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Fuzzy shaper versus leaky bucket shaper in Voice over Internet

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Abstract: - Nowadays, is more and more usual to implement the voice service over Internet (VoIP), due to the reduction in price both for the network operator and for the final users. In this paper, it is presented a new traffic shaper that increases the number of stablished connections and minimizes the delay time in the case of using an IP/ADSL (Internet Protocol/Asymmetric Digital Subscriber Line) environment.

Key-Words: - Traffic shaper, VoIP, ADSL, fuzzy logic, GCRA algorithm, ATM

1 Introduction

For the service of voice transmission in packet switch networks, it is very important to have a small end-to-end delay. Moreover, in case of using the Digital Subscriber Line (DSL) to access Internet, it is difficult to distinguish between the voice packets and the data packets. In these environments, it is necessary, to shape the input traffic packets using the GCRA (Generic Cell Rate Algorithm) method [1], implemented by means of the leaky bucket algorithm [2].

In this paper, it is compared a new proposed traffic shaper based on fuzzy logic, to obtain a smaller packet delay in the input traffic to the network ATM (Asynchronous Transfer Mode). Therefore, it is possible to increase the number of stablished connections taking into account that all of the parameters of VBR (Variable Bit Rate) ATM traffic, contracted in ADSL, are shaped: PCR (Peak Cell Rate), SCR (Sustainable Cell Rate) and MBS (Maximum Burst Size).

2 Voice traffic source

There are many several voice coders that can be used to carry out a telephone call in Internet [3]. In the performed simulations in this paper, it has been used the same voice coder of program 'Netmeeting' because it is one of the most coder used for the voice transmission in the video-conference service in Internet. The coder used is the G.723.1 (6,3 Kbps) and it detects both the activity periods and the idle periods. Therefore, we can model both periods by means of two exponential distributions [4] with these average times: 1,004 seconds for T_{on} period and 1,587 seconds for T_{off} period [5]. With these data and taking into account the use of header IP compression, the obtained bandwidth, for each source, is 3 Kbps.

3 Traffic shapers

In this paper, two traffic shapers will be studied, analyzed and compared: the leaky bucket shaper and a new shaper based on fuzzy logic. The leaky bucket shaper is based on the GCRA algorithm [1], standarized by the ATM Forum [1]. The fuzzy shaper uses the rules defined in Table 1. Also, the fuzzy sets can be seen in Fig. 1.

	λ_l	λ_s	ΔT
1	H	H	H
2	H	M	H
3	H	L	H
4	M	H	M
5	M	M	M
6	M	L	M
7	L	H	M
8	L	M	L
9	L	L	L

Table 1: Rules of the fuzzy shaper

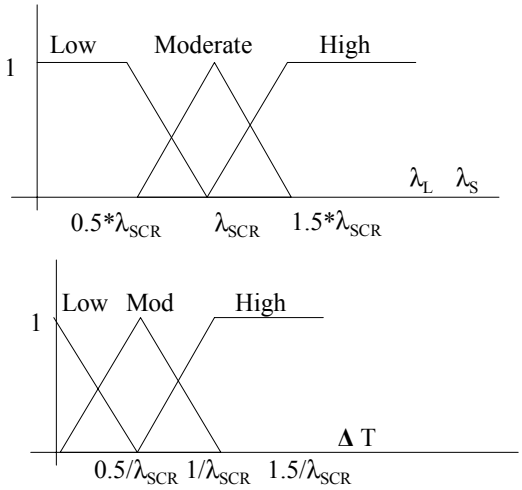

Fig. 1: Fuzzy sets

This fuzzy shaper is composed of two input parameters and one output parameter:
- Sustainable rate in long term, calculated from the beginning of the connection (λL).
- Sustainable rate in short term, taking into account the average rate of the latest MBS cells (λS).
- The output defines the minimum time that the cell must be delayed to be compliant with the contracted rate (ΔT).

The voice sources given in the previous section are connected to the input of these traffic shapers. These traffic sources will be multiplexed one by one to calculate the introduced delays. Two aims are achieved thanks to the trafffic shapers: to send the different voice calls in one and only telephone line, minimizing the delay and to make sure that the parameters of quality of service (QoS) established by the network operator are fulfilled.

For example, the delay associated with the MBS shaping for an on-off traffic source with exponential times can be easily approached with the expression (considered that $T_{off}>T_{on}$ and $T_{off}>>T_{interMBS}$):

$$delay = T_{interMBS} \cdot \frac{e^{-\frac{T_{MBS}}{T_{ON}}}}{1-e^{-\frac{T_{MBS}}{T_{ON}}}} \qquad (1)$$

Where: T_{on} is the activity time, T_{off} is the idle time, T_{MBS} is the burst time and $T_{interMBS}$ is the minimum time between two bursts.

The VoIP transmission scheme is shown in Fig. 2 [6]. In such an environment, it is possible to analyze the introduced delay of the voice packets end-to-end transmitted. This delay can be divided into several steps and it must be considered in both senses of communication. The first 5 ms come from, basically, the propagation. The delay in the gateway (60 ms) is due to the codification and the packetization of the traffic source. In this study, the gateway functions are simulated in such a way that the maximum delay that the traffic packets can suffer is, approximately, 60 ms. In addition to the delay of the voice codification, it is necessary to consider that the voice packets are delayed due to the fact to transmit them in one and only telephone line, and other factors like the SCR shaping or the MBS shaping in the case of using an ATM link, like which is going to be considered in this paper. So, the introduced delay by the codifier will be, approximately, of 30 ms, and this is the reason why the voice packets must be maintained about 60 ms in the gateway, including the maximum multiplexation time of 30 ms. And, finally, the delay experienced by the packets while passing through the network (65 ms), and the variations in this IP packet transfer delay, named, jitter.

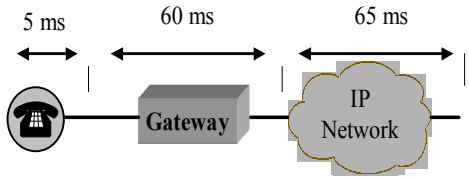

Fig. 2: Transmission scheme of VoIP

4 Results

In Table 2 (at the end of this paper), the values obtained in the simulations, for different traffic contracts between the network operator and the final user, are drawn. With the fuzzy shaper, the number of accepted connections is increased for all the studied PCR values. To obtain the number of connections for each one of the previous traffic contract, it is considered that the maximum allowed delay before the input of the voice samples in the network is 30 ms. In Fig. 3 (at the end of this paper), the delay for several PCR values is drawn and it can be observed that the delays for both shapers are practically the same (initial values and final values); but in the central zone, the fuzzy shaper is much more efficient than the leaky bucket shaper.

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References:
[1] ATM Forum, Traffic management specification, version 4.0, Technical Report, April 1996.
[2] Rathgeb, E., Modeling and performance comparison of policing mechanism for ATM networks, *IEEE Journal on Selected Areas in Communications*, Vol. 9, No. 3, 1991, pp. 325-334.

[3] Wright, D., Voice over MPLS compared to voice over other packet transport technologies, *IEEE Communications Magazine*, Vol. 40, No. 11, 2002, pp. 124-132.

[4] ITU–T, Recommendation P.59 – Artificial Conversational Speech, March 1993, Geneva.

[5] Buchli, M.J.C., de Vleeschauwer, D., Janssen, J. and Petit, G.H., Policing aggregates of voice traffic with the token bucket algorithm, *Proceedings of IEEE International Conference on Communications 2002 (ICC 2002)*, Vol. 4, 28 April-2 May 2002, New York City, pp. 2547-2551.

[6] CISCO, Understanding Delay in Packet Voice Networks, available in http://www.cisco.com/warp/public/788/voip/delay-details.html

PCR (Kbps)	SCR (Kbps)	Accepted sources using leaky bucket	Accepted sources using fuzzy shaper	Theoretical (%)	Improvement (%)
1000	100	24	32	32	33,3
512	51,2	11	15	17	36,6
256	25,6	5	7	8	40
128	12,8	2–3	2–3	4	–

Table 2: Numerical comparison between fuzzy shaper and leaky bucket shaper

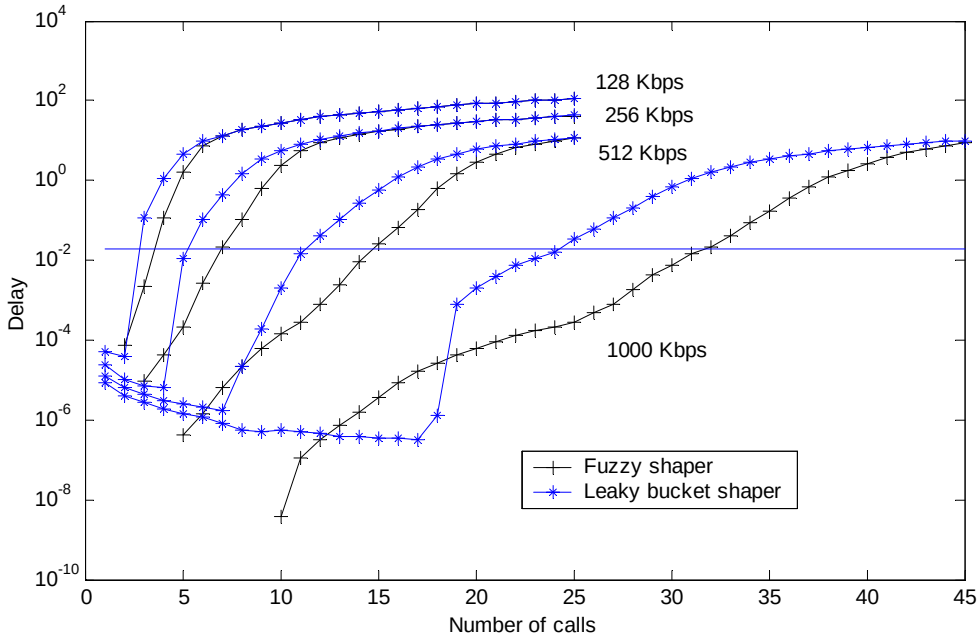

Fig. 3: Number of accepted VoIP sources versus delay for several PCR