

CDR-INSIGHT PROJECT

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|-----------|-------|------------------------------|
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| 3/3/2016 | 1.2 | Muhammad Zahalqa |
| 4/5/2016 | 1.3 | Muhammad Zahalqa |
| 20/7/2017 | 1.4 | Muhammad Zahalqa |
| 31/7/2017 | 1.4.1 | Alex Katz - typo cleaning |

1 Scope

The present document is part of a series of documents that specify charging functionality and charging management in GSM/UMTS and EPS networks.

Specifically, this document describes the handling of CDR files by a processor for charging purposes. Where charging is mediated by processing large files containing CDR records describing services consumed by subscribers.

Each CDR record contains descriptions of charging events such as voice calls and SMS messages with all relevant data.

The processor will produce billing for subscribers and for third party operators that were involved in the service.

2 Definitions, symbols and abbreviations

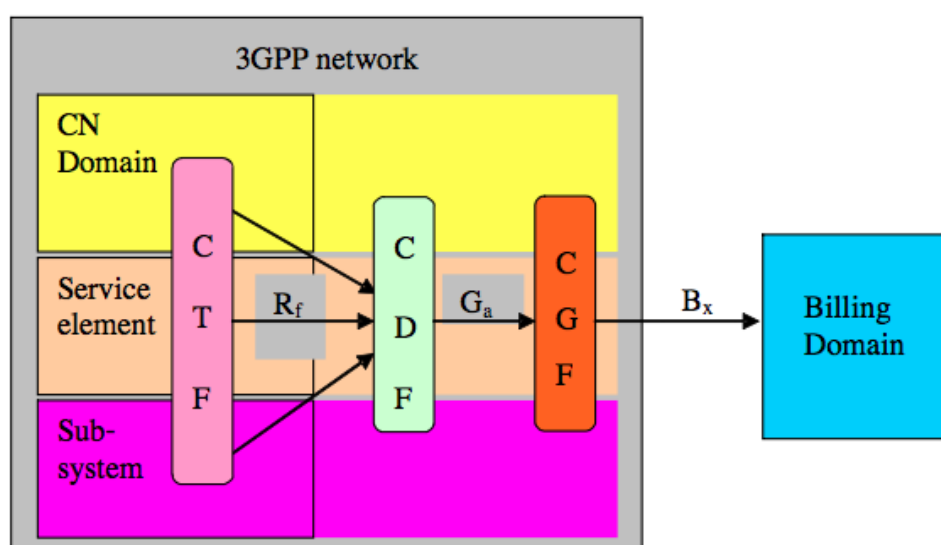
2.1 Definitions

- **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.
- **Accounting:** process of apportioning charges between the Home Environment, Serving Network and Subscriber.
accounting meter record: record containing one or more counters employed to register the usage of resources en
- **Billing Domain:** part of the operator network, which is outside the core network, which 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).
- **Charging Data Record (CDR):** 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.
- **GPRS:** packet switched bearer and radio services for GSM and UMTS systems.
- **Subscriber:** 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.
- **Successful call:** connection that reaches the communication or data transfer phase e.g. the "answered" state for speech connections. All other connection attempts are regarded as unsuccessful.

2.2 Abbreviations

| | |
|--------|--|
| BD | Billing Domain |
| CDR | Charging Data Record |
| CG | Charging Gateway |
| IMEI | International Mobile Equipment Identity |
| IMSI | International Mobile Subscriber Identity |
| MMS | Multimedia Messaging Service |
| MO | Mobile Originated |
| MOC | MO Call |
| MSISDN | Mobile Subscriber ISDN Number |
| MT | Mobile Terminated |
| MTC | MT Call |
| SIM | Subscriber Identity Module |
| SMS | Short Message Service |

3 Common charging architecture



CTF: Charging Trigger Function
CDF: Charging Data Function
CGF: Charging Gateway Function
BD: Billing Domain. This may also be a billing system/ billing mediation device.

4 Charging Mechanisms

4.1 Mechanisms

GSM/UMTS/EPC networks provide functions that implement offline and/or online charging mechanisms on the bearer (e.g. EPC), subsystem (e.g. IMS) and service (e.g. MMS) levels. In order to support these charging mechanisms, the network performs real-time monitoring of resource usage on the above three levels in order to detect the relevant chargeable events.

Typical examples of network resource usage are a voice call of certain duration, the transport of a certain volume of data, or the submission of a MM of a certain size. The network resource usage requests may be initiated by the UE (MO case) or by the network (MT case).

4.2 Offline Charging

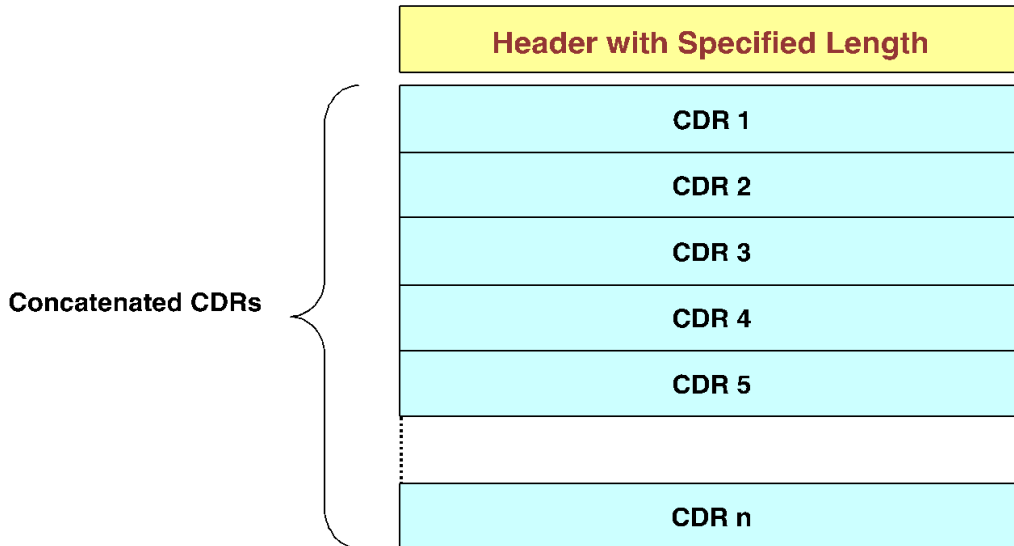
Offline charging is a process where charging information for network resource usage is collected concurrently with that resource usage. The charging information is then passed through a chain of logical charging functions.

At the end of this process, CDR files are generated by the network, which are then transferred to the network operator's BD for the purpose of subscriber billing and/or inter-operator accounting (or additional functions, e.g. statistics, at the operator's discretion). The BD typically comprises post-processing systems such as the operator's billing system or billing mediation device.

4.3 CDR File Format

4.3.1 File format principles

The CDR files contain a header section followed by a variable sized CDR data section. The CDR data section contains zero or more concatenated CDR records. Each CDR record is encoded on a single line.



4.3.2 CDR Format

CDR record is composed of the following fields separated by |

- IMSI
The ITU-T recommendation ITU E.212 limits the maximum length of an IMSI to 15 digits.
- MSISDN
Number uniquely identifying a subscription in a mobile network.
The ITU-T recommendation E.164 limits the maximum length of an MSISDN to 15 digits.
- Subscriber IMEI
The Subscriber Equipment Number field contains the identification of the mobile device
- Operator Brand Name
Operator Brand Name, a string of maximum 64 chars. Such as "Cellcom Israel"
- Operator MCC/MNC tuple
Mobile Country code is a 3-digit value
Mobile Network Code is a 2-3-digit value
i.e.:
 - o Cellcom Israel Ltd is 42502
 - o Pelephone Communications Ltd. Is 42503See
https://en.wikipedia.org/wiki/Mobile_country_code_-_National_operators
- Call Type

- Call type, one of
 - o MOC outgoing voice call
 - o MTC incoming voice call
 - o SMS-MO outgoing message
 - o SMS-MT incoming message
 - o GPRS internet
- Call Date DD/MM/YYYY
- Call Time HH:MM:SS
- Duration in seconds
- Download MB downloaded if type is GPRS
- Upload MB uploaded if type is GPRS
- Party MSISDN Corresponding party in this call, empty for GPRS
- Party Operator Corresponding party's mobile operator in this call

5 Processing Functions

The processor of the CDR files will be fed daily CDR files in a specific configurable directory.

These are usually large files (1-5 GB) and are copied to the directory by a remote process during the day as they are continuously collected from the network switches.

Processor will read and process files in order to fulfill the following functions:

5.1 Billing

For each customer, identified by IMSI an aggregate information will be produced that will contain the total of

- Outgoing voice calls duration to a subscriber within the mobile operator
- Incoming voice calls duration to a subscriber within the mobile operator
- Outgoing voice calls duration to a subscriber outside the mobile operator
- Incoming voice calls duration to a subscriber outside the mobile operator
- SMS messages sent within the mobile operator
- SMS messages received within the mobile operator
- SMS messages sent outside the mobile operator
- SMS messages received outside the mobile operator
- MB downloaded
- MB uploaded

5.2 Inter Operator Settlement

For each mobile operator we will aggregate all:

- Incoming voice call durations
- Outgoing voice call durations
- Incoming SMS messages
- Outgoing SMS Messages

6 Charging Gateway Function

The system will contain a charging gateway function (CGF) that enables interrogation of the system for aggregated data. In phase A it's required to support a human user and in phase B support for external systems integration via an API.

6.1 Required Functionalities of CGF

The system will support the following commands:

6.1.1 MSISDN Retrieve Query

Support retrieving information for one subscriber at a time. The subscriber will be identified by his MSISDN. The result will be formatted according to the description of one record in 7.1.

6.1.2 Operator Retrieve Query

Support retrieving information for one operator at a time. The operator will be identified by his MCC/MNC. The result will be formatted according to the description of one record in 7.2.

6.1.3 All Subscribers Report

Produce one file with one record for each subscriber containing aggregated information. This aggregated information will be imported to other systems for purposes such as billing.

See 7.1 for format of generated report file.

6.1.4 All Operators Report

Produce one file with one record for each operator containing aggregated information to be used in inter-operator settlement process.

See 7.2 for format of generated report file.

6.1.5 Aggregated Information

Produce charging files on receipt of triggers (see 8.4). These charging files will contain aggregated data for subscribers and operators.

7 Format of Output Report Files from CGF

The system will produce charging files on receipt of triggers. These charging files will contain aggregated data for subscribers and operators.

7.1 Subscriber's Billing

A file with a header having the following fields separated by “,” :

- Date in YYYY/MM/DD format
- Time in HH:MM:SS format

For each subscriber, one line record with following fields separated by “,” :

- IMSI
- Outgoing voice calls duration to a subscriber within the mobile operator
- Incoming voice calls duration to a subscriber within the mobile operator
- Outgoing voice calls duration to a subscriber outside the mobile operator
- Incoming voice calls duration to a subscriber outside the mobile operator
- SMS messages sent within the mobile operator
- SMS messages received within the mobile operator
- SMS messages sent outside the mobile operator
- SMS messages received outside the mobile operator
- MB downloaded
- MB uploaded

7.2 Inter-Operator Settlement

A file with a header having the following fields separated by “,” :

- Date in YYYY/MM/DD format
- Time in HH:MM:SS format

For each operator, one line record with following fields separated by “,” :

- Operator MCC/MNC
- Operator Brand name
- Incoming voice call durations
- Outgoing voice call durations
- Incoming SMS messages
- Outgoing SMS Messages

This will contain the accumulated services for inter-operator settlements.

At the end of the processing this will be saved to the inter-operator settlement file with fixed format as following:

Each record is fixed length containing:

- Operator code : string with max length of 16
- one record per operator. Each record is one line the following structure:

Operator Code | total SMS from | total SMS to | total Voice from |
total Voice To

8 Additional Requirements

8.1 Configuration

The system should be driven by configuration files.

For example: setting directories to be read from, number of threads, etc.

Configuration files should have ini file format:

```
[input]
fileMask = *.cdr
directory = /mnt/cdr
```

```
[output]
directory = /mnt/billing
```

```
[readers]
...
```

8.2 Log

The application will report to a log facility. Each module should report warning, errors, debug and other entries to it's own log if possible.

Operations department should be able to configure high detailed logs to gain visibility to everything in the system or to silence specific modules.

8.3 User interface

The application will display a user interface that enables operations to:

- Execute CGF commands, see 6.
 - Pause the system
 - Resume a paused system
 - Shutdown the system
- On shutdown also generate a report for billing, one file for all subscribers and one file for all operators.

8.4 Programmatic Interface

The application will respond to two user defined signals

- SIGUSR1 : generate a billing file with aggregated information for all subscribers relative to the already processed CDRs
- SIGUSR2 : generate a billing file with aggregated information for all operators relative to the already processed CDRs

8.5 Handle input files

Handling of input files should fulfill:

- Discover and process files as they appear in the input directory.
- Processed files should be moved to a “done” directory.
- The system should be able to handle more than one file simultaneously. Typically there will be 2-4 files delivered at once with a total of ~100 files per hour.
- Support future change of file format.
- Support concurrent processing of more than one file format
- Support receiving CDR data via means other than files.

8.6 Performance

The system should allow for high performance by utilizing the most out of the current hardware.

Assume we can put the incoming CDR data files on a file storage with high IO capacity.

9 Deliverables

9.1 High Level Design Document

A document in PDF format with high-level block diagram describing the system.

9.2 Detailed Level Design Document

A document in PDF format with

- Detailed level class diagram describing the system modules.
 - o Each module should describe the detailed implementation requirements and infrastructure dependencies.
 - o Each module should have it's threading requirements described.
- Sequence Diagram describing major interactions in the system.

9.3 Working Project

- A fully commented source code
- Makefile
- Unit tests for applicable infrastructure modules
- Readme file describing how to build and how to execute the system