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Evaluation and Comparison among Scheduling Algorithms in WiMAX

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Abstract: WiMAX is one of the most prevailing networks in the world. There are many concerning issues regarding WiMAX and scheduling of resources is one of them. In this paper, we have evaluated and compared various WiMAX scheduling algorithms such as CAC, MWRR, Modified Priority scheduling algorithm and Proportional Fair scheduling algorithm. We have implemented and simulated these scheduling algorithms using OPNET Modeler. From the results it is concluded that Modified Priority scheduling algorithm is having maximum delay in the network. MWRR and Modified Priority scheduling algorithm are having maximum and minimum load respectively. CAC and Modified Priority scheduling algorithm have high throughput.

Keywords: WiMAX, OPNET Modeler, scheduling algorithms, QoS.

I. INTRODUCTION

WiMAX (Worldwide Interoperability Microwave Access) is IEEE 802.16 which provides fixed as well as mobile network. People are using wireless technologies for many different types of applications such as VOIP, sending emails, downloading files of different formats such as MPEG, JPEG etc. However, all the services of wireless access come with their own requirements and cost. Different techniques for improving their capability and quality have become one of the prominent research areas. Resources such as bandwidth, delay, latency, and packet loss in a network all these parameters are managed with the help of QoS [1]. For providing access to these applications, WiMAX has five QoS classes [2]:

a) ***Unsolicited Grant Service (UGC):*** UGC supports constant Bit Rate (CBR). It is used for applications which consist of fixed-size data packets such as voice-application without silence suppression.
b) ***Real-Time Polling Service (rtPS):*** support real size data packets with variable size and are issued at periodic intervals such as MPEG video.
c) ***Extended Real-Time Polling Service (ertPS):*** those applications which have variable packet size and have data rate and delay guarantees like VoIP with silence suppression.
d) ***Non Real-Time Polling Service (nrtPS):*** streams those have variable size data packet and are delay tolerant, such data streams fall under this class.
e) ***Best Effort (BE):*** it supports those data streams that do not need any QoS guarantees like HTTP.

II. SCHEDULING ALGORITHMS

Scheduling algorithms are those algorithms which maintain resource allocation among the different tasks, so that each and every task gets resources. In WiMAX, scheduling algorithms are used for allocating resources such as bandwidth, channel etc. for the services. The traffic from the BS to the SSs is known as downlink traffic and the traffic from the SSs to the BS is known as uplink traffic. A scheduling algorithm implemented at the BS has to deal with both uplink and downlink traffic. In some cases, separate scheduling algorithms are implemented for the uplink and downlink traffic [3].

A. Call Admission Control Scheduling Algorithm:

Jeevan B. Chalke [4] has proposed a Call admission control scheduling algorithm and implemented it.CAC has three dynamic services, Dynamic Service Addition (DSA), Dynamic Service Change (DSC) and Dynamic Service Deletion (DSD). To provide quality of service, if BS can guarantees the required QoS is checked. Hence whenever any new flow arrives, want to change existing QoS parameters or want to delete the existing flow, the DSA/DSC/DSD request is send to the CAC module on BS.CAC analyzes the connection and sends DSA/DSC/DSD response back. In response, BS sends the data CID back to the SS to use in further transactions.

B. Proportional Fair Scheduling Algorithm:

Ashish Jain et.al have implemented PF which was proposed by Qualcomm Company (also known as High Data Rate (HDR)) [5]. It does this by maintaining trade-off between system throughput and starvation of low priority users. Queue having highest value of U*i*(t) is served at time slot *t*. This algorithm is based on one priority function:

$$Ui(t) = \frac{ri(t)}{Ri(t)}$$

Where *ri*(t) is the current data rate and *Ri*(t) is an exponentially smoothing average of the service rate which is received by SS *i* up to slot *t*.

C. Modified Priority Scheduling Algorithm:

D.Mohd et.al has presented the approach that aims at adjusting the threshold value which represents the number of bandwidth request message [6]. The scheduling scheme starts with the scheduler visits to rtPS and is serviced until no more bandwidth request message is available. Before continuing the other services, the scheduler will check on the amount of bandwidth request available in the nrtPS service class. If the amount of bandwidth request exceeds the threshold assigned, then the scheduler will carry out the service to nrtPS and subsequently the BE. On the other

hand, the scheduler will return to service rtPS if the amount of the bandwidth request is less than the threshold assigned.

D. Modified Weighted Round Robin:

W.Mardani et.al have proposed and implemented MWRR [7]. WRR algorithm uses Greatest Common Divisor (GCD) function to evaluate weight counter for WRR packet scheduler.

$$\text{QueueInfo}[i].\text{Weight Counter} = \frac{(\text{QueueData}[i].\text{Weight} \times \text{WRR Weight Multiplier})}{\text{GCDinfo}}$$

Since the service round is small, it increase the number of calculations and causes delay. WRR was modified to have large service round, due to which the delay and calculations are reduced. In MWRR each queue weight counter is multiplied by constant integer value (r) in order to maximizing the service round. The value of r depends on the network size. MWRR has not only decreased the average end-to-end delay for WiMAX, it has also improved the average throughput. It is calculated that the improvement was around 4%.

III. SIMULATION & RESULTS

These scheduling algorithms are implemented using OPNET Modeler as shown in Figure 1:

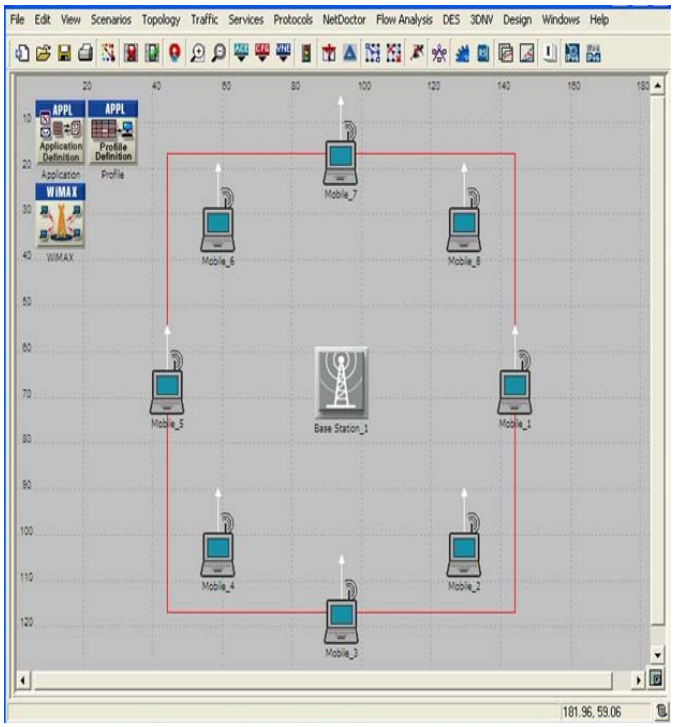

Figure 1: Simulation Network for implementation

A. Delay:

Figure 2 explains that for all the four algorithms delay occurs when the simulation time above 1.8 minutes. MWRR and Proportional Fair scheduling algorithm (FS) have almost same delay rate i.e. having 20 sec delay as maximum value. Modified Priority scheduling algorithm has slightly higher delay than CAC. When the simulation time is 2.8minutes delay is 30sec, 27sec, 20sec and 20 sec for Modified Priority scheduling algorithm, CAC, Proportional Fair scheduling algorithm (FS) and MWRR respectively.

B. Load:

In WiMAX load is maximum for MWRR i.e. 51,000,000 bits/sec and minimum for Modified Priority scheduling algorithm i.e. less than 20,000,000 bits/sec. CAC is having load of 44,000,000 bits/sec at 2.1 minute and 47,000,000 bits/sec at 2.2 minute. For Proportional Fair scheduling algorithm (FS) load lies in the interval of 35,000,000 to 43,000,000 bits/sec as shown in Figure 3.

C. Throughput:

CAC and Modified Priority scheduling algorithms have approximately same throughput values. When the simulation time is 1.8 minutes both have maximum throughput i.e. about 600 packets/sec and the value lies between 550-600 packets/sec afterwards. Proportional Fair scheduling algorithm (FS) and MWRR have throughput is comparatively low. It lies in the range of 450-500 60 packets/sec as shown in Figure 4.

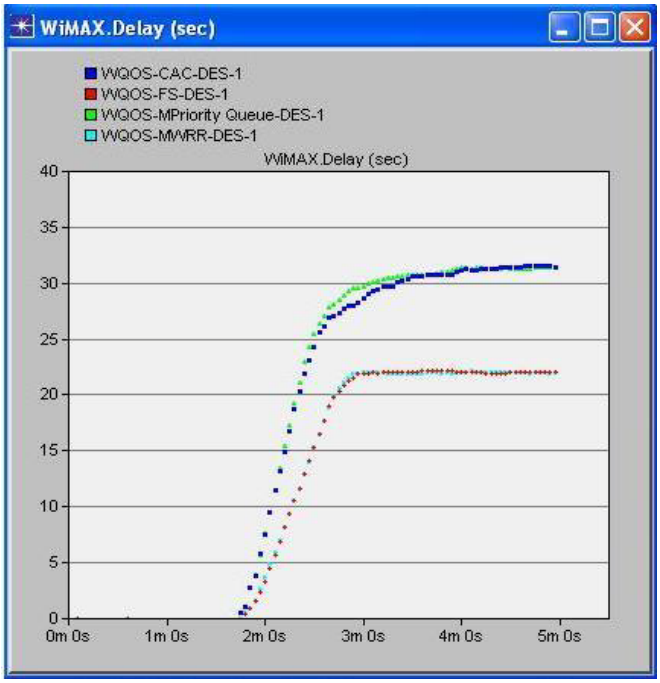

Figure 2 Delay in WiMAX

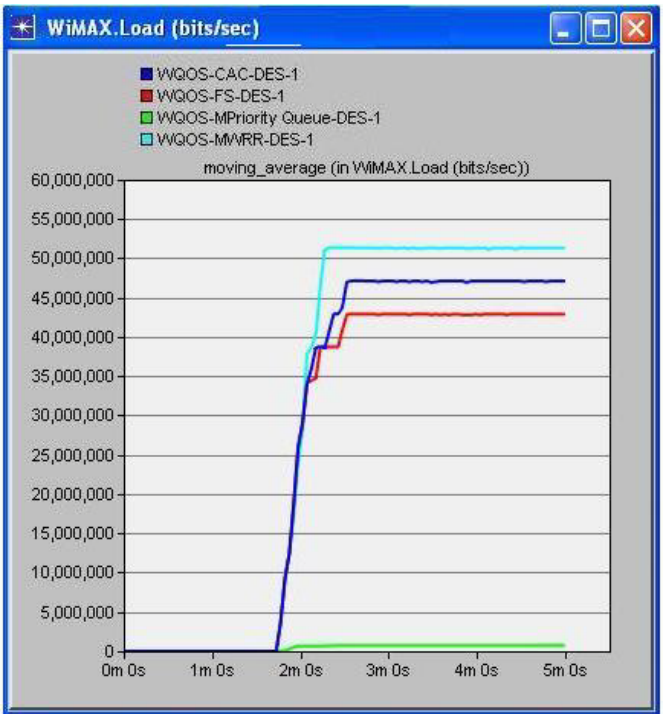

Figure 3 Load in WiMAX

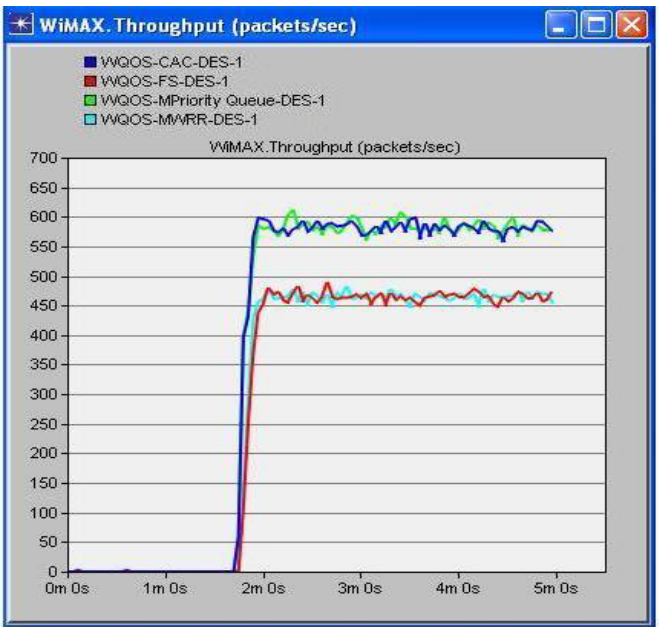

Figure 4 Throughput in WiMAX

IV. CONCLUSION

From the above graphs, it is concluded that the CAC is having high delay and throughput. MWRR is having low delay and throughput but high load. Modified Priority scheduling algorithms has slightly high delay than CAC, but it has comparatively very low load. Both have approximately same throughput values. Proportional Fair scheduling algorithm (FS) is having slightly higher values for delay but as far as values for load and throughput are concerned, FS is having intermediate values for both.

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