Chapter 7
Quality of Service (QoS) in WiMAX

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ABSTRACT

The WiMAX technology provides wireless QoS-enabled broadband access for fixed and mobile users at the metropolitan level. It is end-to-end IP based and provides a rich set of QoS support for multimedia-based ubiquitous computing. The main contribution of WiMAX in terms of technology has been over its radio interface, which is based on the IEEE 802.16-2004 and 802.16e protocols. It is a two layer protocol stack, which provides a very robust QoS framework. At the physical layer, it focuses on optimising the use of radio resources. In the MAC layer, the main focus is on efficient scheduling and allocation of bandwidth to meet the QoS requirements of IP sessions. This chapter investigates the WiMAX architecture, its components, and the QoS support provided by the IEEE 802.16 protocol stack. It also examines mobility management issues, end-to-end QoS, and current and future application areas of the technology.

INTRODUCTION

With the rapid proliferation of ubiquitous computing devices along with them hosting multimedia applications, it has become important to facilitate an infrastructure to support both mobility and QoS over a wireless environment. There have been many attempts to address either of them, but few attempts to address both goals (i.e., mobility and Quality of Service (QoS)) together. For example, the WiFi solution based on IEEE 802.11 provides bandwidth up to 300 Mbps, but is limited in range to less than 100 metres and does not provide any inherent QoS support. On the contrary, most 3G mobile technologies can offer mobility and coverage over a wide area but have bandwidth limited to 20 – 40 Mbps depending on the specific technology. Moreover, it is not fully

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IP based and is therefore an expensive solution for the long term. In this context, the Worldwide Interoperability for Microwave Access (WiMAX) network offers a solution by providing broadband wireless access with QoS and full mobility at the metropolitan level. A single WiMAX base station (BS) can cover a cell radius of up to 30 miles and speed up to 128 Mbps. Typically, as with any wireless technology, a compromise is made between distance and bandwidth based on the channel condition and load.

The WiMAX spectrum ranges from 2 – 66 GHz and covers both licensed and unlicensed bands. Different countries and operators use different subsets of these bands based on local government policies and usage requirements. The radio interface is based on Orthogonal Frequency Division Multiple Access (OFDMA) and the individual channel sizes range from 1.5MHz – 20 MHz. WiMAX supports both Line-Of-Sight (LOS) and Non-LOS (NLOS) communication. The LOS transmission uses the higher frequencies range up to 66 GHz while the NLOS uses frequencies in the range 2-11 GHz. The LOS set-up is used to provide wireless backhaul for telephony and data services as a replacement of existing copper, fiber and satellite-based backbone infrastructure. It could also be used to connect tall office towers with the BS as an alternative to high bandwidth leased line. The NLOS set-up acts as a wireless access network for home and office users. However, unlike WiFi it is not restricted to only hotspots but supports full mobility with QoS over the entire coverage area. With its efficient handover and roaming support, WiMAX is also a candidate for 4G mobile technology.

The WiMAX standard was first introduced in late 2001. After a few ratifications, a comprehensive document covering the various aspects of the technology was produced in 2004 as 802.16-2004 (IEEE 802.16, 2004). An extension to the standard covering mobility and enhanced QoS support was included in the IEEE 802.16e (IEEE 802.16e, 2005). Till this point, WiMAX only supported point-to-point and point-to-multipoint communications. Another extension covering mesh and ad-hoc model of communication was included in IEEE 802.16j.

This chapter focuses on the QoS support provided in the WiMAX technology. It is based on IEEE 802.16-2004 and 802.16e addendum. It presents an analysis of the end-to-end WiMAX protocol stack, the QoS provisions available over each layer and in each segment of the stack and how it is integrated to provide an end-to-end QoS solution.

WIMAX ARCHITECTURE

The WiMAX architecture defines a framework for end-to-end IP-based QoS-enabled multiservice for fixed and mobile users. It is based on the IETF standardized IP protocols and the network specification was developed by the WiMAX Forum's Network Working Group (NWG) with input from the Service Provider Working Group (SPWG) about the service requirements.

The WiMAX network reference model is made of three logical components (Figure 1). This includes the Mobile Station (MS), the Access Service Network (ASN) and the Connectivity Service Network (CSN). Each component is characterized by a set of related functionalities and are interconnected with other components by a clearly defined set of standardized interfaces. This allows smooth interoperability between different types of vendor equipments operating at different levels of the network.

The MS is generic mobile equipment providing connectivity between the mobile host and the ASN. The host could be a notebook, a WiMAX-enabled smart phone or a wireless backhaul point for example. The MS is connected to the ASN via the R1 radio interface based on the IEEE 802.16 MAC and Physical layer (PHY) standards. This interface is used both for data and control plane messages. The ASN consists of Base Stations

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