TRAFFIC MANAGEMENT AND PERFORMANCE ISSUES IN ASYNCHRONOUS TRANSMISSION MODE (ATM) NETWORK

Dr. Gajendra Sharma*

Madhur Jain**

Prabhat Kr. Srivastava***

Abstract

This paper discusses on performance issues of asynchronous transfer mode networks (ATM). in which conventional issues and new techniques have been studied and suggested. The whole discussion is based on improving the QoS, Quality of Service to increase the performance of ATM.QoS has been studied at connection-level, burst-level, cell-level. It discusses on congestion control. The approaches to QoS support of ATM networks are explained, several kinds of schemes such as CBR and ABR, weighted round robin and round robin, ERICA and EFCI are compared. Some simulation work is done and related results are shown and discussed.

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Keywords: ATM, QoS, VPN, TDM, Fuzzy, ANN, Congestion, Traffic Management, ERICA, EFCI, CBR, ABR, Weighted Round Robin.

* Director, INSYLABS

** Assistant Professor(IT), BPIT, Rohini, Delhi

*** Asst Prof. IIMT Gr. Noida

Introduction

Asynchronous Transfer Mode (ATM)[1,2] is a technology in which the information is transmitted using short fixed-sized cells consisting of 48 bytes of payloads and 5 bytes of header. The fixed size of the cells [10] reduces the variance of delay making the networks suitable for integrated traffic consisting of voice, video and data. ATM has desirable characteristics which support broadband Virtual Private Network (VPN)[12] services it provides connection–oriented cell relay using ATM switching and multiplexing. ATM provides a non-hierarchical structure in which cells belonging to different user applications are switched using the same fabric, independent of bit rate and burstiness.

ATM device can be multiplexed either deterministically or statistically [2,3]. If deterministic, in deterministic case the scene of peak bandwidths of the constituent virtual connections is less than the total capacity of the time division multiplex (TDM) transport. On other hand connections can be multiplexed statistically to take advantage of variable bit rates (VBR) [1,9,5] generated by individual applications, in this case, the sum of peak bandwidths offered from all applications is expected to exceed the capacity of the TDM system. This results in a non-zero probability of cell loss due to simultaneous arrival of many peak bandwidth bursts. The cell loss probability in this case represents a measure of the Quality of Service (QoS) [1,20,21] offered by the ATM networks. Due to statistical nature of the congestion control methods are needed to maintain QoS at levels acceptable to the applications running on top of ATM layer. In order to cover the entire spectrum of applications we define QoS at the connection, burst and cell levels which are relevant to traffic management, for traffic management and congestion control, different mechanisms are required for different set of services offered by network. The connection-level QoS is expressed in terms of connection blocking which occurs at network nodes when sufficient bandwidth is not available to accept new connection requests. Burst-level QoS can be expressed in terms of burst-blocking. Cell-level QoS is expressed by cell loss and cell delay variation within the duration of the connection. Cell-level QoS is the most important performance measure since it determines how effectively virtual connections can be used to carry loss-sensitive and delay-sensitive traffic.

Traffic Management

Traffic management is concerned with ensuring that users get their desired quality of service. Proper traffic management ensures efficient and fair operation of networks in spite of constantly varying demands. It is also important for the data traffic which has very little predictability. Congestion control is also a part of traffic management as given in the literature [1,2,3,4,6].

Congestion Control

Due to the unpredictable traffic pattern, congestion is unavoidable. When the total input rate is greater than the output link capacity, congestion happens. Under a congestion situation, the queue length may become very large in a short time, resulting in buffer overflow and cell loss. So congestion control is necessary to ensure that users get the negotiated QoS.

In this study, two major congestion algorithms are focused, which are especially for ABR source. Binary Feedback scheme (EFCI)[26] uses a bit to indicate congestion occurs. A switch may detect congestion in the link if the queue level exceeds a certain level. Accordingly, the switch sets the congestion bit to 1. When the destination receives these data cells with EFCI bit set to 1, the destination sets the CI bit of the backward RM cell to 1 indicating congestion occurs. When the source receives a backward RM cell with CI bit as 1, the source has to decrease its rate. The EFCI only told the source increase or decrease the rate and hence the method converges slowly. The Explicit Rate Indication for Congestion Avoidance (ERICA) algorithm solves the problem by allowing each switch to explicitly tell the desired rate to the passing RM cells, the source adjusts the rate according to the backward RM cells.

Simulation

Simulation Tools

Optimized Network Engineering Tools (OPNET) is the simulation tool used in this study. OPNET has many attractive features and can simulate large communication networks with detailed protocol modeling and performance analysis.

Network

Figure 2 shows an ATM network used in the project to study the ATM network. The network consists of servers, workstations and ATM switches, they are connected by OC3 links that can sustain 155.52Mbps traffic, the ATM switching speed is infinity, and the VC lookup delay is 1E-

10, the hence the network capacity is about 150Mbps. Three kinds of traffic are generated by three applications, which are voice, video conference, and Ftp. Voice is run on AAL2 layer, while video conference and ftp are run on AAL5 layer. Voice and video are sensitive to the timeliness, so arbitrarily defined voice use CBR service, video use rt_VBR service, data uses ABR service. The voice traffic is originally around 4Mbps, and the other two are around 3Mbps.

Figure 3 shows a larger ATM network that is also used in the project. The traffic in this network is generated by ATM_uni_src model, so the traffic generated is ideal--that is no burst occurs. There are also three kinds of traffic voice, video and data. Because the traffic is stable, their ratio can be accurately set as 4: 3: 3. This network model is only used to study in large network, when traffic scales, the behavior of the network for each kind of service category, and the simulation speed is faster than that traffic pattern generated by real application in network1.

Table -1

	CBR	RT_VBR	ABR
ppCDV(msec)	5microsec	10microsec	20microsec
maxCTD(msec)	15microsec	15microsec	3millisec
CLR	3.00E-07	3.00E-07	1.00E-05

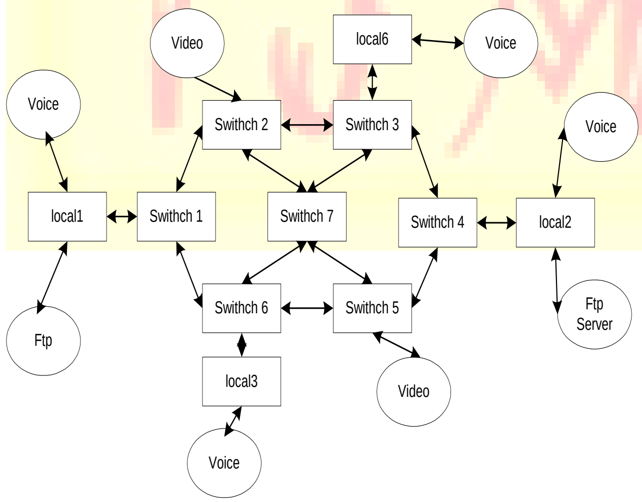

Figure 2 -- Network 1

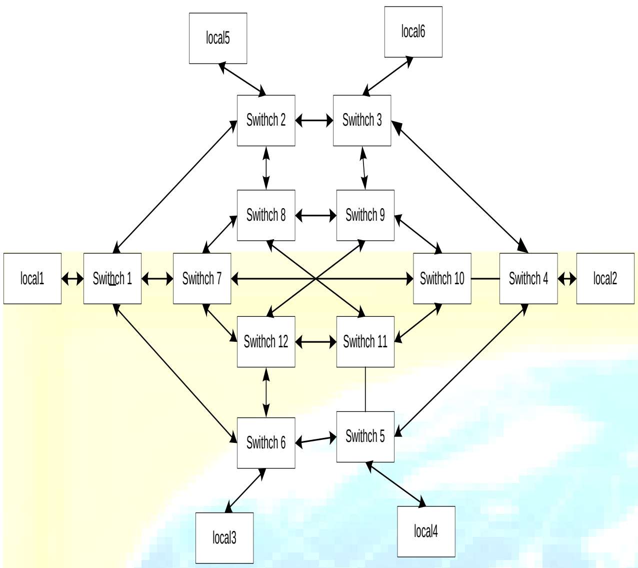

Figure 3 -- Network 2

Design Methodology

Simulation results and discussion

Load and throughput

Three sceneries are run on network 2, they differ in traffic size. The total traffic generated with each scenery and the result collected are listed in table 2.

Traffic size	20M		120M		150M	
Statistic	**Average**	**Maximum**	**Average**	**Maximum**	**Average**	**Maximum**
ATM ABR Cell Delay (sec)	1.8	3.56	0.078	0.155	0.078	0.154

ATM ABR Cell Delay Variation	0.37	1.08	0.00067	0.00198	0.00066	0.00195
ATM ABR Cell Loss Ratio	0	0	0	0	0	0
ATM Call Blocking Ratio (%)	0	0	0	0	0	0
ATM CBR Cell Delay (sec)	0.00164	0.00164	0.00164	0.00164	0.0016	0.0016
ATM CBR Cell Delay Variation	0	0	0	0	0	0
ATM CBR Cell Loss Ratio	0	0	0	0	0	0
ATM Cell Delay (sec)	0.52	1.03	0.0301	0.0586	0.0247	0.0476
ATM Cell Delay Variation	0.25	1.02	0.00027	0.00198	0.00014	0.00145
ATM Global Throughput (bits/sec)	18,218,711	18,252,000	103,970,000	108,600,000	128,052,000	133,800,000
ATM Load (bits)	1,000	1,000	5,000	5,000	5,000	5,000
ATM Load (bits/sec)	19,976,307	20,012,333	115,248,000	120,300,000	139,223,000	145,500,000
ATM RT_VBR Cell Delay (sec)	0.00125	0.00125	0.00125	0.00125	0.00106	0.00106
ATM RT_VBR Cell Delay Variation	0	0	0	0	0	0
ATM RT_VBR Cell Loss Ratio	0	0	0	0	0	0

The simulations only run 10 seconds because the memory of my computer is not large enough, and the speed is very slow. Since the traffic is generated in bunch, it is difficult to scale the traffic size, because when the traffic increases, if it exceeds the capacity of network, the request is rejected; therefore, the load is hard to exceed 150Mbps. Because no network overload is simulated, the throughput increases with the load. Ideally, the throughput should be increase with increased load and become static under infinite load. The latency and jitter is very small, this is because congestions do not occur because of the sable traffic and the QoS is guaranteed for each service. From the table, it can be seen that the cell delay for ABR service is largest amongst the three categories; this result is consist with what we expected.

Conclusion

In this paper definition and deployment of the QoS in ATM networks is dealt. The simulations show that ATM can guarantee the QoS for various classes of applications. ERICA is more effective than EFCI algorithm and weighted round-robin can ensure that the guaranteed bandwidth is reserved for important application classes.

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