Chapter 1

Multi-Access Environments in Next Generation Networks

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ABSTRACT

Wireless heterogeneous environment is becoming increasingly popular because of its ability to support multi access technologies, which keeps the mobile users always connected. The fourth generation (4G) of wireless environment consists of dissimilar technologies like Worldwide Interoperability for Microwave Access (WiMAX) and Long Term Evolution-Advanced (LTE-A). Coexistence of these standards presents technological challenges. Other challenges towards heterogenous 4G environment include coexistence of third generation (3G) and 4G and coexistence of Wireless Local Area Network (WLAN) and 3G/4G technologies. This chapter presents the technical overview of the 4G (WiMAX and LTE-A) standards and identifies the challenges and research issues (i.e., mobility management, network selection, handover, and Quality of Service [QoS]) toward a multi-access environment that consists of 3G, 4G, and WLAN technologies. The chapter also discusses future directions and some research solutions.

INTRODUCTION

The 3G network is the third generation of mobile networking and telecommunications, which features a wider range of services, and advanced network capacity over the previous second generation (2G) network. 3G fulfills the International Telecommunication Union (ITU) specification for mobile telecommunications and uses a software enhancement called High Speed Downlink Packet Access (HSDPA) through which the network can send data (audio, graphics and text) significantly faster than the 2G network. The ITU specifications of 3G include Universal Mobile Telecommunications System (UMTS), Digital Enhanced Cordless Telephone System (DECT), and Code Division Multiple Access 2000 (CDMA2000). The 3G technologies aim to deliver improved

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throughput in addition to voice service. This throughput, however, is not sufficient to meet the increasing demand for wireless broadband (Figure 1). A new standard called WiMAX, developed in 2004. The IEEE 802.16e, also known as mobile WiMAX, is an enhancement over the fixed WiMAX standard and is the meeting point of mobile and fixed broadband networks through wide-area radio access technology and flexible network architecture.

The IEEE 802.16e interface utilizes Orthogonal Frequency Division Multiple Access (OFDMA) in the downlink (DL) and in the uplink (UL) to improve bandwidth scalability, efficiency and multipath performance. The IEEE working group has been working towards the development of a new standard (IEEE 802.16m) to meet the requirements of ITU—Radio Communication Sector / International Mobile Telecommunication (ITU-R/IMT) for the 4th generation wireless networks. The IEEE 802.16m promises more efficient use of the radio spectrum and delivers improved data rates.

Mobile network operators continue with technology developments to improve user experience and service opportunities. One such progressed technology is the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE). LTE-A is an enhancement over LTE, and LTE-A is included in 4G standard in mobile network technology tree, aiming to ensure 3GPP’s competitive edge over the other mobile technologies. It is designed to offer multi-megabit bandwidth (i.e., 1 Gbps DL and 500 Mbps UL) with more efficient use of the radio spectrum, reduced latency and improved mobility. LTE-A uses OFDMA for DL communication and Single Carrier-Frequency Division Multiple Access (SC-FDMA) for UL communication. LTE-A also supports multiple-input multiple-output (MIMO) antenna design. The next generation of wireless communication systems will need to support multiple services ubiquitously in heterogeneous network (Berezdivin, Breinig, & Topp, 2002; Gang, Mizuno, & Havinga, 2002).

Background of wireless network has been changing progressively from homogeneous to heterogeneous and the outlook of the future gen-

Figure 1. Broadband access worldwide