Chapter 3
QoS Architecture of WiMAX

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ABSTRACT

WiMAX technology, based on the IEEE 802.16 standard, is a promising broadband wireless technology for the upcoming 4G network. WiMAX has excellent QoS mechanisms to enable differentiated Quality of service of various applications. QoS in broadband wireless access network such as WiMAX is a difficult and complicated task, as it adds unpredictable radio link, user and traffic demand. WiMAX supports end-to-end QoS provisioning to allow various applications and services. This chapter aims to provide a detailed overview of the QoS in WiMAX, the current and the future. Various air-interface and network mechanisms that enable the end-to-end QoS provisioning are then discussed. Finally, the novel mechanisms to improve the QoS provisioning in the next generation WiMAX system are also discussed.

1. INTRODUCTION TO WIMAX QOS ARCHITECTURE

Recently, IEEE 802.16 (IEEE 802.16e-2005, 2006) based mobile WiMAX has become a very attractive candidate for 4G wireless systems. With Orthogonal Frequency Division Multiple Access (OFDMA) technology and mobility support, mobile WiMAX promises superior spectral efficiency and capacity, allowing mobile stations (MS) to access voice and various IP services through broadband wireless metropolitan area network. WiMAX technology is broadly based on the radio layers developed in IEEE 802.16 working group. Specifically, WiMAX Release 1.0 (WiMAX Forum, n.d.a). and Release 1.5 (WiMAX Forum, n.d.b). are based on IEEE 802.16e (IEEE 802.16e-2005, 2006; IEEE P802.16Rev2/D4, 2008). The next generation WiMAX Release 2.0 currently under development, will be based on IEEE 802.16m standard. Note that we interchangeably use the terms WiMAX and IEEE 802.16 in this chapter.

WiMAX airlink has a centralized medium access control (MAC) layer. All required bandwidth

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for UL applications have to be scheduled and granted by BS on the air interface. Hence, in order to satisfy the end-to-end quality of service (QoS) constraints of heterogeneous applications in WiMAX networks, the UL scheduling on the air link plays an important role. When a MS needs to transmit to BS in the UL, the bandwidth allocation is obtained via bandwidth request/grant process between MS and BS. Corresponding to the traffic characteristics of different services, five types of scheduling services have been defined for the WiMAX airlink: unsolicited grant service (UGS), real-time polling service (rtPS), non-real-time polling service (nrtPS), extended real-time polling service (ertPS) and best effort (BE) service. Among them, UGS, rtPS and ertPS are mainly used for real-time (RT) traffic and interactive traffic such as VoIP, video and online gaming, while nrtPS and BE are usually utilized for non-real-time traffic such as file transfers, emails, and web browsing.

The WiMAX network has been designed to support the WiMAX airlink QoS. The WiMAX network provides mechanisms for the applications (both operator hosted and external web based applications) to negotiate the required QoS for the application in question. The overall QoS framework is very efficient in supporting various types of traffic such as VoIP, Video streaming, online gaming, file transfers, web browsing etc.

The WiMAX forum has developed the concept of USI (WiMAX Forum, n.d.b), which is an API that can be exposed by the WiMAX operator to the external world, wherein the vast majority of web based applications in the external world such as YouTube video, Skype voice, online gaming etc can use this interface to request the required QoS for their services from the WiMAX network.

Interesting surveys, analysis and simulations studies on QoS support over WiMAX networks were published recently. A survey on the basics of Mobile WiMAX networks is given in Li et al. (2007). A survey of scheduling research on Mobile WiMAX network is provided in Chakchai et al. (2009). Filin et al. (2008) introduces an efficient and fast QoS guaranteed adaptive transmission algorithm for Mobile WiMAX. Talwalkar & Ilyas (2008) focuses on analysis of QoS in WiMAX networks. Neves et al. (2008) provides a simulation study of QoS differentiation support in WiMAX networks.

In this chapter we detail the operation of QoS in the WiMAX network and the usage of USI to setup QoS enabled VoIP calls. We then detail the WiMAX airlink QoS mechanisms and then move on to the latest and the greatest innovations happening in the area of QoS for the next generation WiMAX airlink.

2. END-TO-END WIMAX NETWORK ARCHITECTURE AND THE SUPPORT OF QOS

In this section, we will describe the End to End operation of QoS in a WiMAX network (WiMAX Forum, n.d.a) right from the MS to the base station (BS) to the ASN-GW to the core network (CSN/NSP). We will provide insights on how E2E QoS is provisioned, setup and torn down in a WiMAX network as well as the other associated procedures for QoS in the WiMAX network.

WiMAX defines a QoS framework for the air interface. This consists of the following key elements:

- Connection-oriented service
- Five data delivery services at the air interface, namely, UGS, RT-VR, ERT-VR, NRT-VR and BE (IEEE 802.16e-2005, 2006)
- Provisioned QoS parameters for each subscriber
- A policy requirement for admitting new service flow requests

A WiMAX QoS subscription could be associated with a number of service flows characterized