Comparative Analysis of VoIP Application with Different Queuing Schemes in WiMAX Using OPNET

H.S. Mewara
Deptt. Of Electronics Instrumentation and Control Engg.
Govt. Engineering College
Ajmer, India

Dhanwanti Manghnani
M.Tech. Scholar
Govt. Engineering College
Ajmer, India

***Abstract*—this paper will attempt to study the effects & performance of three queuing techniques (First In First Out Queuing, Priority Queuing, Weighted Fair Queuing) with VOIP application in WiMAX through OPNET 14.5 simulator. In recent years VOIP (Voice over Internet Protocol) is one of the most modern and interesting technology. This work inspects the execution of VOIP traffic characteristics over WiMAX (Worldwide Interoperability for Microwave Access). Applications like web browsing (HTTP), email and FTP are very careless or insensitive towards any kind of delay in transmission of information while VOIP technology is very delicate and sensitive towards delay, packet losses and jitter. For this reason three different queuing methods are put into operation to manage, regulate, arrange and also to prioritizing the packets in buffers before their transmission. Here FIFO, PQ and WFQ queuing are implemented with the help of OPNET simulator and various parameters like jitter, mean opinion score, packet delay variation and packet end to end delay are studied. After this analysis and evaluation we can pick the best and right queuing scheme. In this document we are also investigating that how performance of various queuing schemes are affected with different numbers of nodes.**

Index Terms —WiMAX, OPNET, FIFO, PQ, WFQ, MOS, Jitter, Packet Delay Variation, Packet End to End Delay.

I. INTRODUCTION

In recent years, internet access has moved towards a new dimension. It is now not restricted to Web browsing and emailing. Multimedia services including Voiceover-IP (VOIP) and media streaming have become the expectation of the next generation. To offer customers this application high connectivity is requires, for such connectivity BWA (Broadband Wireless Access) comes into the picture. It promises users to be provided with megabit internet access seamlessly. One of the many technologies under BWA is WiMAX (Worldwide Interoperability for Microwave Access) [1]. Based on IEEE 802.16 it has been planned to offer metro area broadband wireless access. With 70 Mbps [2] speed and over 50 miles of coverage area [3], WiMAX supports mobility up to 70-80 miles/hr and is supposed to be the replacement of cable and DSL (Digital Subscriber Line) [4]. IEEE 802.16 support 5 types of service classes, namely BE (Best Effort Service), UGS (Unsolicited Grant Service), rtPS (real time Polling Service), nrtPS (non-real time Polling Service), ertPS (extended rtPS service) [5].In VoIP[6] there is compression of voice signal and this compressed signal is remolded in to digital signal. These digitized voice packets are then uses IP (Internet Protocol) for managing voice packets over IP network. In this manuscript we are investigating the functioning of VOIP application with three queuing schemes (FIFO, PQ and WFQ). Here we implement WiMAX network using a powerful tool, which is called OPtimum NETwork (OPNET). OPNET is an object oriented simulation tool, which provides a visualized simulation environment for network modeling. OPNET is a proficient tool which provides inclusive industrial hold and continuance support. OPNET also provides versatility, robustness, traceability and user friendly environment.

II. ATTRIBUTE AND PERFORMANCE MEASUREMENT UNITS

A. First-in, First-out Queue (FIFO)

FIFO, queuing is one of the easiest queuing scheme. In FIFO queuing, the packet came first in the buffer is treated first i.e. packet appear first in the buffer will transmit foremost. Here it is necessary to mention that, this queuing scheme treating all packets in a same manner regardless of the application and importance that is being employed by packets [7]. Figure 1 shows the procedure by which FIFO queuing works.

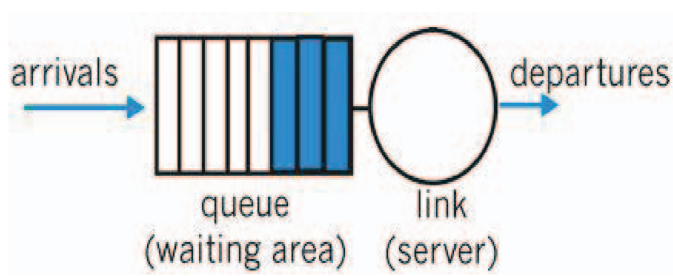

Fig: 1 FIFO Queuing

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B. Priority Queue (PQ)

Basically PQ is similar to FIFO; the only difference between both is tagging mechanism. PQ uses tagging mechanism in which all packets are first tagged according to application and importance and then they put in to the buffer. Furthermore Priority Queues contains two buffer; low priority buffer and high priority buffer. Packet contain higher priority tag will transmit first. Figure 2 shows the procedure by which PQ works.

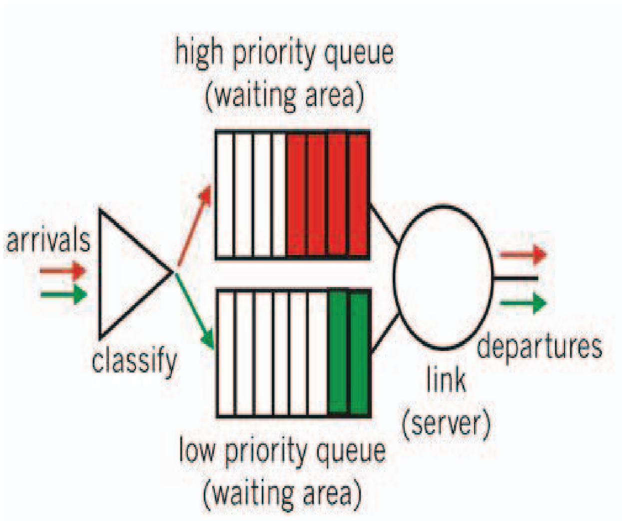

Fig: 2 Priority Queuing

C. Weighted Fair Queue (WFQ)

WFQ is almost same as PQ like priority queuing here also all packets are first tagged according to their urgency and then they put in to either low priority buffer or high priority buffer. Only difference between both of them is, WFQ contain a WFQ scheduler which provides circular mode service to all buffers. Figure 3 shows the procedure by which WFQ operates.

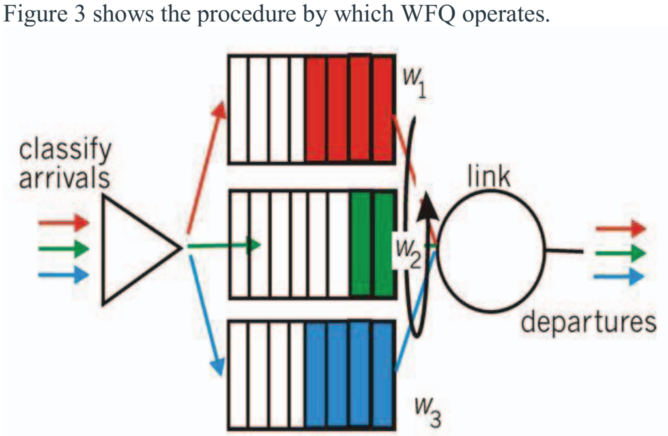

Fig: 3 Weighted Fair Queuing

D. Jitter(Sec)

Jitter is defined as the deviation in End-to-End delay. ETE delay is basically a delay occur in transmission of packet from source to destination. Deviation in ETE delay occurs due position of packets in the queue and different queue sizes; as we know all packets are put into different queues. Therefore it is necessary that jitter should be minimized to improve the voice quality of the transmitted information, especially in applications requiring real-time data transmission.

E. Mean Opinion score(MOS)

The Mean Opinion Score offers a mathematical measurement of the quality of a voice signal that is perceived after it has been transmitted [8]. Table 1 shows the rating scheme used to govern the supposed quality of voice signals.

Table 1: MOS Values and their Perceived Voice Quality

MOS Value	Perceived Quality	Degree of Impairment
5	Excellent	Imperceptible
4	Good	Perceptible but Annoying
3	Fair	Slightly Annoying
2	Poor	Annoying
1	Bad	Very Annoying

F. Packet Delay Variation

Packet Delay Variation is a measurement of the dissimilarity in the ETE delay between packets, ignoring any packets that have been lost. In OPNET, PDV corresponds to the difference of the delay [9].

G. Packet End to End delay(Sec)

Packet ETE delay is basically a delay occur in transmission of packet from source to destination. For real-time applications like voice and video, packet ETE delay should be minimized in order to offer a seamless and natural client experience.

III. SCENARIO AND SETTINGS

Here we have made six projects with different numbers of workstations (5, 10, 15, 20, 25, and 30).In each project there are three different scenarios for each queuing discipline (FIFO, PQ, WFQ). For ease of operation here we showed a simple scenario, which consist of two base stations, every base station having five workstations. Both base stations are connected to backbone node, this node is linked to IP Cloud at last cloud is attached to server. The application supported profile for these workstations is G711. These workstations support VOIP application. Figure 4 shows just a basic network, for each project scenario it is exactly same except no. of workstations or end users. For each new project we just increased no. of end users in each cell.

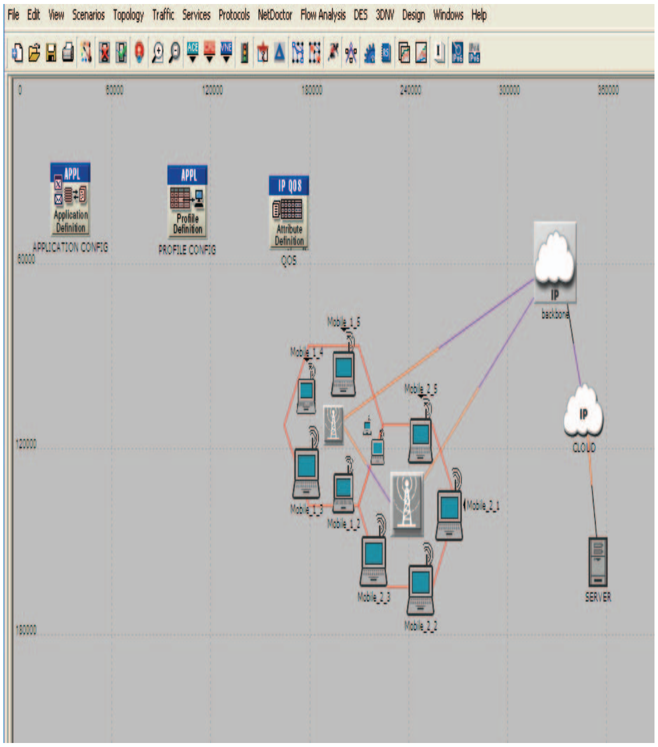

Fig: 4 OPNET scenario of whole network

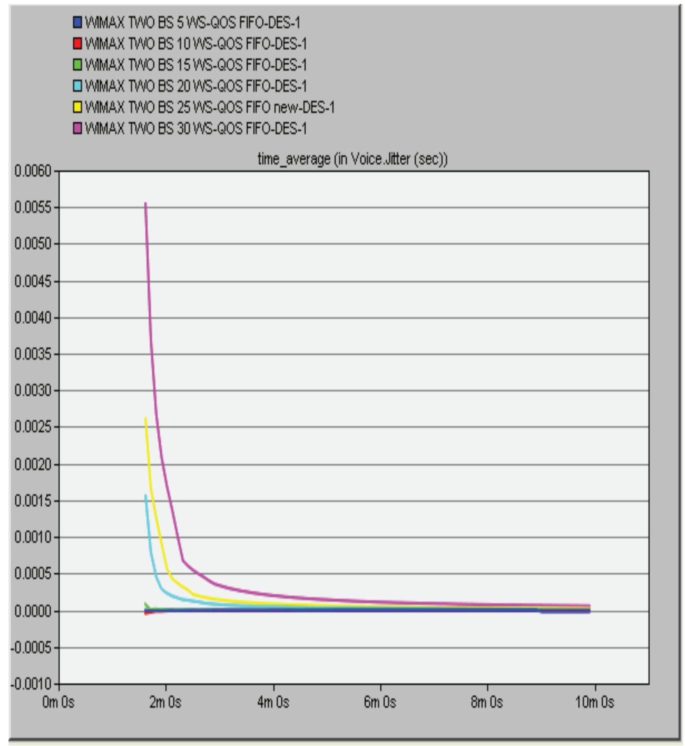

Fig: 5 Jitter for FIFO queuing

IV. SIMULATION ANALYSIS

The simulation analysis had been made by OPNET 14.5simulator. Figure 5, 6, 7 shows jitter value of FIFO, PQ and WFQ queuing schemes. Here we are able to spot that in every queuing method jitter value is almost same 0.0000 sec for 5, 10, and 15 workstations. When the quantity of users increased value of jitter is different for each scheme. For 30 workstations in FIFO value of jitter is 0.0055 sec, for 25 users it is 0.0025 sec and for 20 end users it is 0.0015 sec. As well in PQ scheme for 30, 25, 20 workstations it is 0.0025 sec, 0.0035 sec and -0.0005 sec. In WFQ scheme it is 0.0056 sec, 0.0032 sec and 0.0014 sec for 30, 25, 20 workstations. Similarly here from figure 8, 9 and 10 we are capable to notice that MOS value for workstations 5, 10 and 15 is almost 3.6 for every queuing method. In FIFO scheme for different no. of nodes MOS value is varying it is almost from 2.6 to 3.6, in PQ it is varying from 2.4 to 3.6 and for WFQ it is from 2 to 3.6.

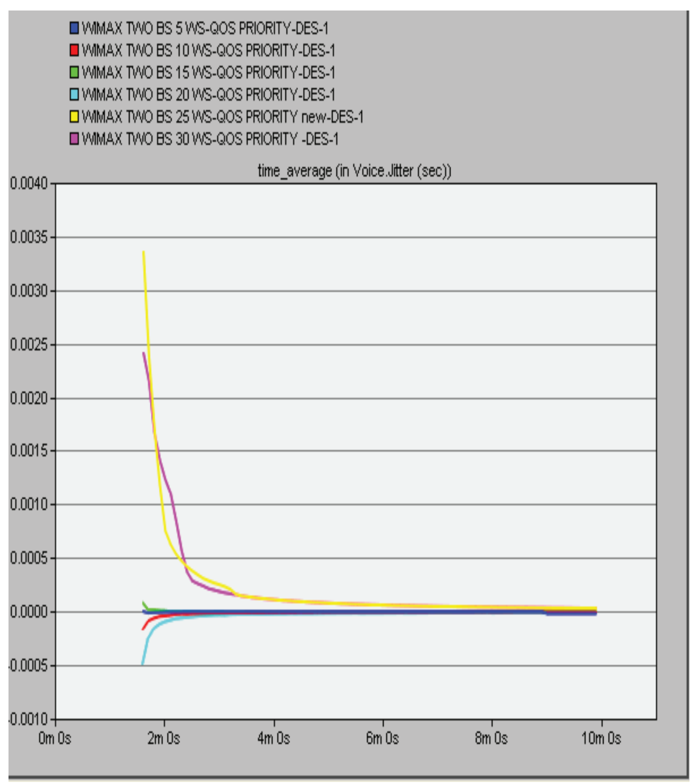

Fig: 6 Jitter for Priority queuing

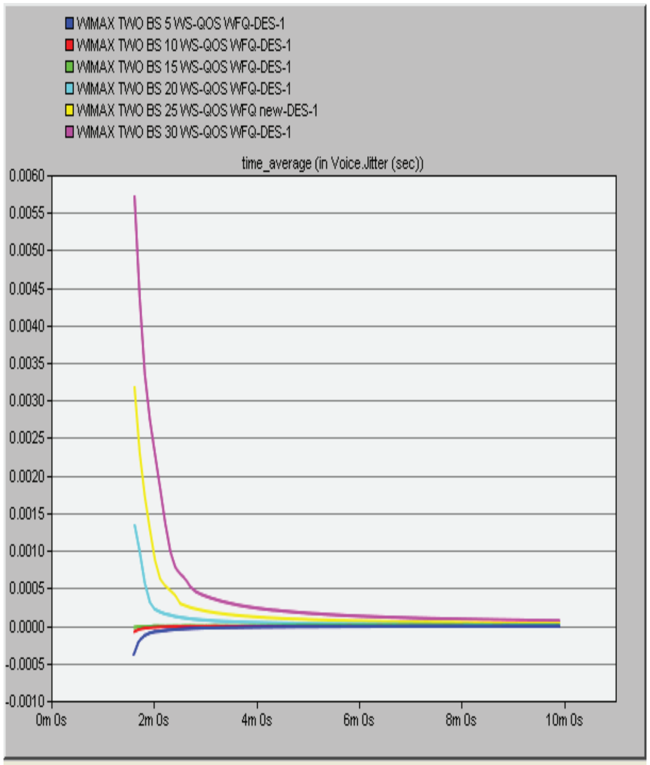

Fig: 7 Jitter for Weighted fair queuing

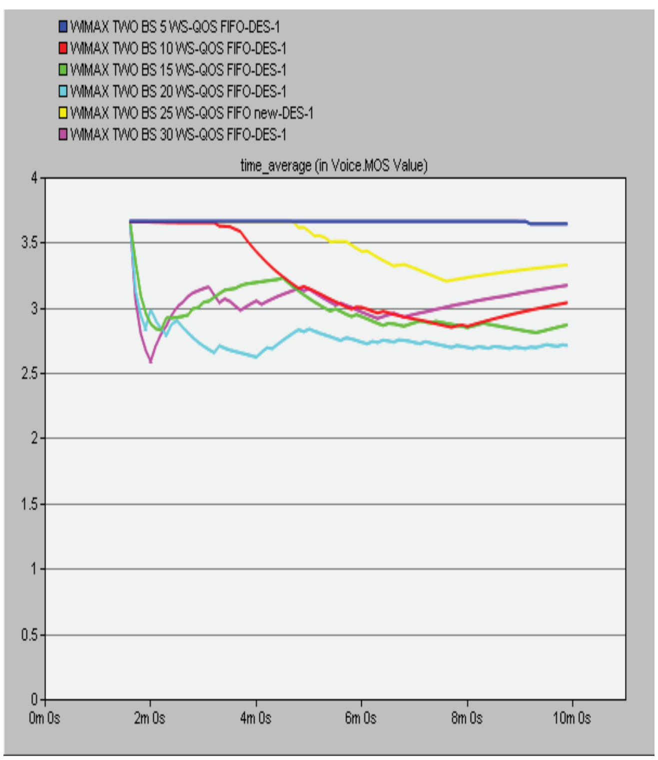

Fig: 8 MOS value for FIFO queuing

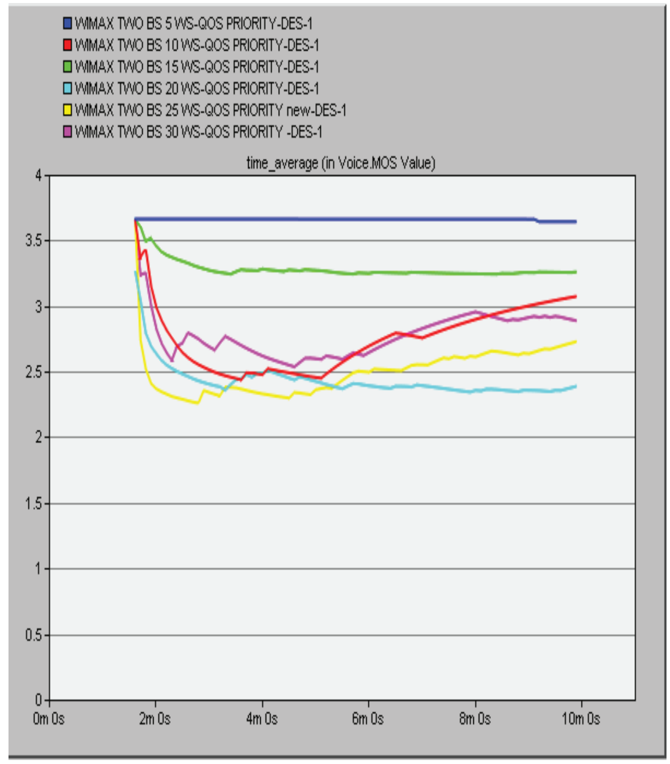

Fig: 9 MOS value for Priority queuing

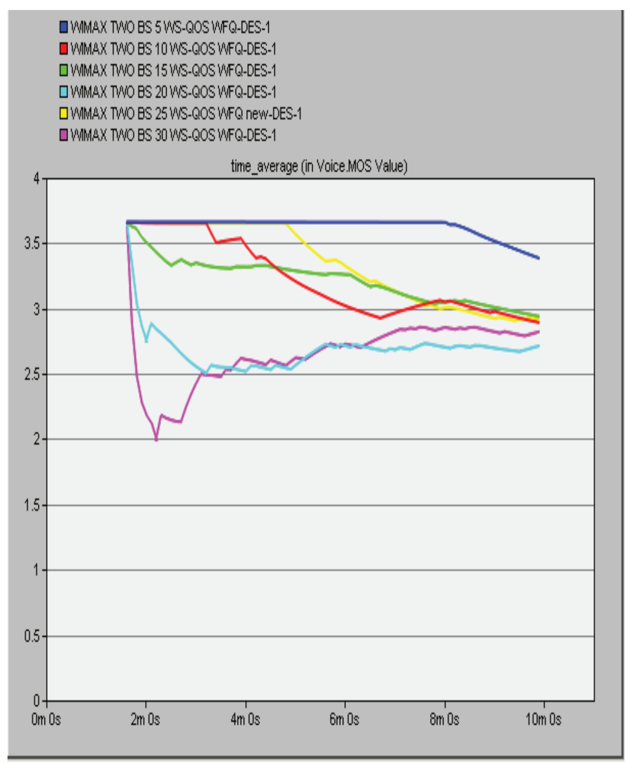

Fig: 10 MOS value for Weighted fair queuing

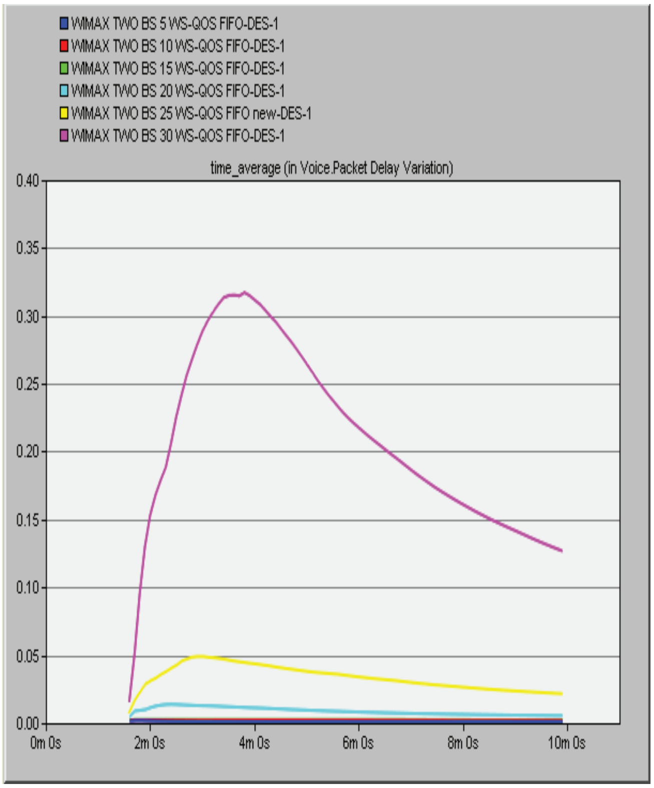

Fig: 11 Packet Delay variation for FIFO queuing

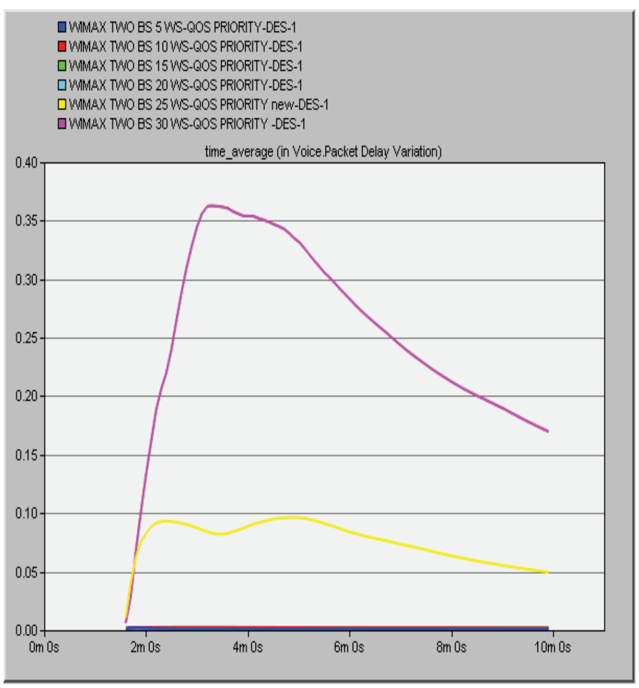

Fig: 12 Packet Delay variation for Priority queuing

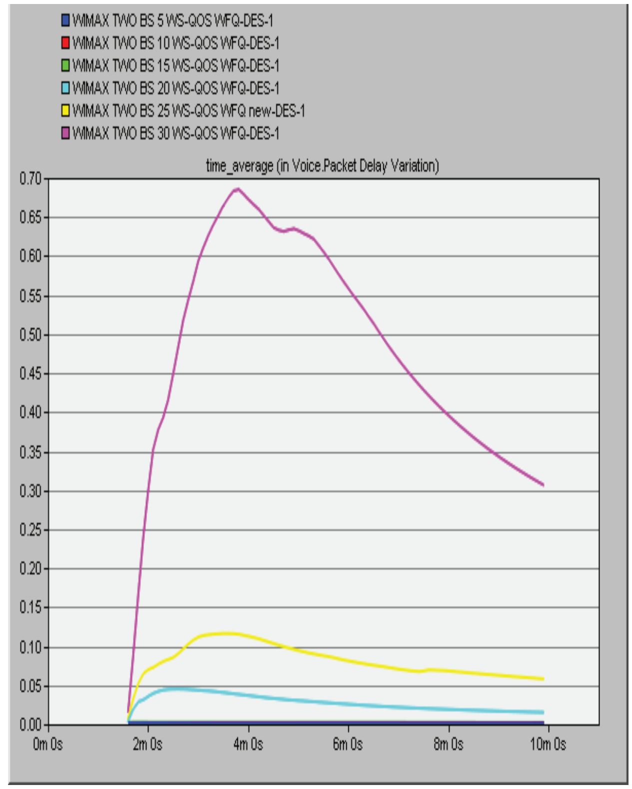

Fig: 13 Packet Delay Variation for Weighted fair queuing

We are able to notice packet delay variation for different queuing schemes from figure 11, 12 and 13. In FIFO it is 0.00 for 5, 10 and 15 workstations even it is also almost 0.00 for 20 workstations. For 25 users in each cell it is changing from 0.01 to 0.05 and for 30 end users it is fluctuate from 0.01 to 0.31. In PQ discipline value of packet delay variation is 0.00 till workstations are 20, for 25 workstations it is changing from 0.01 to 0.10 and for 30 workstation it is from 0.01 to 0.36.Similarly for WFQ discipline it is 0.00 till there are 15 workstations, when no. of workstations multiply value is also changed, for 20 workstations value vary from 0.00 to 0.05, for 25 workstations it is fluctuate from 0.00 to 0.11 and for 30 users it is varying from 0.01 to 0.70.

From figures 14, 15 and 16 we can see packet end to end delay for all queuing disciplines. Up to 15 workstations it is 0.1 sec for all queuing schemes. In FIFO for 30, 25 and 20 workstations it is vary from 0.2 to 1.1, 0.17 to 0.6 and 0.1 to 0.2. In PQ for 30, 25 and 20 workstations it is vary from 0.2 to 1, 0.2 to 0.8 and const 0.19. Similarly for WFQ it is changing from 0.3 to 1.8, 0.2 to 0.9 and 0.1 to 0.4.

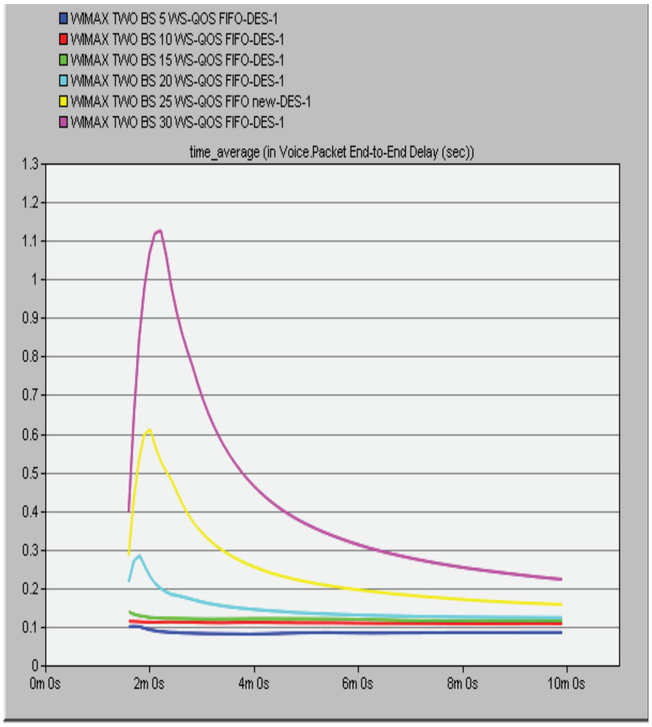

Fig: 14 Packet End to End Delay for FIFO queuing

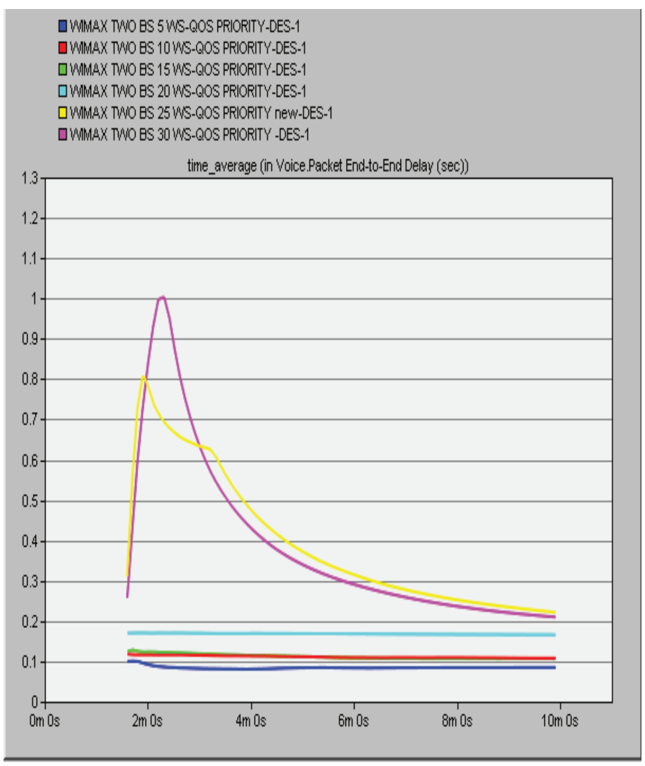

Fig: 15 Packet End to End Delay for Priority queuing

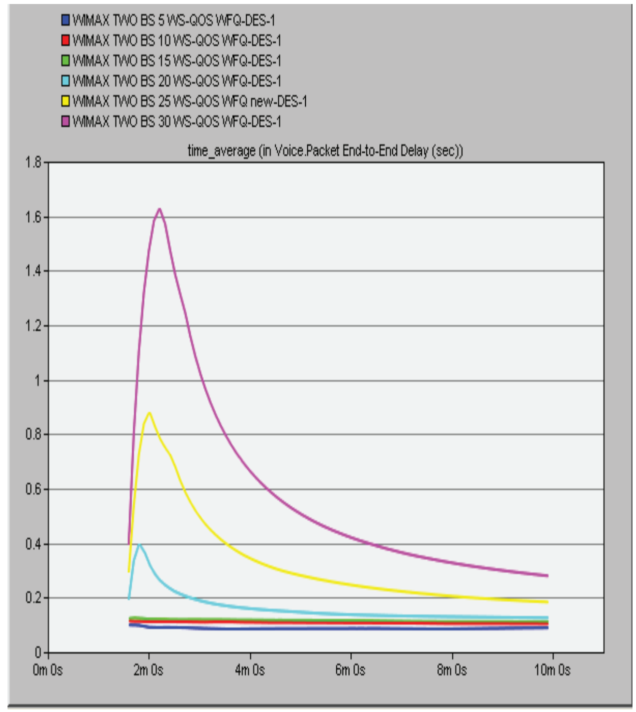

Fig: 16 Packet End to End Delay for Weighted fair queuing

V. CONCLUSION

In this document we investigated the jitter, MOS value, packet delay variation and packet end to end delay for three different queuing schemes. We have also calculated these parameters with different no. of workstations. As it can be noticed that performance of all queuing discipline is almost same when no. of workstations are 15 but when no. of workstations increased values of parameters are changed. When there are 30 workstations we can spot that for FIFO and PQ all constraints are almost same except jitter, value of jitter for PQ is just from 0.0000 to 0.0024sec while for FIFO and WFQ it is almost 0.0000 to 0.0055 sec. As we know that jitter should be zero and here it is almost zero in the case of priority queuing. So we can highlight that PQ offers finest service among all queuing schemes.

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