SCHEDULING AND QOS FOR LEAK RATE IN POLICING MECHANISMS OVER TELECOMMUNICATIONS NETWORK

Somchai Lekcharoen *and Chanintorn Jittawiriyanukoon **
** Faculty of Information Technology, Rangsit University, Thailand*
*** Faculty of Science and Technology, Assumption University, Thailand*

Keywords: VDSL, Fuzzy Control Policing Mechanisms and Queue Leak Rate (QLR).

Abstract: High-performance frame communication networks including VDSL have been conceived to carry traffic sources and support a continuum of transport rates ranging from low bit-rate to high bit-rate traffic. As a number of telecommunications traffic (bursty traffic) fluctuates on a certain network it results in congestion. The traditional policing mechanisms are finite-sized buffers with queue management techniques and fixed leak rate. Most queue management schemes employ fixed thresholds or a limited number of arrival frames, to determine when to allow or discard the entry of frames. However, traditional policing mechanisms have proved to be inefficient in coping with the conflicting requirements of ideal policing mechanisms, that is, low dropping frames and high conforming frames. An alternative solution based on artificial intelligence techniques, specifically, in the field of fuzzy systems is introduced. In this paper, a fuzzy control queue leak rate (QLR) of the buffer prior to policing mechanism is investigated. The performance of this alternative method is then compared with traditional policing mechanisms. Simulation results show that over VDSL network, the fuzzy control scheme helps improve performance of QLR in policing mechanisms. The performance of proposed method is much better than traditional policing ones.

1 INTRODUCTION

In VDSL networks, large number of traffic sources always arises, resulting in network congestion. To prevent this situation, some congestion control mechanisms depending on type of traffic sources are introduced. Also, some policing mechanisms can be considered to help improve the main performance measures, such as queueing delay, transmission delay, bandwidth allocation, and throughput. Presently, VDSL is getting very significant attention from implementers and service providers as it guarantees to deliver highest bandwidth data rates to dispersed locations with little changes to the existing infrastructure. VDSL services ensure dedicated, point-to-point, public network access over twisted-pair copper wire. As it is difficult to model a complicated control system, especially at the scheduling or at the queue leak rate (QLR), the development of alternative modeling and control techniques including fuzzy logic is necessary. Fuzzy model may lead to describe the behavior of systems well whenever the decision has to be made for the ambiguous application in control. Thus due to the demand for an inexpensive but reliable system, the fuzzy approach may turn out to be a useful mechanism to control cases with both the complexity and uncertainty. There are many previous studies involving traffic policing mechanisms (Lekcharoen et al, 2004),(Pakdeepinit et al, 2002),(Chen, 2000), however QLR is not mentioned. In this paper, the idea of QLR control is proposed to help improve the system performance. The performance after being controlled by QLR is compared to the previous one (uncontrolled by QLR).

This paper is organized as follows. An overview of traffic policing mechanisms is proposed in section II. Section III defines the model of a fuzzy control QLR in policing mechanisms. Section IV describes the simulation model and section V discusses about a performance evaluation of the proposed QLR and then a comparison to traditional policing mechanisms is produced. Section VI summarizes the conclusion and makes recommendation for future research.

Lekcharoen S. and Jittawiriyanukoon C. (2005).
SCHEDULING AND QOS FOR LEAK RATE IN POLICING MECHANISMS OVER TELECOMMUNICATIONS NETWORK.
In *Proceedings of the Second International Conference on e-Business and Telecommunication Networks*, pages 359-363
DOI: 10.5220/0001409203590363

2 DESCRIPTION AND MODELING OF TRAFFIC POLICING MECHANISM

2.1 Requirement for policing mechanism

Traffic policing allows us to control the maximum rate of traffic sent or received on an interface during the entire active phase and must operate in real time. The mechanisms have been proposed which are described in the following sections.

2.1.1 Traffic source model

In our simulation, a burst traffic stream from a single source is modeled as a burst/silence traffic stream. The burst-period model is single flow and silence-period model is silent. Burst-periods and silence periods are strictly alternating (Lekcharoen et al, 2004).

2.1.2 Policing mechanisms

Various congestion control traffic policing mechanisms are also introduced in (Lekcharoen et al, 2004). In this paper, three policing mechanisms are investigated including the Leaky Bucket(LB), the Jumping Window Mechanism(JW) and the triggered jumping window(TJW) for our analysis(Pakdeepinit et. al, 2002), (Chen, 2000).

3 FUZZY CONTROL POLICING MODEL

In this section, we will first describe a new fuzzy control policing mechanism which meets the requirements of performance, flexibility and cost-effective implementation of VDSL networks. Concepts of fuzzy sets and fuzzy logic control have been introduced and developed by (Rose and David,2000), (You-Chang et. al, 2001).

3.1 Regulator input fuzzification

Input variables are transformed into fuzzy set (fuzzification) and manipulated by a collection of IF-THEN fuzzy rules, assembled in what is known as the fuzzy inference engine, as show in figure below.

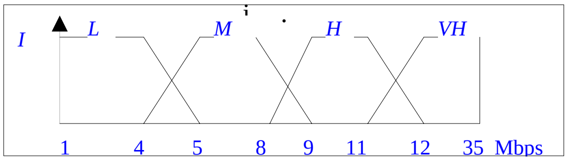

Figure 1: Library of fuzzy sets used in the fuzzification process (The input variable I).

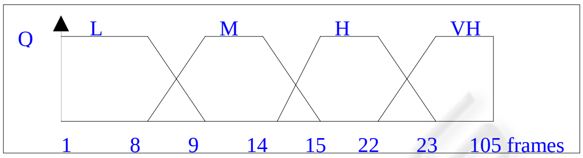

Figure 2: The term set of output variable Q.

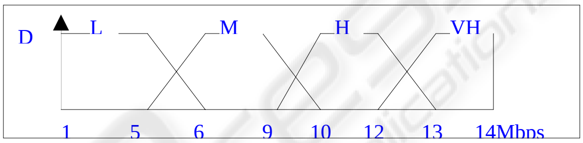

Figure 3.The term set of output variable D.

Table 1: The fuzzy rules

IF I is Low (L)	THEN Q is Low and D is Low
IF I is Medium (M)	THEN Q is Medium and D is Medium
IF I is High (H)	THEN Q is High and D is High
IF I is VeryHigh (VH)	THEN Q is High and D is High

In our experiment, fuzzy control QLR in policing mechanism uses a set of rules as specified above (figure 1,2,3 and table 1). The selection of rule base is based on our previous research (Lekcharoen et al, 2004), (Rose and David, 2000), (Ruy and Torsten, 2004) and assumptions of how the system should respond. The assumptions and set of rules may not relate to the practical point of view but at least it could pinpoint how to improve the performance of the system.

4 SIMULATION MODEL

The following figure 4 shows a simulation model used in this paper.

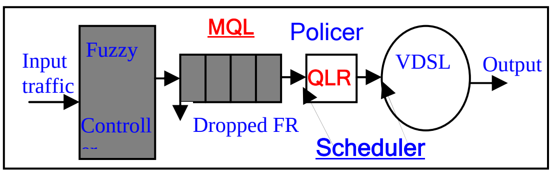

Figure 4: Simulation model.

4.1 Input traffic

This paper confines the discussion on mainly data. Data source are generally bursty in nature whereas voice and video sources can be continuous or bursty, depending on the compression and coding techniques used.

4.2 Characteristics of queuing model

There are three components with certain characteristics that must be examined before the simulation models are developed.

4.2.1 Arrival characteristics

The pattern of arrivals input traffic is mostly characterized to be *Poisson arrival processes* (Pakdeepinit et al, 2002). Like many random events, Poisson arrivals occur in such a way that for each increment of time (*T*), no matter how large or small, the probability of arrival is independent of any previous history. These events may be individual labels, a burst of labels, label or packet service completions, or other arbitrary events.

4.2.2 Service facility characteristics

In this paper, service times are randomly distributed by the *exponential probability distribution*. This is a mathematically convenient assumption if arrival rates are Poisson distributed. In order to examine the traffic congestion at output of VDSL downstream link with capacity 15Mbps (www.dlink.pl/docs/datenblatt/DEV3001_datasheet_en.pdf), the service time in the simulation model is specified by the speed of this VDSL link, resulting that a service time is set to be exponential distribution with mean 216 µs ,where the frame size is 405 bytes (www.etsi.org). The buffer size at the entrance to VDSL network is set to be 1,024 frames (www.dlink.pl/docs/datenblatt/DEV3001_datasheet_en.pdf). Once it is exceeding the buffer size then it is considered to be non-conforming frames (or dropped frames).

4.2.3 Source traffic descriptor

The source traffic descriptor is the subset of traffic parameters requested by the source (user), which characterizes the traffic that will (or should) be submitted during the connection. The relation of each traffic parameter used in the simulation model is defined in table 2.

Table 2: Input parameters

Arrival rate (Mbps)	Max Queue Length (MQL in frames)	QLR (Mbps)
1- 5	9	6
6-9	15	10
11-12	23	13
13-35	105	14

5 RESULTS AND ANALYSIS

The comparison of results before and after applying QLR in policing mechanisms is shown in figure: 5, 6, 7, 8 and 9. They are listed as LB, JW, TJW and FLB, FJW and FTJW respectively. This This section focuses on the simulation results as of LB, JW, TJW, FLB, FJW and FTJW. The input traffic rate (frame rate varies from 1 Mbps to 35 Mbps) with burst/silence ratio of 100:100 was simulated and results were shown in figure 5. It clearly determines that the fuzzy control QLR in policing mechanism (that is FLB,FJW and FTJW) is much better throughput than traditional policing mechanism (LB, JW, TJW). Throughput is one of QoS to help guarantee higher reliability of network performance. In conclusion, the FLB, FJW and FTJW can handle real time applications such as multimedia traffic.

Figure 6 demonstrates that we can help conserve the conforming frames by simply reducing number of dropped frames. The highest number of dropped frames as shown in this figure is produced by traditional policing mechanisms (LB,JW and TJW). A regular network may cause a poor QoS by higher non-conforming frames. Especially, a quality of multimedia traffic such as video conference, video on demand during the online display mode must guarantee QoS while high dropped frames will cause unclear pictures and retransmission. Furthermore It will lead to higher delay time.

In figure 7, the simulation result determines more utilization of fuzzy control prior queue length and depleting rate in policing mechanisms compared to traditional policing mechanisms with burst/silence ratio of 100:100. The increment of utilization factor does not seem to be relevant to the performance improvement. The higher utilization may cause approach of a bottleneck situation which can boggle down the system. In fact the 78% in FLB, FJW and FTJW will not affect the situation of bottleneck. Positively this factor will rather improve the cost effectiveness of the VDSL devices.

Figure 8 and 9 show that all fuzzy control prior queue length and depleting rate in policing mechanisms, all frames have to wait longer in the buffer next to the entrance of VDSL network. The consequence of long waiting hour is compatible to results shown in figure 8and 9. We can observe many more frames in average reside in the queue prior to the entrance of VDSL network. This is trade off fuzzy control policing mechanism. We can help ease this congestion by increasing the data rate in VDSL network to be higher.

6 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

In this paper, we carried out a comprehensive study to investigate the performance of three selected traditional policing mechanisms; namely LB, JW, TJW and fuzzy control QLR in policing mechanism; namely FLB, FJW, FTJW with fixed bursty/silence sources. This study was conducted through simulation for which a model was developed.

We found from simulation result in general that the fuzzy control QLR in policing mechanisms are better than traditional policing mechanisms with fixed bursty/silence sources. The fuzzy control QLR in policing mechanisms will also help ease the tremendous amount of traffic fluctuations into the VDSL network and prevent the network from nonconforming frames with 58% reduction of traffic load as shown in figure 9. Fuzzy control QLR in mechanisms can guarantee that they are better than traditional policing mechanisms.
In the future work, we will focus on the investigation of a network of queue (NoQ) for central pool prior to the VDSL network.

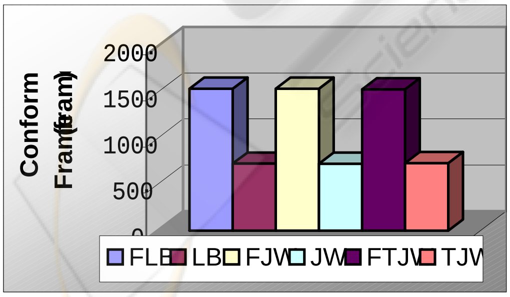

Figure 5 illustrates the conforming frames by comparison between FLB, LB, FJW, JW, FTJW and TJW at burst : silence = 100:100.

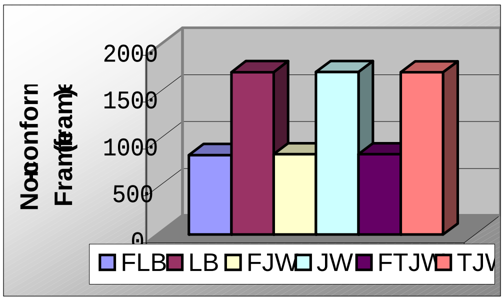

Figure 6 illustrates the non-conforming frames by comparison between FLB, LB, FJW, JW, FTJW and TJW at burst : silence = 100:100.

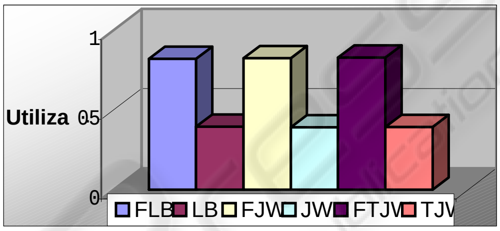

Figure 7 illustrates the utilization by comparison between FLB, LB, FJW,JW, FTJW and TJW at burst : silence = 100:100.

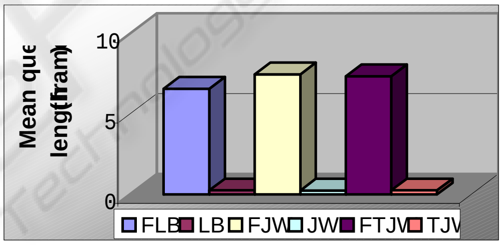

Figure 8 illustrates the mean queue length by comparison between FLB, LB, FJW, JW, FTJW and TJW at burst : silence = 100:100.

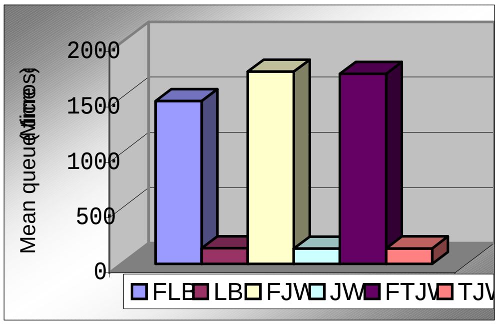

Figure 9 illustrates the mean time in queue comparison between FLB, LB, FJW, JW, FTJW and JW at burst : silence = 100:100

REFERENCES

S. Lekcharoen et. al, “Performance Evaluation of VDSL Network with Fuzzy Control Policing Mechanisms”, Proceeding of International Conference on Telecommunications and Computer Networks (TCN’04), 2004, pp. 56-60.

P. Pakdeepinit et. al, “Performance Comparison of ATM Policy Mechanisms with Telecommunications Traffic", Proceeding of The 6th World Multiconference on Systematics, Cybernetics and Informatics, 2002, pp. 373-378.

Y. W. Chen, "Study on the prevention of SYN flooding by using traffic policing", NOMS 2000 - IEEE/IFIP Network Operations and Management Symposium, no. 1, 2000, pp. 593-604.

Rose Qingyang Hu and David W. Peter, “A Predictive Self-Tuning Fuzzy-Logic Feedback Rate Controller”, IEEE/ACM transactions on networking, 2000, pp. 697-709.

Ruy de Oliveira and Torsten Braun, "A delay-based approach using fuzzy logic to improve TCP error detection in ad hoc networks", WCNC 2004 - IEEE Wireless Communications and Networking Conference, vol. 5, no. 1, 2004.

You-Chang Ko, Sun-Chun Park, Chong-Youn Chun, Hyong-Woo Lee, Choong-Ho Cho, "An adaptive QoS provisioning distributed call admission control using fuzzy logic control", ICC 2001 - IEEE International Conference on Communications, no. 1, 2001., pp. 356-360.

www.dlink.pl/docs/datenblatt/DEV3001_datasheet_en.pdf

www.etsi.org.