Priority Control Scheduling for Downlink and Uplink in WiMAX Network

Mahmoud Ahmad Albawaleez, Kamaruzzaman Seman, Kamarudin Saadan, Khairi Abdulrahim
Universiti Sains Islam Malaysia (USIM), Malaysia.

mahmoud_bawaleez@yahoo.com

ABSTRACT
In a WiMAX scheduler, when scheduling scheme needs to be designed for downlink and uplink, the issues of packet delay is paramount. This is even more when considering real time sensitive packets. In this paper, a Priority Control Scheme (PCS) is proposed to provide better QoS for real time delay sensitive packets in uplink and downlink channel. This is done by classifying the service flow priority of the packets into two types, which are time-delay sensitive and non-time delay sensitive. The performance from the proposed PCS is compared with the WiMAX classification service flow priority. The simulation results using OPNET show that the proposed scheme outperforms the existing scheme by having less delay.

KEYWORDS
WiMAX, QoS, Real time packet and Priority.

I. Introduction
Worldwide Interoperability for Microwave Access (WiMAX) or known as IEEE 802.16-2004, IEEE 802.16d, IEEE 802.16e or IEEE 802.16j technology is developed by IEEE 802.16 working group to improve the speed for mobile wireless network service and support high mobility access point [1].

WiMAX was introduced and published in 2004 by IEEE 802.16, and the standards define only two layers; layer one is the medium access control (MAC) and layer two is the multiple physical layer (PHY). Also, WiMAX is a wireless technology that provides solution for backhaul by mesh Wireless Metropolitan Area (WMAN) and DSL technology [2].

The MAC layer in WiMAX has two modes. The first mode is mesh mode, and it exists in multi-hop ad hoc network where each subscriber station (SS) is connected to a base station (BS) and to each other. The second mode is point to multipoint (PMP) mode, and it allows all (SS) to be connected to (BS) only [3].

To support Quality of Service (QoS), WiMAX standard (IEEE 802.16 2005) [4] classifier packets arrive to WiMAX into five type of service flow.
I. Unsolicited Grant Service (UGS): which is considered a priority packet, for example Voice over IP (VoIP).
II. Real-time Polling Service (rtPS): which is considered a priority packet, for example MPEG video.
III. Extended Real-time Polling Service (etrPS): which is considered a priority packet, Skype.
IV. Non real-time Polling Service (nrtPS): which is considered non priority such as FTP traffic.
V. Best Effort (BE): which is considered non-priority packet because it is the service flow without QoS constraints.

II. Related Work
The most used algorithm by researchers is Priority-based algorithm (PR), where traffic are classified into five different priority classes those as UGS > etrPS > rtPS > nrtPS > BE. Where some researchers applying other algorithms like Delay Threshold Priority Queueing (DTPQ), Round Robin (RR), Weighted Round Robin (WRR), and Deficit Round Robin (DRR) [5].

In determining the quality of service (QoS), every packet has different levels of priority. Therefore, when packets arrive to the output point will classified into different class depend on the
priority [6]. Queue will served packets from the highest priority to the lowest priority, but if there are two packets with the highest priority then the queue will back work with FIFO discipline law [7]. If the queue serving lower priority packet and highest priority packet arrive then the queue will finish serving the packet with the lower priority packet that has been started to serve and serve the highest priority packet after that, this cost delay for the highest priority packet [8].

### III. Problem Statement

Packet delay is the most considered when WiMAX downlink and uplink delay scheme need to be design. Packet with Real time packet classification may suffer delay and dropped [9] and [10].

Traffic classifier in WiMAX classifies the PDU based on the Connection ID (CID), which is 16 bit located in the Packet Data Unit (PDU) header. There are five types of packet classification in WiMAX and these are known as Unsolicited Grant Service (UGS), Extended Real-time Polling Service (ertPS), Real-time Polling Service (rtPS), not-real-time Polling Service (nrtPS), and Best Effort (BE). These five type of services classes have further three level of priority UGS as gold priority class, ertPS and rtPS as silver priority class, while nrtPS and BS as bronze priority class (lower priority class). Packets belonging to silver class, which is the real time sensitive, may suffer a long delay in the buffer that may lead to a poor Quality of Service (QoS) To overcome the problem, therefore this paper proposes a Priority Control Scheme (PCS) The scheme assumes that the service flow could be classified into two types: time delay sensitive and non-time delay sensitive. Time delay sensitive will have both UGS, ertPS and rtPS as one class, whereas non-time delay sensitive will have both nrtPS and BE as one class.

### IV. The proposed scheme

In WiMAX classification service flow, the priority for each frame in consideration is UGS > ertPS > rtPS > nrtPS and BE (for instance, UGS is at higher priority than BE). Conversely, the PCS proposes that UGS + ertPS + rtPS > nrtPS + BE for each frame.

Four types of traffics have been generated to support DL/UL in BS and SS for PCS scheme. Those traffics are video conferencing, voice, http, and ftp.

All four types of traffics follow MM1 queuing system where operation mode is random and arrival packets is exponential with mean income of 1000 packets/sec.

Video conferencing and voice will be for gold class which presenting high priority by (UGS, ertPS, and rtPS). Where http and ftp will be the lower priority class which presented by (nrtPS and BE).

![Diagram of the proposed scheme](image)

**Figure 1.** The design of the proposed scheme

For each queue in the (PCS) scheme FIFO algorithm have been applied. Figure 1 shows both remained bandwidth (BWr) and granted bandwidth (BWg) for both DL/UL. The base station (BS) and subscriber station (SS) granted bandwidth will be calculated as in (1) and (2),
with consideration maximum traffic for gold class and minimum traffic for bronze class [11].

\[
BW_{\text{total}} = BW_g + BW_{\text{remained}}
\]

(1)

\[
BW_g = \sum_{j=1}^{N_{UGS+ertPS+rtPS}} BW_{\text{Max}}^j + \sum_{j=1}^{N_{nrtPS and BE}} BW_{\text{Min}}^j
\]

(2)

V. Simulation Model and Rustles

Priority control scheme (PCS) has been simulated and implemented using OPNET [12], where MAC and PHY layer parameters listed in Table 1. Simulation was conducted for two scenarios: scenario one follows WiMAX classification service flow priority for each frame in consideration where UGS > ertPS > rtPS > nrtPS > BE. Where scenario two follow (PCS) service flow priority for each frame in consideration where UGS + ertPS + rtPS > nrtPS + BE.

Table 1. Simulation Parameters

<table>
<thead>
<tr>
<th>Parameters Type</th>
<th>Parameters Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum SS</td>
<td>100</td>
</tr>
<tr>
<td>Maximum Distance</td>
<td>6km</td>
</tr>
<tr>
<td>Transport protocol type</td>
<td>UDP/TCP</td>
</tr>
<tr>
<td>Symbol Duration</td>
<td>102.86 (n=28/25, delta_f = 10.94 kHz, Tg=Tb/8)</td>
</tr>
<tr>
<td>Base Frequency</td>
<td>5 GHz</td>
</tr>
<tr>
<td>PHY Profile</td>
<td>WirelessOFDMA 20 MHz</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>20MHz</td>
</tr>
<tr>
<td>Frame Duration</td>
<td>5ms</td>
</tr>
<tr>
<td>DL/UL Zone</td>
<td>100%</td>
</tr>
<tr>
<td>DL/UL Usage Mode</td>
<td>PUSU</td>
</tr>
<tr>
<td>Duplexing Technique</td>
<td>TDD</td>
</tr>
<tr>
<td>Modulation Type</td>
<td>16-QAM 1/2</td>
</tr>
<tr>
<td>PHY</td>
<td>OFDMA</td>
</tr>
<tr>
<td>Fast Fourier Transform Size</td>
<td>1024</td>
</tr>
</tbody>
</table>

Figure 2 shows simulation scenario for number of SS with deferent type of traffic, all traffics video conferencing, voice, http, and ftp have been was conducted by application configuration

![Figure 2. Simulation scenario](image_url)

![Figure 3. Average voice packet End-to-End delay](image_url)
Figure 3 shows the improvement in terms of average delay for voice End-to-End delay (the simulation time was one hour with same speed for the two scenarios). The results show that (PCS) provide better performance for voice End-to-End delay, total average voice End-to-End delay was 0.006593 sec in WiMAX classification comparing with 0.004543 sec in PCS scheme.

While Figure 5 shows the total average delay for SS was 0.032535 sec in WiMAX classification comparing with 0.030131 sec in PCS scheme.

VI. Conclusion

Packet delay is most important factor in developing scheme for WiMAX uplink and downlink scheme. This paper proposes a Priority Control Scheme (PCS). The simulation results are presented when comparing the PCS and the WiMAX classification. All figures show significant improvement in delay for real time packet sensitive.

VII. References


