Charging and Billing Architecture for 5G Network

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Abstract

The charging and billing architecture for 5G and corresponding functions and interfaces supporting this new architecture have changed significantly and are now Service Based. There is now a converged charging interface covering online charging, offline charging and production of data records. This means that the interaction with the billing system now is though the Charging Function (CHF) in a converged charging system. The interface to the billing system has not changed, only been updated.

Keywords: 5G, Charging, billing, service based interface.

1 Introduction

The 5G puts new requirements on the way that charging and billing is performed and interacts with the network; this will require a new architecture as well as a new API. A new network function responsible for collecting the charging from the network is introduced for this purpose. This paper tries to give an overview of these new changes in release 15 and the changes that are proposed for release 16. It also tries to explain the charging architecture

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and interface, on a high level. This should give and introduction to what the new architecture looks and what the interface can be used for.

2 5G Charging and Billing Architecture

In September 2018 3GPP published release 15 of the charging architecture. This was the first release that enabled a charging system that adhered to the 5G Service Based Architecture of 3GPP. This comprises, as of today, the 3GPP specifications TS 32.240 [1], TS 32.274 [5], TS 32.255 [3], TS 32.290 [6], TS 32.291 [7] and TS 32.298 [8], which are developed by the 3GPP SA5 Charging Sub-Working Group (SWG), are referred to for further reading. The intention with this article is to give a brief introduction to the 5G charging as per 3GPP release 15, focusing on the architecture and functionality and new ongoing work items for 5G the as per 3GPP release 16.

In the new 5G charging system, the legacy online charging system and offline charging system are combined into one converged charging system. Based on the converged charging system, the message commands, chargeable events and charging information are merged. The converged charging system includes the CHF, Rating Function (RF), Account Balance Management Function (ABMF) and Charging Gateway Function (CGF). The CHF can in turn include both Online Charging Function (OCF) and Charging Data Function (CDF). The Figure 1 is an aggregation of the architecture pictures of converged charging system specified in the TS 32. 240 [1].

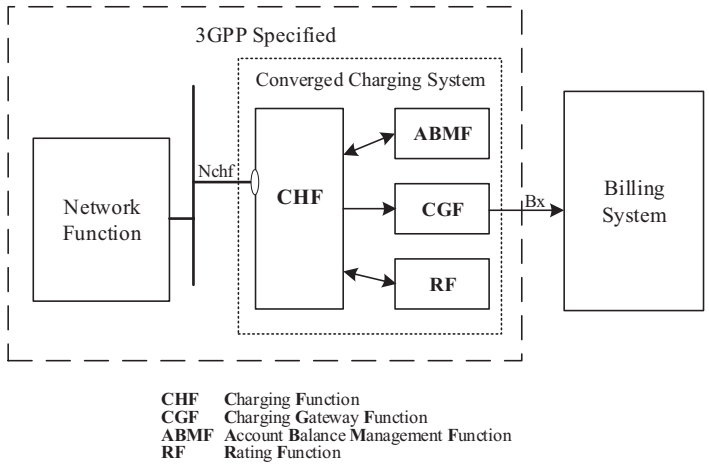

Figure 1 Architecture of Converged charging system.

The new architecture is service based and introduces one new service specified in TS 32.290 [6], converged charging (Nchf_ConvergedCharging), to the network, that is intended to cover all the network's needs of charging and interaction with billing systems. It combines the network's need for both online and offline charging, i.e. either the charging may affect service delivery or not (e.g. granting access the service), and these are differentiated by either having quota management or not. Quota management refer to the possibility to grant a specific number of units (e.g. bytes, seconds) to be used for the service. The function providing this service and interaction with Billing Systems, to the 3GPP Network Functions, is the CHF. Since the CHF is seen as the service provider to the network it needs some more functions to be able to provide all that is needed, and these are collected in the Converged Charging System, which besides the CHF contains an RF that determines the value of the network resource usage, a AMBF which is the location of the subscriber's account balance, and a CGF acting as a gateway between the 3GPP network and the BD as specified in TS 32.240 [1] (Figure 2). The interface towards billing systems is still based on the legacy ASN.1 syntax and has not been updated to the new Service Based Architecture, only the new information needed to support 5G charging.

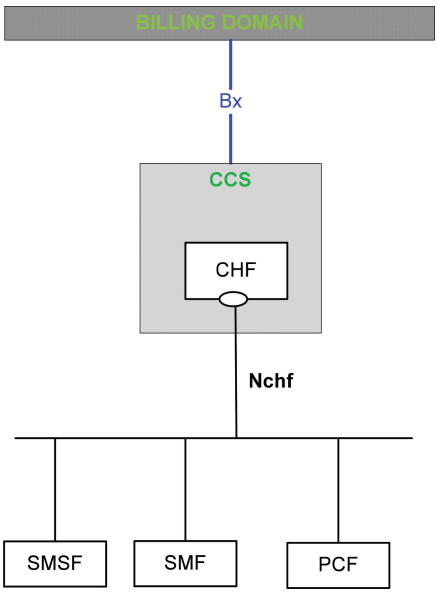

Figure 2 Logical ubiquitous charging architecture and information flows for 5G systems – service based interface.

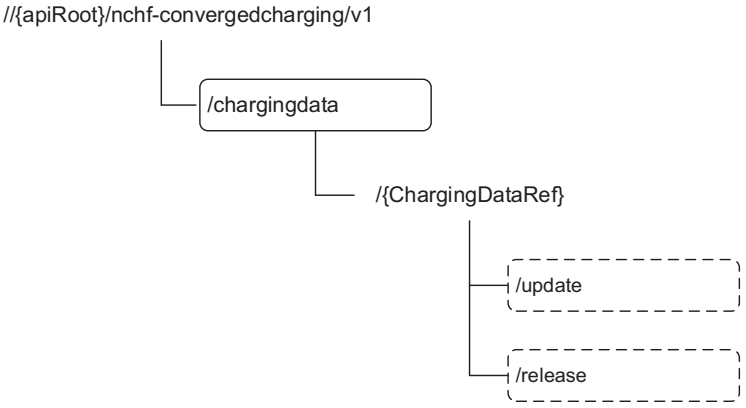

Figure 3 Resource URI structure of the Nchf_ConvergedCharging API.

The current release of the converged charging supports charging for network resource usage (e.g. volume) in the following network functions: the Session Management Function (SMF) for 5G data connectivity charging (i.e. PDU session from SMF), the Short Message Service Function (SMSF) for SMS charging (i.e. SMS over NAS functionalities), and the Policy Charging Function (PCF) for spending limit control.

The main service provided by the CHF is the Nchf_ConvergedCharging service. It contains the operations Create, Update and Release and is specified in TS 32.291 [7] (Figure 3). The current consumers of this service are the SMF and SMSF. The CHF also provides the Nchf_SpendingLimitControl service which is consumed by the PCF; this is specified in TS 23.502 [12].

All the operations for Nchf_ConvergedCharging service are based on the http method POST, with a resource and data model.

2.1 Charging and Billing Capabilities

The 5G charging in the current release 15 includes:

- **5G data connectivity charging:** Specified in TS 32.255 [3] and includes PDU session in SMF, Service data flows (within PDU session) and QoS flows (within PDU session). In the current release 15, only home routed charging is supported. This charging information is collected as QoS flow Based Charging (QBC) performed by the CHF in each PLMN.
- **5G SMS charging:** The SMSF charging and the enhancement of IP-SM-GW charging for 5G converged charging are introduced in TS 32.274 [5], 32.290 [6], 32.291 [7], and 32.298 [8].

The 5G charging in coming release 16 is proposed to define:

- **Charging aspects of network slicing study:** The current 5G data connectivity charging contains information of which network slice instance that was used. Network slicing is seen as an important feature in 5G and is specified in TS 23.501 [11] and TS 23.502 [12]. Most commonly, a network slice is considered to be a composition of network functions to offer communication services with particular network characteristics (e.g. coverage, UE mobility level, sharing level, QoS etc.), as specified in TS 22.261 [10] and TS 28.541 [14]. According to the description in TS 28.530 [13], communication services using network slice instances may be offered by Communication Service Providers (CSPs) to Communication Service Customers (CSCs), which are of various categories: Business to Consumer (B2C) services (e.g. mobile web browsing, 5G voice, rich communication services), Business to Business (B2B) services (e.g. internet access, LAN interconnection), Business to Household (B2H) services (e.g. internet access, MBMS, VOIP, VPN), Business to Business to Everything (B2B2X) services (e.g. services offered to other CSPs offering themselves communication services to their own customers). There is also the Network Slice as a Service (NSaaS) that can be offered by CSPs to CSCs in the form of a communication service as well as the "Network Slices as NOP internals" model, i.e. network slices are not part of the CSP service offering and hence are not visible to CSCs; it is only to provide support to communication services. These different ways of using the network slice may impose new and different charging requirements. The TR 32.845 [9] focuses on charging aspects of a network slice, including the business roles, possible charging requirements, key issues and solutions, based on the 3GPP working groups' SA2 and SA5 (OAM) specifications and technical report. Cooperation with management system will be needed.
- **Northbound API charging via network exposure function:** Network Exposure is supported in 5G System (5GS) as specified in TS 23.501 [11], TS 23.502 [12] and TS 23.503 [16] with corresponding charging architecture and functionalities need to be specified to allow a full 5G commercial deployment. The Network Exposure Function (NEF) Northbound APIs are specified by the TS 29.522 [15] and interworking with the other Network Functions (NFs) using a Service Based Interface (SBI). The current specification TS 32.254 [2] for Northbound APIs charging covers the SCEF interworking with SCS/AS and Diameter

based interface, including event based charging for online and offline charging. To support the Northbound API charging via NEF, the service based charging interface will be updated to allow for 5G converged online and offline charging of the Northbound API.

- **Charging Access and Mobility Management Function (AMF):** In release 15 the service based charging interface is limited to 5G data connectivity (i.e. PDU session from SMF), and SMS. This will now be extended beyond the realm of resource usage collected under session management (including control of UPFs), and SMS over NAS functionalities, to better address the various types of deployments and services. The reason is that it is important for operators to collect usage for other type of 5GS resources such as those associated to Access connection and Mobility for charging or statistics. This means that charging will be specified for the following functionalities supported by the AMF: registration management, mobility management and access connection management specified in TS 32.256 [4].
- **Offline charging services:** The converged charging in release 15 is composed of online charging and offline charging and that the CHF provides CDRs for both online and offline charging. The corresponding Nchf_ConvergedCharging service is specified in TS 32.290 [6] and 32.291 [7]. In order to support flexible deployment of charging with service based interface, it is proposed to define one additional services i.e. offline charging service.
- **Charging enhancement of 5GC interworking with EPC:** To enable interworking between 5GS and EPC, when PCF + PCRF, PGW-C + SMF and UPF + PGW-U are used, i.e. User Equipment (UE) is either EPS/E-UTRAN or 5GS/NR connected and needs to be able to handle handover between these 2 modes. As specified in TS 23.501 [11] and TS 23.502 [12], networks that support interworking with EPC may support interworking procedures and these procedures may use the N26 interface or not. The N26 interface is an inter-CN interface between the MME and 5GS AMF in order to enable interworking between EPC and the NG core. 5GC interworking with EPC specifies interaction between the PGW-C + SMF and CHF using the same interface as between SMF and CHF. In release 15 only N26 based handover scenarios are specified in TS 32.255 [3], TS 32.290 [6] and TS 32.291 [7]. This will now be extended to also support N26 based Idle Mode Mobility procedure, Handover cancel procedure, and procedure without N26. The corresponding triggers, message flow and parameters are specified.

3 Conclusion

To conclude, the charging standard for 5G is well prepared for the initial launch of 5G with the basic capabilities needed, with an expected evolution that will add more possibilities to differentiate and support more business models as the needs arise.

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Biographies

Robert Törnkvist, who joined Ericsson in 1990. During his 29 years with Ericsson, he has worked with various mobile network development projects. Since 1996 he has worked with pre-paid and charging with a shorter break for work with positioning. He has been active in Open Mobile Alliance before he joined 3GPP SA5 in 2016.

Chen Shan is a Vice-chair of 3GPP SA5 SWG charging and works in Huawei Technologies Company Limited, research and standards department in Shenzhen, China.

She has received the master degree in pattern recognition and intelligence system from Dalian University of Technology China and has been working as a standardization delegate representing Huawei since 2008, focusing on the mobile communication networks in IEEE, ITU-T and 3GPP.

In 3GPP SA5, she has participated actively in developing the charging concepts and standards as rapporteur, for work items related to 5G charging including network slicing.