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Congestion Control in Differentiated Services using Fuzzy Logic Controller

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ABSTRACT

Congestion of network phenomenon remains a focused and high priority issue. The increased demand and rapid growth of internet lead to congestion problem active queue management strategy plays a complementary approach for congestion control and a steady stream of research output has been achieved. In this paper we construct an architecture that describes a drop based congestion control method for differentiated services (diff-serv) networks. The fuzzy logic approach proposed for congestion control use the knowledge of linguistic variables for admission/ rejection of packets to the buffer according to service preferences so as to maximize the performance measure.

Keywords: Congestion Control, Fuzzy logic, Diff-Ser, Active Queue Management (AQM).

I. INTRODUCTION

Rapid development of the Internet and modern network applications caused a significant growth of the traffic in the Internet and imposed new demands on the network services. The usage of Internet for time-sensitive voice and video applications demands the design and utilization of new Internet architectures to include more effective congestion control algorithms. As a result, the differentiated services (Diff-Serv) architecture was proposed[1] to deliver (aggregated) quality of service (QoS) in IP networks.

Random Early Marking (REM) significantly differs from random early detection by its congestion measure and by its probability dropping or marking function. The REM implementation aims to decouple the congestion measure from the perfor-mance measure to reach a global optimal operating point by achieving its target queue length and its target rate independent of congestion levels in the network.

II. FUZZY LOGIC

In the year 1965 Lotfi Zadeh launched fuzzy logic by introducing that there are propositions with an infinite number of truth values in infinitely varying degrees. Fuzzy logic deals with degrees of truth that are provided in the context of fussy sets which is called membership functions. The advantages of Fuzzy logic control are

- an ability to quickly express the control structure of a system using a priori knowledge;
- less dependence on the availability of a precise mathematical model;
- easy handling of the inherent nonlinearities; and
- easy handling of multiple input signals.

The application of fuzzy control techniques to congestion control problems in networks is suitable due to the difficulties in obtaining a precise mathematical model using conventional analytical methods. Moreover, traffic congestion on the Internet is a concept, which is well understood; therefore it is possible to obtain simple linguistic rules for congestion control.

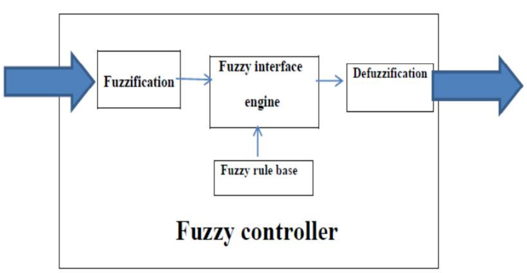

Fig.1Fuzzy Logic Controller

The fuzzy logic controller is the principal part of the system .fig shows the block diagram of a fuzzy logic controller that comprises four main components: a knowledge base, an inference engine, and a defuzzification interface.

In this paper there are two inputs, queue length, buffer ratio and one output packet drop probability the parameters QL_s, Br and Pd denoted the queue length, buffer usage ratio and dropping probability respectively.

The usual way to define the linguistic rules of a fuzzy variable is Gaussian, triangular or trapezoidal shaped membership functions. Since triangular and trapezoidal shaped functions offer more real time computational simplicity, we have selected them for our rule base as shown in Fig.1.

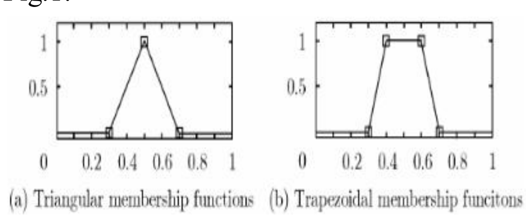

Fig.1 Membership Functions

Consider a single server queuing system with two class of arriving packets as shown in Fig.2

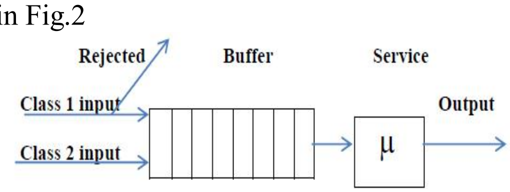

Fig.2

Two independent position arrivals of packets called class and class2 packets arrive at the single buffer with constant arrival rate λ_1 and λ_2 respectively. The size of buffer has unlimited capacity and the order of service in arbitrary. The buffer is an exponential service rate μ. Packets of class1 are either accepted are rejected to the enter buffer, whereas packets class2 enter the buffer without any restriction. A holding cost per packet per unit time occurs to the system and it received fixed reward w for each accepted packet.

III. FUZZY CONROLLER

A linguistic description based on expert knowledge provides the best mechanism. The rule base summarizes the control actions of expert in the form if Input variable then output (control policy).

In this paper there are three inputs, queue sizes of class1 packets QLs_1 and class1 packets QLs_2, and buffer usage ratio by and one output packet dropping probability (P_d). The individual linguistic rule is defined as

Rule1: if $QLs_1=a_1$, $QLs_2=b_1$, and $Br=c_1$, then $P_d=d_1$.
Rule2: if $QL_{s1}=a_2$, $QLs_2=b_2$, and $Br=c_2$, then $P_d=d_2$.
Rule k: if $QL_{s1}=a_k$, $QLs_2=b_k$, and $Br=c_k$, then $P_d=d_k$.

The fuzzy logic controller calculates the dropping probability based on the queue size of differentiate packets, the current buffer usage rate and a set of fuzzy rules. When packets arrive, fuzzy algorithm abstracts the information and buffer usage ratio at the beginning and calculates the packet dropping mechanism of predefined packets classes in the queues, according to the usage of buffer ratios.

The universe of discourse for linguistic variable of queue length is set as QLs_i={short, medium, long}, i=1,2., where "short" means the queue length is in the normal state, "medium" means the queue length is in congestion avoidance state, "long" means the queue length is in congestion state. If is denoted as QLs_i ={S, M, L} for i=1, 2.

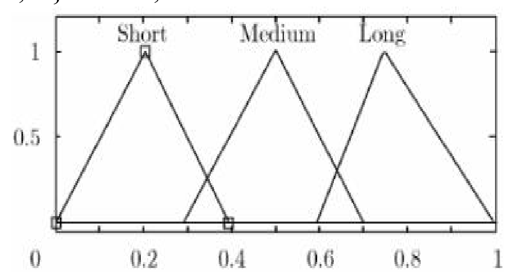

Fig.4 Membership function of Queue lengths

The universe of discourse for linguistic variable of buffer usage ratio is set as Br={less congestion, knee congestion, cliff congestion}, where "less congestion" simplified as Lc means the buffer usage ratio is normal state, "knee congestion" simplified as Kc means the buffer usage ratio is in congestion avoidance state, "cliff congestion" simplified as Cc means buffer usage ratio is in congestion state, represents as Br={Lc, Kc, Cc}

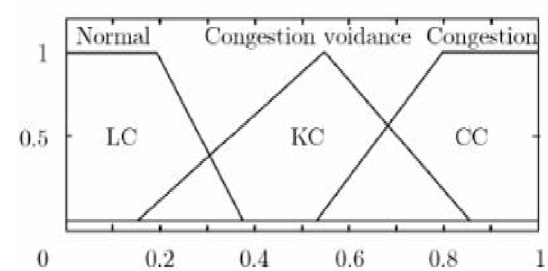

Fig.5 Membership function of Buffer usage ratio

The universe of discourse for linguistic variable of packets drop probability is set as

Pd={very low, low, medium, high, very high} represented as Pd={ VL, L, M, H, VH} as shown in Fig.4.

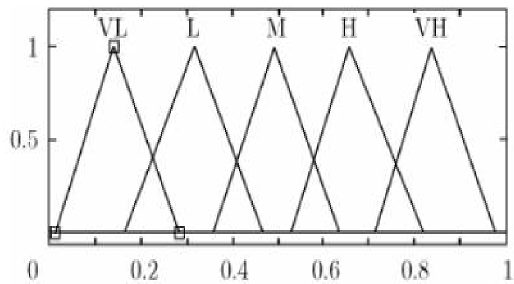

Fig.4 Membership function of Pd

When packet arrives, the current values of QLs_1, QLs_2 and Br are obtained, the packet drop probability Pd is according to three inputs and based on the rules and inferences of the fuzzy congestion control. Table shows the linguistic valued of linguistic variables of fuzzy congestion control.

Table 1. Fuzzy rules

QLs_1	QLs_2	Br		
		Normal	Congestion avoidance	congestion
S	S	VL	VL	L
S	M	VL	L	L
S	L	L	L	M
M	S	L	M	M
M	M	M	M	H
M	L	M	H	H
L	S	H	H	VH
L	M	H	VH	VH
L	L	VH	H	VH

IV. CONCLUSION

In this paper, we propose an efficient fuzzy based Diff-Ser AQM for IP networks which calculates the packet dropping probability by the diff-Ser of queue length and the buffer usage ratio. The aforementioned research concludes that the AQM can also be achieved by fuzzy logic instead of the probability based packed dropping mechanism originated from RED.

REFERENCES

1. Blake, S., *et al*., "An architecture for Differentiated Service", Request for Comments RFC 2475, *Internet Engineering Task Force*, (1998).
2. C. Chrysostomou., *et al*., "Congestion control in differentiated services networks using Fuzzy – RED, *Control Engineering Practices* 11, pp.1153-1170, (2003).
3. R. Adams., "Active Queue Management: A Survey", *Communications Surveys & Tutorials*, Vol.15, No.3, (2013).