J. Sci. Technol. (Dinajpur) Vol. 6: 16-22 (2008)
ISSN 1994-0386

IMPACT OF SELECTING QUEUES FOR SERVICE QUALITY ASSURANCE OF VOICE TRAFFIC

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ABSTRACT

Different queuing principles show disparate characteristics on the voice traffic regarding packet loss, throughput and delay. In this technical paper, the impact of using queues on voice traffic is scrutinized, and the best queuing system is proposed for this particular type of application.

Keywords: *FIFO, PQ, WFQ, VoIP and QoS*

INTRODUCTION

Real time communication seeks out special attention from the network and protocol's designers. One predominant factor needed special attention for this delay variant application is receiver buffer. In reality, buffer size is limited, so if burstiness is aroused in the input, Acknowledgements (ACKs) can be used to prevent message loss. However, in this communication, we do not want to send ACKs from receiver to sender, but the consequences will be lost messages (Moskowitz & Myong, 1995). This also causes huge delay variation or jitter effect in the receiving side. Hence, determining the queue characteristics with an eye to exact functional capabilities is extremely important to reduce cost and to enhance efficiency if there are no ACKs.

FIFO is an acronym for First In First Out. This expression describes the principle of a queueing behavior. What comes first is handled first, and next waits until the first is finished for getting its service (Peterson & Davies, 1999). This type of queuing policy does not give the proper right to the packets that needs special attention. As it serves uniformly to all packets, the performance of some services is suffered from this queuing system.

According to (Feng *et al.,* 1999), Priority queuing (PQ) follows three directives. It can add an element with an associated priority, remove an element from the queue that has the highest priority, and return it. It (optionally) picks at the element with the highest priority. The simplest way to implement a priority queue data type is to keep an associative array mapping to a list of elements with priority. If association lists are used to implement the associative array, adding an element takes constant time but removing or picking at the element of highest priority takes linear ($O(n)$) time, because all keys have to be searched for the largest one. If a self-balancing binary search tree is used, all three operations take $O(\log n)$ time; this is a popular solution in environments that already provide balanced trees but perhaps hardly sopisticated (Amir *et al.,* 1998). This policy respects the important of packets and therfore places the sensitive one in front of the queue.

Weighted Fair Queuing (WFQ) is a method of automatically smoothing out data flow in packet-switched communication networks by sorting packets to minimize the average latency and prevent exaggerated discrepancies between the transmission efficiency afforded to narrowband and broadband signals. In WFQ, the priority given to network traffic is inversely proportional to the signal bandwidth (Stoica *et al*., 1998). Thus, narrowband signals are passed along first, and broadband signals are buffered.

WFQ has little or no effect on the speed at which narrowband signals are transmitted, but tends to slow down the transmission of broadband signals, especially in the time of peak network traffic. Broadband signals share the resources that remain after low-bandwidth signals have been transmitted (Shenker, 1995). The resource sharing is done according to assigned weights. WFQ can prevent high-bandwidth traffic from overwhelming the resources of a network, a phenomenon

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which can cause partial or complete failure of low-bandwidth communications during the high traffic in poorly managed networks.

The overall policy of this queuing discipline is to control the percentage of the link's bandwidth, which can be utilized in an application. In our experiment, we used the OPNET, which is very handy but strong network simulator to pin down the pros and cons of using different queuing principles for voice communication (Stallings, 2004).

MATERIALS AND METHODS

2. IMPLICATION OF QUEUES ON VoIP TRAFFIC

For designing an effective computer network, selecting an appropriate queue is very crucial. By this, different network characteristics: delay, delay variation and throughput can be kept at the optimum level. The simulated outputs in our experiment advocate this statement as well.

2.1 First In First Out (FIFO) Scenario

Considering FIFO queuing only, no packet is discarded initially; but as the time passes by packets are discarding almost linearly when more and more traffic is generated in the network. In this policy, the size of the queue is 500 packets. For the simulation, OPNET, a proprietary software, is used with the simulation parameters stated in Table 1.

Table 1. Simulation parameters used in this Voice over IP communication project

Name of Simulation Parameters	Values
Number of runs in the dataset	1
Duration	150 Seconds
Seed	128
Value per Statistics	100
Update interval	5,00,000 Events

Reaching the maximum limit, the packet dropping starts as shown in Fig. 2.1(a) for AS IS (actual behavior of output), and Fig. 2.1(b) for average dropped packet.

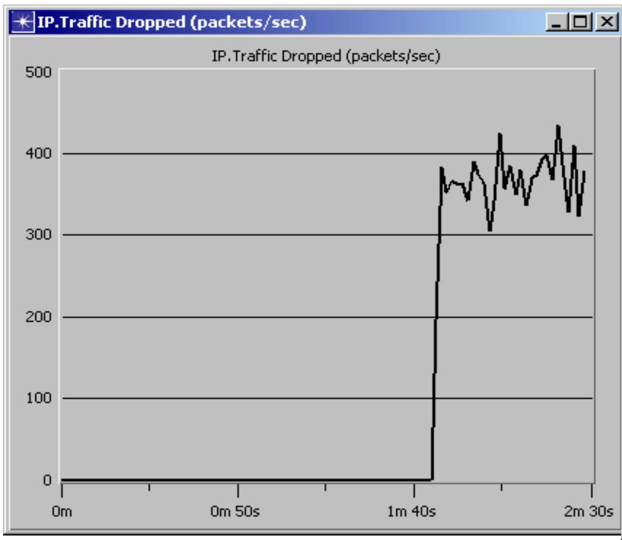

Fig. 2.1(a): Traffic dropped for FIFO queuing system for IP packets

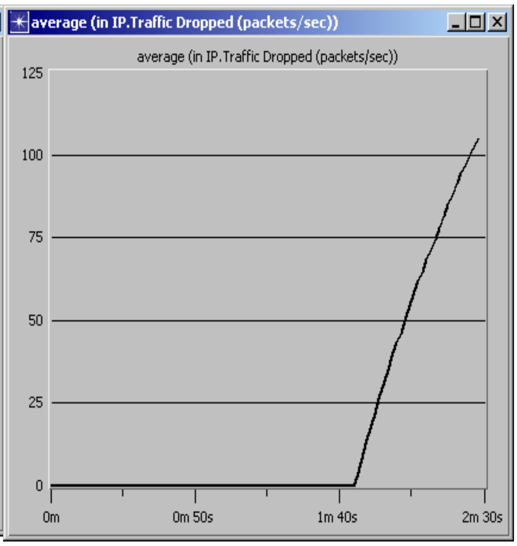

Fig. 2.1(b): Average packet discards for FIFO queuing system for IP packets.

Though the average delay in Fig. 2.1(c) in the FIFO queuing policy is very high, the delay variation (Jitter) is negligible which indicates no special treatment is required for delivering good services to the user.

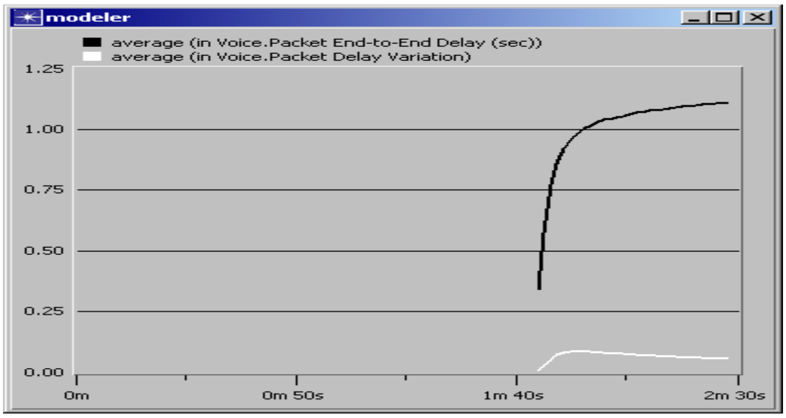

Fig. 2.1(c): Voice packet delay and delay variation for FIFO Queuing.

The throughput for voice traffic is shown in Fig. 2.1(d) which exhibits similar to that found in other time sensitive services in the IP world.

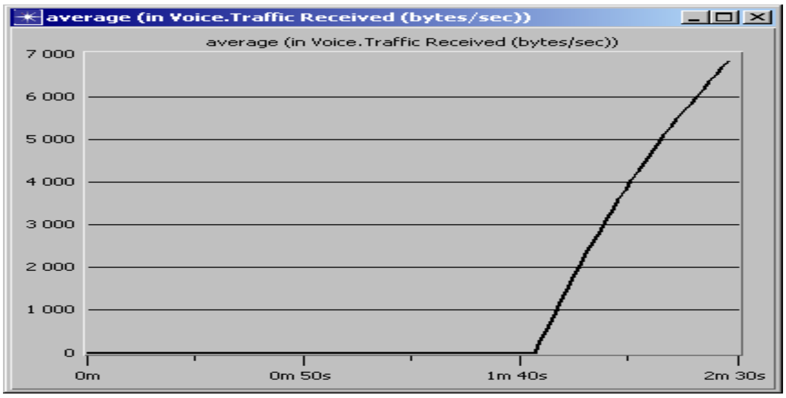

Fig. 2.1(d) average throughput of voice traffic for FIFO queuing.

These results show that the only factor that defines the throughput of the network is the Queue in the router. The behavior of the queue controls the packets irrespective of the service that we are intended to use.

2.2 Considering Multiple Queuing Discipline

The scenario stated in Fig. 2.2(a) depicts that the FIFO queue drops the packets heavily as it is anonymously servicing all the packets. Most demanded service may require for faster delivery, but FIFO is not able to do that. In case of PQ and WFQ, they both show the moderate dropping rate without an exception in which PQ starts dropping earlier. Consequently, it serves the most demanding services and concentrates less on the normal delivery.

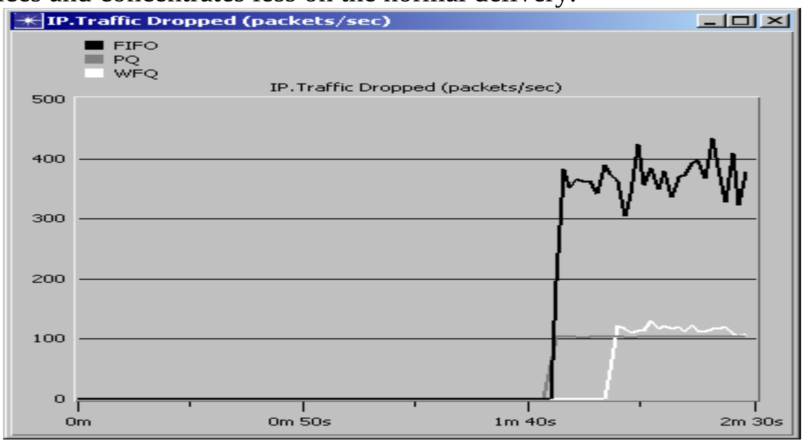

Fig. 2.2 (a): IP traffic drops for various queuing discipline (PQ rises to 100 packets drop line and remains constant thereafter).

For the voice traffic, PQ and WFQ show almost identical performance whereas the FIFO queuing system degrades performance as shown in Fig. 2.2 (b). This is obvious because in PQ and WFQ the necessity of the real time traffic is considered and attention to reduce time delay is paid. But FIFO is not caring all of these. That's why the packet is discarded at the router as there is no provision of retransmission of voice traffic.

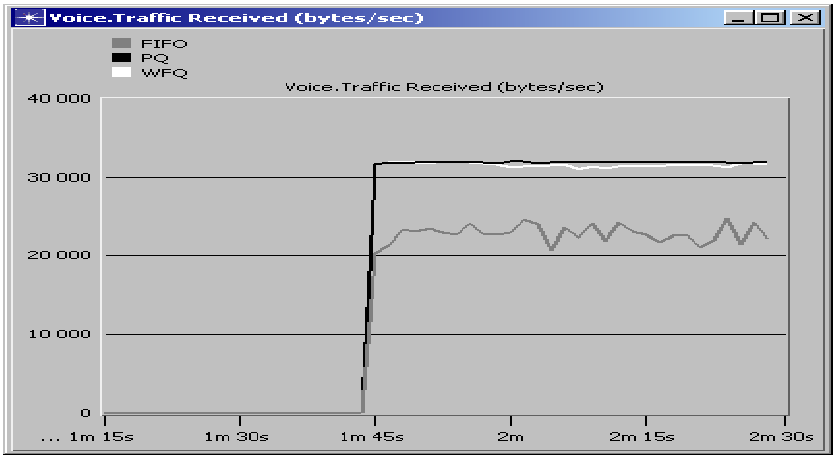

Fig. 2.2 (b): Voice traffic throughput for various queuing discipline.

2.3 Voice Packet End-to-End Delay

The end to end delay is very small for both PQ and WFQ, but it is very high for FIFO queuing policy as depicted in Fig. 2.3. The voice traffic is a real time application, where no retransmission is approved. Therefore, some amount of delay is to be supported not to lose the intelligibility of the signal for smooth reproduction. But the delay that is producing by the FIFO queuing system is exorbitant whereas the other two queuing policies deal this matter seriously and is able to keep the delay at the moderate level.

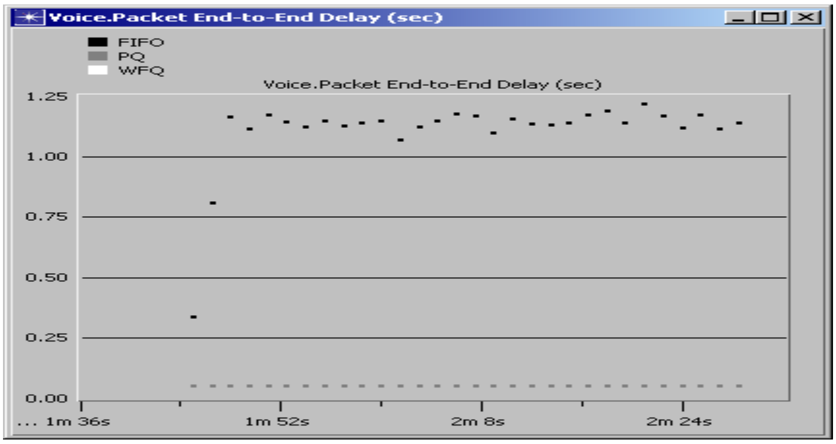

Fig. 2.3: End to end delay for various queuing discipline (Overlaid Mode).

2.4 Voice Packet Delay Variation

Delay variation is a very important issue, which should be considered in the real time traffic. Delay can be somehow tolerable but it is very difficult to tackle the delay variation. Again, the FIFO is not caring for the importance of packet creating high delay variation. On the other hand, PQ and WFQ show no delay variation significantly as shown in Fig. 2.4.

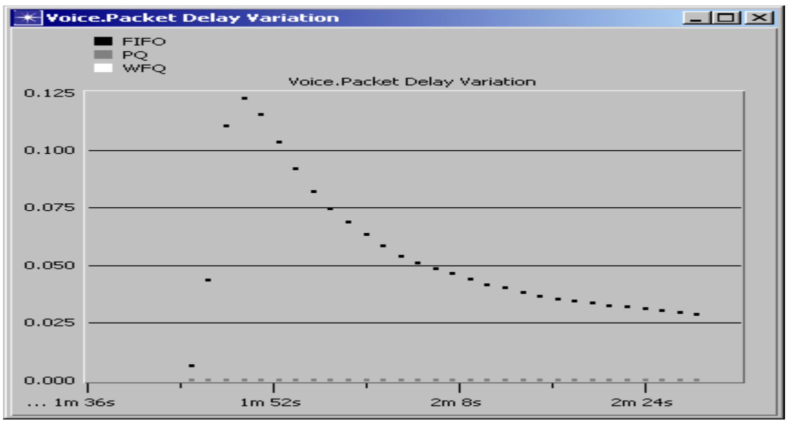

Fig. 2.4: Packet delay variation for various queuing discipline.

3. SERVICE QUALITY COMPARISONS FOR DIFFERENT QUEUING SYSTEM

The internal architecture of the queuing system adopted for any practical application poses a huge impact on the traffic propagation for the intended network. Therefore, for ensuring the service quality of a specific application, we need to call upon the queue with apposite attributes.

3.1 Comparing Delay and Delay Variation

Delay and delay variations have different impact and implications on the specific applications. In Fig. 3.1(a) and Fig. 3.1(b), the simulated results of delay and delay variations are shown for the three types of queuing system considered for our voice traffic applications.

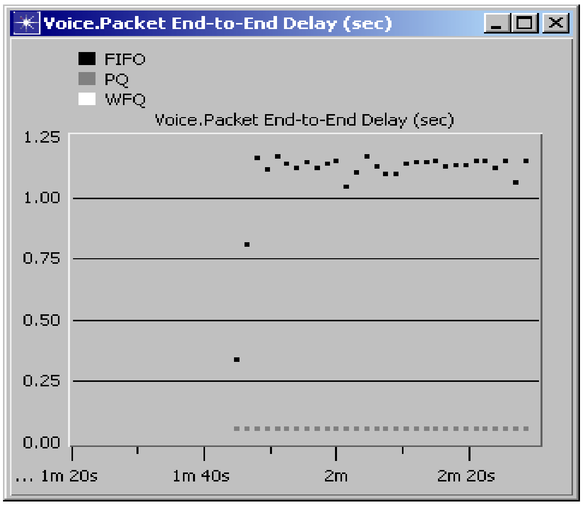

Fig. 3.1(a): Voice packet End-to-End Delay for Queuing Disciplines.

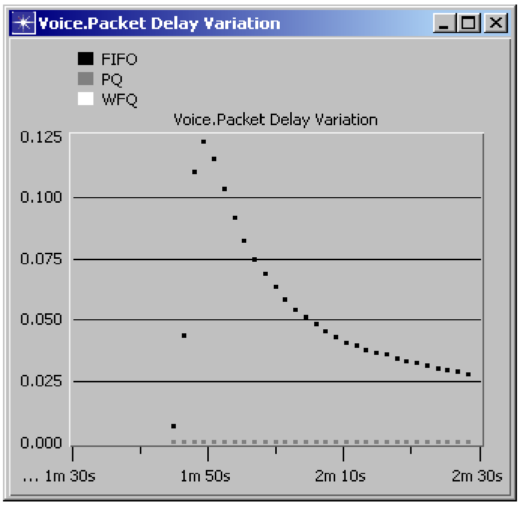

Fig. 3.1 (b): Voice packet Delay variation for Queuing Disciplines.

PQ and WFQ are two real time traffic application queues. That's why they both show the very low delay and no delay variations (the white line for WFQ is superimposed by the gray line for PQ in both Fig. 3.1(a) and Fig. 3.1(b)) as contrary to the FIFO queuing.

3.2 Queuing Size and Policy

Three policies have implemented in our simulation project, in which FIFO, PQ, and WFQ contain1queue, 4 queues, and 8 Queues respectively. Though we used Type of Service (ToS) as the parameter of quality of service, we also used Protocol, Port number, DHCP scheme for priority and weight as a means of QoS assurance (Brakmo and Peterson, 1995).

In PQ, the characteristics of queues such as their priority level, packet size, type of operation and mode of operation are defined in Table 2.

Table 2. Characteristics parameters setting of the PQ for Quality of Service assurance

Priority Level	Queue Size (Pkts)	Classification Scheme	Queue Category
0-Low	80	Best effort(0); Background(1)	Default Queue
1-Normal	60	Standard(2); Excellent Effort(3)	None
2-Medium	40	Streaming Multimedia(4); Interactive Multimedia(5)	None
3-High	20	Interactive Voice(6); Reserve(7)	None

In case of WFQ, there are 8 types of strata for priority management selected for the data communication scheme as shown in table 3. All queues are attributed to a value of 500 and their operation primitives are selected accordingly. The less weighted queue are labeled as a default queue where others are selected as per as their classification scheme (Demers *et al.*, 1990).

Table 3. Characteristics parameters setting of WFQ for Quality of Service (QoS) assurance

Weight	**Max. Queue Size (pkts)**	**Classification Scheme**	**Queue category**
1	500	Best Effort(0)	Default Queue
10	500	Background(1)	None
20	500	Standard(2)	None
30	500	Excellent Effort(3)	None
40	500	Streaming Multimedia(4)	None
50	500	Interactive Multimedia(5)	None
60	500	Interactive Voice(6)	None
70	500	Reserve(7)	None

RESULTS AND DISCUSSIONS

In this paper, the three queuing principles that are currently deploying in the modern networking environment are analyzed. We consider various aspects of using different queues in the voice communication. We have simulated three scenarios by defining the link '**queuing delay** <--' between source and destination router. The output in fig. 4 is resulted for delay comparison.

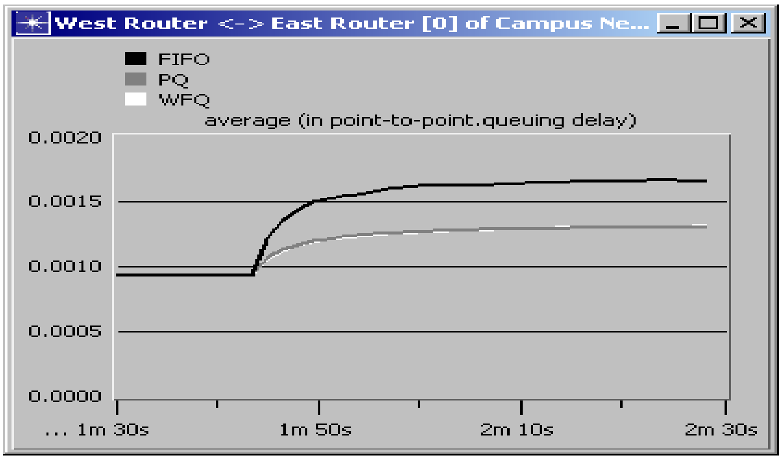

Fig. 4: Queuing delay (Average) for three types of Queues from source to destination Router.

From Fig. 4, in the case of FIFO queue, it is observed the delay is increasing sharply after a certain period of time. This is when the buffer is getting full of packets and consequently discarding any subsequent packets that are arriving in the router. Hence, the delay is increasing rapidly for FIFO queuing. However, the rising of delay is not as significant as FIFO for other two cases, and they almost superimposed to each other. Both PQ and WFQ are designed considering real-time application in core, so delay is less severe as compared to FIFO.

From all perspectives, FIFO implementation friendly with respect to the technological jargon is not capable of showing good performance in packet discarding and throughput as compared to the other two; PQ and WFQ queuing policies.

CONCLUSION

In real time communications, moderate level of delay is tolerable due to the redundant information inserted in the consecutive packets of the message. This delay also causes delay variation, which is very annoying when it crosses its tolerance limit. Therefore delay and delay variation shouldn't exceed the threshold level. FIFO offers simple implementation technique but shows very poor performance considering to delay and delay variation as well as throughput. This is due to its single queue implementation ignoring the priority of services in the communication world. PQ, using four different priority level queues with moderate size, gives a comprehensive output in delay, delay variation and throughput. On the other hand, WFQ exhibits the best performance by implementing fine tuning in service quality confronting the IP precedence that must arise in the computer communication. Thus, this is the best queuing policy with a considerable degree than the other two for voice communication.

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