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Presentation of Technical Specification to TSG SA

Presentation to:	**TSG SA Meeting #22**
Document for presentation:	**TS 32.240, Version 1.0.0** **Charging management; Charging Architecture and Principles**
Presented for:	**Information**

Abstract of document:

Work done against WIDs approved at SA#19 (03/2003) and contained in:

SP-030047 (Charging Management: Work Item ID:CH)

This is a TS on the Charging Architecture and Principles **common to all 3GPP domains**, **subsystems and services**. It provides an umbrella for all other charging management TSs that comprise:

a) a set of 'middle tier' domain/subsystem/service specific TSs covering the bearer (CS, PS, WLAN), subsystem (IMS) and service (MMS, LCS) levels, respectively (32.25x, 32.26x and 32.27x), and

b) a set of TSs in the 32.29x range covering common aspects such as Charging Data Records (CDRs) parameter and syntax descriptions, online and offline charging applications, and charging interactions both within the network and between the network and the Billing Domain.

Changes since last presentation to TSG-SA:
New

Outstanding Issues:
Inclusion of WLAN & IP Flow Bearer Charging (pending on SA2 input) and Rel-6 services.

Contentious Issues:
None.

3GPP TS 32.240 V1.0.0 (2003-12)

Technical Specification

3rd Generation Partnership Project;
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Contents

Foreword

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

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

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is part of a series of documents that specify charging functionality and charging management in GSM/UMTS networks. The GSM/UMTS core network charging architecture and principles are specified in the present document, which thus provides an umbrella for other charging management documents that specify

- the content of the CDRs per domain and subsystem (offline charging);
- the content of real-time charging events per domain / subsystem (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 purposes of the present document are:

- to lay down common principles of charging in the network; and
- to specify a logical common charging architecture that apples to all 3GPP domains, subsystems and services.

A set of domain/subsystem/service specific TSs covers the bearer (CS, PS, WLAN), subsystem (IMS) and service (MMS, LCS, etc.) levels, respectively, in the 32.25x, 32.26x and 32.27x TS number range. These TSs describe the mapping of the common architecture specified in the present document onto the specific domain/subsystem/service and the scenarios and information for online and offline charging that are specific to the domain/subsystem/service.

A set of TSs in the 32.29x range covers common aspects such as CDR parameter and syntax descriptions, online and offline charging applications, and the charging interactions within the network (CDR transfer) as well as between the network and the Billing Domain (CDR file transfer).

The complete document structure for these TSs is outlined in the following figure.

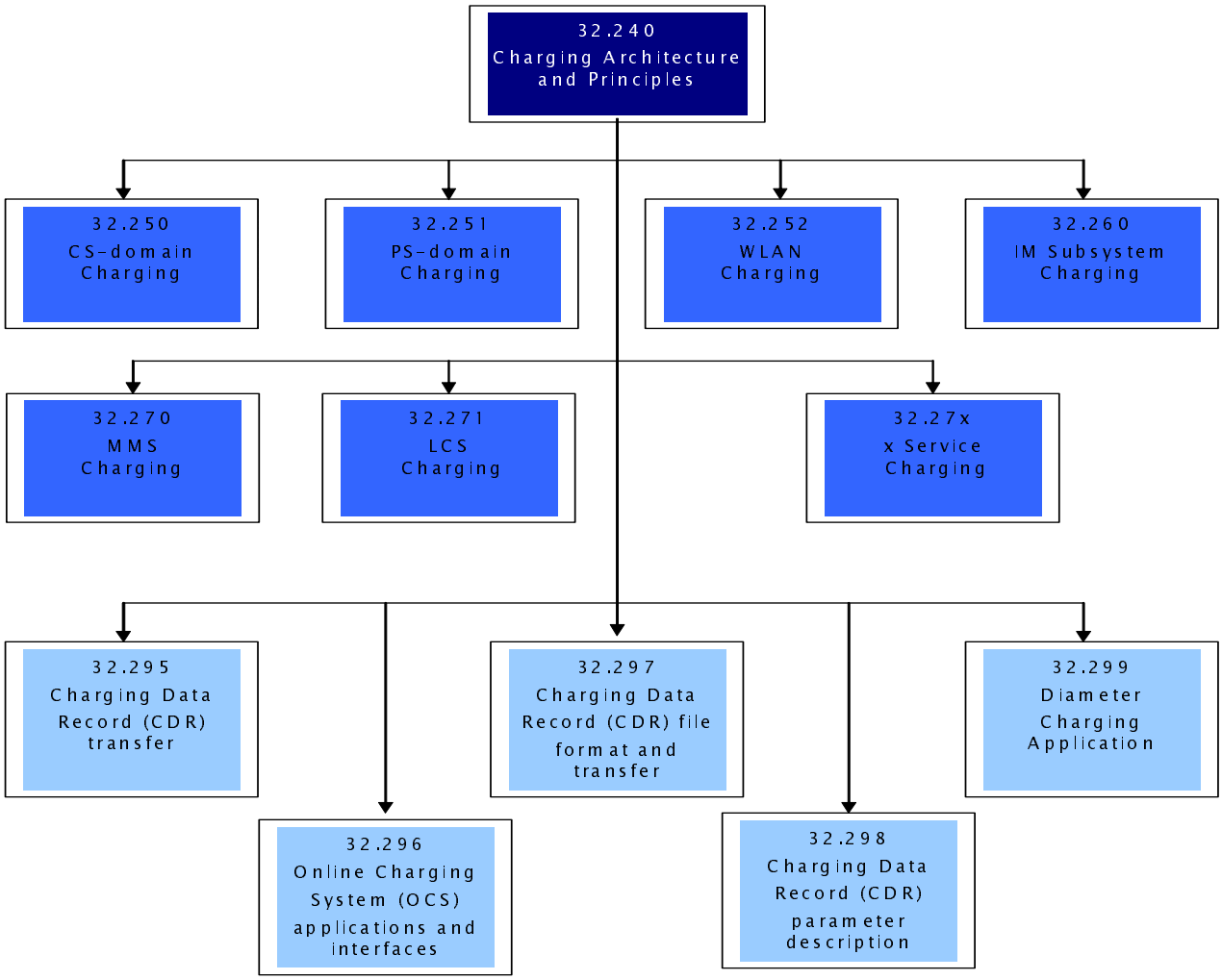


Figure: Charging documents structure

All references, abbreviations, definitions, descriptions, principles and requirements, used in the present document, that are common across 3GPP TSs, are defined in the 3GPP Vocabulary, 3GPP TR 21.905 [50]. Those that are common across charging management in GSM/UMTS domains or subsystems are provided in the present document (umbrella TS), and are copied into clause 3 of the present document for ease of reading. Finally, those items that are specific to the present document are defined exclusively in the present document.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TS 22.024: "Description of Charge Advice Information (CAI)".

[2] 3GPP TS 22.086: "Advice of Charge (AoC) supplementary services; Stage 1".

a) The 3GPP charging specifications

[3]-[9] Void.

[10] 3GPP TS 32.250: "Telecommunication management; Charging management; Circuit Switched (CS) domain charging".

[11] 3GPP TS 32.251: "Telecommunication management; Charging management; Packet Switched (PS) domain charging".

[12] 3GPP TS 32.252: "Telecommunication management; Charging management; Wireless Local Area Network (WLAN) charging".

[13]-[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 32.279: "".

[33]-[39] Void.

[40] 3GPP TS 32.299: "Telecommunication management; Charging management; Charging Protocol description ".

[41] 3GPP TS 32.298: "Telecommunication management; Charging management; Charging Data Record (CDR) parameter description".

[42] 3GPP TS 32.297: "Telecommunication management; Charging management; Charging Data Record (CDR) file format and transfer".

[43] 3GPP TS 32.296: "Telecommunication management; Charging management; Online Charging System (OCS) applications and interfaces".

[44] 3GPP TS 32.295: "Telecommunication management; Charging management; Charging Data Record (CDR) transfer".

[45]-[49] Void.

b) Common 3GPP specifications

[50] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[51] 3GPP TS 22.101: "Service aspects; Service principles".

[52] 3GPP TS 22.115 "Service aspects; Charging and billing".

[53]-[59] Void.

c) other Domain and Service specific 3GPP / ETSI specifications

[60] 3GPP TS 23.002: "Network architecture".

[61] 3GPP TS 23.078: "Customized Applications for Mobile network Enhanced Logic (CAMEL); Stage 2".

[62] 3GPP TS 23.140: "Multimedia Messaging Service (MMS); Functional description; Stage 2".

[63] 3GPP TS 23.271: "Location Services (LCS); Functional description; Stage 2".

[64] 3GPP TS 23.234: "3GPP system to Wireless Local Area Network (WLAN) interworking; System description".

[65]-[100] Void.

d) Network Management related specifications

[101] ITU-T Recommendation D.93: "Charging and accounting in the international land mobile telephone service (provided via cellular radio systems)".

3 Definitions, abbreviations and symbols

3.1 Definitions

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

(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.

(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.

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

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

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

accounting meter record: record containing one or more counters employed to register the usage of resources en masse
Includes simple event counters and/ or cumulative call second counters.

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

Advice of Charge (AoC): real-time display of the network utilization charges incurred by the Mobile Station
The charges are displayed in the form of charging units. If a unit price is stored by the MS then the display may also include the equivalent charge in the home currency.

AoC service: combination of one or more services, both basic and supplementary, together with a number of other charging relevant parameters to define a customized service for the purpose of advice of charge

billing: function whereby CDRs generated in the network are transformed into bills requiring payment

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

Charging Data Record (CDR): record generated by a network element for the purpose of billing a charged party for the provided service
It includes fields that identify the user, the session and the network elements as well as information on the network resources and services used to support a subscriber session.

chargeable event: activity utilizing telecommunications network infrastructure 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 wants to charge for.

charged party: user involved in a chargeable event who 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: function whereby information related to a chargeable event is formatted and transferred in order to make it possible to determine usage for which the charged party may be billed

circuit switched domain: domain within GSM and UMTS in which information is transferred in circuit switched mode

domain: part of a communication network that provides services using a certain technology

GPRS: Packet Services for GSM and UMTS systems

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

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

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 32.279 [32],
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 the present document that specifies the charging architecture and principles. Finally, there are a number of top tier TSs in the 32.29x numbering range that specify common charging aspects such as parameter definitions, encoding rules, the common BD interface or common charging applications.

Multimedia Messaging Service Network Architecture (MMSNA): encompasses all the various elements that provide a complete MMS to a user

observed IMEI ticket: record used to describe an EIR relevant event e.g. a blacklisted IMEI

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 session/service control is required

packet switched domain: domain within GSM and UMTS in which data is transferred in packet switched mode. Corresponds to the term "GPRS".

real time: real time charging and billing information is to be generated, processed, and transported to a desired conclusion in less than 1 s

settlement: payment of amounts resulting from the accounting process

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

tariff: set of parameters defining the network utilization charges for the use of a particular service

3.2 Abbreviations

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

3G	3rd Generation
3GPP	3G Partnership Project
AoC	Advice of Charge
AS	Application Server
BCF	Bearer Charging Function
BD	Billing Domain
BS	Billing System
BSC	Base Station Controller
BSS	Base Station Subsystem

BTS	Base Transceiver Station
CAMEL	Customized Applications for Mobile network Enhanced Logic
CAP	CAMEL Application Part
CCF	Charging Collection Function
CDCF	Charging Data Collection Function
CDR	Charging Data Record
CDGF	Charging Data Generation Function
CG	Charging Gateway
CGF	Charging Gateway Function
CPCF	Content Provider Charging Function
CS	Circuit Switched
CUF	Charging Usage data collection Function
CW	Charging gateWay
ECF	Event Charging Function
EIR	Equipment Identity Register
G-CDR	GGSN (PDP context) generated - CDR
GGSN	Gateway GPRS Support Node
GMSC	Gateway MSC
GPRS	General Packet Radio Service
gsmSCF	GSM Service Control Function
gsmSSF	GSM Service Switching Function
GSN	GPRS Support Node (either SGSN or GGSN)
HLR	Home Location Register
HPLMN	Home PLMN
HSCSD	High Speed Circuit Switched Data
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunication Union - Telecommunications standardization sector
LAC	Location Area Code
LCS	Location Services
MAP	Mobile Application Part
M-CDR	Mobility management generated - Charging Data Record
ME	Mobile Equipment
MGW	Media GateWay
MMI	Man-Machine Interface
MMS	Multimedia Messaging Service
MMSE	Multimedia Messaging Service Environment
MMSNA	Multimedia Messaging Service Network Architecture
MO	Mobile Originated
MOC	MO Call
MRF	Media Resource Function
MRFC	MRF Controller
MS	Mobile Station
MSC	Mobile Services Switching Centre
MSISDN	Mobile Station ISDN number
MT	Mobile Terminated
MTC	MT Call
O-CSI	Originating CAMEL Subscription Information
OCS	Online Charging System
PDN	Packet Data Network
PDP	Packet Data Protocol, e.g. IP
PLMN	Public Land Mobile Network
PS	Packet-Switched
PSPDN	Packet-Switched Public Data Network
QoS	Quality of Service
RAB	Radio Access Bearer
RNC	Radio Network Controller
RNS	Radio Network Subsystem
SCCP	Signalling Connection Control Part

S-CDR	SGSN (PDP context) generated – CDR
SCF	Service Control Function
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SMS	Short Message Service
S-SMO-CDR	SGSN delivered Short message Mobile Originated - CDR
S-SMT-CDR	SGSN delivered Short message Mobile Terminated - CDR
TAP	Transferred Account Procedure
T-CSI	Terminating - CAMEL Subscription Information
TID	Tunnel IDentifier
TS	Technical Specification
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
USIM	Universal SIM
VAS	Value Added Service
VLR	Visitor Location Register
VMSC	Visited MSC
VPLMN	Visited PLMN

3.3 Symbols

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

A	Interface between an MSC and a BSC
Bc	Reference point for the CDR file transfer for the CS domain to the BD, i.e. between the xMSC / HLR and a BD
Bi	Reference point for the CDR interface for the IMS, i.e. between a CDGF/CGF and a BD
Bl	Reference point for the CDR file transfer for LCS to the BD, i.e. between the GMLC and a BD
Bm	Reference point for the CDR file transfer for MMS to the BD, i.e. between the MMS Relay Server and a BD
Bp	Reference point for the CDR file transfer e for the PS domain to the BD, i.e. between a CGF and a BD
Bs	Reference point for the CDR file transfer for CAMEL services to the BD, i.e. between the SCF and a BD
Ga	Interface between a GSN transmitting CDRs (i.e. GGSN or SGSN) and a CDR receiving functionality (CGF)
Gb	Interface between an SGSN and a BSC
Gc	Interface between an GGSN and an HLR
Gd	Interface between an SMS-GMSC and an SGSN, and between a SMS-IWMSC and an SGSN
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 RNS and the core network.
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.
Mc	Interface between the MGW and (G)MSC server
Um	Interface between the Mobile Station (MS) and the GSM fixed network part.
Uu	Interface between the User Equipment (UE) and the UMTS fixed network part.

4 Charging mechanisms

4.1 Generic overview

The main requirements and high-level principles for charging and billing across the domains and subsystems that comprise a GSM or UMTS PLMN are established in the 3GPP TS 22.115 [52]. In order to fulfil these requirements, appropriate charging information needs to be generated and collected by the network elements of the PLMN.

Several charging functions are needed to provide the functionality described above for online and offline charging, respectively. These charging functions are specified in detail in clause 6. The mapping of these functions to the various domains, subsystems and services of the network is specified in the charging TS that is specific to that domain/subsystem/service (3GPP TS 32.25x - 3GPP TS 32.27x).

4.2 Charging mechanisms

GSM/UMTS networks provide offline and/or online charging mechanisms. The network performs real-time monitoring of network resource usage in order to support these charging mechanisms.

In offline charging, the resource usage is reported from the network to the Billing Domain after the resource usage has occurred.In online charging, a subscriber account, located in an online charging system, is queried prior to granting permission to use the requested network resource.

Typical examples of network resource usage are a voice call of a certain duration, the transport of a certain volume of data, or the submission of a MM.

Offline and online charging may be performed simultaneously and independently for the same network resource usage.

4.2.1 Offline charging

Offline charging is a process where charging information for network resource usage is collected concurrently with that resource usage. The charging information is then passed through a chain of charging functions that are further explained in clause 6. At the end of this process CDRs are generated by the network, which are then transferred to the network 'operator's Billing Domain (BD). The BD typically comprises post-processing systems such as the 'operator's billing system or billing mediation device.

In conclusion, offline charging is a mechanism where charging information does not affect, in real-time, the service rendered.

'Editor's note: the text below is moved to new clause 7.

4.2.2 Online charging

Online charging is a process where charging information for network resource usage is collected concurrently with that resource usage in the same fashion as in offline charging. However, authorization for the network resource usage must be obtained by the network prior to the actual resource usage to occur. This authorization is granted by the Online Charging System (OCS) upon request from the network.

When receiving a network resource usage request, the network assembles the relevant charging information and generates a charging event towards the OCS in real time. The OCS then returns an appropriate usage authorization. The resource usage authorization may be limited in its scope (e.g. volume of data or duration), therefore the authorization may have to be renewed from time to time as long as the network resource usage is requested by the user.

The network resource usage request may be initiated by the UE (MO case) or by the network (MT case).

Note that the charging information utilized in online charging is not necessarily identical to the charging information employed in offline charging.

In conclusion, online charging is a mechanism where charging information can affect, in real-time, the service rendered and therefore a direct interaction of the charging mechanism with the control of network resource usage is required.

5 Logical network architecture

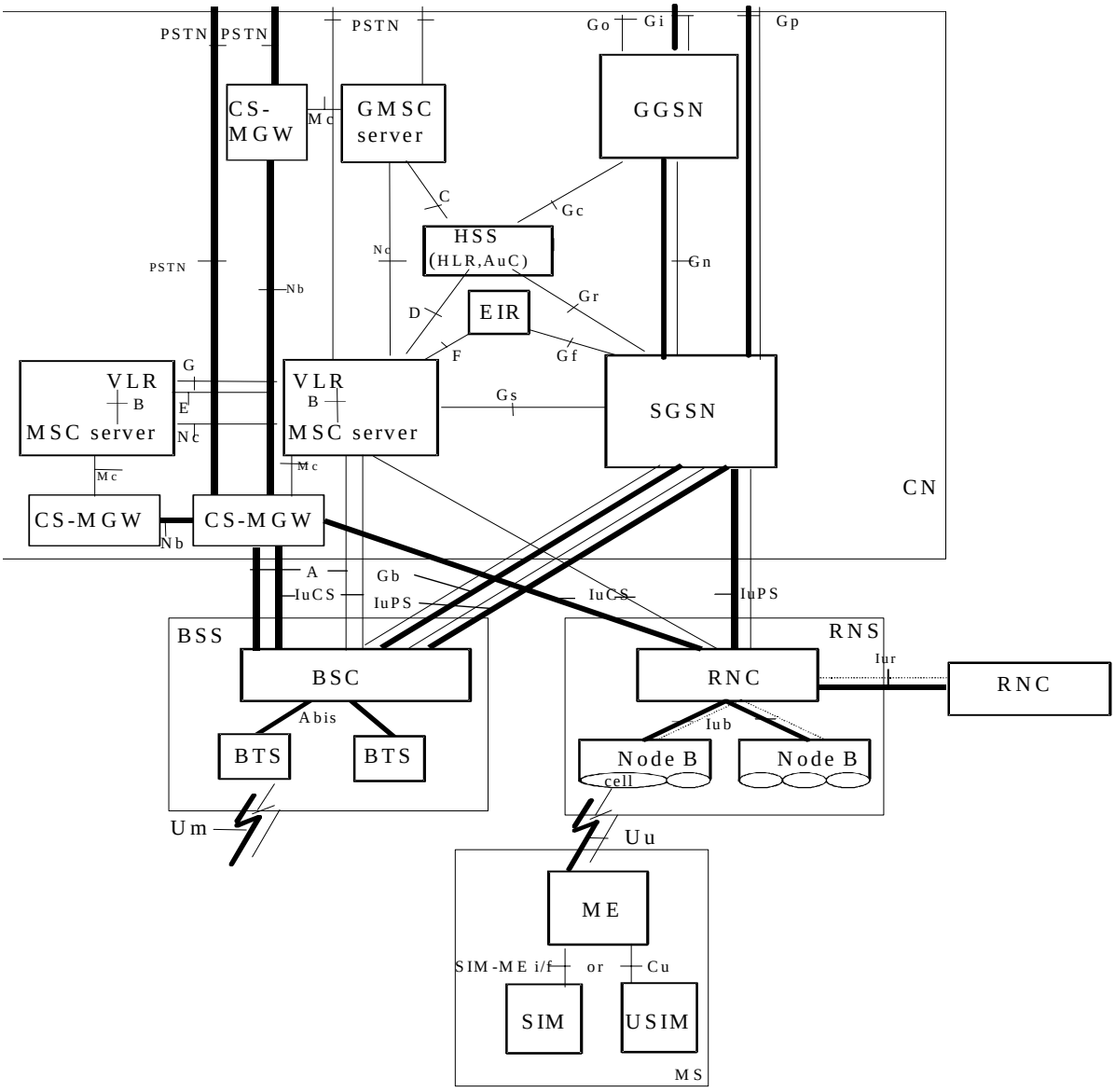
The following clauses depict the logical architecture of the various domains, subsystems and services of the 3GPP network. The components within each architecture that are relevant for charging are highlighted in the architecture diagrams.

5.1 Bearer level

This clause presents the logical architecture for the bearer level systems specified in 3GPP, comprising the Circuit Switched (CS) domain, the Packet Switched (PS) domain, i.e. GPRS, and 3GPP interworked WLAN.

5.1.1 CS/PS architecture for GSM and UMTS

Figure 5.1 shows the basic configuration of a PLMN supporting network and service access through CS and PS domain transport, as described in 3GPP TS 23.002 [60].



Legend:

Bold lines: interfaces supporting user traffic;
Dashed lines: interfaces supporting signalling.

Figure 5.1: Basic Configuration of a PLMN supporting CS and PS services and interfaces

'Editor's note: colorizing this figure causes MS Word to destroy it. Need to provide properly highlighted replacement.

Note that CAMEL entities and functions are outside the scope of the present document. For the relationship of the CAMEL entities to the core network entities illustrated above, refer to 3GPP TS 23.002 [60].

As can be seen in figure 5.1, the following CS and PS nodes are relevant for charging:

- EIR;
- (G)MSC server;
- GGSN;
- HLR;
- SGSN;
- VLR.

'Editor's note: consider adding a second diagram (3GPP TS 32.200 figure 4.2?) to depict the logical charging architecture, i.e. showing the reference points to the BD and the OCS.

5.1.2 WLAN architecture

'Editor's note:to be completed with information from 3GPP TS 23.234 [64].

5.2 Subsystem level

This clause presents the logical architecture for the subsystems specified in 3GPP, comprising the IP multimedia subsystem (IMS).

5.2.1 IMS architecture

Figure 5.2 depicts the logical IMS architecture, as described in 3GPP TS 23.002 [60].

Editors note: Crosscheck with the latest Rel-6 IMS Architecture TS is required to assure consistency (e.g. add the AS) and to choose the proper reference for this diagram (23.002, 23.228, etc..).

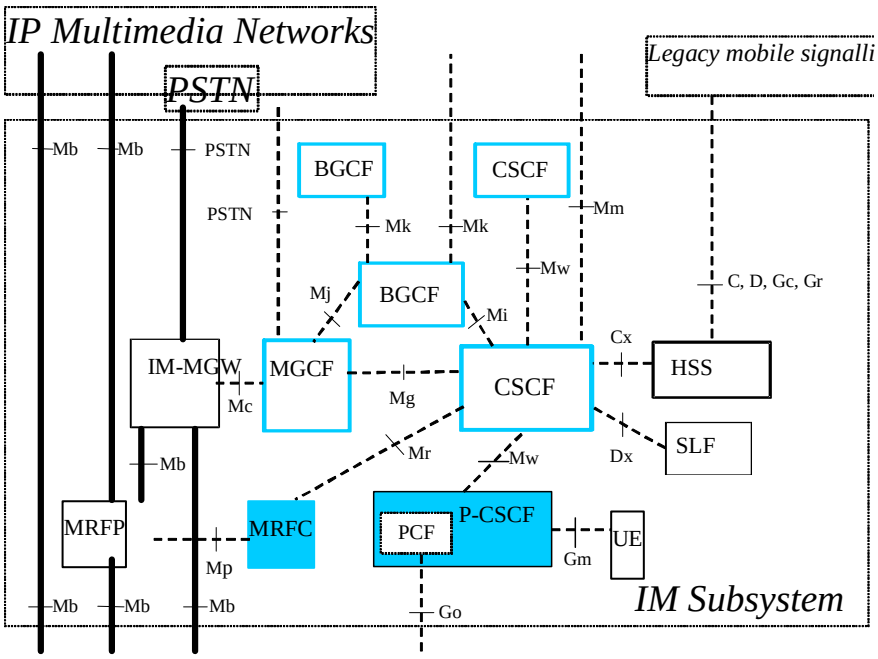


Figure 5.2: Overview of the IM Subsystem entities

As can be seen in figure 5.2, the following IMS nodes are relevant for charging:

- AS;
- BGCF;
- (I-/P-/S-) CSCF;
- MGCF;
- MRFC.

'Editor's note: consider adding more diagrams (TS 32.200 figure 4.4, 4.5, 4.6?) to depict the logical charging architecture, i.e. showing the reference points to the BD and the OCS.

5.3 Service level

This clause presents the logical architecture for the services specified in 3GPP, comprising MMS and LCS.

'Editor's note: cover OMA services (e.g. PoC)?

'Editor's note: add Rel-6 services as they become stable, e.g. Push, Presence, Messaging, MBMS.

5.3.1 MMS architecture

Figure 5.3 depicts the MMS reference architecture, as described in 3GPP TS 23.140 [62] and identifies reference points within an MMSNA.

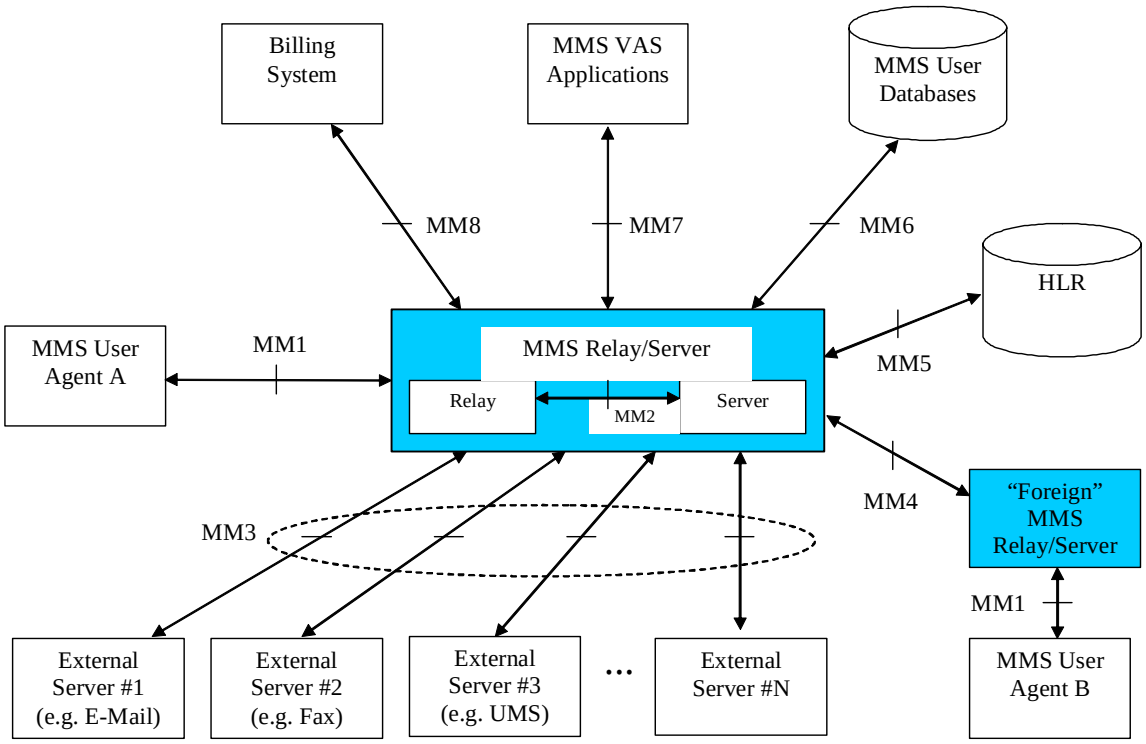


Figure 5.3: MMS Reference Architecture

'Editor's note: it is under discussion with T2 how to enhance this diagram in order to specifically show online charging (e.g. create new reference point, upgrade MM8 such that OCS is shown as additional destination, ….).

The reference point in the MMS Reference Architecture that are relevant for charging are:

- MM1: The reference point between the MMS User Agent and the MMS Relay/Server.
- MM4: The reference point between the MMS Relay/Server and another MMS Relay/Server that is within another MMSE.
- MM7: The reference point between the MMS Relay/Server and MMS VAS Applications.
- MM8: The reference point between the MMS Relay/Server and a billing system.

As can be seen in figure 5.3, the following MMS nodes are relevant for charging:

- MMS Relay/Server;
- "Foreign" MMS Relay/Server.

5.3.2 LCS architecture

Figure 5.4 depicts the logical LCS architecture, as described in3GPP TS 23.271 [63].

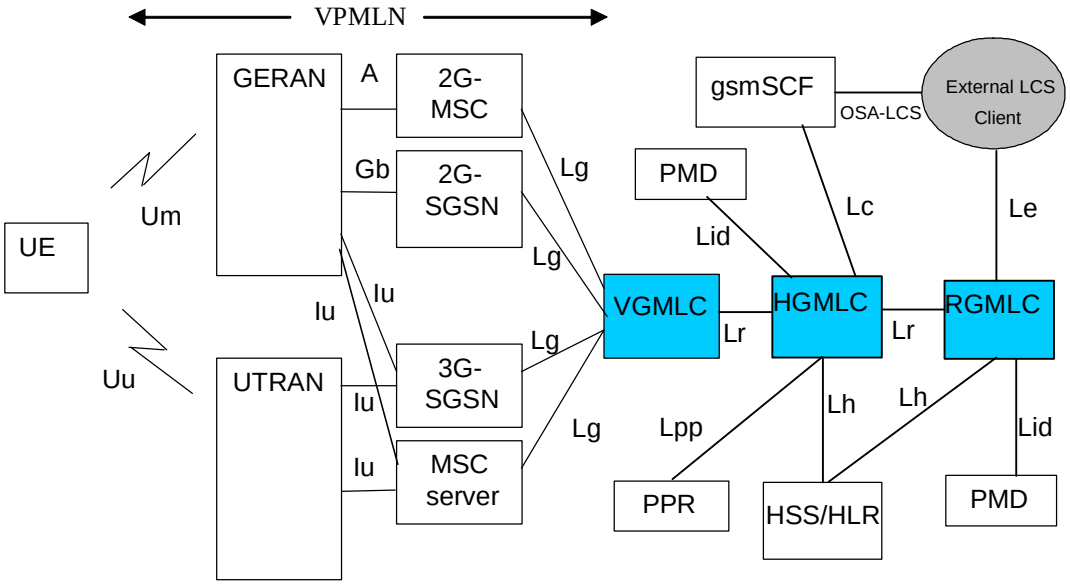


Figure 5.4: LCS logical architecture with inter-GMLC [Lr] interface

The HPLMN is the focal point for authorizing a location request issued as part of a value added Location Based Service. A Location Based Service is in general operated by a service provider which commercially may or may not be an integral part of a PLMN. Technically, the service provider can simply be considered as an LCS client.

In order to obtain the location of the target subscriber, the service provider will need to address the LCS request to a PLMN for further processing. The architecture endorsed in 3GPP TS 23.271 [63] supports the following cases:

- The LCS request is addressed to the HPLMN.
  - In this case the HPLMN will handle the location request completely on behalf of the requesting entity. I.e. the HPLMN will check whether the request is properly authorized and will determine the location of the target subscriber. Where the target subscriber is roaming, the HPLMN will forward the location request to the 'subscriber's current serving network for further processing. The result (i.e. the 'subscriber's current location) will be passed back to the service provider via the HPLMN.

- The LCS request is addressed to VPLMN.
  - In this case the VPLMN shall ask the HPLMN for authorization of the location request. Once the authorization has been performed by the HPLMN the VPLMN will handle the location request without further interaction with the HPLMN.
- The LCS request is addressed to a third PLMN "("Requesting PLMN") which is neither the HPLMN nor the VPLMN but handles the LCS request on behalf of the service provider.
  - In this case the Requesting PLMN shall forward the LCS request to the HPLMN who shall handle the location request in the same manner as for the scenario where the service provider has addressed the HPLMN directly. The result of the location request, however, shall be passed back to the Requesting PLMN who in turn will pass it back to the requesting service provider.

The "Requesting GMLC" is the GMLC, which receives the request from LCS client. The "Visited GMLC" is the GMLC, which is associated with the serving node of the target mobile. The "Home GMLC" is the GMLC residing in the target 'mobile's home PLMN, which is responsible for the control of privacy checking of the target mobile. The Requesting GMLC can be the Visited GMLC, and either one or both of which can be the Home GMLC at the same time.

'Editor's note: the above text (from underneath figure 5.4) is under discussion and may be modified or removed.

As can be seen in figure 5.4, the following MMS nodes are relevant for charging:

- VGMLC;
- HGMLC;
- RGMLC.

'Editor's note: consider adding a second diagram (TS 32.200 figure 4.2?) to depict the logical charging architecture, i.e. showing the reference points to the BD and the OCS.

5.4 Online Charging System (OCS) architecture for GSM and UMTS

Figure 5.5 defines a general reference architecture for online charging that is designed to support online charging mechanisms for bearer charging, service charging as well as for IMS charging based on the reference architecture for IMS online charging.

'Editor's note: Figure 5.1 from 3GPP TR 32.815 shall be added in a revisable layout.

6 Common charging architecture

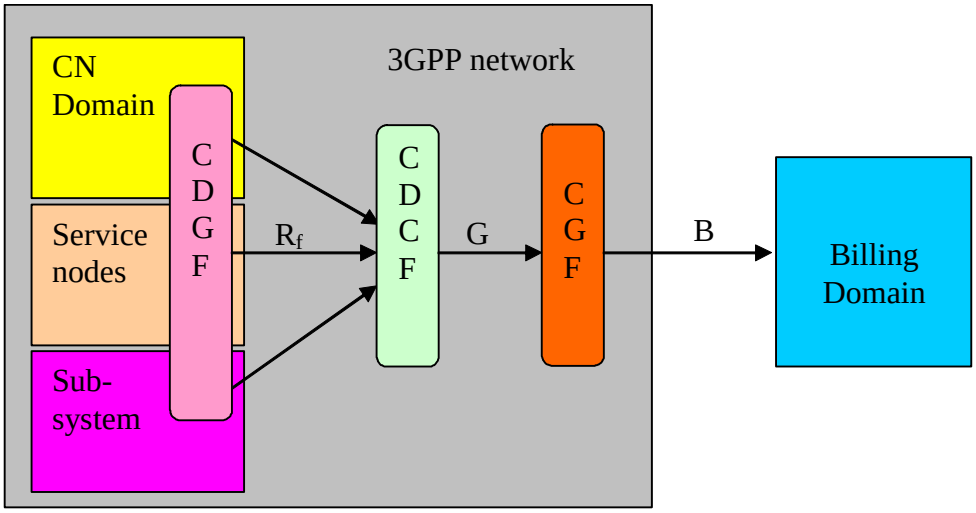
From the architecture figures above it is obvious that there are architectural differences between the CS, PS, Service domains and the IMS. Clearly the way in which the charging functions are embedded within the different domains and subsystems must take into account those architectural differences. However, the functional requirements for charging are always the same across all domains and subsystems. This clause describes a common approach for the definition of the charging functions, which provides a ubiquitous logical charging architecture for all GSM and UMTS network domains and subsystems relevant for charging standardization.

The mapping of the common architecture onto each domain, subsystem or service is described in the respective TS of the 32.25x-series - 32.27x-series.

6.1 Offline charging

6.1.1 Charging functions

Figure 6.1 provides an overview of the offline part of the common charging architecture. It will be detailed further in the following clauses. The arrows depict the direction of the charging information flow, where R_f carries charging events, G_a carries CDRs and B_x carries CDR files.



CDGF: **C**harging **D**ata Generation **F**unction
CDCF: **C**harging **D**ata **C**ollection **F**unction
CGF: **C**harging **G**ateway **F**unction
BD: **B**illing **D**omain. This may also be a billing system/ billing mediation device.

Figure 6.1: Logical ubiquitous offline charging architecture

6.1.1.1 Charging Data Generation Function (CDGF)

Every network and service node that provides charging information relies on the Charging Data Generation Function (CDGF) as the focal point for collecting the information from distributed devices in the node, assembling the information into reasonable sets of parameters, and sending them towards the Charging Data Collection Function. The CDGF is therefore a mandatory component in all network nodes. It is made up of two functional blocks:

- Accounting Metrics Collection Function
  - The node that performs signalling functions for calls or sessions established by the network users, or handles user traffic for these calls or sessions, or is involved in service delivery to the user via these calls or sessions, is required to provide metrics that identify the user and the 'user's consumption of network resources and/or services. Usually, these signalling, traffic and service handling functions are distributed across several physical hardware components that together make up a network node. Therefore, from a logical viewpoint, a "central" component in the network node is necessary that collects the metrics from the distributed components and puts them into the context of the user call, session, or service.
- Accounting Data Forwarding Function
  - This function receives the sets of accounting metrics, as assembled by the Accounting Metrics Collection Function, and forwards the events towards the Charging Data Collection Function.

6.1.1.2 Charging Data Collection Function (CDCF)

The Charging Data Collection Function (CDCF) is the receiving and collection function of the accounting metrics, which are received from the Charging Data Generation Function as charging events. I.e. the CUF is the server function of the CDF. The results of the CUF task are billing-suitable charging data records within a defined format. The 3GPP recommends the ASN.1 format. The content and format of these CDRs correspond to the CDR description in the related 3GPP charging specification (e.g. 3GPP TS 32.250 [10] for the CS domain and 3GPP TS 32.251[11] for the PS domain).

- The CUF may be supported as an integrated functionality of the network node. or as a separate network node e.g. integrated into the CGF In case of the separate configuration a charging protocol is used for transfer of the charging usage data e.g. for IMS the Rf reference point is supported.
- The CUF with its client CDF is the call-, session- or event related part of the charging architecture for CDR generation.
- The CUF can operate with one CDF client (i.e. for one NN or NN-integrated). Alternative the CUF can operate with n CDF clients in order to correlate the accounting metrics from different N.N. to one CDR.

6.1.1.3 Functions of the Charging Gateway

The Charging Gateway Function (CGF) acts as a gateway between the CUF and the BD. The CGF can be NN-integrated which implies that the CUF is also NN-integrated or external. In case of the separate configuration a charging protocol for CDR transfer is used, e.g. for PO domain the Ga reference point or simple file transfer mechanism with FTP. The entity relationship between the CUF (and thus the NN) and the CGF is m:n in the case of external CGFs. Depending on the location and operation purpose the CGF can be cascaded, e.g. a local CGF is cascaded with a central CGF, in order to support simultaneously safety by local storage capability and functionality by correlation option for CDRs from different NNs. The CGF provides the mechanism to transfer charging information from the Charging Usage Data Collection Function to the network operator's chosen BD and comprise the following main functions:

- CDR File Management.
  - The CDR File Management Function stores the formatted CDRs in files on a permanent storage device.
- Interface support to BD.
  - It also manages the exchange of these files with the BD, including the removal of the CDR files from the CDR File Management Functions file store, across the Bx interfaces, see 3GPP TS 32.297 [42].
- Charging Data Reception.
  - The Charging Data Reception Function is an optional component of the CGF that is only needed if the CGF is physically separate from the NN. It contains the protocol provider for the interface to the CUF (e.g. Ga in the case of PO domain). It receives CDRs generated by the CUF.
  - Some additional function should be also supported, which depends on vendor and operator requests. Details of these functionalities are outside the scope of 3GPP standardization.
- Validation and (Re-) Formatting.
  - The CDR Validation and Formatting Function checks the charging data sets received from the CUF for syntactical correctness. Operator specific CDR format is supported.
- CDR Pre-processing.
  - The CDR Pre-processing Function is an optional component of the CGF. If present, it may perform specific activities, such as consolidation of CDRs, pre-processing of CDR fields, filtering of un-required CDR fields, and adding of Operator specific parameters defined fields. These specific activities may be performed to optimize the charging information that is to be forwarded to the Billing Domain, which should reduce the load in the operators post-processing system.

- CDR correlation.
  - CDRs from different NN belonging to the same service can be correlate before provision to the BD e.g. in order to reduce the CDR load.

6.2 Online charging

'Editor's Note: This clause was copied from TS 32.200 and should be subject for further study, including alignment with 3GPP TS 32.296. The existence of SCCF and CPCF in Rel-6 are under study.

Based on the reference architecture for IMS online charging and the requirements for all other domains and services, a general architecture for online charging is defined (see figure 6.2) that is designed to support online charging mechanisms for bearer charging, service charging and IMS charging.

[figure defined in TR 32.815 should be transformed]

Figure 6.2: Logical ubiquitous offline charging architecture

CS and PS domain access online charging are performed using the CAP interface from the MSC and SGSN to the Bearer Charging Function (BCF) refer 3GPP TS 23.078 [61]. Other network entities in the access domain using the Ro reference point or variants thereof towards.

The Session Charging Function (SCF) is responsible for Session Charging including the session control such as e.g. session termination and is using the Ro reference point.

The Event Charging Function (ECF) performs event-based charging (content charging) and use the Ro reference point. It makes use of the rating function in order to determine the value of the service rendered. The ECF may correlate several event-based charging requests. The ECF provides information via the Rc reference point that triggers the Account Balance Management Function to debit or credit the subscriber's account. Additional information sent by the ECF may also be used in the Account Balance Management Function to correlate Event Charging with Bearer Charging and Session Charging.

The Subscriber Content Charging Function (SCCF) is always located in the same operator network as the account of the subscriber. The SCCF handles content charging requests that are made when the subscriber accesses the content. Upon such a content charging request, the SCCF may for example request the Correlation Function to check or to debit the subscriber's account. Content charging requests are received from the Content Provider Charging Function (CPCF). In particular, the SCCF has the following responsibilities:

- to handle charging requests from the CPCF;
- to obtain the identity of the subscriber's account;
- to initiate a procedure to get a charging confirmation from the subscriber, if such a confirmation is needed;
- to request to debit or to credit a certain amount from/to the subscriber's.

The Content Provider Charging Function (CPCF) manages the account that is maintained for the content provider. Upon receipt of a charging request from the service node, the CPCF processes the request and relays it to the SCCF. The CPCF modifies the account of the content provider accordingly. In particular, the CPCF has the following responsibilities:

- to handle charging requests from the service node.
- to interact with the SCCF that manages the communication with the subscriber's account. This interaction may include requests to the SCCF to charge or to credit the account of the subscriber. The Re reference point allows the interaction with a Rating server.

The Account Balance Management Function (ABMF) allows the interaction between Charging Functions (BCF, SCF and ECF) and to access the account of the subscriber and correlation information using the Rc reference point.

7 Charging principles

'Editor' note: the text below is still domain specific in several parts (originating from older domain specific TSs), refinement is needed to make it generally applicable. Also cleanup of references is needed.

7.1 Charging requirements from 3GPP TS 22.115

The following high-level requirements summarize the more detailed requirements of 3GPP TS 22.115 [52].

1. to provide a CDR for all charges incurred and requiring settlement between the different commercial roles (see 3GPP TS 22.115 [52]);
2. to allow itemized billing for all services (including CAMEL) charged to each subscription, including voice and data calls, and services offered by home environments, taking into account:
   - information provided by the user (including authentication parameters, etc.);
   - information provided by the serving network (including Serving Network Id, timestamps, etc.);
   - information provided by the service (including charged party, long calling, multimedia, etc.).
3. to allow fraud control by the Home Environment and the Serving network.

7.2 Charging information

The MSC server and Gateway MSC server are responsible for the collection of all charging relevant information for each MS and PSTN connection and for the storage of this information in the form of CDRs.

Circuit switched calls can be charged in one MSC server (the anchor MSC server) where all relevant data is available. That is guaranteed by routing all signalling information though the anchor MSC server even if the traffic channel of a call is routed through another MSC server due to handover.

The Gateway MSC server acts as a gateway into other PLMN or fixed networks. Within the PLMN, the GMSC server is responsible for the generation of CDRs for calls routed from or into other networks.

If subscribed CAMEL services apply to MS, the (G)MSC servers contain CAMEL subscription data providing the information required for invocation of the CAMEL dialogues for controlling the MS terminating and MS originating calls. Charging data record parameters resulting from the CAMEL treatment applying to MS calls is derived from the CAMEL subscription data.

In addition to user subscribed services, specific dialled CAMEL services might be invoked which also influence existing records or even trigger the generation of separate records steered by service logic.

In addition to the information collected from these network elements, network management functions are required for the administration of on-line charging data stored in the MSC servers. This data is employed to drive the charge display in the Mobile Station (MS) as required by the Advice of Charge (AoC) service and defined by 3GPP TS 22.086 [TBD] and 3GPP TS 22.024 [TBD].

7.2.1 Subscriber billing

The charging data collected from the HPLMN, interrogating PLMN, and/or VPLMN network elements is employed to determine the network utilization charges for the basic and supplementary services utilized by the home subscribers of the PLMN. The charges calculated are then combined with the network access (subscription) charges and billed to those customers directly serviced by the PLMN.

For those subscribers handled by Service Providers, the billing information is employed for both wholesale (Network Operator to Service Provider) and retail (Service Provider to Subscriber) billing. Consequently, having been processed by the PLMN Billing System, the charging data collected from the network elements may also be sent to the Service Provider for further processing.

7.2.2 Settlements of Charges

7.2.2.1 Inter-PLMN accounting

Inter-PLMN accounts for roaming traffic are determined in accordance with ITU-T principles (see ITU-T Recommendation D.93 [101]) and are settled by means of the GSM Association's Transferred Account Procedure (TAP).

7.2.2.2 'Visitors' from other PLMNs

The CDRs collected from the network also include details of the services employed by visiting (roaming) subscribers. The charges for MOMobile Originated Calls (MOCs) and for supplementary services used are calculated as for home subscribers, converted to an agreed accounting currency and included in the CDRs for the TAP. Even if MTCMobile Terminated Calls (MTCs) are zero-priced in the visited network (VPLMN), in the absence of 'optimized routing' the MTC TAP records are still required by the home network (HPLMN) in order to determine the re-routing charges from the HPLMN to the VPLMN.

The TAP records generated are exchanged with each HPLMN on a regular basis. These TAP records form the basis of the invoice submitted by the VPLMN for the traffic carried.

7.2.2.3 'Home' subscribers roaming in other PLMNs

The HPLMN receives TAP records from each VPLMN for services employed by home subscribers whilst roaming. These records are employed to verify the invoices from the VPLMN and to bill the home subscribers for the services used. The charges contained in the TAP records are converted from the accounting currency to the local currency and a handling surcharge (mark-up) is added if required. The TAP records are subsequently passed to the subscriber billing process described in clause 5.1.2.1.

7.2.2.4 Fixed network operators and other service providers

The settlement of accounts with the operators of fixed networks for traffic carried, is generally performed on a bulk basis according to the principles outlined in the ITU-T D-series recommendations.

The traffic accounted for in this manner may include:

- outgoing (Mobile to Land) traffic;
- incoming (Land to Mobile) traffic;
- transit traffic, carried by intermediate networks;
- signalling (MAP/SCCP, CAP/SCCP) traffic such as location updates.

Accounting information may also be required for the use of services provided by other operators such as short message service centres and other Value Added Service (VAS) providers.

The charges for the various traffic shares may be determined on the basis of the CDRs generated by the network elements or on the basis of bulk counters (accounting meter records) in the gateway MSC servers (GMSC servers). For the purpose of the present document, the management information required is assumed to be derived from CDRs. The management of accounting meters is outside the scope of the present document.

7.2.3 Service information

The charging data collected from the network elements may be used to provide statistical information concerning the use of services, by both home and visiting subscribers, within the network. In addition, the introduction of new services and/ or modifications to the tariffs of existing services may also require the distribution of the appropriate tariff information to the network elements for Advice of Charge purposes.

7.3 General aspects of Charging Data

Charging Data Record (CDR) generation and contents should be flexible and unnecessary redundancy in data should be avoided. Charging data are collected for successful and selected unsuccessful subscriber transactions. The subscriber transaction is seen as being successful in the MSC server (where the CDR is generated) either if a call is answered or if the Short Message Service Centre has confirmed the successful receipt of a mobile originated short message.

Unsuccessful call attempts are recorded in the case of partial record generation due to CAMEL FollowOnCalls. If in such a call constellation the answer state is reached at least once, subsequent unsuccessful set-up of a connection configuration is also recorded in order to provide a complete sequence of FIRST, INTERMEDIATE and LAST records.

Charging data is also collected for supplementary service activity.

At termination of the subscriber transaction these data are formatted into CDRs. These records are forwarded onto MSC server's disk file which constitute the source for further transportation of that data to a Billing System. For the purpose of the present document, the CDRs are considered to be collected, in near real-time, by the following network elements: the MSC servers, MGWs, and location registers.

The data collected by the network elements are sent to, or collected by, the appropriate Billing System for storage and further processing.

Similarly, the tariff data required by the network elements to provide on-line charging information are distributed by the appropriate management system.

7.4 Charging data configuration

'Editor's note: This clause should be explaining the common usage of CDR categories.

A logical diagram showing the possible field categories is shown in figure 7.0.

The content of the CDRs shall be specified on all the open network interfaces that are used for CDR transport. They include the CDCF - CGF interface and the outward interface from the core network to the BD. The rules governing the CDR specifications on these interfaces are summarized in the following clause.

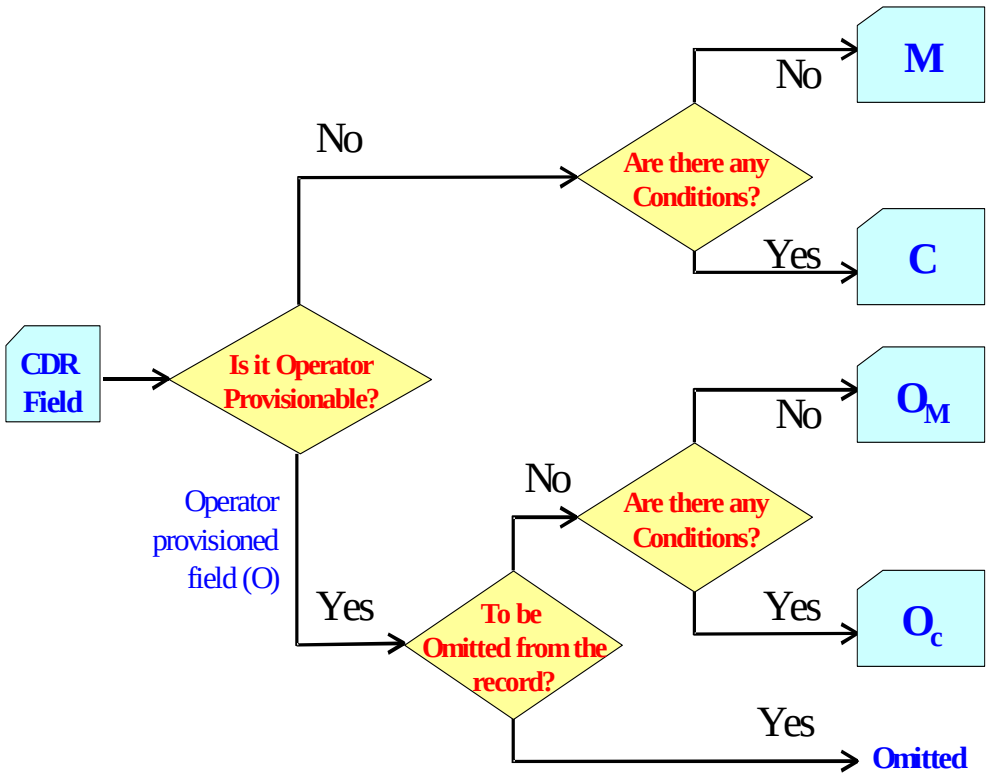


Figure 7.0: Logical diagram illustrating the different CDR field categories

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 **M**andatory 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 CDR tables provide a brief description of each CDR parameter in the corresponding ‘middle 'tier' TSs. The full definitions of the parameters, sorted by the parameter name in alphabetical order, are provided in 3GPP TS 32.298 [41].

8 Architecture mapping

'Editor's note: This clause will eventually be moved to the domain/subsystem/service specific TS (i.e. the middle tier TSs).

8.1 Offline mapping

This clause describes how the ubiquitous offline charging architecture maps onto the CS, PS, Service domains, and the IMS. It should be noted that all architecture diagrams and descriptions define only logical and functional architectures. The physical implementation is vendor specific and out of scope of standardization.

The implementation of a CUF or CGF may support one or more nodes of one or more domains in any combination, as determined by the manufacturer and may be supported in one of the following ways:

- as a centralized separate network element: the Charging Gateway(GW);
- as a distributed functionality resident in the NNs.

The figure 7.1 gives an overview of the two basic configurations: the NNs support an external interface to the charging gateways they are connected to and the NNs support the charging gateway functionality internally. The support of a centralized or distributed CGF in a network is implementation dependent and subject to vendor/manufacturer agreement. Regardless of the way in which the CGF is supported in the network, the functionality of the CGF is similar.

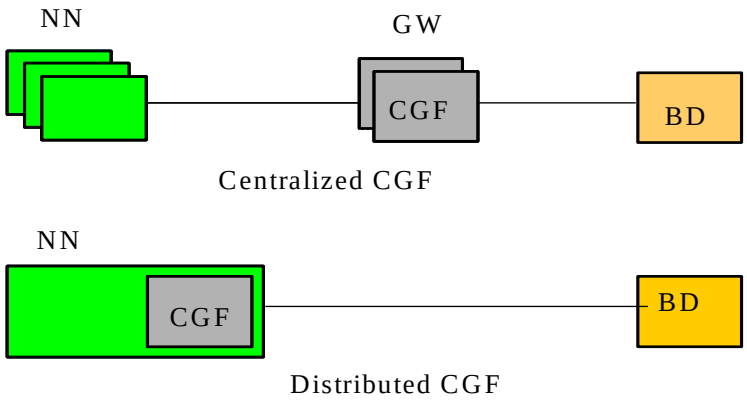


Figure 7.1: Basic architectural scenarios for the CGF location

If the NNs with an internal CGF also support the external interface, additional configurations as shown in figure 7.2 are possible: the NN with integrated CGF also acts as CGF for other NNs and the NN with integrated CGF also supports the transmission of CDRs to external CGFs via Bx interface.

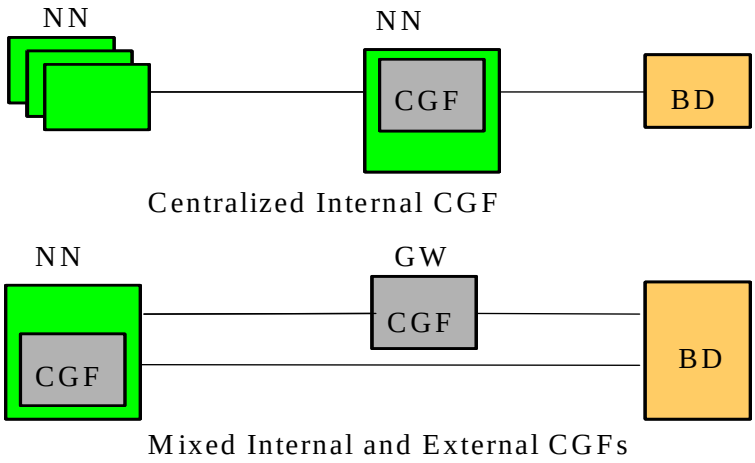


Figure 7.2: Optional scenarios for the CGF configuration

The four scenarios in figures 7.1 and 7.2 are not exhaustive.

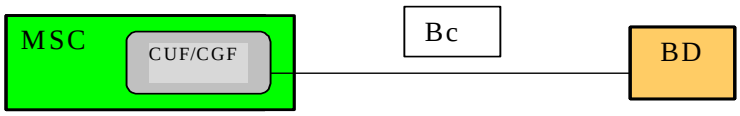
8.1.1 Circuit Switched (CS) domain

In the CS domain, CDRs may origin from the following nodes:

- The MSC (server). This may either be an originating, terminating, gateway, transit, SMS gateway, or SMS interworking MSC.
- The HLR, to record HLR location updates, supplementary service actions, or HLR interrogations.
- The VLR to record location updates.
- The GMSC/gsmSSF for terminating CAMEL call attempts.

In all the above cases, a CUF/CGF are always integrated in the network node. There is no open interface between these components, and there is always one CUF/CGF per node.

Figure 7.3 shows the MSC (server) scenario as an example. The Bc interface corresponds to the file-based interface to the BD as specified in 3GPP TS 32.297 [42]. Note that the MSC (server) comprises a CUF, while all other CS nodes that may generate CDRs comprise a CGF.



MSC: The core switching function (**M**obile-services **S**witching **C**enter).
Bc: The file oriented Billing Interface between the CS and the BD.

Figure 7.3: Ubiquitous offline charging architecture mapped on the CS domain

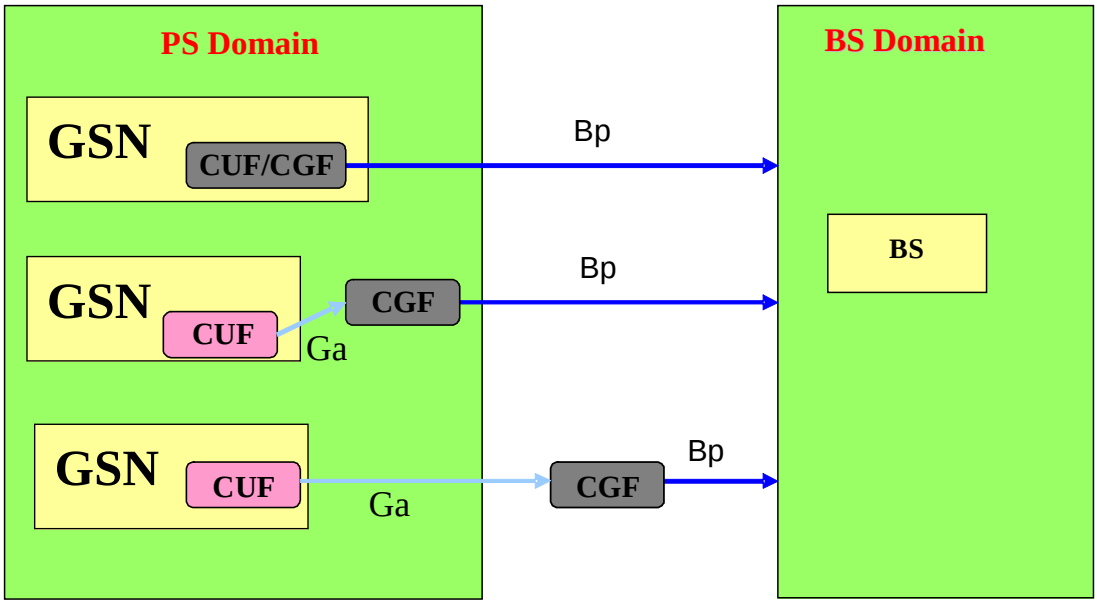
8.1.2 Packet Switched (PS) domain

Accounting metrics sets for PS domain CDRs may be generated by the following nodes:

- The SGSN, to record a 'user's access to PLMN resources, mobility management activities, and SMS usage.
- The GGSN, to record a 'user's access to external networks.

Each GSN has an integrated CUF. If the CGF is also integrated in the GSN, then the open Ga interface does not exist, there is only an internal interface between the CUF and the CGF. The relationship between GSN/CDCF and CGF is 1:1. If the CGF is external to the GSN, then the CUF forwards the usage data records to the CGF across the Ga interface, specified in 3GPP TS 32.250 [10]. In this case, the relationship between GSN/CUF and CGF is m:n, with m ≥ n.

Figure 7.4 depicts the architecture mapping for the PS domain.



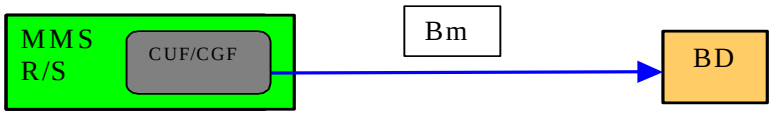
GSN: The core packet switching function (**G**PRS **S**upport **N**ode).
Bp: The file oriented Billing Interface between the PS domain and the billing domain.
Ga: The transaction oriented interface to push accounting metrics sets from the GSN to the external CGF.

Figure 7.4: Ubiquitous offline charging architecture mapped on the PS domain

8.1.3 Service domain

The architecture for service charging is the same as for the CS domain. The 3GPP specifications 3GPP TS 32.270 [30] defines the MMS charging of the MMS Relay/Server (MMS R/S) and 3GPP TS 32.271 [31] the LCS charging of the GMLC. These contain the CDR descriptions and their format. The usage of the file based interface employed to transfer the Service-CDR files from the CDR generating node to a post-processing system residing in the 'operator's billing domain are defined in 3GPP TS 32.297 [42].

In the case of MMS, the MMS Relay/Server has an integrated CUF and CGF. Figure 7.5 shows the offline charging architecture mapping for MMS and other SN that incorporate a CUF/CGF with the external Charging Gateway with CGF.



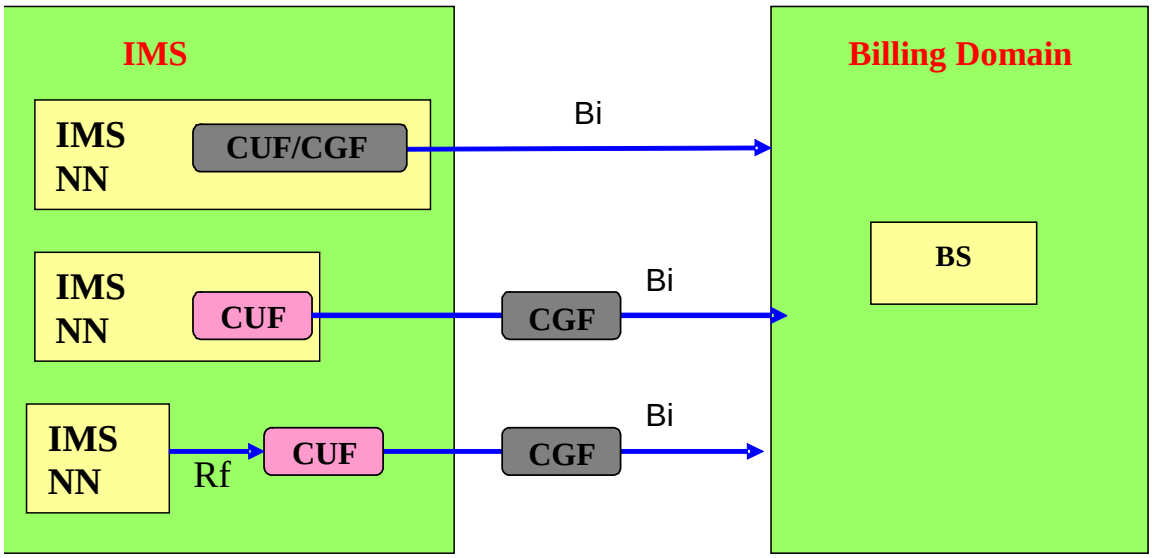
MMS R/S: The **MMS R**elay **S**erver.
Bm: The file oriented Billing Interface between the MMS R/S and the billing domain.

Figure 7.5: Ubiquitous offline charging architecture mapped on the service domain

Editor's note: This clause should also include the Rel-6 services (e.g. LCS).

8.1.4 IM subsystem

Figure 7.6 shows the ubiquitous charging architecture mapped onto the IM domain.



IMS NN: IP Multimedia subsystem network nodes include means P-, I- and S-CSCF, MRFC, MGCF, BGCF and the SIP based AS.
CUF: Charging Usage Data Collection Function, which creates and reselected the IMS-Node-CDRs.
Bi: the file oriented Billing Interface between the IMS and the BD.
Rf: the transaction oriented interface to push charging usage data from the IMS NN to the external CUF.

Figure 7.6: Ubiquitous offline IMS Charging architecture

Editors Note: As is easily visible from figure 7.6, the changes necessary to make the architecture as described in 3GPP TS 32.260 [20] compatible with the ubiquitous charging architecture are very small. In essence, it requires only an alignment of terminology and a consistent set of features attributed to the generic functions, as has been described in clause 2 of this contribution.

8.2 Online mapping

Tbd.

Annex A (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
Dec 2003	S_22	SP-030623	--	--	Submitted to TSG SA#22 for Information	1.0.0	