The affects of different queuing disciplines over FTP, Video and VoIP Performance

Mitko Gospodinov

Abstract: *The objective of the paper is presentation of research the affects of different queuing disciplines on packet delivery for three applications: FTP, Video and VoIP. For modelling, simulation and analysing on these applications is used OPNET (Optimised Network Engineering Tool) environment. In the paper is investigated how the choice of the queuing discipline can affect the applications and utilization of the network resources in the routers.*

Key words: *OPNET, FIFO queue, Priority queue, Weighted-fair queue, QoS, ToS.*

INTRODUCTION

Some applications as FTP, HTTP and e-mail are not sensitive to delay of transmitted information, while other applications like voice and video are vulnerable to loss, delay and jitter of the information. The QoS (Quality of Service) network devices must be able to differentiate among classes of arriving traffic and satisfy their individual requirements. This is the way to handle contention for network resources when the network is intended to service widely varying types of traffic and manages the available resources according to policies set out by the network administrator.

Each router, as part of the resource allocation mechanisms, must implement some queuing discipline that governs how packets are buffered while wait to be transmitted. Various queuing disciplines can be used to control which packets get transmitted (bandwidth allocation) and which packets get dropped (buffer space). The queuing disciplines also affects to the packet latency by determining how long the packets wait to be transmitted. In the paper are discussed three queuing disciplines: first-in-first-out (FIFO) queuing, priority queuing (PQ) and weighted-fair queuing (WFQ).

The modelling is experienced over the network that carries applications (FTP, Video and VoIP) and is investigated how the choice of the queuing discipline in the routers can affect the performance of these applications.

1. QUEUING DISCIPLINES

The affect of different queuing disciplines is analysed by three scenarios: FIFO queuing, priority queuing and weighted-fair queuing in the routers of the simulation network model (Fig.1).

The *FIFO queuing discipline* is basic technique in which the first packet in the queue is the first packet that is processed. The size of buffer space (queue) at each router is finite. When queue becomes full, congestion occurs and incoming packets are dropped [2].

The *Priority queuing discipline* uses multiple queues, but they are serviced with different level of priority. The queue with highest priority is serviced first. When congestion occurs, packets are dropped from lower-priority queues. The only problem with this method is that lower-priority queues may not get service at all if high-priority traffic is excessive. The packets are classified and placed into queues according to information in the packets. The advantages of this discipline are [1]:

- High priority traffic is always ensured quickest handling at the routers;
- This technique has high performance and utilization of available bandwidth.

The disadvantages are:

- Lower priority traffic has extensive packet drops and high queuing delays (starvation problem);
- The priority schemes may be abused by users or applications that mark packets with priorities that are not allowed.

The routers can be programmed to prioritise traffic for a particular port. In the IP Type of Service (ToS) field, each packet is to mark with priority level. The routers are implemented multiple FIFO queues, one for each priority level. This queuing discipline allows high-priority packets to cut to the front of the line.

The *Weighted-fair queuing discipline* provides Quality of Service (QoS) by adding a weight to queues to give some queues higher priority. This shares the bandwidth proportional to the weights. All queues are serviced so that none are starved, but some queues are serviced more than others. Traffic may be prioritised according to the packet information in the source and destination IP address fields, port numbers and information in the ToS field. The Weighted-fair queuing discipline weights traffic so that low-bandwidth traffic gets a fair level of priority. If high-priority queues are not in use, lower-priority traffic uses its queues. This prevents high-bandwidth traffic from grabbing an unfair share of resources. A unique feature of this queuing discipline is moving of the real-time interactive traffic to the front of queues and fairly shares the remaining bandwidth among other flows [4]. ToS bits in the IP header is use to identify weight.

2. OPNET SIMULATOR

OPNET provides a comprehensive development environment for the specification, simulation and performance analysis of communication networks. The key features of OPNET are [3]:

- Modeling and simulation cycle – OPNET provides powerful tools to assist user to go through three phases in a design circle: the building of models, the execution of a simulation and the analysis of the output data;
- Hierarchical modeling – OPNET employs a hierarchical modeling structure. Each level of the hierarchy describes different aspects of the complete model being simulated;
- Specialized in communication networks – Detailed model library provide support for existing protocols and allow researchers and developers to either modify these existing models or develop new models of their own use;
- Automatic simulation generation – OPNET models can be compiled into executable code. An executable discrete-even simulation can be debugged or simply executed, resulting in output data.

3. CREATION AND CONFIGURATION OF SIMULATION NETWORK

The network model for simulation (Fig.1) consists from the following objects: five Ethernet workstations, one Ethernet server and two Ethernet routers. Both routers are connecting together with a bi-directional PPP_DS1 link. The workstations and the server are connected to the routers by bi-directional 10Base_T links.

The QoS Attribute node defines attribute configuration details for protocols supported at the IP layer. The individual nodes using symbolic names can reference these specifications. It defines queuing profiles: FIFO, Priority queuing and Weighted-fair queuing.

The ToS is assigned to the IP packets. It represents a session attribute that allows packets to be provided the appropriate service in the IP queues. For configure the FTP Applications, the ToS assigned as *Best-effort*. The Best-effort delivery means that delivery of a packet is attempted but is not guaranteed. For configure the VoIP Applications is assigned *PCM Quality Speech* to *Voice* as a procedure used to digitise the speech before transmitting over the network.

To test the performance of the applications defined in the simulation network model are collected statistics as follows:

- IP protocol – traffic dropped (packets/sec);
- Video conferencing – traffic received (packet/sec);
- Voice – traffic received (bytes/sec).

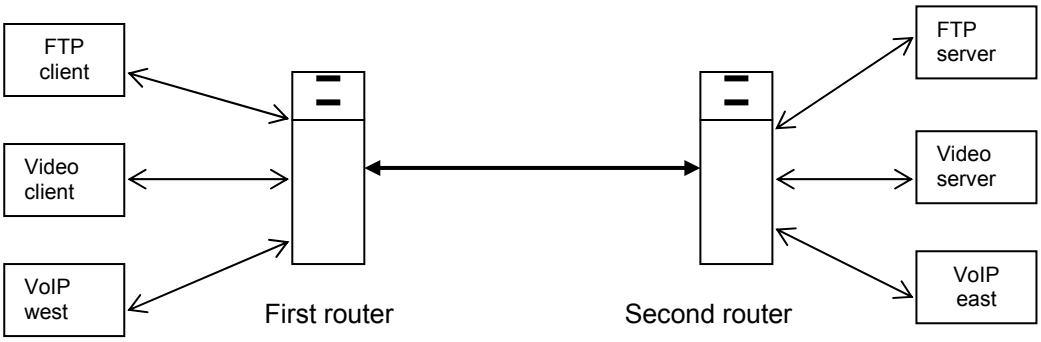

Fig.1 The simulation network model

The *traffic dropped* determines the number of IP datagrams dropped by all nodes in the network across all IP interfaces. The reasons for dropping an IP datagram can be any one of the following:

- Insufficient space in the queue;
- Maximum number of hops exceeded by an IP datagram;
- Non routing nodes - a local router interface was not found to be used as the next hop;
- Routing node with the rote table lookup failed to yield a route to the destination.

3.1. PERFORMANCE RESULTS AND ANALYSIS

Real time IP applications, such as video conferencing and voice traffic require significant bandwidth with minimal packet delay, jitter and loss. They are more sensitive to network QoS. Three types of tools are available to build QoS into the network system:

- Providing adequate bandwidth for all voice, video and data applications that transmitted over the common network.
- Classifying the arriving packets and giving a classification based on their priority. Voice packets are given the highest priority since they are very delay and jitter sensitive. Video packets might be given a slightly lower priority and FTP packets are given the lowest priority.
- Queuing refers to a process that takes place in the routers and switches where different queues or buffers are created for the different packet classifications.

The results of the affect of different queuing disciplines over FTP, Video and VoIP performance are displayed as graphs, which indicate the performance characteristics of queuing disciplines in the routers of network model.

On Fig. 2 is shown the dropped IP data packets for three queuing disciplines (FIFO queue, Priority queue and Weighted-fair queue) as a function of the time in seconds.

The duration of simulation is 150 seconds. After the 104 seconds begin the loss of IP data packets in FIFO queue and Priority queue. The loss of packets in Priority queue is less than FIFO queue. In the Weighted-fair queue discipline there is not the loss of IP data packets.

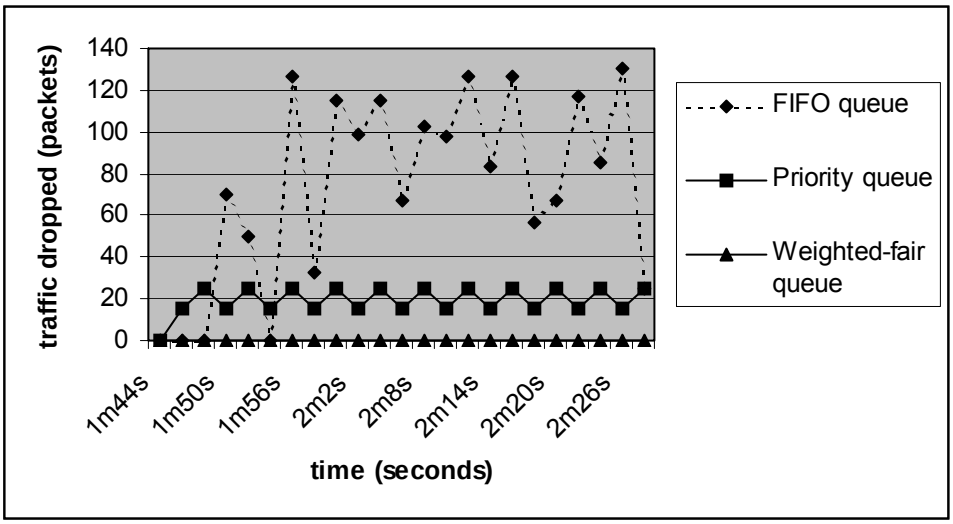

Fig. 2 IP Traffic Dropped (packets/sec)

On Fig. 3 and Fig. 4 are shown the received traffic (bytes) for the three queue disciplines as a function of the time (seconds) for video and voice applications.

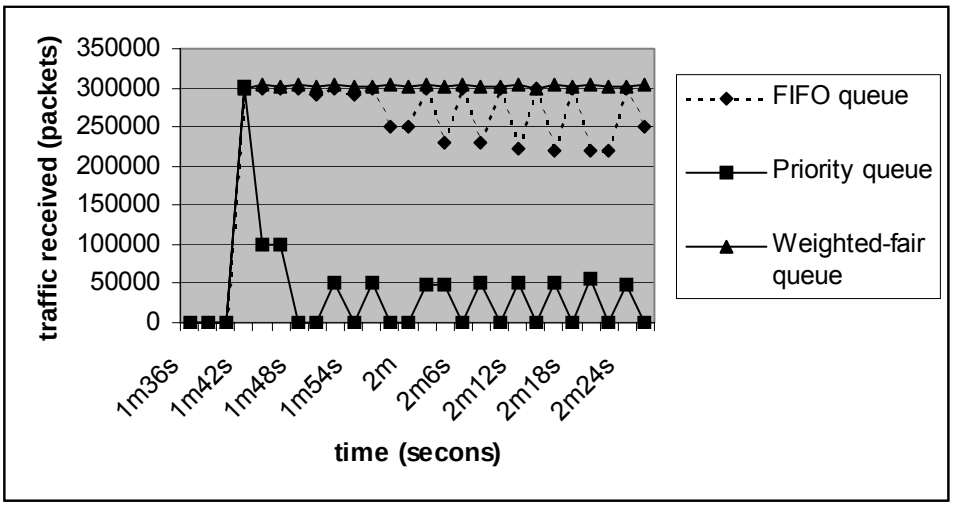

Fig. 3 Video conferencing traffic received (bytes/sec)

In the Priority queuing, videoconference traffic is forwarded (received) on the base of strictly priorities in the queue. The packets with high priority are forwarded first. If there are no packets in the high priority queue then the packets in the medium priority queue are forwarded. In this model high priority packets are never scheduled behind lower priority packets. While providing minimal latency service to packets in high priority queue, strict priority queuing can cause starvation of traffic in lower priority classes. The Weighted-fair queues are the most appropriate scheduling schemes for the handling of video conferencing traffic.

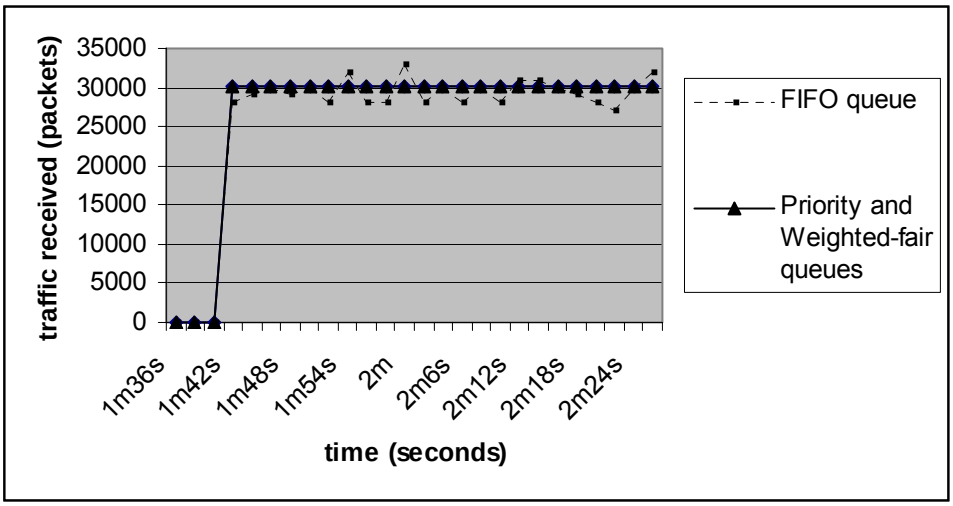

Fig. 4 Voice Traffic receiver (bytes/sec)

The Priority and Weighted-fair queues are the most appropriate scheduling schemes for the handling of voice traffic.

4. CONCLUSIONS

The presented research of the affects of different queuing disciplines over FTP, video and VoIP performance using OPNET and analysed simulations of the results allow to be made conclusions as follows:

- Applications that are sensitive and affected of delay and jitter of information, such as video and voice, need small queues in the routers. Small queues reduce delay, which is essential for real-time traffic. Non-real-time traffic such as electronic mail, file transfers, and backups must be serviced by large queue router architectures.
- The Priority and Weighted-fair queues are the most appropriate scheduling schemes for the handling of voice traffic.
- The loss of IP data packets in Priority queue discipline is less than FIFO queue. In the Weighted-fair queue discipline there is not the loss of IP data packets.

REFERENCES

[1] Cisco Systems Inc., Quality of service solutions configuration guide.

[2] Semeria, C., Supporting differentiated service classes: queue-scheduling disciplines, Juniper networks, 2001.

[3] MIL3, OPNET, http://www.mil3.com

[4] Walran, J., An introduction to queuing networks, New Jersy, 1993.

ABOUT THE AUTHOR

Assoc. Prof. Mitko Gospodinov, PhD, Central Laboratory of Mechatronics and Instrumentation at Bulgarian Academy of Sciences, Fhone: +359 887 426 490, E-mail: mitgo@abv.bg