Congestion control in LAN network using Fuzzy logic

Amritha V, Vismaya T V, Remya Nair T

Abstract: The rapid growth and increased communications over internet has also increased the demand for an effective and efficient communication over the network. Therefore an efficient mechanism to deal with the network traffic can reduce the interruptions caused during communication and provide reliable and enhanced quality of service. Routers are responsible for performing the direction of network traffic over the internet Congestion control mechanisms provide a better way of handling network congestion. This paper analyzed the performance of RED with fuzzy logic. The important objective of fuzzy logic is to reduce packet loss during data transmission. The analysis results show that the packet dropping probability could be reduced with the help of FLRED.

Keywords: Congestion control, RED, Fuzzy logic.

I. INTRODUCTION

Networks are a primary part of every organization, offices and homes. Computer networks guide vast number of applications and services in various Computer means like world wide web access, application and storage server sharing, instant messaging and many more. Congestion control mechanisms are methods that provide a better means of communication by controlling congestion occurring in the network by keeping the traffic load below the capacity and thereby handling the flow control in a reliable manner. AQM(Active Queue Management) are congestion control mechanisms that reduce network congestion by enhancing and reduces the throughput and better utilization of network resources. RED is an AQM algorithm that deals with circumventing congestion in the network. Standard tail drop algorithm used by queuing discipline in network hardware drops packet when the capacity of the queue is insufficient to handle the incoming packets. With this algorithm it simply drops the upcoming packet when the buffer is full without any knowledge whether it can be retained or dropped. It doesn't even sense the packets when the buffer is full, and instead waits for the buffer to become empty and it accepts the upcoming packets. The packets which were sent in between the mean time are simply dropped .This loss of packets causes transmission control protocol to enter into the congestion with other algorithms and it avoids to send packets more than the buffer and which are capable for transmitting when the packets are discarded the acknowledgements which are to be received by the sender will cause the congestion in the window and it leads to global synchronization.

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To overcome these the issues of tail drop algorithm, Fuzzy based RED techniques have been implemented.

II. RELATED WORKS

This paper[1] focuses on fuzzy controlled RED algorithm for the enhancement of the throughput and better utilization of the bandwidth. It uses dynamic network change states other than fixed minimum threshold and maximum threshold. Here the drop probability is calculated by applying a set of fuzzy rules on the rate of queue changes, current buffer size that the packet resides. Thus providing a better control of the network traffic and usage of available resources. This paper[2] proposes Random early detection gateways for network congestion avoidance. The major objective of this method is to lower the congestion by regulating the average queue size. This method focuses on congestion avoidance through red algorithm where the gateway marks the arrived packet and apprise the sender to lower the window size of that connection and this helps in reducing the congestion.

This paper[3] introduces classic RED AQM algorithm incorporated with MATLAB's Fuzzy Logic Toolbox to improve network performance in respect of the metrics like the delivery ratio of the arriving packets, average end-to-end delay, etc. It uses fuzzy inference system with two input functions : average queue size and set of linguistic fuzzy variables. It compares result without integrating fuzzy logic and with the integration of fuzzy logic. The result shows that the overall throughput is high in the case of using fuzzy logic. Furthermore the packet loss ratio and jitter is low using fuzzy logic as compared to without using fuzzy logic. This paper[4] propounds a fuzzy based mechanism for congestion control. The proposed method deals with controlling traffic at the, sooner stage in the queue buffer and resolves the drawbacks of s tail drop method .In this the network traffic issue is dealt with contrasting the average queue length with threshold values maximum and minimum along with the incorporation of fuzzy logic . This paper[5] focuses on the development of a new AQM scheme depend on fuzzy logic. This congestion control system is developed to manage the queues in the IP routers to a predefined level for the achievement of at targets queue length. It either drops the packet or the packet header is set with an even bit at the header . It provides fast system responses and robustness and effective results as compared to other AQM schemes. This paper[6] proposes a fuzzy based red for packet loss. It provides a better evaluation technique for packet losses in virtual circuit network.

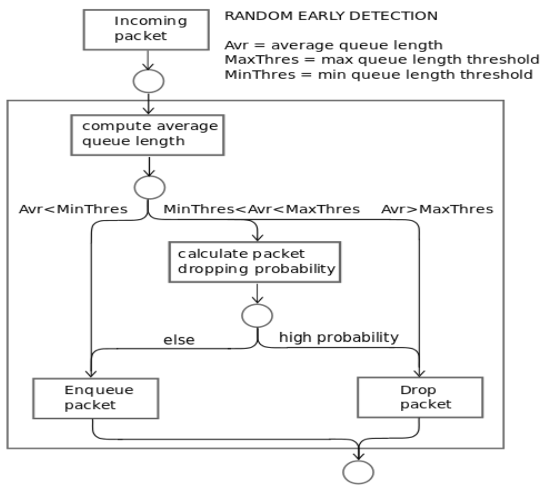
Packet loss can occur due to various reasons during the transmission .Fuzzy based red provides a better way to handle this problem thus enhancing the throughput and reducing delay. This paper [7] focuses on fuzzy based congestion control using AQM techniques. Here the drop probability function is replaced with a fuzzy logic controller to balance the buffer to a desired length. Similarly fuzzy logic controller is used instead of drop probability function in REM to reduce the delay in traditional REM. This paper [8] propounds an analysis of three active queue management algorithms which are RED, GRED and AGRED with three traffic distributions such as Exponential, Geometrical and ON-OFF model.

Fuzzy knowledge base is made simple with the help of linguistic interpretation of the behavior of the system . It enhances RED by reducing packet drop probability and delay. Our research proposes a modified method for controlling congestion in network using fuzzy logic. Various algorithms are used in the transport layer to reduce network congestion. These include Random Detection Algorithm(RED), Random Exponential Marking(REM),Adaptive RED etc. Among the congestion control algorithms we chose Random Early Detection algorithm to be enhanced using fuzzy logic. Random Early Detection algorithm computes the average queue size and contrasting it with two threshold values based on which the drop probability is determined. Fuzzy logic comprises of certain of set rules combined with if and else condition that produces a specified result based on the applied rules. We apply fuzzy rules to the given algorithm such that it reduces the packet drop probability in the network thus enhancing the reduction of packet loss.

III. THEORY

a. Random Early Detection Algorithm

RED algorithms are best suited for congestion avoidance at the routers. Unlike traditional queue management algorithms that drops packets when the buffer is insufficient to handle the arriving packets RED drops packets probabilistically. It resolves and avoid congestion prior to the buffer overflow. The drawback of this algorithm is that the control parameters are not tuned accurately. Average queue size is used by RED to detect the congestion. Mathematical analysis of RED gateways keep average queue length to lower level allowing random bursts of packets in the queue.



b. **Mathematical analysis of RED**

RED computing average queue size and compares the two thresholds, a minimum and maximum . When average queue size is below the minimum threshold no packet is dropped and is sent to the buffer. When average queue size is greater than the maximum threshold each packets arriving is dropped. When average queue size comes between minimum and maximum threshold values then packets are marked with a packet drop probability p_a. average queue length of a router means the duration of empty queue(Inactive duration),m is the number of tiny packets that may be transmitted by the router during the inactive period. Later average queue length is calculated by the router. The low pass filter that is used to calculate the average queue size is an exponential weighted moving average W_{qw} as such:

$$Avg = (1-W_{qw})\times Avg+W_{qw}\times q \text{ if } q>0$$

$$(1-W_{qw})^m\times Avg \quad \text{otherwise}$$

Where:

Avg is the average queue size.

q_w is the present queue size.

Wqw is a queue weight, $0 \leq Wqw \leq 1$.

If average queue length comes in between minth and maxth, then congestion is expected to be occurring. In this situation, the temporary probability (Pb) can be calculated by using equation 2.

$$Pb = Max_p \times \frac{Avg-min_{th}}{max_{th}-min_{th}}$$

Where:

Max_p = Drop probability at maximum.

So the actual dropping probability (pa) is calculated by using equation 3:

$$Pa = \frac{Pb}{(1-count\times Pb)}$$

Where:

Count = The number of packets that are arrived successively and not discarded since the last packet is marked. The Pa enhances slowly as the count increments beginning from the finally marked packet. It assures that the router does not take large amount of line before marking a packet. RED algorithm based on queue weight (wq), Maximum drop probability (maxp), Maximum threshold (max thresh) and Minimum threshold (min thresh).

IV. Fuzzy Logic

The fuzzy inference system is the essential unit of a fuzzy logic system. This paper selects mamdani fuzzy inference method which depends upon below mentioned demands:

"1. A set of fuzzy rules

2. Inputs membership functions (includes the process of changing crisp values into forms applicable for linguistic terms of fuzzy sets).

3. Fuzzy rules to create a rule strength from the fuzzifying inputs.

4. Combining the rule strength and the output membership function to find the consequences of the rules.

5. Combining the consequences to get the output distribution.

6. Defuzzifying the output distribution class type is needed. "

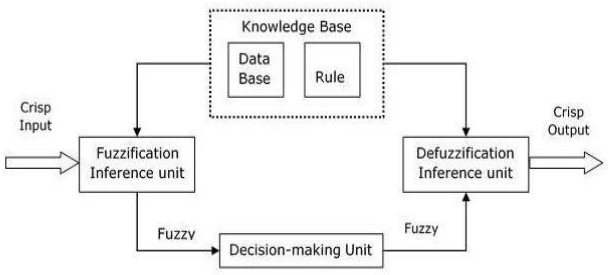


Fig 1.*Fuzzy Inference System*

In this paper we evaluate the performance of FLRED using MATLAB tool version 9.2.We use three input-one output fuzzy inference system the input membership functions are weighted average queue length(Wav), Minimum Threshold (MinTH), Maximum Threshold (MaxTH) and the output is maximum dropping probability (MaxP).The parameter values set in the simulation is MinTH =11.2, MaxTH =26.1, Wav=0.768.We got MaxP as 0.467. That means which retained a probability of a lesser value than the probability value ½.

a)*Weighted Average queue size* b)*Minimum Threshold* c)*Maximum Threshold*

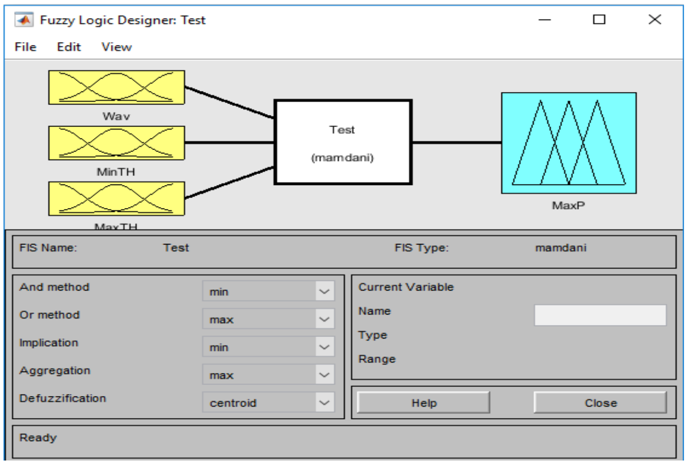


Fig.2. *Membership functions used in Fuzzy inference System*

b)

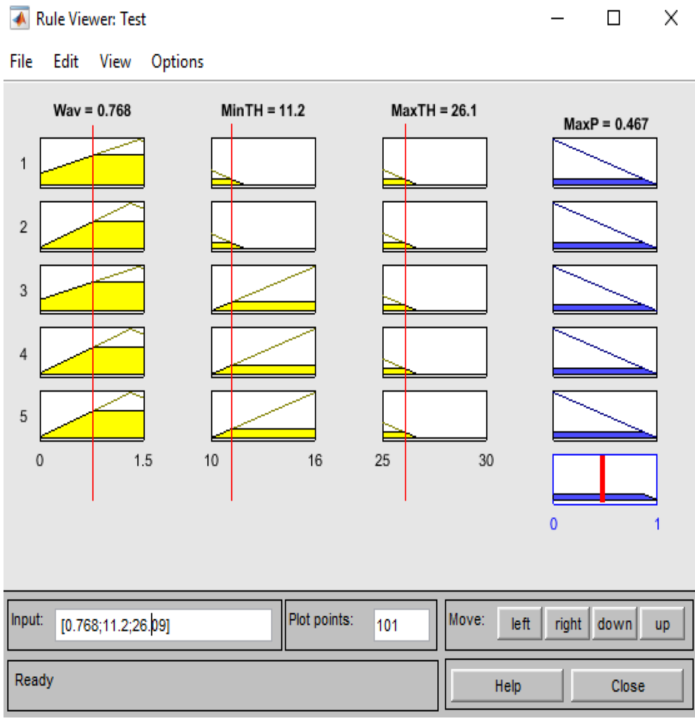
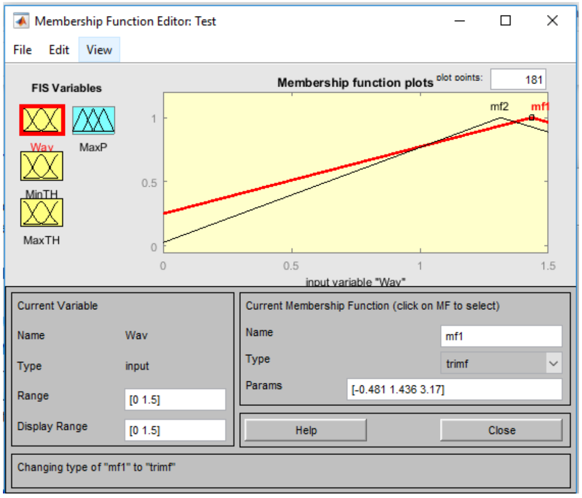
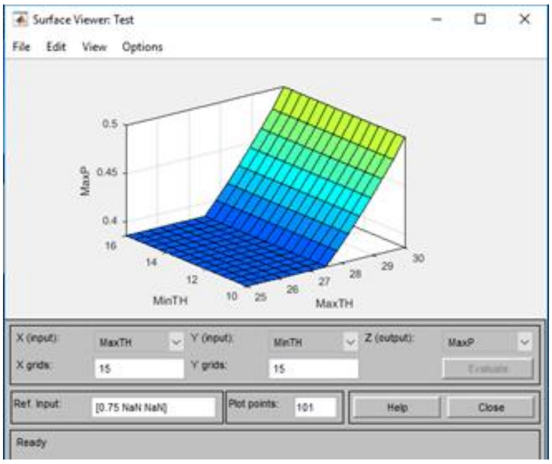


Fig 3. *Rules viewer*

c)Membership Functions



d)Maximum drop probability



The weighted average queue length calculation that is used for simulation is shown in the Table (1).

Average Q Length	Random weight	Weighted Average Q Length
64	0.001	0.064
64	0.002	0.128
64	0.003	0.192
128	0.001	0.128
128	0.002	0.256
128	0.003	0.384
256	0.001	0.256
256	0.002	0.512
256	0.003	0.768
512	0.001	0.512
512	0.002	1.024
512	0.003	1.536

TABLE(1)

V. SIMULATION RESULTS

The obtained results rely on the calculated weighted average value. We took the range for Minimum Threshold as 10-16 packets and Maximum Threshold as 25-30. We calculated weighted average queue length with weights 0.001, 0.002 and 0.003 which are the standard weights used for setting appropriate queue length. During simulation we obtained the amazing results saying that the appropriate weight value is .003 and MaxTh and MinTH are 26-27 and 11-12 respectively.
We actually made an analysis of MaxP using weighted average and optimized MinTH and MaxTH values.

The simulation results shows that the variation in MinTH and MaxTH are affecting the maximum packet dropping probability value than the variation in weighted average value. The above results obtained from MATLAB shows that by employing the above mentioned criteria the probability of packet drops can be reduced to a value lesser than the probability value 0.5. and that value agree with the FLRED packet drop probability values already obtained.

VI. CONCLUSION

This paper analyzed the performance of FLRED with weighted average queue length on average queue size ranging from 64-512. FLRED uses fuzzy logic to avoid the linearity and parameterization problems in RED.FIS is applicable for various traffic states and network loads. The analysis also shows that better MinTH and MaxTH values are 11-12 and 26-27 respectively. By employing weighted average queue length,and appropriate MinTH and MaxTH values together provided a better performance of FLRED. The Packet Dropping probability obtained is lesser than the probability value 0 .5 and that value agree with the FLRED packet drop probability values already obtained.

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