A Holistic Solution for Charging, Billing & Accounting in 4G Mobile Systems

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Abstract— The introduction of open and more flexible business models in 4G mobile networks, as well as the integration of UMTS with WLAN increases the overall overhead and complexity for the dynamic management between heterogeneous networks. To cope with such complexity and enable the seamless provision of value added services the introduction of an integrated platform for at least charging accounting and billing is required. This paper proposes a holistic solution for all management aspects related to charging, billing and accounting in 4G systems. The main concept is the introduction of a platform to incorporate various charging functionalities. The proposed platform is suitable for any business model and is appropriate for the different levels of UMTS-WLAN interworking.

Keywords - Charging; Billing; Accounting; 4G mobile systems

I. INTRODUCTION

The evolution of mobile networks enables service deployment and content delivery by independent providers through the network infrastructure of fixed and mobile operators. Moreover the combination of the Universal Mobile Telecommunication System (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.

The applied billing schemes in voice and data communication networks 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, Alexandros Kaloxylos

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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.

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. The technological convergence and the adoption of flexible business models are going to alter these billing schemes soon. The new models introduce some difficulties in what relates to the execution of the charging process.

There is a need for new mechanisms that would manage the collection of all information related to chargeable events, perform an appropriate processing on this data, apply any desired flexible billing scheme towards the users and apportion the revenues among the involved players.

Several standardization bodies are currently working quite actively in this field [1]. Groups such as the SA5 of the 3rd Generation Partnership Project (3GPP), the UMTS Forum, as well as the Authentication, Authorisation and Accounting (AAA) Working Group of the Internet Engineering Task Force (IETF) and the Authentication Authorisation Accounting ARCHitecture Research Group (AAAARCH) of the International Research Task Force (IRTF) are trying to establish the appropriate functionality and management schemes.

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 [2][3][4] and the mobile world [5][6][7]are diverse in view of the placement and management of the charging functionality. Moreover, the IETF and the IRTF from the one side and the 3GPP and the UMTS Forum from the other side approach the charging management aspects apparently attempting to cover dissimilar needs and carrying the existing functionalities of quite different network systems. 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.

This paper proposes a holistic solution for all management aspects related to charging, billing and accounting in 4G systems. The main concept is the introduction of a platform to incorporate various charging functionalities. The charging information generated by the existing networks' nodes is collected through standard interfaces (i.e. extended OSA interface).

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. The integration of UMTS with WLAN is discussed in Section III. An integrated holistic architecture for the Charging, Billing and Accounting process in 4G mobile networks is presented in Section IV. Section V examines the main advantages of the introduced platform. Finally, Section VI concludes the paper.

II. INVOLVED PLAYERS FOR SERVICE PROVISIONING IN 4G NETWORKS

It is anticipated that several players will have active roles in 4G networks. Overall, from an end user's point of view the various players involved in service provision, that might charge user/subscriber, are presented in Figure 1.

These entities are particularly:

- *Content/Service Provider*: deploys services (content or applications) with added value to its subscribers.
- *Service Aggregator*: is a middleware that enables users/subscribers to be aware of the disposable/available services, categorizes services depending on their content, localization, terminal requirements, etc.
- *Internet Service Provider (ISP)*: provides its subscribers with Internet access.
- *Mobile Operator*: offers bearer and supplementary telecommunications services to mobile users.
- *WLAN Provider*: offers wireless connectivity with high data transmission rates to its subscribers.
- *Subscriber*: has a contract with an operator and/or provider so that to be authenticated and charged by the operator and/or provider for its services usage.

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 for service provisioning in 4G networks

To bypass a complicated charging architecture, a multilevel charging architectural approach structured in several levels (e.g. transport, session, service and content), is proposed in the 3GPP [5]. The management and processing of the relevant information should be made separately for each level.

III. INTEGRATION OF UMTS WITH WLAN

The recent evolution and successful deployment of WLAN systems has fueled the need for the integration of UMTS with WLAN. Since, 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 [8]. The first approach is a tight coupling one, where the WLAN is considered as an additional radio access network (UTRAN, GERAN) in the overall UMTS infrastructure. The second approach is a loose coupling one, where the transport networks are completely separate but the same subscriber and service 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 that should be addressed.

The introduction of open and more flexible business models in 4G mobile networks, as well as the integration of UMTS with WLAN increases the overall overhead and complexity for the dynamic management between heterogeneous networks. To cope with such complexity and enable the seamless provision of value added services the introduction of an integrated platform for at least charging accounting and billing is required. To this end we propose a holistic solution for all management aspects related to charging, billing and accounting in 4G systems.

IV. INTEGRATED HOLISTIC ARCHITECTURE FOR 4G MOBILE NETWORKS

The proposed architecture, illustrated in Figure 2, introduces sophisticated management and reconfigurable support for charging, billing and accounting procedures as discrete services [9].

The charging information is collected by a well-defined CAB gateway through existing network components (i.e. CGF, AAA server, CCF, Metering Devices). This information is generated by the existing networks' nodes (SGSN, GGSN, AAA server, P-, S-, I-CSCF, etc.) and the introduced Metering Devices in case of non-SIP services usage and concerns the network resources usage as well as the services' usage and is transferred using standard protocols and interfaces. Metering Devices (MDs) provides detail records to the CAB gateway, regarding the traffic patterns of deployed non-SIP services and can be reconfigured dynamically by the MD Reconfiguration Manager with regard to the traffic monitoring and reporting functionality.

The Charging, Accounting and Billing (CAB) service, which can be under the administrative domain of one of the involved players or may belong to an independent third trusted party, incorporates:



Figure 2. Integrated Holistic Architecture for 4G Mobile Networks

- Charging function collects information related to chargeable events, correlates and processes the charging data, which following are sent to the billing functional entity.
- Billing function processes the records coming from the charging functional entity according to the respective tariffs in order to calculate the charge for which the user should be billed.
- Accounting function enables an automatic procedure for sharing of revenues in order the portion that is due

to each player to be calculated based on the agreement between the involved players.

- Advanced Service manager manages advanced charging services (e.g. on-line charging indication, current balance of user billing, on-line provision of information concerning the service profits, etc.) and provides a set of open Application Programming Interfaces APIs for the deployment of such services.
- Reconfigurability manager handles reconfiguration actions to the underlying network elements through an

Open Network Service and enables independent providers (i.e. content/service providers) to define the metering and pricing policy dynamically.

• Roaming User manager is responsible to forward billing records concerning roaming users to their home operators and supports the Transferred Account Procedure (TAP), which converts and groups billing records in files under the TAP format in order to be sent to the respective operators.

The CAB service communicates with the appropriate network components and independent provider through open APIs. These APIs are used for configuration messages and charging information [10]. This functionality is based on the standardized Open Service Architecture (OSA) that is used to enable independent players to add application and content charges via the Charging Service Capability Feature (SCF) [11]. Furthermore, the CAB service is able to handle charging information, related to content, coming from independent content/service providers through standard interfaces (i.e. extended OSA interface).

V. ADVANTAGES OF THE INTRODUCED PLATFORM

The proposed framework is able to incorporate various charging functionalities. Its main advantages are the following:

- Fitness for any business model, since CAB is an integrated service that can be under the administrative domain of each player
- Appropriateness for the different levels of UMTS-WLAN interworking
- Dynamic reconfiguration of applicable metering and pricing policies for specific service, specific user or combination of them.
- Provision of advanced services (e.g. on-line charging indication, current balance of user billing, on-line provision of information concerning the service profits, etc.)
- Support of roaming users
- Separation of charging events based on content, service and transport usage information
- Application of various pricing models according to the service profile, the user profile and the location of the user.
- Support of one-stop billing schemes
- Automatic apportioning of incomes among the players
- Definition of a common basis for the homogeneous development of charging functionality for new services

VI. CONCLUSIONS

By summarizing, the paper proposes a holistic solution for all management aspects related to charging, billing and accounting in 4G systems. The main concept is the introduction of a platform to incorporate various charging functionalities. The proposed architecture includes the Charging, Accounting and Billing (CAB) service, which enables sophisticated management and reconfiguration actions for charging purposes. In addition, the proposed architecture is suitable for any business model and appropriate for the different levels of UMTS-WLAN interworking.

The proposed architecture has been designed in SDL and the introduced CAB system has been implemented as a discrete service that can be provided by a third trusted party although it can be an integral part of any business entity. Relevant works take place in standardization groups, such as WG5 of 3GPP, as well as AAA of IETF and AAAARCH of IRTF. Their works have taken into consideration and the CAB service has been designed to reuse the existing functions and network elements involved in the charging process.

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REFERENCES

- M. Koutsopoulou, A. Kaloxylos, A. Alonistioti, K. Kawamura, L. Merakos, "Charging, Accounting & Billing Management in Mobile Telecommunication Networks and the Internet", IEEE Communications Surveys and Tutorials, 1st Quarter 2004
- [2] B. Aboba, J. Arkko and D. Harrington, "Introduction to Accounting Management", RFC 2975, October 2000.
- [3] H. Jonkers and S. Hille, "Accounting Context: Application and Issues", October 2000, www.aaaarch.org/doc06/file-11249.pdf
- [4] G. Carle, S. Zander and T. Zseby "Policy-based Accounting", RFC 3334, October 2002.
- [5] 3G TR 23.815 version 5.0.0 (2002-03), 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; Charging implications of IMS architecture (Release 5).
- [6] 3G TS 22.115 version 5.2.0 (2002-03), 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Service aspects; Charging and Billing (Release 5).
- [7] 3G TS 32.200 version 5.2.0 (2002-12), 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Charging management; Charging principles (Release 5).
- [8] ETSI TR 101 957 version 1.1.1 (2001-08) "Broadband Radio Access Networks (BRAN), HIPERLAN Type 2, Requirements and Architectures for Interworking between HIPERLAN/2 and 3rd Generation Cellular systems"
- [9] M. Koutsopoulou, A. Kaloxylos, A. Alonistioti, "Charging, Accounting and Billing as a Sophisticated and Reconfigurable Discrete Service for next Generation Mobile Networks", Proc. VTC 2002 Fall, Vancouver, BC, Canada, September 2002.
- [10] M. Koutsopoulou, N. Alonistioti, E. Gazis, A. Kaloxylos, "Adaptive Charging Accounting and Billing system for the support of advanced business models for VAS provision in 3G systems", Proc. PIMRC 2001, San Diego, USA, September – October 2001.
- [11] 3GPP TS 29.198-12 version 4.0.0 (2001-06) "3GPP; Technical Specification Group Core Network; Open Service Access (OSA); Application Programming Interface (API); Part 12: Charging (Release 4)".