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Technical Specification

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Packet Switched (PS) domain charging
(3GPP TS 32.251 version 8.10.0 Release 8)**



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Foreword

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Foreword

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1 Scope

The present document is part of a series of documents specifying charging functionality and charging management in Packet Switched networks (GSM/UMTS, EPS). The 3GPP core network charging architecture and principles are specified in 3GPP 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 these TSs is defined in 3GPP 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 3GPP TS 23.060 [201], 3GPP TS 23.401[208] and 3GPP TS 23.402 [209]. 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 (3GPP TS 23.078 [206] and 3GPP 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 3GPP TR 21.905 [100]. Those that are common across charging management in PS domains, services or subsystems are provided in the umbrella document 3GPP 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 3GPP TS 22.115 [102].

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] 3GPP TS 32.273: "Telecommunication management; Charging management; Multimedia Broadcast and Multicast Service (MBMS) charging".
- [33]- [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]- [69] Void.
- [70] Void.
- [71] 3GPP TS 29.212: "Policy and Charging Control over Gx reference point".
- [72] 3GPP TS 23.203: "Policy and Charging Control Architecture".
- [73]- [99] Void.
- [100] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

- [101] Void.
- [102] 3GPP TS 22.115 "Service aspects; Charging and billing".
- [103]- [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); 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); Stage 2".
- [207] 3GPP TS 23.246: "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description".
- [208] 3GPP TS 23.401: "GPRS Enhancements for E-UTRAN Access".
- [209] 3GPP TS 23.402: "Architecture enhancements for non-3GPP accesses".
- [210] 3GPP TS 29.274: "Evolved 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] - [400] Void.
- [401] IETF RFC 3588 (2003): "Diameter Base Protocol".
- [402] IETF RFC 4006: "Diameter Credit Control" Application
- [403] Void.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions defined in 3GPP TR 21.905 [100], 3GPP TS 32.240 [1] and 3GPP 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: 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 shall be 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 [8] for the definition of bearer.

IP-CAN session: The association between a UE represented by an IPv4 and/or an IPv6 address, 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 (charging) 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 3GPP TS 32.250 [10] to 3GPP TS 32.271 [31], e.g. 3GPP TS 32.250 [10] for the CS domain, or 3GPP 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 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 1 minute.

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: 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).

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

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 authorised 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 utilisation 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 User Equipment 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.

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-IW MSC 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. Iu Interface between the 3G SGSN and the UTRAN
Gy	Online charging reference point between a PCEF and an OCS.
Gz	Offline charging reference point between a PCEF and a CGF.
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 Mobile Station (MS) and the UMTS fixed network part.

3.3 Abbreviations

For the purposes of the present document, the abbreviations defined in 3GPP TR 21.905 [50] and the following apply:

3G	3 rd Generation
AoC	Advice of Charge
APN	Access Point Name
ARP	Allocation and Retention Priority
BD	Billing Domain
CAMEL	Customized 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
CTF	Charging Trigger Function
DCCA	Diameter Credit Control Application
EPC	Evolved Packet Core
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.
HLR	Home Location Register
HPLMN	Home PLMN
IEC	Immediate Event Charging
IETF	Internet Engineering Task Force
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 - Charging Data Record
MCC	Mobile Country Code (part of IMSI)
ME	Mobile Equipment
MLC	Mobile Location Center
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
OCF	Online Charging Function
OCS	Online Charging System
OI	Operator Identifier (part of the APN)
P-GW	PDN Gateway
PCEF	Policy and Charging Enforcement Function
PCN	Packet switched Core network Node (SGSN, S-GW, P-GW)
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
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
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
SMS	Short Message Service
S-SMO-CDR	SGSN delivered Short message Mobile Originated – CDR
S-SMT-CDR	SGSN delivered Short message Mobile Terminated – CDR
TR	Technical Report
TS	Technical Specification
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
UTRAN	UMTS Terrestrial Radio Access Network

4 Architecture considerations

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 standardised 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] and TS 23.402 [209].

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 P-GW, to record a user's access to external networks.
- the GGSN, to record a user's access to external networks.

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. Further details on the CGF can be found in TS 32.240 [1] and TS 32.297 [52].

Standalone GGSN utilizes Rel-7 GGSN Charging. When P-GW provides connectivity to GERAN/UTRAN (P-GW acts as a GGSN) it generates P-GW Charging defined in this specification.

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

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 Billing Domain.

If PCN generating the charging information has an integrated CDF, hence a physical 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 3GPP 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.

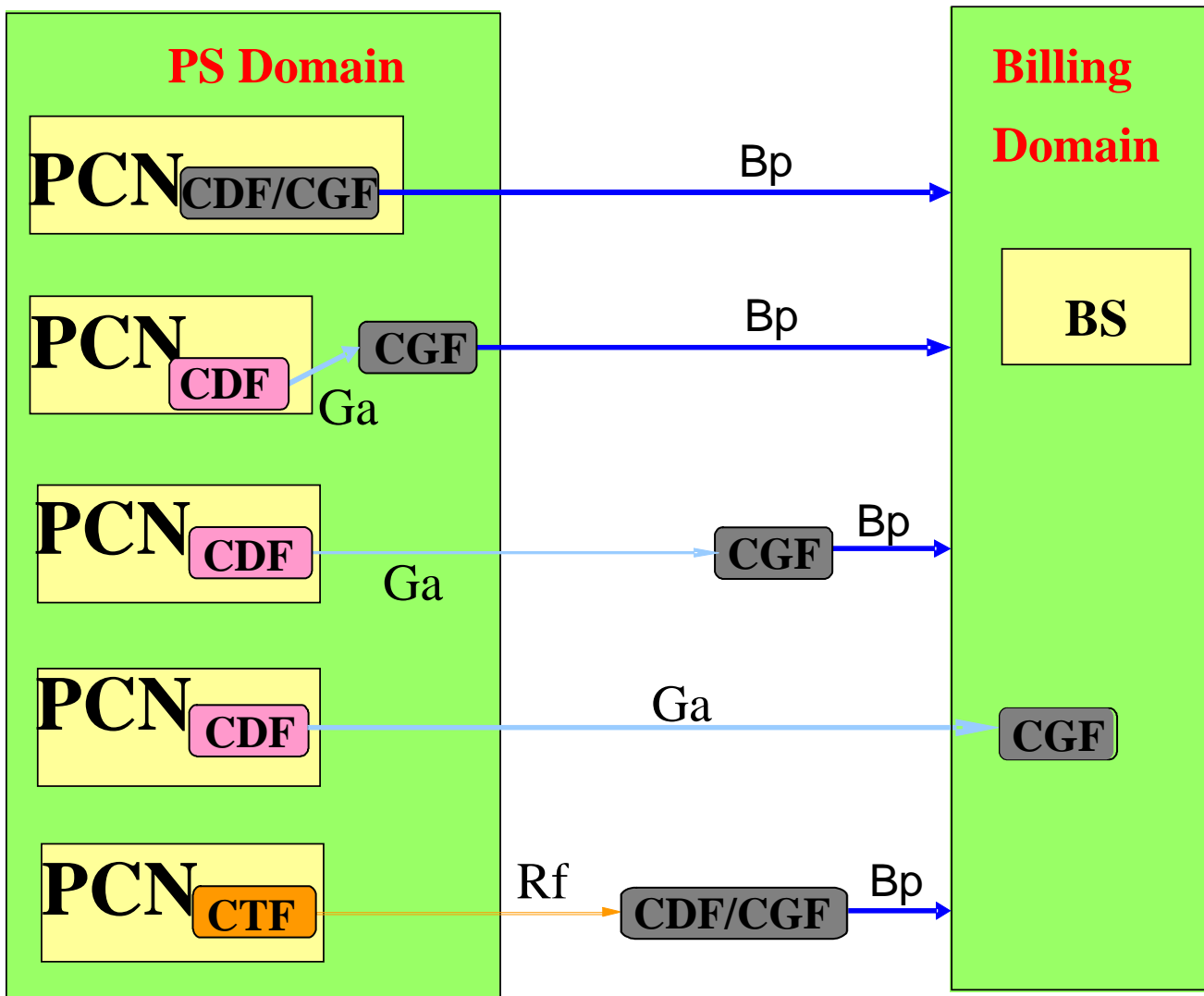


Figure 4.2-1: PS domain offline charging architecture

The P-GW does include 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 Rf, Ga and Bp interfaces include the required functionality, e.g. defined for the Gz reference point in TS 23.203 [72]. Refer to clause 5.2.1.3, TS 32.240 [1] and TS 23.203 [72] 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 [32], 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 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 3GPP TS 23.078 [206] and 3GPP 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 do contain 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.

PS domain online charging based on P-GW functions with included PCEF is specified in the present document, utilising the Ro interface and application as specified in TS 32.299 [50]. The reason for this alternative solution is that operators may enforce the use of HPLMN P-GWs in the case of roaming, hence P-GW service control and charging can be executed in the HPLMN in all circumstances. The P-GW based PS domain online charging architecture is depicted in figure 4.3-1.

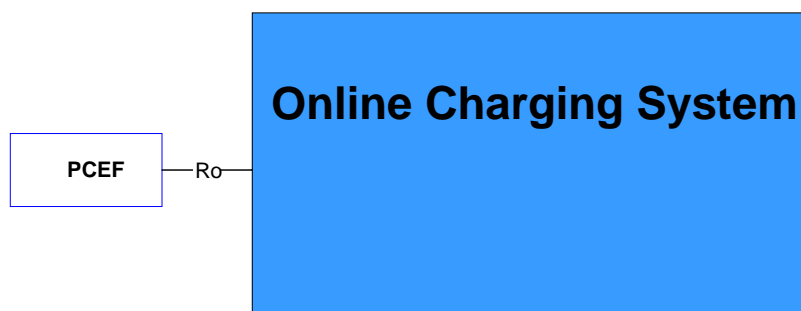


Figure 4.3-1: PS domain online charging architecture

The Ro reference point includes the functionality defined for the Gy reference point (required for the PCEF) in TS 23.203 [72]. Refer to clause 5.2.1.3, TS 32.240 [1] and TS 23.203 [72] 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

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];
- 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 within a IP-CAN bearer, refer to TS 23.203 [72].
- MBMS bearer contexts, refer to TS 23.246 [207] and TS 32.273 [32].

5.1.1 Requirements

The following are high-level charging requirements specific to the packet domain, derived from the requirements in 3GPP TS 22.115 [102], TS 23.060 [201], TS 23.401 [208], TS 23.402 [209] and TS 23.203 [72].

- 1) Every IP-CAN bearer shall be assigned a unique identity number for billing purposes. (i.e. the charging id).
- 2) Data volumes on both the uplink and downlink direction shall be counted separately. The data volumes shall reflect the data as delivered to and from the user.
- 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 Packet-Switched 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 or for subscribed IP-CAN bearer (i.e. per APN), 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, the credit control shall be per rating group.
- 12) P-GW shall allow reporting of the service usage per rating group or per combination of the rating group and service id. This reporting level can be activated per PCC 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 S5/S8 is used .
- 14) Charging support in the SGSN shall apply only for SGSN with Gn/Gp connectivity.

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, S-GWs and P-GWs, which are serving that MS/UE. The SGSN and S-GW collects charging information for each MS/UE related with the radio network usage, while the P-GW collects 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 Access Point Name (APN).
6. location of MS/UE: HPLMN, VPLMN, plus optional higher-accuracy location information.

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 amount of events and corresponding timestamps categorized by rating group or combination of the rating group and service id 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 [72];
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 Access Point Name (APN);
4. location information: the charging information shall describe a list of the downstream nodes being sent the MBMS bearer service.

5.2 PS domain offline charging scenarios

5.2.1 Basic principles

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 S-GW and P-GW shall be able to produce CDRs or report charging events for CDRs generation by CDF, for each of the following:

- Charging Data related to IP-CAN bearers in the SGSN (S-CDR), S-GW (SGW-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 and G-MB-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 3GPP TS 32.298 [51].

When the CDF is implemented as a separate entity (for the S-GW and the P-GW), 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, 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 S5/S8, 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/SGSN so as to allow correlation of S-GW/SGSN IP-CAN bearer CDRs with the matching P-GW CDRs in the BD.

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 and S-GW 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. 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.
 - SGSN to MME. The IP-CAN bearer CDR is closed in SGSN upon encountering this trigger. In S-GW a new MME 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 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. 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 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 [72] 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 [72], 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) change in the P-GW. New SGSN/S-GW 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), 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 3GPP TS 32.299 [50]. This event closes a service data flow container. Further details are described in "Triggers for PGW-CDR Charging Information Addition" (clause 5.2.3.4.1). 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.

Policy and Charging Control rule can contain e.g.:

- service data flow template (filters) 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,
- rating group for that service data flow,
- service id for that service data flow,
- 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.

Policy and Charging Control 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 [72] and TS 29.212 [71].

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.

5.2.1.4 SMS charging

The SGSN collects 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:

- the transfer of a SM through the SGSN in MO direction;
- the transfer of a SM through the SGSN 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

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.

Editor's note: The impact on MBMS Charging is how MBMS functions are allocated to functional entity/entities of the Evolved Packet System in TS 23.246.

5.2.2 Rf message flows

When the CDF is implemented as a separate entity, the offline charging functionality is based on the PCN nodes (S-GW and P-GW) reporting charging information for chargeable events. This reporting is achieved by sending Diameter *Accounting Requests* (ACR) [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 (Diameter *Accounting Requests* (ACR) [Start, Interim, Stop and Event]) reporting has to be activated or not.

The trigger conditions for the chargeable events described in 5.2.3.3 for the S-GW 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 S-GW and P-GW.

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 ACR closure.

Accounting request (Start) is sent at IP-CAN bearer activation.

For an Accounting 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, 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 5.2.3.4 are applicable for charging information addition and ACR closure.

Accounting request (Start) is sent at IP-CAN bearer activation.

For an Accounting 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

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 SGW-CDR by the S-GW and the PGW-CDR and G-MB-CDR by the P-GW 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, or HSS -> MME/ S4-SGSN -> S-GW -> P-GW), are specified 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 – 5.2.1.5. In EPC offline charging, these chargeable events correspond to the triggers for collection of charging information and CDR generation by the SGSN/S-GW/P-GW.

5.2.3.1 Triggers for S-CDR charging information collection

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 5.1 identifies which conditions are supported to trigger S-CDR charging information addition.

Table 5.1: 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.
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 identifies which conditions are supported to permit closure of the S-CDR.

Table 5.2: 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	O&M 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 O&M 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

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

Table 5.3: 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 5.4 identifies which conditions are supported to permit closures of the M-CDR.

Table 5.4: 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	O&M 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 O&M 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

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

Table 5.5: 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.
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. SGSN/MME) addresses. New serving node address is added to the list when e.g. SGSN/MME changes.

When Charging Event (ACR) is triggered by Table 5.5 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 5.6 identifies which conditions are supported to permit closure of the SGW-CDR.

Table 5.6: 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	O&M 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 O&M 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 5.6 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

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 S5/S8, 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 [72] 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 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 3GPP TS 32.299 [50]. Table 5.8 identifies conditions that may be supported as recording triggers under consideration of additional DCCA 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 5.8: 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 change, user location change) 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 DCCA tariff time change from OCS is supported.
DCCA Failure-Handling procedure triggering	When the Diameter 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 DCCA 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 3GPP 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 addresses. New SGSN/S-GW address is added to the list when SGSN/S-GW changes.

When Charging Event (ACR) is triggered by Table 5.8 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	O&M 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 O&M 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 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. If, according to the Charging Characteristics, CDR generation is activated a S-SMO-CDR shall be created when the SGSN 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. If, according to the Charging Characteristics, CDR generation is activated a S-SMT-CDR shall be created when the SGSN has successfully forwarded a SM 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. Equivalent charging functionality for the CS domain is specified in TS 32.250 [10]. 3GPP standards 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

Editor's note: The impact on MBMS Charging is ffs how MBMS functions are allocated to functional entity/entities of the Evolved Packet System in TS 23.246.

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

Table 5.9: 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 5.10.

Table 5.10: 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	O&M 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.

5.2.4 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

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 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 Credit Control Requests (CCR) and Credit Control Answers (CCA) 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 subclauses. A detailed formal description of the online charging parameters defined in the present document is to be found in 3GPP 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.

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 Gn/S5/S8 interface. Time metering is started when IP-CAN bearer is activated.

NOTE: P-GW is aware of bearers in case of GTP based S5/S8. In case of PMIP based S5/S8, 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.

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 [72] 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 have the possibility to output service specific information related to the packet inspection in the online charging information.

According to TS 23.203 [72], 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 [72] and 23.060 [201], upon encountering this event, a CCR initial, indicating the request for activation of dedicated IP-CAN bearer is sent toward the OCS.
- Start of IP-CAN bearer. Upon encountering this event, a CCR 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 CCR update, when the PCEF receives an Update PDP Context Request message with the RAN Procedures Ready flag. PCEF may request quota later when service usage is started.
- Start of service data flow. In case valid quota does not exist a CCR update is generated to request quota. 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 CCR update.
- End of IP-CAN bearer. Upon encountering this event, a CCR termination, 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 CCR update is triggered according the rules defined in TS 32.299 [50].
- Change of charging condition: E.g. QoS change, user location 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 CCR 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.

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.

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. The information can be sent per online session and in case FBC is enabled for a specific APN, the OCS online charging function may also sent specific information per each online charged service by means this procedure.

5.3.1.4 Support of Failure Situations

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

Three different actions are described in [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 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 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 is established (new sessions) or not released (ongoing sessions). Failover for ongoing sessions is supported. Failover for new sessions is always supported.

In both cases, if the user is simultaneously online and offline charged, the failure situation shall be registered in the PGW-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 is opened.

5.3.2 Ro message flows

CCR initial, update and termination, as defined in TS 32.299 [50], are used by the P-GW to transfer the collected charging information towards the OCS. CCA 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.

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

The P-GW 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), 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 clause 5.3.1.1 and 5.3.1.2. In FBC online charging, these chargeable events correspond to the triggers for collection of charging information and CCR emission towards the OCS. The responses from the OCS and the detailed behaviour of the PCEF upon receiving those responses are also specified in the subclauses 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

CCR initial / update / termination is used to convey charging information related to the IP-CAN bearer and service data flows collected in the PCEF. CCA 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 CCR includes details such as CCR Type, Served IMSI, Sequence Number etc. The CCA 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 AVP value. The quota supervision mechanism is further described in TS 32.299 [50]. Details on FBC can be found in TS 23.203 [72] and TS 29.212 [71].

CCR 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 CCR 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 CCR update with Reporting-Reason AVP value set to RATING_CONDITION_CHANGE together with Trigger-Type AVP indicating the accurate reason for the change.

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 CCR 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 AVP is used within the Used-Service-Units AVP 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 AVP and possible values are TERMINATE and REDIRECT. See TS 32.299 [50] for further information.

TS 23.203 [72] specifies that it shall be possible to request online charging quotas for each charging key. Each quota allocated to a Diameter CC session has a unique Rating-Group AVP value. TS 23.203 [72] 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 [72] the service identifier is a piece of information which provides the most detailed identification, specified for flow based charging, of a service data flow. The charging key is a piece of information used for rating purposes as defined in TS 23.203 [72]. The charging key and Service Identifier are mapped into the Rating-Group AVP and the Service-Identifier AVP respectively as defined in DCCA [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

CCR initial is sent to OCS when IP-CAN bearer is activated. For network requested dedicated IP-CAN bearer activation, the CCR 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.

CCR 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

CCR update is sent to OCS when:

- User starts to use certain service
- Active service is removed from the allowed services (e.g. charging rule is removed)
- Granted quota runs out
- Validity time for granted quota expires
- Update is requested by the OCS
- Change of charging conditions occur and according re-authorization trigger re-authorization 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.

5.3.2.3 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 by means of the Diameter Credit Control Application in the Ro interface. The data can be sent either in one Diameter Credit Control *Credit-Control-Answer* message or several Diameter Credit Control *Credit-Control-Answer* 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.

This procedure can only apply when online and offline charging is performed simultaneously for the same session (IP-CAN bearer) or rating group. In any other case, the P-GW shall discard the additional charging information sent by the OCS in the Diameter Credit Control *Credit-Control-Answer* messages.

When the OCS sends session specific charging information, it must send the "PS-Furnish-Charging-Information" AVP at command level in the *Credit-Control-Answer* message. 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" AVP at MSCC level in the *Credit-Control-Answer* message. In this case, the information is added to the specific service container in the PGW-CDR.

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

5.3.2.4 Support of Failure Situations

In case the OCS fails the P-GW must support the Failure Handling procedure and Failover mechanism described in 3GPP TS 32.299 [50].

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

According to 3GPP TS 32.299 [50], timer Tx determines the maximum interval the P-GW shall wait for an answer to each credit control request sent to the OCS. In case FBC is enabled, it is possible that several concurrent Credit Control Request messages are triggered for the same online charging session. In this case, each Credit Control Request message shall reset the Tx timer. When Tx expires, P-GW shall execute the Failover and Failure Handling mechanisms according to the behaviour described in Annex B.

Three different actions are described in [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 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 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 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.

In case the user is simultaneously online and offline charged, the failure situation must be registered in the PGW-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 is opened.

6 Definition of charging information

6.1A Rf message content

This chapter is applicable to the S-GW and P-GW, when the CDF is provided as an external entity.

6.1A.1 Summary of Offline Charging Message Formats

The PS Offline Charging uses the Diameter Base Protocol [401] messages *Accounting-Request* (ACR) and *Accounting-Answer* (ACA) defined in TS 32.299 [50].

The ACR can be of type start, stop, interim and event and includes all charging information. The ACA is an acknowledgement of the ACR.

The following table describes the use of these messages for offline charging.

Table 6.1A.1 : Offline Charging Messages Reference Table

Command-Name	Source	Destination	Abbreviation
Accounting-Request	S-GW,P-GW	CDF	ACR
Accounting-Answer	CDF	S-GW, P-GW	ACA

6.1A.2 Structure for the Accounting Message Formats

This clause describes the AVPs used in the accounting messages.

Category in table 6.1A.2.1 and table 6.1A.2.1 shall use the categories according to clause 6.1B.

6.1A.2.1 Accounting-Request Message

Table 6.1A.2.1 illustrates the basic structure of a Diameter ACR message from the S-GW and P-GW as used for PS offline charging.

Table 6.1A.2.1 : Accounting-Request (ACR) Message Contents

AVP	Category	Description
Session-Id	M	Described in TS 32.299 [50]
Origin-Host	M	Described in TS 32.299 [50]
Origin-Realm	M	Described in TS 32.299 [50]
Destination-Realm	M	Described in TS 32.299 [50]
Accounting-Record-Type	M	Described in TS 32.299 [50]
Accounting-Record-Number	M	Described in TS 32.299 [50]
Acct-Application-Id	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)
Acct-Interim-Interval	O _C	Described in TS 32.299 [50]
Origin-State-Id	O _C	Described in TS 32.299 [50]
Event-Timestamp	O _C	Described in TS 32.299 [50]
Proxy-Info	O _C	Described in TS 32.299 [50]
Route-Record	O _C	Described in TS 32.299 [50]
Service-Context-Id	O _M	This field identifies the PS domain.
Service-Information	O _M	This field holds the 3GPP specific PS information
Subscription-Id	O _M	Described in TS 32.299 [50]
PS-Information	O _M	Described in clause 6.3.1.2
Node-functionality	O _M	Described in TS 32.299 [50]
AVP	O _C	Described in TS 32.299 [50]

AVP	Category	Description
NOTE: The PS-Information is inside the Service-Information AVP and not directly at ACR command level.		

NOTE: Detailed descriptions of the fields are provided in 3GPP TS 32.299 [50].

6.1A.2.2 Accounting-Answer Message

The following table illustrates the basic structure of a Diameter ACA message as used for the S-GW and P-GW.

Table 6.1A.2.2 : Accounting-Answer (ACA) Message Contents

AVP	Category	Description
Session-Id	M	Described in TS 32.299 [50]
Origin-Host	M	Described in TS 32.299 [50]
Origin-Realm	M	Described in TS 32.299 [50]
Destination-Realm	M	Described in TS 32.299 [50]
Accounting-Record-Type	M	Described in TS 32.299 [50]
Accounting-Record-Number	M	Described in TS 32.299 [50]
Acct-Application-Id	O _C	Described in TS 32.299 [50]
User-Name	O _C	Described in TS 32.299 [50]
Error-Reporting-Host	O _C	Described in TS 32.299 [50]
Acct-Interim-Interval	O _C	Described in TS 32.299 [50]
Origin-State-Id	O _C	Described in TS 32.299 [50]
Event-Timestamp	O _C	Described in TS 32.299 [50]
Proxy-Info	O _C	Described in TS 32.299 [50]
AVP	O _C	Described in TS 32.299 [50]

NOTE: Detailed descriptions of the fields are provided in 3GPP TS 32.299 [50].

6.1B CDR content description on Bp interface

The tables in the subsequent parts of clause x 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 provide a brief description of each CDR parameter. Full definitions of the parameters, sorted by the parameter name in alphabetical order, are provided in 3GPP 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 the following table shall be available for each IP CAN bearer.

Table 6.1.1 : 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	M	IMSI of the served party.
Served IMEI	O _C	The IMEI 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 (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".
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. IP, PPP, IHOSS:OSP.
Served PDP Address	O _C	PDP address of the served IMSI, i.e. IPv4 or IPv6. This parameter shall be present except when both the PDP type is PPP and dynamic PDP address assignment is used.
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.
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.
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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
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.

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

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

Table 6.1.2: S-GW IP CAN bearer data (SGW-CDR)

Field	Category	Description
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Record Type	M	S-GW IP CAN bearer record.
Served IMSI	M	IMSI of the served party.
Served IMEISV	O _C	IMEISV of the ME, if available.
S-GW Address used	M	The control plane IP address of the S-GW used.
Charging ID	M	IP CAN bearer identifier used to identify this IP CAN bearer in different records created by PCNs
PDN Connection Id	O _M	This field holds the PDN connection (IP-CAN session) identifier to identify different records belonging to same PDN connection.
Serving Node Address	M	List of serving node control plane IP addresses (e.g. 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 PGW 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 when PDN Type is IPv4, or IPv6 when PDN Type is IPv6 or IPv4v6.
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 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.
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 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.
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.
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 [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
Serving Node PLMN Identifier	O _C	Serving node PLMN Identifier (MCC and MNC) used during this record, if available.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station, when available. This RAT type is defined in TS 29.060 [204] for GTP case, in TS 29.274 [210] for eGTP case and in TS 29.275 [211] for PMIP case.
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.

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 the following table shall be available for each IP CAN bearer.

Table 6.1.3: P-GW IP CAN bearer data (PGW-CDR)

Field	Category	Description
Record Type	M	P-GW IP CAN bearer record.
Served IMSI	M	IMSI of the served party.
Served IMEISV	O _C	IMEISV of the ME, if available.
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.
Charging ID	M	IP CAN bearer identifier used to identify this IP CAN bearer in different records created by PCNs
PDN Connection Id	O _M	This field holds the PDN connection (IP-CAN session) identifier to identify different records belonging to same PDN connection.
Serving node Address	M	List of SGSN/S-GW control plane IP addresses 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.
PGW PLMN Identifier	O _C	PLMN identifier (MCC MNC) of the PGW.
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 type, i.e. IP, PPP, or IHOOSS:OSP, or PDN type (i.e IPv4, IPv6 or IPv4v6).
Served PDP/PDN Address	O _C	IP address allocated for the PDP context / PDN connection, i.e. IPv4 when PDN Type is IPv4 or IPv6 when 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 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 address is static.
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. 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 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.
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.
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.
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.

Field	Category	Description
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.
3GPP2 User Location information	O _C	This field contains the User Location Information of the MS as defined in TS 29.212 [71] for 3GPP2 access, 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 IP CAN bearer IM-CN Subsystem Signalling Flag is set, see [201] is used for IMS signalling.
External Charging Identifier	O _C	A Charging Identifier received from a non-EPC, external network entity e.g ICID.
Serving node PLMN Identifier	O _M	Serving node PLMN Identifier (MCC and MNC) used during this record.
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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type currently used by the Mobile Station, when available. This RAT type is defined in TS 29.060 [204] for GTP case, in TS 29.274 [210] for eGTP case and in TS 29.275 [211] for PMIP case.
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.

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 each time the mobile is attached to the SGSN.

Table 6.1.4: 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 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.
Record Extensions	O _C	A set of network operator/manufacture 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.
Served MSISDN	O _M	The primary MSISDN of the subscriber.
Charging Characteristics	M	The Charging Characteristics used by the SGSN.
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, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
Charging Characteristics Selection Mode	O _M	Holds information about how Charging Characteristics were selected.

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

If enabled, an S-SMO-CDR SGSN Mobile originated SMS record shall be produced for each short message sent by a mobile subscriber via the SGSN. The fields in the record are specified in the following table.

Table 6.1.5: SGSN Mobile originated SMS record (S-SMO-CDR)

Field	Category	Description
Record Type	M	SGSN Mobile Originated SMS.
Served IMSI	M	The IMSI of the subscriber.
Served IMEI	O _C	The IMEI of the ME, if available.
Served MSISDN	O _M	The primary MSISDN of the subscriber.
MS Network Capability	O _M	The mobile station network capability.
Service Centre	O _M	The address (E.164) of the SMS-service centre.
Recording Entity	O _M	The E.164 number of the SGSN.
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.
Message Reference	M	A reference provided by the MS uniquely identifying this message.
Event Time Stamp	M	The time at which the message was received by the SGSN from the subscriber.
SMS Result	C	The result of the attempted delivery if unsuccessful.
Record Extensions	O _C	A set of network operator/ manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
Destination Number	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	Holds information about how Charging Characteristics were selected.

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

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

Table 6.1.6: SGSN Mobile terminated SMS record (S-SMT-CDR)

Field	Category	Description
Record Type	M	SGSN Mobile Terminated SMS.
Served IMSI	M	The IMSI of the subscriber.
Served IMEI	O _C	The IMEI of the ME, if available.
Served MSISDN	O _M	The primary MSISDN of the subscriber.
MS Network Capability	O _M	The mobile station network capability.
Service Centre	O _M	The address (E.164) of the SMS-service centre.
Recording Entity	O _M	The E.164 number of the SGSN.
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.
Event Time Stamp	M	Delivery time stamp, time at which message was sent to the MS by the SGSN.
SMS Result	C	The result of the attempted delivery if unsuccessful.
Record Extensions	O _C	A set of network operator/manufacturer specific extensions to the record. Conditioned upon the existence of an extension.
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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
Charging Characteristics Selection Mode	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.

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 the following table.

Table 6.1.7: 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).
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
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 the following table.

Table 6.1.8: 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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
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 the following table.

Table 6.1.9: 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 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.
RAT Type	O _C	This field indicates the Radio Access Technology (RAT) type, e.g. UTRAN or GERAN, currently used by the Mobile Station as defined in TS 29.060 [204].
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 the following table shall be available for each MBMS bearer context.

Table 6.1.10: SGSN MBMS bearer context data (S-MB-CDR)

Field	Category	Description
Record Type	M	SGSN 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 RAs	O _C	List of routing 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).
Served PDP Address	O _C	Indicates the IP Multicast address used for the MBMS bearer context..
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.
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.
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 [32].

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 the following table shall be available for each MBMS bearer context.

Table 6.1.11: 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).
Served PDP Address	O _C	Indicates the IP Multicast address used for the MBMS bearer context.
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.
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 [32].

6.2 Data description for PS Online Charging

6.2.1 Diameter message contents

6.2.1.1 Summary of Online Charging Message Formats

The PS Online Charging uses the Credit-Control-Request (CCR) and Credit-Control-Answer (CCA) messages defined in TS 32.299 [50].

The following table describes the use of these messages for online charging.

Table 6.2.1.1.1 : Online Charging Messages Reference Table

Command-Name	Source	Destination	Abbreviation
Credit-Control-Request	PCEF	OCS	CCR
Credit-Control-Answer	OCS	PCEF	CCA

6.2.1.2 Structure for the Credit Control Message Formats

This clause describes the AVPs used in the credit control messages.

6.2.1.2.1 Credit-Control-Request Message

Table 6.2.1.2.1 illustrates the basic structure of a Diameter CCR message from the PCEF as used for PS online charging.

Table 6.2.1.2.1 : Credit-Control-Request (CCR) Message Contents

AVP	Category	Description
Session-Id	M	Described in TS 32.299 [50]
Origin-Host	M	Described in TS 32.299 [50]
Origin-Realm	M	Described in TS 32.299 [50]
Destination-Realm	M	Described in TS 32.299 [50]
Auth-Application-Id	M	Described in TS 32.299 [50]
Service-Context-Id	M	Described in TS 32.299 [50]
CC-Request-Type	M	Described in TS 32.299 [50]
CC-Request-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.
Origin-State-Id	O _C	Described in TS 32.299 [50]
Event-Timestamp	O _C	Described in TS 32.299 [50]
Subscription-Id	O _M	Described in TS 32.299 [50]. As a minimum the IMSI and the MSISDN have to be included.
User-Equipment-Info	O _C	Described in TS 32.299 [50]. Contains the identification of the terminal (IMEISV etc.)
Termination-Cause	O _C	Described in TS 32.299 [50]
Multiple-Services-Indicator	O _M	Described in TS 32.299 [50]
Multiple-Services-Credit Control	O _C	Described in TS 32.299 [50]
Route-Record	O _C	Described in TS 32.299 [50]
AVP	O _C	Described in TS 32.299 [50]
Service-Information	O _M	Described in TS 32.299 [50]
PS-Information	O _C	Described in clause 6.3.1.2
IMS-Information	O _C	Described in clause 6.3.1.1
NOTE: The PS-Information and IMS-Information AVPs are inside the Service-Information AVP and not directly at CCR command level.		

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 Credit-Control-Answer Message

The following table illustrates the basic structure of a DCCA message as used for the PCEF. This message is always used by the OCS as specified below, independent of the receiving PCEF and the CCR request type that is being replied to.

Table 6.2.1.2.2 : Credit-Control-Answer (CCA) Message Contents

AVP	Category	Description
Session-Id	M	Described in 32.299 [50]
Result-Code	M	Described in 32.299 [50]
Origin-Host	M	Described in 32.299 [50]
Origin-Realm	M	Described in 32.299 [50]
Auth-Application-Id	M	Described in 32.299 [50]
CC-Request-Type	M	Described in 32.299 [50]
CC-Request-Number	M	Described in 32.299 [50]
Multiple-Services-Credit-Control	O _C	Described in 32.299 [50]
CC-Session-Failover	O _C	Described in 32.299 [50]
Credit-Control-Failure-Handling	O _C	Described in 32.299 [50]
Redirect-Host	O _C	Described in 32.299 [50]
Redirect-Host-Usage	O _C	Described in 32.299 [50]
Redirect-Max-Cache-Time	O _C	Described in 32.299 [50]
Failed-AVP	O _C	Described in 32.299 [50]
Route-Record	O _C	Described in 32.299 [50]
Service-Information	O _M	Described in 32.299 [50]
AVP	O _C	Described in 32.299 [50]

6.2.2 Void

6.3 PS Charging Specific Parameters

6.3.1 Definition of PS charging information

The PS Information parameter used for PS charging is provided in the Service Information parameter.

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.

Table 6.3.1.1 : Service Information used for PS Charging

Field	Category	Description
Service Information	O _M	This is a structured field and holds the 3GPP specific parameter as defined in TS 32.299 [50].
Subscription-Id	O _C	This field contains the identification of the user (e.g IMSI, MSISDN, NAI).
PS Information	O _M	This is a structured field and holds the PS specific parameters. The details are defined in subclause 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].
IMS Charging Identifier	O _C	This field holds the IMS Charging Identifier (ICID) as generated by an IMS node for a SIP session.
Node Functionality	O _M	This field contains the function of the EPC node (SGW, PGW)
NOTE : When Node Functionality is set to 'HSGW' the HSGW Access specific charging information are provided as part of the PS Information		

6.3.1.2 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 (S-GW, P-GW) from which the information is sent.

The detailed structure of the PS Information can be found in the table 6.3.1.2.

Table 6.3.1.2 : Structure of the PS Information

Field	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).
Node Id	O _C	This fields holds the name of the Node
PDN Connection Id	O _C	This field holds the PDN connection (IP-CAN session) identifier to identify different records belonging to same PDN connection.
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 or IPv6. 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.
Dynamic Address Flag	O _C	This field indicates whether served PDP/PDN address is dynamically allocated. This field is missing if address is static.
Negotiated QoS Profile	O _C	This field holds the authorized QoS applied to IP CAN bearer. See NOTE.
Serving Node Address	O _C	This field holds the SGSN/S-GW IP address that is used by the control plane for the handling of control messages, or the AGW IP address, or the ePDG address. It may be used to identify the PLMN to which the user is attached.
Serving Node Type	O _C	This field holds the type of the serving node.
SGW Change	O _C	This field is present if this is first ACR after S-GW change.
PGW Address	O _C	This field holds the IP-address of the P-GW that generated the Charging Id.
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).
PGW MCC MNC	O _C	This field holds the MCC-MNC of the network the P-GW belongs to.
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.
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.
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 extracted from the RAI within the IP CAN beareractivation or Update messages, or provided by SGW/AGW.
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.
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).
3GPP2 User Location Info	O _C	This field holds the 3GPP2 User Location of where the UE is currently located (i.e. 3GPP2 BSID: Cell-Id, SID, NID), as defined in TS 29.212 [71]
RAT Type	O _C	This field indicates which Radio Access Technology is currently serving the UE.

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. It may occur several times within the PS Information field.
User-Equipment-Info	O _C	This field holds the identification of the terminal (IMEISV...) <i>Editor's Note: Aligement with online charging is needed.</i>
Terminal Information	O _C	This field holds the identification of the terminal (IMEISV, 3GPP2-MEID..). <i>Editor's Note : this parameter is only for offline charging and use for online charging instead of User-Equipment-info is ffs</i>
start time	O _C	Timestamp when User IP-CAN session starts
stop time	O _C	Timestamp when User IP-CAN session terminates.
Change Condition	O _C	This field holds the reason for sending ACR 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

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.

6.3.2 Detailed Message Format for offline charging

The following chapter specifies per Operation Type the charging data that are sent by S-GW and P-GW.

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 Accounting Request message for PS offline charging.

Table 6.3.2.1 : Supported fields in Accounting Request Message

Field	Node Type	S-GW	P-GW
Supported Operation Types		S/I/S/E	S/I/S/E
Session-Id		SIS-	SIS-
Origin-Host		SIS-	SIS-
Origin-Realm		SIS-	SIS-
Destination-Realm		SIS-	SIS-
Accounting-Record-Type		SIS-	SIS-
Accounting-Record-Number		SIS-	SIS-
Acct-Application-Id		SIS-	SIS-
User -Name		SIS-	SIS-
Acct-Interim-Interval		SIS-	SIS-
Origin-State-Id		SIS-	SIS-
Event-Timestamp		SIS-	SIS-
Proxy-Info		SIS-	SIS-
Route-Record		SIS-	SIS-
Service-Context-Id		SIS-	SIS-
Service Information with PS and IMS Information			
Subscription-Id		SIS-	SIS-
Node Functionality		SIS-	SIS-
Charging Id		SIS-	SIS-
Node Id		SIS-	SIS-
PDN Connection Id		SIS-	SIS-
PDP/PDN Type		SIS-	SIS-
PDP/PDN Address		SIS-	SIS-
Dynamic Address Flag		SIS-	SIS-
Negotiated QoS Profile		-	-
S-GW Address		-	SIS-
Serving Node Type		SIS-	SIS-
SGW Change		S---	-
P-GW Address		SIS-	-
CG Address		-	-
IMSI MCC MNC		SIS-	SIS-
PGW MCC MNC		SIS-	SIS-
NSAPI		-	SIS-
Called Station Id		SIS-	SIS-
Session Stop Indicator		-	--S-
Selection Mode		SIS-	SIS-
Charging Characteristics		SIS-	SIS-
Charging Characteristics Selection Mode		SIS-	SIS-
Serving Node MCC MNC		SIS-	SIS-
MS Time Zone		SIS-	SIS-
Charging Rule Base Name		-	SIS-
User Location Info		SIS-	SIS-
3GPP2 User Location Info		SIS-	SIS-
RAT Type		SIS-	SIS-
Furnish Charging Information		-	SIS-
Offline Charging		-	-
QoS Information		SIS-	SIS-
Traffic data volumes		-IS-	-
Service data container		-	-IS-
User-Equipment-Info		-	-
Terminal-Information		S---	S---
Start time		S---	S---
Stop time		--S-	--S-
Change Condition		-IS-	-IS-
Diagnostics		--S-	--S-
IMS Charging Identifier		SIS-	SIS-

Table 6.3.2.2 illustrates the basic structure of the supported fields in the Accounting Response message for PS offline charging.

Table 6.3.2.2 : Supported fields in Accounting Response Message

Field	Node Type	S-GW	P-GW
	Supported Operation Types	S/I/S/E	S/I/S/E
Session-Id		SIS-	SIS-
Origin-Host		SIS-	SIS-
Origin-Realm		SIS-	SIS-
Destination-Realm		SIS-	SIS-
Accounting-Record-Type		SIS-	SIS-
Accounting-Record-Number		SIS-	SIS-
Acct-Application-Id		SIS-	SIS-
User -Name		SIS-	SIS-
Acct-Interim-Interval		SIS-	SIS-
Origin-State-Id		SIS-	SIS-
Event-Timestamp		SIS-	SIS-
Proxy-Info		SIS-	SIS-
Route-Record		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 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 and Reserve Units Request for PS online charging.

Table 6.3.3.1: Supported fields in *Debit and Reserve Units Request* Message

Field	Node Type	P-GW
Supported Operation Types		I/U/T/E
Session Identifier		IUT-
Originator Host		IUT-
Originator Domain		IUT-
Destination Domain		IUT-
Operation Identifier		IUT-
Operation Token		IUT-
Operation Type		IUT-
Operation Number		IUT-
Destination Host		IUT-
User Name		IUT-
Origination State		IUT-
Origination Timestamp		IUT-
Subscriber Identifier		IUT-
Termination Cause		--T-
Requested Action		IUT-
Multiple Operation		IU--
Multiple Unit Operation		IU--
Subscriber Equipment Number		IUT-
Route Information		IUT-
Service Information		IUT-
Service Information with PS Information		
Charging Id		IUT-
Node Id		-
PDN Connection Id		IUT-
PDP/PDN Type		IUT-
PDP/PDN Address		IUT-
Dynamic Address Flag		-
Qos Information		IUT-
S-GW Address		IUT-
Serving Node Type		IUT-
SGW Change		-
P-GW Address		IUT-
CG Address		IUT-
IMSI MCC MNC		IUT-
PGW MCC MNC		IUT-
NSAPI		IUT-
Called Station Id		IUT-
Session Stop Indicator		--T-
Selection Mode		IUT-
Charging Characteristics		IUT-
Charging Characteristics Selection Mode		IUT-
Serving Node MCC MNC		IUT-
MS Time Zone		IUT-
Charging Rule Base Name		IUT-
User Location Info		IUT-
3GPP2 User Location Info		IUT-
RAT Type		IUT-
Furnish Charging Information		-
Offline Charging		IUT-
PDP Context Type		IUT-
Traffic data volumes		-
Service data container		-
User-Equipment-Info		-
Terminal-Information		-
Start time		-
Stop time		-
Change Condition		-
Diagnostics		-

IMS Charging Identifier	IUT-
-------------------------	------

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

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

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

6.4 Void

6.5 Bindings for EPC Offline Charging

This clause aims to describe the mapping between the Diameter messages 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 S-GW-CDR and P-GW-CDR in EPC Offline Charging.

Table 6.5.1: Bindings of Accounting AVP to S-/P-GW-CDR parameter

Diameter ACR AVP	S-/P-GW-CDR field
<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>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>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
<i>Node ID</i>	Node ID
<i>PDN-Connection-ID</i>	PDN Connection Id
<i>3GPP-PDP-Type</i>	PDP/PDN Type

Diameter ACR AVP	S-/P-GW-CDR field
<i>3GPP-GGSN-MCC-MNC</i>	PGW PLMN Identifier
<i>GGSN-Address</i>	PGW Address Used
<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 IMEISV
<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>Service-Specific-Info</i>	Service Specific Info
<i>SGSN-Address</i>	Serving Node Address
<i>SGSN-Address</i>	S-GW Address used
<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>3GPP-User-Location-Info</i>	User Location Information
<i>3GPP2-BSID</i>	3GPP2 User Location information

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

Annex A (normative): Charging characteristics

Charging Characteristics can be supplied by the HLR/HSS to the SGSN/MME as part of the subscription information. A subscriber may have charging characteristics assigned to his subscription and/or his subscribed APNs. The 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:

Charging characteristics in SGSN

- 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.

Upon activation of a IP CAN bearer, 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 APN are present in the subscription information they shall be forwarded;
 - if no charging characteristics are present for the APN but subscription related charging characteristics is present, they 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.

Charging characteristics in MME

The MME does not utilize charging characteristics as it does not generate charging information.

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) 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 MME does not forward any charging characteristics to the S-GW.

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 P-GW belongs to 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.

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 supplied parameters, or it may be configured to ignore the SGSN/S-GW 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 belongs to a different PLMN;
- home case, i.e. the subscriber belongs to the same PLMN as the SGSN/S-GW and P-GW; or
- unconditionally, i.e. it always ignores the SGSN/S-GW supplied parameters.

If the P-GW ignores the parameters supplied by the SGSN/S-GW, 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.

Charging characteristics generally

Charging Characteristics consists of a string of 16 bits designated as Behaviours (B), freely defined by Operators, as shown in 3GPP TS 32.298 [41].

For example, one way to define a 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 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;

- **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. P-GW applied CGF address is sent to SGSN/S-GW during IP CAN bearer activation.
- - In the home or visiting case, the S-GW shall apply from P-GW received CGF address 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 SGSN shall apply the received CGF address 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 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 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.

Table A.1, A.2 and A.3 are informative examples intended for clarification.

Table A.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.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 [72] 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 [72] for more information.

Table A.2: 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	...
...

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).

The SGSN selects the charging characteristics behaviour for M-CDR generation upon the creation of a MM context. 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 SGSN shall not send IP CAN bearer modifications for the existing IP CAN bearer to the P-GW because of charging characteristics change.

Annex B (normative): Tx expiration; Failure Handling procedure and session failover mechanism description

DIAMETER 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	IP CAN bearer is not established.	IP CAN bearer is not established.	IP CAN bearer is terminated. The PGW-CDR is marked.	IP CAN bearer is terminated. The PGW-CDR is marked.	N/A	N/A
Failure Action= RETRY & TERMINATE	<p>After Tx expiration, the P-GW sends the Initial CCR 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 is not accepted 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>	IP CAN bearer is not established.	<p>After Tx expiration, the P-GW 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 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>	IP CAN bearer is terminated. The PGW-CDR is marked.	IP CAN bearer is not established.	IP CAN bearer is terminated. The PGW-CDR is marked.

<p>Failure Action= CONTINUE</p>	<p>After Tx expiration, the P-GW sends the Initial CCR 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: "Initial CCR, Tx expiration for second OCS".</p>	<p>The IP CAN bearer is accepted and the credit-control session is considered closed for the P-GW.</p> <p>The operator can limit the duration of the IP CAN bearer.</p> <p>The PGW-CDR is marked.</p>	<p>After Tx expiration, the P-GW 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> <p>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.</p> <p>The PGW-CDR is marked. All active service data flow containers shall be added to the CDR.</p>	<p>After the Tx expiration for the secondary OCS, the failure handling mechanism is immediately triggered:</p> <p>The IP CAN bearer is accepted and the credit-control session is considered closed for the P-GW.</p> <p>The operator can limit the duration of the IP CAN bearer.</p> <p>The PGW-CDR is marked.</p>	<p>After Tx expiration for the secondary OCS, the failure handling mechanism is immediately triggered:</p> <p>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.</p> <p>The PGW-CDR is marked. All active service data flow containers shall be added to the CDR</p>
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Annex C (informative): Bibliography

a) **The 3GPP charging specifications**

- 3GPP TS 32.252: "Telecommunication management; Charging management; Wireless Local Area Network (WLAN) charging".

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: "The TFT Protocol (Revision 2)"

Annex D (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	

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
Sep 2009	SP-45	SP-090536	0110	-	Correction for Supported fields in Accounting Request and Response Messages	F	8.6.0	8.7.0	CH8
Sep 2009	SP-45	SP-090536	0113	-	Correction on Qos handling in PS information for EPS	F	8.6.0	8.7.0	CH8
Sep 2009	SP-45	SP-090536	0115	-	Correction on Charging Characteristics description	F	8.6.0	8.7.0	CH8
Sep 2009	SP-45	SP-090536	0117	-	Correction on Charging characteristics forwarding from MME	F	8.6.0	8.7.0	CH8
Sep 2009	SP-45	SP-090536	0119	-	Correction on supported fields for Credit-Control Request/answer for Online Charging	F	8.6.0	8.7.0	CH8
Dec 2009	SP-46	SP-090720	0122	-	PLMN RAT Change removed as conditions for 'List of Serve Data'	F	8.7.0	8.8.0	CH8
Dec 2009	SP-46	SP-090720	0124	-	Removal of forwarding CGF Address to S4-SGSN from S-GW	F	8.7.0	8.8.0	CH8
Dec 2009	SP-46	SP-090720	0126	-	Re-align Charging description for S4-SGSN	F	8.7.0	8.8.0	CH8
Mar 2010	SP-47	SP-100039	0130	-	Correction to PS Online Charging service context - Alignment with TS 32.299	A	8.8.0	8.9.0	CH7
Mar 2010	SP-47	SP-100040	0132	-	Correction for 'Charging Characteristics Selection Mode' parameter for Rf	F	8.8.0	8.9.0	CH8
Mar 2010	SP-47	SP-100040	0134	-	Clarify 'Change Condition' settings in PS-information for offline Charging	F	8.8.0	8.9.0	CH8
Mar 2010	SP-47	SP-100040	0137	-	Removal of Editor's Note	F	8.8.0	8.9.0	CH8
Mar 2010	SP-47	SP-100040	0138	-	Correction for offline Charging from PGW for 3GPP2 User location	F	8.8.0	8.9.0	CH8
Sep 2010	SP-49	SP-100495	0148	-	Correction on Charging Rule Based Name - Alignment with TS 23.203	A	8.9.0	8.10.0	CH7
Sep 2010	SP-49	SP-100496	0144	-	Correction for Dual IP addresses associated to one PDN connection	F	8.9.0	8.10.0	CH8

History

Document history		
V8.4.0	January 2009	Publication
V8.5.0	April 2009	Publication
V8.6.0	July 2009	Publication
V8.7.0	October 2009	Publication
V8.8.0	January 2010	Publication
V8.9.0	April 2010	Publication
V8.10.0	October 2010	Publication