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A Survey of Managing Congestion Control in ATM Network Using Fuzzy Logic

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ABSTRACT: This survey paper shows different mechanisms for controlling congestion in ATM network and some suggested solution for the existing mechanism to be modified using fuzzy logic. Different mechanisms are Jump Window (JW), Exponentially Weighted Moving Average (EWMA), and traditional Leaky Bucket (LB) and Fuzzy Leaky Bucket Algorithm. The Fuzzy Leaky Bucket (FLB) modifies the token rate according to the peak rate, mean rate and the burst time, which characterize the channel behaviour. This paper shows how the inference engine can be included in the design between Leaky bucket and ATM network. The performance of FLB using inference engine will be better than conventional mechanism techniques, in terms of both adaptive behaviours of responsiveness and selectivity.

Keywords: ATM, Exponentially Weighted Moving Average, Fuzzy Logic, Jump Window, Leaky Bucket

I. INTRODUCTION

By seeing today's potential requirements and existing users in a computer network there is need to manage the congestion within the limited resource. Basically ATM are used to provide the functionality like high bandwidth, Scalability, high throughput etc. Asynchronous Transfer Mode (ATM) is, according to the ATM Forum, "a telecommunications concept defined by ANSI and ITU (formerly CCITT) standards for carriage of a complete range of channel traffic, including, video signals and data". ATM created for the purpose that it can meet the needs for B-ISDN call, as defined in the late 1980s, and designed to unify telecommunication and computer networks. It was created for a network that must control both traditional high-throughput data traffic like voice and video. The B-ISDN model for ATM maps to the three lowest layers of the ISO-OSI reference model: network, data link, and physical layer. ATM is a base protocol used over the SONET/SDH is the main component of the public switched telephone network (PSTN) and Integrated Services Digital Network (ISDN), but its use is declining in favour of all IP. [1]

ATM provides functionality that is similar to both circuit switching and packet switching networks: ATM uses asynchronous time-division multiplexing, and encodes the data into small and fixed-sized called cells. This is different from approaches such as the Internet Protocol or Ethernet that use variable sized like packets and frames. Here model which uses by ATM is connection-oriented model in which a virtual circuit must be established between two endpoints before the actual data exchange begins. These virtual circuits may be "permanent", i.e. dedicated connections that are usually preconfigured by the service provider, or "switched", i.e. set up on a per-call basis using signalling and disconnected when the call is terminated to provide this functionality and avoid congestion in ATM network we introduce the technique like Jump Window Algorithm(JW), Exponentially Weighted Moving Average (EWMA), and traditional Leaky Bucket (LB) and Fuzzy Leaky Bucket Algorithm. The main Focus of this paper is to see how this technique is effectively used to manage congestion in ATM Network.

II. TRAFFIC POLICING IN ATM NETWORK

To maintain network goodness, networks apply traffic policing to virtual circuits to limit them to their traffic contracts at the entry points to the network, i.e. the user–network interfaces (UNIs) and network-to-network interfaces (NNIs): Usage Parameter Control (UPC) and Network Parameter Control (NPC). For Both this parameter control the reference model given by the ITU-T and the ATM Forum for UPC and NPC is the generic cell rate algorithm (GCRA), which is the updated version of the leaky bucket [9]. CBR traffic is normally be manages the PCR and CDVt , whereas VBR traffic will normally be manages using a dual leaky bucket controller to a PCR and CDVt and an SCR and also the Maximum Burst Size (MBS). The MBS will normally do the packet (SAR-SDU) size for the VBR VC in cells [9].

If the traffic on a virtual circuit is proceed further than its traffic contract which is determined by the GCRA, in that case network can either drop cells or we can say mark the Cell Loss Priority (CLP) bit (to identify a potentially redundant of cell). Basic policing works on a concept of cell to cell basis, but this is sub-optimal for encapsulated packet traffic (as discarding a single cell will action that it will discard whole packet). So the r result, schemes such as Partial Packet Discard (PPD) and Early Packet Discard (EPD) have been developed that will discard a whole series of cells until the another packet starts. This will decrease the number of cells which is not use in the network, and saving bandwidth for full packets. EPD and PPD work with AAL5 connections so they can use the end of packet marker: the ATM User-to-ATM User (AUU) Indicating the bit in the Payload Type field of the header, which sets in the last cell of a SAR-SDU [10]

III. TRAFFIC SHAPING IN ATM NETWORK

Traffic shaping generally takes place in the network interface card (NIC) in user equipment, and also attempts to ensure that the cell flow on a VC will meet its traffic contract, such that cells will not be dropped or reduced it's priority at the UNI. Since the B-ISDN model given for traffic managing in the network is the GCRA, used this algorithm for the purpose of shaping as well, and also the single and dual leaky bucket implementations may be used. [9][10]

IV. CALL ADMISSION AND CONNECTION ESTABLISHMENT

A network must create a connection before two parties can send cells to one another. In ATM this is called a virtual circuit (VC). It can be a permanent virtual circuit (PVC), which is created administratively on the end points, or a switched virtual circuit (SVC), which is developed as needed by the communicating parties. SVC creation is managed by signalling, in which the requesting party shows the address of the receiving party, the type of service which are requested, and whatever traffic parameters can be applicable for the selected service. "Call admission" is performed in the ATM network and it will ensure that the requested resources are available and also the route exists for the connection which is created. [1][9][10]

V. CONVENTIONAL MECHANISM TO MANAGE ATM NETWORK

A. Jump Window Algorithm (JW)

This algorithm consist of jumping window where the number of cells in fixed size interval can be moved from window [1].Here the new interval start successively after previous and the associated counter is restarted again with initial value of zero. But once upper bound value is reached then the cells are dropped. Here there is no queuing mechanism so the real time packets are dropped which leads to delay/latency in streaming. So the idea is to assign the priority to real time packets and using time division multiplexing the real time packets can be routed fast than non-real time packets.

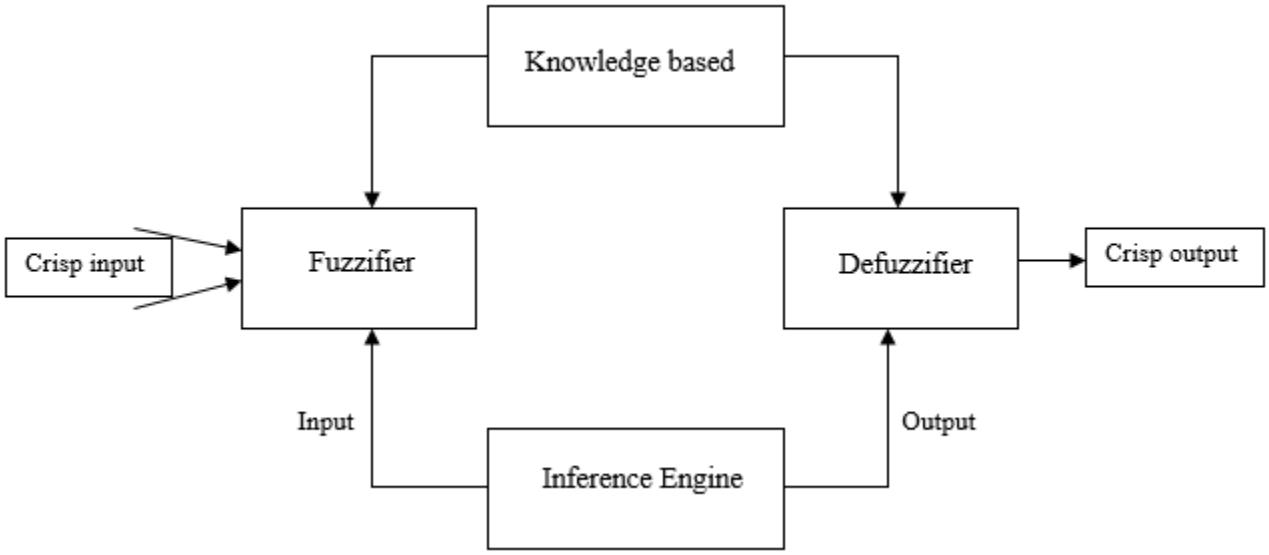

Figure 1: Basic Structure of Fuzzy Inference System

B. Exponentially Weighted Moving Average Algorithm (EWMA)

Exponentially Weighted Moving Average is same as jumping window in which window size is permanent and a new window is fired immediately after the proceeding of one ends. The difference between this scheme and the jumping window is that the number of cells accepted during one window varies from another. The EWMA mechanism uses fixed consecutive-time windows like the JW mechanism.

However, unlike the JW, the limit of the max number (window size) is unfixed. For EWMA, the big difference is that the maximum number of accepted cells in the i^{th} window (Ni) is a function that allows the mean number of cells per interval (windows), N, to be dynamically updated. An exponentially weighted sum of the number of accepted cells in preceding intervals (Xi) are significantly relate to the past amount (burstiness of cell rate), i.e., the number of accepted cells in the previous intervals [1].

The practical implementation of the mechanism EWMA is more complex than that of the previous mechanisms. The formula above may lead to a conclusion that, for different; the changing degree of Ni is different. Ni is related to the number of the real arriving cells in the previous window, and the degree of influence on Ni is different in every window as well. The closer it is to the current window, the more influence on Ni will be present, and vice versa. EWMA mechanism is derived from JW. In EWMA, the monitor window can be changed based on the cell bursty condition. However, cell bursty situation can only be reflected from the formula and cell traffic can only be shown in a certain degree.

C. Leaky Bucket (LB)

The leaky Bucket mechanism is for controlling congestion in network that ensures the sender do not cross over limits of allocated parameters once a connection is ported to network .In this ATM cell is accepted only when it can take token from token pool ,in case if pool is empty than cell is discarded. The traffic policing can be done using buffer holding cells instead of discarding cells from entering token pool which can be made effective run when congestion occurs. [9]

The disadvantage of LB is that control parameters must be set with long tolerable value in order to guarantee to work with allocated bandwidth if not done with care then incoming cells can lost.

VI. FUZZY LEAKY BUCKET ALGORITHM

Fuzzy Leaky Bucket (FLB) identifies the parameters and modifies the token rate based on the peak rate and the burst time, which characterize the channel behaviour. Due to the potential function offered by fuzzy logic, the FLB algorithm with an adaptive adjustment factor will balance the cell loss probability and the mean time delay, and also restrict the behaviour of the traffic source to the traffic contract, FLB policing mechanism show a good dynamic behaviour, a high flexibility in selectivity performance and a good capacity to meet the statistical characteristics of several B-ISDN traffic sources [4].

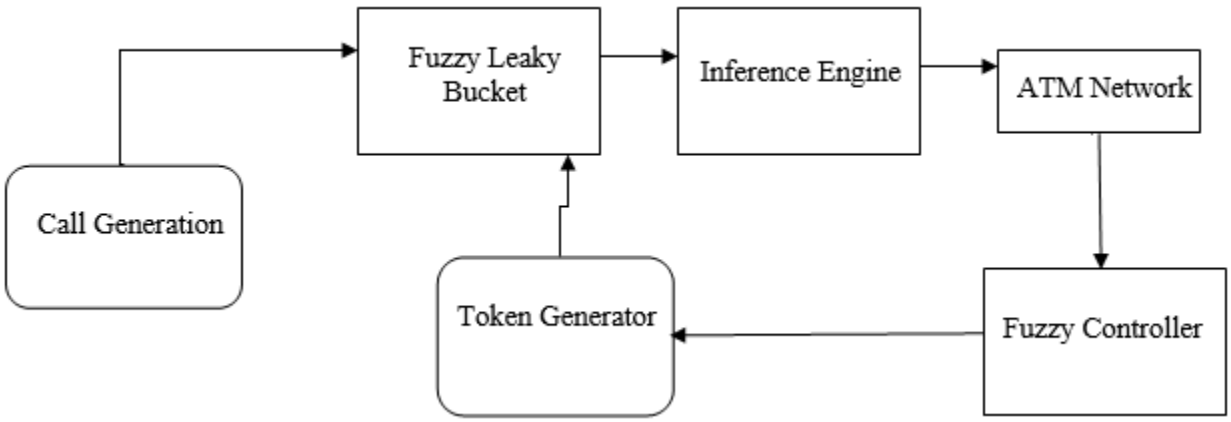

Figure 2: Fuzzy Leaky Bucket Mechanism

The performance of FLB policer is much better than those of conventional policing mechanisms, in terms of both responsiveness and selectivity. The good performance is a result of the fuzzy feedback control mechanism since the token rate is adjusted on the fuzzy feedback control. EWMA can adjust the window size depending on the formula that reflects only a certain degree of few characteristics of cells in the network. However, FLB is based on the virtual leaky bucket and fuzzy logic. The mechanism monitors the real mean cell rate which gets into the network, then uses rules based fuzzy inference engine and defuzzification to adjust the token rate dynamically. Also, the control depends on its fuzzy characteristics [2][6][7].

FLB mechanism shows a higher efficiency than others when the parameters are policed with the average cell rate for a long term. FLB is only good for less violation and quick response. What is important is to monitor and control the mean cell rate variation. The fuzzy inference engine detect the behavior of network and cells arriving at bucket, predicting the behaviour inference the decision based on rules whether to discard the cell from pool if yes then store in some cell buffer occupancy until the congestion is revealed into network [6][7].

VII. CONCLUSION

In this paper, a modified Leaky Bucket (LB) technique to manage network on fuzzy logic system is presented to deal with the congestion control problem in ATM networks. The Fuzzy Leaky Bucket using inference engine in the network architecture

network congestion can be controlled using inferences based on the inputs of control parameters that was negotiated during the network establishment.
Overall, this paper focused on ATM network fuzzy congestion control and management. The fuzzy leaky bucket (FLB) method developed in this paper is to provide better performance behaviors than other conventional technique to manage congestion.

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