Open Access to Control on Quality of Service in Convergent Networks

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ABSTRACT

This paper investigates the capabilities for open access to quality of service management in convergent networks. Based on the analysis of requirements for policy and charging control in Internet Protocol Multimedia Subsystem (IMS), functions for quality of service (QoS) management and charging that are 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, while an approach to development of OSA compliant application programming interfaces for QoS management in IMS networks is presented. The interface’s methods are mapped onto the messages of network control protocols such as Diameter and Session Initiation Protocol (SIP). Finally, aspects of interface implementation are discussed including behavior equivalence of state machines.

Keywords: Convergent Networks, Interface Implementation, Open Access, Open Service Access (OSA), Policy and Charging Control, Quality of Service

I. INTRODUCTION

Internet Protocol Multimedia Subsystem (IMS) is defined as access independent IP-based service control architecture, aimed to provide all kinds of multimedia services (Poikselka & Mayer, 2008). The requirement for the IMS in the conjunction with the underlying IP connectivity access network and transport 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.

Via the IMS, the user equipment negotiates its capabilities and QoS parameters during session setup or modification, using Session Initiation Protocol (SIP) (3GPP TS 24.229 v9.2.0, 2009). The capability to authorize and control the usage of QoS resources, intended for IMS media, based on SIP signaling, is called IP policy control. The IP policy control can increase utilization of bearer resources by parameter control over the access and transport networks. To ensure coherent charging between IP-CAN and IMS, the IP policy control is harmonized with charging control, and the overall interaction between the IMS and the IP-CAN network is called Policy and Charging Control.

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The PCC encompasses the following high level functions for IP-CANs (e.g., GPRS, WLAN, Fixed broadband, etc.): flow based charging, including charging control and online credit control, and policy control e.g., gating control, QoS control, user plane event reporting and network initiated IP-CAN bearer establishment.

One of the design principles of IMS is separation of applications from generic service control functionality and provision of open interfaces. The open access to network functions allows third party applications to invoke communication functions. Instead of using control protocols, the applications access network resources via application programming interfaces (APIs). Defined as service architecture for mobile networks Open Service Access (OSA) provides APIs for a palette of network functions such as call control, data session control, mobility, messaging etc.

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

After this introduction, some related work is discussed in section II. The IMS PCC architecture is presented in section III. The requirements for open access to QoS management based on the PCC framework are summarized in section IV. The standardized capabilities for open access to QoS management are evaluated in section V. In section VI, we describe how OSA compliant interfaces can be designed having in mind the identified requirements. The interface implementation requires mapping of interface’s methods onto SIP and Diameter protocol messages, and it is described in section VII. The interface usage is illustrated by typical use cases. In section VIII, we model the interface behavior by means of state machines and in section IX, we prove formally the behavioral equivalence of the proposed state machines with those, supported by network protocols. Finally, in section X, the paper contribution is summarized.

II. RELATED WORK

A lot of research has been done in the area of policy-based resource allocation. The role of policy-based management as a cornerstone for simplifying the management and reducing operating costs of wireless networks is outlined in (Soulhi, 2004). Policy-based service provisioning system is proposed in (Selvakumar, Xavier, & Balamurugan, 2008) in order to provide different classes of services. An efficient resource allocation technique for a policy-based wireless/wireline interworking architecture is suggested in (Cheng, Song, Huang, Leon-Garcia, & Hu, 2006), where QoS provisioning and resource allocation is driven by the service level agreement. Marti, Caixue, Brandt, Velasco, and Fuertes (2004) present an optimal resource allocation policy that maximizes control performance within the available resources and provide experimental results showing that the optimal policy significantly increases control performance compared to traditional control system implementations, and incurs negligible overhead. Kallitsis, Michailidis, and Devetsikiotis (2009) suggest a model for allocating available resources in service-oriented network, with particular focus on delay sensitive services. The proposed policy is dynamic in nature and relies on online measurements of the incoming traffic for adjusting the resource allocations. Extension of the IETF policy-based management framework is given by Haddadou, Ghamri-Doudane, Ghamri-Doudane, and Agoulmine (2006) in order to support dynamic provisioning of short term services (end system signaling) as well as an scalable instantiation scheme. This instantiation scheme is based on the distribution of the provisioning process while keeping centralized only the parts that involve critical resources, i.e., the bandwidth brokerage. Zhao, Jiang, and He (2008) present a policy-based radio resources allocation scheme. Different channel allocation algorithms and channel allocation strategies form a series of policies, thus constituting a policy-based channel allocation scheme. Pahalawatta and Katsaggelos (2007)
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