SOURCE MODEL FOR VBR-VIDEO TRAFFIC OVER ATM NETWORKS

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ABSTRACT

In this paper it is attempted to assist the design process of a network by simulating a traffic pattern that would appear in a network when a video sequence file is transmitted through an ATM switch. A queuing model is created by software, which simulated an ATM switch. The functions performed by the queuing model are: receiving packets; assigning an appropriate channel to each packet; adding a random delay to each packet; arranging the incoming packets in a queue if the channel is busy. Finally, it calculates the average delay for each packet and the average length of each queue. The performance of the simulated switch is found to be more suitable for video traffic applications and improves the network performance in cost-effective manner.

1. INTRODUCTION

The design of any network used for mutual transfer of information involves a lot of procedures. One of the major procedure is to collect data regarding the traffic patterns, cell loss ratios, busy traffic and related parameters which ultimately influence the hardware and software on which an investment is finally going to be made. So, design of a network is a very important phase in the evolution of any network. Among the various parameters, the traffic pattern plays a very important role. It determines how effectively the resources are going to be used in the network. Therefore, it becomes essential for any organization to have an idea of the kind of traffic that is flowing across its network.

The various types of traffic that can flow through a network are voice, video and text. Among this video traffic is most important because multimedia applications are gaining importance these days. Organizations world over are looking forward towards a technology, which can handle multiple date types over the same physical link i.e., with the existing infrastructure and at the same time improve their network performance also in a cost-effective manner. ATM proves to a boon for such applications [1-3]

In this paper we have attempted to assist the design process of a network by simulating a video traffic pattern that would appear in a network when a video sequence is transmitted through an ATM switch. It is a very complex to simulate an ATM switch by software means, hence we have created a queuing model which simulates the function of an ATM switch. We have studied the performance of the switch by this process and finally arrived at some interesting results.

2. THE PROPOSED MODULE

The complete model used for simulation. Is shown in Figure 1. Making use of VC++ as front-end module develops the model. It gives a graphical display of the ongoing process in this switch. The model depicts the sample values and the corresponding outputs. The module consists of user-defined menu driven option. Using this option user can monitor the process and the flow of the traffic. The queuing model implemented in this paper requires a VBR video file as input. Taking into consideration the difficulties in transmitting an MPEG file as source, it is proposed to use the GBAR Model to simulate a video file.

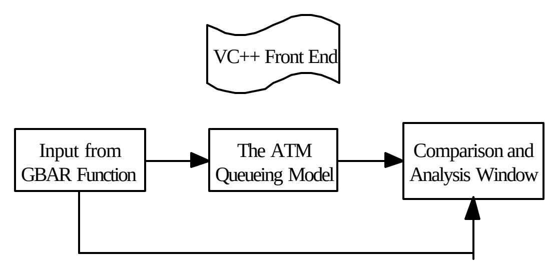


Figure1: The Simulation Model description

The GBAR program segment assumes appropriate values for the input parameters. The output, which is the packet size, is a stream of fractions in the range (0,1). For example, if the output is 0.48 it denotes a packet whose size is 0.48 times the accepted cell size. In the ATM queuing model, one input channel and three outputs channel each with a queue is proposed. The packets that arrive at random intervals of the time following exponential distribution are assigned any one of the three-output channels.

Each channel gives a random amount of delay for each packet following exponential distribution. If a packet comes to a channel, which is already occupied, then it is placed in the queue of that channel. These queues follow first out format.

The nature of traffic over ATM network and the video traffic by Beta and Gamma distributions is analyzed. The distributions are plotted. Typical outputs of GBAR source model are plotted for random values of shape parameters (β) and scale parameter (λ) at various interval of time.

3. GBAR SIMULATION

In this module we present the source model that emulates the behavior of a single VBR videoconference. Videoconference sequences generated have negative binomial marginal distributions and geometric auto correlation functions. The negative binomial distribution is the discrete analog of the gamma distribution. Since the negative binomial and gamma distributions are specif ied by two parameters and these parameters can be easily estimated from the mean and variance of the number of cells per frame, only those two moments and the correlation coefficient mentioned above are needed to specify a model of VBR teleconference traffic, the geometrically decaying auto correlation function and the negative binomial (or Gamma) marginal distributions to produce a simple model based on the three parameters that describe these features. Two inherent features of this process are that the marginal distribution is gamma and the autocorrelation function is geometric.

3.1 Model Definition

Toward defining the GBAR model, let G_a (β, λ) denote a random variable with gamma distribution with shape parameter β and scale parameter λ, that is the density function is

$$f_g(t) = l(l_t)^b * e^{-(l_t)} / \Gamma(b+1), \quad t > 0$$

Similarly, let B_e (p, q) denote a random variable with a beta distribution with parameters p and q, that is with density function

$$f_b(t) = \Gamma(p+q) * t^{(p-1)}(1-t)^{(q-1)} / \Gamma(p+1)\Gamma(q+1), \quad 0 < t < 1$$

where p and q are both larger than –1. That GBAR model is based on two well-known results: the sum of independent G_a (α, λ) and G_a (β, λ) random variables is a G_a ($\alpha+\beta,\lambda$) Random variable and the product of independent B_e ($\alpha,\beta-\alpha$) and G_a (β,λ) random variables is a G_a (α, λ) random variable. Thus if X_{n-1} is G_a (β,λ), An is B_e ($\alpha,\beta-\alpha$), and B_n is G_a ($\beta-\alpha$, λ), and these three are mutually independent, then

$$X_n = A_n X_{n-1} + B_n$$

Defines a stationary stochastic process (X_n) with a marginal G_a (β, λ) distribution.
Autocorrelation of this process is given by
$r(k) = (\alpha/\beta)^k$, k= 0,1,2,….

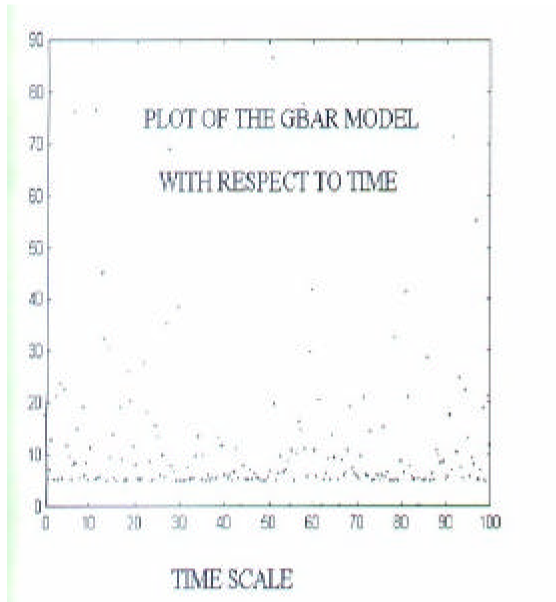


Figure 2. Plot of the GBAR Model Vs Time

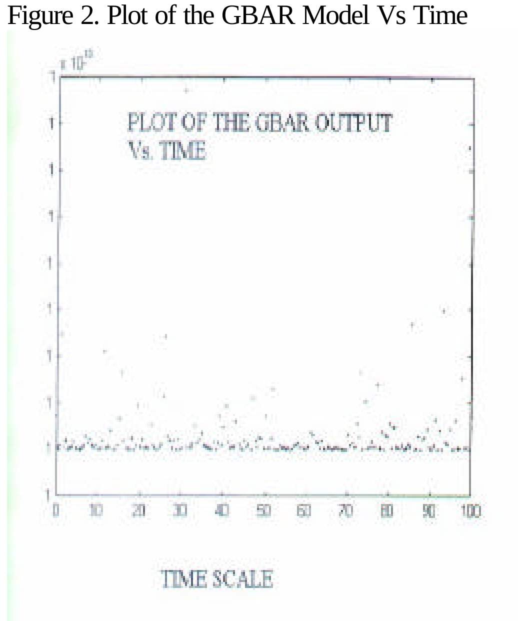


Figure 3. Plot of the GBAR output Vs time

The process defined by (1) is called the GBAR process. The G and B denote gamma and beta respectively and AR stands for autoregressive. Since the current value is determined by only one previous value, this is a autoregressive process of order 1. Figure 2, 3, 4and 5 shows the typical outputs of GBAR source model that are plotted for random values of shape parameters (β) and scale parameter (λ) at various interval of time.

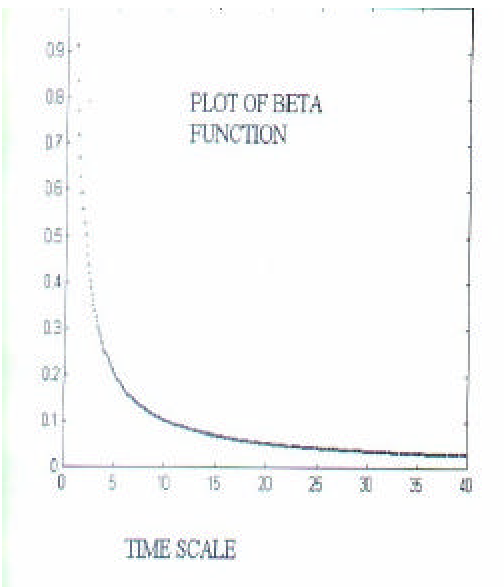


Figure 4. Plot of Beta Function Vs Time

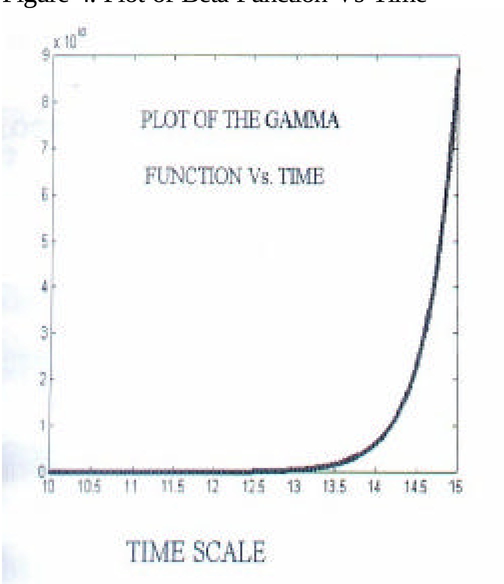


Figure 5. Plot of Gamma Function Vs Time

4. QUEUING MODELS

Queuing is a method using which the working of a processor is made more efficient. Inputs to the processor arrive randomly, and the processor takes the same time to process identical inputs. Using queuing theory the efficiency with which a processor is used can be studied and corrective measures can be thought of. A computer program that goes about this task of queuing is termed a queuing model. The inputs to the queuing model are:

i. Queue lengths
ii. Percent utilization of the service facility.
iii. Total service time.

The outputs from a queuing model are:

i. The probability of large nos. of arrivals in the processor at a given moment.
ii. The expected time a customer/input would spend in the system.
iii. The probability that the processor will be idle.

The most important characteristics of a queue are:

i. Percentage idle time and percentage utilization.
ii. Expected number of inputs to the system.
iii. Expected number of inputs waiting in the queue.
iv. Expected time each input spends in the system.
v. Expected waiting time for each input.

A queuing model may not function well if:

i. The processor speed is small compared to the speed at which inputs arrive.
ii. The no. of stored inputs in a qeue is less than the number of inputs waiting.

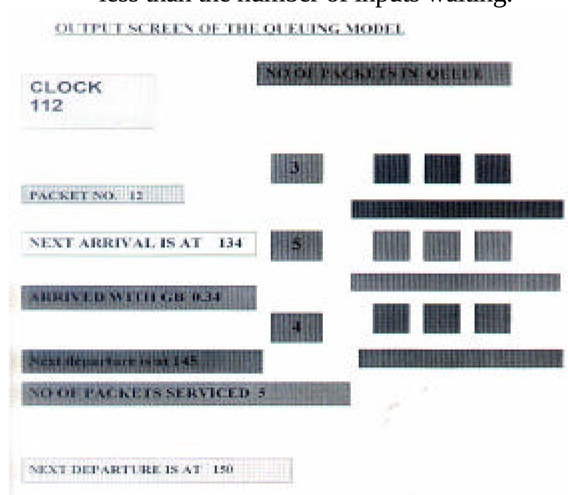


Figure 6. Shows the Output screen of the Queuing Model

The capacity of the queue can be increased and fast processor can be selected. Multi-processing can be increased and fast processor can be selected. Multi-processing can be used to cover-up for slow processing speeds. Figure 6 and 7 shows the output screen of the Queuing model and the packet services through each channel respectively.

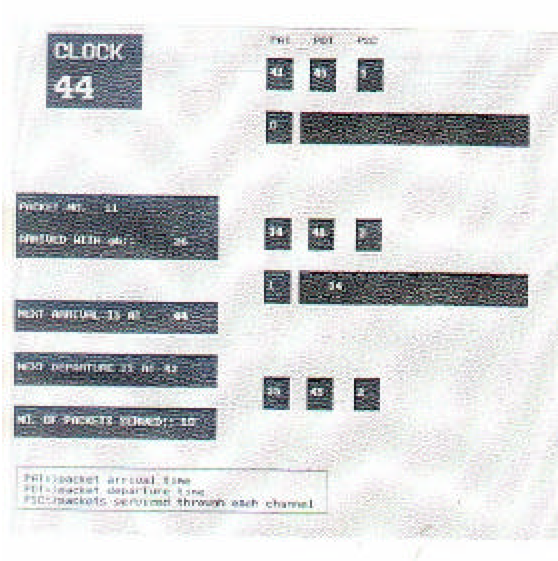


Figure 7. Shows the packet arrival time, departure time and services through each channel

4.1 Single Server Queuing Model

In this model we have one input channel and one output channel. The Packets arrive at random intervals of time with user defined mean packet inter-arrival time. The service time for each packet is also a random number with user defined mean packet service time. These two random numbers follow exponential distribution. All the packets that come in the input channel are placed in the output channel. If any packet arrives before the departure of the previously arrived packets, it is placed at the end of the queue. This queue operates in FIFO (first in first out) format. Whenever a packet is serviced, the elements in the queue are forwarded. Figure 8 and 9 shows the Number of packets serviced / arrived Vs Normal and ATM Queue Models respectively.

4.2 Fair Queuing Model

In this model we have three output channels for a single input channel. Here again the packets arrive at random intervals of time following the exponential distribution with the user input mean packet inter-arrival time. The service time for each packet in each output channel is also a random number following the exponential distribution with the user input mean packet service time for each channel. As and when the packet arrives it is assigned to any one of the output channel by GBAR function. The status of the selected is examined. If it is free, the packet is directly placed in the channel and departure time for that particular packet in that particular channel is calculated. Till this departure time, the channel is said to be in busy state. If another packet comes to the same channel before the departure of the previously arrived packet, it is placed in that channel's queue, which follows FIFO. Each time the packet is taken from the queue the delay for each packet in the queue is calculated. After serving the number of packets defined by the user, the program gives the report. The report consists of the average delay for packets in each queue and the average length of each queue. Figure 10. Shows the output of the queuing model for simulated Fair Queuing model ATM switch

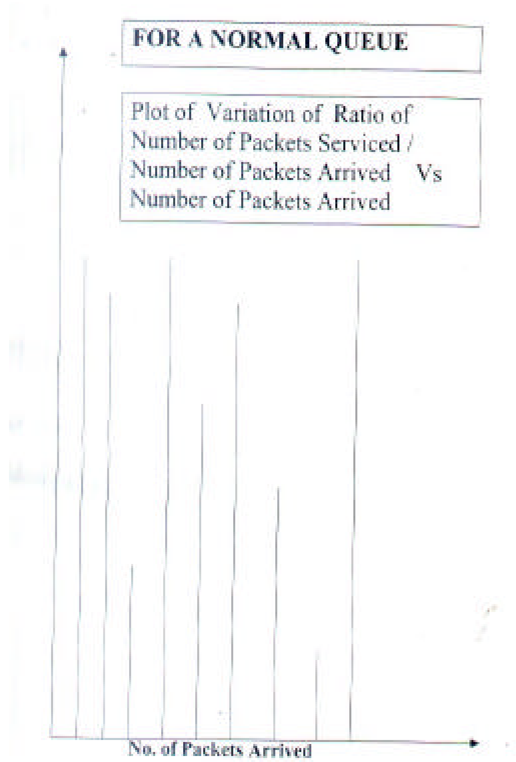


Figure 8 shows the No. of packets serviced Vs Normal Queue

4.3 SIMULATION RESULTS AND COMPARISON

Average delay of packets in the queue is much reduced by providing three separate output channels and queues. Average queue length is also reduced, thereby reducing the buffer required. Provisions can be made for giving the priorities for the arriving packets. In the process of simulation first the various values of the frame size by using GBAR Program is obtained.

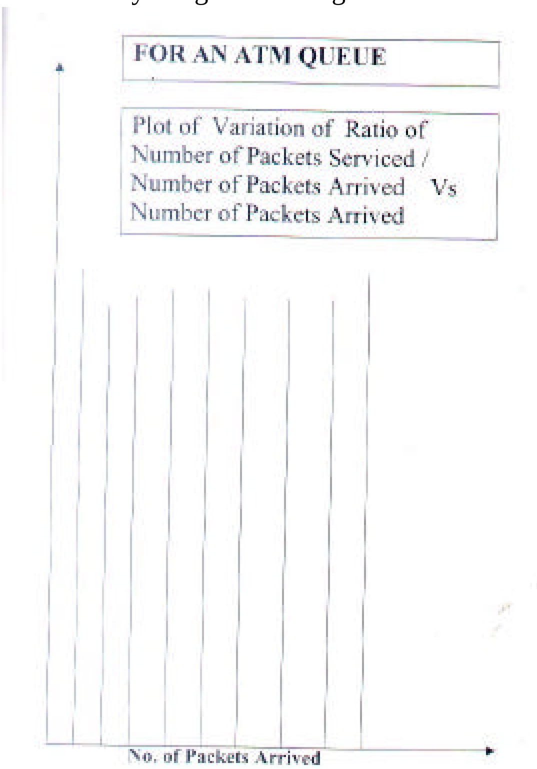
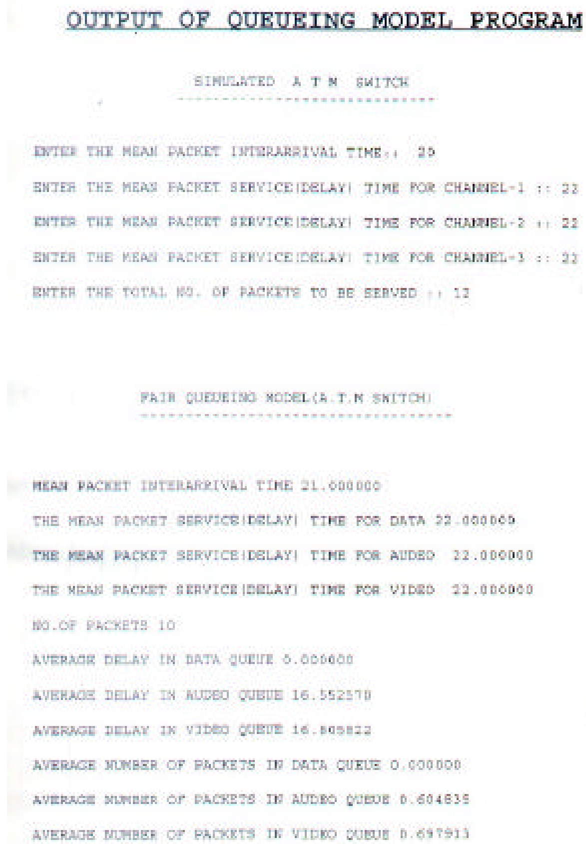


Figure 9 shows the No. of packets serviced Vs ATM Queue.

The output of values of the GBAR program had a random nature and depicted the properties of videoconference traffic very closely. Hence, the correctness of the given model was verified. It is also found that the values of the stochastic process defined lay between 0 and 1. Therefore, it is concluded that the GBAR source model is an acceptable source for representing and modeling data of the VBR nature. The values obtained from GBAR model is fed to the Queuing model. Various graphs were plotted to the arrival time and departure time of the packets of each category namely voice, video and data. From this average value of the delay and average processing time in each loop is calculated.

5. CONCLUSION

In this paper attempt to assist the design process of a network by simulating a video traffic pattern that would appear in a network when a video sequence is transmitted through an ATM switch is proposed. It is a very complex to simulate an ATM switch by software means, hence a queuing model is created which simulates the function of an ATM switch. The performance of the simulated switch is found to be more suitable for video traffic of multimedia applications and it can handle multiple data types over the same link and improves the network performance in a cost-effective manner.



OUTPUT OF QUEUEING MODEL PROGRAM

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SIMULATED A T M SWITCH
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ENTER THE MEAN PACKET INTERARRIVAL TIME:: 25
ENTER THE MEAN PACKET SERVICE(DELAY) TIME FOR CHANNEL-1 :: 22
ENTER THE MEAN PACKET SERVICE(DELAY) TIME FOR CHANNEL-2 :: 22
ENTER THE MEAN PACKET SERVICE(DELAY) TIME FOR CHANNEL-3 :: 22
ENTER THE TOTAL NO. OF PACKETS TO BE SERVED :: 12


FAIR QUEUEING MODEL(A.T.M SWITCH)
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MEAN PACKET INTERARRIVAL TIME 21.000000
THE MEAN PACKET SERVICE(DELAY) TIME FOR DATA 22.000000
THE MEAN PACKET SERVICE(DELAY) TIME FOR AUDEO  22.000000
THE MEAN PACKET SERVICE(DELAY) TIME FOR VIDEO  22.000000
NO.OF PACKETS 10
AVERAGE DELAY IN DATA QUEUE 0.000000
AVERAGE DELAY IN AUDEO QUEUE 16.552570
AVERAGE DELAY IN VIDEO QUEUE 16.865822
AVERAGE NUMBER OF PACKETS IN DATA QUEUE 0.000000
AVERAGE NUMBER OF PACKETS IN AUDEO QUEUE 0.604835
AVERAGE NUMBER OF PACKETS IN VIDEO QUEUE 0.697913
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Figure 10 shows the Output of the Queuing model

REFERENCE

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