



Characteristic Analysis of QoS Parameters of WiMAX using VBR Traffic

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Abstract -- *WiMAX (Worldwide Interoperability for Microwave Access) also known as the IEEE 802.16 standard evolved over a phase of time to escalate the prolusion of wireless services into trade. It is ingenious, user friendly, quickly deployable technology with high performance for delivery of broadband wireless services. Performance analysis of WiMAX has been evaluated by carrying out simulations via QualNet 7.3 wireless network simulator and theoretical analysis. The impact of mobility on QoS parameters are determined and analysed using Variable Bit Rate (VBR) traffic for WiMAX Networks for non-real time polling service (nrtPS), real time polling service (rtPS), extended real time polling service (ertPS), best effort (BE) and unsolicited grant service (UGS) flows.*

Keywords- *QualNet, QoS, VBR, WiMAX, Mobility*

I. INTRODUCTION

WiMAX is treated as an efficacious means to obtain access to internet services for all types of clients. Before the development of WiMAX (Worldwide Interoperability for Microwave Access), broadband internet service were provided mainly through wired architecture or Wi-Fi as a wireless technique. The IEEE working group based on BWA systems designed and coined IEEE 802.16 Wireless MAN, which is cheap in comparison to fiber or coaxial cable and provided for last mile wireless access. WiMAX can be deployed easily in areas which are difficult to reach through wired infrastructures [1]. In the new era of technology, next generation high speed wireless access networks are served basically by this technology. Earlier, Wi-Fi was used as a wireless technique to provide internet access but due to low speed and little coverage this technology has been overtaken by WiMAX. So, this ingenious standard is fast emerging as one of the main technology which will provide broadband internet access to the future generations. WiMAX Forum [6] a pool of around 420 introduced the idea of WiMAX. Next Generation Networks (NGN) standards utilize several technologies offered by WiMAX like orthogonal frequency division multiple access (OFDMA), differentiated quality of service resource allocation methods [3]. MAC relays are defined in 802.16j so WiMAX is used for Hybrid Networks, LANs, MANs or WANs [5]. Many versions of WiMAX are available which operate in licensed and unlicensed frequency bands [7].

1.1 Quality Of Service Classes

The telecommunication industry is propelled to meet the demand of the users as and when they demand the resource [2]. How a network serves this demand is interpreted as its Quality of Service. The demand of the network on the basis of its requirement is fulfilled by providing a particular Quality of Service to the user as per its need. In actual Quality of Service basically narrates the reliability and consistency of a network [4] and is measured by taking into consideration many factors like total unicast messages received, packet loss, average received throughput, average unicast end to end delay, average unicast jitter etc. In WiMAX different users demand for different type of service, in order to efficiently utilize the resources the network is serviced by different service classes as per the specification of the applications a user is interested in. The service classes supported by WiMAX [9] are Unsolicited Grant Service (UGS), Real-time Polling Services (rtPS), Non Real-time Polling Services (nrtPS), Best Effort (BE) and Extended Real-time Polling Service (ertPS).

II. SIMULATION SCENARIO

In this report, the simulation based method is used to analyze the mobility in WiMAX networks. The impact of the mobility is calculated by studying the quality of service parameters for various service flows in the WiMAX networks. Many tools are available in the market for simulation studies. In the present work, QualNet 7.3 Wireless network Simulator [10] is employed to create the simulating environment for simulation of the network in order to explicate the impact of mobility on the WiMAX networks.

The simulation is created by using nodes that are clustered in the subnets. The scenario created involves 20 nodes in all, which are placed in random fashion. These 20 nodes are divided into two networks. One node in each network is made to work as base station (BS) while all other nodes in the subnet behave as subscriber stations (SS) as depicted in Figure 1.

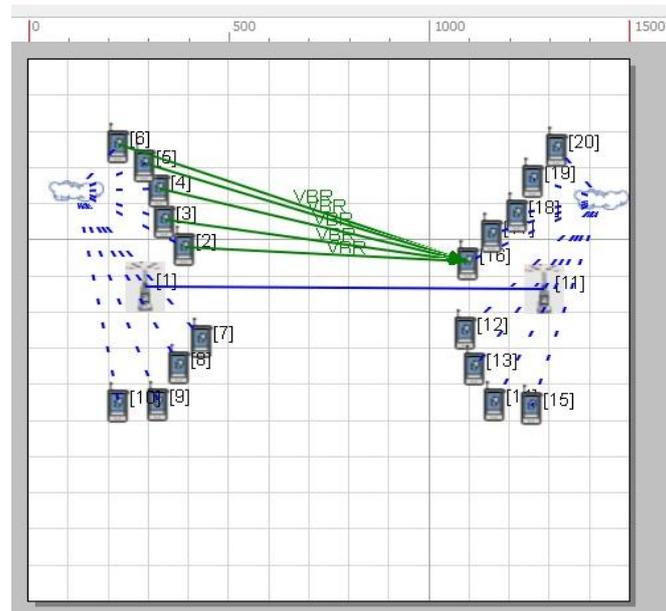


Figure 1: Simulation Scenario

The first subnet consists of 10 nodes out of which node 1 behaves as base station and the second subnet contains 10 nodes out of which node 11 works as base station. Moreover, node 1 of subnet 1 and node 11 of subnet 2 i.e. base stations are connected through a wired media. In order to analyze the impact of mobility, two cases of simulation are taken into consideration. In first case, WiMAX scenario created is simulated for variable bit rate traffic without assigning any mobility model and the results of this simulation are noted. In the second case, the scenario created is simulated by enabling random way point mobility model and accessed at different mobilities. Further, results of both the cases are compared to examine the impact of mobility on the WiMAX networks in these scenarios. Total Unicast Messages sent by VBR client nodes 2, 3, 4, 5 and 6 to VBR server node 16 is shown in Figure 2.

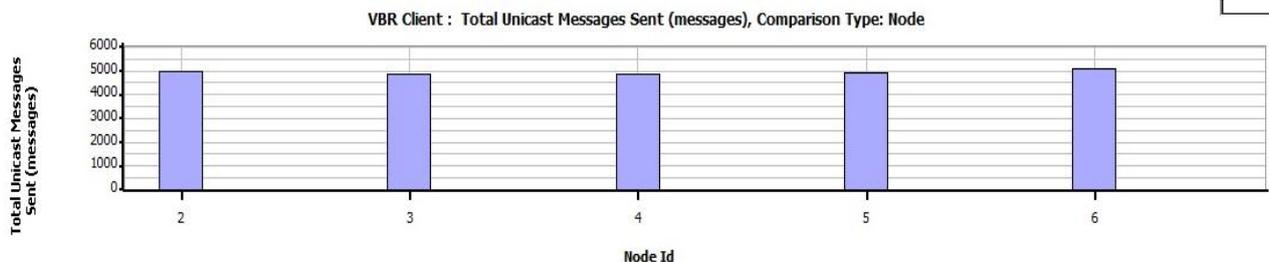


Figure 2: Total Unicast Messages sent

Parameters of simulation are specified as per IEEE 802.16e standard like simulation areas, simulation time, radio type, mobility model, service types, channel frequency, bandwidth, antenna height traffic type, item size, item to send etc and tabulated in Table 2. The simulation was carried out for 10 minutes i.e. the real operation of the network takes 10 minutes to complete. It is noteworthy to mention that the simulator revealed the results in 30 seconds. The default routing protocol used is Bellman Ford routing protocol, which is a distance vector routing algorithm and utilizes User Datagram Protocol (UDP) for controlled packet transmission [8].

Table 1: Simulation Parameters

Parameters	Value
Simulator	QualNet 7.3
Time	10 min
Area(meter)	1500 * 1500
Antenna Model	Omni directional
Mobility Model	Random Waypoint
Service Types	BE, nrtPS, rtPS, ertPS, UGS
Radio Type	802.16 Radio
Node Placement	Random
Channel Frequency	2.42 GHz, 2.44 GHz
Channel Bandwidth	20MHz

Antenna Height(meter)	5
Traffic Type	Variable Bit Rate
Precedence Value	0, 1, 3, 4, 7
Interval between Packets	0.0007 sec
Item Size	512 bytes
FFT Size	2048
Items to send	100

III. SIMULATION RESULTS

To investigate the impact of mobility on WiMAX networks various quality of service parameters i.e. total unicast messages received, unicast received throughput, average unicast end to end delay and average unicast jitter are taken into consideration. Comparative plots (Figure 3 to 6) reveal the impact of mobility on service flows BE, nrtPS, rtPS, ertPS and UGS. All service flows BE, rtPS, nrtPS, ertPS and UGS are depicted on the same plot, which clearly distinguishes and compares the behavior of the quality of service parameters under investigation for the same type of VBR traffic over different type of service flows.

3.1 Total Unicast Messages Received

The relative plot of the total unicast messages received and its relation to mobility for all service flows i.e. BE, rtPS, nrtPS, ertPS and UGS is depicted in Figure 3. The plot clearly points out that the value of total unicast messages received with respect to mobility is almost similar for BE, rtPS, nrtPS, ertPS and UGS service flows. The main reason for this trend is that there is no bandwidth starvation in this simulated scenario. With the increase in mobility i.e. at 20mps, a decrease in the value of total unicast messages received is seen which may be attributed to the fact that with the increase in mobility the processes of hand over mechanism starts, as the nodes which are registered to a particular Base Station move away from that particular base station. Further, among these five service flows, nrtPS flow receives the least number of total messages. Hence, it is noted that the performance of nrtPS flow is worst and the performance of rtPS is equally good. This matches with the data quoted in the literature for these service flows [11]. The packet loss can also be calculated easily with this parameter, as it is the inverse of the total unicast messages received. Therefore, it can also be seen from the Figure 3 that the packet loss is most in case nrtPS service flow out of the five service flows.

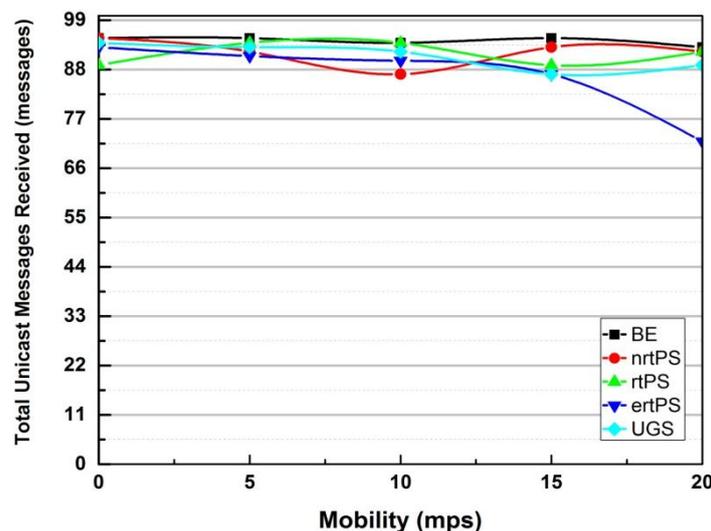


Figure 3: Total unicast messages received with respect to mobility

3.2 Unicast Received Throughput

Figure 4 gives the relative plot of the unicast received throughput versus mobility for BE, rtPS, nrtPS, ertPS and UGS service flows. Throughput measures the rate at which the data is transferred from source to destination in a given interval of time for a particular application and is expressed as bps (bits per second). It determines the capacity of the particular network at the interface of the network layer and the transport layer. In this case, strict priority scheduler is applied in the simulation environment, so nrtPS flows being least priority service flow out of these five service flows has bandwidth starvation during congested environments [13]. As shown in the Figure 4, out of all service flows rtPS flow has the highest value of average unicast received throughput at all the value of mobilities as this service serves the real time applications where high throughput is required to serve the application in a proper and efficient manner [8]. As nrtPS flows deal with the non real time applications so they can deal with the changes in the average unicast received throughput values. Here, ertPS and rtPS flows show similar trend and values of unicast received throughput does not show deterioration at any assigned value of mobility whereas for nrtPS, BE, UGS the values of unicast received throughput show a negative peak at 5mps, 10mps, 15 mps respectively.

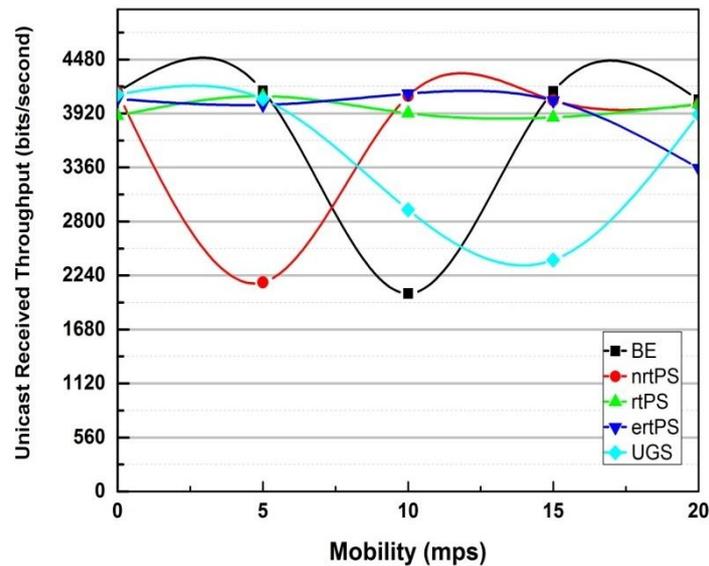


Figure 4: Unicast Received Throughput with respect to mobility

3.3 Average unicast end to end delay

The relative plot of average unicast end to end delay and its relation to mobility for the five service flows i.e. BE, rtPS, nrtPS, ertPS and UGS is clearly depicted in Figure 5. Latency or Average unicast end to end delay is defined as the time the packets take to reach from the source i.e. the client to the destination i.e. the server. rtPS and ertPS service flows have encountered least average end to end delay out of the all service flows and BE, nrtPS and UGS flows follow analogous approach i.e. at mobility 15mps all of these flows experience maximum delay which decreases further as the mobility is increased. The delay values are not large in all the service flows as it can be easily observed from the Figure 5. The range of average unicast end to end delay is around 5-6 seconds only for BE, nrtPS and UGS flows at mobility 15mps. Whereas at all other mobilities for all the service flows the value of delay experienced is negligible. This much amount of time is required for a particular service flow for the essential mechanisms for handling the particular service flow.

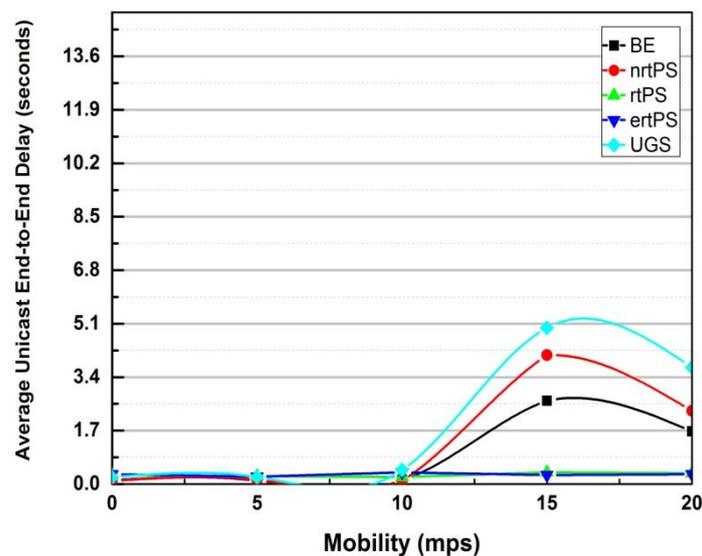


Figure 5: Average unicast end to end delay with respect to mobility

3.4 Average unicast jitter

The relative plots of average unicast jitter and its relation to mobility for all the five service flows i.e. BE, rtPS, nrtPS, ertPS and UGS are clearly depicted in Figure 6. The term jitter specifies the average variation in the delay interposed by the elements on the information conveyed path. The incipient value of jitter is very little i.e. almost close to minimal in all the five service flows in the current scenario created for this simulation. The scenario created does not have much congestion involved in it so these flows have encountered very less average unicast jitter associated with them. At mobility 15mps, the amount of jitter encountered by all the service flows is maximum and UGS flow has encountered maximum average jitter at this mobility that decreases further as the mobility increases. The similar trend was seen in case of the values of average unicast end to end delay too. Out of all the service flows, rtPS flow has minimum variation of jitter at all the mobilities and ertPS flow has least value of jitter compared to all other service flows.

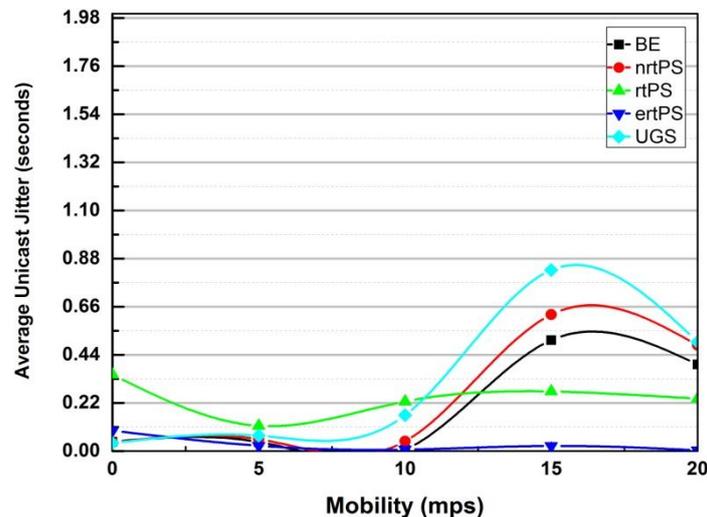


Figure 6: Average unicast jitter with respect to mobility

IV. CONCLUSION

In the paper, the generic notions of Quality of Service (QoS) in wireless network (Worldwide Interoperability for Microwave Access) were studied and a broad comparative analysis of impact of mobility on five service flows BE, rtPS, nrtPS, ertPS and UGS flows handled in WiMAX networks is presented. The Quality of Service is studied for variable bit rate traffic for these service flows. The parameters studied are average throughput, total unicast messages received, average unicast end to end delay and average unicast jitter. By studying all these parameters for the scenario after the simulation it can be concluded that variable bit rate traffic in WiMAX networks is served in the most optimum way by the real time Polling Service (rtPS) flow out of the five service flows i.e. BE, rtPS, nrtPS, ertPS and UGS flows. Further research can be carried out by taking other types of traffic like CBR, FTP, VoIP, video etc and the effect of mobility on such traffic encountered under different service flows can be seen and investigated.

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