Volume 2, No. 6, Nov-Dec 2011
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
RESEARCH PAPER
Available Online at www.ijarcs.info

An Estimation of Traffic Parameters for VBR and ABR Services in ATM Networks

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Abstract: Asynchronous Transfer Mode (ATM) was selected by the telecommunication industry as the technology to deliver the Broadband Integrated Services Digital Network (B-ISDN) carrier service. ATM is designed to handle different kinds of communication traffic (voice, audio, video and data) in an integrated manner. It is particularly important during periods of congestion that traffic flows with different requirements be treated differently and provided a different Quality of Service (QoS).

We have worked on traffic parameters estimation from VBR and ABR source modeling in ATM Networks using Weighted Round Robin Scheme. A user can use the Weighted Round Robin scheme to determine the values on traffic parameters in order to minimize the delay in sec. Some of the QoS parameters like Voice Packet End-to-End Delay, Voice Packet Delay Variation, FTP Upload and Download response and E-mail Upload and Download response time are studied and evaluated for bursty and non-bursty traffic using VBR and ABR Service Categories in this paper.

Keywords: ATM Network, Quality of Service, OPNET Simulator, Voice Packet End-to-End Delay, Voice Packet Delay Variation, Download and Upload response time.

I. INTRODUCTION

With the convergence of telecommunication and computer industries, computer networking is adopting a new paradigm called Asynchronous Transfer Mode (ATM). ATM was selected by the telecommunication industry as the technology to deliver the Broadband Integrated Services Digital Network (B-ISDN) carrier service. ATM is designed to handle different kinds of communication traffic (voice, audio, video and data) in an integrated manner [1]. The international standards for ATM networks have been formulated by the ATM Forum and ITU-T [9].

The ATM Forum specifies that ATM connections belong to ATM service categories that support certain Quality of Service (QoS) requirements [5]. Based on the traffic parameters and the QoS parameters, the ATM Forum specifies five service categories for the transport of ATM cells. The Constant Bit Rate (CBR) service category is defined for traffic that requires a constant amount of bandwidth, specified by a Peak Cell Rate (PCR), to be continuously available. The real time Variable Bit Rate (rt-VBR) class is characterized by PCR (and its associated tolerance), Sustained Cell Rate (SCR) and Maximum Burst Size (MBS) in cells that controls the bursty nature of VBR traffic [6, 12]. The Available Bit Rate (ABR) service category is specified by a PCR and Minimum Cell Rate (MCR), which is guaranteed by the network [7]. Unspecified Bit Rate (UBR) class is intended for best effort applications, and this category does not support any service guarantees.

The QoS parameters are negotiated by the source with the network, and are used to define the expected QoS provided by the network. For each service category, the network guarantees the negotiated QoS parameters if the end system complies with the negotiated traffic contract [5]. The ATM Forum defines six QoS parameters that specify the network performance objectives for the connection – Cell Loss Ratio (CLR), Cell Delay Variation (peak-to-peak CDV), Cell Transfer Delay (max CTD or mean CTD), Cell Error Ratio (CER), Severely Errored Cell Block Ratio (SECBR) and Cell Misinsertion Rate (CMR). Of these, the CDV, CTD and the CLR parameters are negotiated during connection setup, while the others are specified by the network [10].

ATM network shares several services and connections each with a different characterization. The required bit rate may vary from a few kbps to several Mbps range. Some services have stronger real-time constraints than others do. Some services tolerate a few cell losses, others do not. Within such a network, all connections may impact on each other.

Thus, ATM is used as the technology to ensure high-speed data transfer in core network switching elements. In these environments, low latency and very high QoS is required to handle linear audio and video streams.

II. QUALITY OF SERVICE

The definition of QoS given by International Telecommunication Union-Telecommunication (ITU-T) in its recommendation I.350 (ITU, 1988 and 1993) says that, "QoS is the collective effect of service performances that determine the degree of satisfaction of a user of the specific service". In general, QoS is the capability of a network to provide better service to selected network traffic over various technologies, including frame relay, ATM etc [8]. The primary goal of QoS is to provide priority, dedicated bandwidth, controlled jitter and latency (required by some real-time and interactive traffic), and improved loss characteristics [9].

Some of the parameters that are used to quantify the connections' QoS are End-to-End Delay, Cell Loss Probability and Bit Error Rate [13]. Cell Loss and Cell Delay in ATM nodes are the parameters that significantly contribute in the degradation of ATM network performance at cell level [7]. It is noted that the control of each of these parameters has a special impact on the other parameter, for example, voice traffic can tolerate cell loss to certain extent but is very sensitive to cell delay, while the file transfer application can allow for some cell delay but not the cell loss [10].

A. Need for QoS:

It is particularly important during periods of congestion that traffic flows with different requirements be treated differently and provided a different QoS [2]. QoS enables to provide better service to certain flows. This is done by either raising the priority of a flow or limiting the priority of another flow [15].

III. QOS PRIORITY SCHEME

Weighted Round Robin**:** The Weighted Round Robin scheduling mechanism 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 [14]. 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. NETWORK SIMULATION MODEL

OPtimized Network Engineering Tools (OPNET) [3, 4, 11] is a powerful comprehensive engineering system that can be used to model communication systems and predict network performance. It is capable of simulating large communication networks with detailed protocol modeling and performance analysis. Its accuracy and ease-of-use make it a valuable tool for network planners and administrators. OPNET supports modeling efforts with a system of interrelated programs, model libraries, and data files. The key features of this program include object orientation, graphical specification, automated model creation, an extensive model suite, integrated analysis tools, and animation support. OPNET provides an opportunity for developers and researchers of communication networks to develop a feel for what is happening in complex network environments by changing parameters and seeing the corresponding impact through performance statistics and animations.

The following Fig.1 is the ATM network we constructed by OPNET Simulator [4]. This proposed model we are simulating consists of total number of six ATM Switches (four Local ATM Switches i.e., Local Switch_1, Local Switch_2, Local Switch_3, Local Switch_4 and two Central SW_1and Central SW_2), server and clients. In our model there are seven Voice Stations namely Voice Stn 1 to Voice Stn 7, E-mail and FTP are supported by data stations and data servers. We use DS1 link to connect the network for supporting maximum of 155Mbps traffic [11].

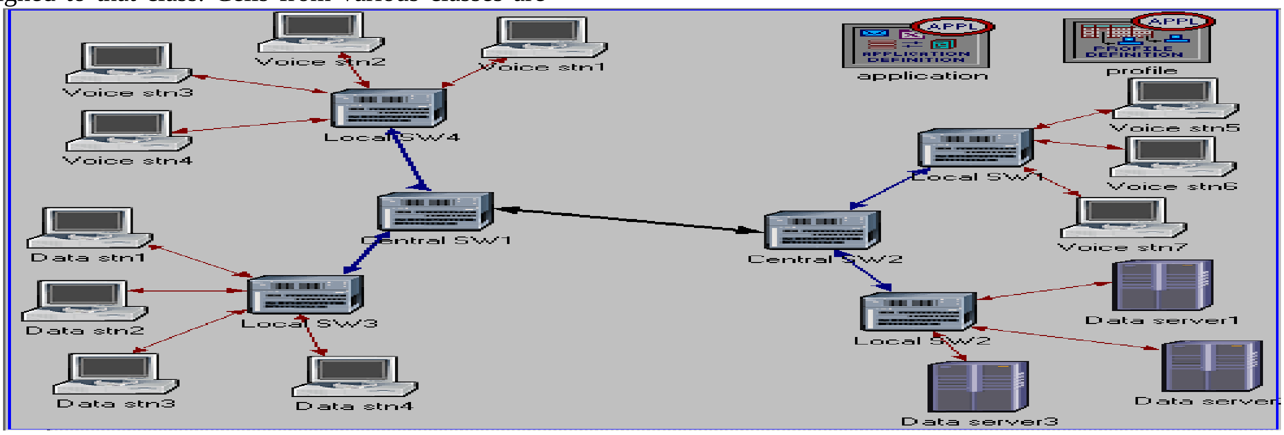

Figure.1 The ATM Network

The two traffic components: voice and data are generated; we use rt-VBR for voice and ABR for data traffic.

A. Network Modeling:

After the topologies have been put into place, they all needed to be linked together with their respective link types. This included DS1 using ATM_adv links from the Voice Stations to Local Switch and from Data Servers to Local Switch and from Data Stations to Local Switch and also between the Local Switches to the Central Switches. By making use of the Application Configuration attributes, we defined a set of applications for running on the backbone networks. Instead of choosing and configuring each application individually, we chose all the applications to be supported by making use of the profile definition attributes.

We are able to choose a number of profile users in the network. Each different profile supports a number of

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different applications. In the simulation environment, we have supported three profiles, namely: Voice user, FTP user and E-mail user.

V. 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 [11]

a. The Cell Size of VBR and ABR Service Parameters are 10000.
b. Maximum Available Bandwidth is 155Mbps with 100% available.
c. The Buffer Size is 512KB.
d. Network performances are plotted as a function of traffic Sent/Received (Packets /sec).
e. In order to represent different types of call requests, three types of traffic types are assumed.
f. The Voice and E-mail traffic's is assumed with Uniform Distribution with maximum outcome of 10 and minimum outcome of 5.
g. The data traffic involving FTP is Exponentially Distributed with a mean outcome of 5.
h. The Queuing parameters assumed are PCR with 10Mbps, SCR with 0.5Mbps and MBS with 10 Cells.
i. The Queuing scheme used is Weighted Round Robin [14].

A. Simulation Results:

In our simulation, we have utilized rt-VBR for Voice with uniform distribution and ABR for FTP and E-mail with exponential distribution and uniform distribution respectively. Fig.2 and Fig.3 shows the Voice Packet End-to-End Delay (sec) and Voice Packet Delay Variation. Fig.4 and Fig.5 shows the FTP Download response time and Upload response time in sec. Fig.6 and Fig.7 shows the E-mail Download response time and Upload response time in sec.

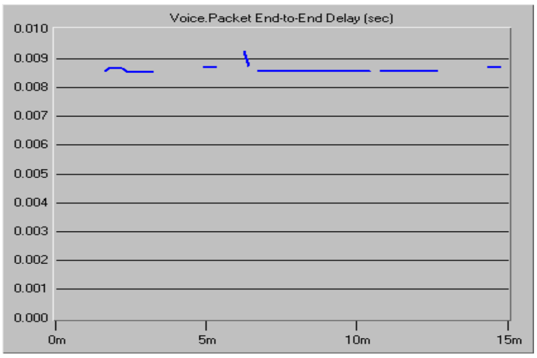

Figure. 2 Voice Packet End-to-End Delay (sec)

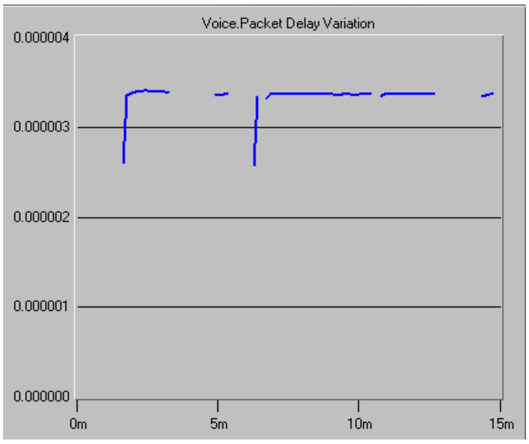

Figure. 3 Voice Packet Delay Variation

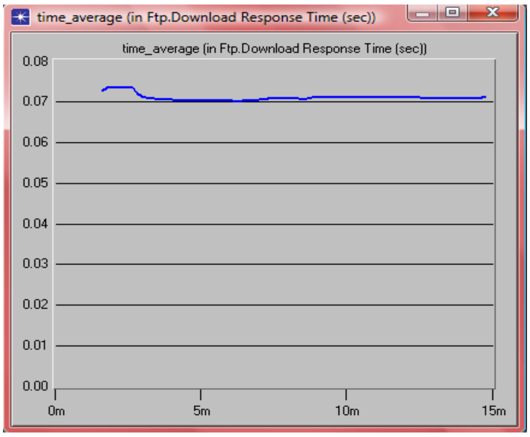

Figure. 4 Ftp Download Response Time (sec)

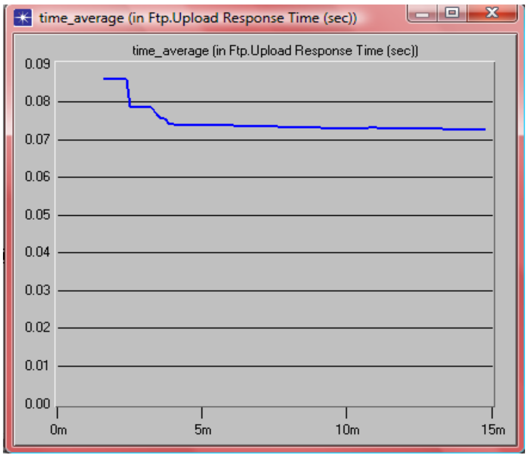

Figure. 5 Ftp Upload load Response Time (sec)

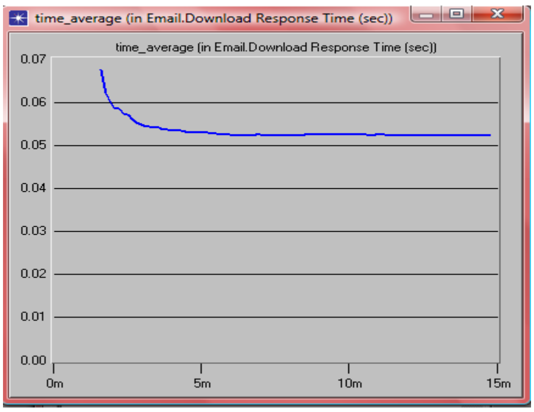

Figure. 6 E-mail Download Response Time (sec)

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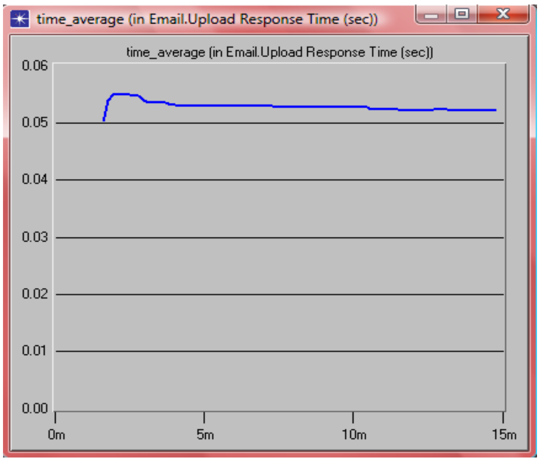

Figure. 7 E-mail Upload Response Time (sec)

The following table I shows the Statistic results of Voice Packet End-to-End Delay, and Delay Variation, FTP and Email Upload and Download response time

Table: I Statistic Result

Statistics	**Maximum**	**Minimum**	**Average**
Voice Packet End-to-End Delay(sec)	0.009262	0.008537	0.008587
Voice Packet Delay Variation	3.42E-06	2.57E-06	3.34E-06
FTP Upload response time(sec)	0.08585	0.068047	0.072779
FTP Download response time (sec)	0.074732	0.06788	0.071105
Email Upload response time(sec)	0.054942	0.050248	0.052859
Email Download response time(sec)	0.067549	0.052266	0.053277

V. CONCLUSIONS

It is particularly important during periods of congestion that traffic flows with different requirements be treated differently and provided a different QoS. In this paper, we have worked on traffic parameters estimation from VBR and ABR Source Modeling in ATM networks using Weighted Round Robin Scheme. The results are shown in the form of graphs (Fig 2 to Fig 7) and statistic table I, which are analyzed for VBR and ABR service categories. Our study considered some of QoS parameters and showed the traffic parameters viz., Voice Packet End-to-End Delay, Voice Packed Delay Variation, FTP Download and Upload response time and E-mail Download and Upload response time. A user can use the Weighted Round Robin scheme to determine the values on traffic parameters in order to minimize the delay in sec.

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