-GW.
 The counters and time stamps for all IP-CAN bearers and the resulting containers added to the CDR. The CDR is closed.

NOTE 3: The End of IP-CAN session event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- Serving node (e.g. SGSN/S-GW/ePDG) change in the P-GW.
 New SGSN/S-GW/ePDG address is added to data for the IP-CAN bearer in the CDR.

- Expiry of an operator configured time limit for keeping a CDR open.
This event closes all counters. The resulting containers are added to the CDR and the CDR is closed.
A new CDR is opened if the IP-CAN session is still active.

NOTE 4: The expiry of an operator configured time limit for keeping a CDR open event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- Expiry of an operator configured time limit per IP-CAN bearer.
The counters and time stamps for the IP-CAN bearer are closed and added to the CDR. A new IP-CAN bearer traffic volume container is opened if the IP-CAN bearer is still active.
- Expiry of an operator configured data volume limit per IP-CAN session.
This event closes the CDR and a new one is opened if the IP-CAN session is still active.

NOTE 5: The expiry of an operator configured data volume limit per IP-CAN session event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- Expiry of an operator configured data volume limit per IP-CAN bearer.
The counters and time stamps are closed and added to the CDR. A new IP-CAN bearer traffic volume container is opened if the IP-CAN bearer is still active.
- Change of charging condition specific to APN-AMBR change.
This event closes the CDR, and a new one is opened if the IP-CAN session is still active.
- Change of charging condition specific to IP-CAN bearer modification QoS change.
When this event is encountered, all counts and time stamps for the modified bearer are captured and new counts and time stamps for the specific bearer are started.
- Change of charging condition.
IP-CAN bearer modification except QoS change (e.g. SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area), or tariff time change. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all active bearers are started.

NOTE 7: The change of charging condition event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

Editor's Note: whether the special case of user location reporting on dedicated bearer release triggers a change of charging condition for the IP-CAN session is ffs.

- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change) visible in the P-GW.
This event closes the CDR, and a new one is opened if the IP-CAN session is still active.

NOTE 8: The intersystem change event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- PLMN change visible in the P-GW. This event closes the CDR.
A new one is opened if the IP-CAN session is still active.

NOTE 9: The PLMN change event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- MS Timezone change visible in the P-GW. This event closes the CDR.
A new one is opened if the IP-CAN session is still active.

NOTE 10: The PLMN change event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

- Expiry of an operator configured limit of number of charging condition changes per IP-CAN session.
This event closes the CDR, and a new one is opened if the IP-CAN session is still active.

NOTE 11: The expiry of an operator configured limit of number of charging condition changes event is a shared event for FBC in clause 5.2.1.10.2 for the single shared CDR.

Management intervention may also force trigger a chargeable event.

5.2.1.10.2 Flow Based Charging (FBC)

For the purpose of end-user charging, FBC is supported by the P-GW by the integration of a PCEF. With PCEF, charging is enhanced by the capability to categorise the service data flows within IP-CAN session data traffic by rating group or combination of the rating group and service id. FBC provides separate counts per each rating group or combination of the rating group and service id. The level of the reporting is defined per PCC rule. Details of this functionality are specified in TS 23.203 [215] and TS 32.240 [1].

NOTE 1: Even though an individual service data flow template is bound to a specific IP-CAN bearer, the assigned rating group or combination of rating group and service id applies to the entire IP-CAN session. As a result, data traffic from multiple bearers can be included in the count maintained for the rating group or combination of the rating group and service id. This implies if an operator wishes to be able to separate usage according to IP-CAN bearer within their billing system they will need to ensure that services having different QCI and ARP do not have the same:

- rating group in cases where rating group reporting is used;
- rating group/service id where rating group/service id reporting is used.

NOTE 2: The P-GW can only include one QoS Information occurrence per service data container. This implies if an operator wishes to be able to separate usage according to QCI and ARP within their billing system they will need to ensure that services having different QCI and ARP do not have the same:

- rating group in cases where rating group reporting is used;
- rating group/service id where rating group/service id reporting is used.

According to TS 23.203 [215], 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 Charging per IP-CAN session is active and FBC measurements are captured in the same CDR as measurements for IP-CAN bearers, the following chargeable events are defined:

- Start of the default bearer for an IP-CAN session.
Upon encountering this event, a new CDR for the IP-CAN session is created. No service data flow counters are started.

NOTE 3: The start of the default bearer for an IP-CAN session event is a shared trigger for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- Start of service data flow.
If service identifier level reporting is required by the PCC rule, and no counts are present already for this combination of the rating group and service id, then new counts and time stamps for this combination of the rating group and service id are started. If rating group level reporting is required by the PCC rule, and no counts are present already for this rating group, then new counts and time stamps for this rating group are started. The type of counters shall be according to the measurement method configured for the PCC rule. When event based charging applies, the first occurrence of an event matching a service data flow template in PCC rule shall imply that a new count is started. When new events occur, the counter shall be increased. Each event shall be time stamped.
- Termination of service data flow.
If service identifier level reporting is required by the PCC rule and this was the last active service data flow for this combination of the rating group and service id or if rating group level reporting is required by the PCC rule and this was the last active service data flow for this rating group, the counters and time stamps are closed and the resulting containers added to the CDR. For information on how the termination of service data flows is detected, refer to TS 23.203 [215].
- End of IP-CAN session (i.e. end of default bearer) in the P-GW.
The counters and time stamps for all rating groups and all combinations of rating group and service id are closed and the resulting containers added to the CDR. The CDR is closed.

NOTE 4: The end of IP-CAN session event is a shared event for IP-CAN Bearer Charging in clause 5.2.1.10.1 for the single shared CDR.

- Expiry of an operator configured time limit for keeping a CDR open.
This event closes all counters. The resulting containers are added to the CDR and the CDR is closed.
A new CDR is opened if the IP-CAN session is still active.

NOTE 5: The end of operator configured time limit for keeping a CDR open event is a shared event for IP-CAN Bearer Charging in clause 5.2.1.10.1 for the single shared CDR.

- Expiry of an operator configured time limit per rating group.
The counters and time stamps are closed and added to the CDR.
A new service data flow container is opened if any matching service data flow is still active.
- Expiry of an operator configured data volume limit per IP-CAN session.
This event closes the CDR and a new one is opened if the IP-CAN session is still active.

NOTE 6: The expiry of an operator configured data volume limit per IP-CAN session event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- Expiry of an operator configured data volume limit per rating group.
The counters and time stamps are closed and added to the CDR.
A new service data flow container is opened if any matching service data flow is still active.
- Expiry of an operator configured data event limit per IP-CAN session.
This event closes the CDR and a new one is opened if the IP-CAN session is still active.

NOTE 7: The expiry of an operator configured data event limit per IP-CAN session event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- Expiry of an operator configured data event limit per rating group.
The counters and time stamps are closed and added to the CDR.
A new service data flow container is opened if any matching service data flow is still active.
- Change of charging condition.
IP-CAN bearer modification except QoS change (e.g. SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area), tariff time change or failure handling procedure triggering.
When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all service data flows are started.

NOTE 8: The change of charging condition event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

Editor's Note: whether the special case of user location reporting on dedicated bearer release triggers a change of charging condition for the IP-CAN session is ffs.

- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change) visible in the P-GW.
This event closes the CDR, and a new one is opened if the IP-CAN session is still active.

NOTE 9: The intersystem change event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- PLMN change visible in the P-GW.
This event closes the CDR. A new one is opened if the IP-CAN session is still active.

NOTE 10: The PLMN change event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- MS Timezone change visible in the P-GW.
This event closes the CDR. A new one is opened if the IP-CAN session is still active.

NOTE 11: The MS Timezone change event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- Expiry of an operator configured limit of charging condition changes per IP-CAN session.
This event closes the CDR, and a new one is opened if the IP-CAN session is still active.

NOTE 12: The expiry of an operator configured limit of charging condition changes per IP-CAN session event is a shared event for IP-CAN bearer charging in clause 5.2.1.10.1 for the single shared CDR.

- Completion of a time envelope as defined in TS 32.299 [50].
This event closes a service data flow container. Further details are described in clause 5.2.3.10.1 "Triggers for PGW-CDR charging information addition".
The need for reporting time envelopes may be statically configured for each rating group or dynamically controlled by online charging.

Management intervention may also force trigger a chargeable event.

Relevant service data flows for an IP-CAN session are determined when FBC is applied. PCC rules are used for this determination. One PCC rule identifies service data flow to be measured but it can also include certain characteristics related to that service data flow.

PCC rules can be activated, deactivated and modified any time during the IP-CAN session lifetime.

IP-CAN bearer deactivation also leads to deactivation of all PCC rules associated with that bearer.

PCC rule activation, deactivation and modification are not chargeable events.

However these PCC rule changes may lead to "start of service data flow" and "termination of service data flow" chargeable events.

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic PCC rule which is active in the PCEF: Charging key, Service identifier, Sponsor Identifier, Application Service Provider Identifier, Measurement method and Service identifier level reporting.

A change of any of this charging information will trigger a "start of service data flow" chargeable event when a valid counter does not exist corresponding to that changed PCC rule.

A change of any of this charging information will trigger a "termination of service data flow" chargeable event when this was the last active service data flow for the counter corresponding to the original PCC rule.

Extended packet inspection can be done in the PCEF with pre-defined PCC rules.

The PCEF also have the possibility to output service specific information related to the packet inspection in the CDR.

5.2.2 Rf message flows

5.2.2.0 General

When the CDF is implemented as a separate entity, the offline charging functionality is based on the PCN nodes (MME, S-GW, ePDG, P-GW and TDF) reporting charging information for chargeable events. This reporting is achieved by sending Charging Data Request[Start, Interim, Stop and Event] from the PCN network elements to the CDF.

The PCNs shall use the Charging Characteristics profiles to determine whether Charging events (Charging Data Request[Start, Interim, Stop and Event]) reporting has to be activated or not.

The trigger conditions for the chargeable events described in 5.2.3.5 for the MME, 5.2.3.3 for the S-GW, 5.2.3.8 for the ePDG, 5.2.3.9 for the TDF and in 5.2.3.4 for the P-GW are also applicable, and charging events are reported to the external CDF when these trigger conditions are met.

The following clauses provide the charging events reporting description for MME, S-GW, ePDG, P-GW and TDF.

5.2.2.1 Triggers for charging events from S-GW

When a Charging Event is reported to the CDF, it includes details such as Subscription id (e.g. IMSI..), Charging-id, SGW address etc. and also a container identifying, for the IP-CAN bearer, the volume count (separated for uplink and downlink traffic), with charging condition change information.

As stated above, the same trigger conditions described in 5.2.3.3 are applicable for charging information addition and Charging Data Request closure.

Charging Data Request[Start] is sent at IP-CAN bearer activation.

For an Charging Data Request[Interim] to be sent with only one container reported, the Partial Record Reason "Maximum number of charging condition changes" should be set to value 1.

5.2.2.2 Triggers for charging events from P-GW

When a Charging Event is reported to the CDF, it includes details such as Subscription id (e.g. IMSI), Charging-id, SGW address, ePDG address, TWAG address, FBC specific charging data etc.,and also a container identifying per rating group or combination of the rating group and service id within the same IP-CAN bearer; the volume counts (separated for uplink and downlink traffic), elapsed time and/or number of events, with associated charging condition change information.

As stated above, the same trigger conditions described in clause 5.2.3.4 are applicable for charging information addition and Charging Data Request closure.

Charging Data Request[Start] is sent at IP-CAN bearer activation.

For an Charging Data Request[Interim] to be sent with only one container reported, the Partial Record Reason "Maximum number of charging condition changes" should be set to value 1.

Editor's Note : tight interworking with online charging and DCCA failure handling is FFS.

5.2.2.3 Triggers for charging events from ePDG

When a Charging Event is reported to the CDF, it includes details such as Subscription id (e.g. IMSI), Charging-id, ePDG address etc. and also a container identifying for the IP-CAN bearer, the volume count (separated for uplink and downlink traffic), with charging condition change information.

As stated above, the same trigger conditions described in clause 5.2.3.8 are applicable for charging information addition and Charging Data Request closure.

Charging Data Request[Start] is sent at IP-CAN bearer activation.

For an Charging Data Request[Interim] to be sent with only one container reported, the Partial Record Reason "Maximum number of charging condition changes" should be set to value 1.

5.2.2.4 Triggers for charging events from MME

Each Short Message transferred through the MME to/from the SMSC, triggers a Charging Event towards the CDF:

- Short Message received by a UE via the MME (MT direction) from the SMSC;
- Short Message sent by a UE via the MME (MO direction) to the SMSC.

This Charging event reporting is achieved by the MME in Event mode, by sending Charging Data Request[Event] to the CDF, on successful or unsuccessful Short Message transfer transaction with UE.

5.2.2.5 Triggers for charging events from TDF

When a Charging Event is reported to the CDF, it includes details such as Subscription id (e.g. IMSI), Charging-id, SGW address, ePDG address, TWAG address, ABC specific charging data etc., and also a container identifying per rating group or combination of the rating group and service id within the same TDF session; the volume counts (separated for uplink and downlink traffic), elapsed time and/or number of events, with associated charging condition change information TDF session charging is achieved by ABC offline charging with vendor specific rating group or a combination of vendor specific rating group and service id within the same TDF session, see clause 5.2.1.9..

As stated above, the same trigger conditions described in 5.2.3.9 are applicable for charging information addition and Charging Data Request closure.

Charging Data Request Start] is sent at TDF session activation.

For an Charging Data Request[Interim] to be sent with only one container reported, the Partial Record Reason "Maximum number of charging condition changes" should be set to value 1.

5.2.2.6 Triggers for charging events from P-GW when charging per IP-CAN session is active

When a Charging Event is reported to the CDF and charging per IP-CAN session is active, it includes details such as Subscription id (e.g. IMSI), Charging-id, SGW address, ePDG address, TWAG address, FBC specific charging data etc.,and contains either one or both of the following different types of containers:

- traffic volumes, used for IP-CAN bearer charging, identifying per QCI/ARP combination, the volume counts (separated for uplink and downlink traffic) with associated charging condition change information
- service data, used for FBC, identifying per rating group or combination of the rating group and service id within the IP-CAN session, the volume counts (separated for uplink and downlink traffic), elapsed time and/or number of events, with associated charging condition change information.

The trigger conditions described in clause 5.2.3.10 are applicable for charging information addition and Charging Data Request closure.

Charging Data Request[Start] is sent at IP-CAN session activation.

For an Charging Data Request[Interim] to be sent with only one container reported, the Partial Record Reason "Maximum number of charging condition changes" should be set to value 1.

5.2.3 CDR generation

5.2.3.0 Introduction

The S-CDR, M-CDR, S-SMO-CDR, S-SMT-CDR, LCS-MO-CDR, LCS-MT-CDR, LCS-NI-CDR and S-MB-CDR are generated by the SGSN, the S-SMO-CDR, S-SMT-CDR by the MME, the SGW-CDR by the S-GW, the ePDG-CDR by the ePDG, the PGW-CDR G-MB-CDR by the P-GW, the TDF-CDR by the TDF to collect charging information that they subsequently transfer to the Charging Gateway Function (CGF).

The PCNs shall use the Charging Characteristics to determine whether to activate or deactivate CDR generation. The Charging Characteristics are also used to set the coherent chargeable event conditions (e.g. time/volume limits that trigger CDR generation or information addition). Multiple Charging Characteristics "profiles" may be configured on the PCNs to allow different sets of trigger values. Further details of this functionality, including the mechanism of conveying the Charging Characteristics data item (HLR -> SGSN -> P-GW, HSS -> MME/ S4-SGSN -> S-GW -> P-GW, or AAA -> ePDG -> P-GW), are specified and then in case of TDF, P-GW -> PCRF -> TDF in annex A. Charging Characteristics are not applicable to MBMS CDR generation.

If CDR generation is activated, it shall be possible to define separate trigger conditions values per Charging Characteristics profile for the following triggers:

- data volume limit;
- time (duration limit);
- maximum number of charging conditions changes (QoS change, Tariff Time change).

The following clauses describe the trigger conditions for the chargeable events described in clause 5.2.1.1 – 5.2.1.6A. In EPC offline charging, these chargeable events correspond to the triggers for collection of charging information and CDR generation by the SGSN/ MME/S-GW/ePDG/P-GW/TDF.

5.2.3.1 Triggers for S-CDR charging information collection

5.2.3.1.0 General

An S-CDR is used to collect charging information related to the IP-CAN bearer data information for a MS/UE in the SGSN.

If according to the Charging Characteristics, CDR generation is activated an S-CDR shall be opened at IP-CAN bearer activation, and the volume for the context is counted separately in uplink and downlink direction. When a change of charging condition occurs, the volume count is added to the S-CDR and a new count is started. The S-CDR includes details such as Record Type, Served IMSI, Sequence Number etc. Not all of the charging information to be collected is static, and other charging information is directly depending on dynamic Packet-Switched service usage.

The subsequent clauses identify in detail the conditions for adding information to, and closing the S-CDR for generation towards the CGF.

5.2.3.1.1 Triggers for S-CDR charging information addition

The "List of Traffic Volumes" attribute of the S-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume count per IP-CAN bearer, separated for uplink and downlink traffic, on encountering that trigger condition. Table 5.2.3.1.1.1 identifies which conditions are supported to trigger S-CDR charging information addition.

Table 5.2.3.1.1.1: Triggers for S-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|-------------------------------------|--|
| QoS Change | A change in the QoS shall result in a "List of Traffic Data Volumes" container being added to the CDR. |
| Tariff Time Change | On reaching the Tariff Time Change a "List of Traffic Data Volumes" container shall be added to the CDR. |
| User CSG Information change | A change in user CSG information shall result in a "List of Traffic Data Volumes" container being added to the CDR, if CSG information reporting is required, and a report of User CSG information change is received. |
| Direct Tunnel establishment/removal | When the SGSN establishes or removes a Direct Tunnel a "List of Traffic Data Volumes " container shall be added to the CDR. See NOTE. |
| CDR Closure | A list of "List of Traffic Data Volumes" container shall be added to the S-CDR. |
| NOTE: | When a direct tunnel is established, the SGSN will no longer be able to count data volumes associated with the IP-CAN bearer for which the direct tunnel is established |

The first volume container of a IP-CAN bearer identifies the uplink/downlink volume since the IP-CAN bearer was opened. Subsequent volume containers store the volume count accrued since the closure of the last container.

5.2.3.1.2 Triggers for S-CDR closure

The S-CDR shall be closed on encountering some trigger conditions.

Table 5.2.3.1.2.1 identifies which conditions are supported to permit closure of the S-CDR.

Table 5.2.3.1.2.1: Triggers for S-CDR closure

| Closure Conditions | Description/Behaviour |
|--------------------------------------|--|
| End of IP-CAN bearer within the SGSN | Deactivation of the IP-CAN bearer in the SGSN shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of IP-CAN bearer; - SGSN change (inter-SGSN routing area update including intersystem change); - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes (QoS/tariff time change); - management intervention; - Intra-SGSN intersystem change (change of radio interface from GSM to UMTS or vice versa). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics.

The Partial Record generation trigger thresholds are GSN configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the S-CDR is closed and the IP-CAN bearer remains active, a further S-CDR shall be opened with an incremented Sequence Number in the SGSN.

5.2.3.2 Triggers for M-CDR charging information collection

5.2.3.2.0 General

An M-CDR is used to collect charging information related to the mobility management of a mobile in the SGSN.

An M-CDR shall be opened for each mobile upon GPRS Attach, indicating the current location information for that MS/UE. When a location change occurs for the attached MS/UE, the new location information is added to the M-CDR. The M-CDR records details such as Record Type, Served IMSI, Sequence Number etc.

Not all of the charging information to be collected is static, and other charging information is directly dependent on the mobility of the MS as provided by the Radio Access Network (RAN). Subsequent partial records may be opened if the M-CDR is closed and the MS is still attached to the network.

The subsequent clauses identify in detail the conditions for adding information to, and closing of the M-CDR for generation towards the CGF.

5.2.3.2.1 Triggers for M-CDR charging information addition

The "Change of Location" attribute of the M-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the time stamped routing area on encountering that trigger condition.

Table 5.2.3.2.1.1 identifies which conditions are supported to trigger M-CDR charging information addition.

Table 5.2.3.2.1.1: Triggers for M-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|--------------------|---|
| Mobility Change | The first "Change of Location" container shall be captured when the MM context is created. Subsequent changes in the Routing Area shall result in a "Change of Location" container being added to the M-CDR. |

5.2.3.2.2 Triggers for M-CDR closure

The M-CDR shall be closed on encountering some trigger conditions.

Table 5.2.3.2.2.1 identifies which conditions are supported to permit closures of the M-CDR.

Table 5.2.3.2.2.1: Triggers for M-CDR closure

| Closure Conditions | Description/Behaviour |
|-------------------------------|---|
| End of MM Context within SGSN | Deactivation of the MM context in the SGSN shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - SGSN change (inter-SGSN routing area update including intersystem change); - GPRS detach; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - time (duration) limit; - maximum number of mobility changes; and - Management intervention; - Intra-SGSN intersystem change (change of radio interface from GSM to UMTS or vice versa). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics. The Partial Record generation trigger thresholds are SGSN configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the M-CDR is closed and the mobile is still known to the SGSN, a further M-CDR shall be opened with an incremented Sequence Number in the SGSN.

5.2.3.3 Triggers for SGW-CDR charging information collection

5.2.3.3.0 Introduction

A SGW-CDR is used to collect charging information related to the IP-CAN bearer data information for a UE/MS in the S-GW.

SGW-CDR separates collected charging information per QCI/ARP pair. SGW-CDR can include:

- IP-CAN bearer specific container reporting the usage and authorized QCI/ARP for IP-CAN bearer.

Each SGW-CDR includes at least IP-CAN bearer specific container(s).

If, according to the Charging Characteristics, CDR generation is activated a SGW-CDR shall be opened at IP-CAN bearer activation and IP-CAN bearer specific container is opened..

When a change of charging condition occurs, the volume counts are added to the SGW-CDR and new counts are started. The SGW-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

The subsequent clauses identify in detail the conditions for adding information to, and closing the SGW-CDR for generation towards the CGF.

5.2.3.3.1 Triggers for SGW-CDR charging information addition

The "List of Traffic Data Volumes" attribute of the SGW-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume count per QCI/ARP pair, separated for uplink and downlink traffic, on encountering that trigger condition.

Table 5.2.3.3.1.1 identifies which conditions are supported to trigger SGW-CDR charging information addition.

Table 5.2.3.3.1.1: Triggers for SGW-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|--|--|
| QoS Change | A change in the QoS shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR and new IP-CAN bearer specific container is opened. |
| Tariff Time Change | On reaching the Tariff Time Change open "List of Traffic Data Volumes" containers shall be closed and added to the CDR. |
| User Location Change | A change in the User Location Info (e.g. ECGI, TAI, RAI, SAI or CGI) shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if location reporting is required, and a report of User Location Change is received. |
| User CSG Information change | A change in the User CSG info (e.g. CSG ID, access mode or CSG membership indication) shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if CSG information reporting is required, and a report of User CSG information change is received. |
| Change of UE presence in Presence Reporting Area | A change of UE presence in Presence Reporting Area shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if such reporting is required, and a report that user enters/leaves the area is received. |
| CDR Closure | Open "List of Traffic Data Volumes" containers shall be closed and added to the SGW-CDR. |

Volume container identifies the uplink/downlink volume since the closure of the last container.

The "Serving Node Address" attribute of the SGW-CDR consists of a list of serving node (e.g. S4-SGSN/MME) addresses. New serving node address is added to the list when e.g. S4-SGSN/MME changes.

When Charging Event (ACR) is triggered by table 5.2.3.3.1.1 conditions, the Change-Condition sub-field associated to the added volume container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added volume container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

5.2.3.3.2 Triggers for SGW-CDR closure

The SGW-CDR shall be closed on encountering some trigger conditions.

Table 5.2.3.3.2.1 identifies which conditions are supported to permit closure of the SGW-CDR.

Table 5.2.3.3.2.1: Triggers for SGW-CDR closure

| Closure Conditions | Description/Behaviour |
|--------------------------------------|---|
| End of IP-CAN bearer within the S-GW | Deactivation of the IP-CAN bearer in the S-GW shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of IP-CAN bearer; - S-GW change; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes (QoS/tariff time change); - management intervention; - MS time zone change; - PLMN change; - radio access technology change (RAT Type). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics.

The Partial Record generation trigger thresholds are S-GW configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the SGW-CDR is closed and the IP-CAN bearer remains active, a further SGW-CDR is opened with an incremented Sequence Number in the S-GW.

When Charging Event (ACR) is triggered by table 5.2.3.3.2.1 conditions, the Change-Condition (at PS information level) associated to the CDR Closure, indicating the appropriate condition shall be present, and it shall be omitted otherwise.

5.2.3.4 Triggers for PGW-CDR charging information collection

5.2.3.4.0 Introduction

An PGW-CDR is used to collect charging information related to the IP-CAN bearer data information for a UE/MS in the P-GW, where the data volumes, elapsed time or number of events within each PGW-CDR are separately counted per rating group or per combination of the rating group and service id. In case of P-GW is not aware of IP-CAN bearers, i.e. in case of PMIP based connectivity, P-GW collects charging information per IP-CAN session as it would be one IP-CAN bearer.

Many service data flow containers per IP-CAN bearer can be active simultaneously in PGW-CDR. A service data flow container is activated when traffic is detected and no matching active service data flow container exist; a service data flow container is closed when the termination of the last service data flow matching to the service data flow container is detected by the P-GW. When event based charging applies, the first occurrence of an event matching a service data flow template shall imply service data flow start. Details on FBC can be found in TS 23.203 [215] and TS 32.240 [1].

If, according to the Charging Characteristics profile, CDR generation is activated an PGW-CDR shall be opened at IP-CAN bearer activation, and the volume (separately in uplink and downlink direction), elapsed time and/or number of events are counted. When a change of charging condition occurs, all containers are added to the PGW-CDR. The PGW-CDR includes details such as Record Type, Served IMSI, Sequence Number etc. and the FBC specific charging data. Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

It shall be possible to activate both online and offline charging interfaces for the same IP-CAN bearer.

The default online and offline charging shall work independently of each other. Optionally it may be possible to operate in a tight interworking between online and offline charging mechanism i.e. only the specified quota re-authorisation triggers armed by OCS (including e.g. tariff time change, returned quotas, etc.) are used to close the service data flow containers for the PGW-CDR charging information addition.

The subsequent clauses identify in detail the conditions for adding information to, and closing the PGW-CDR for generation towards the CGF.

5.2.3.4.1 Triggers for PGW-CDR charging information addition

IP-CAN bearer specific offline charging is achieved with IP-CAN bearer specific rating group/service identifier defined in clause 5.3.1.1.

The "List of Service Data" attribute of the PGW-CDR consists of a set of containers, which are added when specific trigger conditions are met. 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 within the same IP-CAN bearer, on encountering that trigger condition. For envelope reporting, the containers represent complete and closed time envelopes determined by mechanisms defined in TS 32.299 [50].

Table 5.2.3.4.1.1 identifies conditions that may be supported as recording triggers under consideration of additional Debit / Reserve Units triggers.

Some of the triggers are non-exclusive (e.g. IP-CAN bearer modification with a couple of reasons, IP-CAN bearer modification reasons that cause PGW-CDR closure).

Table 5.2.3.4.1.1: Triggers for PGW-CDR charging information addition "List of Service Data"

| Trigger Conditions | Description/Behaviour |
|---------------------------------------|---|
| IP-CAN bearer modification | A change of IP-CAN bearer conditions (e.g. QoS change, SGSN/S-GW/ePDG change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area) shall result in a set of "List of Service Data" containers, i.e. all active service data flow containers, being added to the CDR as described in clause 5.2.1.3. In a tight interworking between online and offline charging the specified quota re-authorization triggers armed by OCS are supported. |
| Tariff Time Change | On reaching the Tariff Time Change a set of "List of Service Data" containers, i.e. all active service data flow containers, shall be added to the CDR. In a tight interworking between online and offline charging the Debit / Reserve Units tariff time change from OCS is supported. |
| Failure Handling procedure triggering | When the Credit Control Failure Handling mechanism is triggered a "List of Service Data", i.e. all active service data flow containers shall be added to the CDR. The causes are only relevant in case of simultaneously usage of an active Debit / Reserve Units session. |
| Service data flow report | In case of independent online and offline charging a "List of Service Data" container for the service data flow shall be added when: <ul style="list-style-type: none"> - expiry of time limit; - expiry of volume limit; - expiry of unit limit; - termination of service data flow. In case of tight interworking online and offline charging a "List of Service Data" container for the service data flow shall be added when: <ul style="list-style-type: none"> - time threshold reached; - volume threshold reached; - unit threshold reached; - time quota exhausted; - volume quota exhausted; - unit quota exhausted; - expiry of quota validity time; - termination of service data flow; - re-authorization request by OCS. |
| CDR Closure | All active "List of Service Data" containers shall be added to the PGW-CDR. Note: The trigger condition is a common value that has to be used for CDR closure together with detailed reason. |

The first traffic container identifies the data traffic since the IP-CAN bearer was opened. Subsequent data traffic containers store the configured counts accrued since the closure of the last container.

For envelope reporting, each envelope contains information about the data volume transferred in both uplink and downlink and / or the number of events that occurred for the duration that envelope is open. Only completed time envelopes shall be added to the PGW-CDR. The determination of completed envelopes are defined in TS 32.299 [50]. The triggers listed in the previous table 5.2.3.4.1.1 shall not apply to envelope reporting. Envelopes that are not complete when a partial PGW-CDR is closed shall be added to the next PGW-CDR.

The "Serving node Address" attribute of the PGW-CDR consists of a list of SGSN/S-GW/ePDG/TWAG addresses. New SGSN/S-GW/ePDG address is added to the list when SGSN/S-GW/ePDG changes.

When Charging Event (ACR) is triggered by table 5.2.3.4.1.1 conditions, the Change-Condition sub-field associated to the added container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

5.2.3.4.2 Triggers for PGW-CDR closure

The PGW-CDR shall be closed on encountering trigger conditions.

Table 5.2.3.4.2.1 identifies which conditions are supported to permit closure of the PGW-CDR.

Table 5.2.3.4.2.1: Triggers for PGW-CDR closure

| Closure Conditions | Description/Behaviour |
|--------------------------------------|--|
| End of IP-CAN bearer within the P-GW | Deactivation of the IP-CAN bearer in the P-GW shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of IP-CAN bearer; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes (i.e. number of service containers); - management intervention; - MS time zone change; - PLMN change; - radio access technology change (RAT Type). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics.
The Partial Record generation trigger thresholds are P-GW configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the PGW-CDR is closed and the IP-CAN bearer remains active, a further PGW-CDR is opened with an incremented Sequence Number in the P-GW.

When Charging Event (ACR) is triggered by table 5.2.3.4.2.1 conditions, the Change-Condition (at PS information level) associated to the CDR Closure, indicating the appropriate condition shall be present, and it shall be omitted otherwise.

5.2.3.5 Triggers for SMS-CDR charging information collection

The generation of the SMS related CDRs is based on the observation and capture of simple events, i.e. the transfer of Short Messages through the SGSN and MME, in MO or MT direction.

A S-SMO-CDR is used to collect charging information related to the transmission of a SM in MO direction via the SGSN or MME. If, according to the Charging Characteristics, CDR generation is activated a S-SMO-CDR shall be created when the SGSN or MME has successfully forwarded a SM to the SMSC on behalf of the UE/MS. The S-SMO-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

A S-SMT-CDR is used to collect charging information related to the transmission of a SM in MT direction via the SGSN or MME. If, according to the Charging Characteristics, CDR generation is activated a S-SMT-CDR shall be created when the SGSN or MME has successfully forwarded a SM from the SMSC to the UE/MS. The S-SMT-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

Note that the above CDR types only capture the SMS events when transferred through the SGSN and MME. Equivalent charging functionality for the CS domain is specified in TS 32.250 [10]. 3GPP specifications do not define service specific charging functionality for SMS.

5.2.3.6 Triggers for LCS-CDR charging information collection

The generation of the LCS related CDRs is based on the observation and capture of simple events, i.e. the invocation of location requests from the UE/MS (LCS-MO-CDR), an external entity (LCS-MT-CDR) or the network (LCS-NI-CDR).

A LCS-MO-CDR is used to collect charging information related to the transmission of a location request, originating from the UE/MS to be located, via the SGSN. If, according to the Charging Characteristics, CDR generation is activated a LCS-MO-CDR shall be created when the SGSN has received the RANAP "Location Report" message from the RNC. The LCS-MO-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

A LCS-MT-CDR is used to collect charging information related to the transmission of a location request for a UE via the SGSN where the location request originates from an external entity. If, according to the Charging Characteristics, CDR generation is activated a LCS-MT-CDR shall be created when the SGSN has received the RANAP "Location Report" message from the RNC. The LCS-MT-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

A LCS-NI-CDR is used to collect charging information related to the transmission of a network induced location request via the SGSN. If, according to the Charging Characteristics, CDR generation is activated a LCS-NI-CDR shall be created when the SGSN has received the RANAP "Location Report" message from the RNC. The LCS-MO-CDR includes details such as Record Type, Served IMSI, Sequence Number etc.

Note that the above CDR types only capture the LCS events when transferred through the SGSN. Equivalent charging functionality for the CS domain is specified in TS 32.250 [10]. Service specific charging functionality for LCS is specified in TS 32.271 [31].

5.2.3.7 Triggers for S-MB-CDR and G-MB-CDR charging information collection for MBMS context charging for GPRS

5.2.3.7.1 Triggers for S-MB-CDR and G-MB-CDR charging information creation

S-MB-CDR and G-MB-CDR are used to collect charging information related to the MBMS bearer context data information for a MBMS bearer service in the GSN. The triggers for both S-MB-CDR and G-MB-CDR to start collecting charging information are the same.

S-MB-CDR and G-MB-CDR shall be opened at MBMS bearer context creation. Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

The subsequent clauses identify in detail the conditions for adding information to, and closing the S-MB-CDR and G-MB-CDR for generation towards the CGF.

5.2.3.7.2 Triggers for S-MB-CDR and G-MB-CDR charging information addition

The "List of Traffic Data Volumes" attribute consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume count per MBMS bearer context, for downlink traffic, on encountering that trigger condition.

Table 5.2.3.7.2.1 identifies which conditions are supported to trigger S-MB-CDR and G-MB-CDR charging information addition.

Table 5.2.3.7.2.1: Triggers for S-MB-CDR and G-MB-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|--------------------|--|
| Tariff Time Change | On reaching the Tariff Time Change a "List of Traffic Data Volumes" container shall be added to the CDR. |
| CDR Closure | A list of "List of Traffic Data Volumes" container shall be added to the relevant CDR. |

The first volume container of a MBMS bearer context identifies the volume since the record was opened. Subsequent volume containers store the volume count accrued since the closure of the last container.

5.2.3.7.3 Triggers for S-MB-CDR and G-MB-CDR closure

The S-MB-CDR and G-MB-CDR shall be closed on encountering the trigger conditions identified in table 5.2.3.7.3.1.

Table 5.2.3.7.3.1: Triggers for S-MB-CDR and G-MB-CDR closure

| Closure Conditions | Description/Behaviour |
|---|---|
| End of MBMS Bearer Context within the GSN | Deactivation of the MBMS bearer context in the GSN shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of MBMS bearer context; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - change in list of downstream nodes; - management intervention. |

The Partial Record generation trigger thresholds are those associated with GSN configured information. In the event that the CDR is closed and the MBMS bearer context remains active, a further CDR is opened with an incremented Sequence Number in the GSN.

5.2.3.7A Triggers for MBMS-GW-CDR charging information collection for MBMS context charging for EPS

5.2.3.7A.1 Triggers for MBMS-GW-CDR charging information creation

MBMS-GW-CDR is used to collect charging information related to the MBMS bearer context data information for a MBMS bearer service in EPS.

MBMS-GW-CDR shall be opened at MBMS bearer context creation. Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Evolved Packet System service usage.

The subsequent clauses identify in detail the conditions for adding information to, and closing the MBMS-GW-CDR for generation towards the CGF.

5.2.3.7A.2 Triggers for MBMS-GW-CDR charging information addition

The "List of Traffic Data Volumes" attribute consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume count per MBMS bearer context, for downlink traffic, on encountering that trigger condition.

Table 5.2.3.7A.2.1 identifies which conditions are supported to trigger MBMS-GW-CDR charging information addition.

Table 5.2.3.7A.2.1: Triggers for MBMS-GW-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|--------------------|--|
| Tariff Time Change | On reaching the Tariff Time Change a "List of Traffic Data Volumes" container shall be added to the CDR. |
| CDR Closure | A list of "List of Traffic Data Volumes" container shall be added to the relevant CDR. |

The first volume container of a MBMS bearer context identifies the volume since the record was opened. Subsequent volume containers store the volume count accrued since the closure of the last container.

5.2.3.7A.3 Triggers for MBMS-GW-CDR closure

The MBMS-GW-CDR shall be closed on encountering the trigger conditions identified in table 5.2.3.7A.3.1.

Table 5.2.3.7A.3.1: Triggers for MBMS-GW-CDR closure

| Closure Conditions | Description/Behaviour |
|---|--|
| End of MBMS Bearer Context within the MBMS GW | Deactivation of the MBMS bearer context in the MBMS GW shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of MBMS bearer context; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes; - change in list of downstream nodes; - management intervention. |

The Partial Record generation trigger thresholds are those associated with MBMS GW configured information. In the event that the CDR is closed and the MBMS bearer context remains active, a further CDR is opened with an incremented Sequence Number in the MBMS GW.

5.2.3.8 Triggers for ePDG-CDR charging information collection

5.2.3.8.0 Introduction

A ePDG-CDR is used to collect charging information related to the IP-CAN bearer data information for a UE/MS in the ePDG.

If, according to the Charging Characteristics, CDR generation is activated an ePDG-CDR shall be opened at IP-CAN bearer activation and IP-CAN bearer specific container is opened.

When a change of charging condition occurs, the volume counts are added to the ePDG-CDR and new counts are started. The ePDG-CDR includes details such as Record Type, Served IMSI, Sequence Number etc. Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

The subsequent clauses identify in detail the conditions for adding information to, and closing the ePDG-CDR for generation towards the CGF.

5.2.3.8.1 Triggers for ePDG-CDR charging information addition

The "List of Traffic Data Volumes" attribute of the ePDG-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume count per QoS, separated for uplink and downlink traffic, on encountering that trigger condition.

Table 5.2.3.8.1.1 identifies which conditions are supported to trigger ePDG-CDR charging information addition.

Table 5.2.3.8.1.1: Triggers for ePDG-CDR charging information addition

| Trigger Conditions | Description/Behaviour |
|--------------------|--|
| QoS Change | A change in the QoS shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR and new IP-CAN bearer specific container is opened. |
| Tariff Time Change | On reaching the Tariff Time Change open "List of Traffic Data Volumes" containers shall be closed and added to the CDR. |
| CDR Closure | Open "List of Traffic Data Volumes" containers shall be closed and added to the ePDG-CDR. |

Volume container identifies the uplink/downlink volume since the closure of the last container.

When Charging Event (ACR) is triggered by table 5.2.3.8.1.1 conditions, the Change-Condition sub-field associated to the added volume container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added volume container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

5.2.3.8.2 Triggers for ePDG-CDR closure

The ePDG-CDR shall be closed on encountering some trigger conditions.

Table 5.2.3.8.2.1 identifies which conditions are supported to permit closure of the ePDG-CDR.

Table 5.2.3.8.2.1: Triggers for ePDG-CDR closure

| Closure Conditions | Description/Behaviour |
|--------------------------------------|--|
| End of IP-CAN bearer within the ePDG | Deactivation of the IP-CAN bearer in the ePDG shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of IP-CAN bearer; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes (QoS/tariff time change); - management intervention; - MS time zone change; |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics.
The Partial Record generation trigger thresholds are ePDG configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the ePDG-CDR is closed and the IP-CAN bearer remains active, a further ePDG-CDR is opened with an incremented Sequence Number in the ePDG.

When Charging Event (ACR) is triggered by table 5.2.3.8.2.1 conditions, the Change-Condition (at PS information level) associated to the CDR Closure, indicating the appropriate condition shall be present, and it shall be omitted otherwise.

5.2.3.9 Triggers for TDF-CDR charging information collection

5.2.3.9.1 Triggers for TDF-CDR charging information creation

A TDF-CDR is used to collect charging information related to the TDF session information for a UE/MS in the TDF, where the data volumes, elapsed time or number of events within each TDF-CDR are separately counted per rating group or per combination of the rating group and service id.

Many application containers per TDF session can be active simultaneously in TDF-CDR. An application container is activated when application traffic is detected and no matching active application container exist; an application container is closed when the application traffic of the matching application container is terminated as detected by the TDF.

When event based charging applies, the first occurrence of an event matching an application shall imply application traffic start. Details on ABC can be found in TS 23.203 [215] and TS 32.240 [1].

If, according to the Charging Characteristics profile, CDR generation is activated, a TDF-CDR shall be opened at TDF session establishment, and the volume (separately in uplink and downlink direction), elapsed time and/or number of events are counted. When a change of charging condition occurs, all containers are added to the TDF-CDR.

The TDF-CDR includes details such as Record Type, Served IMSI, Sequence Number etc. and the ABC specific charging data. Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

It shall be possible to activate both online and offline charging interfaces for the same TDF session.

The default online and offline charging shall work independently of each other. Optionally it may be possible to operate with tight interworking between the online and offline charging mechanisms such that only the specified quota re-authorization triggers armed by the OCS (including e.g. tariff time change, returned quotas, etc.) are used to close the application containers for the TDF-CDR charging information addition, this information would be provided by the OCS in the Offline-Charging AVP. In this case, the information provided by the OCS shall take precedence over the default configuration at the TDF.

The subsequent clauses identify in detail the conditions for adding information to, and closing the TDF-CDR for generation towards the CGF.

5.2.3.9.2 Triggers for TDF-CDR charging information Addition

TDF session specific offline charging is achieved with TDF session specific rating group/service identifier defined in clause 5.2.1.9.2.

The "List of Service Data" attribute of the TDF-CDR consists of a set of containers, which are added when specific trigger conditions are met. 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 within the same TDF session, on encountering that trigger condition. For envelope reporting, the containers represent complete and closed time envelopes determined by mechanisms defined in TS 32.299 [50].

Table 5.2.3.9.2.1 identifies conditions that may be supported as recording triggers under consideration of additional Debit / Reserve Units triggers.

Some of the triggers are non-exclusive (e.g. TDF session modification with a couple of reasons, TDF session modification reasons that cause TDF-CDR closure).

Table 5.2.3.9.2.1: Triggers for TDF-CDR charging information addition "List of Service Data"

| Trigger Conditions | Description/Behaviour |
|---------------------------------------|---|
| TDF session modification | A change of TDF session conditions (e.g. SGSN/S-GW/ePDG change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area) shall result in a set of "List of Service Data" containers, i.e. all active application containers, being added to the CDR as described in clause 5.2.1.9. In a tight interworking between online and offline charging the specified quota re-authorization triggers armed by OCS are supported. |
| Tariff Time Change | On reaching the Tariff Time Change a set of "List of Service Data" containers, i.e. all active application containers, shall be added to the CDR. In a tight interworking between online and offline charging the Debit / Reserve Units tariff time change from OCS is supported. |
| Failure Handling procedure triggering | When the Failure Handling mechanism is triggered a "List of Service Data", i.e. all active application containers shall be added to the CDR. The causes are only relevant in case of simultaneously usage of an active Debit / Reserve Units session. |
| Application traffic report | In case of independent online and offline charging a "List of Service Data" container for the application shall be added when: <ul style="list-style-type: none"> - expiry of time limit; - expiry of volume limit; - expiry of unit limit; - termination of application traffic. In case of tight interworking online and offline charging a "List of Service Data" container for the application shall be added when: <ul style="list-style-type: none"> - time threshold reached; - volume threshold reached; - unit threshold reached; - time quota exhausted; - volume quota exhausted; - unit quota exhausted; - expiry of quota validity time; - termination of application traffic; - re-authorization request by OCS. |
| CDR Closure | All active "List of Service Data" containers shall be added to the TDF-CDR. NOTE: The trigger condition is a common value that has to be used for CDR closure together with detailed reason. |

The first traffic container identifies the data traffic since the TDF session was opened.

Subsequent data traffic containers store the configured counts accrued since the closure of the last container.

For envelope reporting, each envelope contains information about the data volume transferred in both uplink and downlink and / or the number of events that occurred for the duration that envelope is open. Only completed time envelopes shall be added to the TDF-CDR. The determination of completed envelopes are defined in TS 32.299 [50]. The triggers listed in the previous table 5.2.3.9.2.1 shall not apply to envelope reporting. Envelopes that are not complete when a partial TDF-CDR is closed shall be added to the next TDF-CDR.

The "Serving node Address" attribute of the TDF-CDR consists of a list of SGSN/S-GW/ePDG/TWAG addresses. New SGSN/S-GW/ePDG address is added to the list when SGSN/S-GW/ePDG changes.

When Charging Event (ACR) is triggered by table 5.2.3.9.2.1 conditions, the Change-Condition sub-field associated to the added container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

5.2.3.9.3 Triggers for TDF-CDR closure

The TDF-CDR shall be closed on encountering specified trigger conditions.

Table 5.2.3.9.3.1 identifies which conditions are supported to permit closure of the TDF-CDR.

Table 5.2.3.9.3.1: Triggers for TDF-CDR closure

| Closure Conditions | Description/Behaviour |
|-----------------------|---|
| End of TDF session | TDF session termination shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of TDF session by the PCRF; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit; - time (duration) limit; - maximum number of charging condition changes (i.e. number of service containers); - management intervention; - MS time zone change; - PLMN change; - radio access technology change (RAT Type). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics.

The Partial Record generation trigger thresholds are TDF configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in Annex A.

In the event that the TDF-CDR is closed and the TDF session remains active, a further TDF-CDR is opened with an incremented Sequence Number in the TDF.

When Charging Event (ACR) is triggered by table 5.2.3.9.3.1 conditions, the Change-Condition (at PS information level) associated to the CDR Closure, indicating the appropriate condition shall be present, and it shall be omitted otherwise.

5.2.3.10 Triggers for PGW-CDR charging information collection when IP-CAN session charging is active

5.2.3.10.1 General

A PGW-CDR is used to collect charging information related to the IP-CAN bearer data information for a UE/MS in the P-GW. When IP-CAN session charging is active, as described in clause 5.2.2.6, two types of data can be collected: traffic volumes used for IP-CAN bearer charging and service data used for FBC.

Many traffic volume and service data flow containers per IP-CAN session can be active simultaneously in PGW-CDR.

A new traffic volume container is activated when an IP-CAN bearer is activated.

A service data flow container is activated when traffic is detected and no matching active service data flow container exist; a service data flow container is closed when the termination of the last service data flow matching to the service data flow container is detected by the P-GW. When event based charging applies, the first occurrence of an event matching a service data flow template shall imply service data flow start. Details on FBC can be found in TS 23.203 [215] and TS 32.240 [1].

If, according to the Charging Characteristics profile, CDR generation is activated, a PGW-CDR shall be opened at IP-CAN session activation, and the volume (separately in uplink and downlink direction), elapsed time and/or number of events are counted.

When a change of charging condition occurs, all containers are added to the PGW-CDR. The PGW-CDR includes details such as Record Type, Served IMSI, Sequence Number etc. and both the traffic data and FBC specific charging data.

Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

It shall be possible to activate both online and offline charging interfaces for the same IP-CAN bearer.

The default online and offline charging shall work independently of each other. Optionally it may be possible to operate in a tight interworking between online and offline charging mechanism i.e. only the specified quota re-authorisation triggers armed by OCS (including e.g. tariff time change, returned quotas, etc.) are used to close the service data flow containers for the PGW-CDR charging information addition.

The subsequent clauses identify in detail the conditions for adding information to, and closing the PGW-CDR for generation towards the CGF.

5.2.3.10.2 Triggers for PGW-CDR charging information addition when IP-CAN session charging is active

The "List of Traffic Data Volumes" attribute of the PGW-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume counter per QCI/ARP pair, separated for uplink and downlink traffic, on encountering that trigger conditions. Table 5.2.3.10.2.1 identifies which conditions are supported to trigger PGW-CDR charging information addition for the "List of Traffic Data Volumes" attribute.

The "List of Service Data" attribute of the PGW-CDR consists of a set of containers, which are added when specific trigger conditions are met. 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 within the same IP-CAN bearer, on encountering that trigger condition. For envelope reporting, the containers represent complete and closed time envelopes determined by mechanisms defined in TS 32.299 [50]. Table 5.2.3.10.2.2 identifies conditions that may be supported as recording triggers under consideration of additional Debit / Reserve Units triggers.

Some of the triggers are non-exclusive (e.g. IP-CAN bearer modification with a couple of reasons, IP-CAN bearer modification reasons that cause PGW-CDR closure).

Table 5.2.3.10.2.1: Triggers for PGW-CDR charging information addition for List of Traffic Volumes when charging per IP-CAN session is active

| Trigger Conditions | Description/Behaviour |
|--|--|
| End of dedicated bearer in P-GW | The end of a dedicated bearer in P-GW shall result that open "List of Traffic Data Volumes" containers for the dedicated bearer are closed and added to the CDR. |
| Serving node change | A serving node (e.g., SGSN/S-GW/ePDG) change in the P-GW shall result that all open "List of Traffic Data Volumes" containers are closed and added to the CDR. New containers are opened for each bearer. |
| QoS Change | A change in the QoS shall result that open "List of Traffic Data Volumes" containers for the effected bearer being closed and added to the CDR and new IP-CAN bearer specific container is opened if the IP-CAN bearer is still active. |
| Tariff Time Change | On reaching the Tariff Time Change open "List of Traffic Data Volumes" containers shall be closed and added to the CDR. |
| User Location Change | A change in the User Location Info (e.g. ECGI, TAI, RAI, SAI or CGI) shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if location reporting is required, and a report of User Location Change is received. |
| User CSG Information change | A change in the User CSG info (e.g. CSG ID, access mode or CSG membership indication) shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if CSG information reporting is required, and a report of User CSG information change is received. |
| Change of UE presence in Presence Reporting Area | A change of UE presence in Presence Reporting Area shall result that open "List of Traffic Data Volumes" containers being closed and added to the CDR, if such reporting is required, and a report that user enters/leaves the area is received. |
| Traffic volume report | A "List of Traffic Data Volumes" container for an IP-CAN bearer shall be added when: <ul style="list-style-type: none"> - expiry of time limit per IP-CAN bearer; - expiry of data volume limit per IP-CAN bearer. |
| CDR Closure | Open "List of Traffic Data Volumes" containers shall be closed and added to the PGW-CDR. |

Table 5.2.3.10.2.2: Triggers for PGW-CDR charging information addition for "List of Service Data" when charging per IP-CAN session is active

| Trigger Conditions | Description/Behaviour |
|--|--|
| IP-CAN bearer modification except QoS change | A change of IP-CAN bearer conditions (e.g. SGSN/S-GW/ePDG change, user location change, user CSG information change, change in UE presence in Presence Reporting Area) shall result in a set of "List of Service Data" containers, i.e. all active service data flow containers, being added to the CDR as described in clause 5.2.1.10.2. In a tight interworking between online and offline charging the specified quota re-authorization triggers armed by OCS are supported. |
| Tariff Time Change | On reaching the Tariff Time Change a set of "List of Service Data" containers, i.e. all active service data flow containers, shall be added to the CDR. In a tight interworking between online and offline charging the Debit / Reserve Units tariff time change from OCS is supported. |
| ASR or Failure Handling procedure triggering | When the Debit / Reserve Units session is terminated with ASR or Failure Handling mechanism is triggered a "List of Service Data", i.e. all active service data flow containers shall be added to the CDR. The causes are only relevant in case of simultaneously usage of an active Debit / Reserve Units session. |
| Service data flow report | In case of independent online and offline charging a "List of Service Data" container for the service data flow shall be added when: <ul style="list-style-type: none"> - expiry of time limit per rating group; - expiry of volume limit per rating group; - expiry of unit or data event limit per rating group; - termination of service data flow and this is the last service data flow for the rating group or combination of rating group and service identifier. In case of tight interworking online and offline charging a "List of Service Data" container for the service data flow shall be added when: <ul style="list-style-type: none"> - time threshold reached; - volume threshold reached; - unit threshold reached; - time quota exhausted; - volume quota exhausted; - unit quota exhausted; - expiry of quota validity time; - termination of service data flow; - re-authorization request by OCS. |
| CDR Closure | All active "List of Service Data" containers shall be added to the PGW-CDR. Note: The trigger condition is a common value that has to be used for CDR closure together with detailed reason. |

The first traffic container identifies the data traffic since the IP-CAN session was opened. Subsequent data traffic containers store the configured counts accrued since the closure of the last container.

For envelope reporting, each envelope contains information about the data volume transferred in both uplink and downlink and / or the number of events that occurred for the duration that envelope is open. Only completed time envelopes shall be added to the PGW-CDR. The determination of completed envelopes are defined in TS 32.299 [50]. The triggers listed in the previous table shall not apply to envelope reporting. Envelopes that are not complete when a partial PGW-CDR is closed shall be added to the next PGW-CDR.

The "Serving node Address" attribute of the PGW-CDR consists of a list of SGSN/S-GW/ePDG/TWAG addresses. New SGSN/S-GW/ePDG address is added to the list when SGSN/S-GW/ePDG changes.

When Charging Event (ACR) is triggered by table 5.2.3.10.2.1 or 5.2.3.10.2.2 conditions, the Change-Condition sub-field associated to the added container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

5.2.3.10.3 Triggers for PGW-CDR closure when charging per IP-CAN session charging is active

The PGW-CDR shall be closed on encountering trigger conditions.

Table 5.2.3.10.3.1 identifies which conditions are supported to permit closure of the PGW-CDR.

Table 5.2.3.10.3.1: Triggers for PGW-CDR closure

| Closure Conditions | Description/Behaviour |
|---------------------------------------|--|
| End of IP-CAN session within the P-GW | Deactivation of the IP-CAN session in the P-GW shall result in the CDR being closed. The trigger condition covers: <ul style="list-style-type: none"> - termination of last IP-CAN bearer for the IP-CAN session; - any abnormal release. |
| Partial Record Reason | OAM&P reasons permit the closure of the CDR for internal reasons. The trigger condition covers: <ul style="list-style-type: none"> - data volume limit per IP-CAN session; - time (duration) limit for keeping a CDR open; - data event limit per IP-CAN session; - maximum number of charging condition changes; - management intervention; - APN-AMBR change; - MS time zone change; - PLMN change; - radio access technology change (RAT Type). |

The Partial Record generation trigger thresholds are those associated with the Charging Characteristics. The Partial Record generation trigger thresholds are P-GW configuration parameters defined per Charging Characteristics profile by the operator through OAM&P means, as specified in annex A.

In the event that the PGW-CDR is closed and the IP-CAN session remains active, a further PGW-CDR is opened with an incremented Sequence Number in the P-GW.

When Charging Event (ACR) is triggered by table 5.2.3.10.3.1 conditions, the Change-Condition (at PS information level) associated to the CDR Closure, indicating the appropriate condition shall be present, and it shall be omitted otherwise.

5.2.4 Void

5.2.5 Ga record transfer flows

In EPC, 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].

5.2.6 Bp CDR file transfer

In EPC, both fully qualified partial CDRs (FQPC) and reduced partial CDRs (RPC), as specified in TS 32.240 [1] may be supported on the Bp 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 Bp protocol application refer to TS 32.297 [52].

5.3 PS domain online charging scenarios

5.3.1 Basic principles

5.3.1.0 General

PS domain online charging may be performed in the SGSN using CAMEL techniques.

This functionality is specified in TS 23.078 [206] and TS 29.078 [202] and is outside the scope of the present document.

PS domain online charging may be performed by the PCEF in the P-GW and by the TDF using the common Ro based Credit-Control application specified in TS 32.299 [50]. In order to provide the data required for the management activities outlined in TS 32.240 [1] (Credit-Control, accounting, statistics etc.), the PCEF shall be able to perform online charging for each of the following:

- Charging data related to IP-CAN bearers;
- Charging data related to service data flows.

The above items both pertain to sessions (IP-CAN bearers), hence session based online charging (SCUR) with centralized rating and centralized unit determination is required in the PCEF.

The TDF shall be able to perform online charging each of the following:

- Charging data related to TDF session;
- Charging data related to detected application traffic.

The above items pertain to sessions (application traffic), hence SCUR is required in the TDF with centralized or decentralized unit determination and centralized rating.

The Debit / Reserve Units Request and Debit / Reserve Units Response specified for SCUR in TS 32.299 [50] (initial/update/termination) are issued towards the OCS / received from the OCS when certain conditions (chargeable events) are met. The PS domain specific contents and purpose of each of these messages, as well as the chargeable events that trigger them, are described in the following sub-clauses. A detailed formal description of the online charging parameters defined in the present document is to be found in TS 32.299 [50]. Further information on the general principles of the common 3GPP online charging application can also be found in TS 32.299 [50] and TS 32.240 [1].

The Credit-Control is always per rating group but the reporting level can be either per rating group or per combination of the rating group and service id. Reporting level is defined per PCC rule in case of PCEF integrated in the P-GW or per ADC rule in case of TDF.

5.3.1.1 IP-CAN bearer charging

IP-CAN bearer online charging is achieved by FBC online charging, see clause 5.3.1.2. When the IP-CAN bearer is online charged by means of FBC, the quota handling shall also be based on the use of a Rating Group/Service Identifier. The value of this IP-CAN bearer specific Rating Group/Service Identifier shall be vendor specific.

The amount of data counted with IP-CAN bearer specific Rating Group/Service Identifier shall be the user plane payload at the tunnelling (e.g. GTP-u, GRE Tunnel) interface. Time metering is started when IP-CAN bearer is activated.

NOTE 1: P-GW is aware of bearers in case of GTP based connectivity. In case of any other PMIP based connectivity, P-GW is aware of IP-CAN sessions only. If P-GW is not aware of IP-CAN bearers, P-GW collects charging information per IP-CAN session as it would be just one IP-CAN bearer.

NOTE 2: The control plane IP address of SGSN or P-GW(acting as GGSN) is the IP address used at Gn/Gp interface. The control plane IP address of S-GW or P-GW is the IP address used at S5/S8 interface. The control plane IP address of ePDG or P-GW is the IP address used at S2b interface.

5.3.1.2 Flow Based bearer Charging

IP-CAN bearer charging allows the P-GW to collect charging information related to data volumes sent to and received by the UE/MS, categorised by the QoS applied to the IP-CAN bearer. FBC is supported by the P-GW by the integrated PCEF. When the PCEF is present, the normal IP-CAN bearer charging is enhanced by the capability to categorise the service data flows within IP-CAN bearer data traffic by rating group or combination of the rating group and service id. I.e., while there is only one uplink and one downlink data volume count per IP-CAN bearer in IP-CAN bearer charging, FBC may provide one count per each rating group or combination of the rating group and service id. The level of the reporting is defined per PCC rule. Details of this functionality are specified in TS 23.203 [215] and TS 32.240 [1].

NOTE: The P-GW can only include one QoS Information occurrence per service data container. This implies if an operator wishes to be able to separate usage according to QCI and ARP within their billing system they will need to ensure that services having different QCI 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.

Extended packet inspection can be done in the PCEF with pre-defined PCC rules. The PCEF also has the possibility to output service specific information related to the packet inspection in the online charging information.

An Application Function (AF) may provide an external charging identifier to be delivered to the PCEF by the PCRF with a dynamic PCC rule. The PCEF includes this AF correlation information in the online charging information for the rating group and service identifier associated with the dynamic PCC rule when service identifier level reporting is requested.

The capability of P-GW to support ABC is achieved with PCRF providing appropriate PCC Rules to the P-GW. 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.

According to TS 23.203 [215], 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. In general the charging of a service data flow shall be linked to the IP-CAN bearer under which the service data flow has been activated. In online charging the PCEF shall request the reservation of units prior to service delivery.

The following chargeable events are defined for FBC when online charging is activated:

- Network request for IP-CAN bearer activation before the Initiate IP-CAN bearer Activation message is sent. Associated with the network requested dedicated IP-CAN bearer activation procedure, as defined in TS 23.203 [215] and TS 23.060 [201], upon encountering this event, a Debit / Reserve Units Request[Initial], indicating the request for activation of dedicated IP-CAN bearer is sent towards the OCS. For network requested dedicated IP-CAN bearer activation, if known by the PCEF, the PCEF may provide status of UE presence in Presence Reporting Area.
- Start of IP-CAN bearer. Upon encountering this event, a Debit / Reserve Units Request[Initial], indicating the start of the IP-CAN bearer, is sent towards the OCS to authorize the IP-CAN bearer. For network requested dedicated IP-CAN bearer activation, this event triggers a Debit / Reserve Units Request[Update], when the PCEF receives an Update PDP Context Request message with the RAN Procedures Ready flag. If known by the PCEF, the PCEF may provide status of UE presence in Presence Reporting Area. PCEF may request quota later when service usage is started.
- Start of service data flow. In case valid quota does not exist a Debit / Reserve Units Request[Update] is generated to request quota. The type of requested quota shall depend on measurement method configured for the PCC rule in case of decentralized unit determination. 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.
- Termination of service data flow. If reporting is per rating group and this is the last service data flow utilizing that specific rating group or if reporting is per combination of the rating group and service id and this is the last service data flow utilizing that specific rating group and service id, the required counters are updated. Termination of the service data flow itself does not trigger Debit / Reserve Units Request[Update].
- End of IP-CAN bearer. Upon encountering this event, a Debit / Reserve Units Request[Terminate], indicating the end of the IP-CAN bearer, is sent towards the OCS together with the final counts.

- Ro specific chargeable events (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization). Corresponding counts for the rating group(s) are closed and Debit / Reserve Units Request[Update] is triggered according the rules defined in TS 32.299 [50].
- Change of charging condition: E.g. QoS change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area.
When this event is encountered and the corresponding re-authorization trigger is armed, all current counts are captured and sent towards the OCS with a Debit / Reserve Units Request[Update].
- Tariff time change. When this event is encountered, all current counts are captured and a new counts are started. The counts are sent to the OCS in next Debit / Reserve Units Request.

Management intervention may also force trigger a chargeable event.

PCC rules can be activated, deactivated and modified any time during the IP-CAN bearer lifetime. PCC rule activation, deactivation and modification are not chargeable events. However these PCC rule changes may lead to "start of service data flow" and "termination of service data flow" chargeable events.

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic PCC rule which is active in the PCEF: Charging key, Service identifier, Measurement method, Service identifier level reporting. Change of Charging key, ServiceIdentifier, or measurement method will trigger a "start of service data flow" chargeable event when valid quota does not exist corresponding to that changed PCC rule. Change of Charging key, Service Identifier or measurement method, or/Service identifier level reporting will trigger a "termination of service data flow" chargeable event when this is the last service data flow utilizing the quota used for the original PCC rule.

5.3.1.3 PS Furnish Charging Information procedure

The OCS online charging function may use this procedure to add online charging session specific information to the PGW-CDR and to the TDF-CDR. The information can be sent per online session and in case FBC is enabled for a specific APN, or ABC is enabled in case of the TDF, the OCS online charging function may also send specific information per each online charged service by means of this procedure.

5.3.1.4 Support of Failure Situations

In case the OCS fails, the P-GW and the TDF shall support the Failure Handling procedure and Failover mechanism described in TS 32.299 [50]. These mechanisms give flexibility to have different failure handling scenarios when the OCS fails.

Three different actions are described in RFC 4006 [402].

P-GW shall support the following actions when the failure handling mechanism is executed:

- Terminate: The online session is finished. The associated IP-CAN bearer session is released (ongoing sessions) or not established (new sessions). Failover for ongoing sessions is not supported. Failover for new sessions is always supported.
- Retry&Terminate: The online session is finished. The associated IP-CAN bearer session is released (ongoing sessions) or not established (new sessions). Failover for ongoing sessions is supported. Failover for new sessions is always supported.
- Continue: The online session is finished. The associated IP-CAN bearer session is established (new sessions) or not released (ongoing sessions). Failover for ongoing sessions is supported. Failover for new sessions is always supported.

TDF shall support the following actions when the failure handling mechanism is based on the directives received previously from the OCS:

- Terminate: This is the default behaviour. The TDF indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.
- Retry&Terminate: If the OCS and TDF support failover procedures and there is an alternate OCS available, the TDF shall attempt to failover to an alternative OCS. Otherwise, the TDF indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.
- Continue: If the OCS and TDF support failover procedures and there is an alternate OCS available, the TDF shall attempt to failover to an alternative OCS. Otherwise, the TDF indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.

If the user is simultaneously online and offline charged, the failure situation shall be registered in the PGW-CDR/TDF-CDR. When the user is only online charged, the execution of the Failure Handling mechanism with value equal to Continue shall imply that a new PGW-CDR/TDF-CDR is opened.

5.3.1.5 Application Based Charging (ABC)

5.3.1.5.0 Introduction

For the sub-clauses that follow, a single Debit / Reserve Units session is defined to handle both TDF session and application based charging information when both are to be used. Either TDF session charging or ABC but not both may be active as determined by Charging Characteristics.

For ABC the opening and closing of the Debit / Reserve Units session is bound by the TDF session start and end respectively.

5.3.1.5.1 Charging per application

ABC allows collecting charging information related to data volumes sent to and received by the UE/MS, based on the application detection. ABC supported by the TDF, i.e. ADC rules based charging defined in TS 23.203 [215] and TS 29.212 [216], is based on ADC rules. The application traffic within TDF session is categorised by rating group or combination of the rating group and service identifier. The level of the reporting is defined per ADC rule. Details of this functionality are specified in TS 23.203 [215] and TS 32.240 [1].

NOTE: ABC is supported by the P-GW embedding PCEF enhanced with application detection and control functionality as defined in TS 23.203 [215], by mean of appropriate PCC Rules, and therefore specified under FBC clause 5.3.1.2.

According to TS 23.203 [215], ABC shall support different charging models per ADC rule. These charging models may be based on volume and/or time or on number of events as the application referred by the application identifier in ADC rule. In online charging the TDF shall request the reservation of units prior to service delivery.

The following chargeable events are defined for ABC when online charging is activated:

- Start of TDF session. Upon encountering this event, a Debit / Reserve Units Request[Initial] indicating the establishment of the TDF session, is sent towards the OCS to activate the online charging session with the TDF. The quota for each activated ADC rule may be requested in such Debit / Reserve Units Request[Initial] or later when application traffic is detected .
- Start of application traffic. In case valid quota does not exist for the rating group, a Debit / Reserve Units Request[Update] is generated to request quota. The type of requested quota shall depend on measurement method configured for the ADC rule in case of decentralized unit determination. When event based charging applies, the first occurrence of an event detected according to the pre-defined ADC rule shall be considered as the start of a application.
- Termination of application traffic. If reporting is per rating group and this is the last application traffic utilizing that specific rating group or if reporting is per combination of the rating group and service identifier and this is the last application traffic utilizing that specific rating group and service identifier, the required counters are updated.
- End of TDF session in the TDF. Upon encountering this event, a Debit / Reserve Units Request[Terminate], indicating the end of the TDF session, is sent towards the OCS together with the final counts.
- Ro specific chargeable events (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization). Corresponding counts for the rating group(s) are closed and Debit / Reserve Units Request[Update] is triggered according the rules defined in TS 32.299 [50].
- Change of charging condition: e.g. user location change, user CSG information change, change of UE presence in a Presence Reporting Area. When this event is encountered and the corresponding re-authorization trigger is armed, all current counts are captured and sent towards the OCS with a Debit / Reserve Units Request[Update].
- Tariff time change. When this event is encountered, all current counts are captured and a new counts are started. The counts are sent to the OCS in next CCR.

Management intervention may also force trigger a chargeable event.

ADC rules can be activated, deactivated and modified any time during the TDF session lifetime. ADC rules activation, deactivation and modification are not chargeable events. However these ADC rules changes may lead to "start of application traffic" and "termination of application traffic" chargeable events.

Application Detection and Control rule can contain e.g.:

- Application Identifier to identify detected application,
- charging method to identify whether online/offline/both/neither charging interface is used,
- measurement method for online/offline charging to identify whether time/volume/events are measured for this application,
- Charging key (i.e. rating group) for that application,
- service identifier for that application,
- reporting level for the application (rating group or combination of the rating group and service id),
- precedence to the situations where two or more ADC rules are overlapping.

Application Detection and Control rule can be:

- pre-defined in TDF (can be activated by the PCRF) or,
- dynamically provisioned and activated by the PCRF over the Sd interface.

This is specified in TS 23.203 [215] and TS 29.212 [216].

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic ADC rule which is active in the TDF: Charging key, Service identifier, Measurement method, Service identifier level reporting. Change of Charging key, ServiceIdentifier, or measurement method will trigger a "start of application traffic" chargeable event when valid quota does not exist. Change of Charging key, Service Identifier or measurement method, or/Service identifier level reporting will trigger a "termination of application traffic" chargeable event when this is the last application traffic utilizing the quota used for the Charging key or combination of Charging key and Service identifier of original ADC rule.

5.3.1.5.2 Charging per TDF session

TDF session online charging is achieved by ABC online charging such that the quota handling for the TDF session shall be based on associating a specific Rating Group/Service Identifier with the TDF session. The value of this TDF session specific Rating Group/Service Identifier shall be vendor specific.

The amount of data counted with TDF session specific Rating Group/Service Identifier shall be the user plane payload. Time metering is started when TDF session is activated.

5.3.1.6 Charging per IP-CAN session

5.3.1.6.0 General

Charging per IP-CAN session is an optional capability in the P-GW that provides for a consolidated view of the service data flow charging information across all bearers in the IP-CAN session. When charging per IP-CAN session is active, the basic principles in this clause apply to the P-GW instead of the principles in clause 5.3.1.1 and clause 5.3.1.2 above.

For the sub-clauses that follow, a single Debit / Reserve Units session is defined to handle both types of charging information when both are to be used. When Charging per IP-CAN session is active, either IP-CAN bearer charging or FBC but not both may be active as determined by Charging Characteristics.

5.3.1.6.1 IP-CAN bearer charging

IP-CAN bearer online charging is achieved by FBC online charging, see clause 5.3.1.6.2. When the IP-CAN session is online charged by means of FBC, the quota handling shall also be based on the use of a Rating Group. The value of this IP-CAN bearer specific Rating Group or combination of the Rating Group and Service Identifier shall be vendor specific.

The amount of data counted with IP-CAN bearer specific Rating Group/Service Identifier shall be the user plane payload at the tunnelling (e.g. GTP-u, GRE Tunnel) interface. Time metering is started when IP-CAN session is activated.

All bearers in the IP-CAN session are included in the single vendor-specific Rating Group/Service Identifier.

NOTE 1: P-GW is aware of bearers in case of GTP based connectivity. In case of any other PMIP based connectivity, P-GW is aware of IP-CAN sessions only. If P-GW is not aware of IP-CAN bearers, P-GW collects charging information per IP-CAN session as it would be just one IP-CAN bearer.

NOTE 2: The control plane IP address of SGSN or P-GW (acting as GGSN) is the IP address used at Gn/Gp interface. The control plane IP address of S-GW or P-GW is the IP address used at S5/S8 interface. The control plane IP address of ePDG or P-GW is the IP address used at S2b interface.

NOTE 3: The vendor-specific Rating Group/Service Identifier may be configurable through the use of a predefined PCC rule in the P-GW.

5.3.1.6.2 Flow Based Charging (PBC)

FBC is supported by the P-GW by the integration of a PCEF. With PCEF, charging is enhanced by the capability to categorise the service data flows within IP-CAN session data traffic by rating group or combination of the rating group and service id. For online charging, FBC provides credit management for each rating group and may provide reporting (i.e., counts) per each rating group or combination of the rating group and service id. The level of the reporting is defined per PCC rule. Details of this functionality are specified in TS 23.203 [215] and TS 32.240 [1].

NOTE 1: Even though an individual service data flow template is bound to a specific IP-CAN bearer, the assigned rating group or combination of rating group and service id applies to the entire IP-CAN session. As a result, data traffic from multiple bearers can be included in the count maintained for the rating group or combination of the rating group and service id. This implies if an operator wishes to be able to separate usage according to IP-CAN bearer within their charging system they will need to ensure that services having different QCI and ARP do not have the same:

- rating group in cases where rating group reporting is used;
- rating group/service id where rating group/service id reporting is used.

NOTE 2: The P-GW can only include one QoS Information occurrence per service data container. This implies if an operator wishes to be able to separate usage according to QCI and ARP within their charging system they will need to ensure that services having different QCI and ARP do not have the same:

- rating group in cases where rating group reporting is used;
- rating group/service id where rating group/service id reporting is used.

Extended packet inspection can be done in the PCEF with pre-defined PCC rules. The PCEF also have the possibility to output service specific information related to the packet inspection in the online charging information.

According to TS 23.203 [215], 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. In online charging the PCEF shall request the reservation of units prior to service delivery.

The following chargeable events are defined for FBC when online charging and Charging per IP-CAN session is activated:

- Start of IP-CAN session. Upon encountering this event, a Debit / Reserve Units Request[Initial], indicating the start of the IP-CAN session, is sent towards the OCS to authorize the IP-CAN session. PCEF may request quota later when service usage is started.
- Start of service data flow. In no valid quota has been granted for the rating group, a Debit / Reserve Units Request[Update] is generated to request quota. The type of requested quota shall depend on measurement method configured for the PCC rule in case of decentralized unit determination. 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.
- Termination of service data flow. If reporting is per rating group and this is the last service data flow utilizing that specific rating group or if reporting is per combination of the rating group and service id and this is the last service data flow utilizing that specific rating group and service id, the required counters are updated. Termination of the service data flow itself does not trigger Debit / Reserve Units Request[Update].
- End of IP-CAN session. Upon encountering this event, a Debit / Reserve Units Request[Terminate], indicating the end of the IP-CAN session, is sent towards the OCS together with the final counts.
- Ro specific chargeable events (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization). Corresponding counts for the rating group(s) are closed and Debit / Reserve Units Request[Update] is triggered according the rules defined in TS 32.299 [50].
- Change of charging condition specific to APN-AMBR change: When this event is encountered and the corresponding re-authorization trigger is armed, all current counts are captured and sent towards the OCS with a Debit / Reserve Units Request[Update].
- Change of charging condition other than QoS change: E.g. user location change, user CSG information change, change of UE presence in a Presence Reporting Area. When this event is encountered and the corresponding re-authorization trigger is armed, all current counts are captured and sent towards the OCS with a Debit / Reserve Units Request[Update].
- Tariff time change. When this event is encountered, all current counts are captured and new counts are started. The counts are sent to the OCS in next CCR.

Management intervention may also force trigger a chargeable event.

PCC rules can be activated, deactivated and modified any time during the IP-CAN session lifetime. PCC rule activation, deactivation and modification are not chargeable events. However these PCC rule changes may lead to "start of service data flow" and "termination of service data flow" chargeable events.

According to TS 23.203 [215], the PCRF can modify the following charging information in a dynamic PCC rule which is active in the PCEF: Charging key, Service identifier, Measurement method, Service identifier level reporting. Change of Charging key, ServiceIdentifier, or measurement method will trigger a "start of service data flow" chargeable event when valid quota does not exist corresponding to that changed PCC rule. Change of Charging key, Service Identifier or measurement method, or Service identifier level reporting will trigger a "termination of service data flow" chargeable event when this is the last service data flow utilizing the quota used for the original PCC rule.

5.3.2 Ro message flows

5.3.2.0 General

Debit / Reserve Units Request[Initial], update and termination, as defined in TS 32.299 [50], are used by the P-GW/TDF to transfer the collected charging information towards the OCS. Debit / Reserve Units Response is used by the OCS to assign quotas for the rating groups, and to instruct the P-GW whether to continue or terminate a service data flow(s) or IP-CAN bearer. Debit / Reserve Units Response is used by the OCS to assign quotas for the rating groups and to instruct the TDF whether to continue or terminate an application's traffic.

Debit / Reserve Units Response is also used to communicate to the PCEF/TDF for the Termination Action, i.e. the P-GW/TDF behaviour when the user has consumed the final granted units. The Termination Action is specified in TS 32.299 [50].

The P-GW and TDF uses Charging Characteristics profile to determine whether to activate or deactivate online charging. Further details of this functionality, including the mechanism of conveying the Charging Characteristics data item (HLR -> SGSN -> P-GW, or HSS->MME/S4-SGSN ->S-GW->P-GW, or AAA -> ePDG -> P-GW and then in case of TDF, P-GW -> PCRF -> TDF), are specified in annex A.

Editor's note : "non-3GPP Charging Characteristics" conveyance from AGW to P-GW is ffs

The following clauses describe the trigger conditions for the chargeable events described in clauses 5.3.1.1, 5.3.1.2, 5.3.1.5 and 5.3.1.6. In FBC and ABC online charging, these chargeable events correspond to the triggers for collection of charging information and Debit / Reserve Units Request emission towards the OCS. The responses from the OCS and the detailed behaviour of the PCEF/TDF upon receiving those responses are also specified in the sub-clauses below.

5.3.2.1 Triggers for IP-CAN bearer online charging

IP-CAN bearer online charging is achieved by FBC online charging, see clause 5.3.2.2 below.

5.3.2.1.1 Void

5.3.2.1.2 Void

5.3.2.2 Triggers for FBC online charging

5.3.2.2.0 Introduction

Debit / Reserve Units Request[Initial] / update / termination is used to convey charging information related to the IP-CAN bearer and service data flows collected in the PCEF. Debit / Reserve Units Response is used by the OCS to return quotas for rating groups or to instruct the PCEF on the further handling of the IP-CAN bearer (terminate, continue, reroute, etc.). The Debit / Reserve Units Request includes details such as Credit-Control Type, Served IMSI, Sequence Number etc. The Debit / Reserve Units Response includes details such as Credit-Control quotas and session management instructions (continue, terminate, interim interval, etc). Not all of the charging information to be collected is static, and other charging information is directly dependent on dynamic Packet-Switched service usage.

FBC online charging is employed if it is activated for the IP-CAN bearer. The charging method in the PCC rule defines whether service data flow requires the online charging. The PCEF shall request the quota prior to service delivery. If only certain quotas are authorised by the OCS (e.g. due to insufficient credit), the rating groups for which no quota was authorised are handled according the received Result Code value. The quota supervision mechanism is further described in TS 32.299 [50]. Details on FBC can be found in TS 23.203 [215] and TS 29.212 [216].

Debit / Reserve Units Request[Initial] is sent to the OCS during the IP-CAN bearer activation. The OCS supplies a IP-CAN bearer authorisation and may supply volume, time or events quotas for the rating groups, based on the information provided by the PCEF, e.g. QoS, APN.

When start of the service data flow is detected and no valid quota exist, a Debit / Reserve Units Request[Update] is sent to request quota for the rating group unless the rating group is e.g. blacklisted. See TS 32.299 [50] for further information.

When a change of charging condition occurs and corresponding re-authorization trigger is armed, all MSCC instances are reported to the OCS with a Debit / Reserve Units Request[Update] with Reporting-Reason AVP value set to RATING_CONDITION_CHANGE together with Trigger-Type AVP indicating the accurate reason for the change.

At IP-CAN default bearer establishment, the OCS may provide, if not already determined by the PCRF, the "Presence Reporting Area identifier" identifying the PRA to be reported when it subscribes to "Change of UE presence in Presence Reporting Area". The PCEF shall ignore any "Presence Reporting Area identifier" provided during IP-CAN default bearer establishment or during the lifetime of both default and dedicated bearer after establishment procedure.

The OCS may subscribe to "Change of UE presence in Presence Reporting Area" re-authorization event trigger, during IP-CAN bearer establishment (i.e. CCA answer to CCR initial), or during the lifetime of the IP-CAN bearer. In case no "Presence Reporting Area identifier" is provided by the OCS, the trigger subscription refers to the Presence Reporting Area identifier selected by the PCRF.

When the initial UE presence status in PRA resulting from subscription by the OCS is received by the PCEF, and the PCEF has previously requested quota, all MSCC instances are reported to the OCS with a CCR update, indicating the initial status. If PCEF has not previously requested quota, the initial status of UE presence in Presence Reporting Area will be sent towards the OCS on CCR update triggered for quota request when service usage is started.

When Ro specific chargeable event (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization) occurs required MSCC instances are reported to OCS with a Debit / Reserve Units Request[Update] with corresponding Reporting Reason value. See TS 32.299 [50] for further information.

When tariff time change is encountered, the Tariff Change Usage is used within the Used Service Units to distinguish usage before and after the tariff time change. The MSCC instances are sent to the OCS in next Debit / Reserve Units Request.

The OCS may specify the behaviour on consumption of the final granted units known as termination action. The required termination action is indicated with Final Unit Action and possible values are TERMINATE and REDIRECT. See TS 32.299 [50] for further information.

TS 23.203 [215] specifies that it shall be possible to request online charging quotas for each charging key. Each quota allocated to a Debit / Reserve Units session has a unique Rating Group value. TS 23.203 [215] also specifies that PCEF shall report charging information for each combination of the charging key and service identifier when service identifier level reporting is present. As defined in TS 23.203 [215] the service identifier is a piece of information which provides the most detailed identification, specified for FBC, of a service data flow. The charging key is a piece of information used for rating purposes as defined in TS 23.203 [215].

The charging key and Service Identifier are mapped into the Rating Group and the Service Identifier respectively as defined in RFC 4006 [402].

The subsequent clauses identify in detail the conditions for reporting online charging information, management of user and Credit-Control sessions and PS domain quota supervision.

5.3.2.2.1 Triggers for starting and stopping an FBC Credit-Control session

Debit / Reserve Units Request[Initial] is sent to OCS when IP-CAN bearer is activated. For network requested dedicated IP-CAN bearer activation, the Debit / Reserve Units Request[Initial] is sent to the OCS when the PCEF determines a need for the IP-CAN bearer and before any signalling towards a mobile is initiated.

Debit / Reserve Units Request[Terminate] is sent to OCS when:

- IP-CAN bearer is deactivated
- Session termination is indicated by the OCS (e.g. Credit Limit Reached)
- Abort-Session-Request is received from the OCS, this also results in network initiated IP-CAN bearer deactivation.

5.3.2.2.2 Triggers for providing interim information for an FBC Credit-Control session

Debit / Reserve Units Request[Update] is sent to OCS when:

- User starts to use certain service or application
- Start of service data flow (refer to clause 5.3.1.2)
- Termination of service data flow and this is the last service data flow utilizing corresponding to report level(refer to clause 5.3.1.2)
- Active service or application is removed from the allowed services or applications
- Granted quota runs out
- Validity time for granted quota expires
- Update is requested by the OCS
- Change of charging conditions occur and according re-authorisation trigger re-authorisation is needed
- Management intervention
- Quota Holding Timer is expired
- For network requested dedicated IP-CAN bearer activation, reception of an Update PDP Context Request message with the RAN Procedures Ready flag.

5.3.2.2A Triggers for ABC online charging

5.3.2.2A.0 Introduction

For ABC supported within the TDF, i.e. ADC rules based charging defined in TS 23.203 [215] and TS 29.212 [216], Debit / Reserve Units Request[Initial] / update / termination is used to convey charging information related to the application traffic detected in the TDF. Debit / Reserve Units Response is used by the OCS to return quotas for rating groups or to instruct the TDF on the further handling of the application traffic (terminate, continue, reroute, etc.). The Debit / Reserve Units Request includes details such as Credit-Control Type, Served IMSI and Sequence Number etc. The Debit / Reserve Units Response includes details such as Credit-Control quotas and session management instructions (continue, terminate, interim interval, etc).

ABC online charging is employed if it is activated for the TDF session defined in TS 23.203[215].

The charging method in the ADC rule defines whether application traffic requires online charging. The TDF shall request the quota prior to service delivery. If only certain quotas are authorised by the OCS (e.g. due to insufficient

credit), the rating groups for which no quota was authorised are handled according the received Result Code value. The quota supervision mechanism is further described in TS 32.299 [50].

Debit / Reserve Units Request[Initial] is sent to the OCS during the TDF session activation. The OCS supplies application traffic authorisation and may supply volume, time or event quotas for the rating groups, based on the information provided by the TDF, e.g. APN.

When start of the application traffic is detected and no valid quota exist in current Ro session, a Debit / Reserve Units Request[Update] is sent to request quota for the rating group unless the rating group is e.g. blacklisted. See TS 32.299 [50] for further information.

When a change of charging condition occurs and corresponding re-authorization trigger is armed, all MSCC instances are reported to the OCS with a Debit / Reserve Units Request[Update] with Reporting Reason value set to RATING_CONDITION_CHANGE together with Trigger-Type AVP indicating the accurate reason for the change.

At TDF session establishment, the OCS may provide, if not already determined by the PCRF, the "Presence Reporting Area identifier" identifying the PRA to be reported when it subscribes to "Change of UE presence in Presence Reporting Area". The TDF shall ignore any "Presence Reporting Area identifier" provided during the lifetime of the TDF session after establishment procedure.

The OCS may subscribe to "Change of UE presence in Presence Reporting Area" re-authorization event trigger, during TDF session establishment (i.e. CCA answer to CCR initial), or during the lifetime of the TDF session. In case no "Presence Reporting Area identifier" is provided by the OCS, the trigger subscription refers to the Presence Reporting Area identifier selected by the PCRF.

When the initial UE presence status in PRA resulting from subscription by the OCS is received by the TDF, and the TDF has previously requested quota, all MSCC instances are reported to the OCS with a CCR update. If TDF has not previously requested quota, this initial status of UE presence in Presence Reporting Area will be sent towards the OCS on CCR update triggered for quota request when service usage is started.

When Ro specific chargeable event (e.g. threshold reached, QHT expires, quota exhaustion, validity time reached, forced re-authorization) occurs required MSCC instances are reported to OCS with a Debit / Reserve Units Request[Update] with corresponding Reporting-Reason AVP value. See TS 32.299 [50] for further information.

When tariff time change is encountered, the Tariff Change Usage is used within the Used Service Units to distinguish usage before and after the tariff time change. The MSCC instances are sent to the OCS in next CCR.

The OCS may specify the behaviour on consumption of the final granted units known as termination action. The required termination action is indicated with Final Unit Action and possible values are TERMINATE and REDIRECT. See TS 32.299 [50] for further information.

TS 23.203 [215] specifies that it shall be possible to request online charging quotas for each charging key. Each quota allocated to a Debit / Reserve Units session has a unique Rating Group value. TS 23.203 [215] also specifies that TDF shall report charging information for each combination of the charging key and service identifier when service identifier level reporting is present. As defined in TS 23.203 [215] the service identifier is a piece of information which provides the most detailed identification, specified for ABC. The charging key is a piece of information used for rating purposes as defined in TS 23.203 [215]. The charging key and Service Identifier are mapped into the Rating Group and the Service Identifier respectively as defined in RFC 4006 [402].

The subsequent clauses identify in detail the conditions for reporting online charging information, management of user and Credit-Control sessions and PS domain quota supervision.

5.3.2.2A.1 Triggers for starting and stopping an ABC Credit-Control session

Debit / Reserve Units Request[Initial] is sent to OCS when TDF session is activated.

Debit / Reserve Units Request[Terminate] is sent to OCS when:

- TDF session is deactivated
- Session termination is indicated by the OCS (e.g. Credit Limit Reached)
- Abort-Session-Request is received from the OCS.

5.3.2.2A.2 Triggers for providing interim information for an ABC Credit-Control session

Debit / Reserve Units Request[Update] is sent to OCS when:

- Start of application traffic, when no valid quota exists
- Granted quota runs out
- Validity time for granted quota expires
- Update is requested by the OCS
- Change of charging conditions occur and according re-authorisation trigger re-authorisation is needed
- Management intervention
- Quota Holding Timer is expired

5.3.2.2B Triggers for TDF session online charging

TDF session online charging is achieved by ABC online charging, see clause 5.3.2.2A.

5.3.2.2C Triggers for P-GW when charging per IP-CAN session is active

5.3.2.2C.1 General

The triggers identified in clause 5.3.2.2 are utilized when charging per IP-CAN session is active with the following changes:

1. When IP-CAN bearer charging is active, the Debit / Reserve Units Response is used by the OCS to return quotas for rating groups or to instruct the PCEF on the further handling of the IP-CAN session or service data flow, not a specific IP-CAN bearer.
2. Charging per IP-CAN session is employed if it is activated for the default IP-CAN bearer. Charging characteristics determine if the IP-CAN bearer charging is active or if the FBC is active. When IP-CAN bearer charging is active, a vendor-specific rating group and, optionally, service identifier, is used to signify that the IP-CAN session traffic is being monitored as per clause 5.3.1.6.1. This vendor-specific rating group is the only rating for which quota is requested from the OCS using the same mechanism as for FBC. When FBC is active, the charging method in the PCC rule defines whether a service data flow requires online charging.
3. In either case in which FBC is utilized, the PCEF shall request the quota prior to service delivery as in clause 5.3.2.2.
4. Debit / Reserve Units Request[Initial] is sent to the OCS during the IP-CAN session activation. No indication is provided to the OCS when an individual IP-CAN bearer is activated.
5. When IP-CAN bearer charging using the vendor-specific rating group, the OCS may only provide volume quotas.
6. At IP-CAN session establishment, the OCS may provide, if not already determined by the PCRF, the "Presence Reporting Area identifier" identifying the PRA to be reported when it subscribes to "Change of UE presence in Presence Reporting Area". The PCEF shall ignore any "Presence Reporting Area identifier" provided during the lifetime of the IP-CAN session after establishment procedure. OCS subscription to and PCEF reporting of "Change of UE presence in Presence Reporting Area" re-authorization event trigger is the same as in clause 5.3.2.2.
7. When start of the IP-CAN session traffic (if IP-CAN bearer charging is active) or the service data flow is detected and no valid quota exists, a Debit / Reserve Units Request[Update] is sent to request quota for the rating group as in clause 5.3.2.2C.3.

5.3.2.2C.2 Triggers for starting and stopping an FBC Credit-Control session when charging per IP-CAN session is active

Debit / Reserve Units Request[Initial] is sent to OCS when IP-CAN session (i.e., default bearer) is activated.

Debit / Reserve Units Request[Terminate] is sent to OCS when:

- IP-CAN session is deactivated
- Session termination is indicated by the OCS (e.g., Credit Limit Reached)
- Abort-Session-Request is received from the OCS, this also results in network-initiated IP-CAN session deactivation.

5.3.2.2C.3 Triggers for providing interim information for an FBC Credit-Control session when charging per IP-CAN session is active

Debit / Reserve Units Request[Update] is sent to OCS when:

- User starts to use certain service

- Start of service data flow (refer to 5.3.1.2)
- Active service is removed from the allowed services
- Granted quota runs out
- Validity time for granted quota expires
- Update is requested by the OCS
- Change of charging conditions occur and re-authorisation trigger is set
- Management intervention
- Quota Holding Timer is expired

5.3.2.3 PS Furnish Charging Information procedure

The OCS online charging function may use this procedure to add online charging session specific information to the PGW-CDR/TDF-CDR by means of the Debit / Reserve Units operation in the Ro interface. The data can be sent either in one Debit / Reserve Units Response message or several Debit / Reserve Units Response messages with append indicator.

The OCS online charging function can send multiple concatenated PS Furnish Charging Information elements per online charging session in the Ro interface. The OCS online charging function can also send multiple concatenated PS Furnish Information Element per each quota (i.e. per rating group).

The total maximum of free format data is 160 octets per service so the total maximum of free format data per online session is $n \times 160$ octets, where n indicates the number of rating groups activated per online session.

In the OCS online charging function, a PS online charging session shall be identified by the P-GW control plane address and the ChargingId. In the P-GW, the PS online charging session and the PS offline charging session shall be identified by the same ChargingId. Therefore the ChargingId shall allow the P-GW to correlate an online charging session with an offline charging session. In the TDF, the PS online charging session and the PS offline charging session shall be identified by the combination of P-GW control plane address and ChargingId. Therefore the P-GW address/Charging Id shall allow the TDF to correlate an online charging session with an offline charging session.

This procedure can only apply when online and offline charging is performed simultaneously for the same session (IP-CAN bearer or TDF session) or rating group. In any other case, the P-GW/TDF shall discard the additional charging information sent by the OCS in the Debit / Reserve Units Response messages.

When the OCS sends session specific charging information, it must send the PS Furnish Charging Information at command level in the Debit / Reserve Units Response. In this case, the information is added to the main body of the PGW-CDR. When the OCS sends service specific charging information, it must send the PS Furnish Charging Information at MSCC level in the Debit / Reserve Units Response. In this case, the information is added to the specific service container in the PGW-CDR/TDF-CDR.

The PS Furnish Charging Information is described in TS 32.299 [50].

5.3.2.4 Support of Failure Situations

In case the OCS fails the P-GW/TDF must support the Failure Handling procedure and Failover mechanism described in TS 32.299 [50].

The Failure Handling Procedure affects the whole online session so in case FBC/ABC is enabled, the procedure shall affect all services activated during the IP-CAN bearer/TDF session triggering the online charging session.

According to TS 32.299 [50], timer Tx determines the maximum interval the P-GW/TDF shall wait for an answer to each Debit / Reserve Units Request sent to the OCS. In case FBC/ABC is enabled, it is possible that several concurrent Debit / Reserve Units Request messages are triggered for the same online charging session. In this case, each Debit / Reserve Units Request message shall reset the Tx timer. When Tx expires, P-GW/TDF shall execute the Failover and Failure Handling mechanisms according to the behaviour described in Annex B.

Three different actions are described in RFC 4006 [402].

P-GW shall support the following actions when the failure handling mechanism is executed:

- Terminate: The online session is finished. The associated IP-CAN bearer session is released (ongoing sessions) or not established (new sessions). Failover for ongoing sessions is not supported. Failover for new sessions is always supported.
- Retry&Terminate: The online session is finished. The associated IP-CAN bearer session is released (ongoing sessions) or not established (new sessions). Failover for ongoing sessions is supported. Failover for new sessions is always supported.
- Continue: The online session is finished. The associated IP-CAN bearer session is established (new sessions) or not released (ongoing sessions). Failover for ongoing sessions is supported. Failover for new sessions is always supported. It shall be operator configurable to limit the maximum duration of the IP-CAN bearer in this situation.

When charging per IP-CAN session is active, the actions above apply to the entire IP-CAN session instead of the individual IP-CAN bearer.

TDF shall support the following actions when the failure handling mechanism is based on the directives received previously from the OCS:

- **Terminate:** This is the default behaviour. The TDF indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.
- **Retry&Terminate:** If the OCS and TDF support failover procedures and there is an alternate OCS available, the TDF shall attempt to failover to an alternative OCS. Otherwise, the TDF indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.
- **Continue:** If the OCS and TDF support failover procedures and there is an alternate OCS available, the TDF shall attempt to failover to an alternative OCS. Otherwise, the TDF indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The PCRF determines whether to continue or terminate the associated TDF session.

In case the user is simultaneously online and offline charged, the failure situation must be registered in the PGW-CDR/TDF-CDR. When the user is only online charged, the execution of the Failure Handling mechanism with value equal to Continue shall imply that a new PGW-CDR/TDF-CDR is opened.

6 Definition of charging information

6.1A Rf message content

6.1A.0 General

This clause is applicable to the ePDG, MME, S-GW, P-GW and TDF, when the CDF is provided as an external entity.

6.1A.1 Summary of offline charging message formats

The PS Offline Charging and "SMS over MME Charging" utilises the *Charging Data Transfer* that is specified in the 3GPP accounting application described in TS 32.299 [50].

The *Charging Data Transfer* operation employs the *Charging Data Request* and *Charging Data Response* messages.

The *Charging Data Request* can be of type [Start, Interim, Stop and Event] and includes all charging information. The *Charging Data Response* is an acknowledgement of the *Charging Data Request*.

Table 6.1A.1.1 describes the use of these messages for offline charging.

Table 6.1A.1.1 : Offline charging messages reference table

| Message | Source | Destination |
|------------------------|----------------------------|----------------------------|
| Charging Data Request | ePDG, MME, S-GW, P-GW, TDF | CDF |
| Charging Data Response | CDF | ePDG, MME, S-GW, P-GW, TDF |

6.1A.2 Structure for the charging data message formats

6.1A.2.0 General

This clause describes the Information Elements (IE) used in the charging data messages.

Category in table 6.1A.2.1.1 and table 6.1A.2.2.1 shall use the categories according to clause 6.1B.

6.1A.2.1 Charging Data Request message

Table 6.1A.2.1.1 illustrates the basic structure of a Charging Data Request message from the MME, S-GW, ePDG, P-GW and TDF as used for PS offline charging and "SMS over MME Charging".

Table 6.1A.2.1.1: Charging Data Request message contents

| Information Element | Category | Description |
|-----------------------|----------------|---|
| Session Identifier | M | Described in TS 32.299 [50] |
| Originator Host | M | Described in TS 32.299 [50] |
| Originator Domain | M | Described in TS 32.299 [50] |
| Destination Domain | M | Described in TS 32.299 [50] |
| Operation Type | M | Described in TS 32.299 [50] |
| Operation Number | M | Described in TS 32.299 [50] |
| Operation Identifier | O _C | Described in TS 32.299 [50] |
| User Name | O _C | The content of the field corresponds to the Protocol Configuration Options (PCO) field of the Create IP-CAN bearer Request message. (ffs) |
| Destination Host | O _C | Described in TS 32.299 [50] |
| Operation Interval | O _C | Described in TS 32.299 [50] |
| Origination State | O _C | Described in TS 32.299 [50] |
| Origination Timestamp | O _C | Described in TS 32.299 [50] |
| Proxy Information | O _C | Described in TS 32.299 [50] |
| Route Information | O _C | Described in TS 32.299 [50] |
| Operation Token | O _M | This field identifies the PS domain. |
| Service Information | O _M | This field holds the PS charging specific parameters described in clause 6.3. |

NOTE: Detailed descriptions of the fields are provided in TS 32.299 [50].

6.1A.2.2 Charging Data Response message

Table 6.1A.2.2.1 illustrates the basic structure of a Charging Data Response message as used for the ePDG, MME, S-GW, P-GW and TDF.

Table 6.1A.2.2.1 : Charging Data Response message contents

| AVP | Category | Description |
|-----------------------|----------------|-----------------------------|
| Session Identifier | M | Described in TS 32.299 [50] |
| Operation Result | M | Described in TS 32.299 [50] |
| Originator Host | M | Described in TS 32.299 [50] |
| Originator Domain | M | Described in TS 32.299 [50] |
| Operation Type | M | Described in TS 32.299 [50] |
| Operation Number | O _C | Described in TS 32.299 [50] |
| Operation Identifier | O _C | Described in TS 32.299 [50] |
| Operation Interval | O _C | Described in TS 32.299 [50] |
| Error Reporting Host | O _C | Described in TS 32.299 [50] |
| Origination State | O _C | Described in TS 32.299 [50] |
| Origination Timestamp | O _C | Described in TS 32.299 [50] |
| Proxy Information | O _C | Described in TS 32.299 [50] |

NOTE: Detailed descriptions of the fields are provided in TS 32.299 [50].

6.1B CDR content description on Bp interface

6.1B.0 General

The tables in the subsequent parts of this clause specify the Mandatory (M), Conditional (C) and Operator optional (O_M or O_C) designations. The category of a CDR parameter can have one of two primary values:

- M** This parameter is **Mandatory** and shall always be present in the CDR.
- C** This parameter shall be present in the CDR only when certain Conditions are met. These conditions are specified as part of the parameter definition.

All other parameters are designated as Operator (**O**) provisionable, which replaced the "Optional" category, specified in earlier releases. Using network management functions or specific tools provided by an equipment vendor, operators may choose if they wish to include or omit the parameter from the CDR. Once omitted, this parameter is not generated in a CDR. To avoid any potential ambiguity, a CDR generating element **MUST** be able to provide all these parameters. Only an operator can choose whether or not these parameters should be generated in their system.

Those parameters that the operator wishes to be present are further divided into a mandatory and conditional categories:

- O_M** This is a parameter that, if provisioned by the operator to be present, shall always be included in the CDRs. In other words, an O_M parameter that is provisioned to be present is a mandatory parameter.
- O_C** This is a parameter that, if provisioned by the operator to be present, shall be included in the CDRs when the required conditions are met. In other words, an O_C parameter that is configured to be present is a conditional parameter.

The following tables 6.1.1.1 - 6.1.14.1 provide a brief description of each CDR parameter. Full definitions of the parameters, sorted by the parameter name in alphabetical order, are provided in TS 32.298 [51].

6.1.1 IP-CAN bearer charging data in SGSN (S-CDR)

If the collection of CDR data is enabled then the SGSN data specified in table 6.1.1.1 shall be available for each IP-CAN bearer.

Table 6.1.1.1: SGSN IP-CAN bearer data (S-CDR)

| Field | Category | Description |
|---------------------------------------|----------------|---|
| Record Type | M | SGSN IP-CAN bearer record. |
| Network Initiated PDP Context | O _C | A flag that is present if this is a network initiated IP-CAN bearer. |
| Served IMSI | C | IMSI of the served party, if available. |
| IMSI Unauthenticated Flag | O _C | This field indicates the provided served IMSI is not authenticated (emergency bearer service situation). |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. It is used for identifying the user in case Served IMSI is not present during emergency bearer service. |
| SGSN Address | O _M | The IP address of the current SGSN. |
| MS Network Capability | O _M | The mobile station Network Capability. |
| Routing Area Code (RAC) | O _M | RAC at the time of "Record Opening Time". |
| Location Area Code (LAC) | O _M | LAC at the time of "Record Opening Time". |
| User CSG information | O _C | This field contains the User CSG information of the UE, if available, including CSG ID, access mode and CSG membership indication. |
| Cell Identifier | O _M | Cell identity for GSM or Service Area Code (SAC) for UMTS at the time of "Record Opening Time". |
| Charging ID | M | IP-CAN bearer identifier used to identify this IP-CAN bearer in different records created by PCNs. |
| GGSN Address Used | M | The control plane IP address of the P-GW currently used. The P-GW address is always the same for an activated IP-CAN bearer. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the external packet data network (network identifier part of APN). |
| PDP Type | O _M | PDP type, i.e. IPv4, IPv6, IPv4v6, PPP, IHOSS:OSP. |
| Served PDP Address | O _C | PDP address of the served IMSI, i.e. IPv4 address when PDP Type is IPv4 or IPv6 prefix when PDP Type is IPv6 or IPv4v6. This parameter shall be present except when both the PDP type is PPP and dynamic PDP address assignment is used. |
| Served PDP Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Served PDP/PDN Address extension | O _C | This field holds IPv4 address of the served IMSI, if available, when PDP type is IPv4v6. |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this IP-CAN bearer, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. Initial and subsequently changed QoS and corresponding data volumes are also listed. |
| Record Opening Time | M | Time stamp when IP-CAN bearer is activated in this SGSN or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the SGSN. |
| SGSN Change | C | Present if this is first record after SGSN change. |
| Cause for Record Closing | M | The reason for closure of the record from this SGSN. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number in this SGSN. Only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| APN Selection Mode | O _M | An index indicating how the APN was selected. |
| Access Point Name Operator Identifier | O _M | The Operator Identifier part of the APN. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| Charging Characteristics | M | The Charging Characteristics applied to the IP-CAN bearer. |
| Serving Node PLMN Identifier | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN. |

| Field | Category | Description |
|---|----------------|--|
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the 'Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| CAMEL Information | O _C | Set of CAMEL information related to IP-CAN bearer. For more information see Description of Record Fields. This field is present if CAMEL service is activated. |
| RNC Unsent Downlink Volume | O _C | The downlink data volume, which the RNC has not sent to MS. This field is present when the RNC has provided unsent downlink volume count at RAB release. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| Dynamic Address Flag | O _C | Indicates whether served PDP address is dynamic, which is allocated during IP-CAN bearer activation. This field is missing if address is static. |
| Low Priority Indicator | O _C | This field indicates if this IP-CAN bearer has a low priority, i.e. for Machine Type Communication. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.2 IP-CAN bearer charging data in S-GW (SGW-CDR)

If the collection of CDR data is enabled then the S-GW data specified in table 6.1.2.1 shall be available for each IP-CAN bearer.

Table 6.1.2.1: S-GW IP-CAN bearer data (SGW-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|---|
| Record Type | M | S-GW IP-CAN bearer record. |
| Retransmission | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | C | IMSI of the served party, if available. |
| IMSI Unauthenticated Flag | O _C | This field indicates the provided served IMSI is not authenticated (emergency bearer service situation). |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. It is used for identifying the user in case Served IMSI is not present during emergency bearer service. |
| S-GW Address used | M | The control plane IP address of the S-GW used. |
| S-GW Address IPv6 | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the S-GW. |
| Charging ID | M | IP-CAN bearer Charging identifier used to identify this IP-CAN bearer in different records created by PCNs |
| PDN Connection Charging Id | O _M | This field holds the Charging Id of the EPS default bearer in GTP case, or the unique Charging Id of the IP-CAN session in PMIP case: it is used to identify different records belonging to same PDN connection. |
| Serving Node Address | M | List of serving node control plane IP addresses (e.g. S4-SGSN, MME, ...) used during this record. |
| Serving Node IPv6 Address | O _C | List of serving node control plane IPv6 addresses, in case of IPv4v6 dual stack, (e.g. S4-SGSN, MME, ...) used during this record. |
| Serving node Type | M | List of serving node types in control plane. The serving node types listed here map to the serving node addresses listed in the field "Serving node Address" in sequence. |
| S-GW Change | O _C | Present if this is first record after S-GW change. |
| PGW PLMN Identifier | O _C | PLMN identifier (MCC MNC) of the P-GW used. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the external packet data network (network identifier part of APN). |
| PDP/PDN Type | O _M | This field indicates PDN type (i.e. IPv4, IPv6 or IPv4v6). |
| Served PDP/PDN Address | O _C | IP address allocated for the PDP context / PDN connection, if available, i.e. IPv4 address when PDN Type is IPv4 or IPv6 prefix when PDN Type is IPv6 or IPv4v6. |
| Served PDP/PDN Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Served PDP/PDN Address extension | O _C | This field holds IPv4 address of the served IMSI, if available, when PDN type is IPv4v6. |
| Dynamic Address Flag | O _C | Indicates whether served PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity. This field is missing if IPv4 address is static when PDN Type is IPv4, or if IPv6 address is static when PDN Type is IPv6 or IPv4v6. |
| Dynamic Address Flag extension | O _C | Indicates whether served IPv4 PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity with PDP/PDN type IPv4v6. This field is missing if IPv4 address is static. |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this QCI/ARP pair, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. Initial and subsequently changed QoS and corresponding data values are also listed. |
| Record Opening Time | M | Time stamp when IP-CAN bearer is activated in this S-GW or record opening time on subsequent partial records. |

| Field | Category | Description |
|---|----------------|--|
| MS Time Zone | O _C | This field contains the MS Time Zone the MS is currently located as defined in TS 29.060 [203], if available. |
| Last MS Time Zone | O _C | This field contains the UE Time Zone the UE is located at IP-CAN bearer deactivation, or at default bearer deactivation when IP-CAN session charging is active, when available. |
| Duration | M | Duration of this record in the S-GW. |
| Cause for Record Closing | M | The reason for the release of record from this S-GW. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| APN Selection Mode | O _M | An index indicating how the APN was selected. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| User Location Information | O _C | This field contains the User Location Information of the MS as defined in TS 29.060 [203] for GPRS case, and in TS 29.274 [210] for EPC case, if available. |
| User Location Information Time | O _C | This field contains the time at which the user location information was acquired. |
| Last User Location Information | O _C | This field contains the User Location Information of the UE at IP-CAN bearer deactivation, or at default bearer deactivation when IP-CAN session charging is active, when available. |
| User CSG information | O _C | This field contains the User CSG information of the UE, if available, including CSG ID, access mode and CSG membership indication. |
| Presence Reporting Area Information | O _C | This grouped field contains the Presence Reporting Area Identifier for the UE PDN connection and the initial status of the UE presence in the Presence Reporting Area, if available. |
| Charging Characteristics | M | The Charging Characteristics applied to the IP-CAN bearer. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| IMS Signalling Context | O _C | Included if the IM-CN Subsystem Signalling Flag is set, see TS 23.060 [201] IP-CAN bearer is used for IMS signalling. |
| P-GW Address used. | O _C | This field is the P-GW IP Address for the Control Plane |
| P-GW Address IPv6 | O _C | This field is the P-GW IPv6 Address, in case of IPv4v6 dual stack, for the Control Plane |
| Serving Node PLMN Identifier | O _C | This fields holds the PLMN Identifier (MCC and MNC) serving the UE during this record, as received in the "Serving Network" IE over S4/S11, if available. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the "Serving Node PLMN Identifier" has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Start Time | O _C | This field holds the time when User IP-CAN session starts, available in the CDR for the first bearer in an IP-CAN session. |
| Stop Time | O _C | This field holds the time when User IP-CAN session is terminated, available in the CDR for the last bearer in an IP-CAN session. |
| Low Priority Indicator | O _C | This field indicates if this IP-CAN session has a low priority, i.e. for Machine Type Communication. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.3 FBC IP-CAN bearer charging data in P-GW (PGW-CDR)

If FBC is enabled and the collection of CDR data is enabled then the P-GW data specified in table 6.1.3.1 shall be available for each IP-CAN bearer.

Table 6.1.3.1: P-GW IP-CAN bearer data (PGW-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|---|
| Record Type | M | P-GW IP-CAN bearer record. |
| Retransmission | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | C | IMSI of the served party, if available. |
| IMSI Unauthenticated Flag | O _C | This field indicates the provided served IMSI is not authenticated (emergency bearer service situation). |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. It is used for identifying the user in case Served IMSI is not present during emergency bearer service. |
| Served 3GPP2 MEID | O _C | MEID of the served party's terminal equipment for 3GPP2 access. |
| Served MN NAI | O _C | Mobile Node Identifier in NAI format (based on IMSI), if available. |
| P-GW Address used | M | The control plane IP address of the P-GW used. |
| P-GW Address IPv6 | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the P-GW used. |
| Charging ID | M | IP-CAN bearer Charging identifier used to identify this IP-CAN bearer in different records created by PCNs. This field holds the unique Charging Id in the PMIP case. When charging per IP-CAN session is active, this field holds the Charging Id of the EPS default bearer. It is the same as the PDN Connection Charging Id. |
| PDN Connection Charging Id | O _M | This field holds the Charging Id of the EPS default bearer to identify different records belonging to same PDN connection. This field is present in GTP case only. |
| Serving node Address | M | List of SGSN/S-GW/TWAG control plane IP addresses, or the ePDG address used during this record. |
| Serving node IPv6 Address | O _C | List of SGSN/S-GW/TWAG control plane IPv6 addresses, in case of IPv4v6 dual stack, used during this record. |
| Serving node Type | M | List of serving node types in control plane (SGSN, SGW, ePDG, AGW, TWAG). The serving node types listed here map to the serving node addresses listed in the field "Serving node Address" in sequence. |
| PGW PLMN Identifier | O _C | PLMN identifier (MCC MNC) of the P-GW. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the external packet data network (network identifier part of APN). |
| PDP/PDN Type | O _M | PDP/PDN type, i.e. IPv4, IPv6, IPv4v6, or PDP type PPP, or IHOSS:OSP. |
| Served PDP/PDN Address | O _C | IP address allocated for the PDP context / PDN connection, i.e. IPv4 address when PDP/PDN Type is IPv4 or IPv6 prefix when PDP/PDN Type is IPv6 or IPv4v6. This parameter shall be present except when both the PDP type is PPP and dynamic IP-CAN bearer address assignment is used. |
| Served PDP/PDN Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Served PDP/PDN Address extension | O _C | This field holds IPv4 address of the served IMSI, if available, when PDP/PDN type is IPv4v6. |
| Dynamic Address Flag | O _C | Indicates whether served PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity. This field is missing if IPv4 address is static when PDN Type is IPv4, or if IPv6 address is static when PDN Type is IPv6 or IPv4v6. |
| Dynamic Address Flag extension | O _C | Indicates whether served IPv4 PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity with PDP/PDN type IPv4v6. This field is missing if IPv4 address is static. |

| Field | Category | Description |
|---|----------------|---|
| List of Traffic Data Volumes | O _C | A list of changes in charging conditions for all bearers within the IP-CAN session. Each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. Initial and subsequently changed QoS and corresponding data values are also listed. Applicable only when IP-CAN session charging is active. See table 6.1.3.1 for a description of List of Traffic Data Volumes handling. |
| List of Service Data | O _M | A list of changes in charging conditions for all service data flows within this IP-CAN bearer categorized per rating group or per combination of the rating group and service id or per combination of rating group, sponsor identity and application service provider identity. Each change is time stamped. Charging conditions are used to categorize traffic volumes, elapsed time and number of events, such as per tariff period. Initial and subsequently changed QoS and corresponding data values are also listed. Online charging information (PS Furnish Charging Information) may be added per each service data flow container in case it is sent by the OCS. External charging identifiers may be added per each service data flow container in case sent by the PCRF. Failure-Handling: This field shall be present in case P-GW triggers the Failure-Handling procedure. It shall indicate the Failure Handling scenario and the instant the Failure Action is triggered (see annex B). Scenarios: Continue/New Session; Continue/Ongoing Session; Retry&Terminate/Ongoing Session; Terminate/Ongoing Session. When charging per IP-CAN session is active, see table 6.1.3.2 for a description of List of Service Data handling. |
| Record Opening Time | M | Time stamp when IP-CAN bearer is activated in this P-GW or record opening time on subsequent partial records. |
| MS Time Zone | O _C | This field contains the MS Time Zone the MS is currently located as defined in TS 29.060 [203], if available. |
| Last MS Time Zone | O _C | This field contains the UE Time Zone the UE is located at IP-CAN bearer deactivation, or at default bearer deactivation when IP-CAN session charging is active, when available. |
| Duration | M | Duration of this record in the P-GW. |
| Cause for Record Closing | M | The reason for the release of record from this P-GW. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| APN Selection Mode | O _M | An index indicating how the APN was selected. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| User Location Information | O _C | This field contains the User Location Information of the MS when the CDR is opened as defined in TS 29.060 [203] for GPRS case, and in TS 29.274 [210] for EPC case, if available. |
| Last User Location Information | O _C | This field contains the User Location Information of the UE at IP-CAN bearer deactivation, or at default bearer deactivation when IP-CAN session charging is active, when available. |
| User Location Information Time | O _C | This field contains the time at which the user location information was acquired. |
| User CSG information | O _C | This field contains the User CSG Information of the UE, if available, including CSG ID, access mode and CSG membership indication. |
| 3GPP2 User Location information | O _C | This field contains the User Location Information of the MS when the CDR is opened as defined in TS 29.212 [71] for 3GPP2 access, if available. |
| TWAN User Location Information | O _C | This field contains the UE location in a Trusted WLAN Access Network (TWAN) (SSID and, when available, BSSID of the access point), as defined in TS 29.274 [210] for S2a GTP-based case, or 29.275 [211] for S2a PMIP-based case, if available. |
| Presence Reporting Area Information | O _C | This grouped field contains the Presence Reporting Area Identifier for the UE PDN connection and the initial status of the UE presence in the Presence Reporting Area, if available. |
| Charging Characteristics | M | The Charging Characteristics applied to the IP-CAN bearer. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |

| Field | Category | Description |
|---------------------------------|----------------|--|
| IMS Signalling Context | O _C | Included if the IP-CAN default bearer IM-CN Subsystem Signalling Flag is set, see TS 23.060 [201] is used for IMS signalling. |
| Serving node PLMN Identifier | O _M | This fields holds the PLMN Identifier (MCC and MNC) serving the UE during this record , as received in the "Serving Network' IE over S5/S8 or retrieved from the RAI received over Gn/Gp. When the Serving node is TWAG, this field includes the PLMN identifier used for UE authentication, i.e. the VPLMN in roaming case, and the HPLMN in non-roaming case. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the "Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| PS Furnish Charging Information | O _C | Online charging session specific information |
| CAMEL Information | O _C | Set of CAMEL information related to IP-CAN bearer, if available. This field applies only for GPRS. When charging per IP-CAN session is active, this field is not applicable. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Start Time | O _C | This field holds the time when User IP-CAN session starts, available in the CDR for the first bearer in an IP-CAN session. When charging per IP-CAN session is active, this field holds the time when User IP-CAN session starts. |
| Stop Time | O _C | This field holds the time when User IP-CAN session is terminated, available in the CDR for the last bearer in an IP-CAN session. When charging per IP-CAN session is active, this field holds the time when User IP-CAN session is terminated. |
| Low Priority Indicator | O _C | This field indicates if this IP-CAN session has a low priority, i.e. for Machine Type Communication. |
| QoS Information | OC | This field indicates the APN-AMBR uplink and downlink information for the IP-CAN session. Applicable only when charging per IP-CAN session is active. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

Table 6.1.3.2 contains special handling for the fields in the List of Traffic Data Volumes in PGW-CDR when charging per IP-CAN session is active and IP-CAN bearer charging is performed.

Table 6.1.3.2: List of Traffic Data Volumes in PGW-CDR when charging per IP-CAN session is active

| Field | Category | Description |
|--------------------------------|----------------|---|
| Data Volume Uplink | O _C | This field includes the number of octets transmitted during the use of the packet data services in the uplink direction. |
| Data Volume Downlink | O _C | This field includes the number of octets transmitted during the use of the packet data services in the downlink direction. |
| Change Condition | M | This field defines the reason for closing the container as specified in clause 5.2.1.10.1. |
| Change Time | M | This field is a time stamp, which defines the moment when the volume container is closed. |
| User Location Information | O _C | This field contains the location (e.g. CGI/SAI, ECGI/TAI or RAI) where the UE is located and used during the transfer of the data volume captured by the container. This is included in the Traffic data container only if previous container's change condition is "user location change". |
| Presence Reporting Area Status | O _C | This field contains the status of the UE presence in Presence Reporting Area. |
| EPC QoS Information | O _C | This field contains the authorized QoS for the IP-CAN bearer. First container for each QCI/ARP pair includes this field. In following containers this field is present if previous change condition is "QoS change". This field includes: QCI and ARP. For GBR QCI values, this field also includes GBR for the downlink and uplink direction. If the MBR is different than the GBR, then this field also includes the MBR for the downlink and uplink direction. This field does not include the APN-AMBR, which is contained in a separate field in the CDR for the IP-CAN session. |

| Field | Category | Description |
|-------------|----------------|--|
| Charging Id | O _C | Charging Id is generated by P-GW at IP-CAN bearer activation and is included in all containers in order to identifier the containers which pertain to the IP-CAN bearer. |

Table 6.1.3.3 contains special handling for fields in the List of Service Data when charging per IP-CAN session is active. The complete set of fields in the List of Service Data is defined in TS 32.298 [51].

Table 6.1.3.3: List of Service Data in PGW-CDR when charging per IP-CAN session is active

| Field | Category | Description |
|---------------------------------------|----------------|--|
| AF Record Information | O _C | As specified in TS 32.298 [51]. |
| Charging Rule Base Name | O _C | As specified in TS 32.298 [51]. |
| ADC Rule Base Name | O _C | Not applicable to PGW-CDR. |
| Data Volume Downlink | O _C | As specified in TS 32.298 [51]. |
| Data Volume Uplink | O _C | As specified in TS 32.298 [51]. |
| Event Based Charging Information | O _C | As specified in TS 32.298 [51]. |
| Local Sequence Number | O _C | As specified in TS 32.298 [51]. |
| PS Furnish Charging Information | O _C | As specified in TS 32.298 [51]. |
| EPC QoS Information | O _C | This field contains the authorized QoS for the IP-CAN bearer that is first reported for the Rating Group or Rating Group / Service Identifier in the container. If traffic from multiple bearers is included in the report for the container, only one field is included. This field includes: QCI and ARP. For non-GBR QCI values, this field also includes the MBR for the downlink and uplink direction. For GBR QCI values, this field also includes GBR for the downlink and uplink direction. If the MBR is different than the GBR, then this field also includes the MBR for the downlink and uplink direction. This field does not include the APN-AMBR, which is contained in a separate field in the CDR for the IP-CAN session. |
| Rating Group | M | As specified in TS 32.298 [51]. |
| Report Time | M | As specified in TS 32.298 [51]. |
| Result Code | O _C | As specified in TS 32.298 [51]. |
| Service Condition Change | M | As specified in TS 32.298 [51]. Only those values specified for the events in clause 5.3.2.X apply. |
| Service Identifier | O _C | As specified in TS 32.298 [51]. |
| Service Specific Info | O _C | As specified in TS 32.298 [51]. |
| Serving Node Address | O _C | As specified in TS 32.298 [51]. |
| Time of First Usage | O _C | As specified in TS 32.298 [51]. |
| Time of Last Usage | O _C | As specified in TS 32.298 [51]. |
| Tme Usage | O _C | As specified in TS 32.298 [51]. |
| User Location Information | O _C | As specified in TS 32.298 [51]. |
| 3GPP2 User Location Information | O _C | As specified in TS 32.298 [51]. |
| Presence Reporting Area Status | O _C | This field contains the status of the UE presence in Presence Reporting Area. |
| Sponsor Identity | O _C | As specified in TS 32.298 [51]. |
| Application Service Provider Identity | O _C | As specified in TS 32.298 [51]. |
| Time Quota Mechanism | O _C | As specified in TS 32.298 [51]. |

6.1.4 Mobile Station mobility management data in SGSN (M-CDR)

If the collection of MS mobility management data is enabled then the SGSN shall start collecting the information specified in the following table 6.1.4.1 each time the mobile is attached to the SGSN.

Table 6.1.4.1: SGSN Mobile Station mobility management data (M-CDR)

| Field | Category | Description |
|---|----------------|--|
| Record Type | M | SGSN mobility management record. |
| Served IMSI | M | IMSI of the MS. |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. |
| SGSN Address | O _M | The IP address of the current SGSN. |
| MS Network Capability | O _M | The mobile station network capability. |
| Routing Area Code | O _M | Routing Area at the time of the Record Opening Time. |
| Local Area Code | O _M | Location Area Code at the time of Record Opening Time. |
| Cell Identifier | O _M | The Cell Identity for GSM or Service Area Code (SAC) for UMTS at the time of the Record Opening Time. |
| Cell PLMN Id | O _M | The MCC and MNC of the Cell at the time of Record Opening Time. |
| Change of Location | O _C | A list of changes in Routing Area Code including MCC and MNC, each with a time stamp. This field is not required if partial records are generated when the location changes. |
| Record Opening Time | M | Timestamp when MS is attached to this SGSN or record opening time on following partial record. |
| Duration | O _M | Duration of this record. |
| SGSN Change | C | Present if this is first record after SGSN change. |
| Cause for Record Closing | M | The reason for the closure of the record in this SGSN. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number in this SGSN; only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| Charging Characteristics | M | The Charging Characteristics used by the SGSN. |
| Serving Node PLMN Identifier | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the 'Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| CAMEL Information | O _C | Set of CAMEL information related to Attach/Detach session. For more information see Description of Record Fields. This field is present if CAMEL service is activated. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.5 SMS-MO data in SGSN/MME (S-SMO-CDR)

If enabled, an S-SMO-CDR SGSN/MME Mobile originated SMS record shall be produced for each short message sent by a mobile subscriber via the SGSN/via the MME to the SMSC.

The fields in the record are specified in table 6.1.5.1.

Table 6.1.5.1: SGSN/MME Mobile originated SMS record (S-SMO-CDR)

| Field | Category | | Description |
|---|----------------|----------------|--|
| | SGSN | MME | |
| Record Type | M | M | SGSN/MME Mobile Originated SMS. |
| Retransmission | - | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | M | M | The IMSI of the subscriber. |
| Served IMEI | O _C | O _C | The IMEI or IMEISV of the ME, if available. |
| Served MSISDN | O _M | O _M | The primary MSISDN of the subscriber. |
| MS Network Capability | O _M | - | The mobile station network capability. |
| Service Centre | O _M | O _M | The address (E.164) of the SMS-service centre. |
| Serving Node Type | M | M | Type of node handling the SMS (SGSN or MME). |
| Recording Entity | O _M | O _M | The E.164 number of the SGSN/MME. |
| Serving Node Address | - | O _M | The address of the MME used. |
| Serving Node IPv6 Address Address | - | O _C | The IPv6 address, in case of IPv4v6 dual stack, of the MME. |
| MME Name | - | O _M | The operation Identity of the MME. |
| MME Realm | - | O _M | The operation Realm Identity of the MME. |
| Location Area Code | O _M | - | The Location Area Code from which the message originated. |
| Routing Area Code | O _M | - | The Routing Area Code from which the message originated. |
| Cell Identifier | O _M | - | The Cell Identity for GSM or Service Area Code (SAC) for UMTS from which the message originated. |
| User Location Information | - | O _C | This field contains the User Location (User location Information as defined in TS 29.274 [210]) from which the message originated. |
| User Location Information Time | - | O _C | This field contains the time at which the user location information was acquired. |
| Message Reference | M | M | A reference provided by the MS uniquely identifying this message. |
| Event Time Stamp | M | M | The time at which the message was received by the SGSN/MME from the subscriber. |
| SMS Result | C | C | The result of the attempted delivery if unsuccessful. |
| Node ID | O _M | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Charging Characteristics | M | M | The Charging Characteristics flag set used by the SGSN/MME. |
| Serving Node PLMN Identifier | O _C | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN/MME. |
| CN Operator Selection Entity | O _C | O _C | This field indicates whether the Serving Network identified by the 'Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | - | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Destination Number | O _M | O _M | The destination short message subscriber number. |
| CAMEL Information | O _C | - | Set of CAMEL information related to SMS session. For more information see Description of Record Fields. This field is present if CAMEL service is activated. |
| Charging Characteristics Selection Mode | O _M | O _M | Holds information about how Charging Characteristics were selected. |
| Record Extensions | O _C | O _C | A set of network operator/ manufacturer specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.6 SMS-MT data in SGSN/MME (S-SMT-CDR)

If enabled, an SGSN/MME Mobile terminated SMS record shall be produced for each short message received by a mobile subscriber via the SGSN/ from the SMSC via the MME. The fields in the record are specified in table 6.1.6.1.

Table 6.1.6.1: SGSN/MME Mobile terminated SMS record (S-SMT-CDR)

| Field | Category | | Description |
|---|----------------|----------------|--|
| | SGSN | MME | |
| Record Type | M | M | SGSN/MME Mobile Terminated SMS. |
| Retransmission | - | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | M | M | The IMSI of the subscriber. |
| Served IMEI | O _C | O _C | The IMEI or IMEISV of the ME, if available. |
| Served MSISDN | O _C | O _C | The primary MSISDN of the subscriber. |
| MS Network Capability | O _M | - | The mobile station network capability. |
| Service Centre | O _M | O _M | The address (E.164) of the SMS-service centre. |
| Serving Node Type | M | M | Type of node handling the SMS (SGSN or MME) |
| Recording Entity | O _M | O _M | The E.164 number of the SGSN/MME. |
| Serving Node Address | - | O _M | The address of the MME used |
| Serving Node IPv6 Address Address | - | O _C | The IPv6 address, in case of IPv4v6 dual stack, of the MME. |
| MME Name | - | O _M | The Diameter Identity of the MME |
| MME Realm | - | O _M | The Diameter Realm Identity of the MME |
| Location Area Code | O _M | - | The Location Area Code to which the message was delivered. |
| Routing Area Code | O _M | - | The Routing Area Code to which the message was delivered. |
| Cell Identifier | O _M | - | The Cell Identity for GSM or Service Area Code (SAC) for UMTS to which the message was delivered. |
| User Location Information | - | O _C | This field contains the User Location (User location Information as defined in TS 29.274 [210]) to which the message was delivered, if available. |
| User Location Information Time | - | O _C | This field contains the time at which the user location information was acquired. |
| Event Time Stamp | M | M | Delivery time stamp, time at which message was sent to the MS by the SGSN/MME. |
| SMS Result | C | C | The result of the attempted delivery if unsuccessful. |
| Node ID | O _M | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Charging Characteristics | M | M | The Charging Characteristics flag set used by the SGSN/MME. |
| Serving Node PLMN Identifier | O _C | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN/MME |
| CN Operator Selection Entity | O _C | O _C | This field indicates whether the Serving Network identified by the 'Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | - | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Charging Characteristics Selection Mode | O _M | O _M | Holds information about how Charging Characteristics were selected. |
| CAMEL Information | O _C | - | Set of CAMEL information related to SMS session. For more information see Description of Record Fields. This field is present if CAMEL service is activated. |
| Originating Address | O _C | O _C | The address of the originating SME. |
| Record Extensions | O _C | O _C | A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.7 Mobile Terminated location request (LCS-MT-CDR)

If enabled, an SGSN Mobile terminated LCS record shall be produced for each mobile terminated location request that is performed via the SGSN. The fields in the record are specified in table 6.1.7.1.

Table 6.1.7.1: SGSN Mobile terminated LCS record (SGSN-LCS-MT)

| Field | Category | Description |
|---|----------------|--|
| Record Type | M | SGSN Mobile Terminated LCS. |
| Recording Entity | M | The E.164 number of the SGSN. |
| LCS Client Type | M | The type of the LCS client that invoked the LR. |
| LCS Client Identity | M | Further identification of the LCS client. |
| Served IMSI | M | The IMSI of the subscriber. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| SGSN Address | O _M | The IP address of the current SGSN. |
| Location Type | M | The type of the estimated location. |
| LCS QoS | C | QoS of the LR, if available. |
| LCS Priority | C | Priority of the LR, if available. |
| MLC Number | M | The E.164 address of the requesting GMLC. |
| Event Time stamp | M | The time at which the Perform_Location_Request is sent by the SGSN. |
| Measurement Duration | O _M | The duration of proceeding the location request. |
| Notification To MS User | C | The privacy notification to MS user that was applicable when the LR was invoked, if available. |
| Privacy Override | C | This parameter indicates the override MS privacy by the LCS client, if available. |
| Location | O _M | The LAC and CI when the LR is received. |
| Routing Area Code | O _M | The Routing Area Code to which the LCS terminated. |
| Location Estimate | O _C | The location estimate for the subscriber if contained in geographic position and the LR was successful. |
| Positioning Data | C | The positioning method used or attempted, if available. |
| LCS Cause | O _C | The result of the LR if any failure or partial success happened as known at radio interface. |
| Cause for Record Closing | M | The reason for closure of the record from this SGSN. |
| Diagnostics | C | A more detailed information about the Cause for Record Closing if any failure or partial success happened. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Charging Characteristics | M | The Charging Characteristics used by the SGSN. (always use the subscribed CC). |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. (only subscribed/home default/visited default). |
| Serving Node PLMN Identifier | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the "Serving Node PLMN Identifier" has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.8 Mobile originated Location request (LCS-MO-CDR)

If enabled, an SGSN Mobile originated LCS record shall be produced for each mobile originated location request that is performed via the SGSN. The fields in the record are specified in table 6.1.8.1.

Table 6.1.8.1: SGSN Mobile originated LCS record (SGSN-LCS-MO)

| Field | Category | Description |
|---|----------------|--|
| Record Type | M | SGSN Mobile Originated LCS. |
| Recording Entity | M | The E.164 number of the SGSN. |
| LCS Client Type | C | The type of the LCS client that invoked the LR, if available. |
| LCS Client Identity | C | Further identification of the LCS client, if available. |
| Served IMSI | M | The IMSI of the subscriber. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| SGSN Address | O _M | The IP address of the current SGSN. |
| Location Method | M | The type of the location request. |
| LCS QoS | C | QoS of the LR, if available. |
| LCS Priority | O _c | Priority of the LR, if available. |
| MLC Number | C | The E.164 address of the involved GMLC, if applicable. |
| Event Time stamp | M | The time at which the Perform_Location_Request is sent by the SGSN. |
| Measurement Duration | O _M | The duration of proceeding the location request. |
| Location | O _M | The LAC and CI when the LR is received. |
| Routing Area Code | O _M | The Routing Area Code from which the LCS originated. |
| Location Estimate | O _C | The location estimate for the subscriber if contained in geographic position and the LR was successful. |
| Positioning Data | C | The positioning method used or attempted, if available. |
| LCS Cause | O _C | The result of the LR if any failure or partial success happened as known at radio interface. |
| Cause for Record Closing | M | The reason for closure of the record from this SGSN. |
| Diagnostics | C | A more detailed information about the Cause for Record Closing if any failure or partial success happened. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Charging Characteristics | M | The Charging Characteristics flag set used by the SGSN. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| Serving Node PLMN Identifier | O _c | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the "Serving Node PLMN Identifier" has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.9 Network induced Location request (LCS-NI-CDR)

If enabled, an SGSN Network induced LCS record shall be produced for each network induced location request that is performed via the SGSN. The fields in the record are specified in table 6.1.9.1.

Table 6.1.9.1: SGSN Network induced LCS record (SGSN-LCS-NI)

| Field | Category | Description |
|---|----------------|--|
| Record Type | M | SGSN Network Induced LCS. |
| Recording Entity | M | The E.164 number of the SGSN. |
| LCS Client Type | C | The type of the LCS client that invoked the LR, if available. |
| LCS Client Identity | C | Further identification of the LCS client, if available. |
| Served IMSI | C | The IMSI of the subscriber if supplied. |
| Served MSISDN | C | The primary MSISDN of the subscriber if supplied. |
| SGSN Address | O _M | The IP address of the current SGSN. |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. |
| LCS QoS | C | QoS of the LR, if available. |
| LCS Priority | C | Priority of the LR, if available. |
| MLC Number | C | The E.164 address of the involved GMLC, if applicable. |
| Event Time stamp | M | The time at which the Perform_Location_Request is sent by the SGSN. |
| Measurement Duration | O _M | The duration of proceeding the location request. |
| Location | O _M | The LAC and CI when the LR is received. |
| Routing Area Code | O _M | The Routing Area Code from which the LCS originated. |
| Location Estimate | O _C | The location estimate for the subscriber if contained in geographic position and the LR was successful. |
| Positioning Data | C | The positioning method used or attempted, if available. |
| LCS Cause | O _C | The result of the LR if any failure or partial success happened as known at radio interface. |
| Cause for Record Closing | M | The reason for closure of the record from this SGSN. |
| Diagnostics | C | A more detailed information about the Cause for Record Closing if any failure or partial success happened. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Charging Characteristics | M | The Charging Characteristics flag set used by the SGSN. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| Serving Node PLMN Identifier | O _C | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. Only one value is included in case multiple PLMN Ids are supported by the SGSN. |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the 'Serving Node PLMN Identifier' has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.10 MBMS bearer context charging data in SGSN (S-MB-CDR)

If the collection of CDR data is enabled then the SGSN data specified in table 6.1.10.1 shall be available for each MBMS bearer context.

Table 6.1.10.1: SGSN MBMS bearer context data (S-MB-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|---|
| Record Type | M | SGSN MBMS bearer context record. |
| SGSN Address used | M | The control plane IP address of the SGSN used. |
| Charging ID | M | Bearer context identifier used to identify this MBMS bearer context in different records created by GSNs |
| List of RAs | O _C | List of routeing areas receiving data used during this record. equivalent to the list of RAs defined in TS 23.246 [207]. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the BM-SC (network identifier part of APN). |
| PDP Type | O _M | This field indicates PDP type (i.e. IPv4 or IPv6). |
| Served PDP Address | O _C | Indicates the IP Multicast address used for the MBMS bearer context, i.e. IPv4 or IPv6, if available. |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this MBMS bearer context, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. It shall include the required bearer capabilities (QoS Negotiated) |
| Record Opening Time | M | Time stamp when MBMS bearer context is activated in this SGSN or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the SGSN. |
| Cause for Record Closing | M | The reason for the release of record from this SGSN. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| Number of receiving UEs | O _C | Indicates the number of UEs receiving the MBMS bearer service |
| MBMS Information | O _M | MBMS related information related to MBMS bearer context being charged, defined in TS 32.273 [33]. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.11 MBMS bearer context charging data in GGSN (G-MB-CDR)

If the collection of CDR data is enabled then the GGSN data specified in table 6.1.11.1 shall be available for each MBMS bearer context.

Table 6.1.11.1: GGSN MBMS bearer context data (G-MB-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|--|
| Record Type | M | GGSN MBMS bearer context record. |
| GGSN Address used | M | The control plane IP address of the GGSN used. |
| Charging ID | M | Bearer context identifier used to identify this MBMS bearer context in different records created by GSNs |
| List of Downstream Nodes | M | List of SGSN addresses used during this record. equivalent to the list of downstream nodes defined in TS 23.246 [207]. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the BM-SC (network identifier part of APN). |
| PDP Type | O _M | This field indicates PDP type (i.e. IPv4 or IPv6). |
| Served PDP Address | O _C | Indicates the IP Multicast address used for the MBMS bearer context, i.e. IPv4 or IPv6, if available. |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this MBMS bearer context, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. It shall include the required bearer capabilities (QoS Negotiated). |
| Record Opening Time | M | Time stamp when MBMS bearer context is activated in this GGSN or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the GGSN. |
| Cause for Record Closing | M | The reason for the release of record from this GGSN. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| MBMS Information | O _M | MBMS related information related to MBMS bearer context being charged, defined in TS 32.273 [33]. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.12 MBMS bearer context charging data in MBMS GW (MBMS-GW-CDR)

If the collection of CDR data is enabled then the MBMS GW data specified in table 6.1.12.1 shall be available for each MBMS bearer context when MBMS GW doesn't locate in MB-SC.

Table 6.1.12.1: MBMS GW MBMS bearer context data (MBMS-GW-CDR)

| Field | Category | Description |
|--|----------------|--|
| Record Type | M | MBMS GW MBMS bearer context record. |
| MBMS GW Address used | M | The control plane IP address of the MBMS GW used. |
| Charging ID | M | Bearer context identifier used to identify this MBMS bearer context in different records created by Evolved Packet System core network elements |
| List of Downstream Nodes | M | List of SGSN/MME addresses used during this record. equivalent to the list of downstream nodes defined in TS 23.246 [207]. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the BM-SC (network identifier part of APN). |
| PDP/PDN Type | O _M | This field indicates PDN type (i.e. IPv4 or IPv6). |
| Served PDP/PDN Address | O _C | Indicates the IP Multicast address used for the MBMS bearer context. (i.e. IPv4 or IPv6). |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this MBMS bearer context, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. It shall include the required bearer capabilities (QoS Negotiated). |
| Record Opening Time | M | Time stamp when MBMS bearer context is activated in this MBMS GW or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the MBMS GW. |
| Cause for Record Closing | M | The reason for the release of record from this MBMS GW. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Record Extensions | O _C | A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| MBMS Information | O _M | MBMS related information related to MBMS bearer context being charged, defined in TS 32.273 [33]. |
| C-TEID | O _C | Common Tunnel Endpoint Identifier of MBMS GW for user plane, defined in TS 23.246 [207]. |
| IP multicast and Source address for distribution | O _C | IP addresses identifying the SSM channel used for user plane distribution on the backbone network defined in TS 23.246 [207]. |

6.1.13 IP-CAN bearer charging data in ePDG (ePDG-CDR)

If the collection of CDR data is enabled then the ePDG data specified in table 6.1.13.1 shall be available for each IP-CAN bearer.

Table 6.1.13.1: ePDG IP-CAN bearer data (ePDG-CDR)

| Field | Category | Description |
|---|----------------|---|
| Record Type | M | ePDG IP-CAN bearer record. |
| Retransmission | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | C | IMSI of the served party, if available. |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. |
| ePDG Address Used | M | The control plane IP address of the ePDG used. |
| ePDG IPv6 Address | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the ePDG. |
| Charging ID | M | IP-CAN bearer Charging identifier used to identify this IP-CAN bearer in different records created by PCNs |
| PDN Connection Charging Id | O _M | This field holds the Charging Id of the EPS default bearer in GTP case, or the unique Charging Id of the IP-CAN session in PMIP case: it is used to identify different records belonging to same PDN connection. |
| ePDG Change | O _C | Present if this is first record after ePDG change. |
| PGW PLMN Identifier | O _C | PLMN identifier (MCC MNC) of the P-GW used. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the external packet data network (network identifier part of APN). |
| PDP/PDN Type | O _M | This field indicates PDN type (i.e. IPv4, IPv6 or IPv4v6). |
| Served PDP/PDN Address | O _C | IP address allocated for the PDP context / PDN connection, if available, i.e. IPv4 address when PDN Type is IPv4 or IPv6 prefix when PDN Type is IPv6 or IPv4v6. |
| Served PDP/PDN Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Served PDP/PDN Address extension | O _C | This field holds IPv4 address of the served IMSI, if available, when PDN type is IPv4v6. |
| Dynamic Address Flag | O _C | Indicates whether served PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach and UE requested PDN connectivity. This field is missing if IPv4 address is static when PDN Type is IPv4, or if IPv6 address is static when PDN Type is IPv6 or IPv4v6. |
| Dynamic Address Flag extension | O _C | Indicates whether served IPv4 PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach and UE requested PDN connectivity with PDP/PDN type IPv4v6. This field is missing if IPv4 address is static. |
| List of Traffic Data Volumes | O _M | A list of changes in charging conditions for this QCI/ARP pair, each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. Initial and subsequently changed QoS and corresponding data values are also listed. |
| Record Opening Time | M | Time stamp when IP-CAN bearer is activated in this ePDG or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the ePDG. |
| Cause for Record Closing | M | The reason for the release of record from this ePDG. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| APN Selection Mode | O _M | An index indicating how the APN was selected. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| Charging Characteristics | M | The Charging Characteristics applied to the IP-CAN bearer. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |

| Field | Category | Description |
|------------------------|----------------|---|
| IMS Signalling Context | O _C | Included if the IM-CN Subsystem Signalling Flag is set, see TS 23.060 [201] IP-CAN bearer is used for IMS signalling. |
| P-GW Address used. | O _C | This field is the P-GW IP Address for the Control Plane |
| P-GW IPv6 Address | O _C | This field is the P-GW IPv6 Address, in case of IPv4v6 dual stack, for the Control Plane. |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Start Time | O _C | This field holds the time when User IP-CAN session starts, available in the CDR for the first bearer in an IP-CAN session. |
| Stop Time | O _C | This field holds the time when User IP-CAN session is terminated, available in the CDR for the last bearer in an IP-CAN session. |
| Record Extensions | O _C | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

6.1.14 ABC data in TDF (TDF-CDR)

If ABC is enabled and the collection of CDR data is enabled, then the TDF data specified in table 6.1.14.1 shall be available for each TDF session.

NOTE: An indication that online charging is also active for the session may be provided by using PS Furnish Charging Information.

Table 6.1.14.1: TDF session data (TDF-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|---|
| Record Type | M | TDF session record. |
| Retransmission | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | C | IMSI of the served party, if available. |
| Served IMEI | O _C | The IMEI or IMEISV of the ME, if available. It is used for identifying the user in case Served IMSI is not present during emergency bearer service. |
| Served 3GPP2 MEID | O _C | MEID of the served party's terminal equipment for 3GPP2 access. |
| Served MN NAI | O _C | Mobile Node Identifier in NAI format (based on IMSI), if available. |
| P-GW Address used | M | The control plane IP address of the P-GW used. |
| P-GW Address IPv6 | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the P-GW used. |
| TDF Address used | M | The control plane IP address of the TDF used. |
| TDF Address IPv6 | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the TDF used. |
| PDN Connection Charging ID | M | This field holds the Charging Id of the EPS default bearer in case of GTP based connectivity or the unique Charging Id in the PMIP based connectivity case to identify different records belonging to same PDN connection. |
| Serving node Address | M | List of SGSN/S-GW/TWAG control plane IP addresses, or the ePDG address used during this record. |
| Serving node IPv6 Address | O _C | List of SGSN/S-GW/TWAG control plane IPv6 addresses, in case of IPv4v6 dual stack, used during this record. |
| Serving node Type | M | List of serving node types in control plane (SGSN, SGW, ePDG, AGW, TWAG). The serving node types listed here map to the serving node addresses listed in the field "Serving node Address" in sequence. |
| PGW PLMN Identifier | O _C | PLMN identifier (MCC MNC) of the P-GW. |
| TDF PLMN Identifier | O _C | PLMN identifier (MCC MNC) of the TDF. |
| Access Point Name Network Identifier | O _M | The logical name of the connected access point to the external packet data network (network identifier part of APN). |
| PDP/PDN Type | O _M | PDP/PDN type, i.e. IPv4, IPv6, IPv4v6, or PDP type PPP, or IHOOSS:OSP. |
| Served PDP/PDN Address | O _C | IP address allocated for the PDP context / PDN connection, i.e. IPv4 address when PDP/PDN Type is IPv4 or IPv6 prefix when PDP/PDN Type is IPv6 or IPv4v6. This parameter shall be present except when both the PDP type is PPP and dynamic IP-CAN bearer address assignment is used. |
| Served PDP/PDN Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Served PDP/PDN Address extension | O _C | This field holds IPv4 address of the served IMSI, if available, when PDP/PDN type is IPv4v6. |
| Dynamic Address Flag | O _C | Indicates whether served PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity. This field is missing if IPv4 address is static when PDN Type is IPv4, or if IPv6 address is static when PDN Type is IPv6 or IPv4v6. |
| Dynamic Address Flag extension | O _C | Indicates whether served IPv4 PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity with PDP/PDN type IPv4v6. This field is missing if IPv4 address is static. |

| Field | Category | Description |
|---|----------------|--|
| List of Service Data | O _M | A list of changes in charging conditions for application traffic within this TDF session categorized per rating group or per combination of the rating group and service id. Each change is time stamped. Charging conditions are used to categorize traffic volumes, elapsed time and number of events, such as per tariff period and subsequently changed maximal bandwidth limitation and corresponding data values are also listed. Online charging information (PS Furnish Charging Information) may be added per each service data container in case it is sent by the OCS. Failure-Handling: This field shall be present in case TDF initiates an interaction with the PCRF in relation to the OCS's guidance for Failure Handling. It shall indicate the Failure Handling scenario and the instant the Failure Action is triggered (see annex B). Scenarios: Continue/New Session; Continue/Ongoing Session; Retry&Terminate/Ongoing Session; Terminate/Ongoing Session. |
| Record Opening Time | M | Time stamp when TDF session is established or record opening time on subsequent partial records. |
| MS Time Zone | O _C | This field contains the MS Time Zone the MS is currently located as defined in TS 29.060 [203], if available. |
| Duration | M | Duration of this record in the TDF. |
| Cause for Record Closing | M | The reason for closing the record from this TDF. |
| Diagnostics | O _M | A more detailed reason for closing the record. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Node ID | O _M | Name of the recording entity. |
| Record Extensions | O _C | A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension. |
| Local Record Sequence Number | O _M | Consecutive record number created by this node. The number is allocated sequentially including all CDR types. |
| APN Selection Mode | O _M | An index indicating how the APN was selected. |
| Served MSISDN | O _M | The primary MSISDN of the subscriber. |
| User Location Information | O _C | This field contains the User Location Information of the MS as defined in TS 29.060 [203] for GPRS case, and in TS 29.274 [210] for EPC case, if available. |
| User CSG information | O _C | This field contains the User CSG Information of the UE, if available, including CSG ID, access mode and CSG membership indication. |
| 3GPP2 User Location information | O _C | This field contains the User Location Information of the MS as defined in TS 29.212 [216] for 3GPP2 access, if available. |
| TWAN User Location Information | O _C | This field contains the UE location in a Trusted WLAN Access Network (TWAN) (SSID and, when available, BSSID of the access point), as defined in TS 29.274 [210] for S2a GTP-based case, or 29.275 [211] for S2a PMIP-based case, if available. |
| Presence Reporting Area Information | O _C | This grouped field contains the Presence Reporting Area Identifier for the UE PDN connection and the initial status of the UE presence in the Presence Reporting Area, if available. |
| Charging Characteristics | M | The Charging Characteristics applied to the TDF session. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| Serving node PLMN Identifier | O _M | This field holds the PLMN Identifier (MCC and MNC) serving the UE during this record. When the Serving node is TWAG, this field includes the PLMN identifier used for UE authentication, i.e. the VPLMN in roaming case, and the HPLMN in non-roaming case. |
| PS Furnish Charging Information | O _C | Online charging session specific information |
| RAT Type | O _C | This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station as defined in TS 29.061 [205], when available. |
| Start Time | O _C | This field holds the time when TDF session starts. |
| Stop Time | O _C | This field holds the time when TDF session is terminated. |

6.2 Data description for PS online charging

6.2.1 Message contents

6.2.1.1 Summary of online charging message formats

The PS Online Charging uses the Debit / Reserve Units Request and Debit / Reserve Units Response messages defined in TS 32.299 [50].

Table 6.2.1.1.1 describes the use of these messages for online charging.

Table 6.2.1.1.1: Online charging messages reference table

| Messages | Source | Destination |
|--------------------------------|-----------|-------------|
| Debit / Reserve Units Request | PCEF, TDF | OCS |
| Debit / Reserve Units Response | OCS | PCEF, TDF |

6.2.1.2 Structure for the Debit / Reserve Units operation message formats

6.2.1.2.0 General

This clause describes the AVPs used in the Debit / Reserve Units operation messages.

6.2.1.2.1 Debit / Reserve Units Request message

Table 6.2.1.2.1.1 illustrates the basic structure of a Debit / Reserve Units Request message from the PCEF and TDF as used for PS online charging.

Table 6.2.1.2.1.1: Debit / Reserve Units Request message contents

| Information Element | Category | Description |
|-------------------------|----------------|---|
| Session Identifier | M | Described in TS 32.299 [50] |
| Originator Host | M | Described in TS 32.299 [50] |
| Originator Domain | M | Described in TS 32.299 [50] |
| Destination Domain | M | Described in TS 32.299 [50] |
| Operation Identifier | M | Described in TS 32.299 [50] |
| Operation Token | M | Described in TS 32.299 [50] |
| Operation Type | M | Described in TS 32.299 [50] |
| Operation Number | M | Described in TS 32.299 [50] |
| Destination Host | O _M | Described in TS 32.299 [50] |
| User Name | O _M | The content of the field corresponds to the Protocol Configuration Options (PCO) field of the Create IP-CAN bearer Request message. |
| Origination State | O _C | Described in TS 32.299 [50] |
| Origination Timestamp | O _C | Described in TS 32.299 [50] |
| Subscriber Identifier | O _M | Described in TS 32.299 [50]. As a minimum the IMSI and the MSISDN have to be included. |
| Termination Cause | O _C | Described in TS 32.299 [50] |
| Multiple Operation | O _M | Described in TS 32.299 [50] |
| Multiple Unit Operation | O _C | Described in TS 32.299 [50] |
| User-Equipment-Info | O _C | Described in TS 32.299 [50]. Contains the identification of the terminal (IMEI or IMEISV etc.) |
| Route Information | O _C | Described in TS 32.299 [50] |
| Service Information | O _M | Described in clause 6.3.1.1 |

Editor's Note: Terminal capabilities should be taken into account

The full description of the AVPs is specified in TS 32.299 [50].

6.2.1.2.2 Debit / Reserve Units Response message

The following table 6.2.1.2.2.1 illustrates the basic structure of a Debit / Reserve Units operation message as used for the PCEF and TDF. This message is always used by the OCS as specified below, independent of the receiving PCEF/TDF and the C redit-Control type that is being replied to.

Table 6.2.1.2.2.1: Debit / Reserve Units Response message contents

| Information Element | Category | Description |
|--------------------------------|----------------|--------------------------|
| Session Identifier | M | Described in 32.299 [50] |
| Operation Result | M | Described in 32.299 [50] |
| Originator Host | M | Described in 32.299 [50] |
| Originator Domain | M | Described in 32.299 [50] |
| Operation Identifier | M | Described in 32.299 [50] |
| Operation Type | M | Described in 32.299 [50] |
| Operation Number | M | Described in 32.299 [50] |
| Operation Failover | O _C | Described in 32.299 [50] |
| Multiple Unit Operation | O _C | Described in 32.299 [50] |
| Operation Failure Action | O _C | Described in 32.299 [50] |
| Operation Event Failure Action | O _C | Described in 32.299 [50] |
| Redirection Host | O _C | Described in 32.299 [50] |
| Redirection Host Usage | O _C | Described in 32.299 [50] |
| Route Information | O _C | Described in 32.299 [50] |
| Failed parameter | O _C | Described in 32.299 [50] |
| Service Information | O _M | Described in 32.299 [50] |

6.2.2 Void

6.3 PS charging specific parameters

6.3.1 Definition of PS charging information

6.3.1.0 General

The PS Information parameter used for PS charging is provided in the Service Information parameter, as defined in clause 6.3.1.1.

The PS Information parameter used for "SMS over MME Charging" is provided in the Service Information parameter as defined in 6.3.1.1a

6.3.1.1 PS charging information assignment for Service Information

The components in the Service Information that are use for PS charging can be found in table 6.3.1.1.1.

Table 6.3.1.1.1: Service Information used for PS Charging

| Information Element | Category | Description |
|---|----------------|--|
| Service Information | O _M | This is a structured field and holds the 3GPP specific parameter as defined in TS 32.299 [50]. |
| Subscriber Identifier | O _C | This field contains the identification of the user (e.g. IMSI, MSISDN, NAI) if offline charging applies. |
| PS Information | O _M | This is a structured field and holds the PS specific parameters. The details are defined in clause 6.3.1.2. |
| IMS Information | O _M | This is a structured field and holds IMS specific parameters. The complete structure is defined in TS 32.260 [20]. |
| Node Functionality | O _M | This field contains the function of the EPC node (SGW, ePDG, PGW) |
| NOTE: When Node Functionality is set to "HSGW" the HSGW Access specific charging information are provided as part of the PS Information | | |

6.3.1.1a "SMS over MME Charging" information assignment for Service Information

The components in the Service Information that are used for "SMS over MME Charging" can be found in table 6.3.1.1a.1.

Table 6.3.1.1a.1: Service Information used for "SMS over MME Charging"

| Information Element | Category | Description |
|---|----------------|--|
| Service Information | O _M | This is a structured field and holds the 3GPP specific parameter as defined in TS 32.299 [50]. |
| Subscriber Identifier | O _C | This field contains the identification of the user (e.g. IMSI, MSISDN). |
| IMS Information | O _M | This is a structured field and holds IMS specific parameters. The complete structure is defined in TS 32.260 [20]. |
| Node Functionality | O _M | This field contains the function of the EPC node (i.e. MME) |
| PS Information | O _M | This is a structured field and holds the PS specific parameters. The complete structure is defined in clause 6.3.1.2. |
| Node Id | O _C | This field holds the name of the Node |
| Serving Node Type | O _C | This field holds the type of the node handling the SMS with the UE (i.e. MME) |
| Serving Node Address | O _C | This field holds the IP-address of the MME used. It may occur twice in the case when the MME has IPv4v6 dual stack control plane. |
| MME Number for MT SMS | O _C | This field holds the MME international PSTN/ISDN number |
| MME Name | O _C | This field holds the operation Identity of the MME used. |
| MME Realm | O _C | This field holds the operation Realm Identity of the MME used. |
| Charging Characteristics | O _M | This field contains the Charging Characteristics applicable to the MME |
| Charging Characteristics Selection Mode | O _M | This field holds information about how the Charging Characteristics were selected. |
| 3GPP User Location Info | O _C | This field holds the information about the location of the subscriber during the SMS transaction. |
| User Location Info Time | O _C | This field contains the time at which the user location information was acquired. |
| Terminal Information | O _C | This field holds the identification of the terminal (IMEI or IMEISV). |
| SMS Information | O _M | This is a structured field and holds SMS specific parameters. The complete structure is defined in TS 32.274 [34]. |
| Recipient Info | O _M | This field a structured field and holds recipient information for the SM. The complete structure is defined in TS 32.274 [34]. |
| Recipient Address | O _M | This field holds the address of the recipient of the SM. This will typically be an E.164 number or a shortcode. |
| SMSC Address | O _M | This field holds the address of the SMSC to which the originating or terminating SM is directed to. |
| MMS Information | O _M | This is a structure field and the following parameters are specific to SMS. The complete structure is defined in TS 32.270 [30] |
| Originator Address | O _C | This field holds the address of the originator of the SM. This will typically be an E.164 number or a shortcode |
| Submission Time | O _C | This field holds the time the Short Message is received by the MME from UE or sent by the MME to UE. |
| Message Id | O _M | This field holds a reference provided by the UE uniquely identifying this message. It contains the TP-Message-Reference (TP-MR) as defined in TS 23.040 [7]. |

6.3.1.2 Definition of the PS Information

PS specific charging information is provided within the PS Information. The fields of the PS Information are indicated with the node (MME, S-GW, ePDG, P-GW, TDF) from which the information is sent.

The detailed structure of the PS Information can be found in table 6.3.1.2.1.

Table 6.3.1.2.1: Structure of the PS Information

| Information Element | Category | Description |
|--------------------------------|----------------|---|
| Charging Id | O _C | This field holds the Charging Id for this IP-CAN bearer (this together with the P-GW Address constitutes a unique identifier for the IP-CAN bearer). This field holds the unique Charging Id in the PMIP case. |
| Node Id | O _C | This fields holds the name of the Node |
| PDN Connection Charging Id | O _C | This field holds the Charging Id of the EPS default bearer to identify different records belonging to same PDN connection. This field is present in GTP case only. |
| PDP/PDN Type | O _C | This field holds the type of IP-CAN bearer, e.g. IP or PPP, or PDN type (i.e. IPv4, IPv6 or IPv4v6). |
| PDP/PDN Address | O _C | This field holds the IP address of the served IMSI allocated for the PDP context / PDN connection, i.e. IPv4 address or IPv6 prefix. This parameter shall be present except when both the PDP type is PPP and dynamic PDP address assignment is used. It may occur twice within the PS Information field when PDN type is IPv4v6: first occurrence with IPv6 prefix, second occurrence with IPv4 address. |
| PDP/PDN Address prefix length | O _C | PDP/PDN Address prefix length of an IPv6 typed Served PDP Address. The field needs not available for prefix length of 64 bits. |
| Dynamic Address Flag | O _C | This field indicates whether served PDP/PDN address is dynamically allocated. This field is missing if address is static. |
| Dynamic Address Flag Extension | O _C | Indicates whether served IPv4 PDP/PDN address is dynamic, which is allocated during IP-CAN bearer activation, initial attach (E-UTRAN or over S2x) and UE requested PDN connectivity with PDP/PDN type IPv4v6. This field is missing if IPv4 address is static. |
| Negotiated QoS Profile | O _C | This field holds the authorized QoS applied to IP-CAN bearer. See NOTE. This field indicates the bandwidth limitation, applied to TDF session in TDF case. When charging per IP-CAN session is active in P-GW, this field indicates the APN-AMBR applied to the IP-CAN session. |
| Serving Node Address | O _C | This field holds the SGSN/S-GW/TWAG IP address that is used by the control plane for the handling of control messages, or the AGW IP address, or the ePDG address, or the MME address. It may be used to identify the PLMN to which the user is attached. It may occur twice in the case when the serving node has IPv4v6 dual stack control plane. |
| Serving Node Type | O _C | This field holds the type of the serving node (SGSN/S-GW/ePDG/AGW/TWAG from PGW, or SGSN/MME from SGW). |
| SGW Change | O _C | This field is present if this is first Charging Data Request after S-GW change. |
| PGW Address | O _C | This field holds the IP-address of the P-GW that generated the Charging Id. It may occur twice in the case when the P-GW has IPv4v6 dual stack control plane. |
| TDF Address | O _C | The control plane IP address of the TDF used. It may occur twice in the case when the TDF has IPv4v6 dual stack control plane. |
| SGW Address | O _C | This field holds the IP-address of the S-GW used. It may occur twice in the case when the P-GW has IPv4v6 dual stack control plane. |
| ePDG Address | O _C | This field holds the IP-address of the ePDG used. It may occur twice in the case when the ePDG has IPv4v6 dual stack control plane. |
| MME Number for MT SMS | O _C | This field holds the MME international PSTN/ISDN E.164 number used for "SMS over MME Charging". |
| MME Name | O _C | This field holds the operation Identity of the MME used for "SMS over MME Charging". |
| MME Realm | O _C | This field holds the operation Realm Identity of the MME used for "SMS over MME Charging". |

| | | |
|---|----------------|---|
| CG Address | O _C | This field holds the Charging Gateway IP address if available. Only used in EPC Online Charging. |
| IMSI MCC MNC | O _C | This field holds the MCC and MNC extracted from the user's IMSI (first 5 or 6 digits, as applicable from the presented IMSI). |
| IMSI Unauthenticated Flag | O _C | This field is present when IMSI is provided in Subscription Id and this IMSI is unauthenticated (due to emergency bearer service situations). |
| PGW MCC MNC | O _C | This field holds the MCC-MNC of the network the P-GW belongs to. |
| TDF MCC MNC | O _C | PLMN identifier (MCC MNC) of the TDF. |
| NSAPI | O _C | This field Identifies a particular IP-CAN bearer for the associated PDN and MSISDN/IMSI from creation to deletion. See NOTE. |
| Called Station Id | O _C | This field contains the identifier of the access point (APN) the user is connected to. |
| Session Stop Indicator | O _C | This field indicates to the OCS that the last IP-CAN bearer of a session is released and that the IP-CAN session has been terminated. This field only indicates to the OCS that the TDF session is terminated in TDF case. |
| Selection Mode | O _C | This field contains the Selection mode for this APN received in the Create PDP context request, on E-UTRAN initial attach and UE requested PDN connectivity, or Attach in WLAN on GTP S2a. |
| Charging Characteristics | O _C | This field contains the Charging Characteristics for this IP-CAN bearer received in the Create IP-CAN bearer Request Message (only available in R99 and later releases). |
| Charging Characteristics Selection Mode | O _C | This field holds information about how the "Charging Characteristics" was selected. |
| Serving Node MCC MNC | O _C | This field holds the MCC and MNC serving the UE: extracted from the RAI within the IP-CAN bearer activation or Update messages received over Gn/Gp, or provided by the SGW in the "Serving Network" IE over S5/S8 or by AGW/TWAG (For TWAN, PLMN identifier used for UE authentication, i.e. the VPLMN in roaming case, and the HPLMN in non-roaming case). |
| CN Operator Selection Entity | O _C | This field indicates whether the Serving Network identified by the "Serving Node MCC MNC" has been selected by the UE or by the network, as defined in TS 29.060 [203] for GPRS, and in TS 29.274 [210] for EPC, if available. |
| MS Time Zone | O _C | This field indicates the offset between universal time and local time in steps of 15 minutes of where the MS currently resides. |
| Charging Rule Base Name | O _C | This field indicates the name of a pre-defined group of PCC rules residing at the PCEF. It may occur several times within the PS Information field. |
| ADC Rule Base Name | O _C | This field indicates the name of a pre-defined group of ADC rules in TDF case. |
| User Location Info | O _C | This field indicates details of where the UE is currently located (e.g. SAI, TAI, RAI, CGI, ECGI or access-specific user location information). |
| User Location Info Time | O _C | This field contains the time at which the user location information was acquired. |

| | | |
|-------------------------------------|----------------|---|
| User CSG Information | O _C | This field indicates details of the User CSG Information of the UE, if available, including CSG ID, access mode and CSG membership indication. |
| 3GPP2 User Location Info | O _C | This field holds the 3GPP2 User Location Info of where the UE is currently located (i.e. 3GPP2 BSID: Cell-Id, SID, NID), as defined in TS 29.212 [216] |
| TWAN User Location Information | O _C | This field contains the UE location in a Trusted WLAN Access Network (TWAN) (SSID and, when available, BSSID of the access point), as defined in TS 29.274 [210] for S2a GTP-based case, or 29.275 [211] for S2a PMIP-based case, if available. |
| Presence Reporting Area Information | O _C | This field contains part of the Presence Reporting Area Information of UE as defined in TS 29.212 [216], comprising the Presence Reporting Area identifier and an indication on whether the UE is inside or outside the Presence Reporting Area, if available. |
| RAT Type | O _C | This field indicates which Radio Access Technology (RAT) is currently serving the UE as defined in TS 29.061 [205]. |
| Furnish Charging Information | O _C | This field contains the PS Furnish Information Elements. |
| Offline Charging | O _C | This field contains the Offline Charging parameters to control offline charging. |
| PDP Context Type | O _C | This field indicates the type of a PDP context (i.e. Primary or Secondary). This field is present when using the Gn/Gp reference point only. |
| Traffic data volumes | 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 within the PS Information field. |
| Service data container | O _C | This field holds the container associated to a service condition change on a service data flow (categorized per rating group or per combination of the rating group and service id) within this IP-CAN bearer. For TDF case, this field holds the container associated to a charging condition change on an application traffic (categorized per rating group or per combination of the rating group and service id) within this TDF session. It may occur several times within the PS Information field. |
| User Equipment Info | O _C | This field holds the identification of the terminal (IMEI or IMEISV...) It is used for identifying the user in case IMSI is not present during emergency bearer service. Editor's Note: Alignment with online charging is needed. |
| Terminal Information | O _C | This field holds the identification of the terminal (IMEI or IMEISV, 3GPP2-MEID..).It is used for identifying the user in case IMSI is not present during emergency bearer service. Editor's Note : this parameter is only for offline charging and use for online charging instead of User-Equipment-info is ffs |
| Start Time | O _C | Timestamp when User IP-CAN/TDF session starts. |
| Stop Time | O _C | Timestamp when User IP-CAN/TDF session terminates. |
| Change Condition | O _C | This field holds the reason for sending Charging Data Request from the PCN Nodes. |
| Diagnostics | O _C | This field holds a more detailed reason for the release of the connection, and complements the "Change Condition" information |
| Low Priority Indicator | O _C | This field indicates if this IP-CAN session has a low priority, i.e. for Machine Type Communication. |

NOTE: For network requested secondary IP-CAN bearer activation, the CCR[Initial] does not contain a value of NSAPI, whilst the Negotiated QoS profile reflects the requested QoS profile used in the activation request.

6.3.1.3 Multiple Unit Operation information when charging per IP-CAN session is active

The components in the Multiple Unit Operation that are used when charging per IP-CAN session is active can be found in table 6.3.1.3.1.

Table 6.3.1.3.1: Structure of the Multiple Unit Operation when charging per IP-CAN session is active

| Information Element | Category | Description |
|----------------------------|----------------|---|
| Granted Service Unit | O _C | As specified in TS 32.299 [50]. |
| Tariff Time Change | O _C | As specified in TS 32.299 [50]. |
| CC Time | O _C | As specified in TS 32.299 [50]. |
| CC Total Octets | O _C | As specified in TS 32.299 [50]. |
| CC Input Octets | O _C | As specified in TS 32.299 [50]. |
| CC Output Octets | O _C | As specified in TS 32.299 [50]. |
| CC Service Specific Units | O _C | As specified in TS 32.299 [50]. |
| Requested Service Unit | O _C | As specified in TS 32.299 [50]. |
| CC Time | O _C | As specified in TS 32.299 [50]. |
| CC Total Octets | O _C | As specified in TS 32.299 [50]. |
| CC Input Octets | O _C | As specified in TS 32.299 [50]. |
| CC Output Octets | O _C | As specified in TS 32.299 [50]. |
| CC Service Specific Units | O _C | As specified in TS 32.299 [50]. |
| Used Service Unit | O _C | As specified in TS 32.299 [50]. |
| Reporting Reason | O _M | As specified in TS 32.299 [50]. |
| Tariff Change Usage | O _M | As specified in TS 32.299 [50]. |
| CC Time | O _C | As specified in TS 32.299 [50]. |
| CC Total Octets | O _C | As specified in TS 32.299 [50]. |
| CC Input Octets | O _C | As specified in TS 32.299 [50]. |
| CC Output Octets | O _C | As specified in TS 32.299 [50]. |
| CC Service Specific Units | O _C | As specified in TS 32.299 [50]. |
| Event Charging Time Stamp | O _C | As specified in TS 32.299 [50]. |
| Service Identifier | O _C | As specified in TS 32.299 [50]. |
| Rating Group | O _C | As specified in TS 32.299 [50]. |
| Reporting Reason | O _C | As specified in TS 32.299 [50]. |
| Trigger | O _C | As specified in TS 32.299 [50]. |
| Refund Information | O _C | As specified in TS 32.299 [50]. |
| Envelope | O _C | As specified in TS 32.299 [50]. |
| AF Correlation Information | O _C | Supported for PS domain charging, as specified in TS 32.299 [50]. |
| Service Specific Info | O _C | Supported for PS domain charging, as specified in TS 32.299 [50]. |
| QoS Information | O _C | <p>This field contains the authorized QoS for the IP-CAN bearer that is first reported for the Rating Group or Rating Group / Service Identifier. If traffic from multiple bearers is included in the report, only one field is included.</p> <p>This field includes: QCI and ARP. For non-GBR QCI values, this field also includes the MBR for the downlink and uplink direction. For GBR QCI values, this field also includes GBR for the downlink and uplink direction. If the MBR is different than the GBR, then this field also includes the MBR for the downlink and uplink direction.</p> <p>This field also includes the authorized APN-AMBR for the IP-CAN session.</p> |

6.3.2 Detailed message format for offline charging

The following clause specifies per Operation Type the charging data that are sent by MME, S-GW, ePDG, P-GW and TDF.

The Operation Types are listed in the following order: S (Start)/I (Interim)/S (Stop)/E (Event). Therefore, when all Operation Types are possible it is marked as SISE. If only some Operation Types are allowed for a node, only the appropriate letters are used (i.e. SIS or E) as indicated in the table heading. The omission of an Operation Type for a particular field is marked with "-" (i.e. SI-E). Also, when an entire field is not allowed in a node the entire cell is marked as "-".

Table 6.3.2.1 illustrates the basic structure of the supported fields in the *Charging Data Request* message for PS offline charging.

Table 6.3.2.1: Supported fields in *Charging Data Request* message

| Information Element | Node Type | S-GW | ePDG | P-GW | TDF |
|--|---------------------------|---------|---------|---------|---------|
| | Supported Operation Types | S/I/S/E | S/I/S/E | S/I/S/E | S/I/S/E |
| Session Identifier | | SIS- | SIS- | SIS- | SIS- |
| Originator Host | | SIS- | SIS- | SIS- | SIS- |
| Originator Realm | | SIS- | SIS- | SIS- | SIS- |
| Destination Domain | | SIS- | SIS- | SIS- | SIS- |
| Operation Type | | SIS- | SIS- | SIS- | SIS- |
| Operation Number | | SIS- | SIS- | SIS- | SIS- |
| Operation Identifier | | SIS- | SIS- | SIS- | SIS- |
| User Name | | SIS- | SIS- | SIS- | SIS- |
| Destination Host | | SIS- | SIS- | SIS- | SIS- |
| Operation Interval | | SIS- | SIS- | SIS- | SIS- |
| Origination State | | SIS- | SIS- | SIS- | SIS- |
| Origination Timestamp | | SIS- | SIS- | SIS- | SIS- |
| Proxy Information | | SIS- | SIS- | SIS- | SIS- |
| Route Information | | SIS- | SIS- | SIS- | SIS- |
| Operation Token | | SIS- | SIS- | SIS- | SIS- |
| Service Information with PS and IMS Information | | | | | |
| Subscription Id | | SIS- | SIS- | SIS- | SIS- |
| IMSI Unauthenticated Flag | | SIS- | - | SIS- | - |
| Node Functionality | | SIS- | SIS- | SIS- | SIS- |
| Charging Id | | SIS- | SIS- | SIS- | - |
| Node Id | | SIS- | SIS- | SIS- | SIS- |
| PDN Connection Charging Id | | SIS- | SIS- | SIS- | SIS- |
| PDP/PDN Type | | SIS- | SIS- | SIS- | - |
| PDP/PDN Address | | SIS- | SIS- | SIS- | SIS- |
| PDP/PDN Address prefix length | | SIS- | SIS- | SIS- | SIS- |
| Dynamic Address Flag | | SIS- | SIS- | SIS- | SIS- |
| Dynamic Address Flag Extension | | SIS- | SIS- | SIS- | SIS- |
| Serving Node Address | | SIS- | - | SIS- | SIS- |
| Serving Node Type | | SIS- | - | SIS- | SIS- |
| SGW Change | | S--- | - | - | - |
| P-GW Address | | SIS- | - | SIS- | SIS- |
| TDF Address | | - | - | - | SIS- |
| SGW Address | | SIS- | - | - | SIS- |
| ePDG Address | | - | SIS- | - | - |
| CG Address | | - | - | - | - |
| IMSI MCC MNC | | SIS- | SIS- | SIS- | SIS- |
| PGW MCC MNC | | SIS- | SIS- | SIS- | SIS- |
| TDF MCC MNC | | - | - | - | SIS- |
| NSAPI | | - | - | SIS- | - |
| Called Station Id | | SIS- | SIS- | SIS- | SIS- |
| Session Stop Indicator | | - | - | --S- | --S- |
| Selection Mode | | SIS- | SIS- | SIS- | SIS- |
| Charging Characteristics | | SIS- | SIS- | SIS- | SIS- |
| Charging Characteristics Selection Mode | | SIS- | SIS- | SIS- | SIS- |
| Serving Node MCC MNC | | SIS- | - | SIS- | SIS- |
| MS Time Zone | | SIS- | - | SIS- | SIS- |
| Charging Rule Base Name | | - | - | SIS- | - |
| ADC Rule Base Name | | - | - | - | - |
| User Location Info | | SIS- | - | SIS- | SIS |
| User Location Info Time | | SIS- | - | SIS- | - |

| | | | | |
|-------------------------------------|------|------|------|------|
| User CSG Information | SIS- | - | SIS- | SIS- |
| 3GPP2 User Location Info | SIS- | - | SIS- | SIS- |
| TWAN User Location Information | - | - | SIS- | - |
| Presence Reporting Area Information | SIS- | - | SIS- | SIS- |
| RAT Type | SIS- | SIS- | SIS- | SIS- |
| Furnish Charging Information | - | - | SIS- | - |
| Offline Charging | - | - | - | - |
| QoS Information | SIS- | SIS- | SIS- | SIS- |
| Traffic data volumes | -IS- | -IS- | - | - |
| Service data container | - | - | -IS- | -IS- |
| User Equipment Info | - | - | - | S--- |
| Terminal-Information | S--- | S--- | S--- | S--- |
| Start time | S--- | S--- | S--- | S--- |
| Stop time | --S- | --S- | --S- | --S- |
| Change Condition | -IS- | -IS- | -IS- | -IS- |
| Diagnostics | --S- | --S- | --S- | --S- |
| Low Priority Indicator | S--- | - | S--- | - |
| CN Operator Selection Entity | SIS- | - | SIS- | - |

Table 6.3.2.1a illustrates the basic structure of the supported fields in the *Charging Data Request* message for "SMS over MME Charging".

Table 6.3.2.1a: Supported fields in *Charging Data Request* message for "SMS over MME Charging"

| Information Element | Node Type | MME |
|--|---------------------------|---------|
| | Supported Operation Types | S/I/S/E |
| Session Identifier | | ---E |
| Originator Host | | ---E |
| Originator Realm | | ---E |
| Destination Domain | | ---E |
| Operation Type | | ---E |
| Operation Number | | ---E |
| Operation Identifier | | ---E |
| User Name | | ---E |
| Destination Host | | ---E |
| Operation Interval | | ---E |
| Origination State | | ---E |
| Origination Timestamp | | ---E |
| Proxy Information | | ---E |
| Route Information | | ---E |
| Operation Token | | ---E |
| Service Information with PS, IMS, MMS and SMS Information | | |
| Subscription Id | | ---E |
| Node Functionality | | ---E |
| Node Id | | ---E |
| MME Number for MT SMS | | ---E |
| MME Name | | ---E |
| MME Realm | | ---E |
| Serving Node Type | | ---E |
| SGSN Address | | ---E |
| Charging Characteristics | | ---E |
| Charging Characteristics Selection Mode | | ---E |
| 3GPP User Location Info | | ---E |
| User Location Info Time | | ---E |
| Terminal Information | | ---E |
| Recipient Address | | ---E |
| SMSC Address | | ---E |
| Originator Address | | ---E |
| Submission Time | | ---E |
| Message Id | | ---E |
| CN Operator Selection Entity | | ---E |

Table 6.3.2.2 illustrates the basic structure of the supported fields in the *Charging Data* Response message for PS offline charging, and "SMS over MME Charging".

Table 6.3.2.2: Supported fields in *Charging Data* Response message

| Information Element | Node Type | S-GW | ePDG | P-GW | TDF |
|-----------------------|---------------------------|---------|---------|---------|---------|
| | Supported Operation Types | S/I/S/E | S/I/S/E | S/I/S/E | S/I/S/E |
| Session Identifier | | SIS- | SIS- | SIS- | SIS- |
| Operation Result | | SIS- | SIS- | SIS- | SIS- |
| Originator Host | | SIS- | SIS- | SIS- | SIS- |
| Originator Domain | | | | | |
| Operation Type | | SIS- | SIS- | SIS- | SIS- |
| Operation Number | | SIS- | SIS- | SIS- | SIS- |
| Operation Identifier | | SIS- | SIS- | SIS- | SIS- |
| Operation Interval | | SIS- | SIS- | SIS- | SIS- |
| Error Reporting Host | | SIS- | SIS- | SIS- | SIS- |
| Origination State | | SIS- | SIS- | SIS- | SIS- |
| Origination Timestamp | | SIS- | SIS- | SIS- | SIS- |
| Proxy Information | | SIS- | SIS- | SIS- | SIS- |
| Route Information | | SIS- | SIS- | SIS- | SIS- |

6.3.3 Detailed Message Format for online charging

The following table specifies per Operation type the charging data that are sent P-GW and TDF network element for:

The Operation types are listed in the following order: I [initial]/U [update]/T [terminate]/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 "-".

Note that not for all structured fields the individual field members are listed in the table. Detailed descriptions of the fields are provided in TS 32.299 [50].

Table 6.3.3.1 illustrates the basic structure of the supported fields in the Debit / Reserve Units Request for PS online charging.

Table 6.3.3.1: Supported fields in *Debit / Reserve Units Request* message

| Information Element | Node Type | P-GW | TDF |
|--|---------------------------|---------|---------|
| | Supported Operation Types | I/U/T/E | I/U/T/E |
| Session Identifier | | IUT- | IUT- |
| Originator Host | | IUT- | IUT- |
| Originator Domain | | IUT- | IUT- |
| Destination Domain | | IUT- | IUT- |
| Operation Identifier | | IUT- | IUT- |
| Operation Token | | IUT- | IUT- |
| Operation Type | | IUT- | IUT- |
| Operation Number | | IUT- | IUT- |
| Destination Host | | IUT- | IUT- |
| User Name | | IUT- | IUT- |
| Origination State | | IUT- | IUT- |
| Origination Timestamp | | IUT- | IUT- |
| Subscriber Identifier | | IUT- | IUT- |
| Termination Cause | | --T- | --T- |
| Requested Action | | IUT- | IUT- |
| Multiple Operation | | IU-- | IU-- |
| Multiple Unit Operation | | IUT- | IUT- |
| Subscriber Equipment Number | | IUT- | IUT- |
| Route Information | | IUT- | IUT- |
| Service Information | | IUT- | IUT- |
| Service Information with PS Information | | | |
| Charging Id | | IUT- | - |
| Node Id | | IUT- | IUT- |
| PDN Connection Charging Id | | IUT- | IUT- |
| PDP/PDN Type | | IUT- | - |
| PDP/PDN Address | | IUT- | IUT- |
| PDP/PDN Address prefix length | | IUT- | IUT- |
| Dynamic Address Flag | | IUT- | IUT- |
| Dynamic Address Flag Extension | | IUT- | IUT- |
| QoS Information | | IUT- | IUT- |
| Serving Node Address | | IUT- | IUT- |
| Serving Node Type | | IUT- | IUT- |
| SGW Change | | - | - |
| P-GW Address | | IUT- | IUT- |
| TDF Address | | - | IUT- |
| CG Address | | IUT- | IUT- |
| IMSI MCC MNC | | IUT- | IUT- |
| IMSI Unauthenticated Flag | | IUT- | - |
| PGW MCC MNC | | IUT- | IUT- |
| TDF MCC MNC | | - | IUT- |
| NSAPI | | IUT- | - |
| Called Station Id | | IUT- | IUT- |
| Session Stop Indicator | | --T- | --T- |
| Selection Mode | | IUT- | IUT- |
| Charging Characteristics | | IUT- | IUT- |
| Charging Characteristics Selection Mode | | IUT- | IUT- |
| Serving Node MCC MNC | | IUT- | IUT- |
| MS Time Zone | | IUT- | IUT- |
| Charging Rule Base Name | | IUT- | - |
| ADC Rule Base Name | | - | IUT- |
| User Location Info | | IUT- | IUT- |
| User Location Info Time | | IUT- | - |
| User CSG Information | | IUT- | IUT- |
| 3GPP2 User Location Info | | IUT- | IUT- |
| TWAN User Location Information | | IUT- | IUT- |
| Presence Reporting Area Information | | IUT- | IUT- |
| RAT Type | | IUT- | IUT- |
| Furnish Charging Information | | - | - |

| | | |
|------------------------------|------|------|
| Offline Charging | IUT- | IUT- |
| PDP Context Type | IUT- | - |
| Traffic data volumes | - | - |
| Service data container | - | - |
| User Equipment Info | - | - |
| Terminal-Information | - | - |
| Start time | - | - |
| Stop time | - | - |
| Change Condition | - | - |
| Diagnostics | IUT- | IUT- |
| CN Operator Selection Entity | - | - |

Table 6.3.3.2 illustrates the basic structure of the supported fields in the Debit / Reserve Units Response for PS online charging.

Table 6.3.3.2: Supported fields in *Debit / Reserve Units Response* Message

| Information Element | Node Type | P-GW | TDF |
|--|---------------------------|---------|---------|
| | Supported Operation Types | I/U/T/E | I/U/T/E |
| Session Identifier | | IUT- | IUT- |
| Operation Result | | IUT- | IUT- |
| Originator Host | | IUT- | IUT- |
| Originator Domain | | IUT- | IUT- |
| Operation Identifier | | IUT- | IUT- |
| Operation Type | | IUT- | IUT- |
| Operation Number | | IUT- | IUT- |
| Operation Failover | | IUT- | IUT- |
| Multiple Unit Operation | | IUT- | IUT- |
| Operation Failure Action | | IUT- | IUT- |
| Redirection Host | | IUT- | IUT- |
| Redirection Host Usage | | IUT- | IUT- |
| Redirection Cache Time | | IUT- | IUT- |
| Route Information | | IUT- | IUT- |
| Failed parameter | | IUT- | IUT- |
| Service Information | | IUT- | IUT- |
| Service Information with PS Information | | | |
| Furnish Charging Information | | IUT- | IUT- |
| Offline Charging | | I---- | I---- |
| Presence Reporting Area Information | | I--- | - |

6.4 Void

6.5 Bindings for EPC offline charging

This clause aims to describe the mapping between the Diameter Accounting AVP and CDR parameter for EPC offline charging.

Table 6.5.1 describes the mapping of the Diameter Accounting AVP to the CDR parameter of ePDG-CDR, SGW-CDR, PGW-CDR and TDF-CDR in EPC offline charging.

Table 6.5.1: Bindings of Accounting AVP to SGW-/PGW-/TDF-CDR parameter

| Diameter Accounting AVP | ePDG-/SGW-/PGW-/TDF-CDR parameter |
|--|--|
| <i>Called-Station-Id</i> | Access Point Name Network Identifier |
| <i>AF-Correlation-Information</i> | AF record information |
| <i>3GPP-Selection-Mode</i> | APN Selection Mode |
| <i>Change-Condition</i> | Change Condition |
| <i>Change-Time</i> | Change Time |
| <i>3GPP-Charging-Characteristics</i> | Charging Characteristics |
| <i>Charging-Characteristics-Selection-Mode</i> | Charging Characteristics Selection Mode |
| <i>3GPP-Charging-Id</i> | Charging Id |
| <i>Charging-Rule-Base-Name</i> | Charging Rule Base Name |
| <i>Change-Condition</i> | Cause for Record Closing |
| <i>CN-Operator-Selection-Entity</i> | CN Operator Selection Entity |
| <i>Accounting-Input-Octets</i> | Data Volume Uplink |
| <i>Accounting-Output-Octets</i> | Data Volume Downlink |
| <i>Diagnostics</i> | Diagnostics |
| <i>Dynamic-Address-Flag</i> | Dynamic Address Flag |
| <i>Dynamic-Address-Flag-Extension</i> | Dynamic Address Flag extension |
| <i>ePDG-Address</i> | ePDG Address Used |
| <i>ePDG-Address</i> | ePDG IPv6 Address |
| <i>IMSI-Unauthenticated-Flag</i> | IMSI Unauthenticated Flag |
| <i>3GPP-User-Location-Info</i> | Last User Location Information |
| <i>3GPP-MS-Time-Zone</i> | Last MS Time Zone |
| <i>Traffic-Data-Volumes</i> | List of Traffic Data Volumes |
| <i>Service-Data-Container</i> | List of Service Data |
| <i>3GPP-MS-Time-Zone</i> | MS Time Zone |

| Diameter Accounting AVP | ePDG-/SGW-/PGW-/TDF-CDR parameter |
|--|--|
| <i>Node ID</i> | Node ID |
| <i>PDN-Connection-Charging-ID</i> | PDN Connection Charging Id |
| <i>3GPP-PDP-Type</i> | PDP/PDN Type |
| <i>3GPP-GGSN-MCC-MNC</i> | PGW PLMN Identifier, TDF PLMN Identifier |
| <i>GGSN-Address</i> | PGW Address Used |
| <i>GGSN-Address</i> | PGW IPv6 Address |
| <i>TDF-IP-Address</i> | TDF Address Used |
| <i>TDF-IP-Address</i> | TDF IPv6 Address |
| <i>Qos-Information</i> | EPC QoS Information/Qos Information |
| <i>3GPP-RAT-Type</i> | RAT Type |
| <i>Rating-Group</i> | Rating Group |
| <i>Node-Functionality</i> | Record Type |
| <i>Change-Time</i> | Report Time |
| <i>Result-Code</i> | Result Code |
| <i>Change-Condition</i> | Service Condition Change |
| <i>Service-Identifier</i> | Service Identifier |
| <i>Subscription-Id</i> | Served IMSI |
| <i>Terminal-Information</i> | Served IMEI |
| <i>Subscription-Id</i> | Served MN NAI |
| <i>Subscription-Id</i> | Served MSISDN |
| <i>Terminal-Information</i> | Served 3GPP2 MEID |
| <i>3GPP-SGSN-MCC-MNC</i> | Serving node PLMN Identifier |
| <i>PDP-Address</i> | Served PDP/PDN Address |
| <i>PDP-Address</i> | Served PDP/PDN Address extension |
| <i>PDP-Address-Prefix-Length</i> | Served PDP/PDN Address prefix length |
| <i>Service-Specific-Info</i> | Service Specific Info |
| <i>SGSN-Address</i> | Serving Node Address |
| <i>SGSN-Address</i> | Serving IPv6 Node Address |
| <i>Serving-Node-Type</i> | Serving Node Type |
| <i>SGW-Address</i> | S-GW Address used |
| <i>SGW-Address</i> | S-GW IPv6 Address |
| <i>SGW Change</i> | S-GW Change |
| <i>Start time</i> | Start Time |
| <i>Stop-time</i> | Stop Time |
| <i>Time-First-Usage</i> | Time of First Usage |
| <i>Time-Last-Usage</i> | Time of Last Usage |
| <i>Time-Usage</i> | Time Usage |
| <i>TWAN-User-Location-Info</i> | TWAN User Location Information |
| <i>3GPP-User-Location-Info</i> | User Location Information |
| <i>User-Location-Info-Time</i> | User Location Information Time |
| <i>User-CSG-Information</i> | User CSG Information |
| <i>Presence-Reporting-Area-Information</i> | Presence Reporting Area Information |
| <i>3GPP2-BSID</i> | 3GPP2 User Location information |
| <i>Low-Priority-Indicator</i> | Low Priority Indicator |

Table 6.5.2 describes the mapping of the Diameter Accounting AVP to the CDR parameter of S-SMO/S-SMT-CDR in EPC offline charging for SMS.

Table 6.5.2 : Bindings of Accounting AVP to S-SMO/S-SMT-CDR parameter

| Diameter Accounting AVP | S-SMO/S-SMT-CDR parameter |
|--|---|
| <i>3GPP-Charging-Characteristics</i> | Charging Characteristics |
| <i>Charging-Characteristics-Selection-Mode</i> | Charging Characteristics Selection Mode |
| <i>Recipient-Address</i> | Destination Number |
| <i>Submission-Time</i> | Event Time Stamp |
| <i>Message Id</i> | Message Reference |
| <i>MME-Name</i> | MME Name |
| <i>MME-Number-for-MT-SMS</i> | Recording Entity |
| <i>MME-Realm</i> | MME Realm |

| Diameter Accounting AVP | S-SMO/S-SMT-CDR parameter |
|--------------------------------|----------------------------------|
| <i>Node ID</i> | Node ID |
| <i>Originator-Address</i> | Originating Address |
| <i>Node-Functionality</i> | Record Type |
| <i>Subscription-Id</i> | Served IMSI |
| <i>Terminal-Information</i> | Served IMEI |
| <i>Subscription-Id</i> | Served MSISDN |
| <i>Serving-Node-Type</i> | Serving Node Type |
| <i>SGSN-Address</i> | Serving Node Address |
| <i>SGSN-Address</i> | Serving IPv6 Node Address |
| <i>SMSC-Address</i> | Service Centre |
| <i>3GPP-User-Location-Info</i> | User Location Information |
| <i>User-Location-Info-Time</i> | User Location Information Time |

NOTE : The whole set of ePDG-/MME-/SGW-/PGW-/TDF-CDR parameters is described in the TS 32.298 [51].

Annex A (normative): Charging characteristics

A.1 General

Charging Characteristics can be supplied by the HLR/HSS/AAA to the Gn/Gp SGSN or the HSS to the MME as part of the subscription information. Upon IP-CAN bearer activation, the Gn/Gp SGSN (resp. MME) forwards the Charging Characteristics parameter to the P-GW (resp. S-GW then the P-GW). Upon TDF session establishment, the P-GW forwards the Charging Characteristics parameter to the TDF (resp. PCRF then the TDF). A subscriber may have Charging Characteristics assigned to his subscription and/or his subscribed APNs. Default charging characteristics may also be pre-provisioned on the PCN.

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 defined on a per operator basis, configured within the PCN and pointed when bit is set to "1" value.

The Gn/Gp SGSN and the PCN may either apply the Charging Characteristics provided by the HLR/HSS or ignore it to apply a default configuration. For example for a foreign subscriber, the network may choose either the Visiting or the Roaming default behaviour. Consequently, the network may apply:

- The Charging Characteristics provided by the HLR/HSS
- The Home default behaviour (the SGSN and the S-GW belong to the Home PLMN)
- The Roaming default behaviour (the P-GW and/or TDF belongs to the Home PLMN of the subscriber, a.k.a. home-routed scenario).
- The Visiting default behaviour (the SGSN, the S-GW and the P-GW and/or the TDF belongs to the Visited PLMN a.k.a. local breakout scenario)

For example, one way to define a charging behaviour could be to associate it to a specific usage designed according to following guidances:

One usage may consist of a set of trigger profiles associated to CDR types, with following trigger sets, e.g.:

- **S-CDR:** activate/deactivate CDRs, time limit, volume limit, maximum number of charging conditions, tariff times;
- **SGW-CDR:** same as S-CDR, plus maximum number of S4-SGSN/MME changes;
- **PGW-CDR:** same as S-CDR, plus maximum number of S-GW changes;
- **M-CDR:** activate/deactivate CDRs, time limit, and maximum number of mobility changes;
- **TDF-CDR:** same as PGW-CDR
- **SMS-MO-CDR:** activate/deactivate CDRs;
- **SMS-MT-CDR:** active/deactivate CDRs.
- **LCS-MO-CDR.**
- **LCS-MT-CDR.**
- **LCS-NI-CDR.**

In addition to these trigger sets, an optional charging gateway address may also be specified:

- If the CGF address is configured in the P-GW's selected Charging Characteristics behaviour, the P-GW shall apply it for the PGW-CDRs. The P-GW applied CGF address is sent to Gn/Gp SGSN/S-GW during IP-CAN bearer activation.

- If the CGF address is configured in the TDF's selected Charging Characteristics behaviour, the TDF shall apply it for the TDF-CDRs pertaining to the TDF session.
- In the home or visiting case, the S-GW shall apply the CGF address received from the P-GW to the SGW-CDRs pertaining to this IP-CAN bearer. In the roaming case, or if no CGF address is received from the P-GW, the S-GW shall use the CGF address from its own applied Charging Characteristics behaviour, or, if it does not exist, it uses the default CGF address. There is no need to send CGF address to S4-SGSN/MME as it does not generate charging data.
- In the home or visiting case, the Gn/Gp SGSN shall apply the CGF address received from the P-GW to the S-CDRs pertaining to this IP-CAN bearer. In the roaming case, or if no CGF address is received from the P-GW, then the Gn/Gp SGSN shall use the CGF address from its own selected Charging Characteristics behaviour, or, if it does not exist, use the default CGF address. For M-CDRs and SMS CDRs, the Gn/Gp SGSN shall use the CGF address configured in the Charging Characteristics behaviour that it applies to the respective CDRs, or if no such address is configured then the default CGF shall be used.

Tables A.1.1, A.1.2 and A.1.3 are informative examples intended for clarification.

Table A.1.1: Example of Charging Characteristics behaviours for SGSN

| Behaviour Index bits 0 - 3 | CGF Address | S-CDR | | | | | M-CDR | |
|-------------------------------|---------------|--------|------------|--------------|-------------|----------------|--------|-----|
| | | Active | Time limit | Volume limit | Change cond | Tariff times | Active | ... |
| 0 | - | Yes | 30 min | 100 K | 2 | 0-7, 7-12, ... | Yes | .. |
| 1 | 100.128.35.20 | No | - | - | - | - | No | .. |
| 2 | - | Yes | 10 min | 50 K | 1 | 0-24 | Yes | .. |
| .. | .. | .. | .. | .. | .. | .. | .. | .. |

Charging Characteristics behaviour in S-GW is used for SGW-CDR generation

Table A.1.2: Example of Charging Characteristics behaviours for S-GW

| Behaviour Index Bits 0-15 | SGW-CDR | | | | | | |
|------------------------------|-------------------------------------|--------|------------|-----------|--------------|--------------|-----|
| | Primary and Secondary CGF Addresses | Active | Time Limit | Vol Limit | Change Cond. | Tariff times | ... |
| 0 | 100.128.35.20 100.128.35.21 | Yes | 30 min | 100K | 2 | 0-7, 7-12 | ... |
| 1 | 100.128.35.21 100.128.35.20 | No | - | - | - | - | ... |
| 2 | 100.128.35.21 100.128.35.20 | Yes | 10 min | 50K | 1 | 0-24 | ... |
| ... | ... | ... | ... | ... | ... | ... | ... |

Charging Characteristics behaviour in P-GW is used for PGW-CDR generation / and for online charging.

FBC is always active in P-GW. PCRF may provide default charging method to PCEF (P-GW) per IP-CAN bearer session. If received by the PCEF, it supersedes the "Default charging method" in Charging Characteristics behaviour, see TS 23.203 [215] for more information about default charging method. PCRF may also provide CGF/OCS addresses to P-GW per IP-CAN bearer session. If received by the P-GW it supersedes the "Primary CGF/OCS address" and "Secondary CGF/OCS address" in Charging Characteristics behaviour, see TS 23.203 [215] for more information.

Table A.1.3: Example of Charging Characteristics behaviours for P-GW

| Behaviour Index Bits 0-15 | Default charging method | Offline charging (PGW-CDR) | | | | | | | Online charging | | |
|---------------------------|-------------------------|-------------------------------------|--------|------------|-----------|--------------|--------------|-----|-------------------------------------|--------|-----|
| | | Primary and Secondary CGF addresses | Active | Time Limit | Vol Limit | Change Cond. | Tariff times | ... | Primary and Secondary OCS addresses | Active | ... |
| 0 | Online | 100.128.35.20 100.128.35.21 | Yes | 30 min | 100K | 2 | 0-7, 7-12 | ... | 100.128.35.30 100.128.35.31 | Yes | ... |
| 1 | Offline | 100.128.35.21 100.128.35.20 | No | - | - | - | - | ... | - | No | ... |
| 2 | Online /Offline | 100.128.35.21 100.128.35.20 | Yes | 10 min | 50K | 1 | 0-24 | ... | 100.128.35.31 100.128.35.30 | Yes | ... |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

Table A.1.4: Example of Charging Characteristics behaviours for TDF

| Behaviour Index Bits 0-15 | Default charging method | Offline charging (TDF-CDR) | | | | | | | Online charging | | |
|---------------------------|-------------------------|-------------------------------------|--------|------------|-----------|--------------|--------------|-----|-------------------------------------|--------|-----|
| | | Primary and Secondary CGF addresses | Active | Time Limit | Vol Limit | Change Cond. | Tariff times | ... | Primary and Secondary OCS addresses | Active | ... |
| 0 | Online | 100.128.35.20 100.128.35.21 | Yes | 30 min | 100K | 2 | 0-7, 7-12 | ... | 100.128.35.30 100.128.35.31 | Yes | ... |
| 1 | Offline | 100.128.35.21 100.128.35.20 | No | - | - | - | - | ... | - | No | ... |
| 2 | Online /Offline | 100.128.35.21 100.128.35.20 | Yes | 10 min | 50K | 1 | 0-24 | ... | 100.128.35.31 100.128.35.30 | Yes | ... |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

The TDF may apply ABC per TDF session using either charging characteristics or charging information conveyed via ADC rules that are received from the PCRF.

If Charging Characteristics are received by the PCRF from the P-GW, the PCRF may take them into account when providing Charging information and Default charging method to the TDF.

Upon the initial interaction with the TDF, the PCRF may provide:

- Charging Characteristics, if received from the PCEF, defining how to control TDF behaviour regarding online and offline charging.
- Charging information containing OFCS and/or OCS addresses defining the offline and online charging system addresses respectively. If received by the TDF, it supersedes the Primary OFCS/OCS address and Secondary OFCS/OCS address predefined at the TDF.
- Default charging method indicating what charging method shall be used in the TDF session for every ADC rule where the charging method identifier is omitted. If received by the TDF, it supersedes the defined Default charging method.

NOTE: TDF may also ignore the supplied Charging Characteristics for the cases defined in clause A.7.

In case the TDF receives both Charging Characteristics and Charging information and Default charging method parameters, the Charging Information and Default charging method shall supersede the values received in Charging Characteristics.

Other examples for behaviours are:

- Selection of the applicable idle context purge timer, i.e. use global value or use special value. This feature could be used to distinguish between customers and/or APNs whose IP-CAN bearers should be purged after short (e.g. 30 minutes) or long (e.g. 12 hours) periods of inactivity.
- Use specific charging gateway address (override all other configured/selected CG addresses).
- Deactivate SMS-MO-CDRs for customers of the own PLMN using pre-configured SMSC addresses.
- Disable PGW-CDRs for roamers that use the HPLMN P-GW.
- Allow or inhibit the use of own P-GWs by visitors.
- Allow or inhibit network triggered QoS change (upgrade and/or downgrade).
- Inhibit CDR generation when the user data volume has not reached a minimum configurable value, e.g. to limit the number of no/low-value added CDRs when the user activity is null or very low.

The Gn/Gp SGSN selects the Charging Characteristics behaviour for M-CDR generation upon the creation of a MM context. Gn/Gp SGSN, S-GW and P-GW select the Charging Characteristics behaviour upon creation of a IP-CAN bearer. Once selected, the Charging Characteristics behaviour shall be maintained throughout the lifetime of the MM or IP-CAN bearer. If the SGSN receives modified subscriber information from the HLR/HSS (e.g. execution of a stand-alone Insert Subscriber Data procedure) which includes changes the Charging Characteristics, the new Charging Characteristics shall be applied only to new IP-CAN bearers. This implies the following:

- the S4-SGSN/MME shall not send IP-CAN bearer modifications for the existing IP-CAN bearer to the S-GW because of Charging Characteristics change;
- the Gn/Gp SGSN shall not send IP-CAN bearer modifications for the existing IP-CAN bearer to the P-GW because of Charging Characteristics change.

A.2 Charging Characteristics in Gn/Gp SGSN

The Gn/Gp SGSN applies a pre-configured default if no Charging Characteristics are supplied by the HLR/HSS. The SGSN shall support three different Charging Characteristics default configurations:

- the home default behaviour for subscribers of the SGSN's PLMN;
- the visiting default behaviour for visitors using a P-GW belonging to the same PLMN as the SGSN;
- the roaming default behaviour for visitors using a P-GW belonging to their home PLMN.

The SGSN can determine the P-GW PLMN from the operator identifier part of the APN. Optionally the SGSN may support several visiting and roaming default behaviours based on the MNC/MCC combination of the subscriber.

In the case of a home subscriber, the Charging Characteristics are selected by the SGSN according to the following procedures. For IP-CAN bearer specific Charging Characteristics (i.e. those used for the S-CDRs that are generated for this IP-CAN bearer):

- If the MS requests a particular APN then:
 - * If the SGSN accepts this request (i.e. it has been verified against the subscription) then:
 - If it has been matched against the wildcard APN then:
 - If Charging Characteristics for the wildcard APN are present in the subscription information then they shall be used;
 - If no Charging Characteristics are present for the wildcard APN but subscription related Charging Characteristics are present, then they shall be chosen;
 - If neither of the two are present then the SGSN home default shall be applied.
 - If it has been matched against a specific subscribed APN then:
 - If Charging Characteristics for this APN are present in the subscription information then they shall be used;
 - If no Charging Characteristics are present for the APN but subscription related Charging Characteristics are present, then they shall be chosen;
 - If neither of the two are present then the SGSN home default shall be applied.
 - * If the SGSN rejects the request then Charging Characteristics selection does not apply.
- If the MS does not request an APN then:
 - * If the SGSN chooses a subscribed APN then:
 - If Charging Characteristics for this APN are present in the subscription information then they shall be used;
 - If no Charging Characteristics are present for the APN but subscription related Charging Characteristics are present, then they shall be chosen;
 - If neither of the two are present then the SGSN home default shall be applied.
 - * If only the wildcard APN is present in the subscription, i.e. the SGSN applies its configured default APN then:
 - If Charging Characteristics for the wildcard APN are present in the subscription information then they shall be used;
 - If no Charging Characteristics are present for the wildcard APN but subscription related Charging Characteristics are present, then they shall be chosen;

- If neither of the two are present then the SGSN home default shall be applied.

For the non-IP-CAN bearer specific CDR types, i.e. the M-CDRs and the SMS CDRs, the SGSN applies the subscription specific Charging Characteristics, or, if not supplied, it shall choose the home default behaviour as defined above.

In case of subscribers from other PLMNs, the SGSN may be configured to either apply the "home subscriber case" Charging Characteristics selection procedure defined above, or to ignore Charging Characteristics provided by the subscriber's HLR, and apply a default configuration instead. If default Charging Characteristics are selected for the foreign subscriber, then the SGSN shall choose either the visiting or roaming default behaviour for the IP-CAN bearer specific Charging Characteristics, according to the roaming or visiting scenario, as described above. For M-CDRs and SMS CDRs, the operator can configure if the roaming or the visiting behaviour shall be applied, since no P-GW is involved.

Upon activation of a IP-CAN bearer, the SGSN forwards the Charging Characteristics to the P-GW according to the following rules:

- if Charging Characteristics were received from the HLR/HSS, then they shall be sent as provided by the HLR/HSS, regardless of the home, visiting, or roaming case, and regardless of whether the SGSN applies the HLR/HSS supplied Charging Characteristics or chooses to ignore them;
- if no Charging Characteristics were received from the HLR/HSS, then the SGSN does not forward any Charging Characteristics to the P-GW.

If no charging characteristics were received from the HLR/HSS or from another MME or SGSN, then SGSN does not provide any charging characteristics to any MME or SGSN in mobility cases.

If charging characteristics were received from HLR/HSS, but not for all the IP-CAN bearers, then SGSN does not provide any charging characteristics to any MME or SGSN in mobility cases occurring through GTPv1.

A.3 Charging Characteristics in S4-SGSN

The S4-SGSN does not utilize Charging Characteristics as it does not generate charging information.

Upon activation of a IP-CAN session, the S4-SGSN forwards the Charging Characteristics to the S-GW according to the following rules:

- if Charging Characteristics were received from the HLR/HSS, then they shall be sent as provided by the HLR/HSS, regardless of the home, visiting, or roaming case according to the following rules:
 - if Charging Characteristics for the PDN connection (e.g. APN) is present in the subscription information it shall be forwarded;
 - if no Charging Characteristics is present for the PDN connection (e.g. APN) but subscription related Charging Characteristics is present, it shall be forwarded.
- if no Charging Characteristics were received from the HLR/HSS, then the S4-SGSN does not forward any Charging Characteristics to the S-GW.

If no charging characteristics were received from the HLR/HSS or from another MME or SGSN, then SGSN does not provide any charging characteristics to any MME or SGSN in mobility cases.

If charging characteristics were received from HLR/HSS, but not for all the IP-CAN bearers, then SGSN does not provide any charging characteristics to any MME or SGSN in mobility cases occurring through GTPv1.

A.4 Charging Characteristics in MME

The MME applies the subscription specific Charging Characteristics, or, if not supplied, it shall apply a pre-configured default behaviour for generation of SMS CDRs.

Upon activation of a IP-CAN session, the MME forwards the Charging Characteristics to the S-GW according to the following rules:

- if Charging Characteristics were received from the HLR/HSS, then they shall be sent as provided by the HLR/HSS, regardless of the home, visiting, or roaming case according to the following rules:
 - if Charging Characteristics for the PDN connection (e.g. APN) are present in the subscription information they shall be forwarded;
 - if no Charging Characteristics are present for the PDN connection (e.g. APN) but subscription related Charging Characteristics are present, they shall be forwarded.
- if no Charging Characteristics were received from the HLR/HSS, then the MME does not forward any Charging Characteristics to the S-GW.

If no charging characteristics were received from the HLR/HSS or from another MME or SGSN, then MME does not provide any charging characteristics to any MME or SGSN in mobility cases.

If charging characteristics were received from HLR/HSS, but not for all the IP-CAN bearers, then MME does not provide any charging characteristics to any MME or SGSN in mobility cases occurring through GTPv1.

A.5 Charging Characteristics in S-GW

The S-GW shall apply Charging Characteristics to its IP-CAN bearers. It shall either apply the S4-SGSN/MME supplied parameters, or it may be configured to ignore the S4-SGSN/MME supplied Charging Characteristics in any combination of the following cases:

- visiting case, i.e. the the S-GW and the P-GW belong to the same PLMN, the subscriber belongs to a different PLMN;
- roaming case, i.e. the P-GW belongs to a different PLMN;
- home case, i.e. the subscriber belongs to the same PLMN as the S-GW and P-GW; or
- unconditionally, i.e. it always ignores the S4-SGSN/MME supplied parameters.

If the S-GW ignores the parameters supplied by the S4-SGSN/MME, it shall nevertheless accept the IP-CAN session request. It shall then apply its own pre-configured Charging Characteristics as appropriate, i.e. the home, visiting or roaming behaviour. The S-GW shall support the configuration of one set of default Charging Characteristics (i.e. home, visiting, roaming).

Upon activation of a IP-CAN session, the S-GW forwards the Charging Characteristics to the P-GW according to the following rules:

- if Charging Characteristics were received from the S4-SGSN/MME, then they shall be sent as provided by the S4-SGSN/MME, regardless of the home or visiting case;
- if no Charging Characteristics were received from the S4-SGSN/MME, then the S-GW does not forward any Charging Characteristics to the P-GW.

A.6 Charging Characteristics in P-GW

The P-GW shall apply Charging Characteristics to its IP-CAN bearers. It shall either apply the SGSN/S-GW/ePDG supplied parameters, or it may be configured to ignore the SGSN/S-GW/ePDG supplied Charging Characteristics in any combination of the following cases:

- visiting case, i.e. the subscriber belongs to a different PLMN;
- roaming case, i.e. the subscriber belongs to same PLMN and the SGSN/S-GW/ePDG belongs to a different PLMN;
- home case, i.e. the subscriber belongs to the same PLMN as the SGSN/S-GW/ePDG and P-GW; or
- unconditionally, i.e. it always ignores the SGSN/S-GW/ePDG supplied parameters.

If the P-GW ignores the parameters supplied by the SGSN/S-GW/ePDG, it shall nevertheless accept the IP-CAN session request. It shall then apply its own pre-configured Charging Characteristics as appropriate, i.e. the home, visiting or roaming behaviour. The P-GW shall support the configuration of one set of default Charging Characteristics (i.e. home, visiting, roaming) for each of its supported APNs.

A.7 Charging Characteristics in TDF

Upon IP-CAN session establishment, the P-GW forwards the Charging Characteristics parameter to the TDF (resp. PCRF then the TDF). The TDF shall apply Charging Characteristics to its TDF session. It shall either apply the supplied parameters, or it may be configured to ignore the supplied Charging Characteristics in any combination of the following cases:

- visiting case, i.e. the subscriber belongs to a different PLMN;
- roaming case (home routed traffic);
- home case, i.e. the subscriber belongs to the same PLMN as the TDF; or
- unconditionally, i.e. it always ignores the supplied parameters.

If the TDF ignores the supplied parameters, it shall nevertheless accept the TDF session request. It shall then apply its own pre-configured Charging Characteristics as appropriate, i.e. the home, visiting or roaming behaviour. The TDF shall support the configuration of one set of default Charging Characteristics (i.e. home, visiting, roaming) for each of APNs.

Annex B (normative): Tx expiration; Failure Handling procedure and session failover mechanism description

| CREDIT-CONTROL FAILURE HANDLING | Initial CCR, Tx expiration | Initial CCR, Tx expiration | Update CCR, Tx expiration | Update CCR, Tx expiration | Initial CCR, Tx expiration for second OCS | Update CCR, Tx expiration for second OCS |
|--|--|--|---|--|--|--|
| | Session failover enabled | Session failover disabled | Session failover enabled | Session failover disabled | | |
| Failure Action = TERMINATE | P-GW: IP-CAN bearer is not established. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. | P-GW: IP-CAN bearer is not established. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. | P-GW: IP-CAN bearer is terminated. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The TDF-CDR is marked. | P-GW: IP-CAN bearer is terminated. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The TDF-CDR is marked. | N/A | N/A |
| Failure Action= RETRY & TERMINATE | After Tx expiration, the P-GW/TDF sends the Reserve Units Request[Initial] to the secondary OCS. The next considerations also apply: <ul style="list-style-type: none"> - Tx is restarted. - Service is not granted yet, i.e. PDP context/TDF session is not accepted/established yet. - If an answer from the first OCS is received after the first Tx expiration, it is ignored. <p>In case the secondary OCS is not available, the behaviour is described in the column: "Initial CCR, Tx expiration for second OCS".</p> | P-GW: IP-CAN bearer is not established. TDF indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. | After Tx expiration, the P-GW/TDF will move all pending Reserve Units Request [Update] for the online session to the secondary OCS. The next considerations also apply: <ul style="list-style-type: none"> - Tx is restarted - Service is only granted until the quota is exhausted. - If an answer from the first OCS is received after first Tx expiration, it is ignored. <p>In case the secondary OCS is not available, the behaviour is described in the column: " Reserve Units Request[Update], Tx expiration for second OCS".</p> | P-GW: IP-CAN bearer is terminated. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The TDF-CDR is marked. | P-GW: IP-CAN bearer is not established. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. | P-GW: IP-CAN bearer is terminated. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS does not allow the service to continue. The TDF-CDR is marked. |

| | | | | | | |
|--|---|--|---|--|--|---|
| <p>Failure Action= CONTINUE</p> | <p>After Tx expiration, the P-GW/TDF sends the Reserve Units Request[Initial] to the secondary OCS. The next considerations also apply:</p> <ul style="list-style-type: none"> - Tx is restarted - Service is not granted yet, i.e. PDP context/TDF session is not accepted/established yet. - If an answer from the first OCS is received after the first Tx expiration, it is ignored. <p>In case the secondary OCS is not available, the behaviour is described in the column: "Initial CCR, Tx expiration for second OCS".</p> | <p>P-GW: The IP-CAN bearer is accepted and the Credit-Control session is considered closed for the P-GW. The operator can limit the duration of the IP-CAN bearer. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The TDF-CDR is marked.</p> | <p>After Tx expiration, the P-GW/TDF will move all pending update CCRs for the online session to the secondary OCS. The next considerations also apply:</p> <ul style="list-style-type: none"> - Tx is restarted - Service is only granted until the quota is exhausted - If an answer from the first OCS is received after the first Tx expiration, it is ignored. <p>In case the secondary OCS is not available, the behaviour is described in the column: "Update CCR, Tx expiration for second OCS".</p> | <p>After the Tx expiration, the failure handling mechanism is immediately triggered - P-GW: The Credit-Control session is considered closed for the P-GW and access to all services is granted for an operator configurable period of time. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The TDF-CDR is marked. All active service data flow containers shall be added to the PGW-CDR/TDF-CDR.</p> | <p>After the Tx expiration for the secondary OCS, the failure handling mechanism is immediately triggered: P-GW: The IP-CAN bearer is accepted and the Credit-Control session is considered closed for the P-GW. The operator can limit the duration of the IP-CAN bearer. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The TDF-CDR is marked.</p> | <p>After Tx expiration for the secondary OCS, the failure handling mechanism is immediately triggered- P-GW: The Credit-Control session is considered closed for the P-GW and access to all services is granted for an operator configurable period of time. The PGW-CDR is marked. TDF: indicates to the PCRF that the charging session was terminated and the OCS allows the service to continue. The TDF-CDR is marked. All active service data flow containers shall be added to the PGW-CDR/TDF-CDR.</p> |
|--|---|--|---|--|--|---|

Annex C (informative): Bibliography

a) **The 3GPP charging specifications**

- 3GPP TS 32.252: "Telecommunication management; Charging management; Wireless Local Area Network (WLAN) charging".
- 3GPP TS 32.272: "Telecommunication management; Charging management; Push-to-talk over Cellular (PoC) charging".
- 3GPP TS 32.275: "Telecommunication management; Charging management; MultiMedia Telephony (MMTel) charging".
- 3GPP TS 32.276: "Telecommunication management; Charging management; Voice Call Service Charging".
- 3GPP TS 32.280: "Telecommunication management; Charging management; Advice of Charge (AoC) service".
- 3GPP TS 32.293: "Telecommunication management; Charging management; Proxy Function".

b) **Common 3GPP specifications**

- 3GPP TS 22.101: "Service aspects; Service principles".
- 3GPP TS 23.002: "Network Architecture".
- 3GPP TS 23.003: "Numbering, addressing and identification".
- 3GPP TS 27.001: "General on Terminal Adaptation Functions (TAF) for Mobile Stations (MS)".

c) **other Domain and Service specific 3GPP / ETSI specifications**

- 3GPP TS 49.031: "Location Services (LCS); Base Station System Application Part LCS extension (BSSAP-LE)".
- 3GPP TS 24.008: "Mobile radio interface layer 3 specification; Core network protocols; Stage 3".
- 3GPP TS 23.040: "Technical realization of the Short Message Service (SMS)".
- 3GPP TS 32.215: "Telecommunication management; Charging management; Charging data description for the Packet Switched (PS) domain (Release 5)". Not propagated beyond Release 5.

d) **Relevant ITU Recommendations**

- ITU-T Recommendation D.93: "Charging and accounting in the international land mobile telephone service (provided via cellular radio systems)".
- ITU-T Recommendation E.164: "The international public telecommunication numbering plan".
- ITU-T Recommendation Q.767: "Application of the ISDN user part of CCITT signalling System No.7 for international ISDN interconnections".
- ITU-T Recommendation X.25: "Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit".
- ITU-T Recommendation X.121: "International numbering plan for public data networks".

e) **Relevant IETF RFCs**

- IETF RFC 959 (1985): "File Transfer Protocol".

- IETF RFC 1350 (1992): "The TFT Protocol (Revision 2)"

Annex D (normative): Fixed Broadband Access

D.1 General

This annex specifies the enhancement to PS domain Charging for supporting the convergent scenario, where a single operator owns both the fixed broadband access network and the EPC, and the PCEF is located in the fixed broadband access network, as described in the TS 23.203 [215].

This Annex describes only the exceptions and additions in respect the main body requirements, therefore, if not explicitly mentioned the main body is applicable.

In this Annex, the IP-Edge embedding PCEF will be denoted IP-Edge [PCEF].

As specified in the TS 23.203 [215], Charging for following types of traffic is supported:

- traffic from fixed devices, and
- non-seamless WLAN offload traffic from a 3GPP UE.

Editor's note: this Annex might require some adjustments based on exchanges with BBF.

D.2 Architecture considerations

D.2.1 High level architecture

For offline charging the IP-Edge [PCEF] /TDF may generate accounting metrics sets to record a user's access to external networks based on clause D.2.2 architecture.

Online charging is supported from the IP-Edge [PCEF] /TDF based on clause D.2.3.

D.2.2 PS domain offline charging architecture

The Rf interface is supported from the Policy and Charging Enforcement Function (PCEF) located in IP-Edge, and includes the required FBC functionality of the Gz reference point, adapted to IP-Edge [PCEF] as defined in this Annex.

The Rf, Ga and Bp interfaces are supported from the TDF and includes the required ABC functionality of the Gzn reference point as defined for the PCN in clause 4.2

D.2.3 PS domain online charging architecture

The Ro interface is supported from the Policy and Charging Enforcement Function (PCEF) located in IP-Edge as per clause 4.3 architecture, and includes the required FBC functionality of the Gy reference point, adapted to IP-Edge [PCEF] as defined in this Annex.

The Ro interface is supported from the TDF as per clause 4.3 architecture, and includes the required ABC functionality of the Gyn reference point as defined for the PCN in clause 4.3.

D.3 PS domain charging principles and scenarios

D.3.1 PS charging principles

D.3.1.0 General

IP-CAN session applicable for Fixed Broadband Access, is defined in the TS 23.203 [215], clause S.2.

The charging functions specified for the PCEF located in the IP-Edge relate to:

- IP-CAN session.
- individual service data flows within an IP-CAN session.

The charging functions specified for the TDF relate to:

- TDF session.
- individual applications within a TDF session.

D.3.1.1 Requirements

D.3.1.1.1 Requirements for IP-Edge [PCEF]

The high-level charging requirements 1, 2, 3, 10, 11 and 12 specified in clause 5.1.1 apply with the difference that P-GW is replaced by IP-Edge [PCEF].

Since the IP-Edge [PCEF] does not support individual bearers, the high-level charging requirements 1 and 2 apply to the IP-CAN session instead of an IP-CAN bearer.

Additional high level charging requirement:

- The IP-Edge [PCEF] shall be capable of identifying data volumes, elapsed time or events, categorized per QoS (QoS as defined in TS 23.203 [215]).
- IP-Edge [PCEF] shall support charging for 3GPP UEs in roaming scenario, where the HPLMN has deployed the same charging capabilities as the VPLMN.
- The IP-Edge [PCEF] shall be capable of handling local Charging Characteristics for Fixed users and 3GPP UEs NSWO traffic: see clause D.5 for details.

These requirements apply equally to online charging and offline charging.

D.3.1.1.2 Requirements for TDF

The High level Requirements specified in Clause 5.1.1 for TDF shall apply with the difference that Charging Characteristics shall be as described in clause D.5.

D.3.1.2 Charging information

Charging information is collected for each Fixed user served by the IP-Edge [PCEF] /TDF, and for each 3GPP UE served by the IP-Edge [PCEF] /TDF for the Offloaded (NSWO) traffic, both when served in the conditions specified in TS 23.203 [215] Annex S. The IP-Edge [PCEF] /TDF collects charging information related to the Fixed Broadband access resources and to external data network usage.

Charging information is collected for each existing IP-CAN/TDF session per identified user: 3GPP UE, Fixed device or RG.

Charging information collection per device (i.e. fixed device or 3GPP UE) is possible only when an IP-CAN session exists for the 3GPP UE or fixed device connected behind a RG.

NOTE 1: In case of 3GPP UE or fixed device behind a NATed RG it is not possible to perform charging for that specific device.

NOTE 2 : The cases where it is possible to support an IP-CAN session per device are described in TS 23.203 [215] Annex S.

3GPP UE user is identified by the IMSI, and Fixed user (i.e. fixed device or RG) is identified by a user name or Access line identifier, based on the Subscriber ID as defined in Broadband Forum TR 134 [601].

The Access Line Identifier (physical and logical circuit ID) shall also be collected by the IP-Edge [PCEF] when available, when this Subscriber ID identifies a 3GPP UE or a fixed device behind the RG.

The IP-Edge [PCEF] may provide the following fixed broadband access specific information:

- Location of the subscriber; that may include Access Line Identifier (physical and logical circuit ID), SSID of the Access Point, BSSID of the Access Point.

NOTE: How the location information becomes available to the IP-Edge [PCEF] is out of the scope of 3GPP.

- IP-Edge Operator Identifier (i.e., PLMN Id), if available.

For IP-CAN sessions, the IP-Edge [PCEF] shall collect the following charging information for both online and offline charging:

- 1). Usage of the Fixed Broadband access resources: the charging information shall describe the amount of data transmitted in uplink and downlink directions categorized with QoS.

NOTE 3: QoS information used for charging is based on standardized QoS characteristics as defined TS 23.203 [215]. The Fixed Broadband Access specific QoS attribute converted by the IP-Edge [PCEF] from these QoS parameters are out of scope.2). Usage duration: duration of IP-CAN session is counted as the time interval from IP-CAN session establishment to IP-CAN session termination.

- 3). 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. For an IP-CAN session corresponding to a 3GPP UE, the External network can be identified by the NSWO APN.
- 4). Source: the charging information shall provide the actual source addresses used by the subscriber for the IP-CAN session.
- 5). 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;
- 6). The duration of service data flows categorized by rating group or combination of the rating group and service id when time based charging applies;

For TDF sessions and for application traffic defined for ABC, the TDF shall collect the charging information for both online and offline charging:

- 1) Usage of the Fixed Broadband access resources: the charging information shall describe the amount of data transmitted in uplink and downlink directions categorized with maximal bandwidth;

- 2) Usage duration: duration of TDF session is counted as the time interval from TDF session activation to TDF session deactivation;
- 3) Source: the charging information shall provide the actual source addresses used by the subscriber for the TDF session;
- 4) 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. For a TDF session corresponding to a 3GPP UE, the External network can be identified by the APN.
- 5) The amount of data transmitted as specific application in uplink and downlink directions categorized by rating group or combination of the rating group and service identifier when volume based charging applies;
- 6) The duration of application traffic is counted and categorized by rating group or combination of the rating group and service identifier when time based charging applies;
- 7) The number of events and corresponding timestamps categorized by rating group or combination of the rating group and service identifier when event based charging applies.

D.3.2 PS domain offline charging scenarios

D.3.2.1 Basic principles

D.3.2.1.0 General

In order to provide the data required for the management activities outlined in TS 32.240 [1] (billing, accounting, statistics etc.), the IP-Edge [PCEF] /TDF shall be able to report charging events to a CDF implemented as a separate entity for the corresponding IPE-CDR/TDF-CDR generation by CDF for:

- Charging Data related to the IP-CAN session;
- Charging Data related to service data flows (FBC) within an IP-CAN session;
- Charging data related to TDF session (TDF-CDR) in the TDF;
- Charging Data related to application traffic in the TDF (TDF-CDR).

Either Charging Data related to the IP-CAN session, Charging Data related to services data flows (FBC) within an IP-CAN session, or both may be reported for the IPE-CDR generation, as determined by Charging Characteristics. A single IPE-CDR is defined for both types of charging information.

D.3.2.1.1 IP-CAN session charging

IP-Edge [PCEF] collects charging information per user identified as described in clause D.3.1.2, per IP-CAN session.

IP-CAN session charging allows the IP-Edge [PCEF] to collect charging information related to data volumes sent to and received by the user, categorised by the QoS applied, for the timeframe since the establishment till the termination of IP-CAN session, for Fixed user traffic or 3GPP UE NSW0 traffic. The IP-CAN session can be determined by a unique identifier generated by the Edge [PCEF] (a "Charging ID") when establishing IP-CAN session. When IP-CAN session charging is active for this IP-Edge[PCEF], the main collected information items are duration of the IP-CAN session and data volume transferred per QoS during the lifetime of the IP-CAN session, and the following chargeable events are defined:

- Start of IP-CAN session in the IP-Edge [PCEF]. Upon encountering this event, a new IPE-CDR for this context is created.

NOTE 1: The start of IP-CAN session event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR- Start of traffic under a QoS within the IP-CAN session: new data volume counts (i.e. uplink and downlink) are started for this QoS.

- Termination of traffic under a QoS within the IP-CAN session: The counters and time stamps for this QoS are closed and resulting containers added to the CDR.
- End of IP-CAN session in the IP-Edge [PCEF]. Upon encountering this trigger, all the counters are closed and added to the CDR, and the IPE-CDR is closed.

NOTE 2: The end of IP-CAN session event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR

- Expiry of an operator configured time limit for keeping a CDR open. This event closes all counters. The resulting containers are added to the CDR and the CDR is closed. A new CDR is opened if the IP-CAN session is still active.

NOTE 3: Expiry of an operator configured time limit for keeping a CDR open event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR

- Expiry of an operator configured time limit per QoS. The counters and time stamps for the QoS are closed and added to the CDR. New QoS traffic volume containers are opened if the QoS is still active.

- Expiry of an operator configured data volume limit per IP-CAN session. This event closes all counters. The resulting containers are added to the CDR and the CDR is closed. A new CDR is opened if the IP-CAN session is still active.

NOTE 4: Expiry of an operator configured data volume limit per IP-CAN session event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR

- Expiry of an operator configured data volume limit per QoS. The counters and time stamps for the QoS are closed and added to the CDR. New QoS traffic volume containers are opened if the QoS is still active.
- Change of charging condition: tariff time change or failure handling procedure triggering. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps are started.

NOTE 5: Change of charging condition event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR

- Expiry of an operator configured change of charging condition limit per IP-CAN session. This event closes the CDR, and a new one is opened if the IP-CAN session is still active.

NOTE 6: Expiry of an operator configured change of charging condition limit per IP-CAN session event is a shared trigger for FBC in clause D.3.2.1.2 for the single shared CDR

Management intervention may also force trigger a chargeable event.

D.3.2.1.2 Flow-based bearer charging

FBC functionality defined in clause 5.2.1.3 shall apply when provided by the PCEF located in the IP-Edge, with modifications described below:

- Relates to Fixed user traffic and 3GPP UE NSW0 traffic.
- It is applicable within the context of an IP-CAN session.

The chargeable events defined in clause 5.2.1.3, when offline charging is activated, apply with the difference that P-GW is replaced by IP-Edge [PCEF], and IP-CAN bearer is replaced by IP-CAN session.

Change of charging condition is modified to remove conditions related to SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area. The following are the resulting applicable events:

- Change of charging condition: QoS change. When this event is encountered, all current configured counts and time stamps applicable to the QoS level are captured and new counts and time stamps for all service data flows applicable to the new QoS level are started.
- Change of charging condition: tariff time change or failure handling procedure triggering. When this event is encountered, all current configured counts and time stamps are captured and new counts and time stamps for all active service data flows are started.

Following are not applicable:

- Intersystem change.
- PLMN change.
- MS Timezone change.
- SGSN change in the P-GW.

NOTE: A set of chargeable events are shared triggers for IP-CAN session charging in clause D.3.2.1.1 for the single shared IPE-CDR. They are indicated in clause D.3.1.1.

The detailed PCEF behaviour associated to these chargeable events above, are detailed below.

When applicable to the IP-Edge [PCEF], charging information included in the PCC Rule is specified in TS 23.203 [215] Annex S.

D.3.2.1.3 TDF/Application Based Charging

TDF session and ABC functionality defined in clause 5.2.1.9 shall apply with modifications described below:

- Relates to Fixed user traffic and 3GPP UE NSWO traffic.

The chargeable events defined in clause 5.2.1.9, when offline charging is activated, apply except the following:

- Serving node (e.g. SGSN/S-GW/ePDG) change;
- Change of charging condition: TDF session modification (e.g. SGSN change, S-GW change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area);
- Intersystem change (e.g. change of radio interface from GSM to UMTS, RAT change);
- PLMN change;
- MS Timezone change.

The detailed TDF behaviour associated to these chargeable events above, is detailed below.

D.3.2.2 Rf message flows

D.3.2.2.0 General

Charging information reporting is supported from the PCEF located in IP-Edge and by the TDF as defined for PCN in clause 5.2.2.

The trigger conditions for the chargeable events are described in the following clauses.

D.3.2.2.1 Triggers for charging events from IP-Edge [PCEF]

D.3.2.2.1.0 General

Charging event reporting as defined in clause 5.2.2.2 shall apply to the PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and includes, in addition:

- containers identifying per QoS, traffic volumes charging data (separated for uplink and downlink traffic) with associated charging condition change information when IP-CAN session charging is active for this IP-Edge [PCEF].

The trigger conditions applicable are described in following clauses.

D.3.2.2.1.1 Triggers for charging information addition

Charging event for charging information addition and triggers, as defined in clause 5.2.3.4.1 shall apply to the PCEF located in the IP-Edge for FBC (i.e. "List of Service Data" attribute of the IPE-CDR), with following exceptions:

- IP-CAN bearer modification (e.g. QoS change, SGSN/S-GW/ePDG change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area) as trigger conditions is replaced by IP-CAN session modification (e.g. QoS change,..)
- The "Serving node Address" attribute is not applicable.

When IP-CAN session charging is active, the trigger conditions for charging information addition are described in clause D.3.2.3.1.1.

D.3.2.2.1.2 Triggers for charging information closure

Charging event for charging information closure, and triggers as defined in clause 5.2.3.4.2 shall apply to the PCEF located in the IP-Edge, when either FBC or IP-CAN session charging or both are active, with the following differences:

- P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and PGW-CDR is replaced by IPE-CDR.
- following Partial Record Reasons: PLMN change, RAT type, and MS time zone change are not applicable.

D.3.2.2.2 Triggers for charging events from TDF

D.3.2.2.2.0 Introduction

Charging event reporting as defined in clause 5.2.2.5 shall apply to the TDF, with the differences that trigger conditions which are not applicable are described in the following clauses.

D.3.2.2.2.1 Triggers for charging information addition

Charging event for charging information addition and triggers, as defined in clause 5.2.3.9.2 shall apply to the TDF, with the following exceptions:

- TDF session modification (e.g. SGSN/S-GW/ePDG change, user location change, user CSG information change, change of UE presence in a Presence Reporting Area);
- The "Serving node Address" attribute is not applicable.

D.3.2.2.2.2 Triggers for charging information closure

Charging event for charging information closure, and triggers as defined in clause 5.2.3.9.3 shall apply to the TDF, with the following exception:

- following Partial Record Reasons: PLMN change, RAT type, and MS time zone change are not applicable.

D.3.2.3.2 TDF-CDR charging information collection

D.3.2.3.2.0 Introduction

Charging information collection as defined in clause 5.2.3.9 shall apply.

D.3.2.3.2.1 TDF-CDR charging information addition

Charging information addition to TDF-CDR shall be based on charging events received from TDF as specified in D.3.2.2.2.1.

D.3.2.3.2.2 TDF-CDR closure

CDR closure shall be based on charging event closure received from the TDF as specified in D.3.2.2.2.2.

D.3.2.3 CDR generation

D.3.2.3.0 General

The IPE-CDR and the TDF-CDR are generated by the Charging Data Function (CDF) for subsequent transfer to the Charging Gateway Function (CGF).

D.3.2.3.1 IPE-CDR charging information collection

D.3.2.3.1.0 General

Charging information collection as defined in clause 5.2.3.4 shall apply, based on charging events from IP-Edge [PCEF], with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and PGW-CDR is replaced by IPE-CDR, and in addition, when IP-CAN session charging is active:

IPE-CDR is used to collect charging information related to traffic volumes used within the IP-CAN session, identified per QoS.

Many traffic volume containers per QoS can be active simultaneously in IPE-CDR.

A new traffic volume container is activated, when traffic applied with this QoS is detected and no matching active QoS container exists.

When a change of charging condition occurs, all traffic volume containers are added to the IPE-CDR.

When both, IP-CAN session charging and FBC are active, the same IPE-CDR is used for collection of corresponding data.

D.3.2.3.1.1 IPE-CDR charging information addition

Charging information addition to IPE-CDR for FBC, shall be based on charging events received from IP-Edge [PCEF] as specified in D.3.2.2.1.1.

When IP-CAN session charging is active the following behaviour shall apply:

The "List of Traffic Data Volumes" attribute of the IPE-CDR consists of a set of containers, which are added when specific trigger conditions are met, and identify the volume counter per QoS, separated for uplink and downlink traffic, on encountering that trigger conditions. Table D.3.2.3.1.1.1 identifies which conditions are supported to trigger IPE-CDR charging information addition for the "List of Traffic Data Volumes" attribute.

Table D.3.2.3.1.1.1: Triggers for IPE-CDR charging information addition for List of Traffic Volumes

| Trigger Conditions | Description/Behaviour |
|-----------------------|---|
| End of QoS in IP-Edge | The end of a QoS enforced in IP-Edge shall result in open "List of Traffic Data Volumes" containers for the QoS are closed and added to the CDR. |
| Tariff Time Change | On reaching the Tariff Time Change open "List of Traffic Data Volumes" containers shall be closed and added to the CDR. |
| Traffic volume report | A "List of Traffic Data Volumes" container for a QoS shall be added when: <ul style="list-style-type: none"> - expiry of time limit per QoS; - expiry of data volume limit per QoS. |
| CDR Closure | Open "List of Traffic Data Volumes" containers shall be closed and added to the IPE-CDR. |

When Charging Event (ACR) is triggered by table D.3.2.3.1.1.1 conditions, the Change-Condition sub-field associated to the added container, indicating the appropriate condition, shall be present, excluding CDR Closure case.

When Charging Event (ACR) is triggered by CDR Closure condition, this Change-Condition sub-field associated to the added container shall be omitted, except when CDR closure is due to "maximum number of charging condition changes", where it shall be present with the original condition change.

D.3.2.3.1.2 IPE-CDR closure

CDR closure shall be based on charging event closure received from the IP-Edge [PCEF] as specified in clause D.3.2.2.1.2.

D.3.2.4 Ga record transfer flows

Ga protocol applies between the Charging Data Function (CDF) and the Charging Gateway Function (CGF).

For further details on the Ga protocol application refer to TS 32.295 [54].

Ga is not used from the IP-Edge [PCEF].

D.3.2.5 Bp CDR file transfer

The CGF transfers CDR files to the BD as specified for PCN Nodes in clause 5.2.6.

Bp is not used from the IP-Edge [PCEF].

D.3.3 PS domain online charging scenarios

D.3.3.1 Basic principles

D.3.3.1.0 Introduction

The Chargeable events and messages contents applicable to the IP-Edge [PCEF] and to the TDF are specified under the sub-clauses below.

D.3.3.1.1 IP-CAN session charging

IP-CAN session online charging is achieved by associating a vendor specific rating group or combination of rating group and service id with the IP-CAN session, such that the quota handling for the IP-CAN session shall be based on.

The amount of data counted with IP-CAN session vendor specific rating group or combination of rating group and service id shall be the user plane payload. Time metering is started when IP-CAN session is activated.

Either IP-CAN session charging or FBC but not both may be active at the same time, as determined by Charging Characteristics.

D.3.3.1.2 Flow Based bearer Charging

FBC functionality defined in clause 5.3.1.2 shall apply when provided by the PCEF located in the IP-Edge, with specificities described below:

- Relates to Fixed user traffic and 3GPP UE NSW0 traffic.
- It is applicable within the context of an IP-CAN session.

The chargeable events defined in clause 5.3.1.2, when online charging is activated, apply with the difference that P-GW is replaced by IP-Edge [PCEF], and IP-CAN bearer is replaced by IP-CAN session.

Change of charging condition is modified to remove conditions related to user location change, user CSG information change, and change of UE presence in a Presence Reporting Area. The following are the resulting applicable events:

- Change of charging condition: QoS change. When this event is encountered and the corresponding re-authorization trigger is armed, all current counts applicable to the QoS level are captured and sent towards the OCS with a Debit / Reserve Units Request[Update].

Following is not applicable:

- Network request for IP-CAN bearer activation.

The detailed PCEF behaviour associated to these chargeable events above, are detailed below.

When applicable to the IP-Edge [PCEF], charging information included in the PCC Rule is specified in TS 23.203 [215] Annex S.

D.3.3.1.3 TDF/Application Based Charging

TDF session and ABC functionality defined in clause 5.3.1.5 shall apply when provided by the TDF, with specificities described below:

- Relates to Fixed user traffic and 3GPP UE NSW0 traffic.

The chargeable events defined in clause 5.3.1.5, when online charging is activated, apply with the difference that the following chargeable events are not applicable:

- Change of charging condition: e.g. user location change, user CSG information change, change of UE presence in a Presence Reporting Area.

The detailed TDF behaviour associated to these chargeable events above, is detailed below.

D.3.3.2 Ro message flows

D.3.3.2.0 Introduction

Charging information transfer towards the OCS as defined in clause 5.3.2 shall apply to the TDF and to the PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, PGW-CDR is replaced by IPE-CDR and Network requested IP-CAN bearer activation is not applicable.

D.3.3.2.1 Triggers for online charging

Triggers for FBC as defined in clause 5.3.2.2 shall apply to the PCEF located in the IP-Edge, with the difference that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and APN is not applicable. The "Change of UE presence in Presence Reporting Area" change of charging condition is not applicable.

Triggers for ABC online charging as defined in clause 5.3.2.2A shall apply to the TDF.

D.3.3.2.1.1 Triggers for starting and stopping a Credit-Control session

The same triggers as defined in clause 5.3.2.2.1 shall apply to the PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and Network requested IP-CAN bearer activation is not applicable.

The same triggers as defined in clause 5.3.2.2A.1 shall apply to the TDF.

D.3.3.2.1.2 Triggers for providing interim information for a Credit-Control session

The same triggers as defined in clause 5.3.2.2.2 shall apply to the PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and Network requested IP-CAN bearer activation is not applicable.

The same triggers as defined in clause 5.3.2.2A.2 shall apply to the TDF.

D.3.3.2.2 PS Furnish Charging Information procedure

The same PS Furnish Charging Information procedure as defined in clause 5.3.1.3 shall apply to the PCEF located in the IP-Edge and to the TDF, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and PGW-CDR is replaced by IPE-CDR.

D.3.3.2.3 Support of Failure Situations

Support of Failure Situations as defined in clause 5.3.1.4 shall apply to the PCEF located in the IP-Edge and to the TDF, with the differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer is replaced by IP-CAN session, and PGW-CDR is replaced by IPE-CDR.

D.4 Definition of charging information

D.4.1 Data description for PS offline charging

D.4.1.1 Rf message contents

The Offline Charging message as described in clause 6.1A shall apply to the TDF and the PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], and table 6.1A.2.1.1 Service-Information is described in D.4.3.

D.4.1.2 CDR description on the Bp interface

D.4.1.2.1 FBC IP-CAN session charging data in IP-Edge [PCEF] (IPE-CDR)

If the collection of CDR data is enabled then the IP-Edge [PCEF] data specified in table D.4.1.2.1.1 shall be available for each IP-CAN session.

Table D.4.1.2.1.1: IP-Edge [PCEF] IP-CAN session data (IPE-CDR)

| Field | Category | Description |
|--------------------------------------|----------------|---|
| Record Type | M | IP-Edge [PCEF] IP-CAN session record. |
| Node ID | O _M | Name of the IP-Edge [PCEF]. |
| Retransmission | O _C | This parameter, when present, indicates that information from retransmitted Charging Data Request has been used in this CDR. |
| Served IMSI | C | This field holds the IMSI of the served party, if available. |
| Served MN NAI | O _C | Mobile Node Identifier in NAI format (based on IMSI), if available. |
| Served MSISDN | O _M | This field holds the MSISDN of the served party, if available |
| Served IMEI | O _C | The IMEI or IMEISV of the UE, if available. |
| Served Fixed Subscriber Id | C | This field holds the identity of the Fixed Device or the RG, as defined in Broadband Forum TR 134 [601]. |
| Access Line Identifier | O _M | This field holds the Access line id (physical and logical circuit ID) serving the 3GPP UE or fixed device, behind the RG (when in bridge mode or in routed mode without NAT), or Access line Id of the RG when in routed mode with NAT. |
| Fixed User Location Information | O _C | This field contains the UE location in a fixed broadband access network. The location of the subscriber may include Access line id (physical and logical circuit ID), SSID of the Access Point, BSSID of the Access Point, defined in Annex S of TS 23.203 [215]. |
| IP-Edge Address used | M | The control plane IP address of the IP-Edge used. |
| IP-Edge Address IPv6 | O _C | The control plane IPv6 address, in case of IPv4v6 dual stack, of the IP-Edge used. |
| Charging ID | M | IP-CAN session Charging identifier used to identify this IP-CAN session in different records created for IP-Edge [PCEF]. |
| IP-Edge Operator Identifier | O _C | This field holds the PLMN identifier (MCC MNC) of the Convergent Fixed-Mobile Operator. |
| Access Point Name Network Identifier | O _M | This field holds the logical name of the connected access point to the external packet data network (network identifier part of APN) reflecting the "NSWO APN", when the served user is a 3GPP UE. |
| IP-CAN session Type | O _M | IPCAN session type, i.e. IPv4, IPv6, IPv4v6, or PDN type PPP, or IHOSS:OSP. |

| Field | Category | Description |
|---|----------------|---|
| Served IP-CAN session Address | O _C | IP address allocated for the IPCAN session, i.e. IPv4 address when IPCAN session is IPv4 or IPv6 prefix when IP-CAN session is IPv6 or IPv4v6. |
| Served IP-CAN session Address extension | O _C | This field holds IPv4 address of the served subscriber, if available, when IP-CAN session type is IPv4v6. |
| Dynamic Address Flag | O _C | Indicates whether served IP-CAN session address is dynamic, which is allocated during IP-CAN session activation. This field is missing if IPv4 address is static when IP-CAN session Type is IPv4, or if IPv6 address is static when IP-CAN session Type is IPv6 or IPv4v6. |
| Dynamic Address Flag extension | O _C | Indicates whether served IPv4 IP-CAN session address is dynamic, which is allocated during IP-CAN session activation, with IP-CAN session type IPv4v6. This field is missing if IPv4 address is static. |
| List of Traffic Data Volumes | O _C | A list of changes in charging conditions within the IP-CAN session. Each change is time stamped. Charging conditions are used to categorize traffic volumes, such as per tariff period. This field includes the QoS parameters identifying the QoS applied to traffic volumes. |
| List of Service Data | O _M | A list of changes in charging conditions for all service data flows within this IP-CAN session categorized per rating group or per combination of the rating group and service id or per combination of rating group, sponsor identity and application service provider identity. Each change is time stamped. Charging conditions are used to categorize traffic volumes, elapsed time and number of events, such as per tariff period. Initial and subsequently changed QoS and corresponding data values are also listed. Online charging information (PS Furnish Charging Information) may be added per each service data flow container in case it is sent by the OCS. Failure-Handling: This field shall be present in case IP-Edge [PCEF] triggers the Failure-Handling procedure. It shall indicate the Failure Handling scenario and the instant the Failure Action is triggered (see annex B). Scenarios: Continue/New Session; Continue/Ongoing Session; Retry&Terminate/Ongoing Session; Terminate/Ongoing Session. |
| Charging Characteristics | M | The Charging Characteristics applied to the IP-CAN session. |
| Charging Characteristics Selection Mode | O _M | Holds information about how Charging Characteristics were selected. |
| PS Furnish Charging Information | O _C | Online charging session specific information |
| Record Opening Time | M | Time stamp when IP-CAN session is activated in this IP-Edge [PCEF] or record opening time on subsequent partial records. |
| Duration | M | Duration of this record in the recording entity. |
| Start Time | O _C | This field holds the time when User IP-CAN session starts, |
| Stop Time | O _C | This field holds the time when User IP-CAN session is terminated. |
| Cause for Record Closing | M | The reason for the release of record from this IP-Edge [PCEF]. |
| Diagnostics | O _M | A more detailed reason for the release of the connection. |
| Record Sequence Number | C | Partial record sequence number, only present in case of partial records. |
| Local Record Sequence Number | O _M | Consecutive record number created by the CDF, The number is unique within the CDF and allocated sequentially for each partial CDR (or whole CDR) including all CDR types. |
| Record Extensions | OC | A set of network operator/manufacture specific extensions to the record. Conditioned upon the existence of an extension. |

D.4.1.2.2 Application Based Charging data in TDF (TDF-CDR)

Clause 6.1.14 shall apply, with the following two differences.

The following fields are not applicable:

Table D.4.1.2.2.1: Fields of TDF-CDR not applicable

| |
|-------------------------------------|
| Served 3GPP2 MEID |
| Served MN NAI |
| Serving node Address |
| Serving node IPv6 Address |
| Serving node Type |
| MS Time Zone |
| APN Selection Mode |
| Served MSISDN |
| User Location Information |
| User CSG information |
| 3GPP2 User Location information |
| TWAN User Location Information |
| Presence Reporting Area Information |
| Serving node PLMN Identifier |
| RAT Type |

The following field also exists, in addition:

Table D.4.1.2.2.2: TDF-CDR additional field

| Field | Category | Description |
|---------------------------------|----------------|---|
| Access Line Identifier | O _C | This field holds the Access line id (physical and logical circuit ID) serving the 3GPP UE or fixed device, behind the RG (when in bridge mode or in routed mode without NAT), or Access line Id of the RG when in routed mode with NAT. |
| Served Fixed Subscriber Id | C | This field holds the identity of the Fixed Device or the RG, as defined in Broadband Forum TR 134 [601]. |
| Fixed User Location Information | O _C | This field contains the UE location in a fixed broadband access network. The location of the subscriber may include Access line id (physical and logical circuit ID), SSID of the Access Point, BSSID of the Access Point, defined in Annex S of TS 23.203 [215]. |

D.4.2 Data description for PS online charging

D.4.2.1 Ro message contents

The Online Charging message as described in clause 6.2.1 shall apply to the TDF and PCEF located in the IP-Edge, with the differences that P-GW is replaced by IP-Edge [PCEF], and in table 6.2.1.2.1.1:

- Subscription-Id holds the subscribed Identification for 3GPP UE, or Subscriber ID as defined in Broadband Forum TR 134 [601] for Fixed Device.
- Service Information is described in D.4.3.

D.4.3 PS Charging specific parameters

D.4.3.1 Definition of PS charging information

The Information used for PS charging for the TDF and the IP-Edge [PCEF] is provided in the Service Information parameter, as defined in clause 6.3.1.1, with the following difference:

- Subscription-Id holds the subscribed Identification for 3GPP UE, or Subscriber ID as defined in Broadband Forum TR 134 [601] for Fixed Device.
- PS information as defined in clause 6.3.1.2 shall be applicable to the TDF and the IP-Edge [PCEF], with differences that P-GW is replaced by IP-Edge [PCEF], IP-CAN bearer and PDN Connection are replaced by IP-CAN session, and also that the following fields are not applicable:

Table D.4.3.1.1: Fields of PS Information not applicable

| Information Element |
|-------------------------------------|
| PDN Connection Charging Id |
| Serving Node Address |
| Serving Node Type |
| SGW Change |
| SGW Address |
| ePDG Address |
| MME Number for MT SMS |
| MME Name |
| MME Realm |
| NSAPI |
| Selection Mode |
| Serving Node MCC MNC |
| MS Time Zone |
| User Location Info |
| User CSG Information |
| 3GPP2 User Location Info |
| TWAN User Location Information |
| Presence Reporting Area Information |
| RAT Type |
| PDP Context Type |
| Terminal Information |
| Low Priority Indicator |

The following field exists in addition:

Table D.4.3.1.2: PS Information additional field

| Information Element | Category | Description |
|--|----------------|--|
| Access Line Identifier | O _C | This IE holds the Access line id (physical and logical circuit ID) serving the 3GPP UE or fixed device, behind the RG (when in bridge mode or in routed mode without NAT), or Access line Id of the RG when in routed mode with NAT. |
| <i>Fixed User Location Information</i> | O _C | This IE contains the UE location in a fixed broadband access network. The location of the subscriber may include Access line id (physical and logical circuit ID), SSID of the Access Point, BSSID of the Access Point, defined in Annex S of TS 23.203 [215]. |

D.4.3.2 Detailed message format for offline charging

The supported fields in table 6.3.2.1 for the PS offline charging message shall apply to the TDF and the IP-Edge [PCEF] for the applicable fields, with the difference that P-GW is replaced by IP-Edge [PCEF], and the table is extended with additional table D.4.3.2.1 fields:

Table D.4.3.2.1: Additional supported fields in Charging Data Request message

| Information Element | Node Type | IP-Edge[PCEF] |
|--|---------------------------|---------------|
| | Supported Operation Types | S/I/S/E |
| Service Information with PS Information | | |
| <i>Access Line Identifier</i> | | SIS- |
| <i>Fixed User Location Information</i> | | SIS- |

D.4.3.3 Detailed message format for online charging

The supported fields in table 6.3.3.1 for the PS online charging message shall apply to the TDF and the IP-Edge [PCEF] for the applicable fields, with the difference that P-GW is replaced by IP-Edge [PCEF], and the table is extended with additional table D.4.3.3.1 fields:

Table D.4.3.3.1: Additional supported fields in Debit / Reserve Units Request message

| Information Element | Node Type | IP-Edge[PCEF] |
|--|---------------------------|---------------|
| | Supported Operation Types | I/U/T/E |
| Service Information with PS Information | | |
| <i>Access Line Identifier</i> | | IUT- |
| <i>Fixed User Location Information</i> | | IUT- |

D.4.4 Bindings for offline charging

The mapping of the Diameter Accounting AVP to the CDR parameter for offline charging as specified in clause 6.5 shall apply to IPE-CDR/TDF-CDR parameters for applicable fields, and in addition:

Table D.4.4.1: Additional bindings of Accounting AVP to CDR parameter

| Diameter Accounting AVP | IPE-CDR/TDF-CDR parameter |
|--|---|
| <i>Logical-Access-ID, Physical-Access-ID</i> | Access Line Identifier |
| <i>Fixed-User-Location-Info</i> | Fixed User Location Information |
| <i>3GPP-PDP-Type</i> | IP-CAN session Type |
| <i>3GPP-GGSN-MCC-MNC</i> | IP-Edge Operator Identifier |
| <i>GGSN-Address</i> | IP-Edge Address used |
| <i>GGSN-Address</i> | IP-Edge Address IPv6 |
| <i>Subscription-Id</i> | Served Fixed Subscriber Id |
| <i>PDP-Address</i> | Served IP-CAN session Address |
| <i>PDP-Address</i> | Served IP-CAN session Address extension |

D.5 Charging Characteristics

The Charging Characteristics as specified in annex A.1 shall apply to the IP-Edge [PCEF] and TDF with the following modification:

- Only configured Charging Characteristics are applicable to IP-Edge [PCEF] and TDF
- When a CGF address is included, the IP-Edge [PCEF] shall apply it for the IPE-CDRs
- A set of trigger associated to IPE-CDR may be: activate/deactivate CDRs, time limit, volume limit, maximum number of charging conditions, tariff times, and an example is provided by Table A.1.3 with P-GW replaced by IP-Edge [PCEF].
- Charging Characteristics behaviour in IP-Edge [PCEF] is used for IPE-CDR generation and for online charging
- Default charging method negotiation between the PGW and the PCRF shall apply with P-GW replaced by IP-Edge [PCEF] and IP-CAN bearer replaced by IP-CAN session.
 - The following may be selected by the IP-Edge [PCEF] or TDF for charging behaviour, as appropriate:-
 - The Home behaviour, for 3GPP UE belonging to same PLMN as the IP-Edge [PCEF] or TDF respectively.
 - The Visiting behaviour, for 3GPP UE belonging to a different PLMN than the IP-Edge [PCEF] or TDF respectively.
 - The Fixed behaviour for Fixed users.

Annex E (informative): Change history

| Change history | | | | | | | | | |
|----------------|-------|-----------|------|-----|---|-----|-------|-------|-----------|
| Date | TSG # | TSG Doc. | CR | Rev | Subject/Comment | Cat | Old | New | Work Item |
| Sep 2007 | SP-37 | SP-070619 | 0061 | -- | Add service specific charging information for extended packet inspection - Align with 23.203 | C | 7.5.0 | 8.0.0 | |
| Oct 2007 | -- | -- | -- | -- | Correction of typo on previous line of history table | -- | 8.0.0 | 8.0.1 | |
| Mar 2008 | SP-39 | SP-080060 | 0062 | -- | Align with the Rel-8 EPC architecture - Align with stage 2 in 23.401/23.402 | B | 8.0.1 | 8.1.0 | EPC-CH |
| Mar 2008 | SP-39 | SP-080060 | 0063 | -- | Enhance the PS architecture to correspond with the Rel-8 EPC architecture - Align with stage 2 in 23.401/23.402 | B | 8.0.1 | 8.1.0 | EPC-CH |
| Jun 2008 | SP-40 | SP-080274 | 0064 | -- | Impact on Charging trigger for EPC Charging | B | 8.1.0 | 8.2.0 | EPC-CH |
| Sep 2008 | SP-41 | SP-080462 | 0065 | -- | Alignment on Bx interface | D | 8.2.0 | 8.3.0 | EPC-CH |
| Sep 2008 | SP-41 | SP-080462 | 0066 | -- | Impact on Charging trigger for EPC Charging | B | 8.2.0 | 8.3.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0069 | - | Correction on CDR generation for EPC Charging | F | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0070 | - | EPC Offline Charging architecture - Alignment with TS 23.060 | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0071 | - | Clarification on Charging Characteristics for EPC Charging | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0074 | - | TS 32.251 small refinements on PS Online Charging parameters for non-3GPP access consideration. | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0076 | - | TS 32.251 PS offline charging - basic principles description enhanced for Rf consideration | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0077 | - | TS 32.251 PS offline charging- Rf message flows description for S-GW and P-GW | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0078 | - | Enhancement of Offline Charging Architecture for EPC Charging | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0079 | - | Correction on CDR data tables for EPC Charging | C | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0081 | - | TS 32.251 PS offline charging - data description for Rf messages content | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0082 | - | TS 32.251 PS offline charging - PS information description extension for EPC offline charging | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0083 | - | Addition of Rf interface on S-GW and P-GW | B | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080852 | 0084 | - | Addition of non-3GPP access information for EPC Online Charging | C | 8.3.0 | 8.4.0 | EPC-CH |
| Dec 2008 | SP-42 | SP-080841 | 0073 | - | Correction on Multiple Service Indicator category | A | 8.3.0 | 8.4.0 | CH7 |
| Dec 2008 | SP-42 | SP-080706 | 0080 | - | Add Serving Node Type to PS domain charging | B | 8.3.0 | 8.4.0 | CH8 |
| Mar 2009 | SP-43 | SP-090206 | 0086 | - | PS offline charging - Rf description refinements for EPC offline charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0087 | - | PS offline charging - Refinements on PGW CDR content description and PS-information description | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0088 | - | Clarifications on EPC charging | C | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0089 | - | User Location description enhancement for complying to EPC context | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0090 | - | Correction of QoS handling in EPC Charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0091 | - | Refinements on SGW CDR content description | C | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0092 | - | Subscription identifier added in "service information" description for EPS offline charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0093 | - | Node-Functionality use for Rf in EPC charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0094 | - | Non-3GPP access "CDMA2000 HRPD access" information in EPC charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0095 | - | Mapping ACR to CDR in EPC charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0096 | - | Missing information in PS information for SGW/PGW CDRs in EPS offline charging | B | 8.4.0 | 8.5.0 | EPC-CH |

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|----------|-------|-----------|------|---|--|---|--------|--------|---------------|
| Mar 2009 | SP-43 | SP-090206 | 0097 | - | Add new chargeable events to IP-CAN bearer charging | B | 8.4.0 | 8.5.0 | EPC-CH |
| Mar 2009 | SP-43 | SP-090206 | 0098 | - | SGW CDR and PGW CDR fields description refinement for fields applicable to GPRS only | B | 8.4.0 | 8.5.0 | EPC-CH |
| Jun 2009 | SP-44 | SP-090432 | 0099 | - | Correction on Serving Node Address | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0100 | - | Add missing symbols and abbreviations for EPC | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0101 | - | Remove generic "Non 3GPP specific information" parameter | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0102 | - | Clarify "IP-CAN bearer Charging" is achieved by "Flow Based Charging" in P-GW | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0103 | - | Clarify the SGSN Charging description applies to SGSN with Gn/Gp connectivity only | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0104 | - | "Mobile Node Identifier" used for PMIP S5/S8 and S2a/S2b | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0105 | - | Alignment between PS-information used for offline charging and SGW / PGW CDRs | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090432 | 0106 | - | Correction on EPC Charging | F | 8.5.0 | 8.6.0 | CH8 |
| Jun 2009 | SP-44 | SP-090296 | 0107 | - | MBMS charging in EPS alignment in MBMS context charging principle | B | 8.6.0 | 9.0.0 | MBMS_EPS |
| Jun 2009 | SP-44 | SP-090296 | 0108 | - | MBMS charging in EPS alignment in MBMS bearer context charging data | B | 8.6.0 | 9.0.0 | MBMS_EPS |
| Sep 2009 | SP-45 | SP-090541 | 0109 | - | CR 32.251 Add IP multicast distribution address in eMBMS charging | B | 9.0.0 | 9.1.0 | MBMS_EPS |
| Sep 2009 | SP-45 | SP-090536 | 0111 | - | Correction for Supported fields in Accounting Request and Response Messages | A | 9.0.0 | 9.1.0 | CH8 |
| Sep 2009 | SP-45 | SP-090541 | 0112 | - | Add MBMS-GW-CDR to basic principles for PS domain offline charging scenarios | F | 9.0.0 | 9.1.0 | MBMS_EPS |
| Sep 2009 | SP-45 | SP-090536 | 0114 | - | Correction on Qos handling in PS information for EPS | A | 9.0.0 | 9.1.0 | CH8 |
| Sep 2009 | SP-45 | SP-090536 | 0116 | - | Correction on Charging Characteristics description | A | 9.0.0 | 9.1.0 | CH8 |
| Sep 2009 | SP-45 | SP-090536 | 0118 | - | Correction on Charging Characteristics forwarding from MME | A | 9.0.0 | 9.1.0 | CH8 |
| Sep 2009 | SP-45 | SP-090536 | 0120 | - | Correction on supported fields for Credit-Control Request/answer for Online Charging | A | 9.0.0 | 9.1.0 | CH8 |
| Sep 2009 | SP-45 | SP-090537 | 0121 | - | Emergency bearer service consideration for charging | B | 9.0.0 | 9.1.0 | CH9 |
| Dec 2009 | SP-46 | SP-090720 | 0123 | - | PLMN RAT Change removed as conditions for "List of Service Data" | A | 9.1.0 | 9.2.0 | CH8 |
| Dec 2009 | SP-46 | SP-090720 | 0125 | - | Removal of forwarding CGF Address to S4-SGSN from S-GW | A | 9.1.0 | 9.2.0 | CH8 |
| Dec 2009 | SP-46 | SP-090720 | 0127 | - | Re-align Charging description for S4-SGSN | A | 9.1.0 | 9.2.0 | CH8 |
| Dec 2009 | SP-46 | SP-090721 | 0128 | - | Add user CSG information to the CDR | B | 9.1.0 | 9.2.0 | CH8 |
| Mar 2010 | SP-47 | SP-100039 | 0131 | - | Correction to PS Online Charging service context - Alignment with TS 32.299 | A | 9.2.0 | 9.3.0 | CH7 |
| Mar 2010 | SP-47 | SP-100040 | 0133 | - | Correction for "Charging Characteristics Selection Mode" parameter for Rf | A | 9.2.0 | 9.3.0 | CH8 |
| Mar 2010 | SP-47 | SP-100040 | 0135 | - | Clarify "Change Condition" settings in PS-information for offline Charging | A | 9.2.0 | 9.3.0 | CH8 |
| Mar 2010 | SP-47 | SP-100041 | 0136 | - | PLMN and RAT Change removed as conditions for "List of Service Data" | F | 9.2.0 | 9.3.0 | CH9 |
| Mar 2010 | SP-47 | SP-100040 | 0139 | - | Correction for offline Charging from PGW for 3GPP2 User location | A | 9.2.0 | 9.3.0 | CH8 |
| Mar 2010 | SP-47 | SP-100043 | 0140 | - | Add definitions, abbreviations and requirements for SIPTO charging to TS 32.251 | B | 9.3.0 | 10.0.0 | LIPA_SIPTO-CH |
| Mar 2010 | SP-47 | SP-100042 | 0141 | - | Add Originating Address in S-SMT-CDR | B | 9.3.0 | 10.0.0 | CH10 |
| Jun 2010 | SP-48 | SP-100267 | 0142 | - | Small Corrections in Text of Descriptions | D | 10.0.0 | 10.1.0 | CH10 |
| Sep 2010 | SP-49 | SP-100495 | 0150 | - | Correction on Charging Rule Based Name - Alignment with TS 23.203 | A | 10.1.0 | 10.2.0 | CH7 |
| Sep 2010 | SP-49 | SP-100496 | 0146 | - | Correction for Dual IP addresses associated to one PDN connection | A | 10.1.0 | 10.2.0 | CH8 |
| Sep 2010 | SP-49 | SP-100499 | 0143 | - | Improve PGW Charging description for WLAN access via ePDG/S2b | B | 10.1.0 | 10.2.0 | IFOM |

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|----------|-------|-----------|------|---|---|---|--------|--------|------------|
| Sep 2010 | SP-49 | SP-100499 | 0151 | - | Charging Identifiers description - simultaneous PDN connections through different access networks | B | 10.1.0 | 10.2.0 | IFOM |
| Dec 2010 | SP-50 | SP-100759 | 0153 | 2 | Clarifications on Charging Characteristics | F | 10.2.0 | 10.3.0 | CH10 |
| Dec 2010 | SP-50 | SP-100760 | 0154 | 2 | Adding PGW Charging description for Non-3GPP access via GTP based ePDG/S2b - Align with TS 23.402 | B | 10.2.0 | 10.3.0 | IFOM |
| Dec 2010 | SP-50 | SP-100760 | 0155 | 2 | Adding IP Flow Mobility (IFOM) Charging principle description - Align with SA2 TS 23.261 | B | 10.2.0 | 10.3.0 | IFOM |
| Mar 2011 | SP-51 | SP-110107 | 0160 | 2 | Correcting the condition to deliver SGW-CDR | A | 10.3.0 | 10.4.0 | CH8 |
| Mar 2011 | SP-51 | SP-110105 | 0156 | 3 | Adding CDR fields needed for Machine Type Communication | B | 10.3.0 | 10.4.0 | NIMTC-CH |
| Mar 2011 | SP-51 | SP-110099 | 0161 | 2 | Adding LIPA SIPTO charging description | B | 10.3.0 | 10.4.0 | LIPA_SIPTO |
| Mar 2011 | SP-51 | SP-110109 | 0163 | 1 | Clarification on forwarding of Charging Characteristics Information Elements | F | 10.3.0 | 10.4.0 | CH10 |
| Mar 2011 | SP-51 | SP-110110 | 0164 | 1 | Adding IP Flow Mobility (IFOM) Charging principle description when PCC is not deployed | B | 10.3.0 | 10.4.0 | IFOM |
| Mar 2011 | SP-51 | SP-110110 | 0165 | - | Add description for User Plane from the PGW for S2b interface | B | 10.3.0 | 10.4.0 | IFOM |
| May 2011 | SP-52 | SP-110404 | 0168 | 1 | Correction of Charging Functionalities For Standalone GGSN | A | 10.4.0 | 10.5.0 | CH8 |
| May 2011 | SP-52 | SP-110281 | 0169 | 1 | Correction of RAT-Type AVP, alignment with TS 29.212, Gx interface | F | 10.4.0 | 10.5.0 | CH10 |
| May 2011 | SP-52 | SP-110404 | 0172 | 1 | Correction on essential supported fields in EPC Online Charging | A | 10.4.0 | 10.5.0 | CH8 |
| May 2011 | SP-52 | SP-110404 | 0175 | 1 | Correction on Rf interface for missing information in SGW CDR | A | 10.4.0 | 10.5.0 | CH8 |
| May 2011 | SP-52 | SP-110280 | 0177 | 1 | Clarification on forwarding of Charging Characteristics for inter-RAT | A | 10.4.0 | 10.5.0 | CH9 |
| Sep 2011 | SP-53 | SP-110528 | 0180 | 1 | Correction on PDN connection identifier for Charging | A | 10.5.0 | 10.6.0 | CH8 |
| Sep 2011 | SP-53 | SP-110528 | 0183 | - | Correction for dynamic address flags associated to PDN connection of PDP/PDN type IPv4v6 | A | 10.5.0 | 10.6.0 | CH8 |
| Sep 2011 | SP-53 | SP-110528 | 0186 | - | Correction on RAT Type - Align with CT3 TS 29.061 | A | 10.5.0 | 10.6.0 | CH8 |
| Sep 2011 | SP-53 | SP-110530 | 0196 | - | Correction on Charging identifiers description | F | 10.5.0 | 10.6.0 | CH10 |
| Sep 2011 | SP-53 | SP-110541 | 0195 | 1 | Addition of Sponsored Data Connectivity charging – Align with TS 23.203 | B | 10.6.0 | 11.0.0 | PEST-CH |
| Dec 2011 | SP-54 | SP-110708 | 0213 | 2 | Add clarification for control plane address used in IP-CAN Bearer charging | A | 11.0.0 | 11.1.0 | CH8 |
| Dec 2011 | SP-54 | SP-110708 | 0217 | 1 | Correction on PDP/PDN Address definition - Alignment with TS 23.401 | A | 11.0.0 | 11.1.0 | CH8 |
| Dec 2011 | SP-54 | SP-110708 | 0221 | - | Correction of Dynamic Address Flag usage for IPv4v6 PDN Connection in PS Information AVP | A | 11.0.0 | 11.1.0 | CH8 |
| Dec 2011 | SP-54 | SP-110710 | 0212 | - | Correction on duplicated parameters in S/P-GW CDR description | A | 11.0.0 | 11.1.0 | CH10 |
| Dec 2011 | SP-54 | SP-110710 | 0226 | - | Correction on PDP/PDN Address definition - Alignment with TS 23.40 | A | 11.0.0 | 11.1.0 | CH10 |
| Mar 2012 | SP-55 | SP-120048 | 0228 | 1 | Clarification on "SGSN change" for SGW in EPC Charging | A | 11.1.0 | 11.2.0 | CH10 |
| Jun-2012 | SP-56 | SP-120362 | 0229 | - | Correction to PS architecture with ePDG introduction - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120362 | 0230 | - | Correction to PS charging principles with ePDG introduction - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120362 | 0231 | - | Correction to PS charging with ePDG Rf charging introduction - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120362 | 0232 | - | Correction to PGW charging with ePDG as serving Node - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120362 | 0233 | - | Correction to PS charging with ePDG CDR generation description - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120365 | 0234 | 1 | Correction of charging information for MTC devices | C | 11.2.0 | 11.3.0 | SIMTC-CH |
| Jun-2012 | SP-56 | SP-120361 | 0236 | 2 | Correction of the structure of Diameter ACA message for S-GW and P-GW | A | 11.2.0 | 11.3.0 | CH10 |
| Jun-2012 | SP-56 | SP-120362 | 0237 | 1 | Clarification of visiting case description in Charging Characteristics in the S-GW | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120360 | 0240 | 1 | Correction on SGW and PGW Address reporting, alignment with 29.212 | A | 11.2.0 | 11.3.0 | CH9 |
| Jun-2012 | SP-56 | SP-120362 | 0241 | 1 | Correction of the CDR generation on Ga | F | 11.2.0 | 11.3.0 | CH11 |

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| Jun-2012 | SP-56 | SP-120362 | 0242 | | Correction to Charging Characteristics conveyance for Ro when serving Node is ePDG | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120362 | 0243 | 1 | Correction to PS charging with ePDG charging (CDR, Rf) description - Alignment with 23.402 | F | 11.2.0 | 11.3.0 | CH11 |
| Jun-2012 | SP-56 | SP-120365 | 0244 | 1 | Introduction of MME in PS Charging architecture for MTC | B | 11.2.0 | 11.3.0 | SIMTC-CH |
| Jun-2012 | SP-56 | SP-120365 | 0245 | 1 | Introduction of MME offline charging for SMS | B | 11.2.0 | 11.3.0 | SIMTC-CH |
| Jun-2012 | SP-56 | SP-120360 | 0248 | 1 | Rel-11 CR 32.251 Correction of IMSI Unauthenticated Flag usage in PS charging | A | 11.2.0 | 11.3.0 | CH9 |
| Sep-2012 | SP-57 | SP-120566 | 0250 | 1 | Alignment with the PCC defined in TS 23.203 | F | 11.3.0 | 11.4.0 | CH11 |
| Sep-2012 | SP-57 | SP-120566 | 0251 | 1 | Correction on Supported fields in Accounting Request Message | F | 11.3.0 | 11.4.0 | CH11 |
| Sep-2012 | SP-57 | SP-120568 | 0252 | 2 | Triggers for SMS offline charging from MME | B | 11.3.0 | 11.4.0 | SIMTC-CH |
| Sep-2012 | SP-57 | SP-120568 | 0253 | 2 | SMS CDRs description for SMS in MME | B | 11.3.0 | 11.4.0 | SIMTC-CH |
| Sep-2012 | SP-57 | SP-120627 | 0254 | 1 | Reference list correction to align with the corrected TS 29.212 title | F | 11.3.0 | 11.4.0 | TEI11 |
| Dic-2012 | SP-58 | SP-120792 | 0256 | 3 | R11 CR 32251 Introduction Rf description for Offline Charging for SMS in MME | B | 11.4.0 | 11.4.1 | SIMTC-CH |
| Dic-2012 | SP-58 | SP-120788 | 0260 | 1 | R12 CR 32.251 correction on data volume counters requirements | C | 11.4.1 | 12.0.0 | CH12 |
| Mar-2013 | SP-59 | SP-130054 | 0263 | 1 | Introduction of Charging for access to Trusted WLAN Access Network in EPC - over S2a - Alignment with TS 23.402 | A | 12.0.0 | 12.1.0 | CH11 |
| Jun-2013 | SP-60 | SP-130270 | 0265 | 1 | Correction on SSID availability in TWAN User Location | A | 12.1.0 | 12.2.0 | CH11 |
| | | SP-130273 | 0269 | 1 | Correction for use of Charging Characteristics for SMS in MME | A | | | SIMTC-CH |
| | | SP-130271 | 0272 | 1 | Adjustment on IMEI - alignment to TS 29.274 | F | | | CH12 |
| | | SP-130317 | 0274 | 1 | Adding CDR fields needed for MTC | A | | | NIMTC-CH |
| | | SP-130270 | 0277 | - | Binding of TWAN User Location Info and Serving Node Type to Diameter AVP | A | | | CH11 |
| | | SP-130276 | 0279 | 1 | Introduction of the principle for TDF supporting application based charging | B | | | ABC |
| Sep-2013 | SP-61 | SP-130436 | 0280 | 1 | skeleton for ABC modification of 32251 | B | 12.2.0 | 12.3.0 | ABC |
| | | SP-130436 | 0281 | 1 | Adding new symbols and abbreviations for ABC | B | | | ABC |
| | | SP-130436 | 0282 | 1 | Introduction of the architecture for supporting application based charging | B | | | ABC |
| | | SP-130436 | 0283 | 1 | charging information collected for ABC | B | | | ABC |
| | | SP-130435 | 0287 | - | on retransmission indication in PS CDRs | F | | | CH12 |
| | | SP-130442 | 0288 | 1 | Introduction of Scope and abbreviations Charging PCEF located in Fixed Broadband access | B | | | P4C-F-CH_P |
| | | SP-130442 | 0289 | 1 | Introduction IP-Edge (PCEF) Charging Offline and Online Charging architectures | B | | | P4C-F-CH_P |
| | | SP-130442 | 0290 | 1 | Introduction IP-Edge (PCEF) Charging High level requirements | B | | | P4C-F-CH_P |
| SP-130436 | 0291 | - | Addition of TDF on Rf and Ro | B | ABC | | | | |
| Dic 2013 | SP-62 | SP-130620 | 0294 | 1 | Triggers for application based online charging in TDF | B | 12.3.0 | 12.4.0 | ABC |
| | | SP-130616 | 0300 | - | Correction on Serving Node PLMN description in EPC CDRs for Network Sharing | A | | | CH8 |
| | | | 0305 | 1 | Correction on Serving Node MCC MNC description in PS information for Network Sharing | A | | | CH8 |
| | | SP-130625 | 0310 | 2 | Full applicability of TDF based charging requirements in case of Fixed Broadband Access scenario | B | | | P4C-F-CH_T |
| | | SP-130620 | 0311 | 2 | Requirements for Application Based Charging functionality | B | | | ABC |
| | | SP-130626 | 0312 | 1 | Refinement on Charging architecture description for PCEF located in IP-Edge | B | | | P4C-F-CH_P |
| | | | 0313 | 2 | Introduce Charging principles and additional requirements for PCEF located in IP-Edge | B | | | |
| | | | 0314 | 1 | Introduction of Charging Information - PCEF located in Fixed Broadband access | B | | | |
| 0315 | 2 | | Introduction of Offline Charging scenarios - PCEF located in Fixed Broadband access | B | | | | | |

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| | | | 0316 | 2 | Introduction of Online Charging scenarios - PCEF located in Fixed Broadband access | B | | | |
| | | SP-130620 | 0317 | 2 | Online charging principles of application based charging | B | | | ABC |
| | | | 0318 | 2 | Offline charging principles of application based charging | B | | | |
| | | | 0320 | 1 | Addition of Charging Characteristics for TDF | B | | | |
| | | SP-130618 | 0321 | - | Correction for User Location Info Time | A | | | CH11 |
| | | SP-130626 | 0323 | 1 | Introduction of Rf and CDR triggers for Offline Charging - PCEF located in Fixed Broadband access | B | | | P4C-F-CH_P |
| | | | 0324 | 1 | Introduction of Ro triggers for Online Charging - PCEF located in Fixed Broadband access | B | | | |
| | | SP-130616 | 0329 | - | Correction for use of Destination-Host AVP in ACR | A | | | CH8 |
| | | SP-130620 | 0330 | 1 | Addition of requirements for Application Based Charging functionality | B | | | ABC |
| | | | 0332 | 1 | Addition of TDF specific charging information to support application based charging | B | | | |
| | | SP-130622 | 0338 | 1 | Charging principles for Charging per IP-CAN Session | B | | | CHIPS |
| | | SP-130616 | 0339 | 2 | Correction on missing Serving Network in PS CDRs for Network Sharing | A | | | CH8 |
| Mar-2014 | SP-63 | SP-140036 | 0340 | 1 | Requirements and parameters alignment for application based charging | B | 12.4.0 | 12.5.0 | ABC |
| | | SP-140154 | 0341 | 1 | Introduction of TDF/ABC description and alignment within the the normative Annex for fixed broadband access | B | | | P4C-F-CH_T, P4C-F-CH_P |
| | | SP-140034 | 0343 | 1 | Application based charging in case of PCEF enhanced with ADC - alignment with TS 23.203 | A | | | CH11 |
| | | SP-140044 | 0348 | 1 | Correction for Partial Record Closure Reason in MBMS-EPS Charging | A | | | MBMS_EPS |
| | | SP-140038 | 0351 | 1 | Correction on use of rating group for CHIPS | F | | | CHIPS |
| | | SP-140042 | 0353 | - | Correction of CDR generated for SMS in the MME | A | | | SIMTC-CH |
| | | SP-140040 | 0354 | 1 | Use of Bp Reference Point for CDR files transfer | B | | | P4C-F-CH_P |
| | | | 0355 | 1 | Add requirements and clarify miscellaneous charging information | B | | | |
| | | | 0356 | 1 | Introduce IPE-CDR description and PS Charging information | B | | | P4C-F-CH_P, P4C-F-CH_T |
| | | SP-140036 | 0359 | - | Add support for TDF into Failure Situations | B | | | ABC |
| | | SP-140036 | 0360 | - | Requirements and parameters alignment for application based charging for online scenarios | B | | | |
| Jun-2014 | SP-64 | SP-140337 | 0360a | 1 | Requirements and parameters alignment for application based charging | B | 12.5.0 | 12.6.0 | ABC |
| | | SP-140340 | 0361 | 1 | Completion of TDF related requirements for Fixed Broadband Access | B | | | P4C-F-CH_T, P4C-F-CH_P |
| | | SP-140341 | 0362 | 1 | Complete Identifiers used for Charging in Convergent scenario | B | | | P4C-F-CH_P, P4C-F-CH_T |
| | | | 0363 | 1 | Introduce Binding for IPE-CDR | B | | | |
| | | | 0364 | 1 | Introduce IP-CAN session Charging description | B | | | |
| | | SP-140339 | 0365 | 1 | Completion of charging per IP-CAN session in PS domain | B | | | CHIPS |
| | | SP-140334 | 0370 | 1 | Removal of IMS charging identifier from PGW CDR and command level online charging messages | A | | | CH8 |
| | | SP-140336 | 0372 | 1 | Introduce Core Network Operator selection origin for Shared Networks | B | | | CH12 |
| | | SP-140337 | 0373 | 1 | Credit Control Failure Handling for TDF | F | | | ABC |
| | | SP-140339 | 0374 | - | Inter-level correlation clarification for CHIPS | B | | | CHIPS |
| | | SP-140341 | 0376 | 1 | Introduce IP-CAN session Offline Charging description | B | | | P4C-F-CH_P |
| | | SP-140341 | 0377 | - | Introduce Traffic Data Volumes in IPE-CDR description | B | | | P4C-F-CH_P |
| 2014-07 | - | - | - | - | Rapporteur/MCC: General editorial changes and clean-up. | - | 12.6.0 | 12.6.1 | - |
| 2014-09 | SP-65 | SP-140565 | 0378 | 1 | Introduction of Presence Reporting Areas for Charging | B | 12.6.1 | 12.7.0 | CNO_ULI-CH |
| | | SP-140564 | 0379 | 1 | Corrections for alignment between charging specifications | F | | | CH12 |
| | | SP-140563 | 0380 | 1 | Introduction of report the most up to date User Location Information | B | | | P4C-F-CH_P |
| | | SP-140567 | 0381 | 1 | Introduce Charging Characteristics in Convergent scenario | B | | | CH12 |
| | | SP-140563 | 0382 | 1 | Complete ePDG offline charging description | B | | | P4C-F-CH_P, P4C-F-CH_T |
| | | SP-140567 | 0383 | 1 | Corrections to include missing fixed user location information for NSWO | F | | | |

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|--|--|---------------|------|---|--|---|--|--|-------|
| | | SP- 140586 | 0384 | - | Minor corrections to CHIPS for clarification | F | | | CHIPS |
|--|--|---------------|------|---|--|---|--|--|-------|

History

| Document history | | |
|-------------------------|--------------|-------------|
| V12.7.0 | October 2014 | Publication |
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