Performance evaluation of variable channels for WiMAX network

Saif A. Abdulhussein
Al- Mustansiriya University, Faculty of Engineering, Electrical Engineering Department, Baghdad, Iraq
Saifabc0001@gmail.com

Abstract— WiMAX can offers or adds some qualifications to the wireless technologies such as long coverage area and supports different types Quality of service to the customers' and high data rate. The long distance area of WiMAX coming from the high transmit energy and from the structure of the network which is similar, to. mobile network. This technology takes to support flexibility, efficiency and various requirements of QoS over a variety of different services and environments several provisioning and mechanisms are provided in the standard. Voice over Internet Protocol (VoIP) through WiMAX is found to be very promising. In this paper, simulative discussion for VoIP in WiMAX network have been done considering the effect of Modulation coding (MC) and variable channels mechanisms on the QoS performance types of scheduling like rtPS, ertPS and UGS using network simulator is called OPNET. The discussion have been done in terms of important QoS parameters like average throughput, data dropped, end to end delay, WiMAX load, The results present that the best service type of the MCs that would be enhanced the QoS performance of the

WiMAX network is found that the modulation coding type Adaptive code has good for WiMAX measurements (Data Dropped, through put and WiMAX Load) and also found the QAM3/4 64 code has good for packet end to end Delay over the Vehicular environment. Asa for scheduling services it has been found that the best is the rtPS.

Index Terms— WiMAX, QoS, UGS, rtPS, ertPS, QPSK, QAM and adaptive modulation coding.

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) technology is one of the solutions of fourth-generation (4G) wireless network which provides high data rates for IP networks that is capable of offering high Quality of Service (QoS) [1]. Originally, four different service types were supported in the 802.16 standard: UGS, rtPS, nrtPS and BE.

The UGS(Unsolicited Grant Service) is alike to the CBR (Constant Bit Rate) service in ATM, which generates a fixed size burst periodically. This service can be used to replace T1/E1 wired line or a constant rate service. It also can be used to support real time applications such as VoIP or streaming applications. Even though the UGS is simple, it may not be the best choice for the VoIP in that it can waste bandwidth during the off period of voice call. The rtPS (real-time polling service) is for a variable bit rate real-time service such as VoIP. Every polling interval, BS (Base Station) polls a mobile and the polled mobile transmits bandwidth request (bandwidth request) if it has data to transmit. The BS grants the data burst using UL-MAP-IE upon its reception. The nrtPS (non-real-time polling service) is very similar to the rtPS except that it allows contention based polling. The BE (Best Effort) service can be used for applications such as e-mail or FTP, in which there is no strict latency requirement. The allocation mechanism is contention based using the ranging channel. Another service type called ertPS (Extended rtPS) was introduced to support variable rate real-time services such as VoIP and video streaming. It has an advantage over UGS and rtPS for VoIP applications because it carries lower overhead than UGS and rtPS [2]. The Quality of Service (QoS) and high data rate guarantee provided by this standard has made it commercially viable to support multimedia applications such as, mobile TV broadcasting and video telephony. WiMAX base station (BS) can provide broadband wireless access in a range up to 30 miles (50 km) for fixed stations and 3 to 10 miles (5 to 15 km) for mobile stations with a maximum data rate of up to 70 Mbps [1].

OPNET is a research oriented network simulation tool. It is a very powerful software tool that simulates the real world behavior of wired and wireless networks. OPNET modeler was selected, as it has the following abilities:

a) provides a comprehensive development environment supporting the modeling of communication networks and distributed systems.

b) Performing discrete event simulations.
c) Provides Graphical specification of model wherever possible; so models are entered via graphical editors.
d) OPNET modeler has library of models for most of the common networks around us [3].

In this paper [4] a simulation study to calculate the QoS performance of WiMAX and UMTS for supporting VoIP traffic is conducted. It designed simulation modules in OPNET for WiMAX and UMTS, and carried out extensive simulations to calculate and consider several important performance metrics such as end-to-end delay, jitter, packet delay variation and MOS. Simulation results are shown that WiMAX outscore the UMTS with a sufficient margin, and is the better technology to support VoIP applications compared with UMTS.

paper [5] was found that in case of voice signal quality, one of the primary differences between the PSTN and the VoIP network is that the PSTN provides a dedicated voice channel of consistent bandwidth for each voice call, whereas a VoIP network provides best-effort voice packet delivery consistent with IP network behavior and it is found that the voice jitter increases as the number of nodes is increased and the packet delay variations are similar to voice jitter results. On the basis of the results it was found that VOIP systems have a more stable and less delay connection than PSTN systems connection.

In paper [1] a simulative discussion for VoIP in WiMAX network have been done considering the effect of Modulation Coding (MC) mechanisms on the Quality of Service (QoS) performance of scheduling types such as; nPS ertPS and UGS, using Network simulator OPNET. It is found that the modulation coding type QPSK with coding rate 1/2 has good behavior over the suburban area. Therefore, it has the best result compared with other modulation coding types.

A. Modulation Coding in WiMAX:
WiMAX supports different types of modulation and coding schemes. Table (1) summarizes some combinations of modulation and coding rates, which can be allocated selectively to each subscriber, specified by the PHY layer [1].

<table>
<thead>
<tr>
<th>Modulation</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPSK</td>
<td>1/2</td>
</tr>
<tr>
<td>QPSK</td>
<td>3/4</td>
</tr>
<tr>
<td>16-QAM</td>
<td>1/2</td>
</tr>
<tr>
<td>16-QAM</td>
<td>3/4</td>
</tr>
<tr>
<td>64-QAM</td>
<td>1/2</td>
</tr>
<tr>
<td>64-QAM</td>
<td>3/4</td>
</tr>
</tbody>
</table>

WiMAX supports link adaptation techniques known as adaptive modulation and coding in which the modulation scheme changes depending on channel conditions. Using adaptive modulation scheme, WiMAX system can switch to the highest order modulation scheme depending on the channel conditions. As the signal-to-noise ratio (SNR) is very good near the base station (BS), so higher order modulation scheme is used in this area to increase the throughput [6].

B. propagation models:
The common propagation models namely Suburban Fixed, Free Space (Erceg),Outdoor to Indoor, Pedestrian Environment, Vehicular Environment. This research used two types of propagation models as shown below:

a) Vehicular environment: has larger cells and higher transmitter power. All subscriber stations have a high mobility, which is described by the following relation:

\[ PL = 40(1.4*10^{-3}*\Delta h_b) \]

Where;
\( \Delta h_b \) is the base station antenna height in meters.
\( R \) is the distance between the base station and the mobile station.
\( f \) is the carrier frequency.

b) Suburban area: It is based on extensive experimental data collected at 1.9 GHz in 95 macro cells of suburban areas across the Some States. Very large cell size, base stations with high transmission power and higher antenna height. Subscriber stations are of very low mobility which is described by the following relation:

\[ PL = H + 10* \log(f) + Xf + Xh + s. \]

where
\( P_l \) is the instantaneous attenuation in dB.
\( H \) is the intercept and is given by free space path-loss at the desired frequency over a distance of \( d_0 = 100 \) m.
\( s \) is a Gaussian random variable over the population of macro cells within each terrain category.
\( Xf \) and \( Xh \); are the correlation factors of the model for the operating frequency and for the MS antenna height respectively [1].

II. SYSTEM MODEL DESIGN:
The network topology for the system model is given in figure (1). The simulation model of the studied case is designed for 5-Hexagonal cell network, which contain one mobile subscriber that moves in the range of base stations. The parameters of simulation are shown in table (2), that illustrates some important parameters such as channel. Three types of scheduling services have been used for simulation. In these kinds (rtPS, ertPS and UGS), the behavior of different Modulation Coding have been analyzed for VoIP using OPNET Modeler (14.5). OPNET is perfect networking simulator to
evaluate the performance of a network [1]. QoS achieved is (Wimax load, Packet end to end delay, Data Dropped, and Average throughput).

Figure (1): System Model Design

### TABLE II. SIMULATION PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simulation time</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Number of BS</td>
<td>5</td>
</tr>
<tr>
<td>Number of MS</td>
<td>1</td>
</tr>
<tr>
<td>MS speed</td>
<td>50 km/h</td>
</tr>
<tr>
<td>Scheduling type</td>
<td>UGS, rtps, ertps</td>
</tr>
<tr>
<td>Base frequency (MHZ)</td>
<td>5.8</td>
</tr>
<tr>
<td>Antenna Gain BS (dbi)</td>
<td>0.5</td>
</tr>
<tr>
<td>Maximum transmission power (W)</td>
<td>Vehicular</td>
</tr>
</tbody>
</table>

III. IMPORTANT VOIP OF WIMAX MEASUREMENTS:
Before going further it is important to know the meaning of Quality of service Parameters used in VOIP. Here a brief definition of QOS parameters is given.

i. Packet loss ratio (PLR): is the corrupted, lost, or excessively delayed packets divided by the total number of video client station. Packets expected at the video client station [1].

\[
\text{PLR} = \frac{\text{Number of lost packets}}{\text{Total number of packets expected}}
\]

ii. Packet end-to-end delay: The total voice packet delay is calculated as:

\[
\text{De} = Dn + De + Dd + Dc + Dde
\]

where \(Dn\), \(De\), \(Dd\), \(Dc\) and \(Dde\) represent the network, encoding, decoding, compression and decompression delay, respectively [4, 1].

iii. Throughput (bps): is defined as the traffic load that the media stream will add to the network. It can be measured in bits/sec.

The throughput for variable bit rate (VBR) traffic loading is dynamic in nature and it is a function of the scene complexity and associated audio content. Variable bit rate (VBR) traffic loads is typically quoted as peak throughput ranges [2].

iv. WiMAX load: It represents the total load submitted to WiMAX layers by all higher layers in all WiMAX nodes of the network [7].

IV. RESULTS AND DISCUSSIONS:

The histogram of data dropped is shown in fig (2). Data dropped: It is found by the results that the (adaptive) is the best in terms compared to other codes that have been tested and compared with the search data loss rate [1] in rtps scheduling service. It was also found that the (QAM 3/4 64) with regards in ertps scheduling service is the least among the rest of the results as well as the research referred to above for the rest in ertps scheduling service codes. Where the high value in search [1].

The histogram of end to end delay measurements is shown in Fig(3) end to end delay: It is Found by the results that the QAM 3/4 64 (in rtps scheduling service) is the best among the rest and found that QPSK 1 / 2 (in ertps scheduling service) is the worst among the rest. Similarly, if our comparison between the results of this research with [8] would have found that the results were better in terms of the (rtps scheduling service). But if it were compared with other [1, 8] have found that the [1] is the best with regards to (rtps scheduling service).
service). It has been found that with regards to (UGS scheduling service), the (QPSK1/2) be the best, but (QAM3/4 64) is worst. if our comparison between the results of this research with [1], it would have found that the results were worst in terms of the (in rtps, ertps and UGS scheduling service) in terms compared to other codes that have been tested.

Figure (4): The histogram of throughput measurements

the histogram of WiMAX load measurement is shown in fig (5) WiMAX load (bits/sec): By observing the results shown in Figure(5), it was found that the best result in terms of the (WiMAX load) is the (adaptive) with regards to (rtps scheduling service).

Figure (5): The histogram of wiMAX load measurements

V. CONCLUSIONS:
In this paper, different modulation coding schemes such as; QPSK, QAM and adaptive are treated with real types of scheduling services (UGS, rtPS and erTPS). It was a comparison between Vehicular environment and suburban area. It is found that the modulation coding type Adaptive code has well for WiMAX measurements (Data Dropped, through put and WiMAX Load) and also found the QAM3/4 64 code has good for packet end to end Delay over the Vehicular environment. As for scheduling services it has been found that the best one is the rtPS. After a comparison with the search [4] Adaptive show that the best with respect to data dropped. But the QAM3/4 64 is the worst regarding the end to end Delay.

REFERENCES: