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Provisioning and performance of mobility-aware personalized push services in wireless broadband hotspots

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Abstract

In this work we investigate the deployment of so-called "media points" to facilitate the provisioning of personalized push services to mobile users within WLAN hotspots. We present the feasible usage scenarios with stationary and moving user terminals for some envisioned services and outline the requirements characteristic for a media point system. A hierarchical architecture with centralized service control for small-scale media point networks is proposed and the employment of Session Initiation Protocol (SIP) for handling the mobility and session management of media point services is described. A demonstrator system has been developed in order to show the technical feasibility of the concept by means of state-of-the-art technologies and to allow an experimental performance evaluation of the proposed protocols and mechanisms for a typical service-provisioning scenario. We observed that system performance is strongly dependent on the level of interworking between the various protocols and software modules, e.g., SIP modules, DHCP modules, WLAN device driver, etc. In particular the signaling mechanism within the network by means of SIP doesn't cause any significant delay. The overall system performance is found as acceptable when assuming that the dwell time of mobile users within WLAN hotspots is in the order of minutes or longer.

Keywords: Personalized services; Media point concept; WLAN; Mobility management; SIP; Performance evaluation

1. Introduction

Because information and communication belong to the elementary needs of human beings by now, a further increase in demand—especially in the field of mobile Internet access—is to be expected. Present research aims at overcoming the scarcity of costly spectrum in 2G/3G networks by

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sharing frequencies with broadcast radio systems like DVB-T [1,2] or by integrating short-range wireless technologies like Wireless Local Area Networks (WLANs) [3,4]. General integration of different access technologies in a Beyond 3G network is discussed, e.g. in [5,6].

Nowadays many cellular operators are begining to extend their networks with WLAN hotspots in public and strategic areas like train and bus stations, shopping malls, campus or downtown areas as they recognize the importance of broadband wireless Internet access for their subscribers. Users with suitable wireless equipment can "hop" from one WLAN island to another to get high-speed Internet access. However, delay-sensitive and conversational services like voice calls or videoconferences still have to be provided by cellular systems with full coverage like GSM or UMTS, because continuous radio connection is required during the service usage. But that is not a necessity for Internet services such as e-mails, pre-selected (personalized) browsing, download of city information, pre-cached streaming audio and video, etc. With higher flexibility and mobility of the users, the importance of such personalized and customized Internet-based services increases. One main issue for the corresponding network is to be aware of the presence status and location as well as device capabilities of each mobile user. Since the dwell time of a mobile user within a WLAN hotspot is limited and the data transmission session could therefore be interrupted when the terminal leaves the WLAN coverage, the network should support fast and reliable session re-establishment and continuation at the next hotspot.

In this paper we present our media point service concept [7–11], which aims at enhancing the capabilities of WLAN-based access networks to provide personalized services to users in accordance with their mobility behavior and device capabilities. As *media points* we refer to regular broadband radio access points installed at easily reachable places in public areas, e.g., traffic signs, street lamps, walls of buildings (inside and outside), etc., that are controlled in such a way to strive for service session continuity in spite of discontinuous radio coverage. We propose a hierarchical network architecture with a centralized service control for small scale media point networks and employ the Session Initiation Protocol (SIP) to deal with mobility issues and session management of the provided services. We investigate the technical feasibility and the performance of the service concept for the delivery of personalized high-volume data for stationary or very-slowly moving users or terminals by means of state-of-the-art technologies in the form of a prototypical network, i.e., the media point system demonstrator.

This paper is structured as follows. We discuss the typical media point usage scenarios, envisioned services and their requirements in Section 2. In Section 3, we present the proposed network architecture and point out the functionality of each network component. In Section 4, we describe the service control mechanisms using SIP and the related mobility issues. Section 5 describes the setup of our media point system demonstrator as well as the protocol and service implementation in detail. We give an insight into the experimental performance evaluation using the demonstrator and discuss the results in Section 6. Finally, Section 7 concludes our work and provides an outlook on further study.

2. Scenarios, services and requirements

Numerous mobile Internet users tend to visit their favorite Web sites like "CNN", "Spiegel Online", or the "Wired Magazine" on a regular basis. Hence a push service providing these users with personalized information appears to perfectly meet today's demands. A push service could also enable the delivery of e-mails and multimedia contents such as songs, music videos, etc. The most important advantage that can be drawn from providing users with information by means of such a narrowcasting technology is the fact that patchy radio coverage is sufficient for giving the user the impression of having an omnipresent access to content concerning those topics of interest to the user. New user data (or its fragments) will be pushed to the user terminal each time the user passes the coverage area of a media point (Fig. 1), which may be extended in coverage by fixed relays using multi-hop techniques [12].