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Original Article

Examining the Impact of ATM Adaptation Layers and Service Classes on the Performance of Network

Omojokun Gabriel Aju[1], Ajayi Olusola Olajide[2]

[1,2]*Department of Computer Science, Faculty of Science, Adekunle Ajasin University, Akungba-Akoko, Nigeria*

Abstract *- Asynchronous Transfer Mode (ATM) is a connection-oriented packet switching high-speed networking technology with fixed-length bytes called cells designed to support voice, video, and data communications and improve utilization and quality of Service (QoS) on high-traffic networks. ATM provides quality of service capabilities through its service classes. The Adaptation Layers (AAL), which contains the information needed by the destination to reassemble the individual cells back into the original message, sit between ATM and the variable-length packet protocols that use ATM. The ATM was designed to support various services, including voice, video, and data, and these services require different service classes and adaptation layers needed to support their applications. Therefore, this experiment is conducted to study how the choice of the adaptation layers and the service classes affects the performance of the applications on a network using The Download Response Time, Traffics Sent, Traffics Received, Packet Delay Variation, and Packet End-to-End Delay as performance metrics.*

Keywords *- Asynchronous Transfer Mode, Adaptation Layers, Service Classes, Applications, Simulation*

I. INTRODUCTION

Asynchronous Transfer Mode (ATM) is an International Telecommunication Union of the Telecommunications section (ITU-T) standard for cell relay wherein information for multiple service types, such as voice, video, or data, is conveyed in small, fixed-size cells.

ATM is a high-speed networking standard designed to support voice, video, and data communications and improve utilization and quality of Service (QoS) on high-traffic networks. ATM operates at the data link layer (Layer 2 in the OSI model) and is normally utilized by internet service providers on long-distance networks [7]. The ATM uses zero routing and dedicated hardware devices known as ATM switches to establish point-to-point connections between endpoints enabling the data to flow directly from source to destination.

More importantly, the ATM does not use variable-length packets such as Ethernet and Internet Protocol. Rather, it utilizes fixed-sized cells to encode data for transmission [8]. Each cell is processed in its own time. The procedure then calls for the next cell to process when one is finished. This is why it is called asynchronous; none of them go off simultaneously relative to the other cells. The service provider can preconfigure the connection to make a dedicated permanent circuit or be switched, set up on demand, and then terminated.

Without routing and with fixed-size cells, networks' bandwidth is much more easily managed under ATM than other technologies such as Ethernet or token ring, resulting in its usage by the high-performance and specialized networks.

II. ATM OVERVIEW

Asynchronous transfer mode (ATM) is a technology that has a history of developing broadband ISDN in the 1970s and 1980s. It is technically viewed as an evolution of packet switching protocols, such as X.25, Frame Relay, Transmission Control Protocol, and Internet Protocol (TCP IP) [2].

The ATM's multiplexing and switching functions are well suited for bursty traffic (in contrast to circuit switching) and allow communications between devices that operate at different speeds. Unlike packet switching, ATMs are designed for high-performance networks with various classes of service to meet a broad range of application needs.

The ATM networks transmit their information in small, fixed-length packets called "cells," each containing 48 bytes of data and 5bytes of header information. The small, fixed cell size was chosen to facilitate the rapid processing of the packet in hardware and to minimize the amount of time required to fill a single packet [3].

A. ATM Cell

ATM transfers information in fixed-size units called *cells*, and each cell consists of 53 bytes.

The first 5 bytes contain cell-header information, and the remaining 48 bytes contain the payload (user information). The small and fixed-length cells are well suited to transfer voice and video traffic because such traffic is intolerant to delays resulting from waiting for a large data packet to download, among other things.

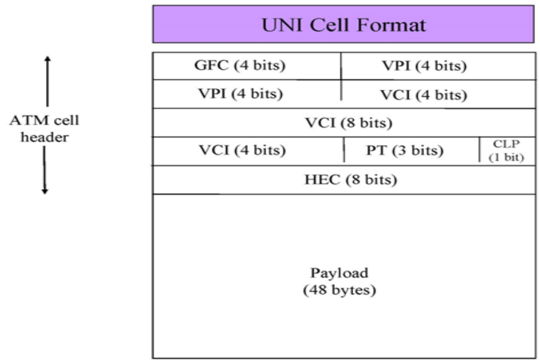

Fig. 1 ATM Cell Format (Source: K. Y. Siu and R. Jain, 2007)

The following descriptions summarize the ATM cell header fields shown in Figure 1.

a. **Generic Flow Control (GFC)**: Provides local functions, such as identifying multiple stations that share a single ATM interface. This field is typically not used and is set to its default value of 0 (binary 0000).
b. **Virtual Path Identifier (VPI)**: This, in conjunction with the VCI, identifies the next destination as it passes through a series of ATM switches on the way to its destination.
c. **Virtual Channel Identifier (VCI)**: This, in conjunction with the VPI, identifies the next destination as it passes through a series of ATM switches on the way to its destination.
d. **Payload Type (PT)**: Indicates in the first bit whether the cell contains user data or control data. If the cell contains user data, the bit is set to 0. If it contains control data, it is set to 1. The second bit indicates congestion (0 = no congestion, 1 = congestion), and the third bit indicates whether the cell is the last in a series of cells representing a single AAL5 frame (1 = last cell for the frame).
e. **Cell Loss Priority (CLP)**: Indicates whether the cell should be discarded if it encounters extreme congestion as it moves through the network. If the CLP bit equals 1, the cell should be discarded in preference to cells with the CLP bit equal to 0.
f. **Header Error Control (HEC)**: Calculates checksum only on the first 4 bytes of the header. HEC can correct a single bit error in these bytes, preserving the cell rather than discarding it.

B. ATM Adaptation Layers and Service Classes

The ATM layer provides routing, traffic management, switching, and multiplexing services within the ATM network system. It processes outgoing traffics by accepting a 48-byte segment from the AAL sub-layers (ATM Adaptation Layers) and transforming them into a 53-byte cell by adding a 5-byte header [5]. The ATM layer is responsible for the simultaneous sharing of virtual circuits over a physical link (cell multiplexing) and passing cells through the ATM network using the Virtual Path Identifier (VPI) and Virtual Channel Identifier (VCI) information in the header of each ATM cell.

The ATM adaptation layer (AAL) is roughly analogous to the data link layer of the OSI model; it is responsible for isolating higher-layer protocols from the details of the ATM processes [6]. The adaptation layer prepares user data for conversion into cells and segments the data into 48-byte cell payloads. It allows the existing packet networks to connect to ATM facilities. The AAL Protocol accepts transmission (e.g., packet data) from upper-layer services and maps them into fixed-sized ATM cells [4]. These transmissions can be of any type, variable, or fixed data rate. At the receiver, this process is reversed, and segments are reassembled into their original formats and passed to the receiving services.

Instead of one protocol for all types of data, the ATM standard divides the AAL layer into categories, each supporting the requirements of different types of service classes. Four types of service classes are identified: Constant-bit rate, variable bit rate, connection-oriented packet data transfer, also known as an available bit rate (ABR), and connectionless packet data transfer, otherwise known as an unspecified bit rate (UBR) [10] [11]. In addition to dividing AAL by category (AAL1, AAL2, and so on), ITU-T also divides it based on functionality.

C. ATM Benefits

The benefits delivered through the use of ATM services deployed on ATM technology can be summarized as follows:

a. ATM supports dynamic bandwidth for bursty traffics to meet application needs and deliver high networking resources, particularly for bursty applications. Most applications are or can be viewed as inherently bursty; for example, voice application is considered bursty, as both parties are neither speaking at once nor all the time; also, the video application is viewed as bursty, as the amount of motion and required resolution varies over time.
b. ATM also uses a smaller header concerning the data to use bandwidth efficiently.
c. It can handle mixed network traffic very efficiently; unpredictable packet sizes. All the network equipment should incorporate elaborate software systems to manage the various sizes of

packets. ATM handles these problems efficiently with the fixed size cell.

d. ATM uses a cell network as all data is loaded into identical cells that can be transmitted with complete predictability and uniformity.

e. ATM incorporates common LAN/WAN architecture allowing the mode to be used consistently from one desktop to another; traditionally, LAN and WAN technologies have been very different, with implications for performance and interoperability, but ATM technology can be used either a LAN technology or a WAN technology.

III. NETWORK SIMULATION DESIGN

This section presents the network's simulation tool platform, the network's performance metrics, the modeling parameters, and the network description used to analyze and evaluate the performance of the proposed scenarios.

A. Simulation Tool Platform

The experimental modeling is conducted using the discrete event simulation software popularly called Riverbed modeler version 14.5, a network and application management design and evaluation software suite from Riverbed Technologies Inc. The tool provides dynamic simulation of communication devices, protocols, technologies, and architectural performance in a virtual network environment [9].

Although other various software platform tools (Simulators) such as NS-2, GloMoSim, Qualnet, OMNET++, and J-Sim, among others, are being employed in the performance of the network modeling and application simulation and evaluation, while some of these tools are open-source, others are commercial tools that need to be licensed through purchase. However, the choice of a simulation tool for the specific experiment will be determined by the user’s (researcher) requirements and the exact experimental scope of the modeling network [1].

In this case, the Riverbed modeler is chosen as it features an interactive development environment that allows for the design and evaluation of networks, devices, protocols, services, and applications that support many protocols. The tool's ability to execute, monitor, and compare several network scenarios makes it the best option for this experiment.

B. Performance Metrics

For this experiment, the following five performance metrics were considered:

a. The Download Response Time in seconds, which is the time elapsed between sending a request and receiving the response packet measured from the time a client application sends a request to the server to the time it receives a response packet, including signaling delay for the connection setup, every response packet sent from a server to an FTP and Email applications are included in this statistic;

b. The Traffics Sent in packets per second describing the average number of packets per second submitted to the transport layers by the three applications in the network.

c. Traffics Received in Packets per Second is the average number of packets per second forwarded to the three applications by the transport layers in the network.

d. Packet Delay Variation determines the variance among end-to-end delays for voice packets.

e. Packet End-to-End Delay in Seconds determines the time the sender node gave the packet to RTP to the time the receiver got it from RTP measured from the time it is created to the time it is received.

The Download Response Time, Traffics Sent, and Traffics Received metrics are chosen because they are very good in measuring the transmission rates when dealing with connection-oriented packet transfer or available bit rate (ABR) and connectionless data transfer or unspecified bit rate (UBR) applications such as FTP and Email applications which are part of the applications being considered in the experiment. In contrast, the Packet Delay Variation and Packet End-to-End Delay are chosen as part of the performance metrics because they measure a transmission policy's effectiveness which is very important when dealing with Constant Bit Rate (CBR) applications such as real-time audio as in the case of voice application which is one of the applications supported by the simulated networks.

Therefore, the network is designed to support and service FTP, Email, and Voice applications for the traffic analysis with all the applications considered with heavy traffic loads.

C. Network Modelling Area and Parameters

The network model simulations took place over a country area in the United States of America (USA) with 9 826, 675km^2. The chosen area is large enough to establish the network's service classes and adaptation layers. The model made use of the three ATM service classes of the constant bit rate (CBR), unspecified bit rate (UBR) & available bit rate (ABR), and the adaptation layers of AAL1, AAL2 & AAL5 with the appropriate parameters and equipment.

Since the motive of this experiment is to examine the impact of ATM adaptation layers and service classes on the performance of networks on different applications by studying how the choice of an adaptation layer, as well as service classes, affect the performance of the applications within a period, resulting in the reason for the choice of FTP, Email and Voice applications with heavy loads, the FTP, Email and Voice applications were chosen to allow for both data and voice applications traffic to get the full effects of these factors (adaptation layers and service classes) on different applications. Heavy traffics was chosen for the applications. The impact of the factors (service classes and adaptation layers) can be fully determined when the network models are at their peak traffics mode.

The network components used during the design of the network models, which allow for the attributes definitions and tuning, are as follows: An Application Configuration Node; A Profile Configuration Node; Switch Nodes; Data Server Nodes, and Subnet Nodes, as shown in figure 3. The same network was duplicated for the CBR-UBR and UBR-UBR scenarios to observe the impact of the service classes and the adaptation layers on the applications.

The application configuration node is an important component object in the network; it defines the transmitted segments, the file size, and the traffic load. Although, it supports common applications, such as Email, HTTP, FTP, Voice, Print, and database, among others. FTP, Email, and Voice applications were purposely chosen because of the heavy traffic required to critically test the impact of the layers and classes in view, and unlike other applications such as printing and HTTP; FTP, Email, and Voice would generate heavy traffic that could meet the purpose of the experiment and more so, the applications are of different categories which are very useful in the study.

The profile configuration node was used to create the user's profiles. It describes the activity patterns or group of users regarding the applications used over some time. For these network models, FTP, Email, and Voice profile were created in a profile configuration component to support the FTP, Email, and voice traffic generated by the application configuration on the component.

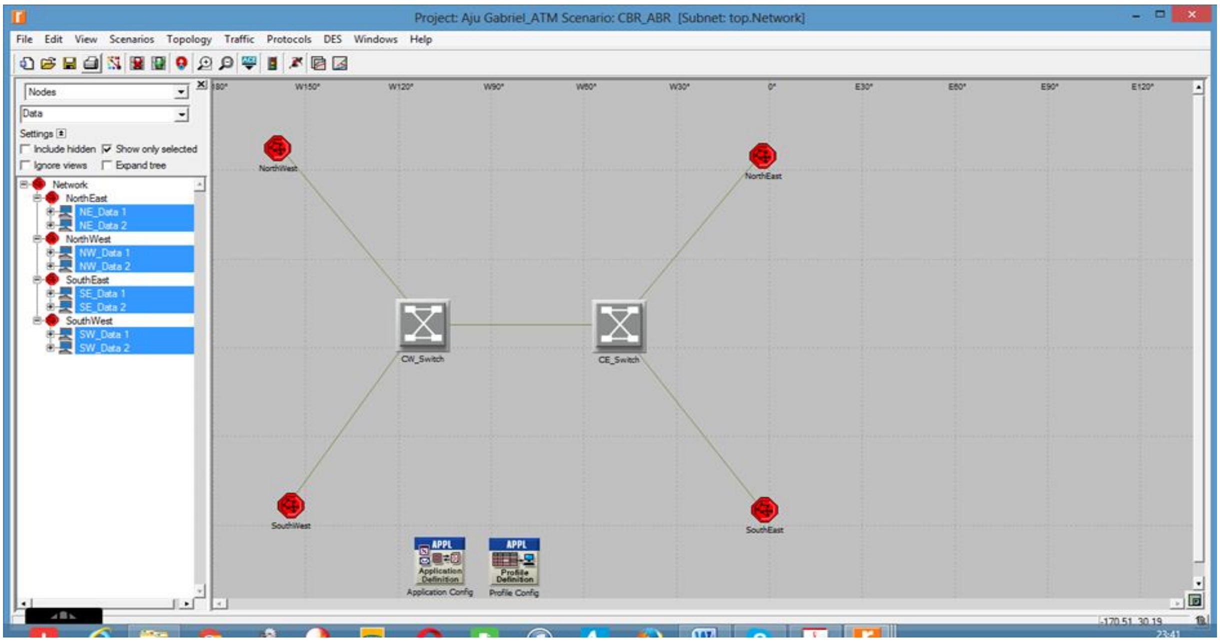

Fig. 2 An ATM Network of CBR-ABR Scenario

Tables 1-IV demonstrate the individual node parameters that were used in the course of designing the network models and simulation.

Table 1. Network General Parameters

General Parameters	Value
Simulator	Riverbed 14.5
Area	9, 826, 675 square kilometers
Data rate	DS1
Switches	ATM8_CrossConn_Adv
Servers	ATM_Uni_Server_Adv
Clients	ATM_Uni_Client_Adv
Subnets Size	Four: NE, NW, SE, SW
Connection Links	ATM_Adv_Duplex Link
Traffic types	FTP, EMail, and Voice
File size	Heavy loads
Service Classes	ABR, CBR & UBR
AAL	AAL1, AAL2 & AAL5
Address mode	IPv6
Simulation time	3,600 seconds

Table 2. Application Configuration Parameters

Application Configuration	Value
Number of Applications	3 (FTP, Email, and Voice)
Description Hierarchy	FTP: High Load
	Email: High Load
	Voice: PCM Quality Speech

*PCM = Pulse Code Modulation (A procedure used to digitize speech before transmitting it.

Table 3. Profile Configuration Parameters

Profile Configuration	Value
Number of profile	3 (FTP, Email, and Voice)
Operation mode	Simultaneous
Start time (seconds)	Uniform (100, 110)
Duration (seconds)	End of simulation
Profile repeatability	Once at start time
Inter-repetition time (seconds)	Constant (300)
Number of repetition	Constant (0)
Repetition pattern	Serial

Table 4. ATM8_CrossConn_Adv Configuration

Crosson Parameters (Switches)	Value
Total Number	Six (6)
Queue type	Class-Based
Queue Category	ABR, CBR & UBR
Address	Auto Assigned
Max_Avail_BW (%Link BW)	100%
Min_Guaran_BW(%Link BW)	20%
Oversubscription (%Min_Guaran_BW)	100%
Weight	Low Latency Queue
Size(cells)	10000

*Max_Avail_BW (%Link BW) = Available Maximum Bandwidth (Traffics will be admitted into the queue only if they are within the maximum available bandwidth requirements.

D. *Network Models Description*

The experiment consists of nine (9) scenarios implemented on service classes of ABR, CBR, and UBR using adaptation layers AAL1, AAL2, and AAL5 on the FTP, Email, and Voice applications to determine how the choice of the adaptation layer, as well as the service classes, affect the performance of the applications.

In each scenario, FTP, Email, and Voice applications were used with FTP and Email traffics set to high loads and the Voice application set to PCM Quality Speech. The experiments are structured as follows:

I. CBR-ABR with AAL1, AAL2, and AAL5 on FTP, Email, and Voice applications
Three scenarios were modeled. In each scenario, CBR was used for Voice applications, while ABR was used for FTP and Email applications using AAL1, AAL2, and AAL5.

II. CBR-UBR with AAL1, AAL2, and AAL5 on FTP, Email, and Voice applications
Three scenarios were modeled. In each scenario, CBR was used for Voice applications, while UBR was used for FTP and Email applications using AAL1, AAL2, and AAL5.

III. UBR-UBR with AAL1, AAL2, and AAL5 on FTP, Email, and Voice applications
Three scenarios were modeled. In each scenario, UBR was used for all the three applications (Voice, FTP, and Email) using AAL1, AAL2, and AAL5.

The performance of the applications in the network under each scenario was measured and analyzed through the applications' download response time, traffic sent, traffic received, packet delay variation, and end-to-end packet delay on the three applications.

IV. SIMULATION INVESTIGATION AND ANALYSIS

This section provides the detailed results of the simulations and the analysis of the service classes and adaptation layers behaviors in the specified scenarios. The simulation duration was set to 3,600 seconds (60 minutes). The performance statistics of download response time, traffic sent, packet delay variation and end-to-end packet delay were collected.

A. *CBR-ABR with different AAL Scenarios*

Table V shows the simulation results for the CBR-ABR with different adaptation layers. The service class CBR was used for the voice application, while the ABR service class was used for the FTP and Email applications. The experiments were conducted on the adaptation layers AAL1, AAL2, and AAL5 to observe the effects of the service classes and the adaptation layers on the applications.

TABLE V: CBR-ABR with different AAL Scenarios

Simulation 1:The ATM Network with CBR-ABR Scenario				
AAL	Metrics	Applications		
		FTP	Email	Voice
AAL1	Download Response Time	1.45	1.12	-
	Traffics Sent	2200	950	72100
	Traffics Received	2020	830	69300
	Packet Delay Variation	-	-	0.00005
	Packet End-to-End Delay	-	-	0.052
AAL2	Download Response Time	1.45	1.11	-
	Traffics Sent	2000	980	70500
	Traffics Received	1800	850	68200
	Packet Delay Variation	-	-	0.00005
	Packet End-to-End Delay	-	-	0.052
AAL5	Download Response Time	1.01	0.51	-
	Traffics Sent	3700	1300	63000
	Traffics Received	3520	1250	62000
	Packet Delay Variation	-	-	0.00007
	Packet End-to-End Delay	-	-	0.058

B. *CBR-UBR with different AAL Scenarios*

Table VI shows the simulation results for the CBR-UBR with different adaptation layers. The service class CBR was used for the voice application, while UBR service class was used for the FTP and Email applications. The experiments were conducted on the adaptation layers AAL1, AAL2, and AAL5 to observe the effects of the services classes and the adaptation layers on the applications.

TABLE VI: CBR-UBR with different AAL Scenarios

Simulation II: The ATM Network with CBR-UBR Scenario				
AAL	Metrics			
		FTP	Email	Voice
AAL1	Download Response	1.15	1.32	-
	Traffics Sent	2800	550	72100
	Traffics Received	2650	430	69300
	Packet Delay Variation	-	-	0.0000
	Packet End-to-End Delay	-	-	0.052
AAL2	Download Response	1.15	1.32	-
	Traffics Sent	2850	500	70500
	Traffics Received	2720	400	68200
	Packet Delay Variation	-	-	0.0000
	Packet End-to-End Delay	-	-	0.052
AAL5	Download Response	0.93	0.71	
	Traffics Sent	4200	750	63000
	Traffics Received	3950	630	62000
	Packet Delay Variation	-	-	0.0000
	Packet End-to-End Delay	-	-	0.058

C. UBR-UBR with different AAL Scenarios

Table VII shows the simulation results for the UBR-UBR with different AAL Scenarios. The service class UBR was used for all three applications (FTP, Email, and Voice applications). The experiments were conducted on the adaptation layers AAL1, AAL2, and AAL5 to observe the effects of the service classes and the adaptation layers on the applications.

TABLE VII: UBR-UBR with different AAL Scenarios

Simulation III: The ATM Network with UBR-UBR Scenario				
AAL	Metrics	Applications		
		FTP	Email	Voice
AAL1	Download Response	1.15	1.32	-
	Traffics Sent	2800	550	46500
	Traffics Received	2650	430	45300
	Packet Delay Variation	-	-	0.0000
	Packet End-to-End Delay	-	-	0.15
AAL2	Download Response	1.15	1.32	-
	Traffics Sent	2850	500	42000
	Traffics Received	2720	400	37000
	Packet Delay Variation	-	-	0.0000
	Packet End-to-End Delay	-	-	0.15
AAL5	Download Response	0.93	0.71	-
	Traffics Sent	4200	750	32000
	Traffics Received	3950	630	25000
	Packet Delay Variation	-	-	0.0001
	Packet End-to-End Delay	-	-	0.18

D. Performance Metrics Results Analysis

1. Download Response Time

The results from tables V-VII show that the download response time in seconds for FTP application on CBR-UBR & UBR-UBR networks remains the same for AAL1 and AAL2 adaptation layers but much lower for AAL5 adaptation layers than the AAL1 and AAL2 adaptation layers in the networks. The download response time for an Email application on CBR-UBR & UBR-UBR networks also remains the same for the AAL1 and AAL2 adaptation layers but much lower on the AAL5 adaptation layer than on the AAL1 and AAL2 adaptation layers, too; the download response time for an Email application on AAL5 is almost half of the download response time of the same application on AAL1 and AAL2.

The download response time of the applications was also affected by the type of service class used in the network; for the FTP application, the CBR-ABR network has a higher download response time than CBR-UBR and UBR-UBR networks, which have lower download response time, with both having relatively the same values. Likewise, for the Email application, the CBR-ABR network has a lower download response time than the CBR-UBR and UBR-UBR networks, which have higher download response times with both (CBR-UBR and UBR-UBR) having relatively the same values. This shows that both service classes and the adaptation layers impact the download response time of the two applications.

2. Traffics Sent

The results from tables V-VII show that the FTP application traffic sent on the CBR-UBR & UBR-UBR networks are the same with some variation on the adaptation layers with the AAL1, AAL2, and AAL5 sending 2800, 2850, and 4200 packets per second respectively. However, the traffic sent for the FTP application on the CBR-ABR network is much lower than on CBR-UBR & UBR-UBR networks, with little difference in the traffic and the adaptation layers with AAL1 AAL2, and AAL5 sending 2200, 2000, and 3700 packets per second respectively.

For the Email application, the traffics sent on the CBR-UBR & UBR-UBR networks are the same with some variation on the adaptation layers with the AAL1, AAL2, and AAL5 sending 550, 500, and 750 packets per second, respectively. However, the traffic sent for the email application on the CBR-ABR network is much higher than on CBR-UBR & UBR-UBR networks, with little difference in the traffic and the adaptation layers with AAL1 AAL2 AAL5 sending 950, 980, and 1300 packets per second respectively.

The traffics sent on CBR-ABR, and CBR-UBR networks are the same for the voice application, with the AAL1, AAL2, and AAL5 sending 72100, 70500, and 63000 packets per second, respectively. This is because the CBR service class is used for the voice application in the two networks. However, the traffic on the UBR-UBR network in which the UBR service class was used for voice application is much lesser than the CBR-ABR and CBR-UBR networks with the AAL1, AAL2, and AAL5 sending 46500, 42000, and 32000 respectively.

3. Traffics Received

The results of the experiments show that the FTP application traffics received on the CBR-UBR & UBR-UBR networks are the same with some variation on the adaptation layers with the AAL1, AAL2, and AAL5 receiving 2650, 2720, and 3950 packets per second respectively because the two networks made use of UBR service class. However, the traffic received for the FTP application on the CBR-ABR network is much lower than CBR-UBR & UBR-UBR networks, with little differences in the traffic and the adaptation layers with AAL1 AAL2, and AAL5 receiving 2020, 1800, and 3520 packets per second respectively.

For the Email application, the traffics received on the CBR-UBR & UBR-UBR networks in which UBR service class was used for the Email application are the same with some variation along with the adaptation layers with the AAL1, AAL2, and AAL5 receiving 430, 400 and 630 packets per second respectively. However, the traffics received for the email application on the CBR-ABR network in which ABR service class was used for the Email application is much higher compared to CBR-UBR & UBR-UBR networks, with little differences in the traffic along with the adaptation layers with AAL1, AAL2 and AAL5 receiving 830, 850 and 1250 packets per second respectively.

The traffics received on CBR-ABR, and CBR-UBR networks are the same for the voice application, with the AAL1, AAL2, and AAL5 receiving 69300, 68200, and 62000 packets per second, respectively. This is because the CBR service class was used for the voice application in the two networks. However, the traffic on the UBR-UBR network in which the UBR service class was used for voice application is much lesser than the CBR-ABR and CBR-UBR networks, with the AAL1 and AAL2 AAL5 receiving 45300, 37000, and 25000 respectively.

4. Packet Delay Variation

The simulations show that the voice application packet delay variation on CBR-ABR and CBR-UBR networks are the same, with the AAL1, AAL2, and AAL5 having 0.00005, 0.00005, and 0.00007, respectively. This is because the CBR service class was used for the voice application in the two networks. However, the traffic on the UBR-UBR network in which the UBR service class was used for voice application is much lesser than the CBR-ABR and CBR-UBR networks, with the AAL1, AAL2, and AAL5 having 0.00008, 0.00008 and 0.00010 respectively.

5. Packet End-to-End Delay

The experiments' results show that the voice application packet end-to-end delay in seconds on CBR-ABR and CBR-UBR networks are the same, with the AAL1, AAL2, and AAL5 having 0.052, 0.052, and 0.058 respectively as the CBR service class was used for the voice application in the two networks. However, the traffic on the UBR-UBR network in which the UBR service class was used for voice application is much higher than the CBR-ABR and CBR-UBR networks, with the AAL1, AAL2, and AAL5 having 0.15, 0.15 and 0.18 respectively.

V. EXPERIMENTAL OBSERVATION AND PERFORMANCE EVALUATION

From the simulation results, it is observed that the ATM adaptation layers and service classes have different effects on the performance of various applications (FTP, Email, and Voice) in the networks, as witnessed in the applications' download response time, traffic sent, traffics received, packet delay variation and packet end-to-end delay.

A. Impact of ATM Service Classes on the Network Applications

The impact of service classes on the different ATM network applications was reflected in the simulation results as observed from the download response time and traffic sent, traffic received, packet delay variation, and end-to-end packet delay. While the ABR and UBR were used for the FTP and Email applications using the download response time, traffics sent, and traffics received as the performance metrics, the CBR and UBR were used for the voice application using the traffics sent, traffics received, packet delay variation and packet end-to-end delay as the performance metrics.

On the FTP application, UBR service class enables the networks to send and receive more packets per second than the ABR service class in all the ATM adaptation layers. It is also noted that UBR service class experiences a lower download response time compared to the ABR service class in all the ATM adaptation layers.

On the Email application, the UBR service class causes the networks to send far fewer packets per second than the ABR service class in all the ATM adaptation layers. Also, the UBR service class experiences a higher download response time than the UBR service class. On the other hand, the CBR service class enables the networks to send and receive higher voice packets per second on the voice application than the UBR service class in all the ATM adaptation layers. Also, the networks experience lower packet delay variation and end-to-end packet delay in the CBR service class as against the UBR service class.

Therefore, the ABR service class gives the best service to the FTP application from the observed results. It enables the networks to generate higher traffic, thereby causing the networks to send and receive more packets per second than the UBR service class. The higher generation of traffics by the ABR on the FTP application resulted from the lower download response time of the application. Similarly, the UBR service class performs better on Email application by causing the networks to generate higher traffics and allow for the sending and receiving of larger packets than the ABR service class. The Email application also experiences a lower download response time in the ABR service class. So also, the voice application receives the best performance in the CBR service class by causing the networks to provide the highest traffic in sending and receiving voice packets per second. Under the CBR service class, the application also experiences the lowest packet delay variation and end-to-end packet delay.

In summary, the ABR service class is a preferred service class for the FTP applications, the UBR service class is a better choice for the Email applications, while CBR would be a perfect service class for the voice applications.

B. Impact of ATM Adaptation Layers on the Network Applications

The impact of adaptation layers on the various ATM network applications was shown in the simulation results as observed from the performance metrics of download response time, traffic sent, traffic received, packet delay variation, and end-to-end packet delay.

From the results, on the FTP and Email applications, the AAL5 produces higher traffic by causing these network applications to send and receive higher packets per second than both AAL1 and AAL2. The FTP and Email applications also experience lower download response time under the AAL5 compared to AAL1 and AAL2. However, the AAL5 produces lower traffic on the voice application, causing the network voice application to send and receive lower voice packets per second compared to both AAL1 and AAL2. The voice application also experiences high packet delay variation and end-to-end packet delay under the AAL5 against the AAL1 and AAL2.

Therefore, the results from the experiments have shown that AAL5 is a preferred adaptation layer for data transmission in an ATM network such as FTP and Email applications. At the same time, AAL1 and AAL2 would be the better choice for the voice transmission in an ATM network, such as voice applications.

VI. CONCLUSION

This work aims to examine the impact of ATM adaptation layers and service classes on the performance of various applications on a network. The three ATM adaptation layers of AAL1, AAL2, and AAL5 were examined in the ABR, CBR, and UBR service classes on network scenarios using download response time, traffic sent, traffic received, and packet delay variation, and end-to-end packet delay as performance metrics. The FTP, Email, and Voice traffic were submitted to the ATM networks, while the network adaptation layers and service classes were varied to establish different network scenarios.

The results show that the network applications' performance on download response time, traffic sent, traffic received, packet delay variation and end-to-end packet delay varies according to adaptation layers and service classes. It is observed from the results of the study that the ABR service class is a preferred service class for the FTP applications, and the UBR service class is a better choice for the Email applications. At the same time, CBR would be a perfect service class for voice applications. Also, the results from the experiments show that AAL5 is a preferred adaptation layer for data transmission in an ATM network such as FTP and Email applications. At the same time, AAL1 and AAL2 would be the better choice for the voice transmission in an ATM network, such as voice applications.

Therefore, a combination of ABR service class and AAL5 adaptation layer would provide the best performance for FTP application, and UBR service class and AAL5 adaptation layer would provide the best performance on Email application. In contrast, the voice application would perform best on the CBR service class and AAL1/AAL2 adaptation layers.

REFERENCE

[1] NI. Sarkar, S. A. Halim, “Simulation of computer networks: simulators, methodologies and recommendations," The Proceeding of 5th International Conference on Information Technology and Application, Cairns, Australia. 2008, pp. 420-425

[2] R. Jain. "ATM Network: An Overview," Lecture Note on ATM Networks, Washington University at Saint Louis. MO 63130, USA. https://www.cse.wustl.edu/~jain/talks/netsem2.htm. 2016.

[3] C. Blondia and O. Casals. “Traffic Management in ATM Networks: An Overview. In: Kouvatsos D. (eds) Performance Evaluation and Applications of ATM Networks”. The International Series in Engineering and Computer Science, Vol. 557. Springer, Boston, MA. 2002.

[4] K. Y. Siu and R. Jain. “A Brief Overview of ATM: Protocol Layers, LAN Emulation and Traffics Management” Lecture Note on ATM Networks, University of California, Irvine, CA 92717, USA. 2007.

[5] N. Nake. "An Overview of Network Architecture and security framework of Asynchronous Transfer Mode," International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013.

[6] L. L. Peterson and B. S. Davie. "Computer Networks: A Systems Approach ."3rd Edition, Morgan Kaufmann Publishers, Boston, USA. 2003

[7] E. Aboelela. "Network Simulation Experiment Manual ."4th Edition. Morgan Kaufmann Publishers, Boston, USA. 2008

[8] W. Stallings. Data and Computer Communications. 8th Edition. Pearson Prentice Hall. NJ 07458, USA.

[9] (2018). The Riverbed Technologies website. [Online]. Available: https://www.riverbed.com/gb/products/steelcentral/opnet.html

[10] R. L. Cruz and H. N. Liu. End-to-End Queuing Delay in ATM Networks. Journal of High-Speed Networks. Vol. 3, No. 4. pp. 413-427. 1994.

[11] O. L. Nneka and O. K. Rita. "Congestion Control in Asynchronous Transfer Mode (ATM) Network," International Journal of Computer Applications. Vol. 142. No. 4. pp. 11-15. May 2016.