Understanding the Issues of Providing IMS Capabilities on Different Access Networks – The Use of Policies for QoS Provision

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Abstract: - The third Generation Partnership Project (3GPP) aimed to merge two of the most successful paradigms in communications: cellular networks and the Internet. Within the IP Multimedia Subsystem (IMS) the 3GPP specified a comprehensive and service oriented architecture that includes session based QoS in IP, charging mechanisms and offers standardized interfaces for application service integration and seamless interactions with legacy services. To extend the IMS capabilities to other technologies, for instance a WLAN network, we analyse policy-based management issues in this scenario. We focus on issues relating to the Policy Decision Function (PDF) and describe a simple architecture for interworking WLAN with the IMS that is being implemented at Fraunhofer FOKUS Institute *[17]*.

Key-Words: - Policy-Based QoS, Next Generation Networks, IMS, PDF.

1 Introduction

The concept of next generation networks (NGN) is based on the convergence of fixed and mobile telecommunication networks and the Internet towards an all-IP environment. These NGNs support the provision of integrated information and communication services in face of increasingly more complex value chains, enabled by so-called service delivery platforms (SDPs). Therefore an NGN is an environment of high complexity, in which different actors, such as fixed and mobile network operators, service providers, system integrators and an open set of application providers have to co-operate for the provision of advanced converged services. A converged service is the integration of voice, multimedia, web content and Web Services provided seamlessly over all kinds of access technologies. The introduction of Universal Mobile Telecommunications System (UMTS) services to major European mobile communications markets in recent months marked another milestone in the convergence of the Internet and telecommunication world. UMTS network consists of the following three domains: Circuit Switched (CS), Packet Switched (PS) and IP Multimedia Subsystem (IMS). Efforts for interworking access networks with IMS, as in [1,2,3], are becoming very important to the success of the UMTS IMS services.

In this paper we will focus on the policy-based QoS mechanisms within the IMS. The next section introduces briefly the capabilities of the IMS architecture. Section 3 describes the policy-based architecture in the IMS where the PDF is the enabler of the policy control and explains why a policy-based approach can assist in controlling QoS. Section 4 highlights the QoS issues in WLAN and describe the approach of the proposed architecture. In section 5 we conclude the paper.

2 The IP Multimedia Subsystem

The IP Multimedia Subsystem (IMS) [4] as part of the 3GPP Release 5 specifications defines an overlay architecture on top of the 3GPP Packet Switched (PS) Core Network for the provision of real time multimedia services. The IMS is based on principles and protocols defined for the Internet by the IETF (Internet Engineering Task Force), which have been adapted for their use within a secure, scalable carrier grade environment. The Session Initiation Protocol (SIP) is used as the signalling protocol that establishes, controls, modifies and terminates voice, video and messaging sessions between two or more participants. In the context of the IMS Architecture the related signalling points are referred to as Call State Control Functions (CSCFs) and distinguished by their specific functionalities. Functionalities related to

Authentication, Authorization and Accounting (AAA) within the IMS are based on the IETF Diameter protocol and implemented in the HSS, CSCFs and various other IMS components in order to provide charging functionality. The HSS forms the organisational glue between the CSCFs and the application servers (ASs), whereas the real time signalling between CSCF and ASs is based on SIP.

To provide IMS capabilities to other technologies, we are considering the P-CSCF, which is the first element that a user contacts when sending a SIP request, and the PDF that controls the bearer traffic in the user plane based on policy rules.

3 Policy-based management

Policy-based management is the application of the concepts of organizational policy, like agreements and procedures, to the governance of computer-based systems.

The problem with current network management systems is that they lack the ability to state long-term, network-wide configuration objectives, and have them automatically realized in the network. A policy-based management system allows the network operator to enter the above objectives as policies into the management system, and ensures automatic enforcement of these policies so that no further manual action is required on the part of the network operator.

IETF defines "Policy" from two perspectives [5]:

- A definite goal, course or method of action to guide and determine present and future decisions.
- Policies as a set of rules to administer, manage, and control access to network resources [6].

In a standard policy-based network, policies consist of a set of conditions and a set of actions (eg. If... then...).

Table 1 shows the categories of policies.

Table 1 – Categories of policies.

Policy Categories	Description
Authorization [7]	Permit or forbid an autonomous entity from carrying out an action
Obligation [7]	Defines the duties, roles and responsibilities of an autonomous entity
Abstract [8]	Specifies a goal, objective or constraint that needs to be achieved without specifying how it is to be achieved
Concrete [8]	Specifies a process or procedure that explicitly needs to be followed

The advantages of concrete policies include that they are typically easy to achieve, because there are no details which are unclear or unspecified. Furthermore, the manner is which the outcome is measured is also specified, so that autonomous entity knows that it has met its obligation. Abstract policies have missing details, requiring enough knowledge and intelligence from the autonomous entity to work out how it can be achieved, and how the outcome can be measured. On the other hand, the abstract policies are easier to read and write and can be applied to more general (or aggregated) properties of the system [9]. Examples of Typical usage of policies include device configuration, Service Level Agreement (SLA) between two adjacent domains, resource reservation, admission control and charge correlation.

The use of policies can help the system to improve QoS. Policies allow an operator to specify how the network is to be configured and monitored through rules that will trigger when determined events occur. To understand how policies control the behaviour of a system, an example is given [23]. An abstracted policy:

Jack has access to the high quality Video on Demand service
The high quality Video on Demand service must have higher priority than best-effort traffic

could be represented by the following rules in a hypothetical policy language (which contains both ‘data’ and ‘behavioural’ statements):

Jack.Services = [HighQualVoD]
HighQualVoD.priority > BestEffort.priority

This is a simple example. A more refined rule could be something like that (for diff-serv case) [23]:

Jack.IPAddress = 192.168.0.1
HighQualVoD.Port = 1024
HighQualVoD.DiffServCodePoint = AssuredForwarding11
AssuredForwarding11.DSCP = 001010b
AssuredForwarding11.Scheduling = PriorityQueuing
EdgeRouters = [192.168.1.1, 192.168.5.1]
CoreRouters = [192.168.2.1, 192.168.3.1, 192.168.4.1]

And the resulting concrete policy:

For all [EdgeRouters]
If UDPPacket.DestIPAddress = 192.168.0.1 and UDPPacket.Port=1024
Then UDPPacket.DSCP = AssuredForwarding11.DSCP
For all [CoreRouters]
If IPPacket.DSCP = AssuredForwarding11.DSCP
Then Queue1.Enqueue (IPPacket)

3.1 Policy Architecture in the IMS

3GPP adopted a policy-based QoS solution to ensure that sufficient QoS resources are provided to authorized users. The reference model of a policy-based network consists of two main elements, the Policy Decision Point (PDP) and the Policy Enforcement Point (PEP) [10]. The PDP weighs the policy request sent by the PEP, as a result of a policy event against a corresponding set of policy rules. As a response to a policy request, the PDP either evaluates the policy rules for the request, which is referred to outsourced policy or retrieves the set of policy rules relevant for the request, which is referred to provisioned policy (The Provisioning and Outsourcing policy models are described in [11]). The policy decision or the set of policy rules is then transported to a PEP using the policy transaction protocol Common Open Policy Service (COPS). The PDP is the final authority the PEP needs to refer to for actions to be taken.

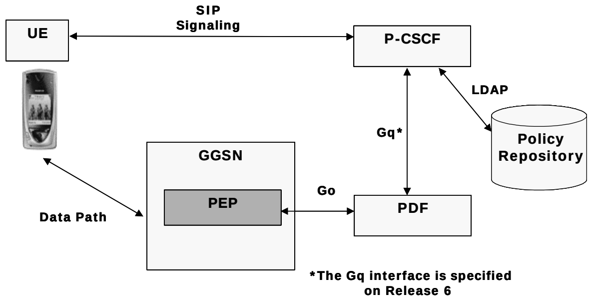

Figure 1- Policy Architecture in the IMS.

The PDF can be a logical component of a P-CSCF (Release 5) or a separate entity altogether (Release 6). Since the GGSN is in the data path, it is the logical location for the PEP. The policy repository can be an entity external to the PDF. A Lightweight Directory Access Protocol (LDAP) capable data store can be used for this purpose. The PDF communicates with the PEP via the Go interface [12]. Figure 1 depicts the relationship between these entities.

3.1.1 Proxy-CSCF

The Proxy-Call Session Control Function (P-CSCF) is the first contact point for users within the IMS. All SIP signalling traffic from or to the UE go via the P-CSCF. The P-CSCF validates the request, forwards it to selected destinations and processes and forwards the response. There can be one or many P-CSCFs within an operator's network. Please see [13,14] for the detailed descriptions of the functions performed by the P-CSCF.

3.1.2 PEP in the GGSN

The role of the PEP is to ensure that only authorized IP flows are allowed to use network resources that have been reserved and allocated to them. The PEP in the GGSN is responsible to drop the IP flow that was not permitted by the PDF. This process is called *policy-based admission control*. This process ensures that an IP flow is only allowed to use resources that have been approved by the policy rules. The PEP may store decisions in a local PDP. In this case, the GGSN can make admission control decisions without additional interactions with the PDF, reducing this way, the traffic over the Go interface.

3.1.3 User Equipment

The UE obtains an authorization token from the P-CSCF via SIP signaling during session setup. This token is used to provide the binding mechanism that associates the PDP context bearer to the IP flow in order to support IP policy enforcement in the GGSN. By examining this token received from the GGSN, the PDF can direct the GGSN to admit or drop the flow.

3.1.4 The Go and Gq Interfaces

The Go interface allows service-based local policy and QoS inter-working information to be requested by the GGSN from a Policy Decision Function. This allows operators to control QoS in a user plane and exchange charging correlation information between IMS and GPRS network. The protocol used for this is the Common Open Policy Service (COPS) [11]. The COPS protocol is a simple query and response protocol that allows policy serves (PDPs) to communicate policy decisions to network devices (PEPs). The protocol uses TCP to provide reliable exchange of messages. COPS provides the means to establish and maintain a dialogue between the client and the server and to identify the requests.

The Go interface provides information to support the following functions in the GGSN [12]:

- Control of service-based policy "gating" function in GGSN
- UMTS bearer authorization
- Charging correlation related function

The Gq reference point is used to exchange policy decisions-related information between P-CSCF and PDF and is being standardized in 3GPP Release 6 [4]. The protocol specified for this interface is Diameter.

3.2 The role of the Policy Decision Function (PDF)

In the IMS, the PDF plays the role of the PDP. The PDF is a logical policy decision element that uses standard IP mechanisms to implement Service Based Local Policy (SBLP) in the IP bearer layer. The PDF is a PDP and makes decisions in regard to SBLP using policy rules, and communicates these decisions to the IP BS Manager in the gateway GPRS serving node (GGSN), which is the IP PEP. The PDF refers to the policy rules, generally stored in a policy repository, governing the local domain.

The main task of the PDF is to enable coordination between events in the application layer and the resource management in the IP bearer layer during session establishment.

As described in [14], the following policy decision point functionalities for SBLP are identified:

The PDF is responsible:

- To store session and media-related information (IP addresses, port numbers, bandwidths, etc.).
- To generate an authorization token that identifies the PDF and the session.
- To provide an authorization decision according to the stored session and media related information on receiving a bearer authorization request from the GGSN.
- To update the authorization decision at session modifications which changes session and media-related information.
- The capability to revoke the authorization decision at any time.
- The capability to enable the usage of an authorized bearer (e.g., Packet Data Protocol, or PDP, context).
- The capability to prevent the usage of an authorized bearer (e.g., PDP context) while maintaining the authorization.
- To inform the P-CSCF when the bearer (e.g., PDP context) is lost or modified. A modification indication is only given when the bearer is upgraded or downgraded from or to 0 kbit/s.
- To pass an IMS-charging identifier to the GGSN and to pass a GPRS-charging identifier to the P-CSCF.

The 3GPP has taken approach to the QoS matter by defining four separate traffic (QoS) classes that will be handled according to the operator's requirements on the each of the traffic classes. The 3G traffic classes are:

- Conversational class for voice and RT multimedia messaging
- Streaming class for streaming type of applications, Video On Demand (VOD) etc.
- Interactive class for interactive type of applications, eCommerce, WEB-browsing, etc.
- Background class for background type applications, email, FTP, etc.

4 WLAN interworking with the IMS at FOKUS Testbed

There are several concerns about the QoS support in the currently leading WLAN standard. The IEEE 802.11a, b, and g, version do not have any QoS support unless extended with the IEEE 802.11e. The current standard doesn't support QoS for all of the existent applications and it has open issues. In [15], the authors summarize the IEEE 802.11e technology and present a survey of the 27 ongoing research activities, and in [16] the author makes an overview of the advances in the WLAN QoS for 802.11. The WLAN QoS in its actual state cannot offer end-to-end QoS [20] [21] for real time applications like videoconference. Thus there are interests to study how to provide the QoS guarantees for the services offered to the users.

There is a 3GPP work in progress that is studying the feasibility of interworking UMTS and WLAN technologies [1]. This effort intents to extend UMTS services and functionality to the WLAN access environment so that the WLAN becomes a complementary [22] radio access technology to UMTS. For that, QoS control is required to handle QoS guaranteed services over the WLAN component of the integrated network. Based on the specifications of the 3GPP we propose a simple policy-based QoS architecture (Figure 2) for WLAN that is being implemented (work in progress) in the Fraunhofer FOKUS Testbed [17].

The authors in [18] proposed two approaches for coupling WLAN networks with UMTS: tightly coupled architecture and loosely coupled architecture. There are advantages and disadvantages when the two architectures are compared. The main difference between these two approaches is the point where the networks are connected in the network architecture. In a tightly coupled architecture, the WLAN network is connected to the UMTS network as an alternative radio access network. The data sent by WLAN devices must go through the UMTS PS domain served by the connecting SGSN to reach its destination (or WLAN router in our case). The session control entities like the CSCFs interact directly with the WLAN devices as if they are normal UMTS user equipment (UE). This way a PDF can enforce the network-level policies at the WLAN router directly as if the WLAN network is a part of the UMTS PS domain.

As the WLAN is an alternative radio access network of the UMTS network, the 3GPP PDF can be reused. There is no effect on the 3GPP access control and billing/charging entities. In a loosely coupled architecture, the WLAN router is connected to a GGSN, and the WLAN network is considered a peer UMTS network (in this case the WLAN is connected to a GGSN of the UMTS network as a separate network).

In [19], the authors proposed an architecture based on loosely coupled architecture and analysed different interworking scenarios. Our proposed architecture is based on a tightly coupled, because our objective is to apply the policy control via PDF, providing this way, the IMS capabilities to the WLAN network with end-to-end QoS Control using the four 3GPP standardized QoS classes described before. Figure 2 shows the proposed architecture (The other components of the IMS architecture at FOKUS are omitted for clarity).

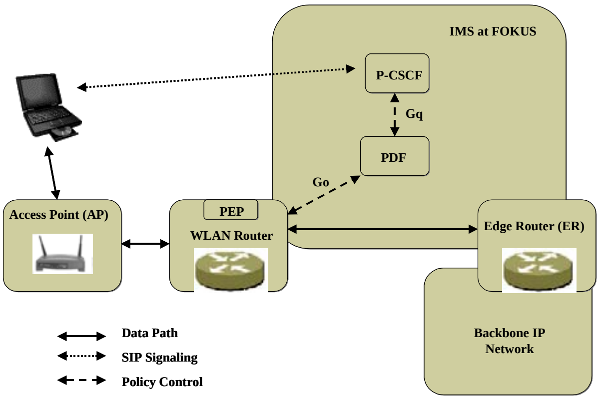

Figure 2 – Policy-Based QoS architecture in WLAN

5 Conclusion and future work

This paper described the policy-based architecture in the IMS highlighting the issues related to QoS in an UMTS - WLAN interworking scenario. A simple policy -based architecture (tightly coupled) to the management of end-to-end QoS in a WLAN network has been described, and it is being implemented in the Fraunhofer FOKUS Testbed [17]. The principal advantage of this architecture is that the PDF can be reused. In other words, the PDF can enforce the network-level policies at the WLAN Router directly as if the WLAN were an alternative radio access network. The principal disadvantage is the configuration of the client devices, because the

WLAN cards would need to implement the 3G protocol stack.

3GPP defines the integration stages for WLANs based on a feasibility study while it is always trying to minimize the impact on existing 3GPP systems. The goal of this effort is to integrate 3GPP system functionalities into a contracted WLAN access network in order to complement the WLAN functionalities.

The open issues of this approach are being studied. So this paper serves as the beginning point of study towards our series of related research results.

References:

[1] 3GPP TR 23.234 V6.4.0 (2005-03), "3GPP System to Wireless Local Area Network (WLAN) Interworking".

[2] B. Marsie, T. Borosa, S. Pocuca, "IMS to PSTN/CS interworking", 7th International Confe-rence on Telecommunications, 2003.

[3] D.I. Axiotis, T. Al-Gizawi, K. Peppas, A.N. Protonotarios, F.I. Lazarakis, C. Papadias, P.I. Philippoulos, "Services in Interworking 3G and WLAN Wnvironments", IEEE Wireless Communications, October 2003.

[4] 3GPP TS 23.228 V6.7.0, "IP Multimedia Subsystem (IMS); Stage 2".

[5] IETF RFC 3198, "Terminology for Policy-Based Management", November 2001.

[6] IETF RFC 3060, "Policy Core Information Model - Version 1 Specification", February 2001.

[7] M. Sloman, "Policy Based Management of Telecommunication Systems and Networks 1998," presented at First UK Programmable Networks and Telecommunications Workshop, Hewlett-Packard Laboratories, Bristol, 1998.

[8] draft-ietf-policy-framework-00.txt, M. Stevens, W. Weiss, H. Mahon, B. Moore, J. Strassner, G. Waters, A. Westerinen, and J. Wheeler, "Policy Framework," Policy Framework, 13 Sept 99.

[9] N. Sheridan-Smith, D. Colquitt, and J. Wootton, "Moving from Next-Generation Networks to Enriched-Experience Networks," University of Technology, Sydney, Australia, Confidential deliverable 1A, 30 September 2003.

[10] IETF RFC 2753, "A Framework for Policy-based Admission Control", January 2000.

[11] ETF RFC 2748, The COPS (Common Open Policy Service) Protocol", January 2000.

[12] 3GPP TS 29.207 V6.1.0, "Policy control over Go interface", September 2004.

[13] 3GPP TS 24.229 V6.4.0, "Internet Protocol (IP) multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3", September 2004.

[14] M. Poikselka, G. Mayer, H. Khartabil, A. Niemi, "The IMS: IP Multimedia Concepts and Services in the Mobile Domain", Wiley, April 2004.

[15] F. Mico, P.Cuenca, L. Orozco-Barbosa, "QoS in IEEE 802.11 Wireless LAN: Current Research Activities", IEEE, 2003.

[16] Shugong Xu, "Advances in WLAN QoS for 802.11: an Overview", International Symposium on Personal, Indoor and Mobile Radio Communication Proceedings, IEEE, 2003.

[17] Fraunhofer FOKUS Institute Testbed, www.fokus.fraunhofer.de/ims.

[18] ETSI TR 101 957, "Requirements and Architectures for Interworking between HIPERLAN/2 and 3rd Generation Cellular Systems", August 2001.

[19] Wei Zhuang, Yung-Sze Gan, Kok-Jeng Loh, Kee-Chaing Chua, "Policy-Based QoS Management Architecture in an Integrated UMTS and WLAN Environment", IEEE Communications Magazine, November 2003.

[20] Zoran Perisic, Zoran Bojkovic, "Model for quality of service management on Internet based on resource allocation", WSEAS NNA-FSFS-EC 2002, February 11-15, 2002, Interlaken, Switzerland.

[21] Zheng Lin,Yang Zongkai, He Jianhua, "A QoS provisioning framework for multimedia cellular networks", WSEAS NNA-FSFS-EC 2003, May 29-31, 2003, Vouliagmeni, Athens, Greece.

[22] Zoran Bojkovic, Zoran Perisic, "Quality of service as an essentila component of the next generation Internet", WSEAS NNA-FSFS-EC 2003, May 29-31, 2003, Vouliagmeni, Athens, Greece.

[23] N. S. Smith, "A Distributed Policy-based Network Management (PBNM) system for Enriched Experience Networks™ (EENs)", Doctoral Assesment, November 2003.