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I. Introduction

IEEE 802.16 [1] is a very promising system enabling broadband wireless access (BWA). IEEE 802.16 standard also known as worldwide interoperability for microwave access (WiMAX) defines two modes to share wireless medium: point-to-multipoint (PMP) mode and mesh mode. In the PMP mode, a base station (BS) serves several subscriber stations (SSs) registered to the BS. In IEEE 802.16, data are transmitted on the fixed frame based. The frame is partitioned into the downlink subframe and the uplink subframe. Frame duration and the ratio between the downlink subframe and the uplink subframe are determined by the BS. In the PMP mode, the BS allocates bandwidth for uplink and downlink. The BS selects connections to be served on each frame duration[2]. the IEEE 802.16 standard [3] defines four types of service flows, each with its own QoS needs. Each connection between the SS and the BS is coupled with one service flow. The Unsolicited Grant Service (UGS) transmit constant bit rate (CBR) flows of CBR like applications such as Voice over IP. The real-time Polling Service (rtPS) is considered for applications with real time needs which produce variable size data packets regularly, such as MPEG video streams. In this class, QoS guarantees are given in the form of restricted delay with minimum bandwidth guarantees. The non real-time Polling Service (nrtPS) is adequate for better than- best-effort services such as FTP services. Similar to rtPS, minimum bandwidth guarantees are also given to nrtPS connections. The Best Effort service (BE) is used for best-effort traffic such as HTTP[4]. For years, the IEEE has devoted continuous efforts to develop the wireless metropolitan area network (MAN) 802.16 standard, streamlined as the Worldwide Interoperability for Microwave Access (WiMAX) by the WiMAX Forum. This standard has since attracted a great deal of attention in both the research and industry communities, and is touted as the next killer technology that promises to offer multiplay services in the future wireless multimedia marketplace. The main advantages of WiMAX lie in its cost-competitive deployment and comprehensive quality of service (QoS) support for large numbers of heterogeneous mobile devices with high-datarate wireless access. Since 2004, WiMAX has established its relevance as a wireless extension (or alternative) to conventional wired access technologies, such as T1/E1 lines, cable modems, and digital subscriber line (xDSL), extending the reach to remote areas. Mobile WiMAX, based on the IEEE 802.16-2004 and IEEE 802.16e amendment [5], fills the gap between the wireless local area network (WLAN) and third-generation (3G) cellular systems with respect to their data rate and coverage trade-offs, and acts as a strong competitor to the current 3G Partnership Project (3GPP) long-term evolution (LTE) on the road to 4G wireless broadband markets[6]. there are huge and different kinds of videos streaming from different users which may influence each other and thus, it is essential to enforce a scheduling policy designed for suitable video metrics and efficient network utilization, preferably in a distributed manner[7].

II. History of Scheduling Environment

Many papers has been proposed new packet scheduler environment for 802.16 network, in order to provide different levels of QoS guarantees for various applications. This is driven by the lack of standardisation for the Admission Control and Uplink Scheduling

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algorithm for rtPS, nrtPS and BE service flows in the 802.16 standard. [8] Proposes an architecture that introduces a framework for the scheduling algorithm and admission control policy for 802.16. They also suggest system parameters that may be used, and define traffic characteristics for which the network can provide QoS .[9] provides a detailed description of the proposed architecture and more background on the 802.16 standard. Authors in [10] Presents a scheduler where the priority is based on the channel and service quality. Huei-Wen Ferng and Han-Yu Liau[11] has proposed how to simultaneously achieve fairness and quality-of-service (QoS) guarantee in QoS-oriented wireless local area networks (LANs) is an important and challenging issue. Targeting at this goal and jointly taking priority setting, fairness, and cross-layer design into account, four scheduling schemes designed for the QoS-oriented wireless LAN mainly based on concepts of deficit count and allowance are proposed in this paper to provide better QoS and fairness. Bader Al-Manthari, et al.[12] has proposed a novel downlink packet scheduling scheme for QoS provisioning in BWASs. The proposed scheme employs practical economic models through the use of novel utility and opportunity cost functions to simultaneously satisfy the diverse QoS requirements of mobile users and maximize the revenues of network operators. Liang Zhou, et al.[7] has proposed important issue of supporting multi-user video streaming over wireless networks is how to optimize the systematic scheduling by intelligently utilizing the available network resources while, at the same time, to meet each video's Quality of Service (QoS) requirement. In this work, they proposed the problem of video streaming over multi-channel multi-radio multihop wireless networks, and developed fully distributed scheduling schemes with the goals of minimizing the video distortion and achieved certain fairness. HONGFEI DU, et al.[6] has proposed the design issues and the state of the art of multimedia downlink scheduling in the multicast/broadcast-based WiMAX system. This proposed a viable end-to-end framework, connection-oriented multistate adaptation, by considering cross-layer adaptations in source coding, queue prioritization, flow queuing, and scheduling. Its performance is confirmed by simulations on important metrics, showing that the framework can effectively accommodate heterogeneity in link variations, queue fluctuations, and reception diversities.

III. WiMAX Architecture

Broadband wireless architecture is being standardized by the IEEE 802.16 Working Group (WG) and the Worldwide Interoperability for Microwave Access (WiMAX) forum [9]. The basic IEEE 802.16 architecture consists of one Base Station (BS) and one or more Subscriber Stations (SSs) [7]. Figure (1) shows a typical IEEE 802.16 network in PMP mode comprising a Base Station (BS) that communicates with one or more Subscriber Stations (SS) known as Customer Premises Equipment (CPE) [4][10]. IEEE 802.16 specifies the following modes of deployment architectures [11]:

- Point-To-Point (PTP): A connection between one BS and one SS. The PTP mode extends the range over the PMP mode.
- Point-to-MultiPoint (PMP): A connection between one BS and multiple SS nodes. The BS always coordinates the uplink and downlink transmission. This mode supports multicast communication.
- Point-To-Consecutive Point (PTCM): It involves the creation of a closed loop through multiple PTP connections.
- Mesh: SSs can communicate with each other without the coordination of a BS. Both BS and SS are stationary while clients connected to SS can be mobile. BS acts as a central entity to transfer all the data from SSs in PMP architecture. Two or more SSs are not allowed to communicate directly. Transmissions take place through two independent channels downlink channels (from BS to SS) and uplink channel (from SS to BS). The uplink channel is shared among all the SSs while the downlink channel is used only by BS.

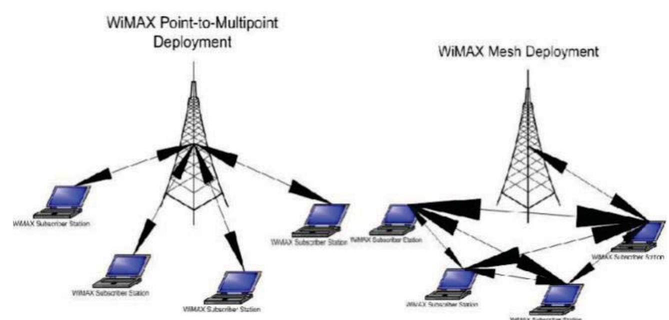


Figure 1: Mesh and Point-to-Multipoint (PMP) mode [7].

IV. Why use OPNET

A good modeling tool should closely reflect the true behavior of a network or computer system. It should support a wide range of network protocols and applications. It must be easy to use and master, especially for beginners. On the other hand, a good modeling tool should provide comprehensive technical support and maintenance assistance. In summary, we believe that a good modeling tool should have the following properties:

- Versatile: able to simulate various network protocols/applications under a wide range of operating conditions.

- **Robust:** provide users with powerful modelling, simulation and data analysis facilities.
- **User Friendly:** easy to use and master.
- **Traceable:** easy to identify modeling problems and simulation faults. OPNET is hailed by network professionals because it has all these properties. OPNET is a software package that has been designed with an extensive set of features. It can be tailored to suit almost every need of network protocol designers, network service providers, as well as network equipment manufacturers. OPNET supports most network protocols in existence, both wire line and wireless. It can be used to model and analyse a complex system by performing discrete event simulations.

V. Sheduling Queuing Algorithem

The research of packet scheduling algorithms in wireless channel has been taken for a long time[9,10,11]. In the physical world, the purpose of a real-time system is to have a physical effect within a chosen time-frame. Typically, a real-time system consists of a controlling system (computer) and a controlled system (environment). The controlling system interacts with its environment based on information available about the environment. On a real-time computer, which controls a device or process, sensors will provide readings at periodic intervals and the computer must respond by sending signals to actuators. It is imperative that the state of the environment, as received by the controlling system, be consistent with the actual state of the environment. Otherwise, the effects of the controlling systems' activities may be disastrous. Therefore, periodic monitoring of the environment as well as timely processing of the sensed information is necessary . In a real-time system, there may be unexpected or irregular events and these must also receive a response. On the other hand, having a sufficient number of processors, one is able to schedule the tasks without missing any deadlines. In this dissertation, various type of scheduling algorithm, like FIFO,PQ,WFQ, for comparison of four type of service, with its own QoS needs, as explained as under.

a) Fifo Queuing Algorithem

First-in-first-out (FIFO) is the simplest type of queuing. The incoming packets are placed in a single queue and are served in the order as they were received. This queuing policy requires very little computation and its behavior is very predictable, i.e. packet delay is a direct function of the queue size. There are many undesirable properties related to this queuing policy, due to the simplistic nature.

- It is impossible to offer different services for different packet classes since all packets are inserted into the same queue.
- If an incoming flow suddenly becomes bursty, then it is possible for the entire buffer space to be filled by this single flow and other flows will not be serviced until the buffer is emptied.

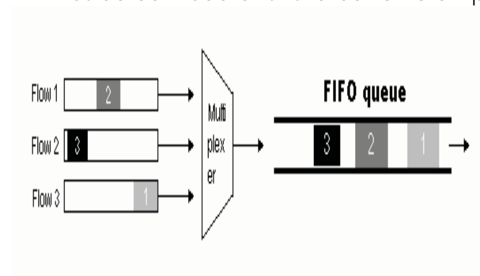


Figure 2: FIFO queuing[14]

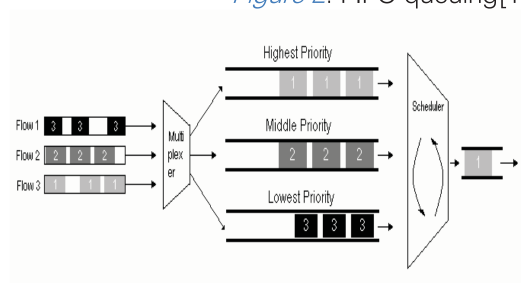


Figure 3: Priority queuing[14]

b) Priority Queuing

A simple way of offering different services to different classes of packets is Priority Queuing. Its operation involves classifying each incoming packet into different priorities and placing them into separate queues accordingly. The packets that have the highest priority are transmitted on the output port before the packets with lower priority. Even though this queuing policy is a good way of providing differentiated service, it also has some shortcomings, like large continuous flow of high priority traffic into the queue, equals excessive delay, and perhaps even service starvation for lower priority packets. Further, in our case we make use of both a non-preemptive priority network and a preemptive priority network. The difference between a so-called non-preemptive priority queuing discipline and a preemptive priority queuing discipline is that the transmission of a packet in a non-preemptive queuing discipline is not interrupted once it has begun.

c) Weighted Fair Queuing

Processor Sharing (PS) is a class of queueing mechanism with the purpose of allowing fair access for each incoming flow and to prevent a bursty flow from consuming all of the output bandwidth. PS contains a queue for each distinct flow and packets from each flow are inserted into its respective queue. The system then services each queue one packet at a time in a round–robin fashion.

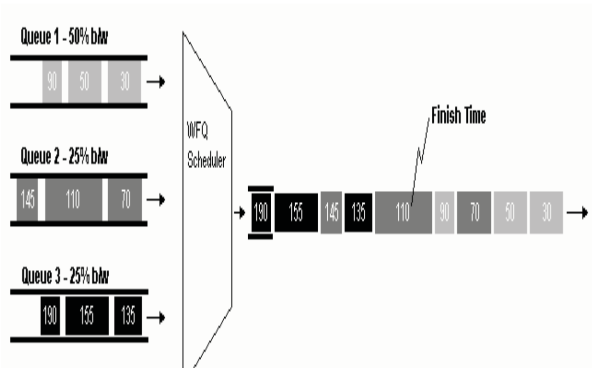


Figure 4 : WFQ Scheduling[14]

Weighted Fair Queuing (WFQ) is a variation of Processor Sharing (PS) in that it supports flows with different bandwidth requirements. It does this by assigning each queue with different weights that corresponds to the proportion of the allocated output bandwidth. In WFQ, each incoming packet is time stamped with a finish time in addition to being placed into its corresponding flow queue. Unlike Processor Sharing, selection of which packet to be serviced is now based on this time stamp on each packet. Further packets are serviced by examining their finish times. The ones with earlier finish times are transmitted before the ones with later finish times. It is possible for a later packet to have a finish time stamp that is smaller than an earlier packet.

VI. Simulation Methodology with OPNET Modeler

OPNET Modeler 14.0 is a powerful discrete-event simulation tool with an easy and convenient development environment and GUI I used an OPNET modeler 14.0 with WiMAX Wireless Advanced Module to develop a simulation for this paper. The key parameters that are provided here are: delay, network load, through put and application response time. A snap shot of the system simulation model is captured in figure (5).The proposed scenario consists of a wireless Network implemented as a WiMAX network, which was modeled within an area of10km x 10km.

Figure 5: WiMAX network scenario with QoS

A WiMAX Configuration Node (WiMAX_config) is used to store profiles of PHY and Service Class which can be referenced by all WiMAX nodes in the network.

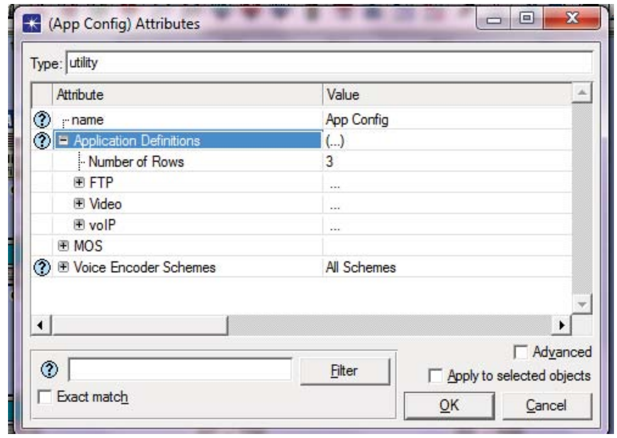


Figure 6: Application configuration

To support the VoIP ftp and video application, the application definition has to be configured.

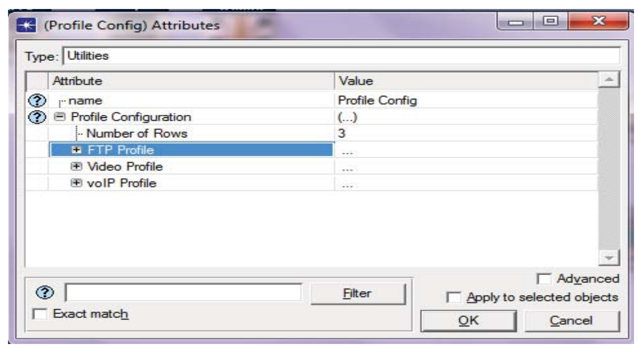


Figure 7: Profile configuration

Once the application configuration has been set, the profile would be ready to be configured since the profile definition was built upon the VoIP, ftp and Video application.

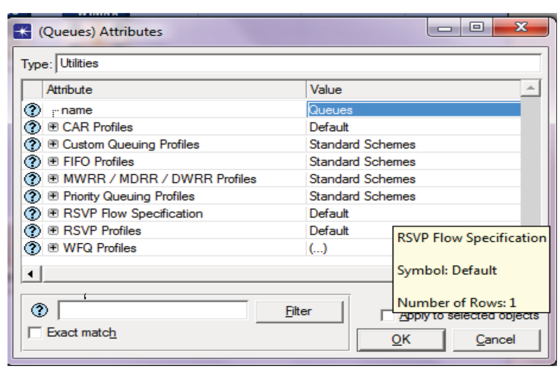


Figure 8: Queue Attribute

Queue attribute show the different parameter of FIFO, PQ and WFQ algorithms.

VII. Simulation results

WiMAX is often compared with Wi-Fi and existing 3G technologies, such as UMTS and CDMA2000. With Wi-Fi's advantage in speed and 3G's advantage in mobility, WiMAX sits between the two in data transfer rate and coverage range. The duration of the simulation for all four scenarios was 200 seconds. In all simulated results, dark blue line indicates the FIFO scenario, red line represents the PQ scenario, and green line indicates the WFQ scenario.

In case video traffic, Average bytes per second forwarded to all video conferencing applications by the transport layers in the network.

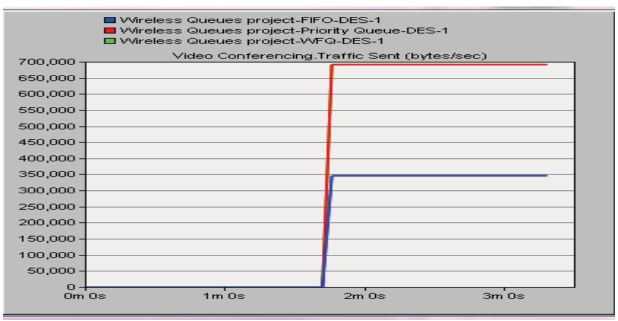


Figure 9: Video conference traffic (sent byte/sec)

In case FIFO (for the video traffic) number of transmitted byte is less (350,000 byte/sec) but in case of PQ and WFQ In which green lines are underneath the dark red line, number of transmitted byte is 700,000 byte/sec as shown in figure 9.Thus for the Video conference traffic FIFO traffic is less as compared to the PQ and WFQ traffic.

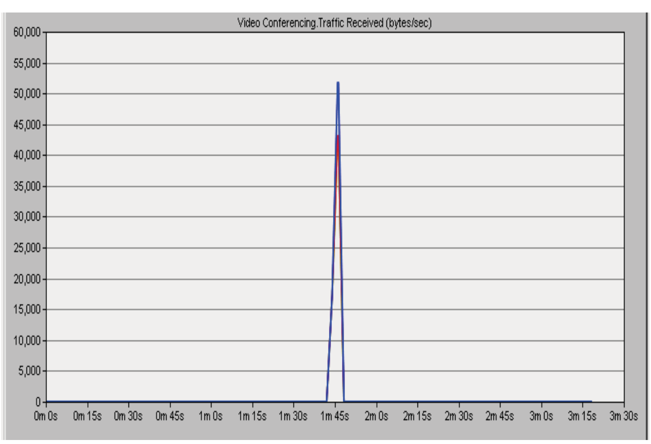


Figure 10: Video conference received (sent byte/sec)

In FIFO number of received byte is 53,000 byte/sec but in case of PQ and WFQ In which green lines are underneath the dark red line, number of received byte is 43,000 byte/sec as shown in figure 10. Thus in this scenario result of FIFO is better than result of PQ and WFQ.

In the scenario of voice traffic(shown in figure 11) number of transmitted byte is 32,000 byte/sec in FIFO,PQ and WFQ algorithms in which green lines line are underneath the dark blue line.

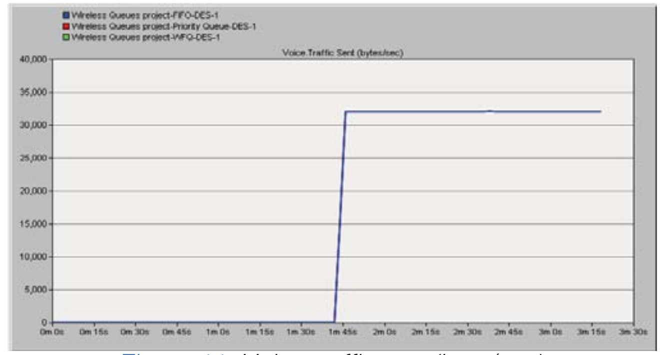


Figure 11: *Voice traffic sent(byte/sec)*

After the transmission of voice traffic, number of received byte/sec is varried with time,as shown in figure 12.In this scenerio, in the case of WFQ, at the time 1m 45s,number of received byte is 41,000 and in the case of FIFO, at the time 2m 0s,number of received byte is 64,000 and and in the case of PQ, at the time 2m 8s,number of received byte is 64,000.Thus traffic is varied at every instant of time at all.

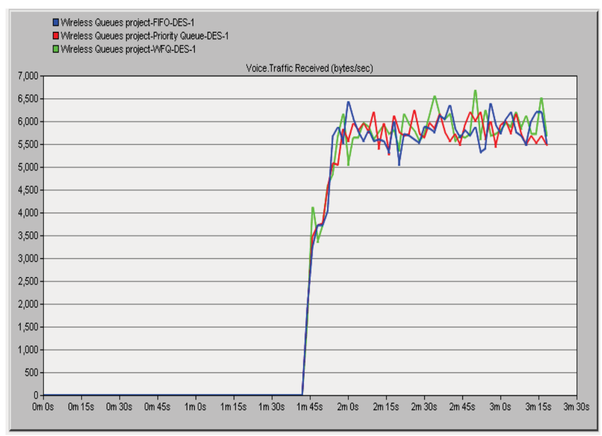
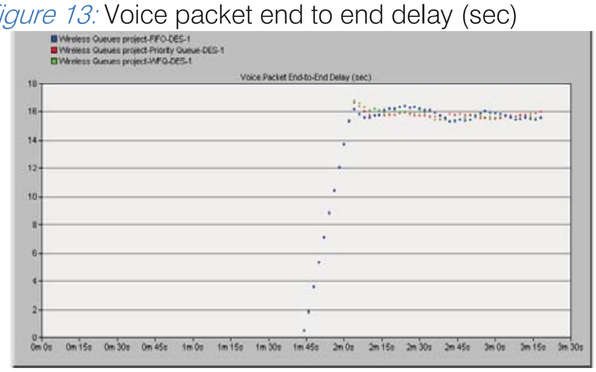


Figure 12: *voice traffic received (byte/sec)*

The total voice packet delay, called "analog-to-analog" or "mouth-to-ear" delay = network_delay + encoding_delaydecoding_delay+compression_delay+ decompression_dela. In the scenario of voice traffic (shown in figure 13) packet end to end delay

Figure 13 Voice packet end to end delay(sec)

Figure 13: Voice packet end to end delay (sec)



varied every instant of time at all in FIFO,PQ & WFQ algorithms.

VIII. Conclusion

The purpose of the paper is to demonstrate the comparative study of different queuing algorithms, implementation in WiMAX network with OPNET modeler . The factors that were studied in the simulation are the end to end delay traffic sent and traffic received. The introduction of an queue will not add more hardware since its elements will be deleted once it is extracted from the original queue. If there are connections with different service levels in the network, the scheduler allocates enough slots for each connection, so that the QoS requirements are supported.

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