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Mobility management for multi-user sessions in next generation wireless systems

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Abstract

Mobility management and ubiquitous access for real-time multi-user sessions with *Quality of Service* (QoS) support are major requirements to the success of next generation wireless systems. In this context, *Multi-User Session Control* (MUSC) is proposed to allow fixed and mobile users to access multi-user sessions ubiquitously, while providing QoS mapping, QoS adaptation and connectivity control in heterogeneous environments with mobile receivers and static senders. By interacting with resource allocation controllers, MUSC allows the construction of QoS-aware distribution trees over networks with different QoS models and aims to keep sessions with an acceptable quality of experience in congestion periods. Furthermore, by interacting with mobility controllers, MUSC assures the session continuity with QoS and connectivity support. MUSC was evaluated in a simulation and in an experimental environment to analyze its convergence time as well as its efficiency in allowing seamless mobility and in keeping sessions with an acceptable quality level during handover.

Keywords: Multi-user session; Quality of Service; Mobility; Heterogeneous networks

1. Introduction

Next generation IP networks are expected to allow mobile users to access real-time group communication sessions over heterogeneous wireless environments with *Quality of Service* (QoS) support. Examples of these sessions are IPTV, video streaming and seismic activity reports, in which the session content is distributed to multiple mobile users at the same time (one source and multiple simultaneous receivers) [1]. Multi-user sessions can be classified as non-scalable and scalable, where the latter is composed by a set of flows with well-defined priorities, rates and QoS requirements as supported by common encoders, such as H.264, MPEG-2 and MPEG-4. In addition, the session distribution must be done in a multicast to save network resources, and the importance of each flow must be used to adapt the overall quality of the session to the availability of the different network traffic classes. This scheme allows the network to be independent from the encoders, which does not happen in transcoding approaches [2].

Fig. 1 illustrates a generic definition of a multi-user session as well as the distribution environment and the characteristics of the users. Additionally, it shows that a multi-user session is received by heterogeneous receivers according to the importance of each flow (from high to low).

The distribution of multi-user session content to multiple mobile subscribers with different devices and needs may be done using different QoS models (e.g., *Differentiated Services* or IEEE 802.11e), connectivity schemes (e.g., IP multicast or IP unicast) and access technologies (e.g., *Worldwide Interoperability for Microwave Access –*

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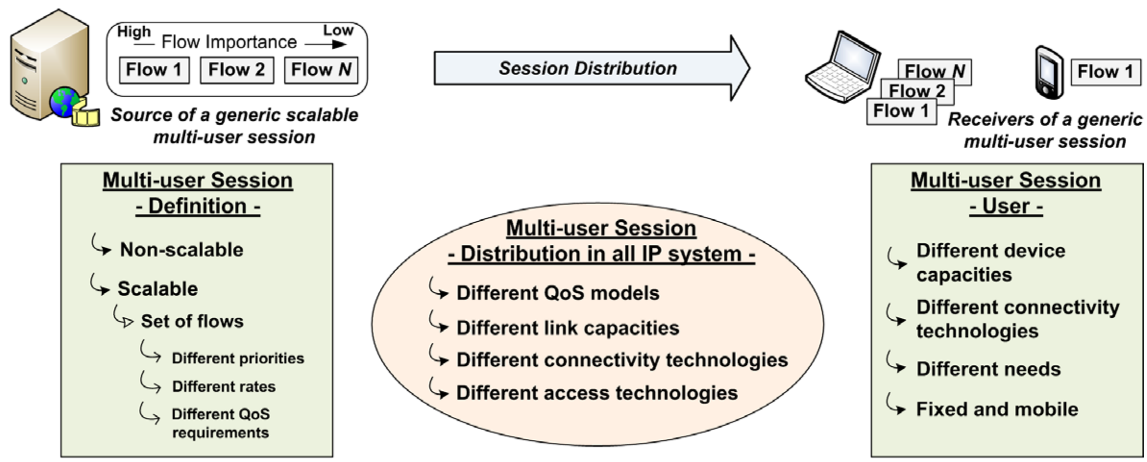

Fig. 1. Generic example of multi-user session definition and distribution.

WiMAX) [3]. In such heterogeneous environment the QoS guarantees, connectivity, ubiquitous access and mobility for multi-user sessions are requirements to the success of next generation wireless systems.

The distribution of multi-user sessions with end-to-end QoS support also requires the session QoS control in environments with asymmetric routing, which is not accomplished by most IP multicast protocols [4], such as *Protocol Independent Multicast for Source–Specific Multicast* (PIM–SSM). The above functionality requires the creation of distribution trees taking into account the QoS characteristics and current network conditions of the path from source to receivers. Moreover, due to the use of diverse QoS models in an all-IP system (or the same QoS model but configured with different traffic classes and performance metrics), flows of multi-user sessions need to be mapped into different service classes inside or between networks. However, current static approaches for QoS mapping or even guidelines for IP QoS mapping [5] alone are not sufficient to assure the quality level of sessions.

Furthermore, in order to increase the satisfaction of users and to avoid session blocking, it is necessary to keep multi-user sessions with acceptable quality level, independently of the existence of links with distinct capacities, movement of users or even due to a re-routing event caused by a failure in a network agent or link. For instance, in a congestion period, a QoS adaptation mechanism must be used to adapt the session to the current network conditions, by re-mapping the session to a different service class or controlling the session quality level by dropping and adding flows. In addition to the QoS control, a connectivity control scheme must be used to allow the end-to-end session continuity over networks that support the same and/or different address realms, such as unicast to multicast and vice-versa.

In handover situations, the QoS and connectivity support for ongoing multi-user sessions must be done independently of hard or seamless mobility controllers. In terms of standard hard handover controllers, *Mobile IP* version 4 (MIPv4) [6], *Session Initiation Protocol* (SIP) [7] and *Multicast Remote-Subscription* [8] can be pointed out. In order to improve the satisfaction of users, QoS support for seamless mobility controllers is also required, where packet loss and latency are reduced during handovers by using caching and buffering mechanisms.

This article describes the *Multi-user Session Control* (MUSC) [9] solution to manage the ubiquitous access and mobility for multi-user sessions across heterogeneous wireless networks. MUSC provides QoS mapping, QoS adaptation and connectivity control for ongoing multi-user sessions. From the mobility point of view, the interaction between MUSC and hard handover controllers allows the continuity of sessions with QoS support. The multi-user sessions controlled by MUSC can be supplied with seamless mobility capability through the communication with the *Seamless Mobility of Users for Media Distribution Services* (SEMUD) mechanism [10]. In addition, the creation of QoS-aware distribution trees associated with multi-user sessions is done based on an interface between MUSC and *Multi-service Resource Allocation* (MIRA) [11]. MUSC, SEMUD and MIRA were developed in the *Quality of Service for Mobile*, *Multimedia*, *Multi-user Sessions* (Q3M) project developed in cooperation between the University of Coimbra and NTT DoCoMo Euro-Labs.

The remainder of this article is organized as follows. Section 2 introduces the related work. A description of MUSC together with resource allocation and mobility controllers is presented in Section 3. Section 4 illustrates examples of the proposed solution. Section 5 presents evaluation results about the efficiency of MUSC in a simulation and in an experimental environment. Finally, conclusions and future work are summarized in Section 6.

2. Related work

The *Real-Time Streaming Protocol* (RTSP) [12] and SIP are IETF standard signaling protocols used to control the streaming and the access of users to announced sessions. SIP can also be used to control handover at the application layer, where it keeps the mobility support independently of