Chapter 15
Quality of Service Management by Third Party in the Evolved Packet System

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ABSTRACT
The chapter investigates the capabilities for open access to quality of service management in the Evolved Packet System. Based on the analysis of requirements for policy and charging control in the Evolved Packet Core, functions for quality of service (QoS) management and charging, available for third party applications, are identified. The functionality of Open Service Access (OSA) and Parlay X interfaces is evaluated for support of dynamic QoS control on user sessions. An approach to development of OSA-compliant application programming interfaces for QoS management in the Evolved Packet System is presented. The interface’s methods are mapped onto the messages of network control protocols. Aspects of interface implementation are discussed, including interface to protocol conversion.

I. INTRODUCTION
The 3rd Generation Partnership Project (3GPP) developed standards for all-IP based architecture referred as Evolved Packet System (EPS) aimed to provide all kinds of multimedia services. EPS enables a feature-rich common packet core which supports high speed radio access networks based on not only 3GPP standards like Long Term Evolution (LTE), but for example WLAN, WiMAX or fixed access. This common core is referred as Evolved Packet Core (EPC).

The requirement to EPC in conjunction with IP connectivity access network (IP-CAN) is to provide quality of service. Quality of service (QoS)
is used to differentiate multimedia offering from traditional Internet services which in most cases do not provide QoS. In order to provide a mechanism for service-aware QoS control and coherent charging, 3GPP defines the Policy and Charging Control concept. The Policy and Charging Control (PCC) is a key concept in EPC architecture and it is designed to enable flow-based charging, including, for example, online credit control, as well as policy control, which includes support for service authorization and QoS management (Ouellette, Marchand, Pierre, 2011; Balbas, Rommer, Stenfelt, 2009).

One of the possible IP services layer on the top of EPC is IMS (Gouveia, Wahle, Blum, Magedanz, 2009). IMS stands for IP Multimedia Subsystem and it is an architectural framework for delivering IP multimedia services. The EPC/IMS interworking brings the advantage to integrate broadband access to all voice, messaging and data services. In IMS, the user equipment negotiates with the network the session parameters by means of Session Initiation Protocol (SIP) signaling (Iqbal, Javed, Rehman, & Khanum A., 2010). The interface between IMS and PCC architecture allows transfer of service-related information used to form authorized IP QoS data (e.g. maximum bandwidth and QoS class) and charging rules as well as user plane event reporting (e.g. bearer loss recovery, access network change and out of credit) for any access network (Wang, Liu, & Guo, 2010; Bertenyi, 2011).

To stimulate service provisioning and to allow applications outside of network operator domain to invoke communication functions, an approach to opening the network interfaces is developed (Jain & Prokopi, 2008). The open access to network functions allows third party applications to make use of network functionality and to receive information from the network through application programming interfaces (APIs). Open Service Access (OSA) is defined as service architecture for mobile networks. OSA provides APIs for a palette of network functions such as call control, data session control, mobility, messaging etc. Currently, no APIs are defined for QoS control on end users’ multimedia sessions.

The OSA APIs provide resource programmability and hide the network technology and protocol complexity for application developers but the level of abstraction remains low. Parlay X interfaces are defined to allow open access to network functions for a wider IT community (Yang & Park, 2008). Parlay X Web services are simplified, highly abstracted means for access to network functionality.

The main goal of the chapter is to assess the support of existing APIs for access to PCC functions in EPC and to present an approach to design OSA compliant APIs for QoS management.

Some related works are discussed in section II. The PCC architecture with user data convergence is presented in section III. The requirements for open access to QoS management based on the PCC architectural framework are summarized in section IV. The standardized capabilities for open access to QoS management are evaluated in section V. In section VI, it is described how OSA compliant interfaces can be designed having in mind the identified requirements. The interface implementation requires mapping of interface’s methods onto network control protocol messages, and it is described in section VII. The interface usage is illustrated by typical use cases. In section VIII, a model of QoS related data in the user profile is proposed. The interface behavior is modeled by means of state machines in section IX. An approach to formal verification of API to protocol conversion is presented in section X. Finally, section XI concludes the chapter highlighting the benefits of third party QoS management in the EPS.

II. RELATED WORK

Delegating the QoS resource authorization in wireless networks to the service control layer provides a number of benefits such as session and service
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