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A Generic Framework for the Management of Charging, Billing and Accounting Process in Heterogeneous Networks

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ABSTRACT

The introduction of the IP in the mobile networks and furthermore the convergence of heterogeneous networks (e.g. UMTS, EDGE, WLAN) brings additional requirements and complexity for managing flexible service provision and charging in heterogeneous environments. To cope with such complexity the introduction of an integrated framework for at least charging process is required. In that context, this paper discusses the involved business players and the imposed requirements and describes a generic framework for all management aspects related to charging, billing and accounting in heterogeneous environments.

I. INTRODUCTION

During the recent past it has been well established that the Internet Protocol will play a dominant role in the Universal Mobile Telecommunication System (UMTS). This has been decided in order to provide, in an efficient manner, a wide range of connectionless services to mobile users. Moreover the combination of the UMTS with the Wireless Local Area Network (WLAN) into an integrated mobile communication environment will enable users to access IP services ranging from low to high speed in cases of WiFi hot spots. This evolution leads to the involvement of additional players in the control and sharing of the cost of a provided service.

In voice and data communication networks the billing schemes have been quite simple until now. Users have been mainly billed with a flat rate, based on their subscription and/or the duration of their connection. The flat rate model that has been adopted to charge people for accessing the Internet was a simple one and didn't require complex systems for monitoring and billing purposes. Content/service providers' revenues were based mainly on advertisements, since their services and content were usually offered to the users free of charge. While in mobile communication networks the charges were based on the network resource usage.

These schemes are expected to be altered soon as a consequence from the technological convergence and the adoption of new more flexible business models. The new models introduce some difficulties in what relates to the execution of the charging process. It is expected that, contrary to the existing approaches, the user should be able to access a plethora of services provided either by its home operator or by independent providers, without any additional contracts.

Moreover, the introduction of the IP in the mobile networks causes the design and adoption of new schemes for QoS provision, that aim to support real time services in a quality acceptable by the users. The deployment of such schemes signals the differentiation among users as well as the service flows and packets exchanged through the network. Furthermore, in an integrated mobile communication environment the users will be able to access various heterogeneous underline networks (e.g. UTRAN, EDGE, WLAN etc.). The latest creates another differentiation not among users nor among services but among chargeable events. This evolution creates the need for new mechanisms that will collect all information concerning chargeable events and after the appropriate processing will impose flexible billing schemes on the users. We should note that the records, containing all information related to the chargeable events, should impose adequate granularity to deploy advanced charging schemes such as content-based and location-based charging.

The existing approaches in charging management aspects are apparently attempting to cover dissimilar needs and have under consideration different business models, while carrying the existing functionalities of quite different network systems. Although the IP is the glue that will tie together the Internet with the Mobile Networks, the business models and the related charging approaches considered by the internet research community and the mobile world are diverse in view of the placement and management of the charging functionality. In an open marketplace a holistic solution for all management aspects related to charging, billing and accounting process is a key enabler for future evolution to support the convergence of heterogeneous and generalised access.

The rest of the paper is organized as follows. In Section II, the players involved in the service provision process through heterogeneous networks are presented. Charging related requirements in heterogeneous networks are discussed in Section III. A generic framework for the

management of Charging, Billing and Accounting process in an open marketplace is presented in Section IV. Finally, Section V concludes the paper.

II. BUSINESS PLAYERS INVOLVED IN SERVICE PROVISIONING PROCESS THROUGH HETEROGENEOUS NETWORKS

The evolution of an integrated mobile communication environment enables service deployment and content delivery offered by independent providers through heterogeneous networks' infrastructure. This evolution leads to the involvement of additional players in the service provision process and therefore in the control and sharing of the cost of a provided service. Overall, from an end user's point of view the various players involved in service provision are illustrated Figure 1.

The application domain includes the Content/Service Provider, who deploys services with added value (weather forecast, maps, on line stock exchange etc) to its subscribers and the Service Aggregator, a middleware that enables its subscribers to be aware of the disposable services and supports services' classification depending on their content, localization, terminal requirements, etc. As service aggregator can be considered a mobile portal [1].

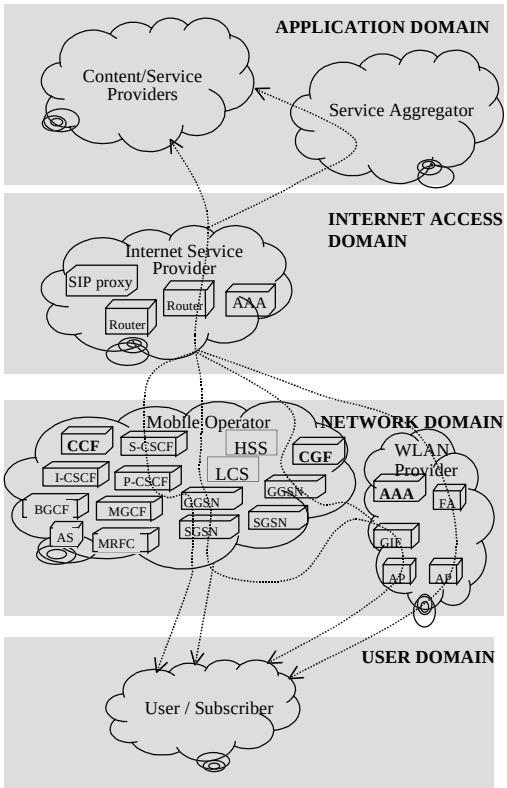
The Internet Service Provider (ISP), who provides its subscribers with Internet connectivity, is included in the Internet access domain.

The network domain incorporates the Mobile Operator, who offers bearer and supplementary telecommunications services to mobile users and the WLAN Provider: that provides its subscribers with wireless connectivity with high data transmission rates.

The User/Subscriber is attended to user domain. The subscriber has a contract with an operator, service aggregator and/or provider so that to be authenticated and charged by the operator and/or provider for its services usage. A subscriber could play itself the role of the user, or give to a number of different entities the ability to access services making use of the transport service provided by network operators.

The aforementioned players represent roles that are not necessarily mapped into different business entities. For example a mobile operator could play all roles in the application, internet access and network domains. However it is possible that several of these roles will be played by different business entities.

Figure 1. Involved players in service provisioning process



Related to the functionality of the network components presented in Figure 1 we can summarize the following. In the service provisioning process the Packet Switched (PS) domain of the UMTS ensures efficient data transfer and supports various services using packet switched type of connection [2]. Moreover, the IP Multimedia Subsystem (IMS), which has recently introduced in the UMTS architecture, enables the support of Session Initiation Protocol (SIP) based services [3]. SIP [4] is a text-based protocol introduced by the IETF, similarly to HTTP and SMTP, for initiating interactive communication sessions between users. The prime network elements of the PS Domain and the IMS have the ability to provide charging information in a form of Charging Data Record (CDR).

The Service GPRS Support Node (SGSN) and the Gateway GPRS Support Node (GGSN) for the PS domain [5], which handle originating and terminating packet data transfer, generate CDRs regarding the usage of radio interface, of the general GPRS resources as well as of external data networks. These CDRs include attributes such as the usage duration (PDP context duration), the source (served IP address) and destination (Access Point Name, APN) as well as the volume of transferred data and QoS related information.

The Charging Gateway functionality (CGF) provides a mechanism to transfer charging information from the GSNs (GPRS Supports Nodes) to the Billing System. In addition, the CGF acts as storage buffer for real-time CDR collection and may perform consolidation of CDRs and pre-processing of CDR fields. The CGF can be undertaken by a separate Network Element, the Charging Gateway (CG) or be integrated in the GSNs.

For the IMS [6] the Serving-Call Session Control Function (S-CSCF) and the Proxy-Call Session Control Function (P-CSCF) generate charging records related to session events (e.g., session start, session stop, etc.) and may include information related to session configuration such as session timestamps, end-point identifiers and QoS related information. The Interrogating-Call Session Control Function (I-CSCF) creates charging records related to session events exchanged with other networks. The Media Gateway Control Function (MGCF) generates records related to session gateway resource utilization and the Multimedia Resource Function Controller (MRFC) generates records related to session bearer processing resource utilization (e.g., transcoders, bridges, etc.). The Breakout Gateway Control Function (BGCF) produces records related to session events and may include information related to the PSTN network in which a session is going to breakout. The Application Server (AS) generates records when acting as an AAA proxy.

The Charging Collection Function (CCF) is responsible for the IMS domain and it is a logical function equivalent to the CGF. Additionally, the CCF is able to validate, combine, aggregate and consolidate the received charging information, to generate partial records (when it is necessary), to remove duplicated charging data as well to support load sharing, redundancy, high availability and efficient management of the generated CDRs.

Additionally, the subscription-related information for the home subscribers contained in the Home Subscriber Server (HSS) and the user location information provided by the Location Server (LCS) will be used in order to support an intelligent billing process.

Furthermore, in the network domain WLAN technology can complement UMTS in environments with high user density and demand for higher data rates. For the interworking of the two systems two generic approaches are currently under consideration by the ETSI [7]. The first approach is a tight coupling one, where the WLAN is considered as an additional radio access network in the overall UMTS infrastructure. The second approach is a loose coupling one, where the transport networks are completely separate but the same subscribers and services databases are used for functions such as authentication and billing (e.g. HSS). In both approaches there is demand for common charging and billing. The automatic apportioning of revenues between the WLAN provider and the mobile operator in case these are different business entities is another fundamental requirement.

III. CHARGING RELATED REQUIREMENTS IN HETEROGENEOUS ENVIRONMENTS

In next generation mobile networks users should be able to enjoy advanced services and contents offered by a large number of independent providers through a number of network providers over various underlying network technologies. This originates several charging, billing and accounting issues that should be addressed and tackled [1][2][8][9].

The main recorded demand is the support of "One Stop Billing" as far as the service provision concerns. Users would like to be charged by a trusted party with a total cost for the provision of a service. The trusted party could be the mobile operator, the service aggregator or the content service provider depending on the applied business model [1]. This requirement implies that the trusted party would be responsible for collecting charging data from all players and billing the users.

Generally, in such networks, where a number of players has an active role in the service provision process, there is need for a generic charging architecture that accommodate various charging models (e.g., time-, volume-, QoS- based, flat rate, one-off charge per service, etc.). To bypass a complicated charging architecture, a layered charging architecture approach structured in three layers (i.e. transport, service and content) could be adopted. The management and processing of the relevant information should be made separately for each layer. In addition, the selection of a specific charging model could be possibly based on user and service profile parameters. Nevertheless, different charging models should be possible to be applied on each charging layer.

In a multi-player environment each authorized player should be able to apply dynamically the desired pricing policy for its services' usage. The independent providers should be able to add or modify tariffs for the service and/or content part.

Since in most cases, the access to a WLAN network and the Internet requires a kind of subscription, the necessary authentication and authorization processes are performed by an Authentication, Authorization and Accounting (AAA) Server, which is able to generate charging information for its network resources usage.

In terms of sharing the incoming revenue between the players (i.e. mobile operators, WLAN providers, ISPs, service aggregators and content/service providers), it is necessary to introduce an automated process, which apportions the incomes, based on the commercial agreements between them. Till now, only simplified mechanisms have been used for sharing revenues due to practical considerations. However, in the oncoming UMTS environment, complex mechanisms making use of information regarding the resource allocation and usage could and should be possible to be applied.

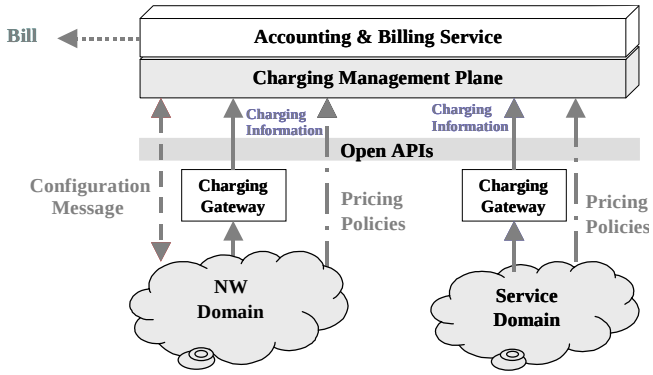
IV. A generic framework for the management of Charging, Billing and Accounting process

The service provision process in heterogeneous networks increases the overall overhead and complexity for the dynamic management. To cope with such complexity and enable the seamless provision of value added services the introduction of an integrated framework for at least charging process is required.

To this end we propose a holistic solution for all management aspects related to charging, billing and accounting in heterogeneous networks. This framework should introduce sophisticated management support for charging, accounting and billing procedures as a discrete service. This service will cater for all the involved players, in order to avoid any duplication of functionality and enable the efficient handling of these new tasks. An example of such architecture is presented in Figure 2 that can be under the administrative domain of one of the involved parties, or it belongs to an independent third trusted party that will have the responsibility and authorization for the overall charging procedure.

Note that a charging, accounting and billing management plane provides for the coordination of charging approaches to be applied and for appropriate policy provision. In order to enable charging requirements, policies and schemes to be applied, the use of open APIs among the players that will enable the configuration of network entities for the collection of all required information becomes necessary. For example, the standardized OSA can be used enabling independent players to add application and content charges via the OSA SCF [10]. Furthermore, the introduction and provision of a set of open APIs for the support and

Figure 2: Generic framework for the management of Charging, Billing and Accounting process



management of charging related reconfiguration actions (e.g., pricing policies updates) and the deployment of advanced charging services (on-line charging indication, current balance of user billing, on-line provision of information concerning the service profits) are essential.

A well defined Charging Gateway could have the responsibility for collecting all the charging information concerning the network resources usage as well as the services usage using standard protocols and interfaces. This gateway should also be able to handle charging information, related to content plane, coming from independent application/service providers through standard interfaces (e.g. extended OSA interface).

The main advantages of the proposed framework are that it is able to incorporate various charging functionalities. More specifically, it 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. Furthermore, it caters for different levels of UMTS-WLAN interworking Moreover, it enables the automatic apportioning of incomes among the players.

V. CONCLUSIONS

By summarizing, the existing approaches related to the management of the charging process seem to lack the potential to fully cover present and arising requirements in service provision. An important drawback relates to the inability to cope with the prerequisites for flexible service provision and download of the emerging novel communication systems. This would result in the facilitation of an open market place, where the management for the overall charging, billing and accounting should in principle be open to various players (e.g., third trusted parties) and consider requirements and policies from all the involved players. This paper introduces a generic framework for Charging, Billing and Accounting contributing to flexible and dynamic service provision in an open marketplace.

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