

## Chapter III

# Research Challenges in Multimedia WiMAX

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### ABSTRACT

*On the stage of today's communications world, broadband mobile technologies are a continuously flourishing trend. In this context, WiMAX, a technology based on the IEEE 802.16 standards, currently plays a noteworthy role. Throughout the chapter we survey current literature related to the delivery of multimedia data in WiMAX systems and, most importantly, identify research areas in which promising improvement opportunities exist. We start by portraying how both market and technical conditions have encouraged the adoption of WiMAX, and then, by building upon a fundamentals introduction, we focus on issues related to capacity and frame assembly. We also identify relevant aspects related to scheduling and mapping between user applications and WiMAX services. We close the chapter with a discussion on quality of service in wireless systems and visit the mathematical background of opportunistic scheduling for WiMAX.*

## INTRODUCTION

In recent years, the fields of wireless communications and broadband access technologies have undergone a remarkable growth process. A steady increase in the demand for broadband access is nowadays perceived as a real necessity, rather than a luxury, in developed countries. The growth is also considered as a way to sustain emerging nations' telecommunication systems (Bouwman & Fijnvandraat, 2006). Moreover, a personal broadband experience and a need for ubiquitous access to multimedia content seem to foster a wireless broadband paradigm that materializes in the market as fixed and mobile options; the former being an appealing alternative to current wired technologies, such as DSL, while the latter offering both nomadic and mobile capabilities.

WiMAX, which stands for Worldwide Interoperability for Microwave Access, is a technology that has the potential to breach on the stage of wireless broadband communications and attain a prominent position. It builds on the IEEE 802.16 standards (IEEE, 2004, 2006) and shows potentialities to support fixed and mobile deployments. The case for WiMAX arises from both market and technical considerations. Wireless based approaches make it easier and more cost-efficient to connect new customers. Furthermore, a high degree of scalability is granted thanks to enhancements of physical layer technologies and radio resource management techniques.

Numerous WiMAX networks have already been deployed all over the world and many others are being rolled out in plentiful places. Even though the 2004 version of the IEEE standard mainly targets a market of residential and commercial fixed subscribers, it has been adopted both in emerging markets and, to some extent, in developed countries. WiMAX represents a cost-effective last-mile alternative to wired technologies. The 2005 version supports mobile nodes and could further foster WiMAX adoption. However, WiMAX is not a unique option in the market since

it faces competition from other technologies. In particular, HSxPA (High Speed Downlink/Uplink Packet Access), Ev-DO (Evolution-Data Optimized), and LTE (Long Term Evolution) could be other viable alternatives.

Rather than waiting for yet-to-come, though promising, enhanced 3G alternatives, operators could decide to concentrate their resources on WiMAX. Therefore, standardization issues and certification activities assume in this context a noteworthy role. The WiMAX Forum, an industry-led organization, promotes and advocates the adoption and certification of 802.16 based technology. Recently, the forum also proposed WiMAX as one of the air interfaces to be included in the International Telecommunications Union (ITU) IMT-2000 umbrella. The ITU approved such request in late 2007 and this will allow WiMAX operators to deploy systems in bandwidth already available and reserved at a global scale for IMT-2000 third generation technologies.

The technology built into WiMAX allows for efficient transport of non real-time and real-time traffic. It is expected that a wide variety of applications will be deployed on it. Web browsing, voice over IP (VoIP), IP television (IPTV) or video on demand (VoD) are among them. These applications will have to be delivered complying with specific quality of service (QoS) requirements. For instance, WiMAX systems will require low losses and delays to assure adequate VoIP quality or satisfactory user-network-content interaction for IPTV or VoD. The challenge is then the incorporation of efficient scheduling algorithms as well as enhanced radio resources management techniques to satisfy the requirements.

This chapter builds upon a technical foundation, presented in the next section, to illustrate the specific research challenges that the delivery of multimedia data over WiMAX poses. We do not intend to present a comprehensive view of the standard; instead we portray only those aspects that are relevant to our discussion. We elaborate on the research opportunity that WiMAX pres-

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