DATA PERFORMANCE OF MODIFIED PUSHOUT+PPD MECHANISM WITH ELASTIC AND DETERMINISTIC TRAFFIC SOURCES WITH PRIORITIES

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Abstract: *Plain ATM (Asynchronous Transfer Mode) has poor performance in case of Data transmission. In order to improve its performance many Buffer Management Mechanisms have been proposed, e.g. push-out. The aim of this paper is to propose improved approach to push-out based on the analysis of various packet discard policies, and create a simulation model in GPSS (General Purpose Simulation System) in order to evaluate its data performance. It provides a step- by- step description of the design of a simulation model, from concept to GPSS algorithm. Some results of the data performance of UDP (User Datagramme Protocol) running over ATM are presented.*

Key words: *Asynchronous Transfer Mode, Data Performance, Push-out mechanism, and Simulation model.*

1. INTRODUCTION

The aim of this paper is to propose modified pushout mechanism and present approximate traffic analyses in ATM network. Cells generated by different type of traffic sources face different priority schema entering the ATM switch: Deterministic traffic generated by real-time services like telephone and video obtain higher priority; Elastic traffic or data services are considered to be non-delay sensitive and obtain lower priority. Because of the different nature of the used services, the throughput of elastic traffic is bound to be significantly lower than those of real time, even sees a collapse as the ATM switch is overloaded. This is resulting in disparity with respect to elastic and real-time traffic. The mechanism proposed here aims at overcoming this unfairness during dynamic share of ATM links within elastic and real-time traffic.

Cell delays and losses are correlated and have different influence on different type of services. Cell delays are a matter of importance for real-time services like telephone and interactive video services. Elastic traffic is more sensitive to the probability of cell loss. Both parameters have to be kept in given thresholds for all kind of broadband services. End-users can negotiate quality of service parameters in accordance with their specific requirements. There are 3 types of packet-level throughput: packet loss ratio (PLR), goodput and badput. PLR is probability of packet discarding. The goodput is the throughput of successfully transmitted packets and is interpreted as the bandwidth usage for successful packet transmission. The badput is the throughput of corrupted packets, which provides a measure of wasted network resources.

2. PARTIAL PUSHOUT

Many existing packet-discarding mechanisms are implemented for the efficient transport of data over asynchronous transfer mode (ATM) networks. ATM adaptation layer type 5 (AAL5) was initially proposed by the computer industry to cope with the complexity and implementation difficulties in other AAL's and has become a predominant choice for data communications equipment. AAL5 is shared by both the control and user planes and has a special feature called end-of-packet (EOP) indicator in the header of an ATM cell.

The source AAL5 marks the last cell of a message by End-of-Packet (EOP) bit. If the EOP cell is dropped at the switch, the retransmitted packet gets merged with previous partial packet at the destination. The merged packet fails the CRC test and is dropped at the destination by AAL5. The source will have to retransmit this (retransmitted) packet again. Hence, the source performs two retransmissions in a row. After the first retransmission, the SSTHRESH is set to half the previous window size and the window is set to one. When the second retransmission occurs, the SSTHRESH is set to 2 (the minimum value). The window remains at one. TCP henceforth increases the window linearly resulting in low throughput for this source. Since the EOP cells of the other TCP sources may not have been dropped, they do not experience this phenomenon and get high throughput. The disparity in throughput results in unfairness among sources [9].

A simple fix is what we call Partial Pushout, which prevents the back- to-back retransmissions and improves fairness by applying Pushout in subbuffer. Since this policy only enhances tail drop, it can still be used in conjunction with other drop policies. The motivation for packet-level control includes preventing the link bandwidth or buffer space from being wasted by cells from already corrupted packets. In order to achieve additional utilization of bandwidth and buffer space, we use the partial-packet discarding (PPD) mechanism, which uses the EOP indicator, thus if a cell is dropped from a switch buffer the subsequent cells in the packet are discarded (w/o EOP cell).

The mechanism proposed here with aims at overcoming the unfairness with respect to data traffic during dynamic share of ATM links within real-time traffic uses two thresholds. More precisely, reaching the high threshold– RH, cells are serviced in the following manner:

(1) On arrival of a high-priority cell and with a high threshold (RH) reached, all cells between RL and RH (in subbuffer) are checked either from RL to RH or RH to RL, and if a low-priority cell is found, it is discarded, thus it is created free place in buffer for the high-priority cell;

(2) If no low-priority cell is found between RL and RH, and buffer end K is not reached, a high-priority cell is inserted in the buffer;

(3) On overfilled of buffer capacity, cells are discarded following a PPD policy[1], e. g. Once the buffer limit is crossed, the switch drops all cells in packet except the EOP cell. This, the EOP cells will reach the destination and result in the dropping of the first packet and merging of packets is avoided in the destination AAL5.

(4) EOP cells of packets are assumed (serviced with) high-priority because even when buffers are small, dropping of EOP cells should be avoided. This avoids merging of packets at the destination AAL5 and improves fairness. If such cell is discarded, its packet as well as next packet will be merged i.e. discarded by the upper layers because the merged packet fails the CRC test at the destination AAL5.

3. SIMULATION MODEL

In the literature, the ATM switch is approximated usually as a single server queue with different priority disciplines [4]. Our ATM switch also differentiates many types of traffic sources. Queue length is assumed 76 waiting places. Cell serving rate is 2.7 us (□=155 Mbps). Serving discipline is FIFO (First Input First Output) with and without priorities. Figure 1 shows the main structure of the simulation model. For elastic traffic the servicing discipline is without priorities the queue acts as pure FIFO. In other case we apply priority schema the queue is FIFO for different types of priority classes (fig. 1) due to the nature of the pushout mechanism. High-level priority cells overcome all low level priority cells.

The simulation model is single server queue and is encoded on GPSS (General Purpose Simulation System). Load of the queue system varies among 0.7□ and 1.1□ . All types of traffic sources in the model have different representation and weight during the simulation. Ratio of high- to low priority cells varies among 3:1, 1:1 and 1:3. The ATM line interface serves only one cell at given moment. New cell arriving at the same moment waits in the queue or is lost in case of full queue.

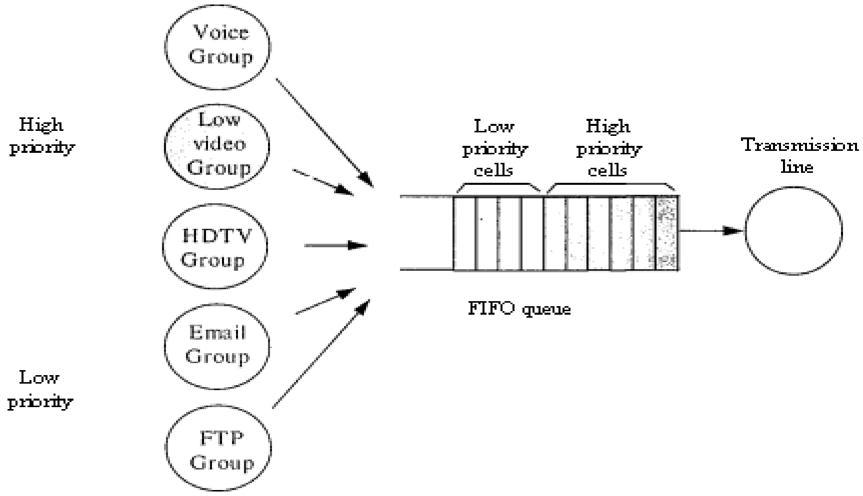

Figure 1. The simulation model with priorities

4. TRAFFIC SOURCES AND THEIR PRIORITIES

ATM traffic is specific in comparison with the traffic in other networks. We model telephone, e-mail, ftp, low speed video and HDTV traffic sources. We also apply on-off model for voice and video sources and data sources. Usually AAL2-4 present the decomposition technology of traffic stream into cells for voice and video traffic, and AAL5- for elastic traffic. Traffic sources generate cells with deterministic rates. The lengths of calls are exponentially distributed. The mean duration of the HDTV session is one hour and a half. The duration of the low speed video call is the same as the duration of the voice call. We assume that it is used for videotelephone service. The length of the burst and the pause are exponentially distributed with varied mean values. The assumption that these sources generate cells with deterministic rate makes the simulation process easier. The results are approximate and aim to evaluate the planning parameters of the modified PUSHOUT in worst case scenario: For instance, when ABR feedback can't cope with burst traffic[4].

Figures 2 shows the case of data traffic sources where the packets length and burst level is determed by apriory information about traffic in Internet backbone [7].

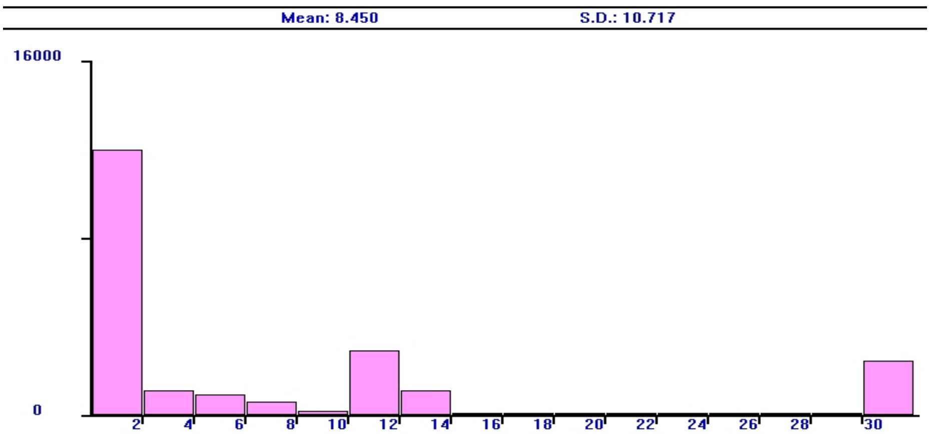

Figure 2. Internet data packets distribution.

5. RESULTS

The rest of the paper represents part of the results obtained after simulation. On Figures 3 and 4 the dependence of cell/packet loss can be seen as a function of intensity of traffic sources (load), and the nature of the traffic sources.

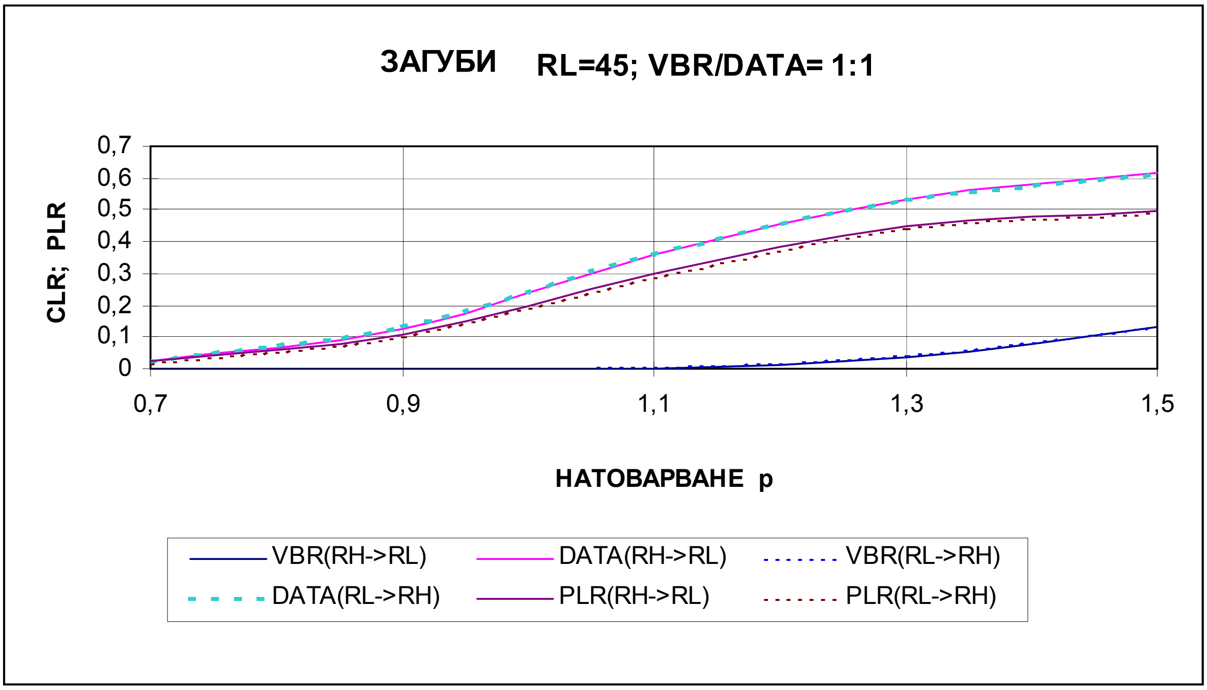

Fig.3. Losses of cells and packets vs. load.

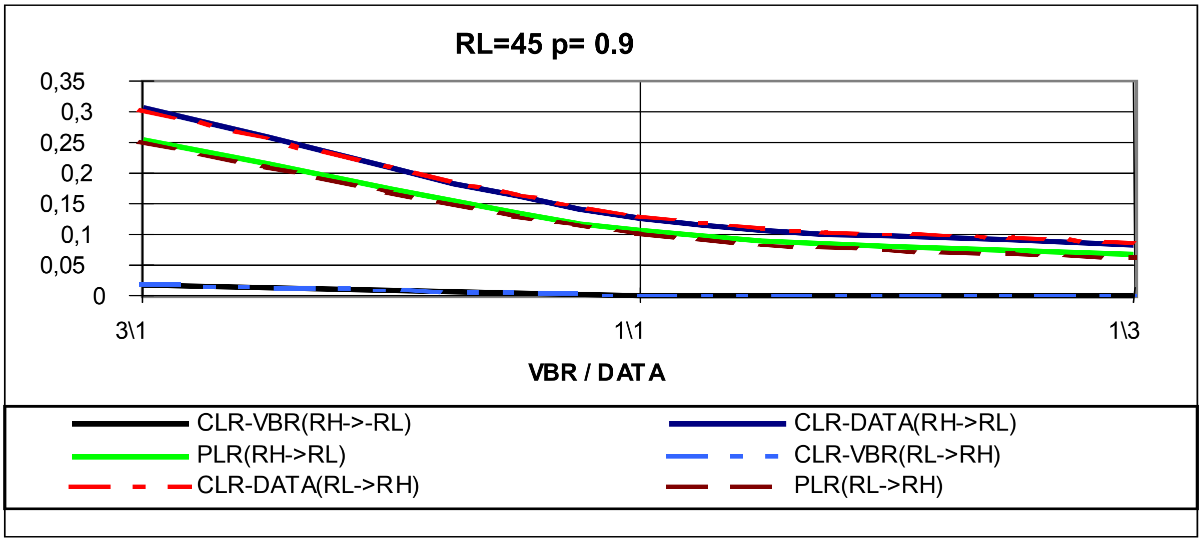

Fig.4. Losses of cells and packets vs. VBR toward data traffic.

The packet loss ratio (PLR), respectively success probability is of primary importance to an individual application, as it gives the expected percentage of packets that the application may send successfully.

The servicing discipline is pure FIFO with priorities. It is visible that because of the different cell priorities the queue serves mostly VBR cells.

As can see on figure 5 if search for low priority cell from R_H to R_L then losses of last cell in packets are approximately two times more ones in case of searching for low priority cell in opposite direction. The TCP as flow control mechanism will realize many a times lower data performance for some VCs because these TCPs' control window and threshold setup at the minimum values when last cell in packet is discarded. Note, Partial Pushout sets a threshold a few cells before the buffer limit. Once the threshold is crossed, the switch drops all cells except the EOP cells. The EOP cells will reach the destination and result in the dropping of the first packet and merging of packets is avoided in the destination AAL5. This prevents the back- to-back retransmissions and improves fairness. Since this policy only enhances tail drop, it can still be used in conjunction with other drop policies i.e.Partial Packet Discard- PPD.

Therefore only modification of mechanism with searching from R_L to R_H is adequate то TCP/IP running (fig. 5). Thus, the next figures represent the results only for direction from R_L to R_H.

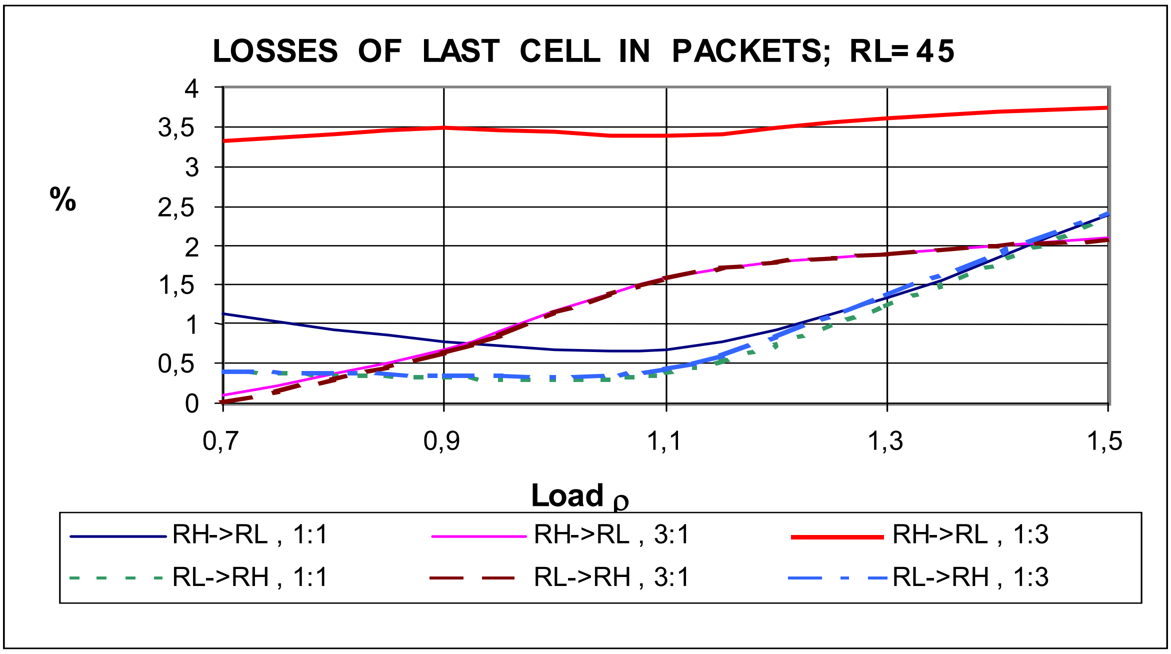

Fig.5. Losses of last cell in packets.

In contrast, the goodput/badput gives us a notion of bandwidth usage/waste and thus may be interpreted as the performance measure of interest from the network's point of view (figure 6).

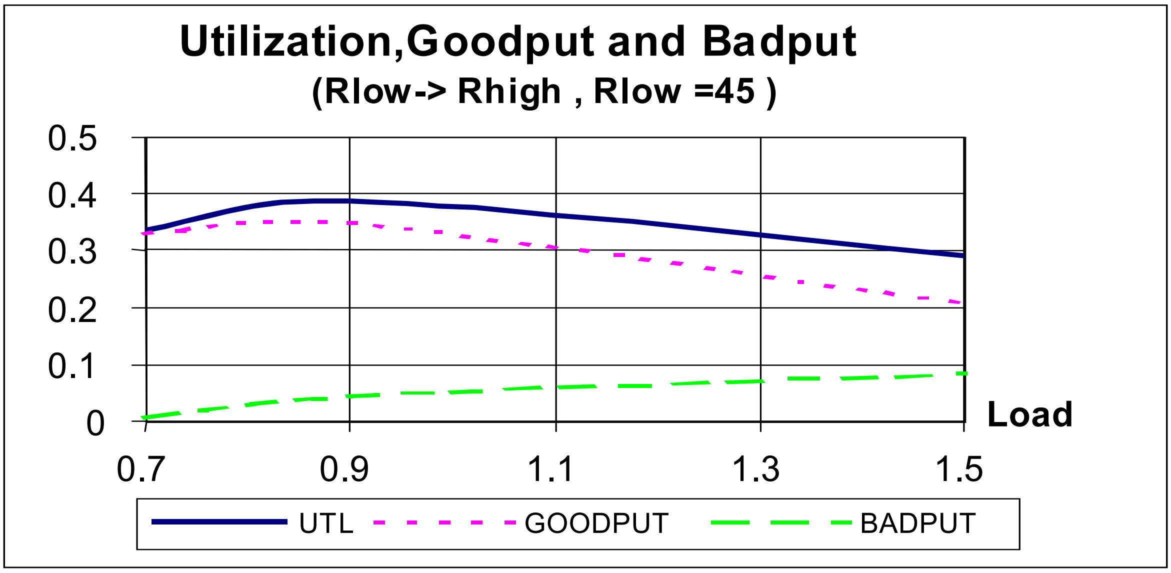

Fig.6. Utilization,Goodput and Badput vs.load.

Notice Goodput= UTL-Badput , for the goodput, which is significant. As load increases the difference among the goodput and utilization gradually increases.

Also as expected, the badput increases with load, since more packets are corrupted at a higher load, especially when [illegible] which leads to the decline of goodput. This is because shorter packets in proposed mechanism as well as that in PPD[kim] are more likely to be successfully transmitted (*Fig.7*) than longer ones. Further, the badput of proposed mechanism is slightly less than 10 % due to no EOP cells are discarded, respectively serviced as high-priority cells.

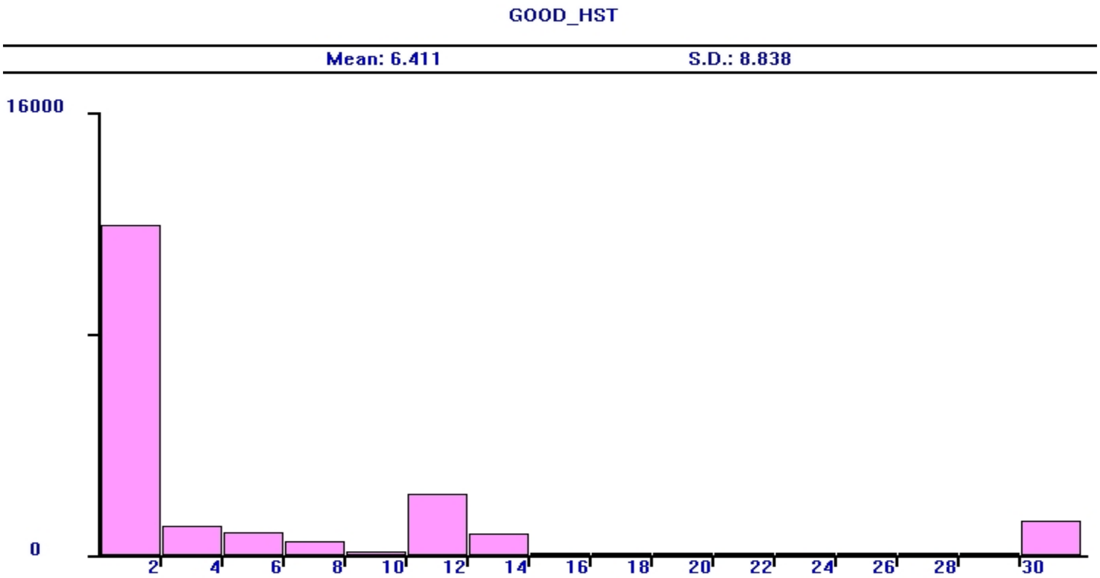

Fig.7. Length of successfully transmitted packets

Figures 8 and 9 show the estimation of waiting times.The dependence of waiting times can be seen as a function of intensity of traffic sources (load) and pushout thresholds. The servicing discipline is pure FIFO with priorities. Due to the deterministic nature of the traffic sources the effect of statistical multiplexing is almost not seen. High priority sources like VBR occupy the queue. This assumption influences on end-to-end delay. Thus, the delay of the high priority cells is increased. Note, these services are considered to be real-time. Other types (low priority) of services are served almost without delay.

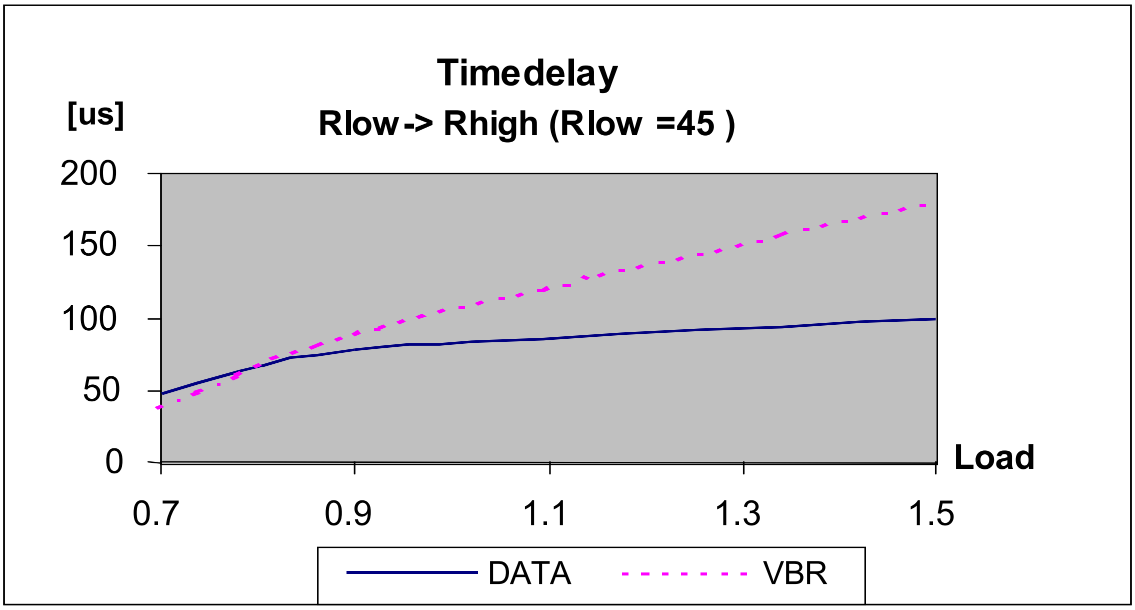

Fig.8. Waiting times vs.load.

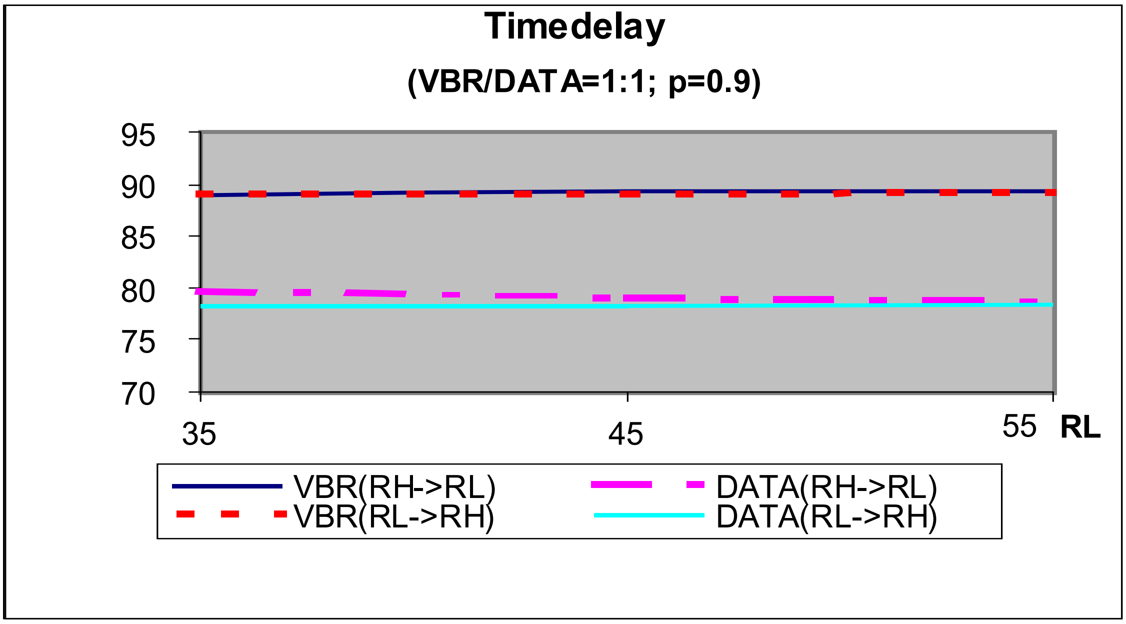

Fig.9. Waiting times vs.low threshold.

As a whole, the discussed results can explain with the different logical length of buffers for high-priority (roughly K cells) and of those for low-priority cells (most roughly - R_H and R_L, respectively, for search from high to low threshold (R_H to R_L) and for search from low to high threshold- R_L to R_H). Thus, for search from low to high threshold, waiting times of low-priority traffic are the smallest ones, and those of high-priority traffic are the greatest ones, respectively ($K > R_H > R_L$).

The above considerations also explain the fact that losses for high-priority traffic are smaller in case of search from low to high threshold (Fig. 2.) as compared to those for search from high to low threshold. Note that in the first case, i.e. when carrying out a low-to-high threshold search, there remains more buffer room for high-priority cells at the expense of buffer room for low-priority cells. This fact is indirectly confirmed by the greater values of time delays for high-priority traffic (Fig. 7).

The given above results correspond with many papers (see [5] and its references) which have shown that the loss probability estimate asymptotically obeys: b(x) ~□ exp(-□x) ,as the buffer approaches infinity for a fixed bandwidth, where x is the buffer threshold, □ and □ are the positive constants called asymptotic constant and asymptotic decay rate.

The presented here results are of the significance for network engineers. These may be helpful as to improve fairness in ATM networks as well to define the optimal combination of bandwidth and buffer as the minimum cost (associated with each unit of bandwidth and buffer) choice that achieves the desired QoS. The ratio of the cost per unit bandwidth to the cost per unit buffer should reflect the relative demand for bandwidth to buffer from all of the traffic flowing through the router[5].

6. CONCLUSION

This paper presents the Quality of Services analyses in ATM switch that serves different types of traffic sources, applies different priorities and different serving rates. Special attention is paid to the ATM traffic sources with different nature of cell generation. Only two types of traffic sources (deterministic e.g. telephone, slow video and HDTV, and elastic e.g. e-mail, ftp) are used. We detect some specific thresholds of cell loss and cell delay that depend on specific thresholds of queue length, intensity of traffic sources (load) and the ratio between high and low-priority traffic. Increasing load the effect of statistical multiplexing is almost lost because only the deterministic traffic flows. Priority schema applied influences the waiting times of cells (for real-time services), as well as number of cell lost, and increases fairness.

The main evidences with practical value from simulation results of proposed in this work method are new approach for packet discarding, through applying modification of push-out with PPD increasing fairness in ATM networks. As future work, we plan in next researches to determine these thresholds which give the maximum throughput. Previous study[8] indicates the importance of selecting a right threshold to achieve the maximum throughput is found to be relatively insensitive to traffic statistics.

7. REFERENCES

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