# Customised Billing for Location-based Services

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**Abstract.** As the new communications era aims to provide mobile users with advanced and customised services, it becomes apparent that the requirement for intelligent charging and customised billing of service access emerges bravely. In that scope, the enrichment of mobile services with attributes related to user profiles, context, location, presence and other elements providing customization, affects also the charging process. In particular, the charging and billing for service access have to be more flexible and personalised, so that especial, customised billing for new location-based services and applications is enabled. Hence, charging information related to the user profile and preferences as well as the user location will also have to be encountered at the billing process. This paper presents an integrated architecture, which allows flexible charging and customised billing for the usage of location-based services.

## 1 Introduction

The emergency services offered by mobile network operators since 1998, was the first kind of location-based services. The cell-wide positioning information provided by that networks was not accurate, since the size of cells varies notably depending on location area due to differences in terrain and population density. Nowadays that the mature of positioning technologies enables the detection of persons and objects with much greater accuracy, mobile users start carrying their terminal devices (i.e. cellular phones, PDAs and laptops) not only for emergencies but basically for work and entertainment purposes. Hence, the user location detection is mainly used anymore for the provision of location-based information, guidance, and entertainment services.

Unlike applications that constitute transformation of applications originally developed for personal computers accessing the World Wide Web, to the constraints of mobile devices, location-based services take full advantage of the mobile device's portability. In that sense, location-based services may change the way consumers come to depend on their mobile equipment, since mobile users can get highly location-specific, real-time information at the precise moment they are making a decision. For example, a driver can be alerted to alternative traffic routes on a turn-by-turn basis, a traveler can be informed of the nearest hotel at night in an unknown city, etc.

In practice, mobile network operators, service and content providers, equipment vendors, handset manufacturers and software developers need to co-operate to bring efficient location-based services in the daily life of mobile consumers. The provision of advanced location-based services is a big opportunity for all business players involved to increase their revenues. Therefore, charging and billing for location-based services are crucial issues that should be addressed.

The charging criteria for location-based services seem to be different from the ones traditionally used in mobile networks such as measuring the connection time or data volume. Definitely, the time- or volume-based charging can of course still be used for the transport part of provided location-based services. However, the charging information related to the usage of location-based services concerns mainly the added value of such a service and content and is additional information to the transport level information. The introduction of location-based services in service provisioning opens up a large variety of new pricing models that can apply. It should be mentioned here, that apart mobile users the location-based service providers could also constitute potential charged parties. For example, push initiators can be charged for the services they offer.

This paper addresses the charging issues related to location-based services and introduces an integrated architecture that allows flexible charging and customised billing for advanced location-based services usage. In particular, next section introduces location-based services, and Section 3 discusses some charging issues related to location-based services. Section 4 describes the proposed integrated charging architecture, while an indicative example of its functionality is given in Section 5 and finally, Section 6 concludes the paper.

## 2 Typical Categories of Location-based services

The term "Location-based services" refers to services offered to mobile users in which the user location information is used in order to add value to the service as a whole. Currently the most common location-based services include "Yellow Pages" and "Point of Interest" that allow users to find the nearest hotel, pharmacy or cinema based on their current location. Other common location-based services provide navigation and traffic conditions information. Typical location-based services can be distinguished in five categories [1]:

- <u>Traffic coordination and management</u>
  Such services identify traffic jams and taking into account the current location of subscribers inform the subscribers driving around. Alternatively, they can determine the fastest route between two positions at the moment, estimate the total travel time, or provide alternative routes for the remaining travel.

- Location-aware advertising and general content delivery
  Whenever a subscriber indicates to the service that he is in “shopping-mode”, he receives sales information (e.g. discounts) based on his current location. Location information is used along with his shopping preferences included in an associated shopping profile so that better advertising service is provided (e.g., the user receives only advertisements related to his preferences).
- Integrated tourist services
  Such services may include from advertisement of the available options for numerous tourist services and guided tours, to accommodation information, transportation, cultural events and museum guides.
- Safety-related services
  It is possible to monitor tourists or workers traveling in dangerous terrain and guide them to desired destinations along safe paths.
- Location-based games and entertainment
  Examples of such services are the treasure hunting, and the location-based ICQ service.

## 3 Charging Issues Related to Location-based Services

Much effort have been put by the 3G Partnership Program (3GPP) [2] and the Open Mobile Alliance (OMA) [3] in standardizing location-based services. The 3GPP mainly focuses on the development and promotion of common and ubiquitous solutions for Location Services, which should be network independent. In particular, 3GPP has specified the stage 2 of the LoCation Services (LCS) feature in UMTS and GSM [4], which provides the mechanisms to support mobile location services for operators, subscribers and third party service providers. This service description [4] covers the LCS system functional model for the whole system, the LCS system architecture, state descriptions, message flows, etc., along with the operations performed by the LCS Server. The LCS Server is considered to be a software and/or hardware entity offering LCS capabilities. It accepts services requests and sends back responses to the received requests. The LCS server consists of LCS components (e.g., the GMLC), which are distributed to one or more PLMN and/or service providers [4].
On the other hand, the OMA continues the technical activities originated in the Location Interoperability Forum (LIF) [5] for the specification of the Mobile Location Protocol (MLP) [6]. The MLP is an application-level protocol for obtaining the position of mobile stations (mobile phones, wireless personal digital assistants, etc.) independent of underlying network technology. The MLP serves as the interface between a Location Server and a location-based service/application, acting as LCS client. Possible realization of such a Location Server is the 3GPP GMLC [4], which act as the front-end of the LCS Server defined in GSM and UMTS by 3GPP. In the most scenarios an LCS client initiates the dialogue by sending a query to the Location Server and the server responds to the query. The OMA MLP specification [6] defines the core set of operations that a Location Server should be able to perform.

Till now the LCS Server incorporated in the mobile operator's infrastructure provides charging information related to the LCS features usage. The charging information collected by the mobile operator is used only to charge LCS Clients for receiving information about the user location. In addition, 3GPP [7, 8] and researchers [9] have thoroughly studied an advanced location-based service providing subscribers with customised billing, the location-based charging. More specifically, the location-based charging is a flexible model that takes into account location information provided by the LCS Server of the network operator to provide subscribers with a customised charging scheme depending on its location or geographic zone. To elaborate, specifically, this service could apply reduced rates to those areas most often frequented by the subscriber by taking into consideration the subscriber's daily route and life style. For example, a "home" zone may be defined around a user's home, work or travel corridor. Additionally, different rates may be applied in different zones based on the time of day or week. Location-based Charging should analyze location information to compare against "home" zones established for the subscriber. The service would notify the subscriber of its relative location to the established "home" zones, indicating either "in" or "out" of zone, along with the associated tariffing and pricing policies.

The existing approaches in charging and location-based services attempt to cover different needs. Definitely, the "charging of location-based services" is something different from the "location-based charging" and the charging of the LCS Client for receiving information on the location of users. In order to enable customized charging and billing for location-based services, some unresolved charging issues remain.

Firstly, additional charging information in forms of Charging Data Record (CDR) is required [7]. The following additional information should be included:

- Type of the location-based service
- Identity of the location-based service
- Required location information accuracy
- Time stamps
- Type of user equipment

Additionally, the CDR should indicate the charged party, i.e. normally the calling party. Alternatively, it is possible the application of reverse charging or the charged party not to be involved in the chargeable event (e.g. a company). It should be possible for multiple leg calls (e.g. forwarded, conference or roamed) each party to be charged as if each leg was separately initiated. In any case the charged party should be provided with charging information accurately, and in time, so that is informed about expected call charges. Finally, the location-based service usage should be recorded on event, call or session basis [10]. This brings additional requirements for the management of the charging process.

Hence, the need for a solution that will manage all aspects related to the charging process for location-based services emerges. In that context, we propose the introduction of an integrated charging architecture that caters for all players involved in location-based services provision, manages all aspects related to the measurement and recording of location-based service usage, and enables customised billing for such services. Next section elaborates on the proposed architecture.

## 4 Integrated charging architecture

The proposed charging architecture, which is already prototyped in SDL (Specification and description Language) and illustrated in Fig. 1, is ambitiously regarded that will cover the aforementioned unresolved charging issues.

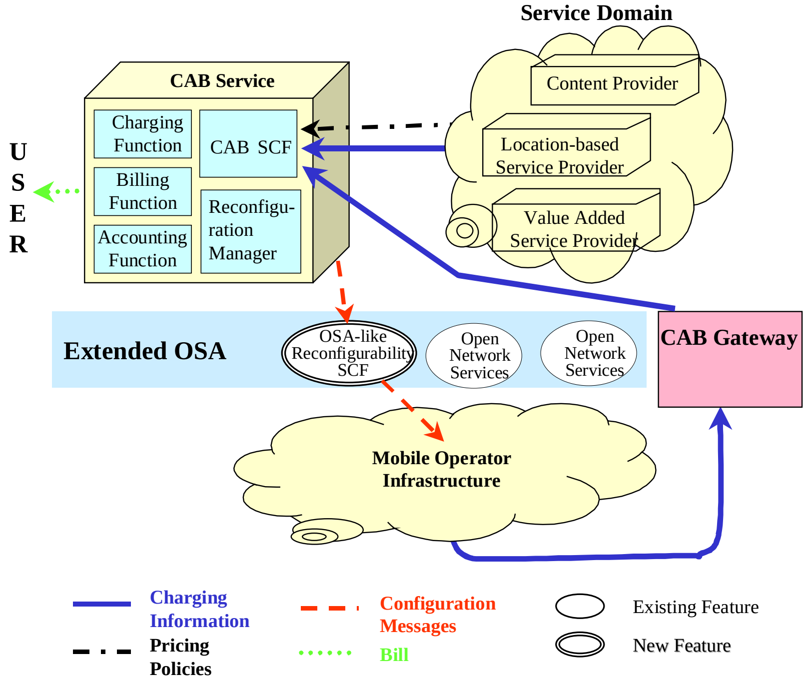


**Fig. 1.** Integrated charging architecture for customised billing

Definitely, the provision of location-based services enriches the traditional business players comprising the mobile service provisioning chain (i.e. network operators, service providers, content providers) with new ones (i.e. location-based service providers, location information brokers, location information interpreters, etc.). All players, old and new, should be able to participate in the control and cost sharing of the provided services. To bypass a complicated charging architecture, a layer-based charging approach can be adopted. According to this approach the charging architecture should be structured in three layers: transport, service and content. The management and processing of the relevant information should be made separately for each layer. Furthermore, different charging models should be possible to apply on each charging layer. The additional information required for customised billing of location-based services can be provided either by the mobile operator or by the respective provider. Finally, the location-based service provider is responsible to define the charged party and the applied pricing policy for service usage.

The introduced architecture supports the layer-based charging approach and enables all business players involved to submit their charging records on-line, to define the pricing policies dynamically, and to apportion their revenues automatically.

The charging information produced by the mobile network operator components and the third party service provider infrastructure is collected by a discrete service providing advanced charging mechanisms, flexible pricing and customised billing. The Charging, Accounting and Billing (CAB) service can be either under the administrative domain of one of the involved parties (i.e. mobile operator, value added service provider, location-based service provider, etc.), or it belongs to an independent third trusted party (e.g. charging/payment provider) that has the responsibility and authorization for the overall charging procedure.

The use of open APIs among players belonging to different administrative domains is regarded as the necessary mean that will enable the configuration of network entities for the collection of all required information. For example, the standardized OSA interfaces [11] enabling independent players to retrieve the user location information from the underlying mobile operator infrastructure via the respective OSA SCF [12] could be used. Furthermore, the introduction and provision of a set of open APIs for the support and management of charging related reconfiguration actions (e.g., for pricing policies updates) and the deployment of advanced charging services is essential.

The CAB service depicted in Fig. 2 comprises the following functional entities:

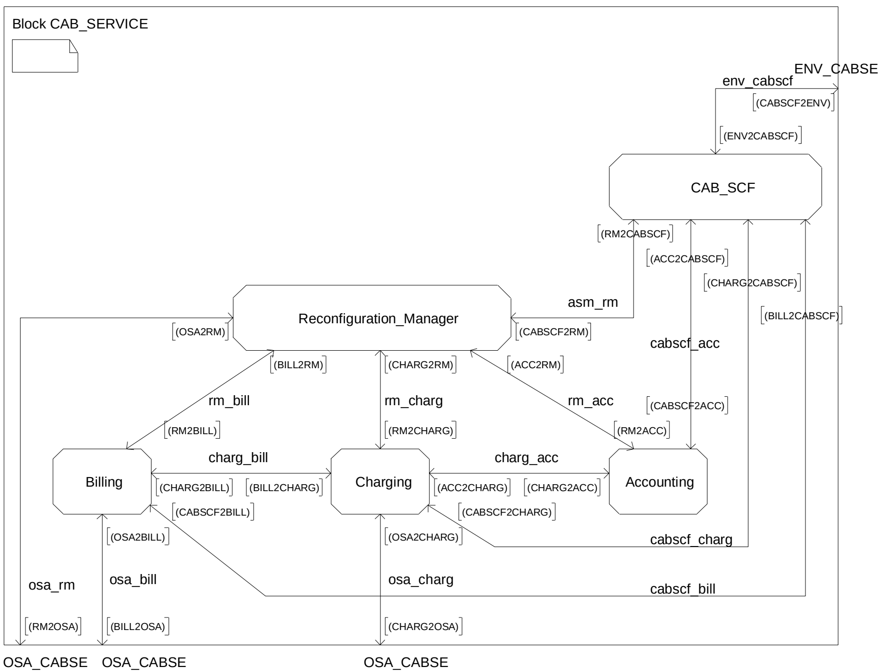


**Fig. 2.** Internal modules of the CAB service

- The CAB Service Capability Feature (SCF) is the functionality offered by the CAB service that is accessible via the proposed open APIs. It enables authorized business players to register new services to the CAB service, to refine the parameters of a registered service, to define pricing policies dynamically, and to submit charging records. Additionally, it provides authorized entities with advanced charging services such as location-based charging, on-line charging indication, current balance of user bill and on-line provision of statistical information. The CAB SCF incorporates the well-defined Charging SCF for content charging [13].
- The Charging module receives and processes charging information from the network elements via the CABG and the usage data and content charges from authorized independent providers via the CAB SCF. Based on the applied layer-based model, the charging information and usage data are correlated and processed. After this step transport, service, and content records are generated.
- The Billing module applies the pricing policies to the transport and service records in order to calculate the charges. The applied pricing policy depends on user, service or session characteristics and can be different from layer to layer. In addition, the billing process includes the content charges and produces a bill requiring payment.
- The Accounting module is an automatic procedure for sharing of charges and revenues between involved business entities.
- The Reconfiguration Manager module includes intelligent mechanisms for identifying the particular high-level requirements of the business players and mapping them to appropriate reconfiguration actions on the underlying network infrastructure. Specifically, in case of service registration it configures the underlying network elements to monitor the related IP flows and produce usage records according to the applied metering policy. Then, based on the specific pricing policy it configures the billing and accounting modules accordingly. Furthermore, it supports the dynamic modification of the services parameters and the applied pricing policies reconfiguring the aforementioned modules appropriately. Finally, it configures the charging module to generate charging sensitive alerts when the charging information meets some conditions, so that it provides the authorized and subscribed entities with specific event notifications (e.g. modification of tariffs).

In order to have a single logical interface between the network elements related to charging and the CAB service for the charging records transmission, we introduce a charging accounting and billing gateway (CABG). This executes a first correlation of the collected chargeable events and transfers them to the CAB service. The entities that collect and process the charging information concerning the usage of network resources (i.e. CGF and AAA) and the services' consumption (i.e. CCF and MDs) support different protocols and interfaces. The CABG receives the charging records using the respective protocols over the existing interfaces, correlates the records related to a specific chargeable event and transmits them using an open standard API to the CAB service.

In the case of roaming users, the accounting module is responsible for apportioning charges between the home environment, the serving network, and the user, and then calculating the portion that is due to each operator. The transport records concerning a roaming user are forwarded to its home network operator using the transferred account procedure (TAP) and a specific TAP format. The transfer of TAP records between the visited and the home mobile networks may be performed directly, or via a clearinghouse. Clearing-houses are independent business players responsible for TAP records creation, tariffing, and re-tariffing.

## 5 Customised billing for location-based services

In this section we present a part of the functionality of the proposed architecture with the execution of an indicative example scenario. This example, deals with the charging, billing and accounting process during the execution of a location-based service offered by an independent VAS provider. Specifically, the user accesses a service, which identifies traffic jams and taking into account the user's current location provides him with alternative routes. For such services the user has to pay for the transport, service and content part, while the VAS provider is charged for the LCS features usage. Furthermore, the user requests to be informed about the charging status of the executing location-based service. Moreover, the VAS provider submits to the CAB his own charging information for the provided contents with added value.

Fig. 3 presents the Message Sequence Chart (MSC) for this scenario. For the shake of simplicity, the MSC does not contain the messages exchanged between the user, the VAS provider and the Location Broker, the messages exchanged between the underlying network components and the CABG, as well as the acknowledgement messages.

More specifically, at first each authorized entity should create a session with the CAB service in order to use the services offered by the CAB SCF (CREATE_CAB_SERVICE_SESSION). Following the successful creation of the session, the user requests to be informed the applicable charges (ON_LINE_CHARGING_ INDICATION) providing the user identity and the charge unit that defines when a notification should be sent to the user.

The reconfiguration manager receives the request (through the CAB SCF) and configures the billing module to notify it when a certain limit is reached (CHARGE_EVENT_NOTIFICATION). During the execution of the service the CABG sends the charging information (CHARGING_ RECORD), collected by the underlying network elements, to the charging module. The charging module correlates the collected charging information and generates a TRANSPORT_RECORD and a SERVICE_ RECORD that are sent to the billing module.

In parallel, the VAS provider retrieves the user's location from the Location Broker; this has as result the Location Broker to send its service charges (CHARGING RECORD) to the charging module (through the CAB SCF). This information is processed and transmitted to the billing module (SERVICE_RECORD) in order the VAS provider to be charged for the LCS features usage and the accounting module

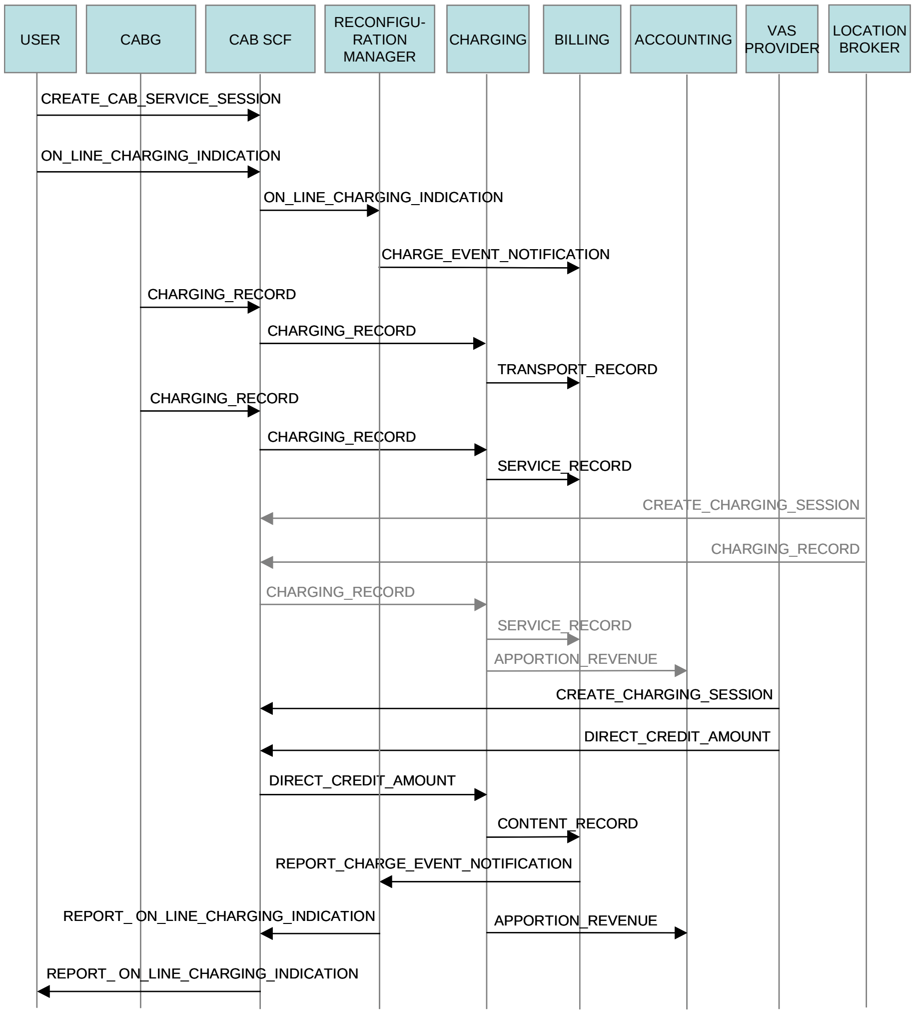


**Fig. 3.** CAB's functionality example

(APPORTION_ REVENUE) in order to calculate the revenues of the Location Broker (these interactions are presented in grey in Fig. 3).

Additionally, the VAS provider sends its content charges (DIRECT_CREDIT_AMOUNT), through the OSA/Parlay charging interface provided by the CAB service, to the charging module (through the CAB SCF) as well. The charging module correlates this information with the one sent by the operator and notifies appropriately the billing module (CONTENT_RECORD).

The billing module processes then the received information applying the appropriate pricing models and calculates the transport, service and content charges that concern the location-based service usage. In case that a certain limit (the charge unit) is overcame, the billing module informs the reconfiguration manager about

(REPORT_CHARGE_EVENT_ NOTIFICATION) and following the requesting user is notified (REPORT_ON_LINE_CHARGING_ INDICATION). In parallel, the charging module provides the accounting system with the required information (transport, service and content charges) to apportion the revenues between the players (APPORTION_ REVENUE).

## 6 Conclusion

By summarizing, this paper addresses the main unresolved charging issues for location-based services and introduces an integrated architecture, which allows flexible charging and customised billing for advanced location-based services usage. The proposed CAB service supports one-stop billing schemes for the end users as well as the separation of charging events based on content, service, and transport usage information. Moreover, it enables the automatic apportioning of incomes among the players. Finally, the CAB service allows flexible charging and customised billing for advanced location-based services usage.

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