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Performance Evaluation of Weighted Round Robin Scheduling for WiMAX Networks Using Qualnet Simulator 6.1

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Abstract: *Worldwide Interoperability for Microwave Access (WiMAX), which is also known as IEEE 802.16 standard supports broadband wireless access networks. WiMAX is an example of infrastructure based wireless network where mobile hosts can communicate through some access points. When the host changes its position and comes out of the scope of an access point, it connects with a new access point and resumes the connection. WiMAX has many advantages over wide coverage area and also aims to support the high data rates, QoS, long transmission range & low deployment cost as compared to cellular and Wi-Fi network. In recent times, WiMAX is known to cover areas up to approximately 35 miles using 2.3 - 2.7GHz frequency range. In this paper, we evaluate the performance parameters of a Weighted Round Robin (WRR) scheduler in order to decrease the average end-to-end delay, proper transmission and reception of the packets and improvement in the average throughput. The scheduling technique has been designed and simulated using the QualNet 6.1 network simulator.*

Keywords: *WRR, Scheduling Techniques, WiMAX*

I. Introduction To Wimax Networks And Characteristics

Mobile WiMAX is a fast growing broadband access technology that supports the low-cost mobile Internet applications over longer distances than standard Wi-Fi. WiMAX is based on standard IEEE 802.16 technology and can provide broadband wireless access upto 30 miles. WiMAX uses fixed and mobile stations to provide users with high speed voice, data and Internet connectivity. There are two models in WiMAX viz. Point to Multipoint (PMP) networks and Multipoint to Multipoint networks. PMP is an access network which includes a few numbers of Subscriber Stations (SSs) that are connected to a full functional Base Station (BS). When users install the equipment, they can get immediate access to the network. In this model, the SSs can direct the antennas towards the base station where the base station is the clustering point among all SSs [1]. Multipoint to Multipoint, also known as mesh network. Mesh network without centralized base station, and each subscriber station has the ability to connect directly to another subscriber station or via intermediate subscriber stations in such a way that all subscriber stations cooperate in the distribution of data in the network [1]. The communications between the SSs and the BS is managed by Access Service Network (ASN). For connectivity between SSs, WiMAX also allows two subscriber stations to communicate directly with each other whenever both are present in the transmission range; such functions are provided by Connectivity Service Network (CSN). Otherwise, they need another intermediate node such as BS or SS to perform the connection [2]. Fig. 1 shows an example of WiMax network architecture that involves a collection of subscriber stations connected to one base station. Many applications are currently using this type of network to get fast and wide range connection, such as broadband home networking [3]. In urban and suburban areas, problem arises in using wired based technologies such as digital subscriber line (DSL) and cable because of the need to satisfy rural area's requirements at lower cost and higher speed of deployment. WiMAX can be the best solution for such cases. Moreover, even in metropolitan cities, WiMAX can be used to extend services over the large area efficiently [4, 5]. Recently, the world has witnessed the evolution of many multimedia applications in different fields and the demand of such applications is increasing. Internet Protocol Television (IPTV) is an most important application that uses broadband multimedia services to contribute to the next generation of wireless networks. Day by day WiMAX is becoming more wide spreading than DSL and cable in providing high performance of Quality of Service (QoS) in multimedia applications [6].

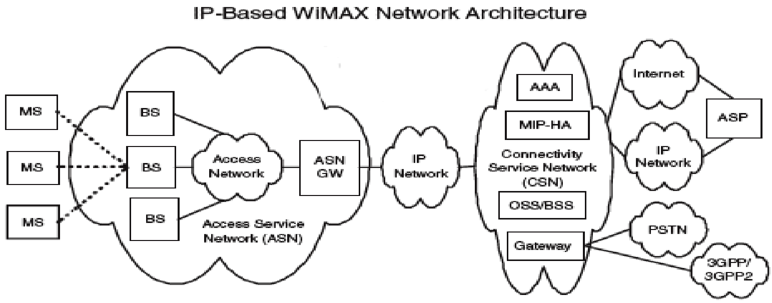


Figure 1. WiMAX Network Architecture

The data rate can be up to 70 Mbps which would enable WiMAX to serve all SSs with the required Quality of Service (QoS) and to support different class of services in many applications such as web browsing, VoIP, and multimedia applications [7, 8]. When SSs ask for specific class of service, the BS locates bandwidth suitable for this class with attention to required delay. There are five levels of QoS: Unsolicited Grant Scheme (UGS), real time Polling Service (rtPS), extended real time Polling Service (ertPS), non-real time Polling Service (nrtPS), and Best Effort (BE). Each service class has different QoS requirements and must be treated differently by the Base Station. The scheduling algorithm must guarantee the QoS for both multimedia applications (real-time and non-real-time), whereas efficiently utilizing the available bandwidth.

II. Research Methodology

Scheduling is done by the distribution of available resources among different users in a fair manner. Main aim is to achieve maximum throughput with minimum delay in order to ensure fairness among the users. This paper evaluates the performance of two scheduling techniques such as RR and WRR. The evaluation of results will be based on how each scheduler can serve different classes of services in a fair manner. In each scheduler, when a new connection arrives, the Call Admission Control (CAC) ensures whether the network is able to provide the required QoS or not, then it decides to reject or accept this connection. The required QoS for each class is usually mapped into a certain bandwidth allocation depending on the type of desired class of service. These levels of service are discussed later in the article. To assess the performance of different scheduling techniques, QualNet simulator 6.1 has been used. Different parameters are compared that are average throughput, average delay jitter, total bytes received and end-to-end delay metrics. In order to provide QoS, the queue status and priority for each packet to guarantee fairness between all users must be considered. In our study it is proposed that Weighted Round Robin (WRR) scheduler is an extension of RR scheduling.WRR is always executed at the beginning of the every frame at the base stations.WRR is basically used to determine the bandwidth allocated among each subscriber stations based on the weights .WRR tends to decrease the average jitter and average end-to-end delay while maintaining or increasing the average throughput. In order to evaluate the performance of the proposed approach, results are evaluated with the results of well-known scheduling technique Round Robin (RR). The reason behind choosing the RR scheduler is that it designed mainly for time sharing systems. The RR scheduler is the simplest algorithm that distributes the equal bandwidth to the SSs. However, it does not support the QoS requirements for different traffic classes, such as delay and jitter.

Scheduling and Call Admission Control in WiMAX Networks:

Scheduling mechanism plays an important role in the different applications of WiMax therefore application performance depends directly on the scheduling mechanism used. Scheduling guarantees to provide better QoS in the network. It also helps in reducing unnecessary complexity in the network by providing a meaningful QoS. The scheduling mechanisms are classified under three categories: Homogeneous, Hybrid, Opportunistic scheduling. These three categories of scheduling mechanisms have the same aims but differ by the characteristics of the scheduling algorithms employed in the scheduling mechanism [12].In homogeneous category are proposed for wired networks, but are used in WiMAX to satisfy the QoS while do not address the issue of link channel quality.In the hybrid category employs multiple schemes in an attempt to satisfy the QoS requirements of the multi-class traffic in WiMAX networks and also address the issue of variable channel conditions in WiMAX. Opportunistic category refers to algorithms that exploit variations in channel conditions in WiMAX networks.

Call admission control in WiMAX is responsible for the acceptance of new connections in the network. Before accepting any new connections, the CAC make sure that the network is able to provide the required QoS [9]. WiMAX supports different classes of QoS. The QoS requirements for each class are usually alloted at a certain bandwidth depending on the class specified [10]. There are generally five levels of QoS which are: [11] Unsolicited Grant Services (UGS) that supports real time data streams which consists of fixed sized data packets which are issued into network at periodic interval. Real-time Polling Services (rtPS) supports a real time data stream consists of variable sized packets that are issued at the periodic interval. Extended real-time Polling

Services (ertPS) supports variable rate application that includes data rate & delay .Non real-time Polling Service (nrtPS) supports delay tolerant data streams which consist of variable size data packets for which a minimum data rate is required. Last class of service is Best Effort Services (BE) which supports data streams in which no minimum service guarantees are required.

III. Simulation Setup

The Qualnet 6.1 network simulator is used to analyze the performance of WRR. Qualnet provides graphical user interface in order to create the scenarios by settings its specifications.The network scenario consists of 40 nodes with CBR applications. These nodes are randomly distributed over the scenario having the dimension of 1500 m × 1500 m. The IEEE 802.16 is used as a MAC layer communication protocol. Many rounds of simulation have been conducted. In the application layer, the nodes communicate using Constant Bit Rate (CBR) traffic generators over UDP with random source/destination pairs. CBR applications are used as a constant bit rate for data traffic which keeps the bit rate same throughout the complete process. The CBR is also modelled so as to sends data packets from sources to destinations. If the value of the items to be sent equals 0, CBR will run until the end of the time value or the end of the simulation, depending on which one occurs first. If the end time equals 0, CBR will be running until all the items are sent or until we reach the end of the simulation depending on which occurs first. In order to extensively evaluate the performance we studied the effect of a number of traffic generators i.e. CBR by assuming 10, 15, 20, and 25. The overall system traffic load increases with the number of sources and the CBR value. Table 1 illustrates the simulation parameters related to the discussed work.

TABLE 1:- Simulation Parameters

Parameter	Value
Simulator	QualNet 6.1
Scenario Dimensions	1500m x 1500m
Simulation Time	110 seconds
Number of Nodes	40
Scheduling Algorithm Evaluated	WRR
Node Placement	Random
Traffic Type	CBR
Number of CBR	10, 15, 20, 25
Antenna Type	Omni directional
FFT Size	2048
Radio Type	802.16
Items to Send	100
Item Size (bytes)	512
Interval	1millisecond
Channel Frequency	2.4GHz
Data Rate	2Mbps
Path loss model	Two ray model

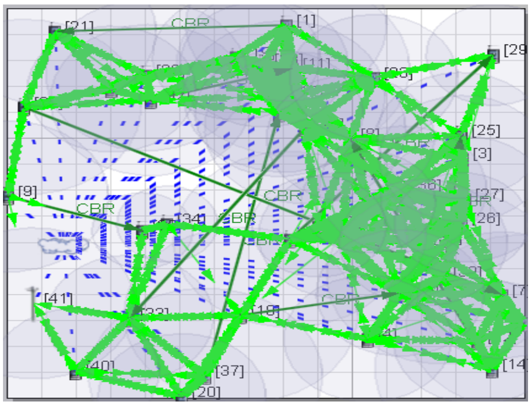


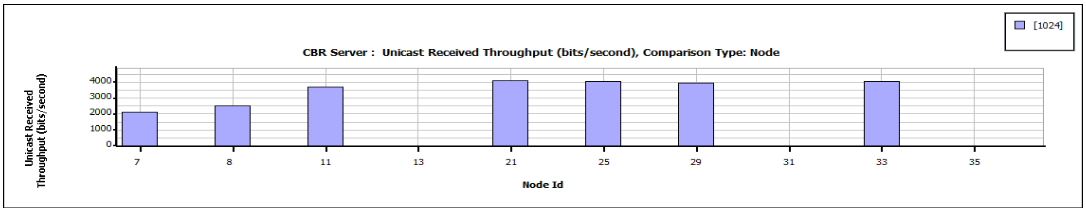
Figure 2. Snapshot of Simulated scenario on Qualnet simulator 6.1

IV. Simulation Results

The results of different simulation experiments performed to evaluate the performance of WRR scheduler have been reported. The performance metrics discussed are the average jitter, end to end delay, total bytes received and average throughput. The performance metrics are presented for different traffic loads. The overall results in graph shows that WRR scheduler is far much better than the conventional RR when different numbers of CBR connections are applied in the network. This is due to the fact that in WRR the calculations have been reduced and also the time saved due to which it is used to serve more packets.

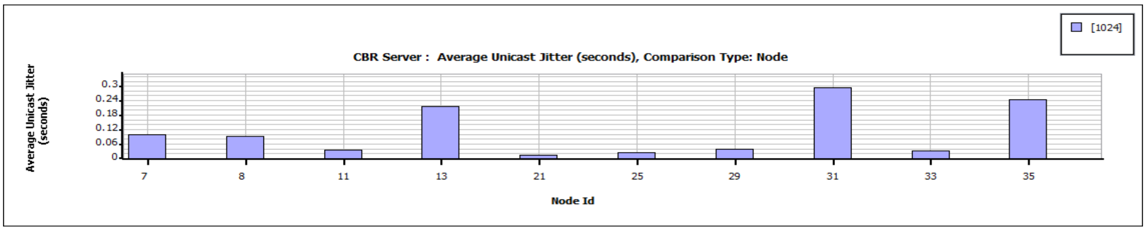
4.1 Throughput: - In communication network, throughput defines as the average rate of successful delivery of packets to the destination per unit time. It is measured in bits per second .The fig. 3 shows that node. 21, 25 and 29 having high throughput while other nodes shows minimum throughput thus analyzed that WRR scheduling improves throughput at different CBR connections in the network.

Figure 3:- Throughput



4.2 Average Jitter: - As the packets transmit from source to destination, then the packets will reach the destination with different delays. A packet's delay varies with its position in the queues .Jitter refers to the rapid variations in a waveform resulting due to the fluctuations in the voltages or due to other sources. In fig 4 nodes 11, 21, 25, 29 and 23 shows less jitter while node 13, 31, 35 indicates more jitter .As more the jitter less the performance experienced.

Figure 4:- Average Jitter for different number of connections.



4.3 Average End-to-End Delay: - This performance metric represents the average delay between the time when the data packet was originated at the source node and the time it reaches the destination node. The end to end delay metric includes delays due to route discovery, queuing and transmissions at the MAC level. In fig 5 shows the better performance because the maximum node having minimum end to end delay.

Figure 5:- Average End-to-End Delay

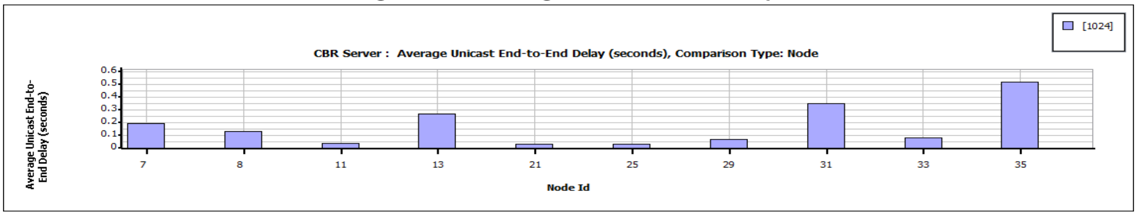
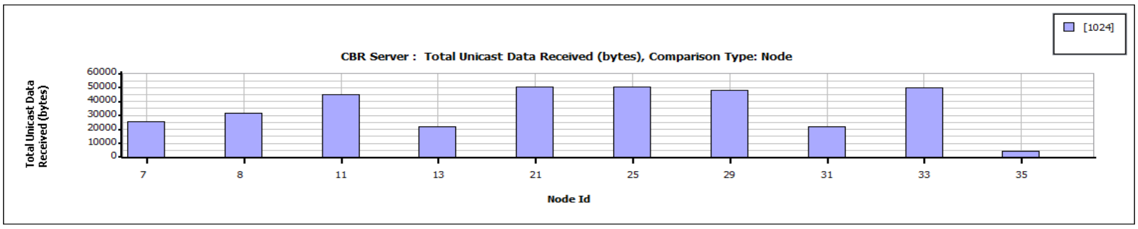


Figure 6:- Total Bytes Received



Total Bytes Received: - It specifies total number of data packets received at the server end. In fig 6 shows that total number of packet received at the destination by different nodes.

V. Conclusion And Future Scope

In this paper performance evolution of WRR for WiMax networks has been discussed. Weighted Round Robin (WRR) scheduler for WiMax supposed to provide better services than to the original RR scheduler.The major aim of the study to reduce the average delay and increasing the average throughput especially to the lower classes by increasing the size of service round than that in the existing RR. The simulation experiments show that the proposed algorithm significantly outperforms the RR algorithm in terms of reducing end to end delay. In future, the effectiveness of network density can be performed by adding more schedulers to compare with them. Also, analysis can be made by increasing the node density and varying the number of CBR applications employed and their apparent effect on the network traffic.

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