Chapter 16

QoS and Mobility Management Issues on Next Generation Mobile WiMAX Networks

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ABSTRACT

Selection of a MIMO (Multiple Input Multiple Output) antenna to achieve high throughput, minimize errors, and optimize data speed is an important design issue. Radio resource management to provide Quality of Service (QoS) in WiMAX involves dynamic scheduling of resources according to the user’s priority, based classes Platinum, Gold, Silver, and Bronze. Mobility and handoff management in WiMAX is another important issue involving location update, signaling traffic and service delay, and call blocking and dropping. This chapter focuses on some issues concerning MIMO configuration to improve transmit diversity, developing an appropriate scheduling algorithm to improve QoS, and presenting a novel mobility management protocol THMIP (Three Level Hierarchical Mobile IP) in IEEE 802.16e environment to reduce signaling cost with respect to QoS parameters like throughput, end-to-end delay, interference, path loss, bit error rate, and Signal-to-Noise Ratio (SNR). For the simulation, the authors use OPNET Modeler and MATLAB.

INTRODUCTION

Ever increasing demand for higher bandwidth cannot be met with existing Digital Subscriber Line (DSL) cable Internet and other non-optical wired solutions requiring the installation of transmission cables. Wireless technologies eliminate the need for such installations. WiMAX is a solution for wireless broadband communication. WiMAX is flexible, robust, affordable and economically feasible and, therefore, assures high bandwidth communication and networking solutions of up to 48 Mbps (fixed downlink) and 7 Mbps (fixed uplink), even in the remote areas with a coverage area of 8 Km (Andrews, Ghosh, & Muhamed, 2007).
Mobile WiMAX provides 9.4 Mbps for downlink and 3.3 Mbps for uplink across a coverage area of 3 km. Its high speed data enables various multimedia applications, along with the conventional telephony service.

The original WiMAX standard, IEEE 802.16(2001), specifies a 10 to 66GHz range for fixed and nomadic services. This, however, has gradually (Yarali, Rahman, 2008) evolved to IEEE 802.16m (2011) through various stages as shown in Table 1. WiMAX operates in both licensed and unlicensed bands. Unlicensed band operates on the 2.4 Ghz and 5.8 Ghz frequencies. Licensed band operates on 700 Mhz, 2.5 Ghz.

**BACKGROUND STUDY**

A group formed by the industry and standardization forums and agencies in telecommunication such as Internet Engineering Task Force (IETF), 3rd Generation Partnership Project (3GPP2), DSL forum, Open Mobile Alliance (OMA) and Intel joined hands to form WiMAX forum (with more than 470 members to date) in 2003 to conceptualize WiMAX towards its deployment.

Etemad (2008) describes the brief overview, technology, architecture, interface, network specification of WiMAX and its evolution through the WiMAX forum. The new WiMAX standard IEEE 802.16m, proposed in 2011 (as Advance WiMAX), illustrates the extended features need to meet the requirements of ITU-R/IMT advanced 4G and support the mobility of 500km/hr. This standard is scheduled to be on the market by 2013.

The main promises of WiMAX are high throughput and expanded coverage. (Nuaymi, 2007), (Belghith & Nuaymi, 2008) for all QoS classes of WiMAX use, unsolicited grant service (UGS), real time polling service (rtPS), non-real time polling service (nrtPS) and best effort (BS). A different type of data uses a different type of QoS class to obtain maximum throughput while using the minimum bandwidth. This paper also provides a thorough analysis of mobile WiMAX architecture using the NS-2 module.

**Table 1. Comparative study of different QoS service classes**

<table>
<thead>
<tr>
<th></th>
<th>UGS</th>
<th>rtPS</th>
<th>nrtPS</th>
<th>erTPS</th>
<th>BE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum sustained traffic rate</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Minimum reserved traffic rate</td>
<td>(Can be present)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>--</td>
</tr>
<tr>
<td>Request/transmission policy</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Tolerated jitter</td>
<td>Yes</td>
<td>--</td>
<td>--</td>
<td>Yes</td>
<td>--</td>
</tr>
<tr>
<td>Maximum latency</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic priority</td>
<td>--</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Piggyback grant request</td>
<td>Allowed</td>
<td>Not allowed</td>
<td>Not allowed</td>
<td>Extended piggyback</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Bandwidth stealing</td>
<td>Allowed</td>
<td>Not allowed</td>
<td>Not allowed</td>
<td>Allowed</td>
<td>Not allowed</td>
</tr>
<tr>
<td>Unicast polling</td>
<td>PM (Poll-Me) bit can be used</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>Contention -based polling</td>
<td>Not allowed</td>
<td>Not allowed</td>
<td>Allowed</td>
<td>Allowed</td>
<td>Allowed</td>
</tr>
<tr>
<td>Differentiated Services</td>
<td>EF*</td>
<td>AF2,AF3**</td>
<td>AF1</td>
<td>AF4</td>
<td>Default</td>
</tr>
<tr>
<td>Application</td>
<td>T1/E1 transport, fixed size packet on periodic basis</td>
<td>MPEG video</td>
<td>FTP with guaranteed minimum throughput</td>
<td>VoIP</td>
<td>HTTP, web browsing</td>
</tr>
</tbody>
</table>

*EF(expedidate forwarding)*

**AF(Assured forwarding)**
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