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Performance Evaluation of ATM Networks with Round Robin and Weighted Round Robin Algorithm

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***Abstract*– The Asynchronous Transfer Mode (ATM) Network is believed to be capable of supporting various services with drastically different traffic characteristics and Quality of Service (QoS) requirements. The deployment of integrated services with a broad range of burstiness characteristics and their integration through statistical multiplexing has focused a great deal of attention on the impact of priority scheduling on ATM networks. Provision of QoS guarantees is an important and challenging issue in the design of ATM networks. This paper presents a simulation study devoted to comparing the performance of two different classes of service viz, Available Bit Rate (ABR) and Variable Bit Rate (VBR) services for a range of priority scheduling Algorithms with bursty and non bursty traffic. The two scheduling algorithms simulated and analyzed in this work are Round Robin (RR) and Weighted Round Robin (WRR). The algorithm performance is measured in terms of three QoS parameters namely Cell Blocking Ratio, Cell Delay and Throughput. The results of our performance study shows that the WRR scheme has better performance in comparison to the RR scheme.**

***Index Terms*– ATM Network, Quality of Service, Round Robin, Weighted Round Robin, Cell Blocking Ratio, Cell Delay and Throughput**

I. INTRODUCTION

AN important development in high-speed networking area is the emergence of Broadband Integrated Services Digital Network (B-ISDN) and Asynchronous Transfer Mode (ATM). ATM is designed to support different classes of multimedia traffic with different bit rates and variety of Quality of Service (QoS) requirements [1]. The ATM technique is connection oriented, where the source initially declares a set of traffic parameters to describe its traffic and generates its traffic according to the declared parameters [2]. Once a call is accepted, the network agrees to guarantee the required QoS. The QoS of the network is specified in terms of End-to-End Cell Delay and Cell Loss Ratio (CLR) in the End-to-End Cell Delay and Cell Loss Ratio (CLR) in the ATM multiplex network [3]. ATM is thus accepted as the ultimate solution for the ISDN, due to its capability of having faithful connection, with a need for flexible network and the progress in technology and system concepts. In addition to high speed, ATM networks can handle a set of traffic of heterogeneous nature and QoS requirements [4]. The only limitation is the links total channel capacity in accepting the arriving calls wherein the call must wait at the entry of the node until it passes the bandwidth availability check [5].

There are following most reported parameters in the literature that characterize the performance of ATM network:

1) *Throughput:* This can be defined as the rate at which the cells depart the switch measured in the number of cell departures per unit time. It mainly depends on the technology and dimensioning of the ATM switch. By choosing a proper topology of the switch, the throughput can be increased [6].
2) *Connection Blocking Probability*: Since ATM is connection oriented, there will be a logical connection between the logical inlet and outlet of a switch during the connection set up phase. The connection blocking probability [7] is defined as the probability when there are not enough resources between inlet and outlet of the switch to assure a good QoS for all existing as well as new connections.
3) *Cell Loss Probability*: In ATM switches, when more number of cells than a queue can accommodate in the switch will compete for this queue, cells will be lost. The Cell Loss Probability [3], [8] has to be kept within limits to ensure high reliability of the switch. In internally non-blocking switches, cells can only be lost at their inlets/outlets. There is also a possibility that, ATM cells may internally be misrouted and they reach erroneously on another logical channel. This is called Cell Insertion Probability.
4) *Switching Delay*: The time taken by an ATM cell to move into the switch. The typical values of switching delay range between 10 and 1000microseconds. This delay has two parts. i). Fixed switching delay which is due to internal cell transfer through the hardware, ii). Queuing delay, this occurs when the cells get queued up in the buffer of the switch to avoid the cell loss.

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5) *Jitter on the Delay*: This is also called as Cell Delay Variation (CDV) and this is denoted as the probability that the delay of the switch will exceed a certain value [9], [10].

The objective of this paper is to develop an ATM network model and compare the model for two different priority schemes viz., Round Robin and Weighted Round Robin for Cell Blocking, Cell Delay and Throughput QoS parameters. Our proposed network is based on the ATM LAN model [11], which is extended to guarantee QoS.

The rest of the paper is structured as: the related LAN model is presented in the second section. We describe the considered system and its model in section III. In section IV we introduced the requirements for simulation the proposed model. Section V shows the results of the proposed system using OPNET. Finally, in section VI we conclude the paper.

II. ATM LAN MODEL

Figure 1 shows a network model of ATM LAN based on [11], which is used as the reference model in our study. The model is a client-server model connected through a single ATM switch. Independent client computers are connected to the ATM switch which communicates with a single server through a shared output link of the switch. The output link uses OC-3 with a transmission capacity of 150Mbps.

An ATM output buffer on per-connection basis is allocated during the connection establishment. The buffer of the accepted connection is emptied by the output port using either Round Robin Scheduler or Weighted Round Robin Scheduler. If homogenous traffic is used, the output buffer is partitioned into 'n' smaller buffers. The Round Robin Scheduler services all the 'n' buffers equally. For a heterogeneous traffic source, the output buffer is allocated to each connection based on the connection's characteristics such as traffic parameters and QoS requirement, weighted Round Robin Scheduler which access the buffers based on the weights for each connections is used.

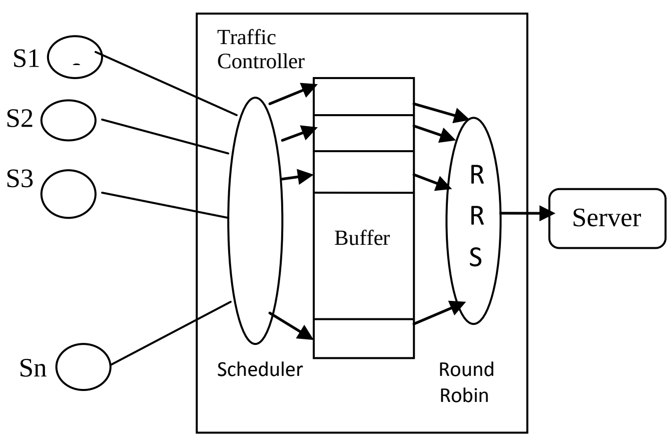


Figure1: ATM LAN Model

III. SYSTEM AND MODEL DESCRIPTION

OPtimized Network Engineering Tools (OPNET) [9] provides a comprehensive development environment for the specification, simulation and performance analysis of communication networks. It is capable of simulating large communications networks with detailed protocol modeling and performance analysis. The OPNET system consists of a set of well-behaved application programs, object code libraries, and data files. OPNET provides four tools called editors to develop a representation of a system being modeled. These editors, such as the network, node, process and parameter editors are organized in a hierarchical fashion, which supports the concept of model level reuse. Models developed at one layer can be used by another model at a higher layer.

The OPNET components interact with the operating system and the user in a predictable manner that is common to other programs [12]. The predefined ideal traffic generator module in OPNET, which uses a probability distribution to control the inter-arrival time and packet length, is only sufficient to model simple traffic source, such as the Poisson process. However, in many cases it is necessary to create a process model to represent more complex traffic types [10].

The Figure 2 shows an ATM network constructed by OPNET simulator. The proposed simulated model [13] consists of 6 ATM switches (Four Local ATM switches i.e., Local SW1, Local SW2, Local SW3, Local SW4 and two Central switches i.e., Central SW1 and Central SW2), server and clients. The model also has seven voice stations namely Voice Stn1 to Voice Stn7, E-mail and FTP are supported by four data stations and three data servers. We use DS1 link to connect the network for supporting a maximum of 155Mbps traffic. Two types of traffic components viz., voice and data are generated, using rt-VBR for voice and ABR for data traffic [2], [14].

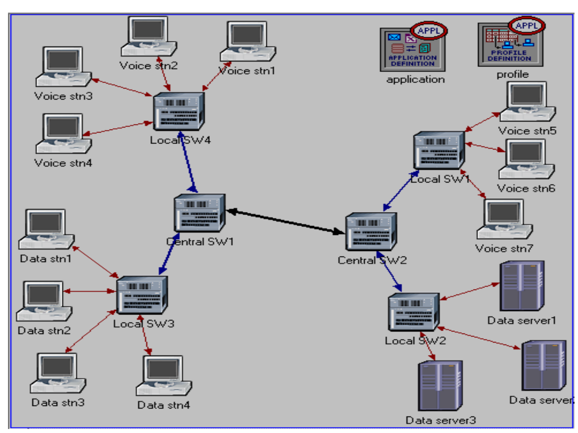


Figure 2: ATM Network

A. ATM QoS Priority Schemes

1) *Round Robin*: Round Robin scheme [15] treats each queue equally by serving each queue in turn. For N number of sources there are N number of buffer queues which are used to store the arriving packets. The length of

each queue may differ from each other since the traffic is generated from independent sources that may behave differently. Round Robin scheme scans each of the queues in a cyclic manner looking for non-empty queue to remove a packet from it. Thus each queue will be served again after the completion of one full cycle, where in the period to complete one full cycle may differ depending on the number of non-empty queues in each cycle. Hence, the larger the number of non-empty queues, the longer the time a packet has to wait in the queue in order to be removed.

2) *Weighted Round Robin*: The Weighted Round Robin scheduling mechanism [16] multiplexes cells from every Virtual Channel Connection (VCC) with different priority levels. It is an extension of Round Robin scheduling based on the static weight. Each VCC link can transmit one cell in its turn when there are cells to transmit. Each class queue has a counter that specifies the number of cells that can be sent. The counter value is initially equalized to the weight value assigned to that class. Cells from various classes are sent in a cycle from the head of these class queues while counter values are greater than zero. After sending a cell, the counter value of the class is reduced by one. When the counter value or the queue length has reached zero in all classes, all counters are reset to their weight values.

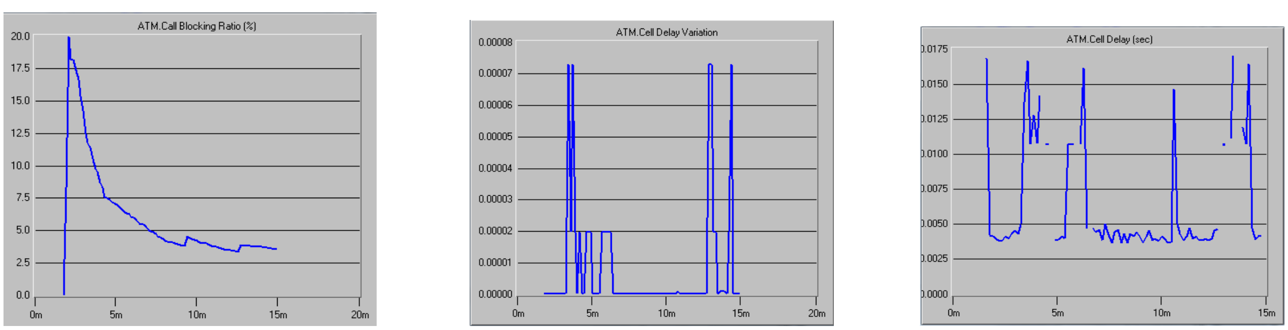
IV. SIMULATION PARAMETERS

To evaluate the performance of our proposed ATM network, we employed the OPNET simulator. The assumptions for our simulation model are as follows:

- The cell size of VBR service parameters is 100000.
- The cell size of ABR service parameters is 100000.
- Maximum Available Bandwidth is 155Mbps with 100% available.
- The Buffer Size is 5MB.
- Network performances are plotted as a function of ATM Cell Blocking Ratio, ATM Cell Delay and ATM Cell Delay Variation along with traffic sent/received in (packets /sec).
- In order to represent different types of call requests, three types of traffic types are assumed.
- The voice traffic is assumed with Exponential Distribution with mean outcome of 100.
- FTP traffic is assumed with Poisson's distribution with mean outcome of 10 and duration of the traffic is Poisson with an outcome of 20.
- The data traffic involving E-mail is Poisson's distributed with a mean outcome of 10.
- The Queuing parameters for VBR are PCR with 1Mbps, SCR with 0.5Mbps and MBS with 10 Cells.
- The Queuing parameters for ABR are PCR with 1Mbps and MCR with 0Mbps.
- The priority queuing schemes used are Round Robin and Weighted Round robin.

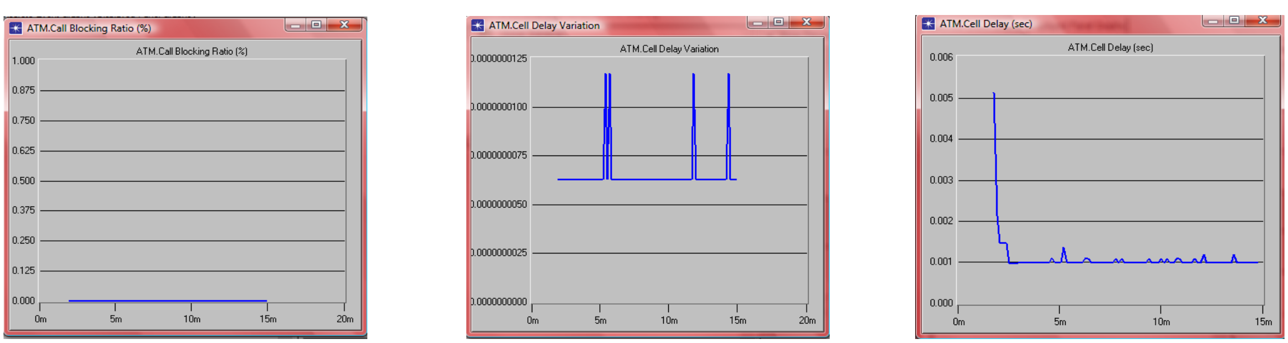
V. SIMULATION RESULTS

In our simulation, we have utilized rt-VBR for voice with Exponential distribution and ABR for E-mail and FTP with Poisson's distribution. Figure 3(a), 3(b), 3(c) and Figure 4(a), 4(b), 4(c) show the compared results, when the ATM network is simulated using RR and WRR queuing schemes.



(a) (b) (c)

Figure 3: (a) ATM Cell Blocking, (b) ATM Cell Delay Variation and (C) ATM Cell Delay using Round Robin Queuing Scheme



(a) (b) (c)

Figure 4: (a) ATM Cell Blocking, (b) ATM Cell Delay Variation and (c) ATM Cell Delay using Weighted Round Robin Queuing Scheme

The following two tables are the results obtained for the proposed model using two different queuing schemes.

Table 1: Statistics using Round Robin Queuing Scheme

Statistic	Average	Maximum
ATM Cell Blocking Ratio (%)	6.063491	20
ATM Cell Delay (sec)	0.00370	0.00755
ATM Throughput (bits/sec)	53826.33	204085.3

Table 2: Statistics using Weighted Round Robin Queuing Scheme

Statistic	Average	Maximum
ATM Cell Blocking Ratio (%)	0	0
ATM Cell Delay (sec)	0.001074	0.00514
ATM Throughput (bits/sec)	184910.2	236864

VI. CONCLUSIONS

In this paper we have presented two most often used scheduling scheme with their implementation. One of the main goals of this study is to provide some framework for the source modeling using OPNET environment. We have evaluated the algorithm performance through simulation using OPNET simulator. Our simulation results show that the WRR algorithm minimizes the Cell Delay, reduces the Call Blocking Ratio and increases the Throughput of the network. Also Comparing the results obtained in this paper with [15], based on the previous papers we conclude that the average Cell Delay for the ATM network we simulated has been further reduced for the offered traffic load using Round Robin method. Also comparing the results obtained for the Weighted Round Robin with [16] we conclude that Cell Delay for the ATM network has been reduced significantly.

REFERENCES

[1]. J. Bae and T. Suda, "Survey of Traffic Control Schemes and Protocols in ATM Networks", Proceedings of the IEEE, Vol: 79, No: 2, pp: 170-189 (1991)

[2]. Xin Li,Yucheng Zhou, Georgi M.Dimirovski and Yuanwei Jing, "Simulated Annealing Q-Learning Algorithm for ABR Traffic Control of ATM Networks", American Control Conference ,pp:4462-4467 (2008)

[3]. H.El-Madbouly and M.Nassef, "Estimation of Cell Loss Ratio and Cell Delay for ATM Networks using Novel Genetic Algorithm Approach",6th International Workshop on System on-Chip for Real Time Applications,IEEE,pp:70-74 (2006)

[4]. ATM Forum White papers, ATM Service Categories, The Benefits to the User (1996)

[5]. H.Abu Zaied, "A Generic Connection Admission Control in ATM", 8-th International Conference, Laser and Fiber-Optical Networks Modeling (LFNM), pp: 29-31 (2006)

[6]. Karen Langona, Tereza Cristina M.de B.Carvalho and Christiane Mane Schweitze T, " Quality of Service Control for rt-VBR Connections in ATM Networks", Joint 4th IEEE International Conference on ATM and High Speed Intelligent Internet Symposium , pp:108-112 (2001)

[7]. Gupta, B.K., Lal, M., and Sharma, S.C., "Evaluation of Cell Loss Probability of Non-Blocking Multiple Input ATM Switches" Indian Journal of Information Science and Technology, Vol: 1, No: 1, pp: 33-42, INDIA (2005)

[8]. Gupta, B.K., Sharma, S.C., and Lal, M., "Evaluation of Cell Loss Probability of Shared-Memory ATM Switch", Journal of the Computer Society of India (CSI), Vol: 30, No: 4, pp: 15-20, INDIA (2000)

[9]. OPNET Modeling Manual Vol:1, OPNET Version 3.5, MIL 3 Inc., (1997)

[10]. Opnet Technologies Inc.: Opnet Modeler, Version 7.0B, Manual, (2000)

[11]. Y.Cho and A.Leon-Garcia , "Performance of Burst level Bandwidth Reservation in ATM LANS", IEEE INFOCOM'94, pp.812-820 (1994)

[12]. Jason Schreiber, Mehradad Khodai Joopari, M.A.Rashid, "Performance of Voice and Video Conferencing over ATM and Gigabit Ethernet Backbone Networks", Res.Lett.Inf.Math.Sci., Vol:7,pp:19-27 (2005)

[13]. Sethi.J and Gupta.B.K., "Performance Evaluation of ATM Network with VBR and ABR Services: A Simulation Study", in Proceeding of 4th IEEE International Conference on Advanced Computing and Communication Technologies (ICACCT2010) (2010)

[14]. Kalyanaraman.S, Jain.R, Fahmy.S, Goyal.R and Vandalore.B, "The ERICA Switch Algorithm for ABR Traffic Management in ATM Networks", IEEE/ACM Transactions on Networking,Vol:8,No:1,pp:87-98 (2000)

[15]. M.M.N.Aldeer, "Performance Comparison of Packet-Level Multiplexing Algorithms with Bursty Traffic", Journal of Engineering Science and Technology Review, Vol: 3, No: 1, pp: 46-52 (2010)

[16]. Ji-Young Kwak, Ji-seung Nam and Doo-Hyun Kim, "A Modified Dynamic Weighted Round Robin Cell Scheduling Algorithm", Electronics and Telecommunication Research Institute (ETRI) Journal, Vol:24, No:5, pp:360-372 (2002).