

Chapter 4

Cross-Layer Architecture: The WiMAX Point of View

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ABSTRACT

WiMAX is the most promising technology of recent years; it can be the technology that resolves some problems related to the spread of wireless service. When thinking of the concept of service, the most important related issue is the QoS (Quality of Service). Behind WiMAX, there is the IEEE 802.16 protocol (IEEE 802.16, 2004), which provides some basic mechanisms to guarantee QoS. This chapter aims to explore these mechanisms, but it also attempts to highlight the absence of some elements in the protocol or those components in it that can be improved. The protocol can be optimized and in the last part of chapter we show how to improve it using a set of algorithms collected by literature. Finally, it is explained how instruments not designed to be applied to the world of wireless, such as games theory or fuzzy logic, can be used to deal with wireless issues.

INTRODUCTION

This chapter deals with a particular aspect of 802.16 protocol, i.e. the QoS point of view. An overview of the mechanisms related to the QoS is given in this chapter, differentiating the mechanisms on the basis of the specific operating mode of 802.16 protocol. The 802.16 can operate in two mode: PMP (Point-to-Multipoint) mode and the mesh mode, and for each of them, the concepts related to QoS

will be introduced and commented, and in doing this, a cross-layer approach will be used. Various gaps in protocol have been left in a voluntary way, this gives greater flexibility to the protocol, since the implementers have the opportunity to create algorithms that are optimized according to their objectives and their application scenarios. In order to better understand how the protocol can be improved and enriched, what is present in the literature will be observed.

Finally, at the end of the chapter some specific cases of integration of WiMAX networks with other

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technologies will be discussed, and also it will be seen how to solve problems of traditional wireless networks using specific theories.

The purpose of this chapter is to make the reader aware of how the protocol guarantees the QoS and what basic concepts the protocol provides for this. To ensure that these concepts do not remain only as theoretical concepts, in discussions of the open issues of the protocol, practical solutions proposed in the literature will be included.

BACKGROUND

The main topic of this chapter is the QoS. QoS is very important, indeed essential, to any type of network taken into account. The quality is a concept closely related to the type of services provided to users. In fact, once certain restrictions for a quality service are set, it means meeting customer expectations and hence their satisfaction. QoS can be defined in different ways depending on the point of view and the level of abstraction that is considered. The user point of view is higher and is more abstract, everything is done in a transparent manner. The network point of view, or more correctly, the protocol point of view is undoubtedly the most complex. Each protocol uses its own set of mechanisms to ensure QoS at different layers of the protocol stack. In this chapter the QoS term is approached to WiMAX technology. This choice is linked to the fact, that the WiMAX technology is suitable for a wide variety of scenarios and can solve a great number of problems. In the literature there are several works that describe different scenarios for the applicability of this technology:

- (Diamond, Hossain & Niyato, 2007) a tele-medicine application scenario
- (De Rango, Malfitano & Marano, 2006) an application of 802.16 protocol to an HAP (High Altitude Platform) scenario
- (Gheorghisor & Leung, 2008; Matolak, Sen, & Wan, 2007) an airport scenario

- (Hempel, Sharif, Wang, Mahasukhon & Zhou, 2008) a railroad application
- A military application instead is described in Ganz & Wongthavarawat (2003)

Other papers, (Andrews, Chen, Ghosh & Wolter, 2005) instead analyze the potentialities and the future of this promising technology.

WiMAX is the acronym for Worldwide Interoperability for Microwave Access, and behind this label there is a non-profit-making society whose purpose is to accelerate the introduction of wireless devices with 802.16 technology. The IEEE 802.16 protocol is the name that identifies the standard proposed by IEEE. This protocol has a considerable number of opportunities for improvements that are related to specific processes, such as the call admission control process, the bandwidth allocation and others. In support of this, a list of interesting works in the literature can be found (Hossain & Niyato, 2006; Chou, Lin & Liu, 2008) related to the scheduling problem, related to call admission control (Agrawal, Li & Wang, 2005; Chang, Chen & Chou, 2007) and inherent handoff issue (Kwon, Park & Suh, 2006).

Issues, Controversies, Problems

Even if the QoS, in the considered protocol, is something that is well defined by a series of constraints, it is affected by the goodness of solutions designed to enrich the protocol and to improve and optimize certain aspects. The completion of protocol can be made by adding call admission control algorithms, bandwidth granting algorithms, handoff and adaptive modulation algorithms, these can be addressed and resolved by using a wide range of solutions and architectures.

To enrich the protocol is possible to create integrated solutions which aim to achieve optimized solutions. In works of Hossain & Niyato (2007) and of Geetha & Jayaparvathy (2007), for example, the authors consider an integrated solution for both call admission control and bandwidth problems.

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