A Novel Simulation Based Methodology for the Congestion Control in ATM Networks

Heven Patel, Hardik Patel, Aditya Jagannath, Syed Rizvi, Khaled Elleithy
Computer Science and Engineering Department
University of Bridgeport, Bridgeport, CT

Abstract- ***In this project, we use the OPNET simulation tool for modeling and analysis of packet data networks. Our project is mainly focused on the performance analysis of Asynchronous transfer mode (ATM) networks. Specifically, in this project, we simulate two types of high-performance networks namely, Fiber Distributed Data Interface (FDDI) and Asynchronous Transfer Mode (ATM). In the first type of network, we examine the performance of the FDDI protocol by varying network parameters in two network configurations. In the second type, we build a simple ATM network model and measure its performance under various ATM service categories. Finally, we develop an OPNET process model for leaky bucket congestion control algorithm and examine its performance and its relative effect on the traffic patterns (loss and burst size) in an ATM network. Our simulation results show that the ATM network has longer response time than FDDI. On the other hand, it shows that for both token ring and MAC delay, ATM is shorter than FDDI***

I. INTRODUCTION

ATM is the new generation of computer and communication networks that is being deployed throughout the telecommunication industry as well as in campus backbones. ATM technology distinguishes itself from the previous networking protocols in that it has the latest traffic management technology and thus allows guaranteeing delay, throughput, and other performance measures. This report describes key features of the ATM network and some relative simulation work we have done in OPNET. FDDI and ATM are two well known technologies used in today's high-performance packet data networks. We use OPNET to simulate networks employing these two technologies. FDDI network is an older and well-established technology used in LAN's. FDDI is a networking technology that supports 100Mbps transmission rate, for up to 500 communicating stations configured in a ring or a hub topology. In a dual ring topology, maximum distance is 100 km. FDDI supports three types of devices: single attachment stations, dual-attachment stations and this topology provide high degree of fault tolerance. Since OPNET does not support dual-attachment stations, we used scenarios with single – attachment stations connected in a hub topology with FDDI concentrators. Our simulation scenarios include client server and source destination networks with various protocol parameters and service categories. We also simulate a policing mechanism for ATM networks .In this section we simulate the performance of the FDDI protocol. We consider network throughput, link utilizations, and end-to-end delay by varying network parameters in two network configurations. The leaky bucket mechanism limits the difference between the negotiated mean cell rate (MCR) parameter and the actual cell rate of a traffic source. It can be viewed as a bucket, placed immediately after each source. Each cell generated by the traffic source carries token and attempts to place it in the bucket. If the bucket is empty, the token is placed and the cell is sent to the network. If the bucket is full, the cell is discarded. The size of the bucket is equal to an upper bound of the burst length, and it determines the maximum number of cells that can be sent consecutively into the network.

A. *Asynchronous Transfer Mode (ATM)*

In this section we present the OPNET implementation of the leaky bucket congestion control algorithm. In ATM networks, channels do not have fixed bandwidths. Thus, users can cause congestion in the network by exceeding their negotiated bandwidth. Prohibiting users from doing so (policing) is important, because if excessive data enters the public ATM network without being controlled, the network may be overloaded and may encounter an unexpected high cell loss. This cell loss affects not only the violating connections, but also the other connections in the network. This degrades the network functionality. As shown in Figure-1 we create a scenario with five different clients connected by central hub and that hub in turn connected to a main server through 10 base-T links. Then the simulation is run and compared with the result of FDDI. The average of Ftp response time in second is observed. From Figure-2 we concluded that ATM gives higher response time then FDDI.

B. *Fiber Distributed Data Interface (FDDI)*

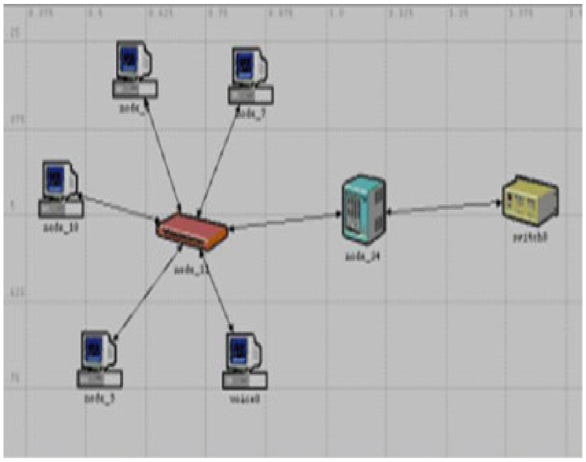

Figure-1 ATM with servers, hub and switches network in client-server application

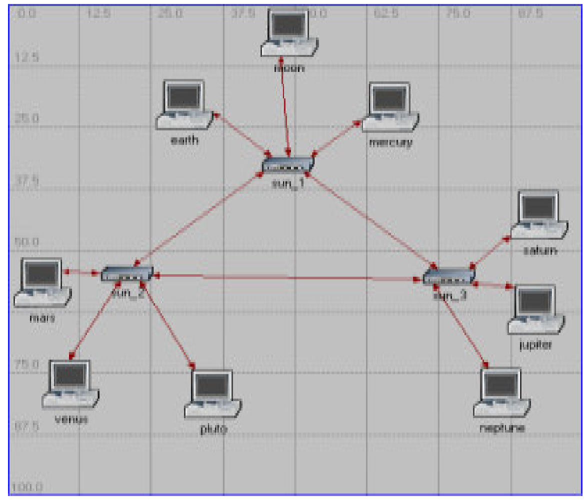

Figure.3 Ring topology configuration

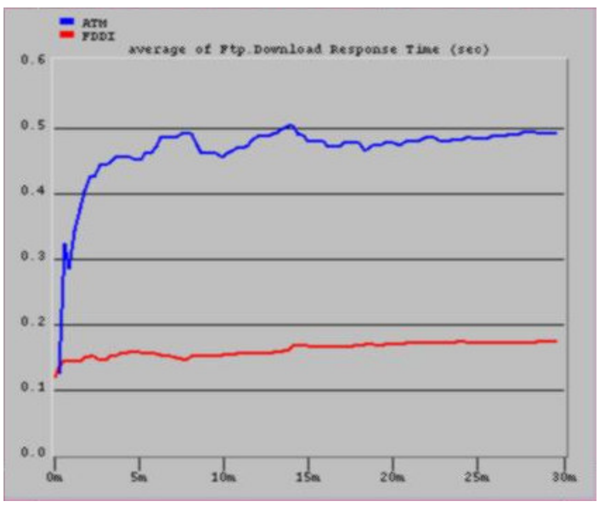

Figure-2 average response time(sec)

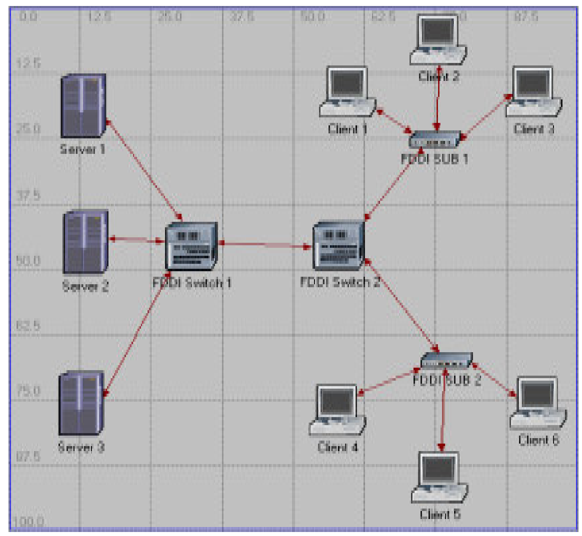

Figure.4 Client-server configuration

Our next main goal to simulate the same scenario as we did on ATM. We create two different scenarios for FDDI. First as shown in Figure-3 is a ring topology configuration. In this configuration, the network in connected in a ring fashion. Further each hub is connected to the station through a 10 Base T connection.Figure-4 shows a client server configuration connected via two switches with 100Base-T link. The delay (sec) and throughput (sec) are observed from the first and second configurations respectively.

C. Leaky Bucket Algorithm

The leaky bucket mechanism limits the difference between the negotiated MCR parameter and the actual cell rate of a traffic source. It can be thought of as a bucket placed immediately after each source. The traffic source generates cells. Each cell thus generated carries a token and attempts to place it in the bucket. If the bucket is empty, the token is placed and the cell is sent to the network. If the bucket is full, the cell is discarded. The bucket gets emptied at a constant rate equal to the negotiated MCR parameter of the source.

The size of the bucket is equal to an upper bound of the burst length, and it determines the maximum number of cells that can be sent consecutively into the network. The model is shown in the above figure. From the figure we observe that the process can reach the arrival state when the packet arrives or can reach an idle state where it waits for the packets. This can happen starting from the initial state. Depending on whether the bucket is full or empty, from arrival state, the process reaches either serve or drop state. Users can change the following parameters in the leaky bucket process model leaking rate bucket size.

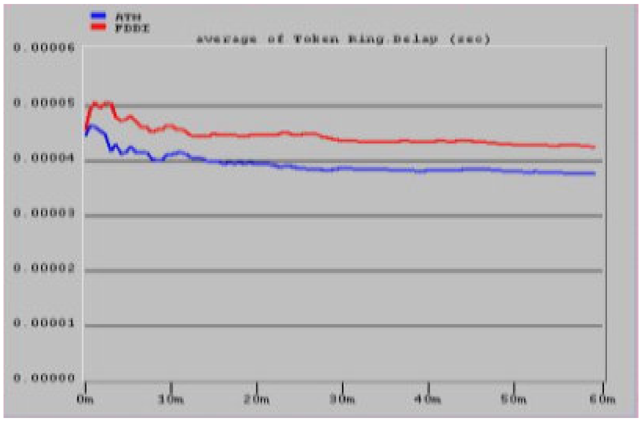

Figure-5 Average ring token delay (sec)

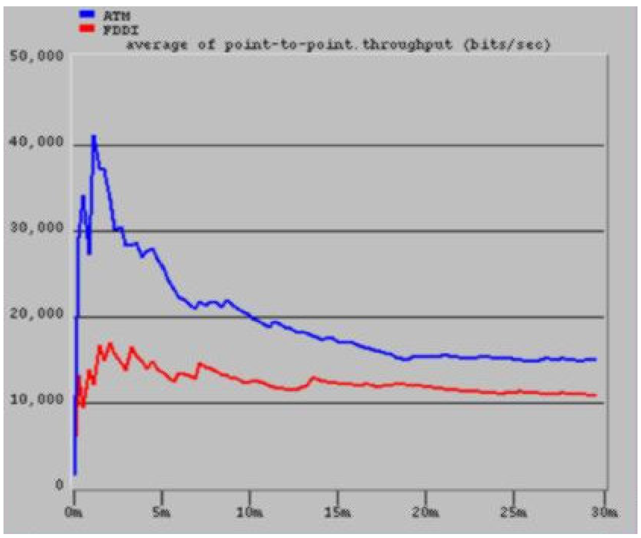

Figure-6 Average point to point throughput (bits/sec)

D. Configuration Parameters

Token Ring Station Latency (fddi_tr_slip8_gtwy): 4 bits Switch BPDU Service Rate (fddi16_switch): 500,000 packets per second. Switch packet Switching Speed (fddi16_switch): 500,000 pkts/sec. ATM Switching speed (atm4_crossconn): infinity.

IP Forwarding Rate (subnet router): 50,000 packets/seconds. IP Ping traffic (subnet router): None. We set applications running as: Email (heavy), File Transfer (heavy), Telnet Session (heavy), Web Browsing (heavy). To do this, In Profile configuration: Start time: Exponentially Distributed, Mean Outcome 100 seconds Start time offset Exponentially Distributed, Mean Outcome 10 seconds. Operation mode: Simultaneously Duration: end of Profile.

Some workstations in susbnet1 and 2 are clients of the applications supplied by the four servers on the subnet3. We ran simulation for 60 minutes, and collected statistics

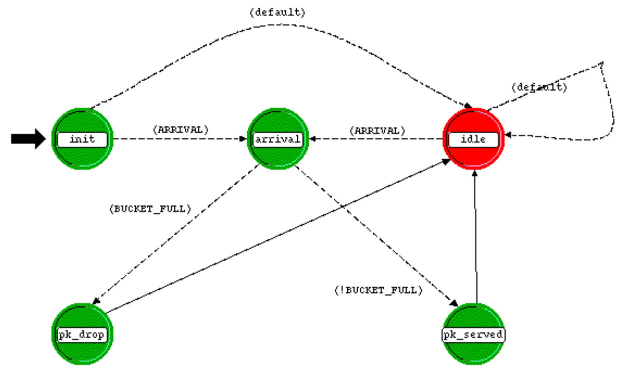

Figure-7 Architecture of Leaky Bucket Algorithm

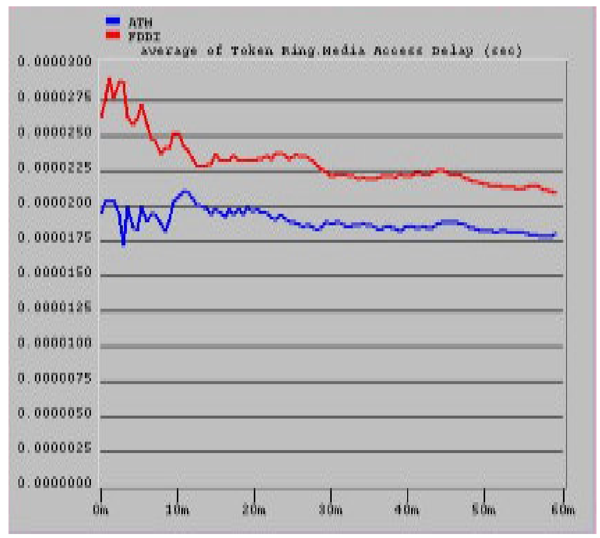

Figure-8 average token access delay(sec)

such as service Response Time, Token Ring Delay and Token Ring MAC Delay.

II. Conclusion And Future Work

In this paper we focused on simulating two commonly used packet data network technologies: FDDI and ATM. We simulated two FDDI and one ATM network scenarios. From that we concluded that ATM has longer response time than FDDI, while for the token ring delay and MAC delay, ATM is shorter than FDDI. Also this paper came out with a solution to the congestion control by implementing the famous leaky bucket algorithm in OPNET.

References

[1] Available at: http://www.cs.wustl.edu/~jain/cis78895/ftp/atm_cong/index.html

[2] ANSI X3.139-1987: Fiber Distributed Data Interface (FDDI) - Token Ring Media Access Control (MAC) *http://www.ansi.org*.

[3] ATM Forum. Traffic Management SpecificationVersion4.0. ftp://ftp.atmforum.com/pub/approved-specs/*aftm 0056.000.pdf*

[4] G.Niestegge,"The leaky bucket policing method in asynchronous transfer mode networks," *International Journal of Digital and Analog Communication Systems*, vol. 3, pp. 187-197, 1990.

[5] OPNET Contributed Model Depot: *http://www.opnet.com/services/depot/home.html*.