Effects of Various Queuing Algorithms for Network Services

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Abstract — with recent development and research, various network services like FTP (file transfer), VoIP, videoconferencing (streaming), E-mail are going to more useful in current generation. In such services some of services like email, web browsing (HTTP), FTP (file transfer) are not much sensitive to delay of transmitted data. Services like VoIP (voice), video conferencing are very sensitive to delay, jitter (delay variation), and packet losses of transmitted data. Therefore they require various traffic management systems for efficient data transmission. Queuing disciplines is such a traffic management system in various network services for efficient data transmission. Queuing algorithms FIFO(first in first out), PQ(priority queue), WFQ(weight fair queue) are implemented in OPNET and some of the parameter including end to end delay, and packet received are studied and effect of various queuing algorithms on this parameters is analysed.

Index terms— queue management, FIFO, PQ, WFQ

I. INTRODUCTION

Various network services like VoIP, file transfer, videoconferencing are becoming more useful now a day. They require different traffic management systems for efficient data transmission. Queuing is the one of such traffic management mechanism.
Queuing algorithm play an important role in traffic management and in performance of networks. Queuing algorithms generally distribute the network resource and reduces packet dropping due to congestion. Congestion in various networks is generally created when receiving data packet rate is greater than transmitting packet rate. This results in data delivery delay and waste of resources due to packet dropping. Voice and videoconferencing data information transmissions are more sensitive to delay.
Some of the queuing disciplines are FIFO (first in first out), PQ (priority queue), and WFQ (weighted fair queue). When we apply various queuing algorithm for different network services we get remarkable change in quality of services. QoS is the ability of network to support good services.

II. FACTORS AFFECTING QUALITY OF SERVICES:

Quality of Service can be refers to several aspects that allows the transport of traffic with special requirements, such as service response time and it guarantee a certain level of performance to data flow. For examples in some network application like voice over IP, video streaming, online gaming some parameters such as packet delay, delay variation, and packet dropped rate should guaranteed to certain level and give a quality performance.
According to ITU recommendations QoS is measured on different parameters such as delay, jitter, and packet loss. Value for this parameter can be controlled and changed within limited range to improve quality of services. Factor affecting QoS is explained in the following sections:

A. average delay (latency):

Delay is much sensitive in case of high priority network application VoIP and video(for example voice can't tolerate too much delay) while in low priority network application Email, file transfer it is not much sensitive than high priority networks. Latency is the average delay time for packet to travel from its source to its destination. Ideally delay should be as low as possible but too much congestion (traffic on the network line) cause voice packet to be delayed at the point that the quality of voice, video is compromised. The maximum amount of latency/delay that a VoIP can handle for one way caller to destination is 150 Milliseconds (0.15sec) but can be allowed up to 100 Milliseconds (0.10sec).
The calculation of average delay (D) is given as the sum of all delays (D_i), divided by the total number of all delay measurements (n).

$$D = \sum_{i=1}^{n} (\mathrm{Di}/\ \mathrm{n})$$

B. Jitter (delay variation):

Jitter is defined as a variation in the delay of received packets. At the transmission point packets are sent at regular interval of time or fixed amount of time, in ideal world these packet arrive at regular intervals. But unfortunately in reality packets are not arriving at regular interval of time. Jitter can be described as degree of fluctuation in packet access, which may be caused by too much traffic on the line. Maximum jitter tolerate capacity for voice packets is only about 75 milliseconds(0.075 sec) but it is preferred to be 40 milliseconds(0.040 sec). jitter can be calculated by following equation and measured in seconds.

$$j = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(\mathrm{Di} - D)^2}$$

In the equation j= jitter, D = average delay, Di= all the delay (i=1 to n)

C. packet loss

Packet loss can be describe as discarding of packets in a network due to congestion or when router and other network device is overloaded hence they cannot accept additional packets at a given moment. Packets which are not arriving at the desire destination are considered as loosed packets. Generally voice network traffic can tolerate less than 3% loss of packets. And 1% loss is optimum.
Equation for calculation of packet loss is given as ratio of the number of lost packet to the total number of packet sent. In the equation N = total no of packet sent, N_L = the number of packets lost during the same time period.

$$\text{Lost packet ratio} = (N_L / N)\mathrm{X}100\%$$

III. QUEUING ALGORITHMS

Primary role of router is to route the packets from transmitting link to receiving link through buffer. Apart from the routing of the packets, router is involved in controlling the traffic congestion in the network. It is possible through the concept of queuing.
Queuing algorithms deals with the length of packet queue by discarding or dropping the packet whenever necessary and determine which packet is going to be sent next.
Some of the commonly used queuing algorithms are listed and explained below.

a) First in first out (FIFO)
b) Priority queue (PQ)
c) Fair queue(FQ)
d) Weight fair queue (WFQ)

A. First in first out (FIFO):

Simplest way of queuing is first in first out queuing in which the first packet arrives at router is first one to be transmitted. Buffer space at router is limited and if this buffer is occupies totally due to higher packet arrival rate or any of the reason, then the packet dropping occurs which cause the packet losses, in this algorithms router only transmits incoming packet according to order without considering size, packet origin or how critical the packet is.
Hence largest disadvantages of FIFO algorithm is that it is not able to serve high priority packet to network faster than other and advantages of is it is extremely simple to implementation and no need of packet recording.

B. Priority queue (PQ):

Priority queue assures that during congestion the highest priority data does not get delayed by lower priority traffic. However, lower priority traffic can experience significant delays. PQ is designed for environments that focus on mission critical data, excluding or delaying less critical traffic during periods of congestion. Main disadvantage of PQ is starvation of bandwidth for lower priority application services.
There is more than one buffer in contrast to FIFO queue. This queue is arranged according to their priority.

C. Fair queue (FQ):

Fair queuing algorithm can solve the problem of starvation of bandwidth in priority queuing by round robin algorithm in scheduler. Scheduler allows bandwidth to the queues in round robin fashion so that busty flows cannot make congestion and cannot affect performance of network. The disadvantage of this queuing is as follow.
If packet length is bigger in particular queue than this queue use large bandwidth of total network and hence require more time to be served.

D. Weight fair queue (WFQ):

Weight fair queue can be considered as combination of both PQ and FQ. In Weighted-fair queuing discipline finish time is assign to all the packets. Then according to link bandwidth, packet length, and number of queue, packets are classified and placed into queues according to information in ToS field in IP header. The Weighted-fair queuing discipline weights traffic therefore low-bandwidth traffic gets a high level of priority. A unique feature of this queuing discipline is the real-time interactive traffic will be moved to the front of queues and fairly the other bandwidth shares among other flows. queue having larger finish time packets get high weight and lower bandwidth in contrast to queue having smaller finish time.

IV. SIMULATION SCENARIO AND RESULTS

Simulation tool OPNET is used to simulate desire scenario as shown in figure network is created with VoIP, FTP, and video application over IP network.

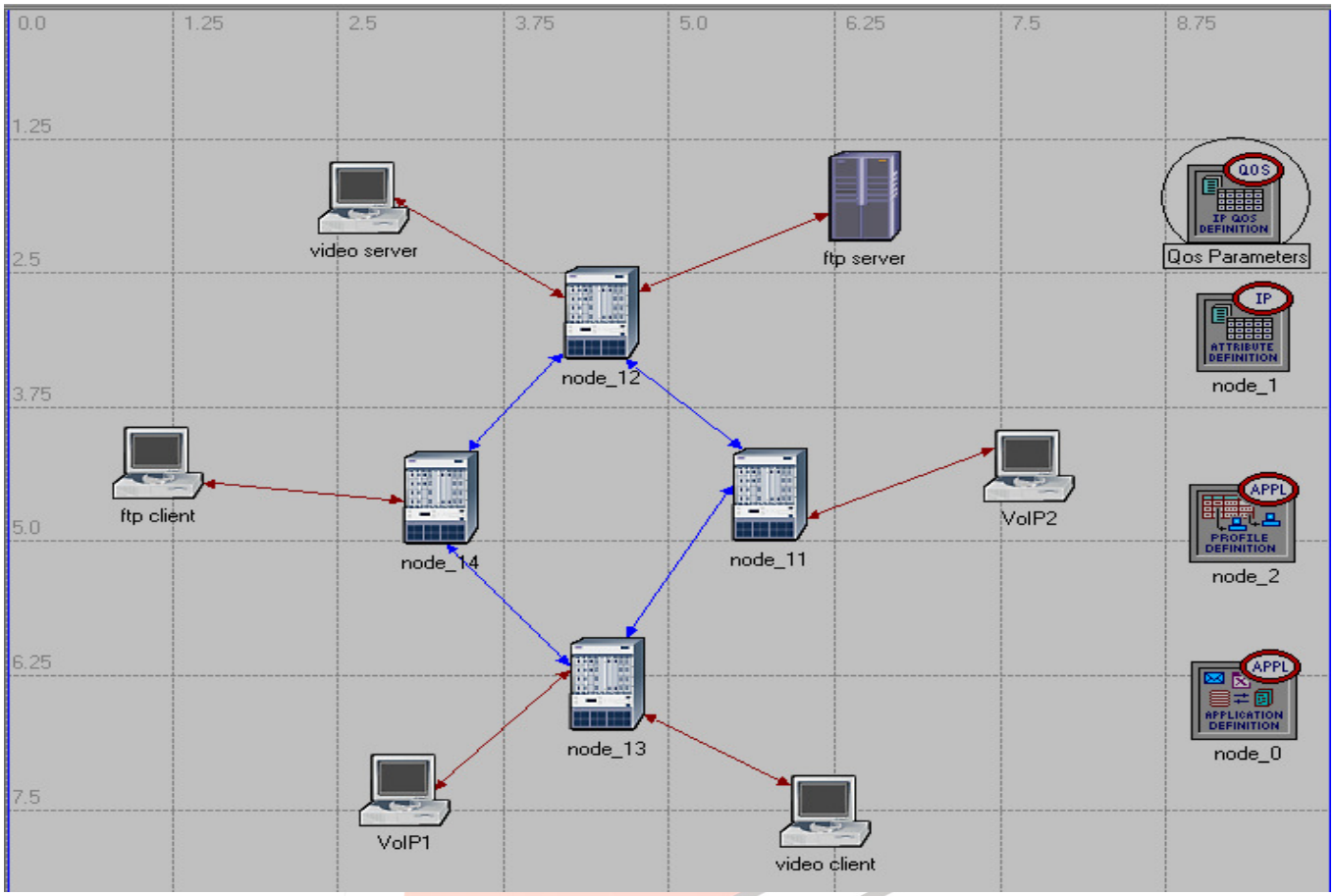

Fig.1 Simulation scenario for network

For File transfer and Video transferring protocol traffic received graph is shown below

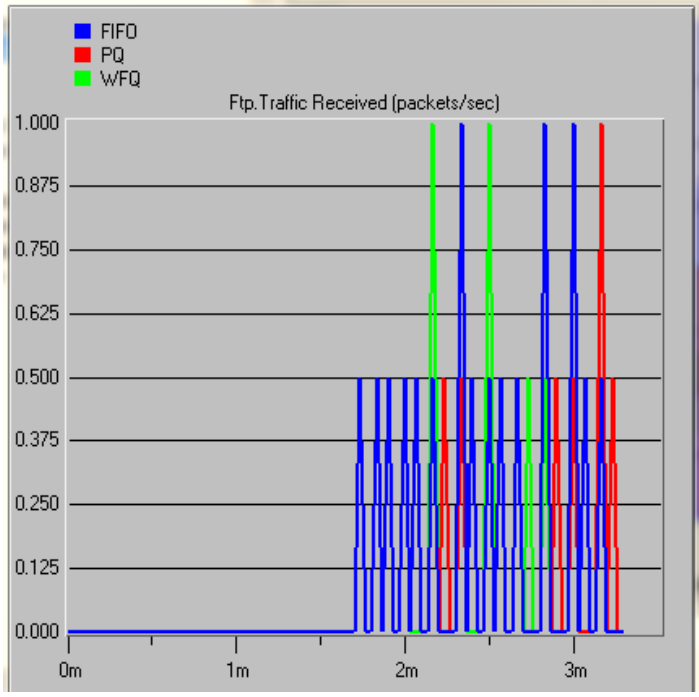

Fig. 2 FTP traffic received (packet/sec)

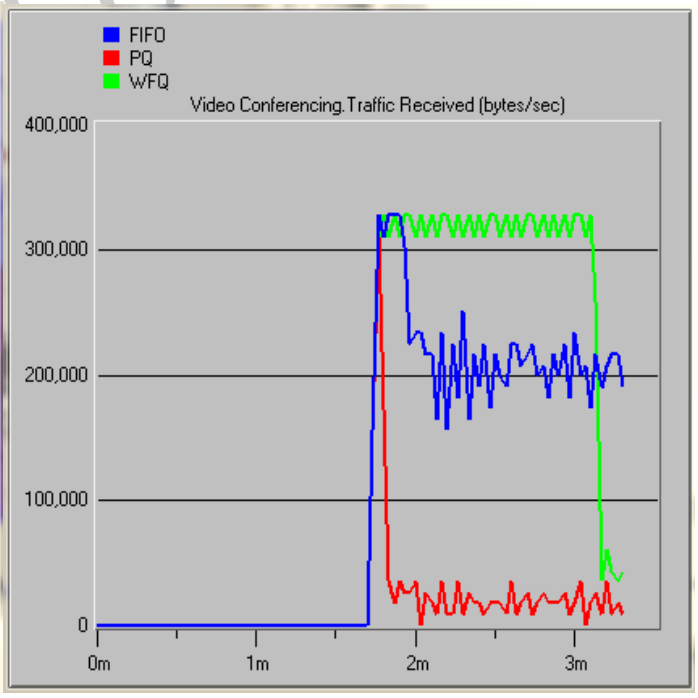

Fig. 3 Video conferencing traffic received (packet/sec)

For Voice over internet protocol Traffic received, packet delay variation and packet End to end delay graph is shown below

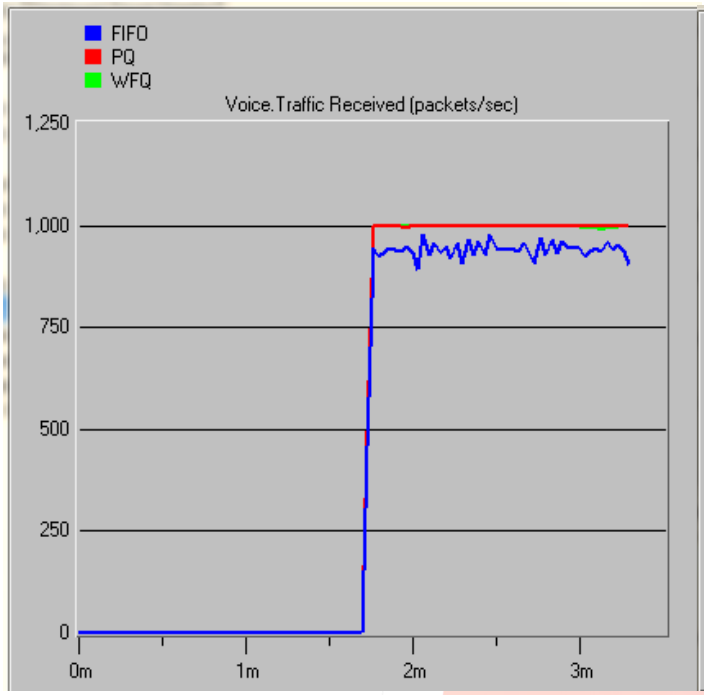

Fig. 4 voice traffic received (packet/sec)

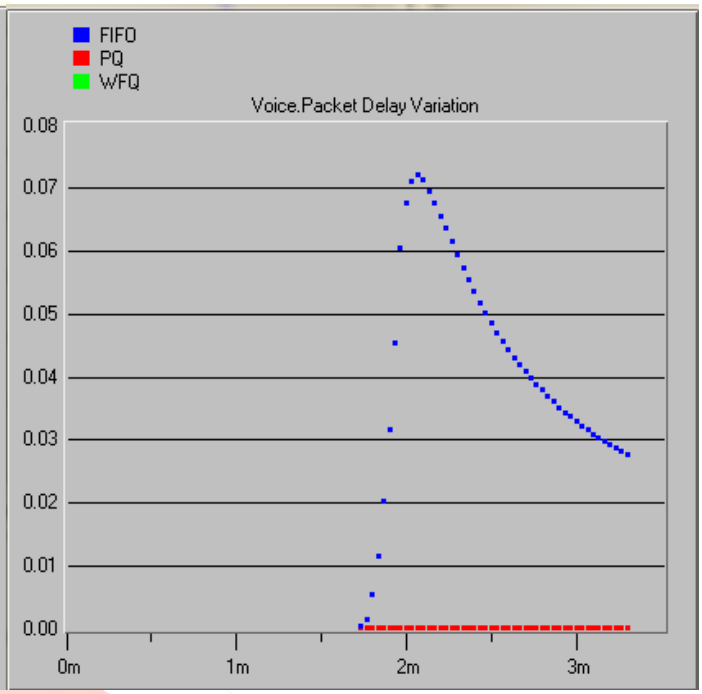

Fig. 5 voice packet delay variation

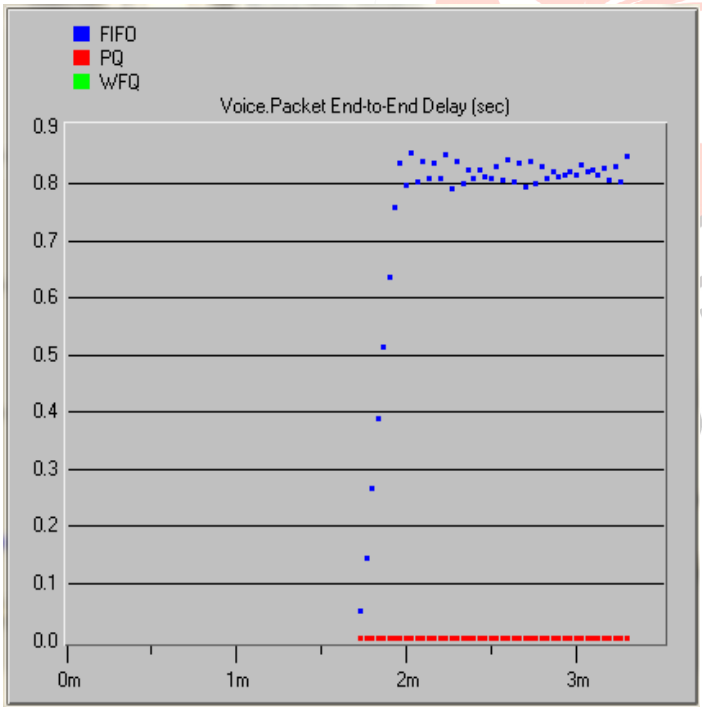

Fig. 6 voice packet end to end delay (sec)

For whole IP network IP traffic dropped is given by below graph

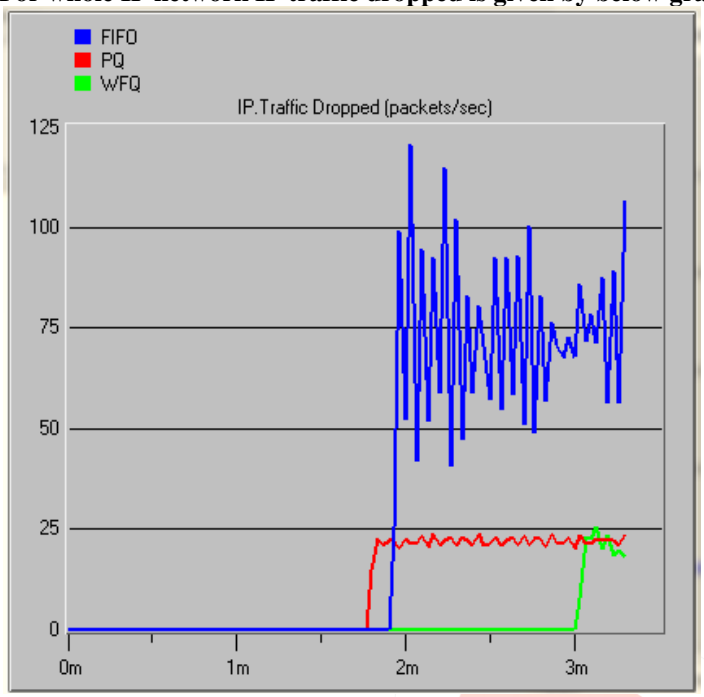

Fig. 7 IP. Traffic dropped (packet/sec)

V. CONCLUSION

In this paper effect of queuing algorithm is compared for IP network having FTP, VoIP, and video application. We have concluded from the simulation result that FIFO algorithm is better than WFQ, and PQ for FTP application, but in the case of VoIP and video application it doesn't give efficient results as WFQ. For video conferencing WFQ gives better result than FIFO, and FIFO is better than PQ. WFQ and PQ work almost same for VoIP application.
Packet dropping ratio is more in FIFO algorithm it indicate that traffic loss is more in FIFO while in PQ algorithm traffic loss ratio result is efficient than other queuing algorithm in simulation.

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