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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a marks of zero will be awarded.

Acknowledgement

I would like to express my appreciation to my college Islington College as well as my university London Metropolitan University for providing me this opportunity to do this coursework on Network and Operating Systems. This coursework would not have been completed without the help of our teacher and the module leader who has suggested and encouraged me.

Completing this coursework was not as simple as it looks. To finish this lot of time was sacrificed on research works and developing the WAN model. It assisted me to properly understand the coursework practically as well as theoretically. To complete this coursework, research was done with the help of different books, journals, websites, and conference papers. Finishing the coursework within the limited time was also a great challenge. I am grateful to everyone who has helped me, directly and indirectly, to finish this coursework in a limited time.

Abstract

In this coursework there are two tasks to be conducted which are Task A and Task B. Task A of this report is all about network simulation, the tools used, and its simulation. In this task, we had properly implemented the scenario given in the coursework. The WAN model is also explained properly in this report. The simulation is done and its report is also described understandably. To make it easier to understand the chart of this report is created and explained properly.

Task B of this report is all about the research of Wireless Networks. The wireless network is explained here and its background is also described. In this report, we also talk about the wireless network's history, its advantages, and disadvantages. IEEE 802.11 architecture and IEEE 802.11 priorities are also described in this report. Wireless technology is also described properly in this coursework.

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1. Task A

For first task of this coursework, network simulation is done in COMNET III and its report is explained.

1.1. Introduction

Network simulation is a system where the tools will examine the activities of a network by processing the relation between various networking devices (routers, switch, access points, and the hub) and the technique of applying the network on the computer is known as network simulator and it gives visualization, animation of flow of packets, low price technique and execution of network *(Patel, 2018)*. Network simulation is a very useful tool as it gives a source for creating or modeling a network to know its execution characteristics *(CompuwareCorporation, 2000)*. In this coursework network simulation is done of the provided scenario by using COMNET III.

COMNET III is a network simulator that looks for serving users as a guide in a data communications and networks course and brings the network layout and simulation from the theoretical world to the virtual world *(Ahuja, 2000)*. The COMNET III software was scripted in MODSIM III programming language by using object-oriented design and those objects are made inside the software which represents different parts of hardware that might be spotted in a network. The work place and toolbar of COMNET III are shown below:

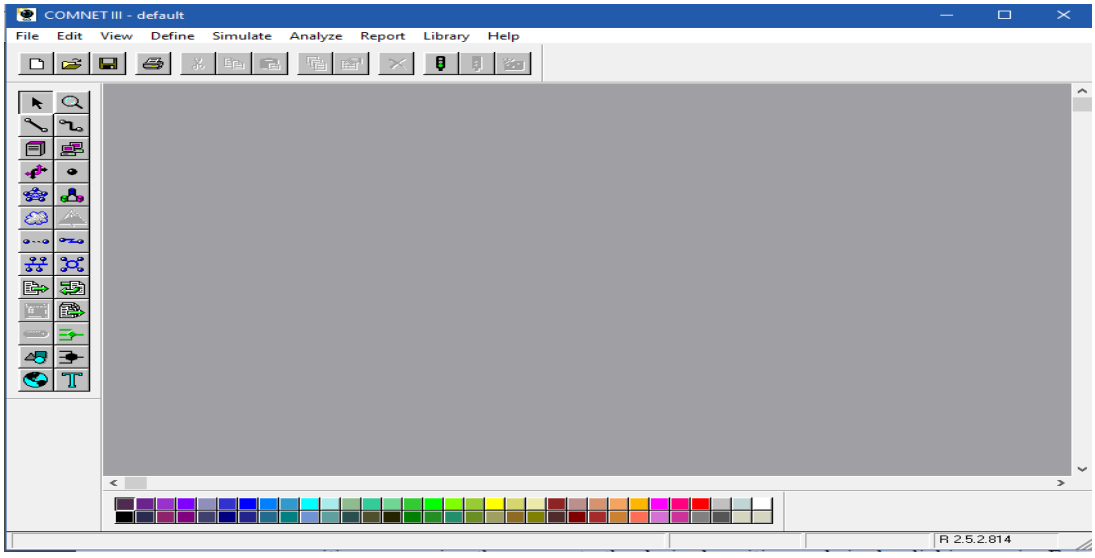

Figure 1: Working Area of COMNET III

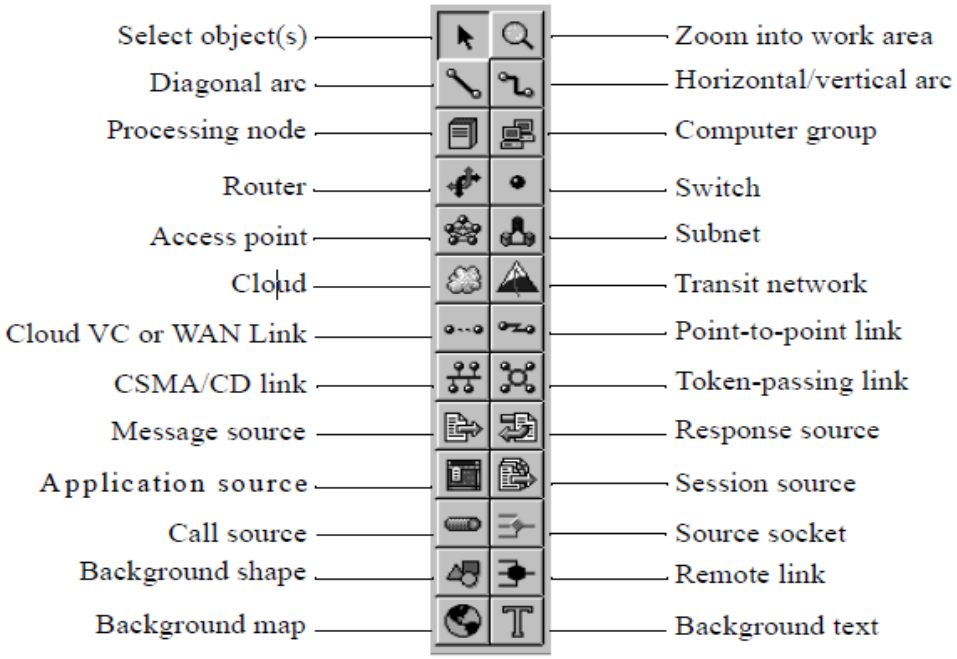

Figure 2: COMNET III Toolbar

The pictures shown above are the workplace and toolbar of COMNET III which we will be using while doing the coursework. Task A of the coursework aims to make a WAN model for Asia Bank a multinational bank with headquarters in Edinburg and the bank wanted to set up two ATM (Automated Teller Machines) transaction networks in Butwal and Itahari. Therefore all the LANs in the network become Edinburg LAN, Butwal LAN, and Itahari LAN.

The main aim of this network simulation is to design a network that is given in the scenario, design a WAN network, which works with WAN clouds and simulates the given network and observe the result. The main objective while doing task A is to research the network simulation with its working principle, research COMNET III, simulate the network, and generate the required reports.

1.2. WAN model

The Wireless Area Network (WAN) cloud allows an intellectual process of modeling WANs, which gives an alternative to modeling a WAN by using network device nodes, HOL Blocking, Switch nodes, and Point-To-Point links and it behaves like the link object in where it delivers frames and models a delay of these frames over the network *(CompuwareCorporation, 2000)*.

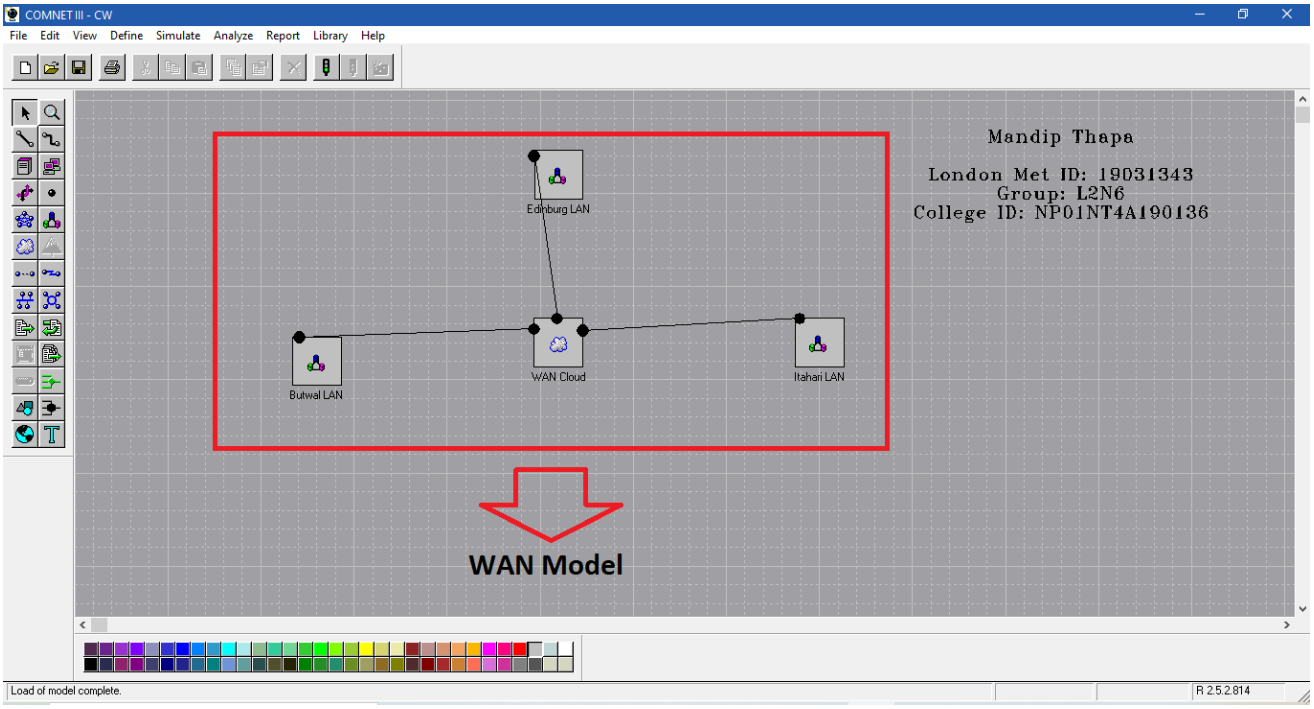

Figure 3: WAN Model

In the WAN model shown in the above figure, we can see three various LANs which is connected with the help of point to point link in the WAN cloud. The WAN model is designed by following all the instructions mentioned in the coursework. The WAN model is responsible for controlling ATMs transaction networks in Butwal LAN and Itahari LAN. The WAN model control all by sending the entire message request to the Edinburg Server and it resend by response source and this is the major part of Task A.

1.2.1. Edinburg LAN

A local area network (LAN) is the solo owned network, which runs inside and nearby a small fixed place like an office, home, or factory, and they are used broadly to interconnect personal computers and consumer electronics to give them accessibility to share resources and exchange data *(Andrew S.Tanenbaum, 2011)*.

The Edinburg LAN is created using a token pass that is connected to the router and the ATM processing server. Cisco 7010sp, V10.0 router is used here. The main component of this LAN is the ATM Processing Server. The access point is connected to the router and the LAN model is completed. The access point is connected to the WAN cloud so that the request from Butwal and Itahari LAN enters the router. The router sends the server request through a token-passing link and it is done so that all the requests and responses may not generate traffic and will work reliably. With the help of a response source, the server will respond to the request. The Edinburg LAN is shown in the figure below.

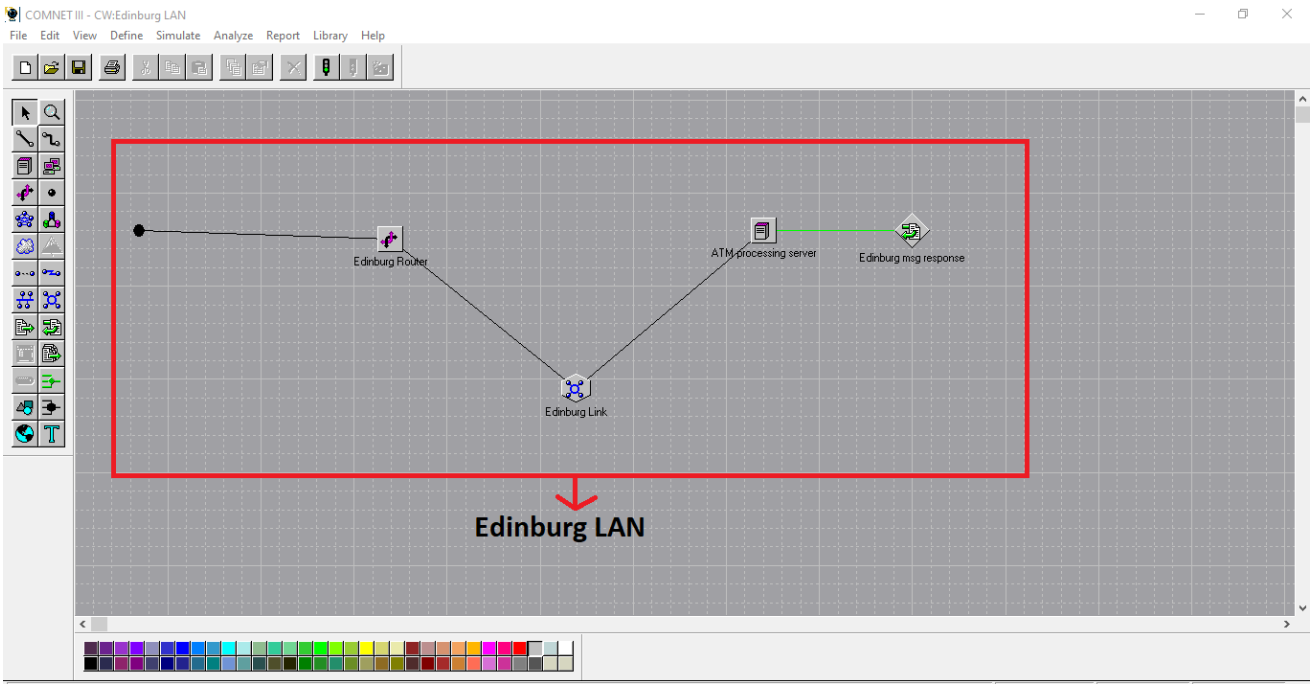

Figure 4: Edinburg LAN

1.2.1.1. Network device: Router

A router is a networking device that receives and sends data on the computer networks and it has the combined characteristics of switches, hubs, or modems which improves internet access or assists to create business networks *(Cisco, 2019)*. In Edinburg LAN the router used is the cisco 7010sp, V10.0 router that connects to the WAN cloud. The router is connected to the access point to the token passing link to transfer the request and respond to the server and the figure is shown below.

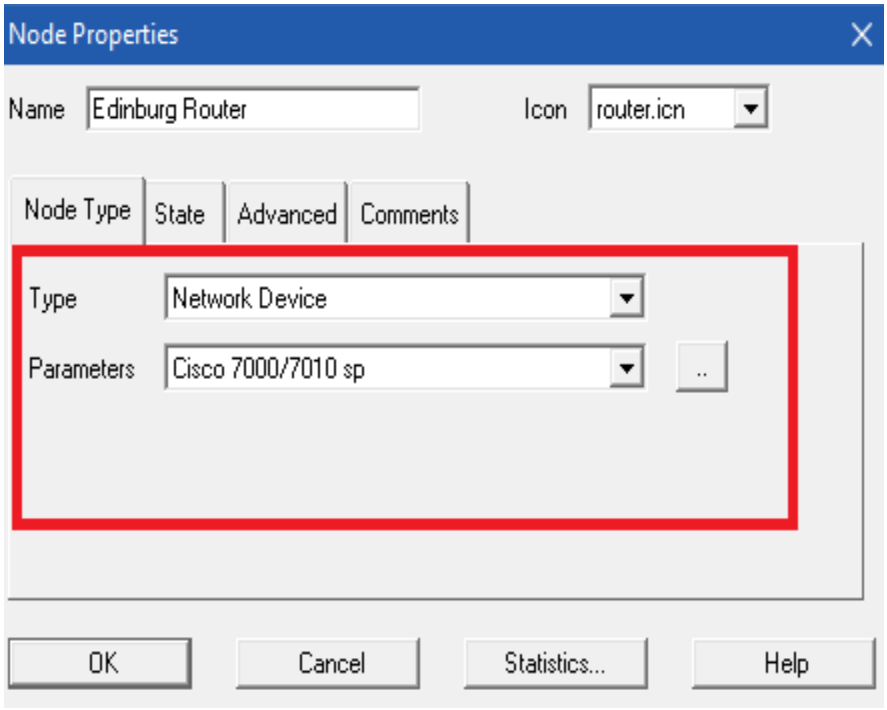

Figure 5: Edinburg Router

1.2.1.2. Token Passing Link

The Token passing links are generally used to model the functions of the IEEE 802.4 and 802.5 features. When the nodes have to transfer the packets then it determines which node presently has the token and the time that will pass till it receives the token back. Then the node delays the time calculated before transferring the packet. In this LAN token passing link parameter is set to 802.5 16 Mbps and the figure is given below.

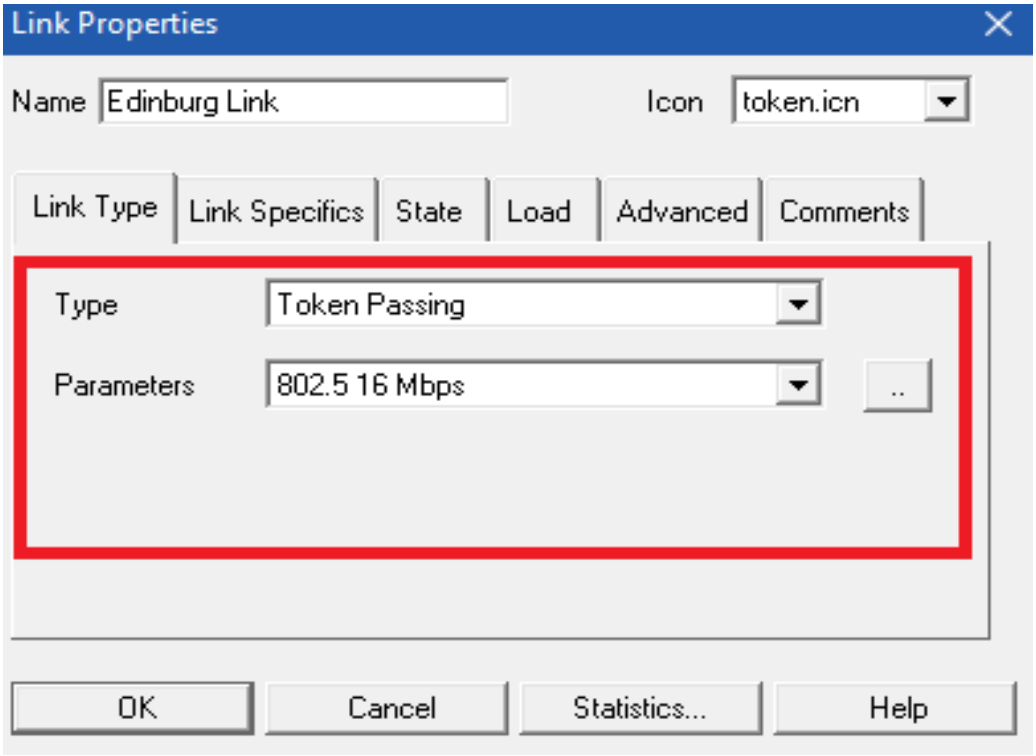

Figure 6: Edinburg token passing link

1.2.1.3. Processing Server

The processing server is connected to token passing link to receive request and send response with the assist of the response source. The figure is given below.

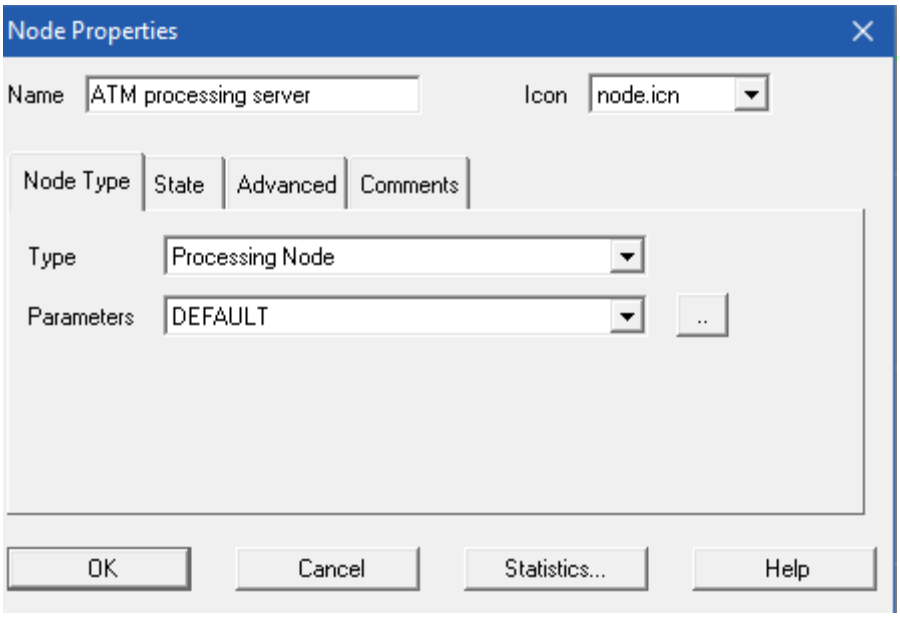

Figure 7: Edinburg processing server

1.2.1.4. Response source

The response source is a message creator that is used to send message replies upon request receipt of a message that is useful in modeling database queries, e-mail replies, and any type of message traffic and the message that is generated by a response source is always transfer to the node that generates the message, which triggered the response source *(CompuwareCorporation, 2000)*. All the ATM requests form Butwal and Itahari LAN are taken at the Edinburg server, which respond with a message that is described with uniform probability at where the size is equally distributed the the scale of 40 to 80 bytes with stream 2 and the figures are given below.

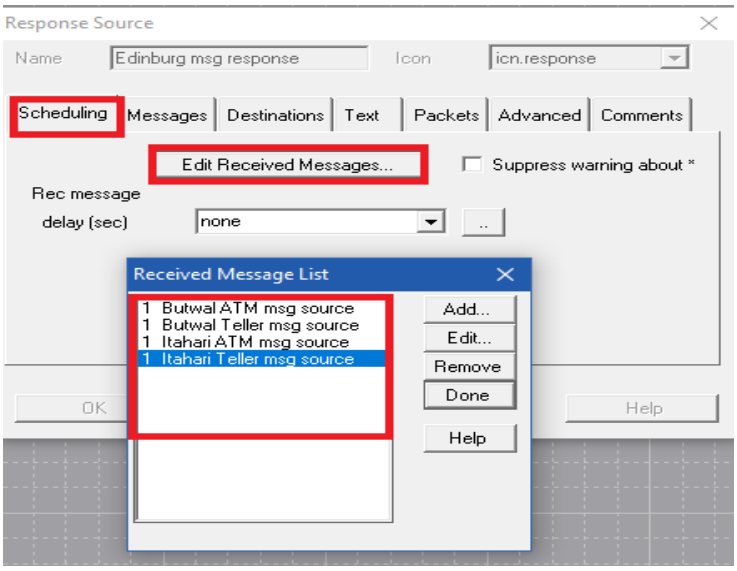

Figure 8: Response source: Scheduling

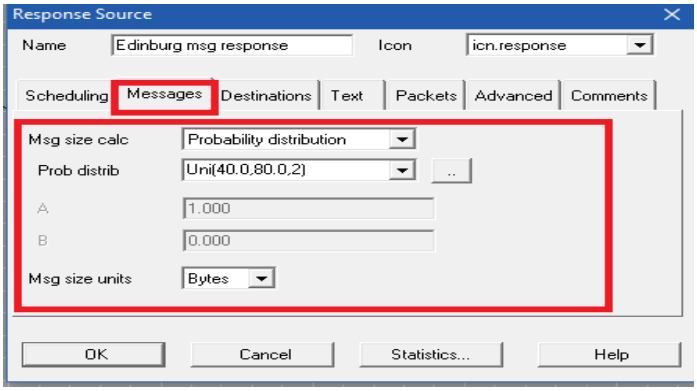

Figure 9: Response source: Messages

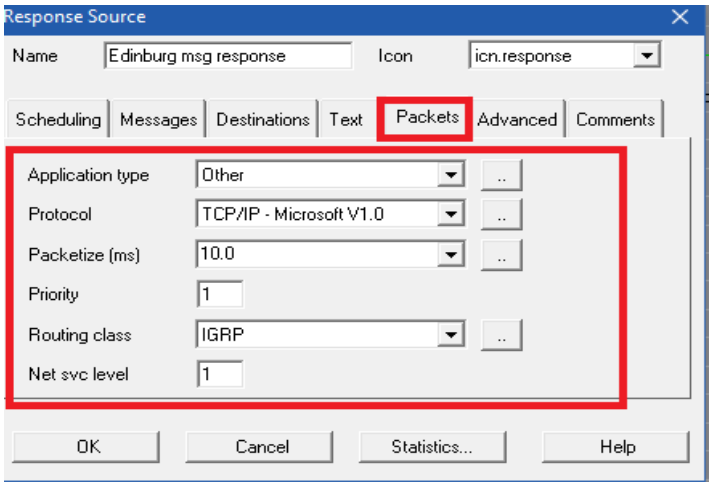

Figure 10: Response source: Packets

1.2.2. WAN Cloud

The WAN Cloud has a great importance while creating the WAN model. In the COMNET file to create the WAN Cloud, we should use WAN link and point to point link tool. The WAN Links which are used are Edinburg, Butwal, and Itahari. The point to point links that we use is Edinburg-Butwal, Butwal-Edinburg, Edinburg –Itahari, and Itahari-Edinburg. So, to ensure the tunnel from the WAN to LAN, we change the property of WAN links to 128 Kbps, and make link transmission rate to 16 Kbps. Every point to point links is connected to virtual circuits to set the path for request or response to transfer. The model of the WAN cloud is shown in the figure below.

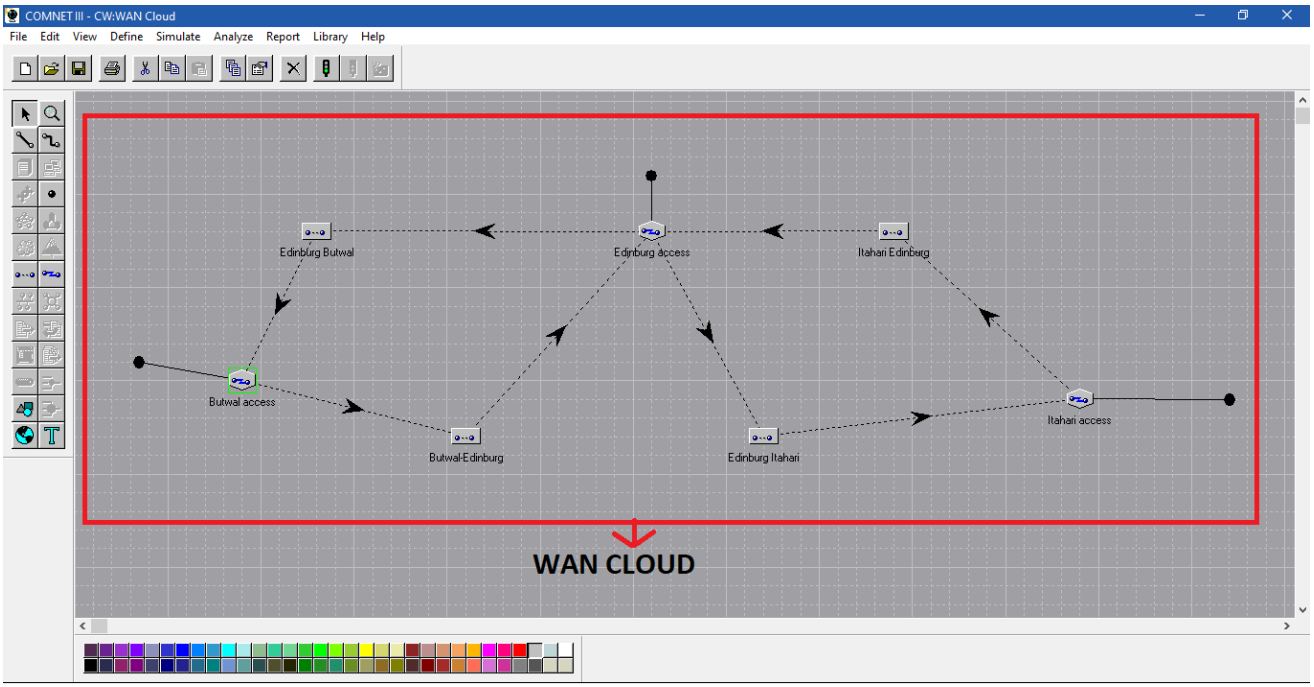

Figure 11: WAN Cloud

1.2.2.1. Access Link

The Access link is used to model the access link from LANs to WAN and to create an Access link in the WAN cloud we should use the point-to-point link icon in the toolbar and the created Access link must be attached to the Access point *(CompuwareCorporation, 2000)*. Here we have used three access links which are: Edinburg, Butwal, and Itahari in the WAN model. In the given scenario, the rate of data transmitted to and from the tunnel is 128 Kbps so the Access link is set to 128 Kbps in the parameter as shown in the figure below.

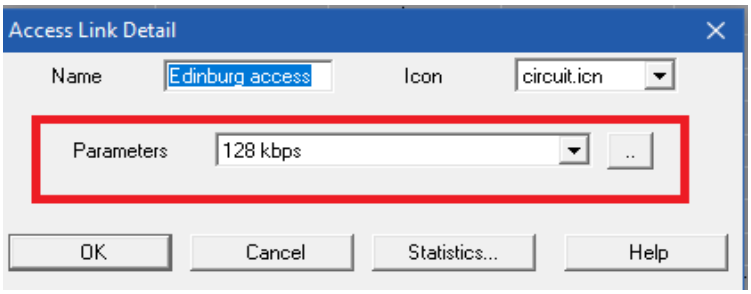

Figure 12: WAN cloud: Access link

1.2.2.2. Virtual Circuit

The major use of the virtual circuit is to identify the traffic burst limits that allow judging the grade of service for the WAN (wide area network). In this scenario, the links in the WAN cloud have a data transmission rate of 16 Kbps, and the virtual circuits are set as 16 Kbps by using Frame Relay VC. The figure is shown below.

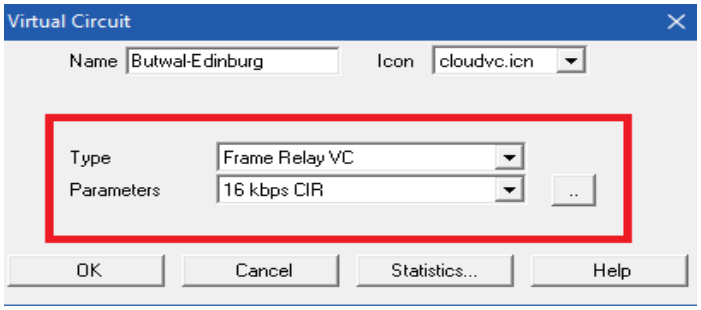

Figure 13: WAN cloud: Virtual circuit

1.2.3. Itahari and Butwal LAN

In both Butwal and Itahari LAN there are 30 ATM transaction nodes and one single teller. Two message sources are connected to processing node and computer group. These message sources of Butwal and Itahari LAN sends request message to the ATM processing server of Edinburg LAN and the response message source of Edinburg LAN respond it. The access point is connected to the router from where all the request from ATM group, ATM teller and respond from server enters the router. The LAN model of Itahari and Butwal are shown in the figure below.

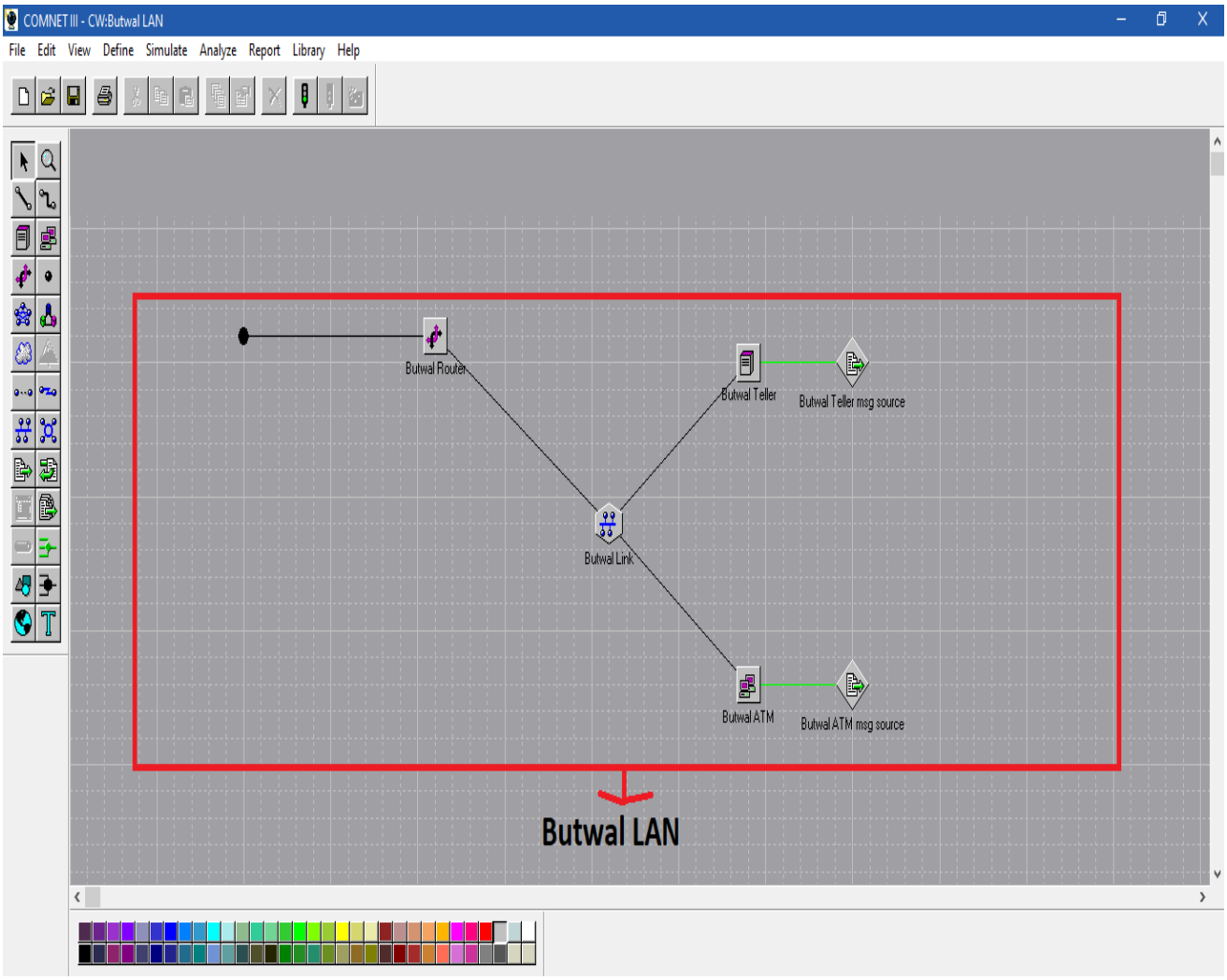

Figure 14: Butwal LAN

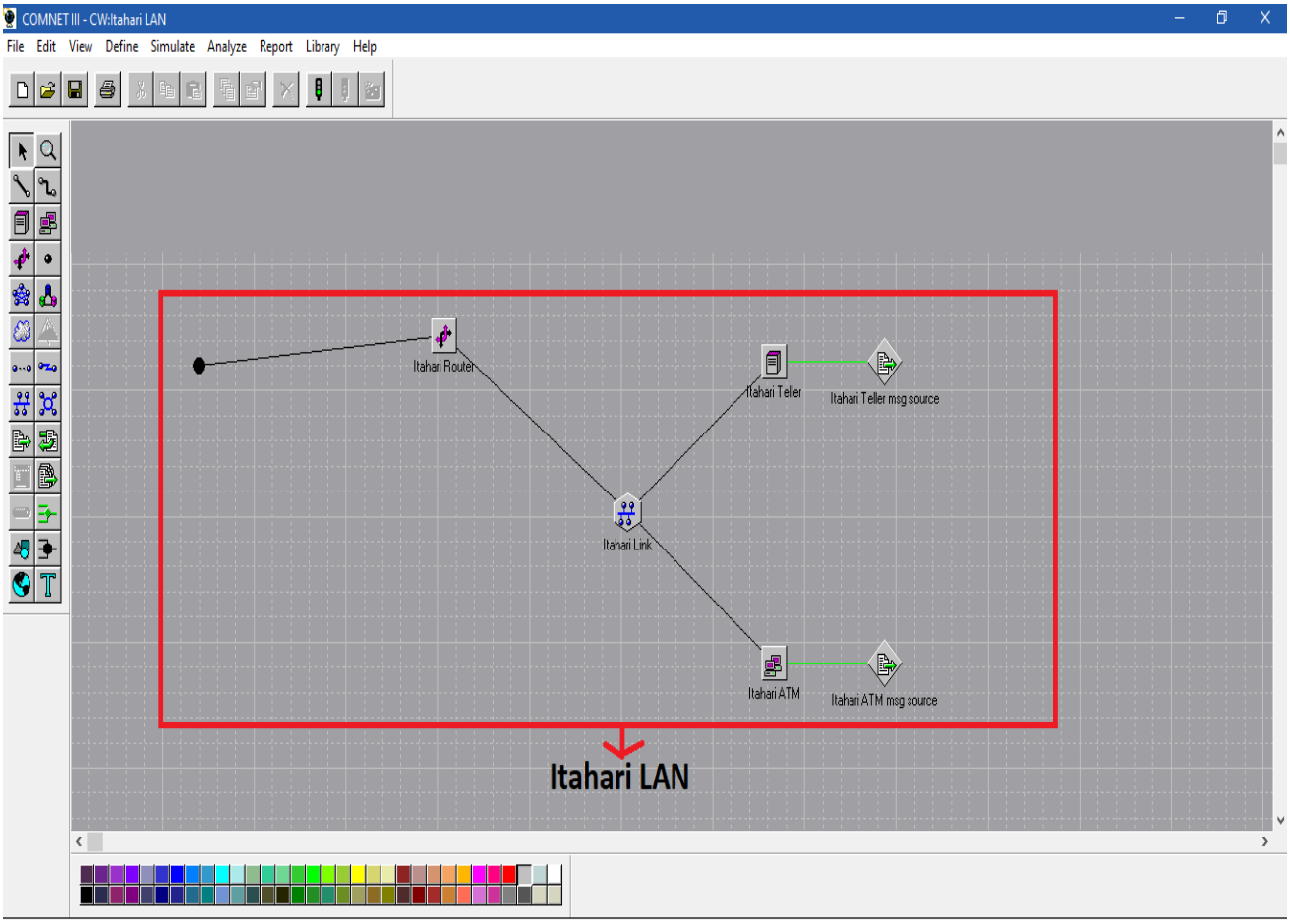

Figure 15: Itahari LAN

1.2.3.1. Network device: Router

In the scenario, cisco 7010sp, V10.0 router was given and this version of router is used here. This router is used in both Butwal and Itahari LAN. They are named as Butwal router and Itahari router. The router of this Butwal and Itahari LAN a forward ATM request to ATM processing server in Edinburg LAN and receives the response coming from the ATM processing server to their respective LAN. The figure is given below.

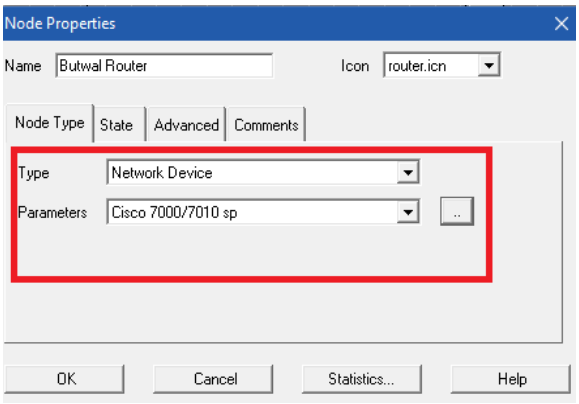

Figure 16:Itahari and Butwal LAN router

1.2.3.2. CSMA/CD Link

CSMA/CD link is a multi-access link which is used to model random access links and nodes in this link initially listen to the link to observe if it is busy prior to transmitting packets *(CompuwareCorporation, 2000)*. Here we have used using 802.3 CSMA/CD 10BaseT parameters for CSMA/CD link.

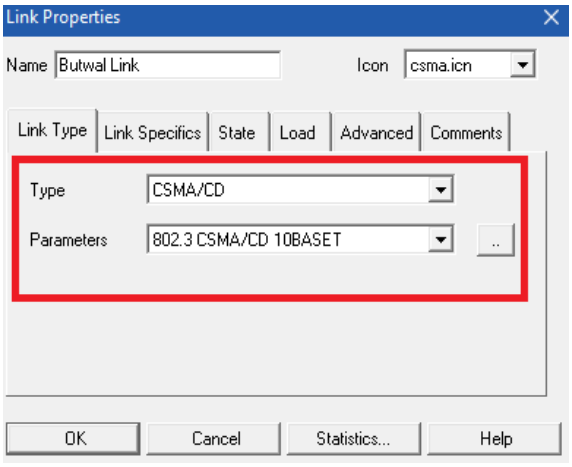

Figure 17: CSMA/CD Link

1.2.3.3. Processing node

The processing nodes serve as the origin or destination for messages or behave as a switching point inside the network. The processing node generates the request for the server with the assist of message source. . There are three processing node used in this LAN Model and they are Butwal Teller and Itahari Teller. The figure of processing node is shown below.

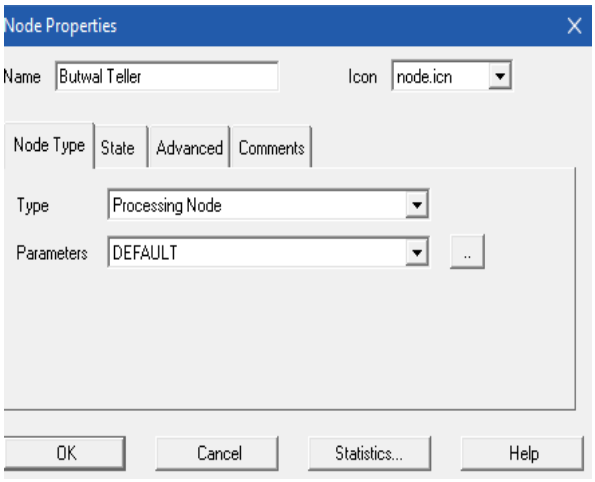

Figure 18: processing node of Butwal LAN

1.2.3.4. Message source

In the COMNET message source is a message generator that has capacity of transmitting messages to more than one location, and in this WAN model, there are four message sources which are: Butwal teller msg source, Itahari teller msg source, Butwal ATM msg source, and Itahari ATM msg source. Butwal ATM msg source and Itahari ATM msg source are set at an interarrival time to 0.5 with stream 2. Their message is set with a uniform distribution with the size equally distributed in the scale of 50 to 100 bytes with stream 2. Their destination is set at the ATM processing server of Edinburg LAN. Butwal teller msg source and Itahari teller msg source message are set with a uniform distribution where the size is equally distributed in the span of 40 to 100 bytes. Their destination is set at the ATM processing server of Edinburg LAN. The figures of message sources are below.

Since both Butwal and Itahari LANs message sources contains same content, so the figures shown below are of Butwal LAN's message source.

i. Butwal and Itahari Teller msg source:

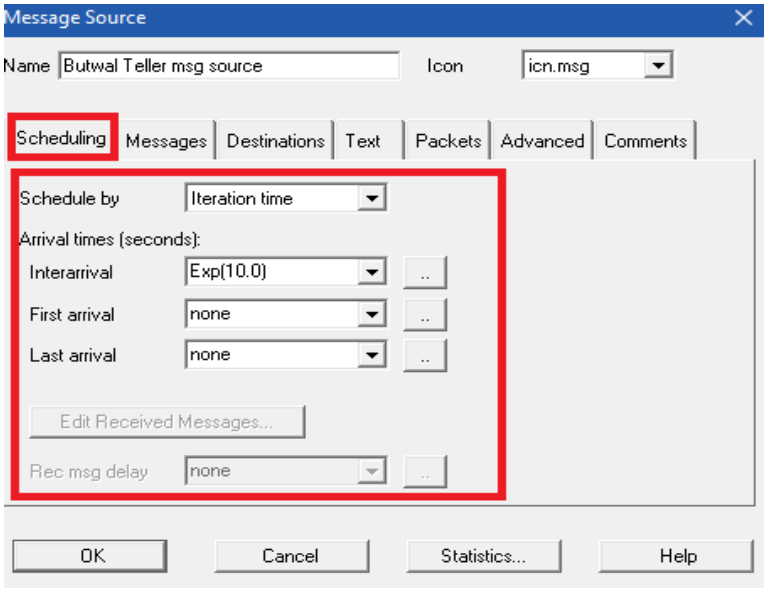

Figure 19: Butwal teller msg source: Scheduling

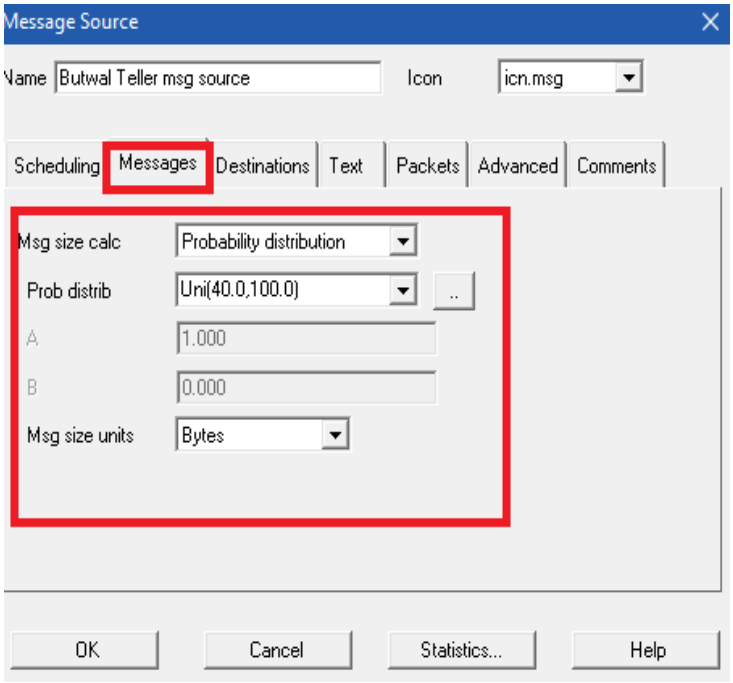

Figure 20: Butwal teller msg source: Messages

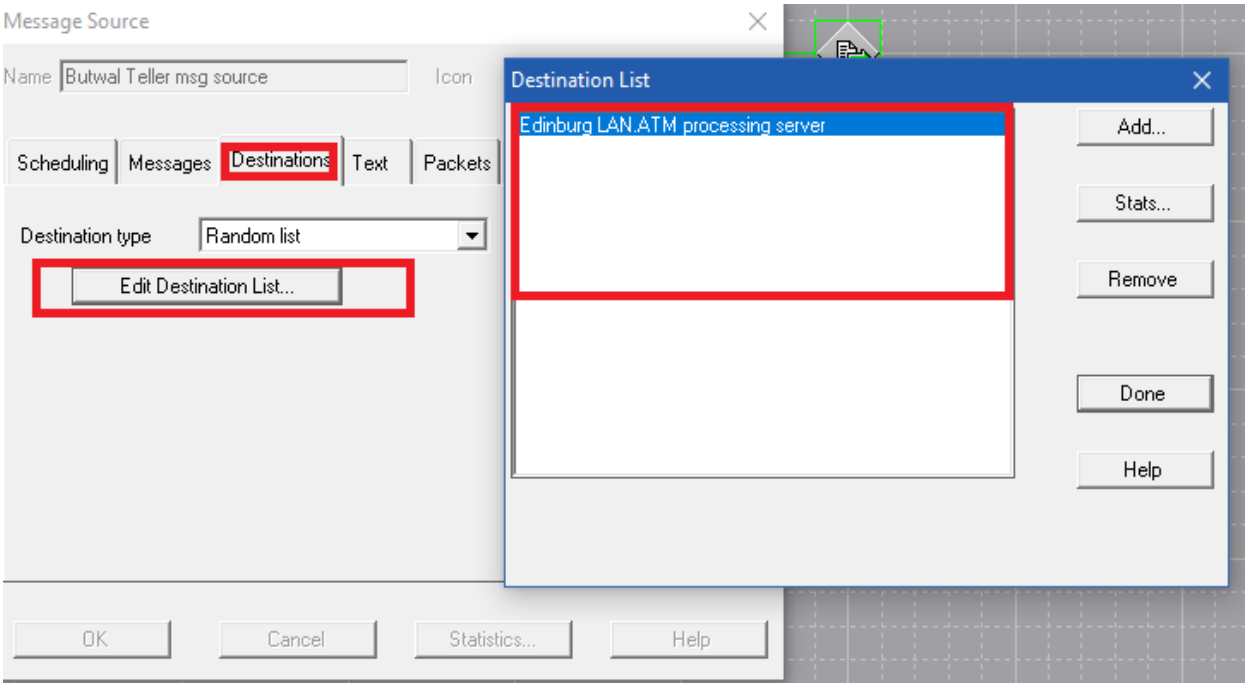

Figure 21: Butwal teller msg source: Destinations

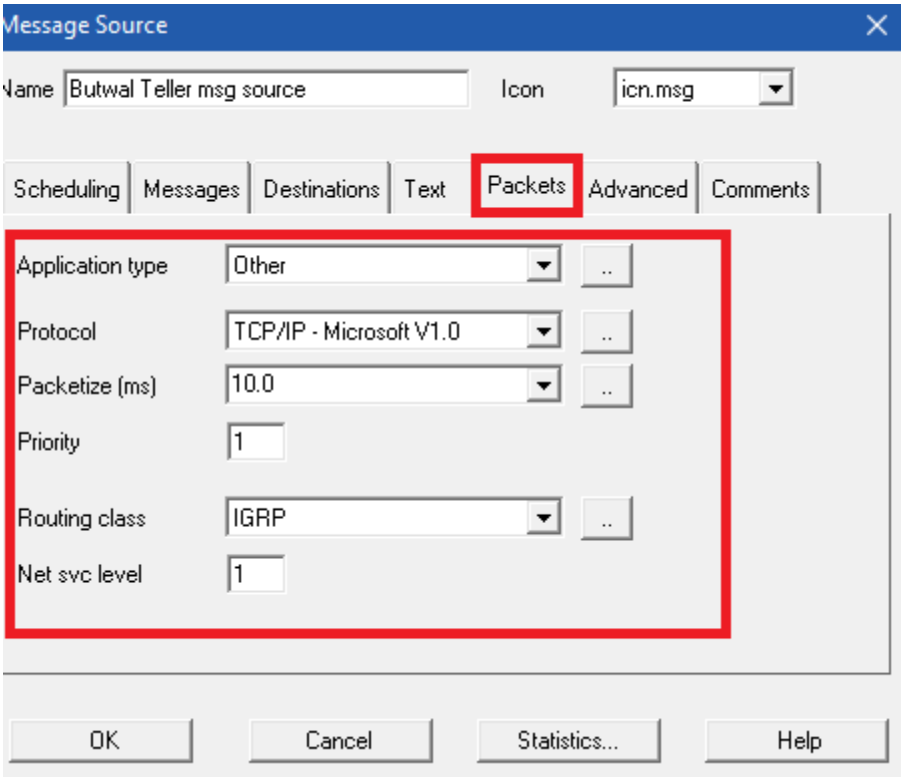

Figure 22: Butwal teller msg source: Packets

ii. Butwal and Itahari ATM msg source:

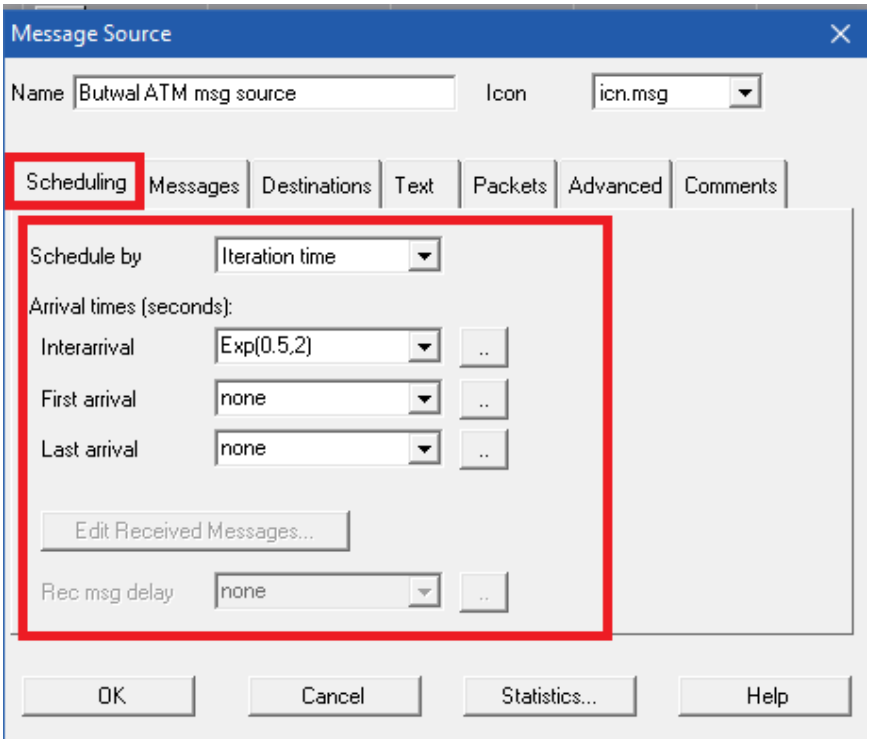

Figure 23: Butwal ATM msg source: Schedulings

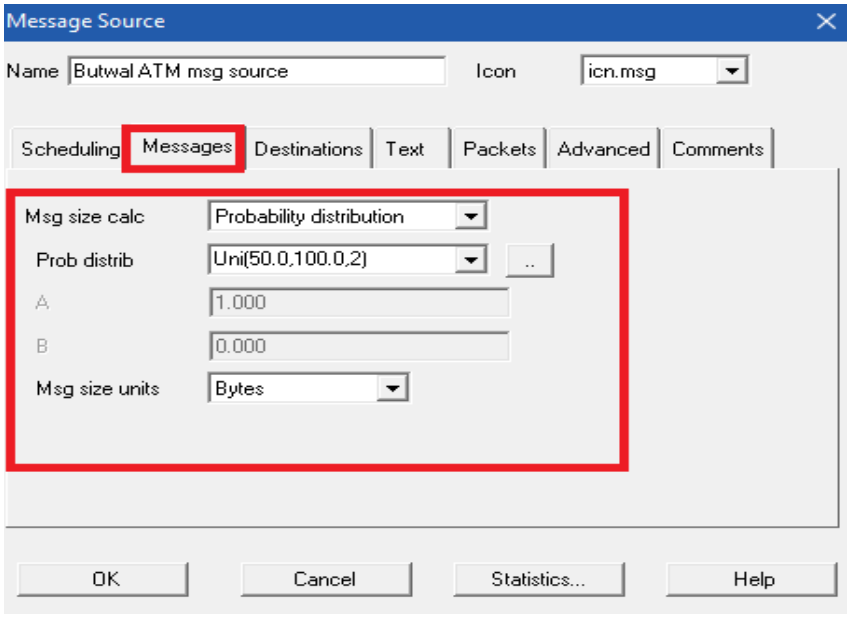

Figure 24: Butwal ATM msg source: Messages

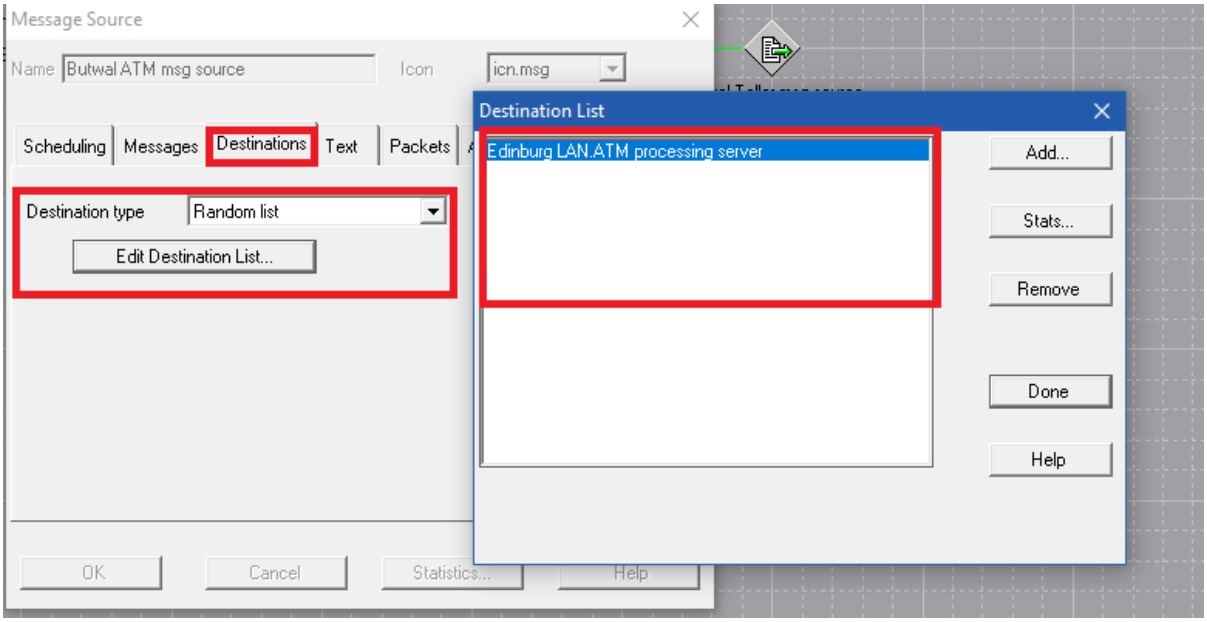

Figure 25: Butwal ATM msg source: Destinations

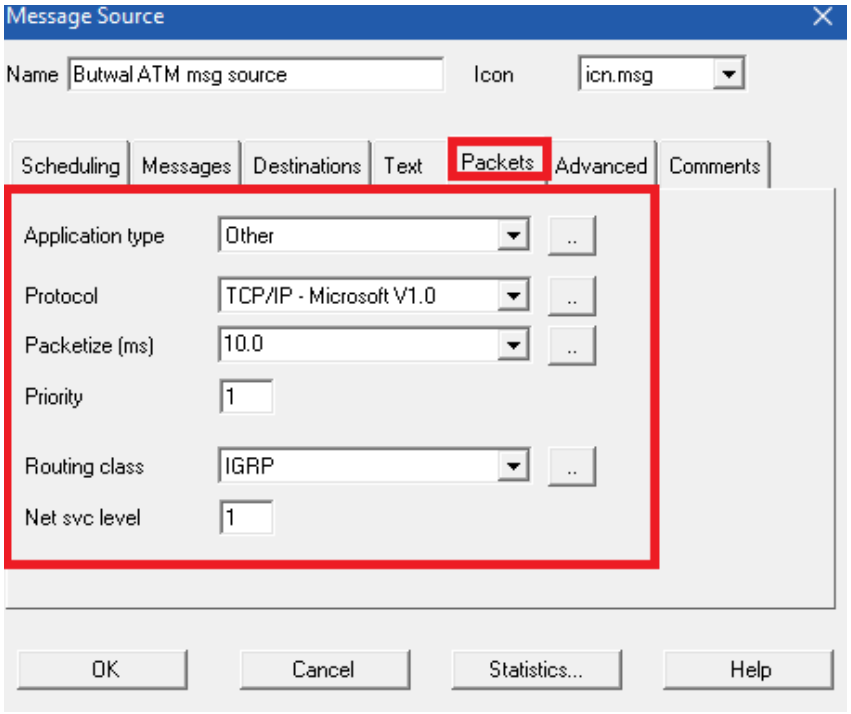

Figure 26: Butwal ATM msg source: Packets

1.2.3.5. Computer Group

The computer group which is also ATM group, it generates the request for the server with the assist of message source: Butwal ATM msg source and Itahari msg source. There are two computer groups used in WAN model in Butwal LAN and Itahari LAN and in these computer groups there are 30 ATMs connected to each other. The figure of computer group is shown below.

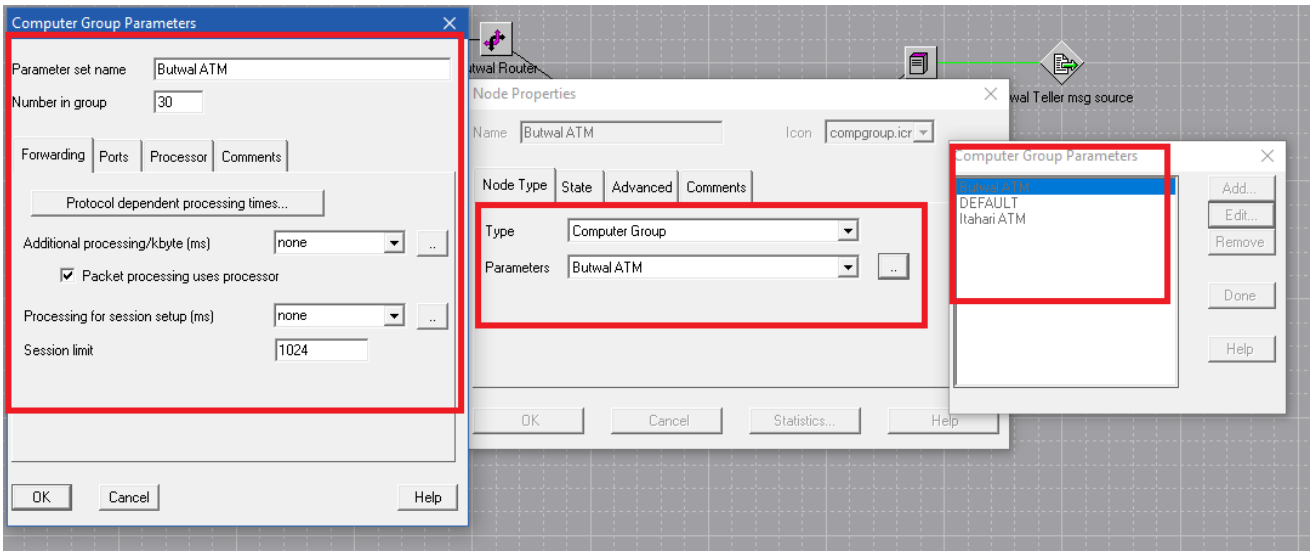

Figure 27: Computer group of Butwal and Itahari LAN

1.3. Description of Reports

The COMNET file is simulated and it gave report in notepad. It contained report about Node reports, Link reports, WAN cloud reports, Message and Report response. All these reports are described below:

1.3.1. Node Report: Received message count

Receiver	Count	Message name
Butwal LAN.Butwal ATM	1	Butwal ATM msg source
Edinburg LAN.ATM processing	980	Butwal ATM msg source
Edinburg LAN.ATM processing	997	Itahari ATM msg source
Edinburg LAN.ATM processing	1	Butwal Teller msg source
Edinburg LAN.ATM processing	2	Itahari Teller msg source

Table 1: Node Report: Received message count

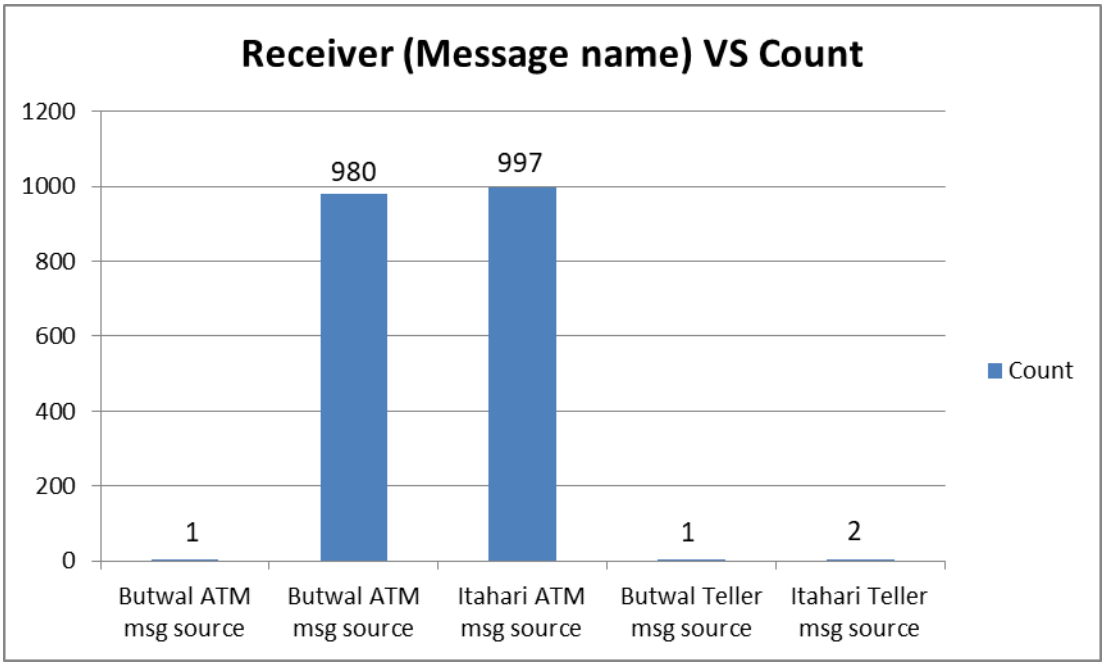

Figure 28: Bar graph: Receiver(Message name) vs Count

From the above table and bar graph, Butwal ATM msg source and Itahari ATM msg source have the message count of 980 and 997. It means the request from both ATM msg source are received properly. The Butwal Teller msg source and Itahari Teller msg source have the message count of 1 and 2.

1.3.2. Link Report: Channel Utilization

	Frames		Transmission Delay (ms) %			
Link	Delivered	RST/ERR	Average	STD DEV	Maximum	UTIL
Butwal LAN.Butwal Link	19025	0	0.073	0.028	0.722	2.2549
Itahari LAN.Itahari Link	19061	0	0.073	0.028	0.756	2.2556
Edinburg LAN.Edinburg Link	12737	0	0.038	0.014	0.082	0.8031

Table 2: Link report: Channel utilization

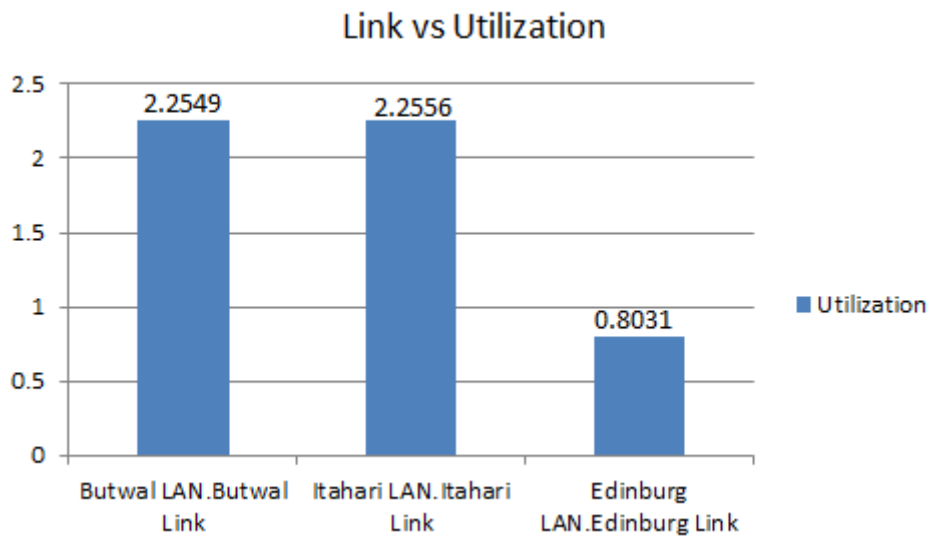

Figure 29: Bar graph: Link vs utilization

From the above table and bar graph, the CSMA/CD link used in Itahari and Butwal LAN and token passing link in Edinburg LAN is working properly and utilized as 2.2549 %, 2.2556% and 0.8031% respectively.

1.3.3. WAN Cloud Report: Frame Delay, Frame Count, Access Link Stat

i. WAN Cloud Report: Frame Delay

CLOUD:	Frame Delay (ms)			Burst Size (kb)	
VC	AVG	STD	MAX	AVG	MAX
Butwal-Edinburg	1164	697	2518	158	320
Edinburg-Butwal	17	0	22	111	243
Itahari-Edinburg	1168	701	2522	159	320
Edinburg-Itahari	17	0	17	111	251

Table 3: WAN Cloud report: Frame delay

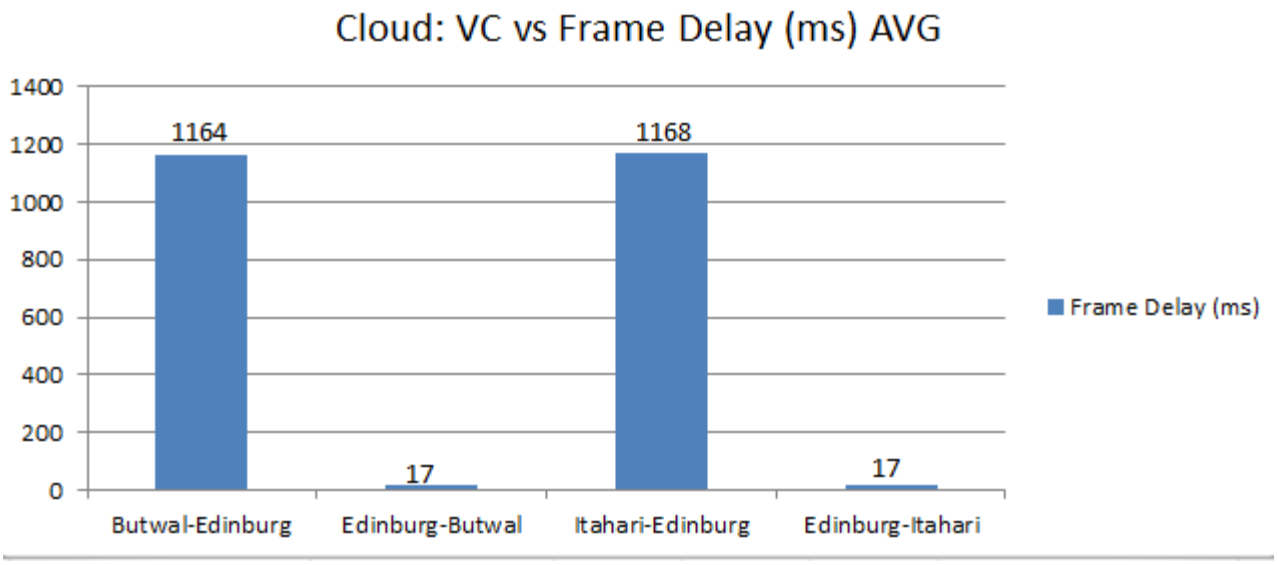

Figure 30: Bar graph: Cloud:VC vs Frame Delay(ms) AVG

From the above table and bar graph, the virtual circuit used in WAN cloud has an average frame delay for Butwal-Edinburg VC, Edinburg-Butwal VC, Itahari-Edinburg VC and Edinburg-Itahari VC are 1164ms, 17ms, 1168ms and 17ms respectively. It is clear that the response from the server is quicker than the request from the client LAN's ATM.

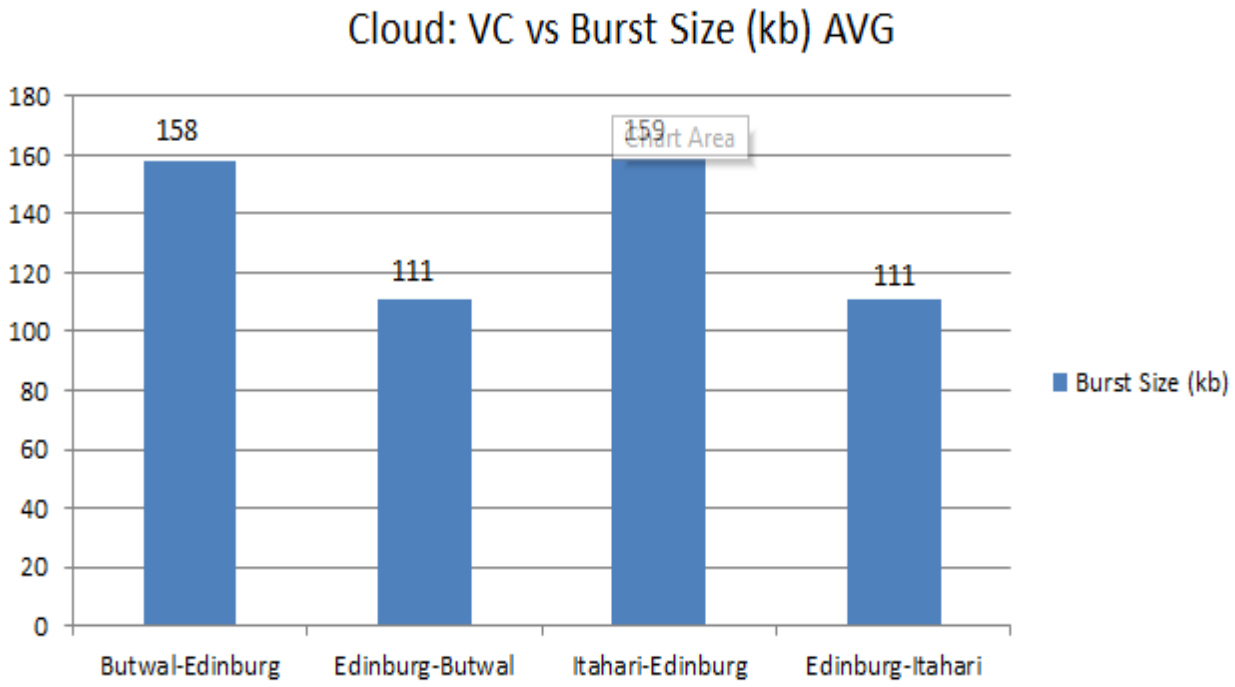

Figure 31: Bar graph: Cloud: VC vs Brust size(kb) AVG

From the above table and bar graph, the Virtual Circuit used in the WAN Cloud has an average frame delay for Butwal-Edinburg VC, Edinburg-Butwal VC, Itahari-Edinburg VC and Edinburg-Itahari VC are 158kb, 111kb, 159kb and 111kb respectively. It is clear that the response from the server has low burst size than the request from the client LAN ATM.

ii. WAN Cloud Report: Frame Count

CLOUD:	FRAMES / KILOBITS			
	ACCEPTED		DROPPED	
VC: FRAMES KILOBITS	NORMAL	DE	NORMAL	DE
WAN CLOUD	(TOTAL Kilobits TRASNMITTED= 5265)			
Butwal-Edinburg frm kb	1616 803	1570 810	0 0	9640 4656
Edinburg-Butwal frm kb	2303 737	884 283	0 0	0 0
Itahari-Edinburg frm kb	1600 805	1582 808	0 0	9568 4693
Edinburg-Itahari Frm kb	2304 737	878 281	0 0	0 0

Table 4: WAN Cloud report: Frame count

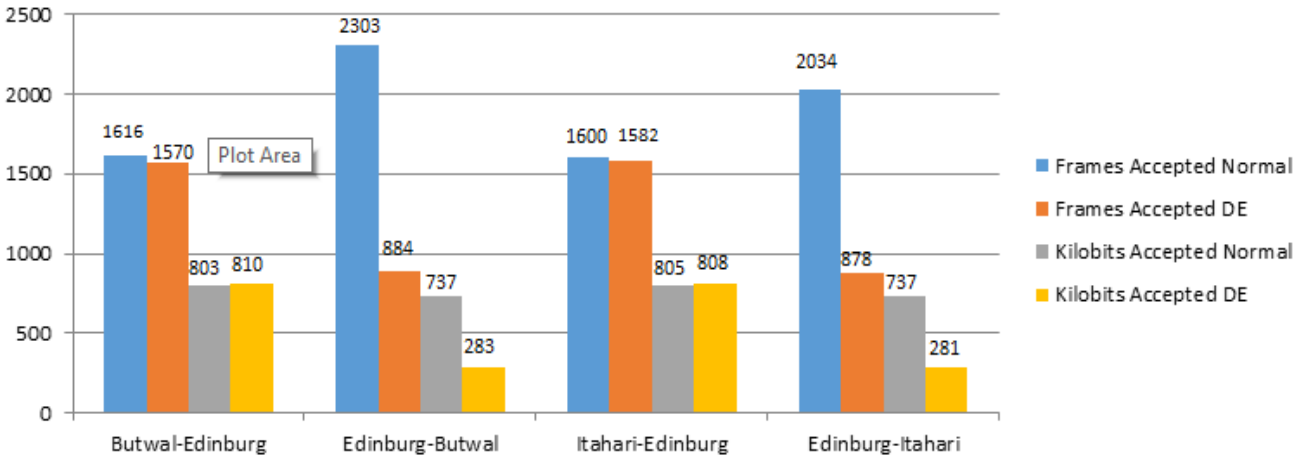

Figure 32: Bar graph: WAN Cloud Report: Frame Count

From the above table and bar graph the virtual circuits used in the WAN Cloud are: Butwal-Edinburg VC, Edinburg-Butwal VC, Itahari-Edinburg VC and Edinburg-Itahari VC. They accept more frames than kilobits. It is clear that the frames accepted by the VC are greater than the kilobits accepted by VC.

iii. WAN Cloud Report: Access Link Stat

CLoud:		Buffer (Bytes)			Frames		% Util
Access Link (Entry) (Exit)		MAX	AVG	STD	Accepted	Dropped	
Edinburg access	Entry	N/A	N/A	N/A	6369	0	34.50
	Exit	33947	7808	10305	6368	0	49.97
Butwal access	Entry	N/A	N/A	N/A	3186	9460	97.44
	Exit	83	7	15	3187	0	17.27
Itahari access	Entry	N/A	N/A	N/A	3182	9568	98.03
	Exit	80	7	15	3182	0	17.24

Table 5: WAN Cloud report: Access link stat

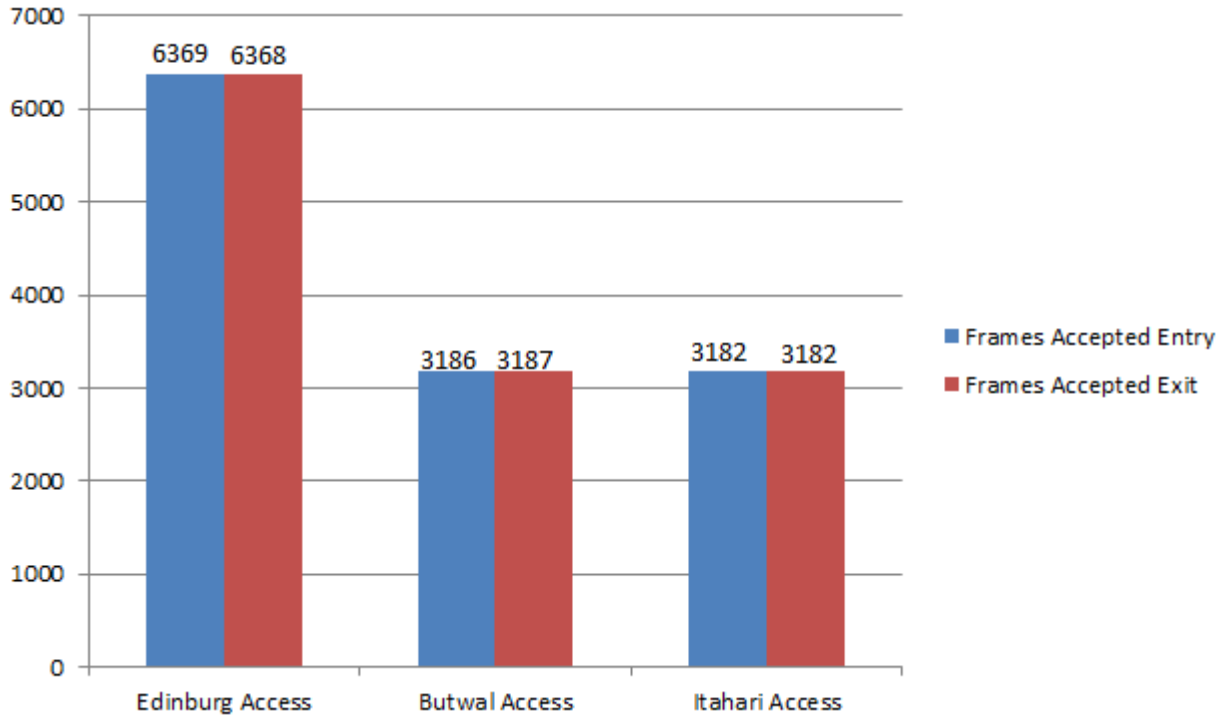

Figure 33: Bar graph: WAN Cloud Report: Access Link Stat

From the above table and bar graph, the access link that are used in WAN cloud are Edinburg Access, Butwal Access and Itahari Access which accepts same value of entry frames but differ while frame exit. It is clear that the exit frames are high in Edinburg LAN than any other LANs.

1.3.4. Message and Report Response: Message Delay For All Nodes

Origin/ MSG SRC Name: Destination List	Messages Assembled	Average	Message Delay STD DEV	Maximum
Butwal LAN.Butwal Teller/src Butwal teller msg source: Edinburg LAN.ATM pro	1	1008.668 ms	0.000 ms	1008.668 ms
Butwal LAN.Butwal ATM/src Butwal ATM msg source: Edinburg LAN.ATM pro	518	21513.292 ms	13605.498 ms	51182.433 ms
Itahari LAN.Itahari Teller/src Itahari teller msg source: Edinburg LAN.ATM pro	1	33986.285 ms	0.000 ms	33986.285 ms
Itahari LAN.Itahari ATM/src Itahari ATM msg source: Edinburg LAN.ATM pro	511	21796.426 ms	14132.238 ms	51880.044 ms
Edinburg LAN.ATM processing server/src Edinburg msg response: ECHO	0	0.000 ms	0.000 ms	0.000 ms

Table 6: Message and Report Response: Message Delay For All Nodes

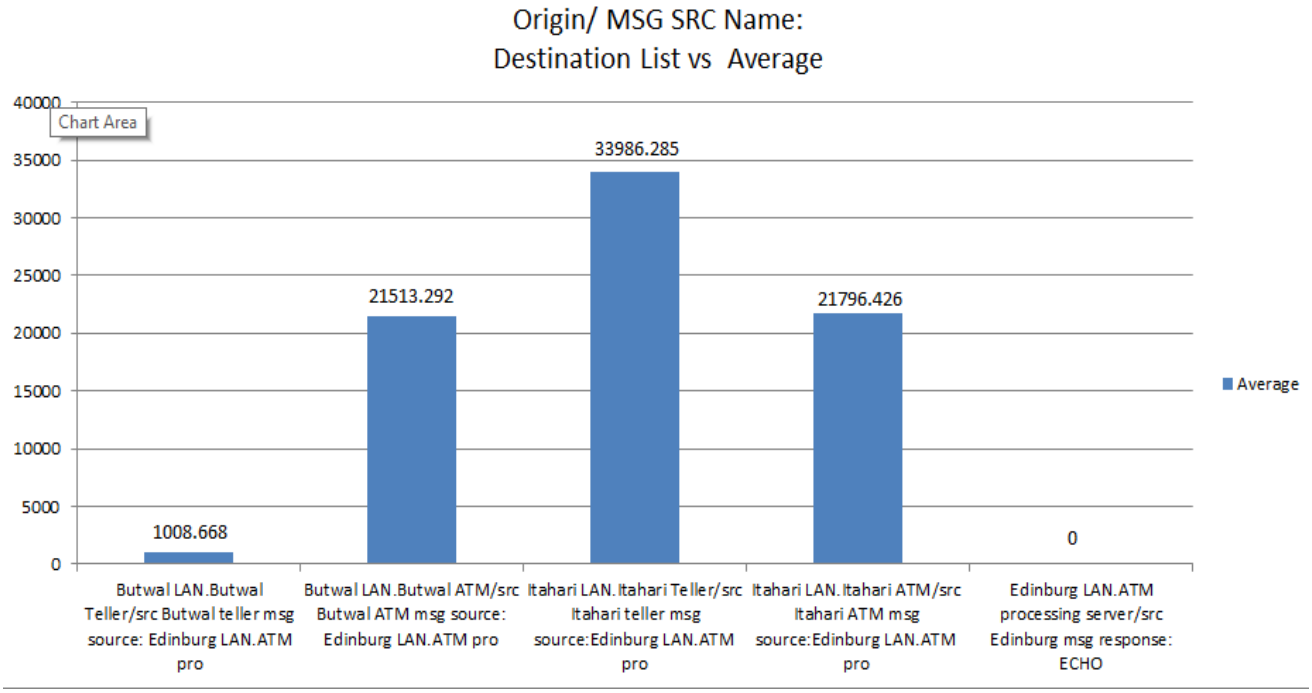

Figure 34: Bargraph: Destination list vs Average

From the above table and bar graph, Butwal ATM msg source and Itahari ATM msg source has an average delay of 21513.292 and 21796.426 respectively which clarify that the request from both the ATM msg source are received. From the above table and bar graph, Butwal teller msg and Itahari teller msg has an average delivered rate of 1008.668 and 33986.285 respectively.

1.4. Conclusion

All the works of task A that was assigned in the coursework as completed after going through many difficulties as the research was conducted about the network simulation and tools used. While doing this report it had also helped me a lot in gaining knowledge about network simulation and using its tools. With the completion of this task, I also have gained a good experience.

2. Task B

For the second task of this coursework we had to write technical report about Wireless Networks.

2.1. Introduction

In the task B of this coursework we had to do research works and write technical report about the wireless network. Our main goal was to do research about the wireless networks, its features and write a technical report about it so that it would be easy for any individual who wants to know or learn about wireless networks.

This report will give an easier way to understand about wireless networks, wireless technologies and their functions. The main objective of this report is to gain knowledge about Wireless networks, its history and its types. To achieve this goal research works were conducted. Information was gathered from different sources like website, Journal, Books and conference papers.

2.2. Background

Wireless networks have a significant role in our day to day life. Wireless network is the reason behind the connectivity from one part to another part of this world. The wireless network is growing rapidly in the context of both home and business networking. The wireless network allows everybody to communicate and access applications and information without any type of physical connection *(Andrew S.Tanenbaum, 2011)*. Wireless network keeps on being advanced and at the same time the cost of wireless products are also decreasing with the increase in advancement of the technology *(A.Matin, 2012)*. In this world, there are around 4.66 billion internet users, and each day more than 875,000 new users are added. In today's time, wireless networks are used in different fields such as health care, education, finance, hospitality, airport, etc. The wireless network has a significant impact on this world as its usage is being increased day by day in different fields. The Wireless network has revolutionized the digital and communications world like nothing ever before.

2.1.1. Wireless Networks

The wireless network enables different networking devices to remain connected to the network by using the wireless data connection and it allows everyone to communicate and access applications and information without any type of physical connection *(Kaveh Pahlavan, 2011)*. As we are the people of the modern age, we are more familiar with wireless networks. Wireless network provides us freedom of mobility as we can access to different kinds of information and we can be connected to network form different part of this world. Wireless networks enable us to communicate with e-mail, online video conference, watch online videos, use different social media, or surf the Internet from a location we prefer. In wireless networks radio waves, infrared light, microwaves are used as the medium for transmitting data between users, servers and between different kinds of networks and this kind of communication medium is invisible to the normal human eye *(Stallings, 2003)*. The wireless communication devices are easy to use and give us the freedom of mobility so it is the great problem solving technology of the century. This kind of network is very suitable as it terminates the desire to have connected cables to assist any communicating device.

Figure 35: Wireless Networks (360Technologies, 2019).

There are various types of wireless networks which are wireless local area network (WLAN) used in a small area, wireless wide area network (WWAN) used in the whole world, wireless personal area network (WPAN) used in a personal area, wireless metropolitan area network (WMAN) used in a certain area as of metropolitan, Hybrid network, and wireless ad hoc network.

i. Wireless Local Area Network (WLAN):

This type of network is also known as LAWN (Local Area Wireless Network). This kind of network usually takes place if any kind of portable device, smartphones are interconnected to the closest networks with the assist of a wireless connection, and WLAN can be made through any type of wireless network protocol, but the most usual way of making sure a connection is through a Bluetooth or Wi-Fi *(Shireeninc, 2019)*. Due to the widespread implementation of wireless LAN adapters in laptops, wireless network providers (ISP) install wireless LANs to provide broadband access to the Internet, People within range of a wireless LAN at a hotspot, place such as an airport or hotel, can access e-mail and surf the Internet *(Etutorial, 2018)*. The continuous increment in WLANs is making the Internet accessible to users at different places.

ii. Wireless Wide Area Network (WWAN):

Wireless WANs cover a large location, such as states, country, and continent. Wireless WAN provides long-range connectivity for the huge user base. A person can access Internet services from the wireless WAN from almost every part of this world. Wireless WAN has different kinds of usage which are surfing the Internet, sending and e-mails, using variants of social media, and using the work place's applications and documents when we are away. A wireless WAN is way advanced than any other networks and it reaches more locations than other kinds of wireless network, which allows people to continue their work and do online tasks from more different places *(Harpreet S.Dhillon, 2017)*.

iii. Wireless Personal Area Network (WPAN):

Wireless Personal Area Networks are the short-ranged networks, which are used to interconnect the devices based on Bluetooth technology in a central place like a desk and the range of personal area network is around 30 feet *(TetraMou, 2018)*. This type of network provides data transmission for networking gadgets such as computers, smartphones, and tablets. The radio wave is used to carry the information and data through the air in most of the wireless PANs and the Bluetooth feature is the best example, which describes the operation of the Wireless Personal Area Network (WPAN). Wireless personal area network (WPAN) is a short-range network system, which provides interconnection between user's PDAs and networking devices *(Wemangi Shinde, 2005)*.

iv. Wireless Metropolitan Area Network (WMAN):

The wireless computer network, which connects different persons with communicating devices in a location that size about a metropolitan area, is known as Wireless Metropolitan Area Network (WMAN). Wireless Metropolitan Area Network (WMAN) is specially made for the larger geographical area that is bigger than a Wireless Local Area Network (WLAN) which has the range to 30 miles with a speed of 34 Mbps to 155 Mbps and it is usually used in schools, universities, and different public places that has a high-speed network *(TetraMou, 2018)*.

2.1.1.1. History

Wireless network transmission dates back into the history of human beings as in ancient periods, humans used primitive measures for communication that is categorized as wireless and some of the examples which were used in ancient periods were signals given from smoke, flashing the mirrors, showing the flags, creating huge fires, etc. In 1895, Guglielmo Marconi became the first person to successfully transmit and receive long-distance radio signals by developing a functional transmitter and receiver *(Alfred Wicks, 2003)*. Transmitting information without wire was a scientific interest in the last half of the 19th century. 1G stands for the 1st generation of wireless telephone technology also known as mobile telecommunications. This analog technology used radio signals and it was introduced in 1979 *(P. Nicopolitidis, 2003)*. In the 1960s the most popular wireless wide area network, the internet was invented. The Wireless network has revolutionized the digital and communications world like nothing ever before. The invention of the telegraph, the telephone, the radio, and the computer had made wireless networks more advanced. The development of commercial wireless networks happened basically in the last part of the 1980s and 1990s and after that, there was a huge competition in the wireless industry and there was the mass acceptance of wireless technologies *(A.Matin, 2012)*.

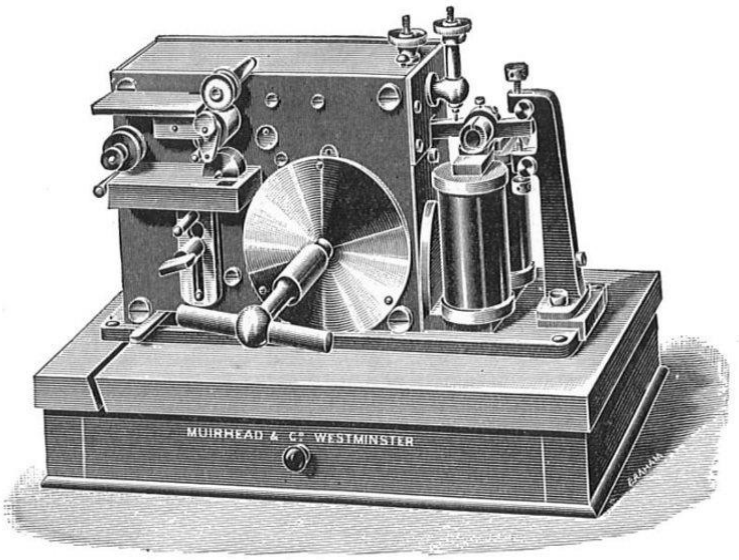

Figure 36: Wireless Telegraph (OPCM, 2018).

2.1.1.2 Advantages and Disadvantages

Wireless Network is the type of technology which has both advantages as well as some disadvantages.

The advantages are:

- The wireless network allows staying connected while roaming around the worksite without getting disconnected from the network,
- It provides the network even in a location where it is difficult for the wired network to reach, so we can stay connected and access information or application from the network,
- It helps to grow the network efficiently by adding new customers and adding different destination without the need for wires and cables,
- We do not have to connect cables and wires so it would be less expensive and quick to install *(Cisco, 2020)*.

The disadvantages are:

- The wireless networks are usually less secured and more exposed to attackers than wired networks,
- It can be disturbed by the sources of electromagnetic (radio) signals, household substances, and things such as ceilings, walls, and furniture,
- It would be difficult to set up a wireless network for those users who are not properly experienced using computers,
- It can be less efficient and slow than the wired network as the connection decreases if we are far from the router which is a great problem in big buildings or space *(INFO, 2019)*.

2.1.2. IEEE 802.11 Architecture

IEEE 802.11 is a group of MAC (media access control) and PHY (physical layer) features that carry out WLAN (wireless local area network) computer communication at 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands *(Ques10, 2019)*. The architecture of the IEEE 802.11 wireless local area network was formed to assist the network where most administrative task is dispense to portable stations *(Ezeme, 2014)*. There are different types of components of IEEE 802.11 architecture which are given below:

i. STA (Stations):

Stations consist of all the equipment and device, which are connected to the WLAN (wireless local area network). Every station consists of a wireless network interface controller. A station also has two types:

a) WAP (wireless access point), which are commonly routers that form the access or the base station,
b) Clients are computers, smartphones, workstations, printers, etc.

ii. BSS (Basic Service Set):

A basic service set consists of stations communicating in the physical layer level. BS (basic service set) is made of two types which are:

a) Infrastructure BSS: where the devices through the access points communicate with another device,
b) Independent BSS: where the devices communicate on the peer to peer basis in the ad hoc manner (Tutorialspoint, 2019).

iii. ESS (Extended Service Set): It is a group of all the connected BSS.
iv. DS (Distribution System): In ESS, distribution system (DS) connects the access points.

2.1.3. IEEE 802.11 Priorities

After IEEE 802.11 was introduced in 1977, major and minor amendments were made to this standard. IEEE 802.11 standard is also known as Wi-Fi, which gives the architecture and features of wireless LANs (WLANs). Total there are 6 major amendments in this standard that describe the new mac and the physical layer. These six versions are IEEE 802.11a, IEEE 802.11b, IEEE 802.11n, IEEE 802.11g, IEEE 802.11ax and IEEE 802.11ac. The common specifications of IEEE 802.11 are:

i) Frequency bands of 2.4 GHz or 5GHz are used.
ii) Half-duplex signaling is used.
iii) CSMA/CA is used to avoid a collision.

The speed supported by IEEE 802.11b is up to 11 Mbps and it uses the same 2.4 GHz frequency band as the original IEEE 802.11 standard *(Mitchell, 2020)*. The bandwidth supported by IEEE 802.11a is up to 54 Mbps and it uses the 5 GHz frequency spectrum. In the early 2000s different WLAN products supporting the latest standard (IEEE 802.11g) were launched in the market, which supports speed up to 54 Mbps and has 2.4 GHz frequency for greater range *(Mitchell, 2020)*. IEEE 802.11n also known as Wireless N was introduced in 2009, which provides network bandwidth up to 600 Mbps. IEEE 802.11ac also known as Wi-Fi 5 has network bandwidth up to 1300 Mbps on 5 GHz frequency and up to 450 Mbps on 2.4 GHz *(Mitchell, 2020)*. This standard is compliant with most of the home wireless routers *(Jiri Milos, 2017)*. In 2019, IEEE 802.11ax was released and was branded as Wi-Fi 6 and it will be replacing IEEE 802.11ac. Wi-Fi 6 has network bandwidth up to 10 Gbps and has better security.

2.1.4. Wireless Technology

The technology which uses electromagnetic waves to communicate with other communicating devices instead of using any type of physical connection (cable, wire) is known as wireless technology. This technology is an alternative to the traditional wired network technology such as cable, wire, and fiber optics. In today's time, wireless technology has become one of our basic needs. Wireless technology is changing the world as wireless devices are portable, easy to use and it provides connectivity in any location. Some of the examples of wireless technology are cellular networks (3g/4g/5g), Wi-Fi, Bluetooth, Zigbee, Wi-Max, etc. The cellular network, Wi-Fi, Bluetooth are the most common wireless technology which we use in our day to day basis.

The cellular network had been well established in the consumer's mobile market for decades. It offers reliable wireless communication that supports various voice calls, messages, e-mails, and video streaming applications. Wi-Fi (Wireless Fidelity) is a high-speed wireless connection between computing devices (Laptops, smartphones, tablets, etc.) and the internet. Bluetooth is also wireless technology (radio technology) which uses radiofrequency to transfer data between the communication devices.

Figure 37: Wireless technology (Elprocus, 2018) .

2.1.4.1. WAP

WAP (Wireless access point) is the configured node or networking hardware in a local area network, which allows wireless communicating devices and wired networks to connect through a wireless medium like Wi-Fi or Bluetooth. WAPs help to give connectivity between communicating devices and the internet. Wireless Access Point (WAP) is usually known as a hotspot. WAPs can also be used to give wireless network connectivity in different locations like offices, institutes, and different public places. Wi-Fi hotspots frequently use one or more Wireless Access Point to support a Wi-Fi extended area *(Mitchell, 2020)*.

Figure 38: Wireless Access Point (Cisco, 2019).

2.1.4.2. WML

WML stands for Wireless Markup Language, which is a markup language used for wireless devices to develop websites for mobile phones and it is based on HTML and HDML. It is also recognized as an XML document type. It provides the content to wireless devices, which do not have proper processing capacity. WML handles the small screen and the low bandwidth. HTML is a page whereas WML is a card and it is the major variance between HTML and WML. WML file consists of many multiple cards so; it forms a deck *(Robson, 2020)*. The specifications of WML are:

i) It gives hints about the way text and images are presented to the user.

ii) It provides browsing history and hyperlink navigation.

iii) Compared to HTML it has fewer tags.

iv) It is case sensitive as it follows XHTML specification.

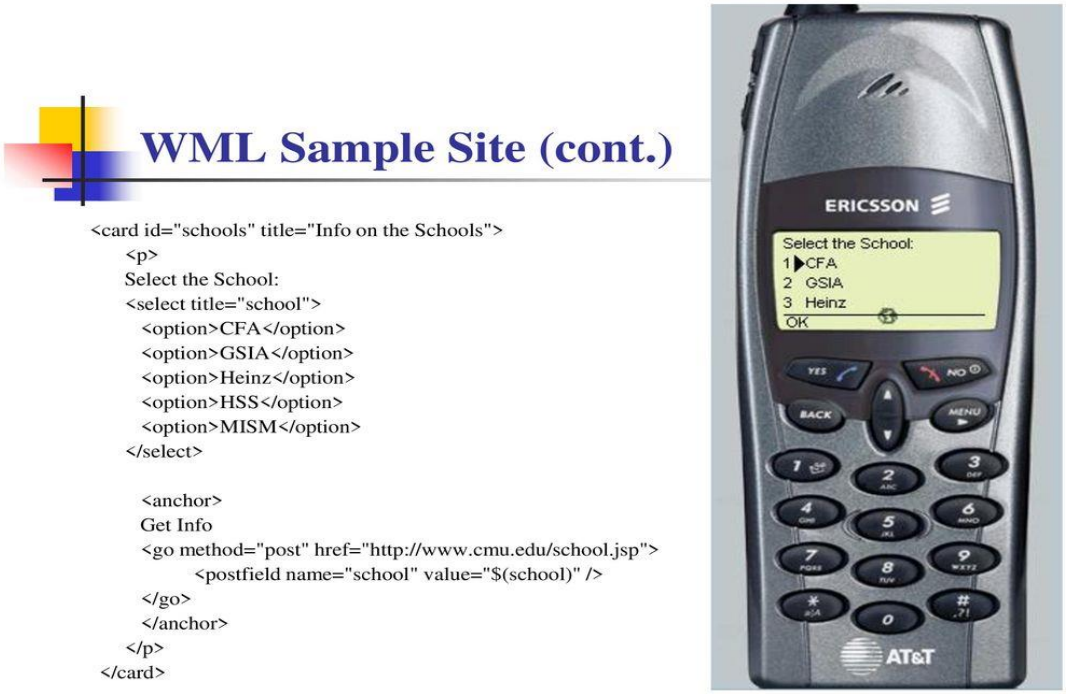

Figure 39: WML Sample (SlidePlayer, 2017).

2.3. Conclusion

Wireless networks are very suitable as they terminate the desire to have connected cables to assist any communicating device. Wireless networks have also become one of the basic needs of the people. By going through the report we can learn about the importance, history, and advancement of wireless technology. Wireless networks are the reason behind this world becoming a narrow place as people can be connected with each other from different parts of this world. From this report, we can conclude that the wireless network is the fastest growing technology and it is great problem-solving technology for mankind.

3. References and Bibliography

References

360Technologies, S. (2019) *Advanced Wireless Technology Applications* [Online]. Available from: https://smart360tech.com/advanced-wireless-technology-applications/ [Accessed December 2020].

A.Matin, M. (2012) Introduction to Wireless Networks. In *Developments in Wireless Network Prototyping, Design, and Deployment: Future Generations*. 1st ed. Brunei Darussalam: IGI global. pp.1-9.

Ahuja, S.P. (2000) *COMNET III: A Network Simulation Laboratory Environment For A Course In*. Allendale: Grand Valley State University.

Alfred Wicks, J.K. (2003) A brief early history of wireless technology. *Experimental Techniques*, pp.57-58.

Andrew S.Tanenbaum, D.J.W. (2011) *Computer Networks*. 5th ed. Prentice hall.

Cisco. (2019) *Cisco Small Business 500 Series Wireless Access Points* [Online]. Available from: https://www.cisco.com/c/en/us/products/wireless/small-business-500-series-wireless-access-points/index.html [Accessed December 2020].

Cisco. (2019) *Small Business Networking Resources* [Online]. Available from: https://www.cisco.com/c/en/us/solutions/small-business/resource-center/networking/what-is-a-router.html#:~:text=A%20router%20receives%20and%20sends,or%20help%20create%20business%20networks. [Accessed December 2020].

Cisco. (2020) *Wireless Network: Benefits* [Online]. Available from: https://www.cisco.com/c/en/us/solutions/small-business/resource-center/networking/wireless-network.html#~benefits [Accessed December 2020].

CompuwareCorporation. (2000) *Comnet III tutorial*. Compuware Corporation.

Elprocus. (2018) *Different Types of Wireless Communication with Applications* [Online]. Available from: https://www.elprocus.com/types-of-wireless-communication-applications/ [Accessed December 2020].

Etutorial. (2018) *Wireless Networks Defined* [Online]. Available from: http://etutorials.org/Networking/wn/Chapter+1.+The+Wireless+World+An+Introduction+to+Concepts/Wireless+Networks+Defined/ [Accessed December 2020].

Ezeme, O. (2014) *Analysis of IEEE 802.11: Architecture, Protocols, QoS and Interference*. Research Gate.

Harpreet S.Dhillon, H.H.H.V. (2017) *Wide-area Wireless Communication Challenges for the Internet of Things*, 55(2), pp.168-74.

INFO, N. (2019) *Wireless technology: Pros and cons* [Online]. Available from: https://www.nibusinessinfo.co.uk/content/pros-and-cons-wireless-networking [Accessed December 2020].

Jiri Milos, L.P.M.S. (2017) Performance Analysis of IEEE 802.11ac/ax. In *International Conference on Radioelektronika*., 2017. IEE.

Kaveh Pahlavan, P.K. (2011) *Principles of Wireless Networks: A Unified Approach*. 1st ed. New Jersy: Prentice Hall.

Mitchell, B. (2020) *802.11 Standards Explained* [Online]. Available from: https://www.lifewire.com/wireless-standards-802-11a-802-11b-g-n-and-802-11ac-816553 [Accessed December 2020].

Mitchell, B. (2020) *Life wire* [Online]. Available from: https://www.lifewire.com/wireless-access-point-816545 [Accessed December 2020].

OPCM. (2018) *DR CRIPPEN AND WIRELESS TELEGRAPHY* [Online]. Available from: https://www.oldpolicecellsmuseum.org.uk/content/learning/educational-programmes-and-tours/dr-chippen-wireless-telegraphy [Accessed December 2020].

P. Nicopolitidis, M.S.O.G.I.P.A.S.P. (2003) *Wireless Networks*. Chester: John Wiley & Sons Ltd.

Patel, R. (2018) Survey on Network Simulators. *International Journal of Computer Applications*, 182(1), p.23.

post, T.s. (2016) *World's first pirate broadcast on Easter 1916 to be celebrated* [Online]. Available from: https://swling.com/blog/2016/04/worlds-first-pirate-broadcast-on-easter-1916-to-be-celebrated/ [Accessed 2020].

Ques10. (2019) *Architecture of IEEE 802.11* [Online]. Available from: https://www.ques10.com/p/10715/architecture-of-ieee-80211-1/ [Accessed December 2020].

Robson, M. (2020) *GeeksforGeeks* [Online]. Available from: https://www.geeksforgeeks.org/wml-introduction/ [Accessed December 2020].

Shireeninc. (2019) *Types of wireless network* [Online]. Available from: https://www.shireeninc.com/types-of-wireless-networks [Accessed December 2020].

SlidePlayer. (2017) *Wireless Markup Language* [Online]. Available from: https://slideplayer.com/slide/12303504/ [Accessed December 2020].

Stallings, W. (2003) *Data and computer communications*. 5th ed. New Jersey: Prentice Hall.

TetraMou. (2018) *TYPES AND APPLICATION OF WIRELESS NETWORK* [Online]. Available from: https://www.tetramou.com/types-of-wireless-network/ [Accessed December 2020].

Tutorialspoint. (2019) *IEEE 802.11 networks* [Online]. Available from: https://www.tutorialspoint.com/what-are-ieee-802-11-networks [Accessed December 2020].

Wemangi Shinde, M.B. (2005) High-Rate Wireless Personal Area Networks. In *IEEE International Conference on Personal Wireless Communication*. New Delhi, 2005. IEE.

4. Appendix

4.1. Appendix - A

This report is about Nodes: Received message counts. This report is explained in task A by using bar graph and table. The original report is given below.

```
Compuware COMNET III  Release 2.5.2.814  Fri Dec 18 16:50:09 2020   PAGE     1

                                      CW

                        NODES: RECEIVED MESSAGE COUNTS

                     REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

      RECEIVER              COUNT                    MESSAGE NAME
_____________________  __________  ____________________________________________

Butwal LAN.Butwal ATM           1    Butwal ATM msg source

Edinburg LAN.ATM proce        980    Butwal ATM msg source
Edinburg LAN.ATM proce        997    Itahari ATM msg source
Edinburg LAN.ATM proce          1    Butwal Teller msg source
Edinburg LAN.ATM proce          2    Itahari Teller msg source
```

Figure 40: Report: Nodes: Received message counts

This report is about Links: Channel utilization. This report is explained in task A by using bar graph and table. The original report is given below.

```
Compuware COMNET III  Release 2.5.2.814  Fri Dec 18 16:50:09 2020   PAGE     2

                                      CW

                        LINKS: CHANNEL UTILIZATION

                     REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

                          FRAMES          TRANSMISSION DELAY (MS)       %
LINK                   DELIVERED RST/ERR  AVERAGE    STD DEV    MAXIMUM   UTIL
_____________________  _________ _______  _________  _________  _________  _____

Butwal LAN.Butwal Link     19025       0     0.073      0.028      0.722 2.2549
Itahari LAN.Itahari Li     19061       0     0.073      0.028      0.756 2.2556
Edinburg LAN.Edinburg      12737       0     0.038      0.014      0.082 0.8031
```

Figure 41: Report: Links: Channel utilization

This report is about WAN clouds: Frame Delay by VC. This report is explained in task A by using bar graph and table. The original report is given below.

```
Compuware COMNET III  Release 2.5.2.814  Fri Dec 18 16:50:09 2020   PAGE     3

                                    CW

                        WAN CLOUDS: FRAME DELAY BY VC

                    REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD:                      FRAME DELAY (MS)              BURST SIZE (kb)
  VC                      AVG      STD      MAX          AVG           MAX
_____________________  _______  _______  _______    ____________  ____________

WAN Cloud
  Butwal-Edinburg         1164      697     2518           158           320
  Edinburg Butwal           17        0       22           111           243
  Itahari Edinburg        1168      701     2522           159           320
  Edinburg Itahari          17        0       17           111           251
```

Figure 42: Report: WAN Clouds: Frame delay by VC

This report is about WAN clouds: Frame Count by VC. This report is explained in task A by using bar graph and table. The original report is given below.

```
Compuware COMNET III  Release 2.5.2.814  Fri Dec 18 16:50:09 2020   PAGE     4

                                    CW

                        WAN CLOUDS: FRAME COUNTS BY VC

                    REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD:                                    FRAMES / KILOBITS
  VC:  FRAMES                    ACCEPTED                      DROPPED
       KILOBITS             NORMAL          DE           NORMAL          DE
_____________________  _____________  ___________  _____________  ___________

WAN Cloud                (TOTAL KILOBITS TRANSMITTED =         5265 )
  Butwal-Edinburg  Frm          1616         1570              0         9460
                   kb            803          810              0         4656
  Edinburg Butwal  Frm          2303          884              0            0
                   kb             737          283              0            0
  Itahari Edinburg Frm          1600         1582              0         9568
                   kb            805          808              0         4692
  Edinburg Itahari Frm          2304          878              0            0
                   kb            737          281              0            0
```

Figure 43: Report: WAN clouds: Frame Count by VC

This report is about WAN clouds: Access Link Stats. This report is explained in task A by using bar graph and table. The original report is given below.

```
Compuware COMNET III  Release 2.5.2.814  Fri Dec 18 16:50:09 2020   PAGE     5

                                    CW

                        WAN CLOUDS: ACCESS LINK STATS

                    REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD:                                FRAMES          BUFFER (BYTES)       % UTIL
  ACCESS LINK  (ENTRY)     ACCEPTED    DROPPED    MAX     AVG     STD
               (EXIT)
_____________________________ __________ _________ ______ ______ ______ ______

WAN Cloud
  Edinburg access  Entry        6369          0    N/A     N/A     N/A    34.50
                    Exit        6368          0  33947    7808   10305   49.97
  Butwal access    Entry        3186       9460    N/A     N/A     N/A    97.44
                    Exit        3187          0     83       7      15   17.27
  Itahari access   Entry        3182       9568    N/A     N/A     N/A    98.03
                    Exit        3182          0     80       7      15   17.24
```

Figure 44: Report: WAN clouds: Access Link Stats

This report is about Message and response sources: Message Delay. This report is explained in task A by using bar graph and table. The original report is given below.

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                                    CW

                  MESSAGE + RESPONSE SOURCES: MESSAGE DELAY

                    REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

ORIGIN / MSG SRC NAME:  MESSAGES                MESSAGE DELAY
  DESTINATION LIST      ASSEMBLED      AVERAGE       STD DEV       MAXIMUM
_____________________ __________ ____________ _____________ _____________

Butwal LAN.Butwal Teller / src Butwal Teller msg source:
  Edinburg LAN.ATM pro          1    1008.668 MS      0.000 MS   1008.668 MS
Butwal LAN.Butwal ATM / src Butwal ATM msg source:
  Edinburg LAN.ATM pro        518   21513.292 MS  13605.498 MS  51182.433 MS
Itahari LAN.Itahari Teller / src Itahari Teller msg source:
  Edinburg LAN.ATM pro          1   33986.285 MS      0.000 MS  33986.285 MS
Itahari LAN.Itahari ATM / src Itahari ATM msg source:
  Edinburg LAN.ATM pro        511   21796.426 MS  14132.238 MS  51880.044 MS
Edinburg LAN.ATM processing server / src Edinburg msg response:
  ECHO                          0       0.000 MS      0.000 MS      0.000 MS
```

Figure 45: Report: Message and response sources: Message Delay

4.2. Appendix- B

Wireless Networks

The old system of single computing device serving all the organization's digital needs, now have been replaced by the communication devices which have large numbers and are separated but interconnected computers do the job, this kind of system are called computer networks and it comes in many sizes, shapes, and form *(Andrew S.Tanenbaum, 2011)*. Nowadays wireless network is used all over the world, it has drastically reduced the networking costs that the last decades and the overall installation for the wireless networks do not need cable and wires like those wired networks.

History

In human history various types of technologies were used to communicate and share information. In the late 19th century and early 20th century, people realized that wireless information gathering is the key technology that can drastically change the lifestyle of humans, so they began to do research and production of wireless communication devices such as radio, wireless telegraph, etc. It gave rise to today's advanced wireless technologies. In ancient time to deliver the message, there was hardly some technologies to deliver the message to a certain distance and to deliver message long-distance people had to use different means of transportation. We can imagine how difficult it used to be to deliver important messages to long distances. We can easily predict that the origin of wireless networks started from the day of the first radio wave transmission and it was a big achievement for mankind. We have also studied radio-based telephone which dates back to 1915 during First World War when the first radio-based communication was done between the ships and the pioneers like Samuel and Guglielmo Marconi are the big family of present wireless networks system *(P. Nicopolitidis, 2003)*.

WAP (Wireless)

The wireless application protocol (WAP) is defined as the set of rules governing the reception and transmission of information through different computer applications or different wireless console-like smartphones. Allowing all the wireless computing devices to observe advanced designed pages from the internet with the help of only plain text and black-and-white images is the main feature of WAP. It is the technology that has similar features to the internet's combination of HTTP (Hypertext Transfer Protocol) and HTML (Hypertext Markup Language).

4.3. Appendix- C

Glossary:

Telegraph: A system of transferring and receiving information to different far locations.
Amendment: To change the protocols.
Transmitter: The system which transmit the information.
Spectrum: The component of the sound.