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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 for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgement

I would like to express our gratitude and thanks to Islington College as well as our module leader Mr. Dipeshor Silwal who gave us the opportunity to make this project which allowed us to express what we have learnt in a practical way which was a great exercise and experience.

Secondly, I would like to convey our sincere thanks to our lecturers and tutors for providing us with guidance through online classes without which the completion of the project may have been delayed or not as good as expected.

The project was really an enjoyable experience

Sincerely, Bijay

Abstract

The Task A of the report deals with simulation of WAN using COMNET III. Network simulation and reports generated from simulation will be discussed. Task B will look at wireless networks in general and talk about the history, terminologies and technologies of wireless networking in brief.

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1 Task A

1.1 Introduction

This part of the report is focused on simulation of network. The scenario is that a fictional company named Asia bank, headquartered in Edinburg is trying to setup two ATM networks in Nepal. The networks are to be setup in Butwal and Ithari Each network in Nepal consists of 30 ATM transaction nodes plus one single teller giving a total of 31 ATMs each in a LAN.

COMNET III will be used to simulate the LAN and WAN structures. COMNET III is a performance measuring tool for communication networks. It is in modelling networks, their control algorithms and workload on the network model. COMNET III then duplicates the operation of the network and provides analysis report of network performance. Students in data communications and networking courses can use COMNET III to model and simulate LANs, WANs and interconnections of various networks (Internets) (Ahuja, 1998).

We use COMNET III to simulate the network of ATMs, LAN and WAN. This allows for a way to model our network and determine its characteristics like performance and efficiency. Network simulation before implementation saves a lot of time and money. We can check the performance of complex networks with multiple parameters and scenarios to determine which type of configuration will be the most effective for our use. We can plan for maintenance and growth of the network. We can also check for faults in our designs and improve the faults immediately before going live. Simulations like these provide us with deeper understanding of the networks as we can interact with different components of the network in a virtual environment with minimal cost.

1.2 WAN Model

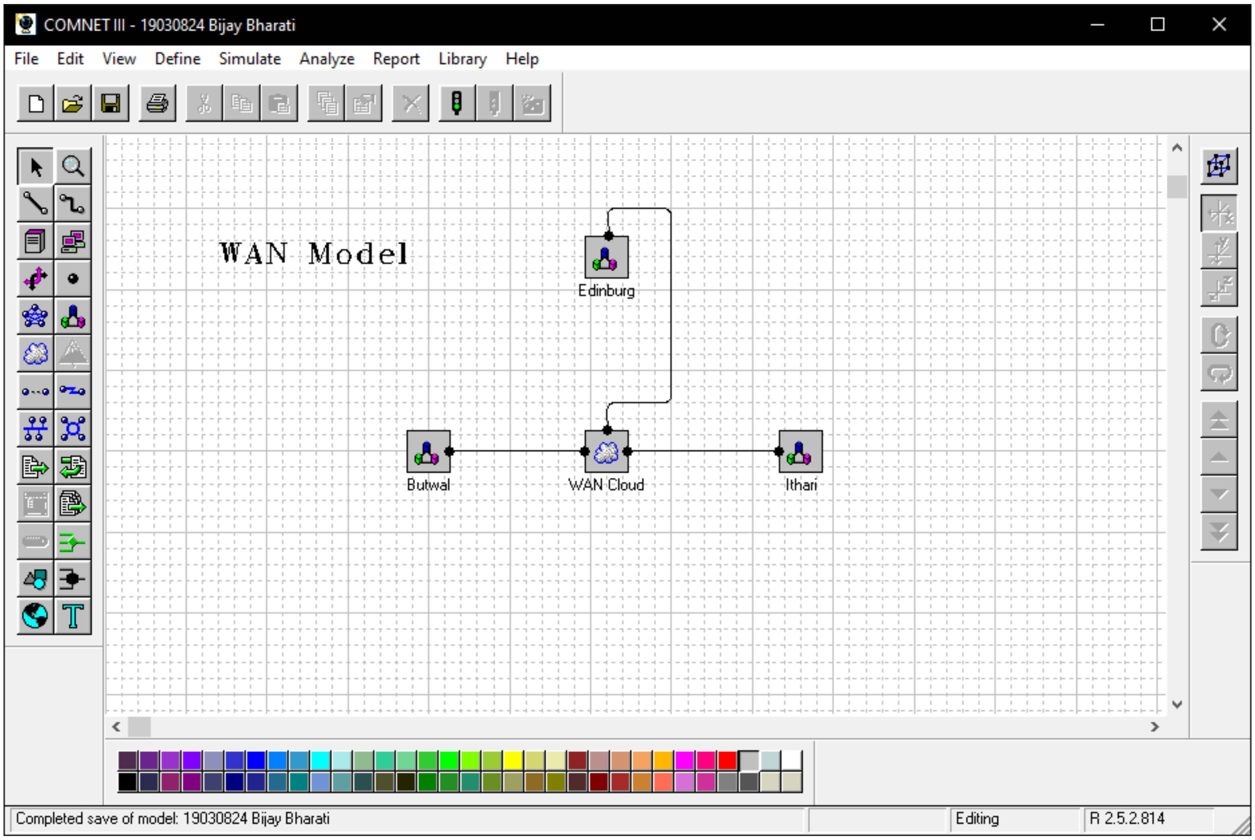


Figure 1: WAN Model

The figure shows the WAN model designed according to the give scenario. There are three subnets Edinburg, Butwal and Ithari. We use the WAN cloud to model our network. WAN cloud provides abstraction for our model, just showing the end user a simplified model, inside the WAN cloud, there are Access Links and Virtual Circuits which will be described below.

Everything shown in the figure is created in COMNET III using the elements from palette menu seen in the left-hand side of the figure.

1.2.1 Edinburg LAN

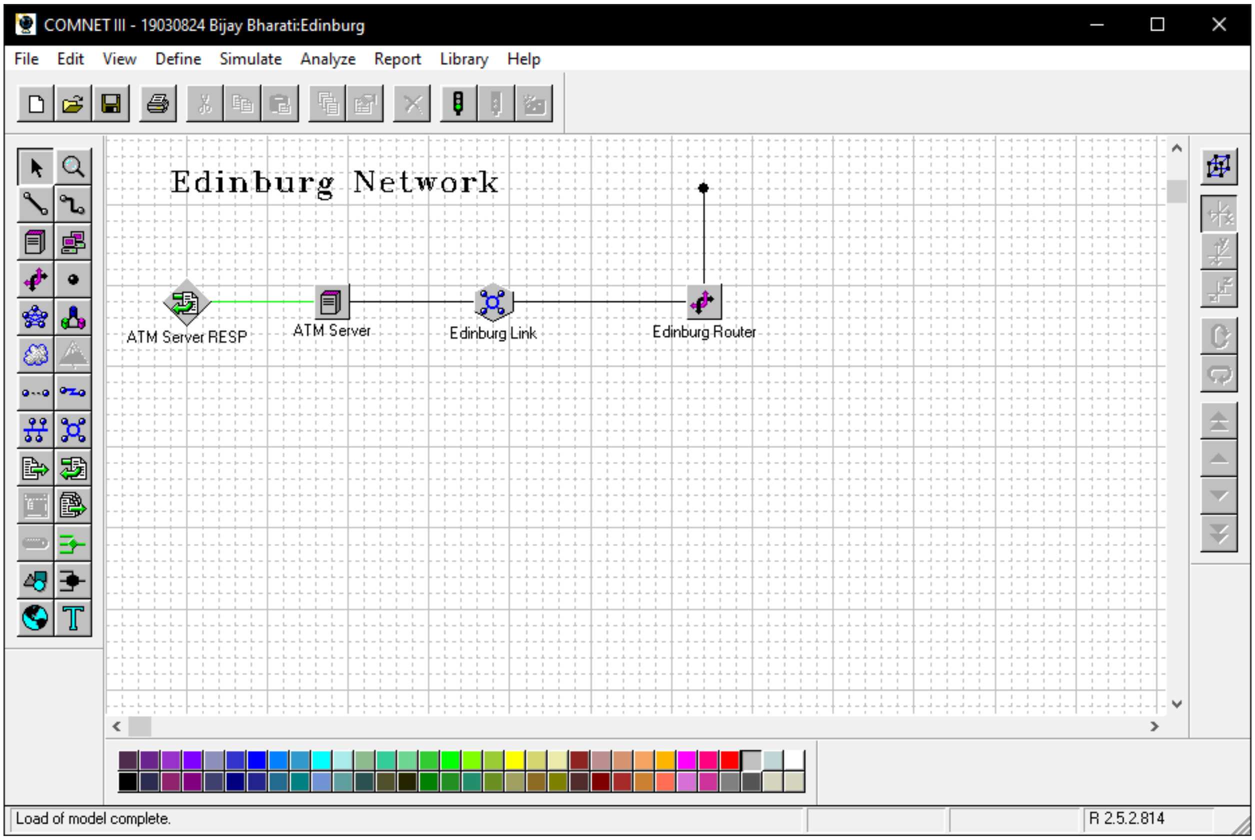


Figure 2: Edinburg LAN

The figure shows the design for Edinburg LAN. The components of the design include a processing node (ATM Server), token passing link (Edinburg Link) and network device (Edinburg Router).

1.2.1.1 Token Passing Link

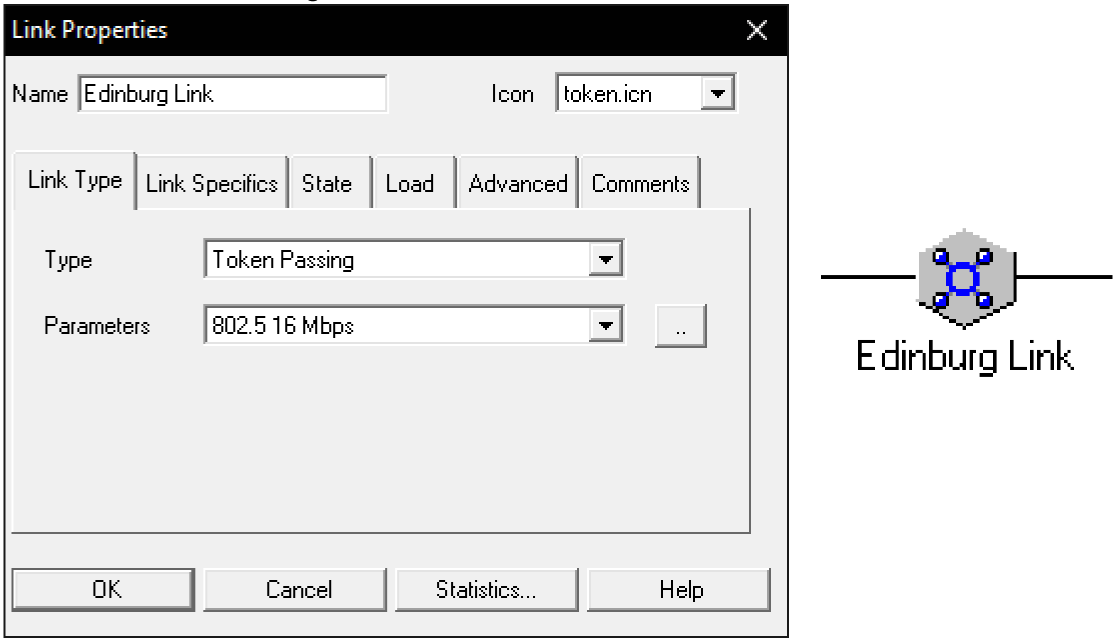


Figure 3: Token Passing Link Edinburg LAN

We can see in the properties that it is a Token Passing type link with parameters IEEE 802.5 16 Mbps.

1.2.1.2 Network Device: Router

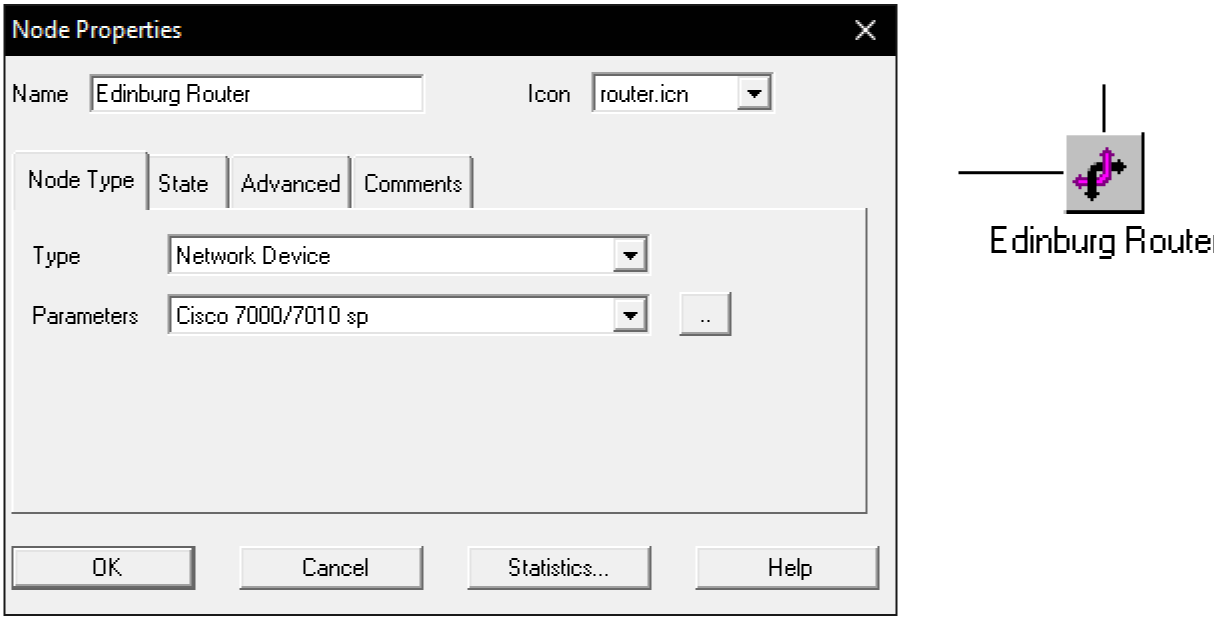


Figure 4: Network Device Edinburg LAN

Router used is Cisco 7010 sp.

1.2.1.3 Processing Server

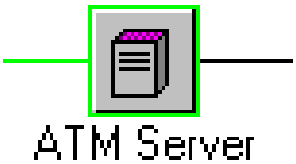


Figure 5: Edinburg Server

The icon in our design represents a server. It is a processing node that replies to the requests made by other computers in the network. It is responsible for replying messages to requests from Butwal and Ithari LAN ATMs.

1.2.1.4 Response Source

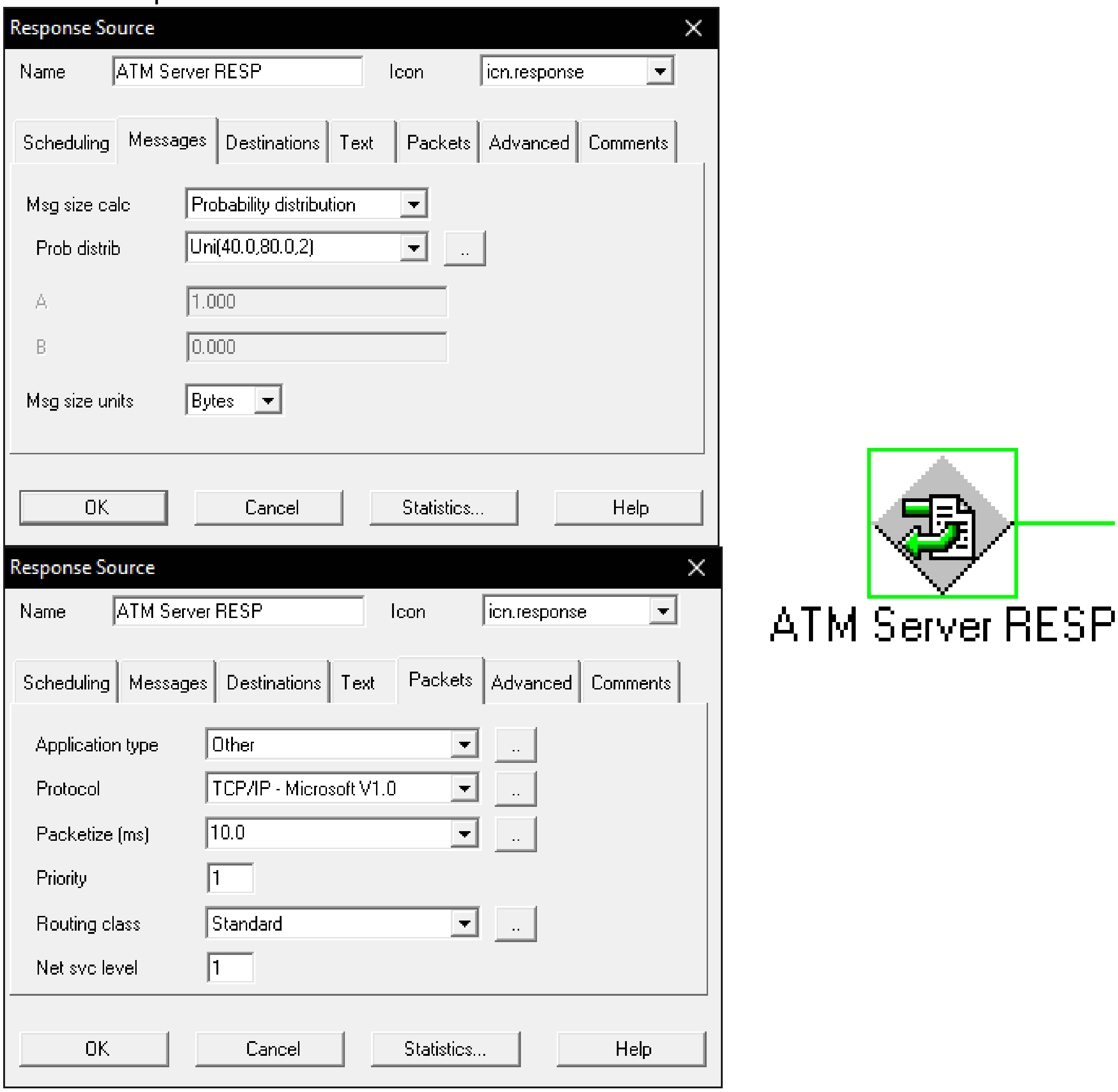


Figure 6: Response Source Edinburg LAN

London server processes all the requests from Nepal and responds with a message that can be explained with uniform probability distribution where the size is evenly dispersed over the range of 40 to 80 bytes with stream 2. TCP/IP Microsoft V1.0 protocol is used which can be seen in figure 6

1.2.2 WAN Cloud

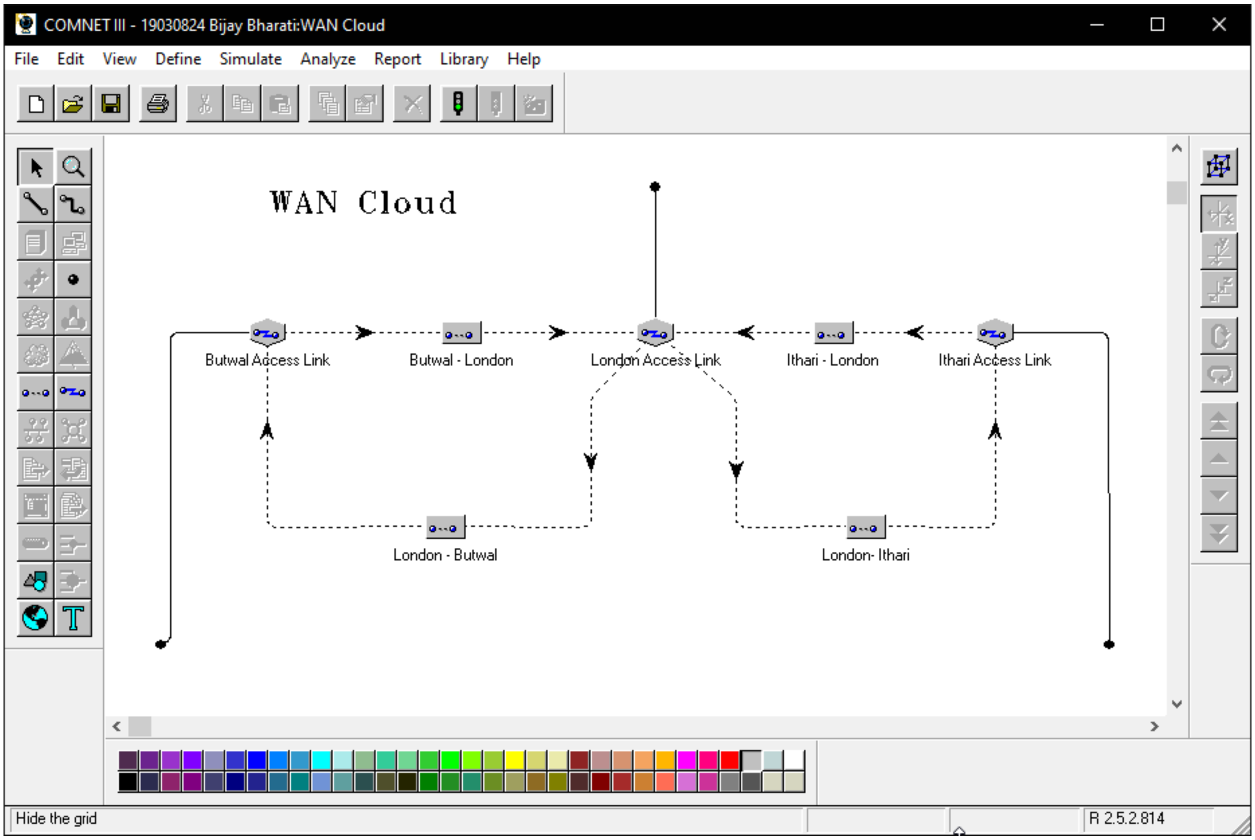


Figure 7: WAN Cloud

The wan cloud connects the Edinburg, Butwal and Ithari subnets. The Edinburg subnet is referred as London LAN in WAN cloud.

1.2.2.1. Access Link

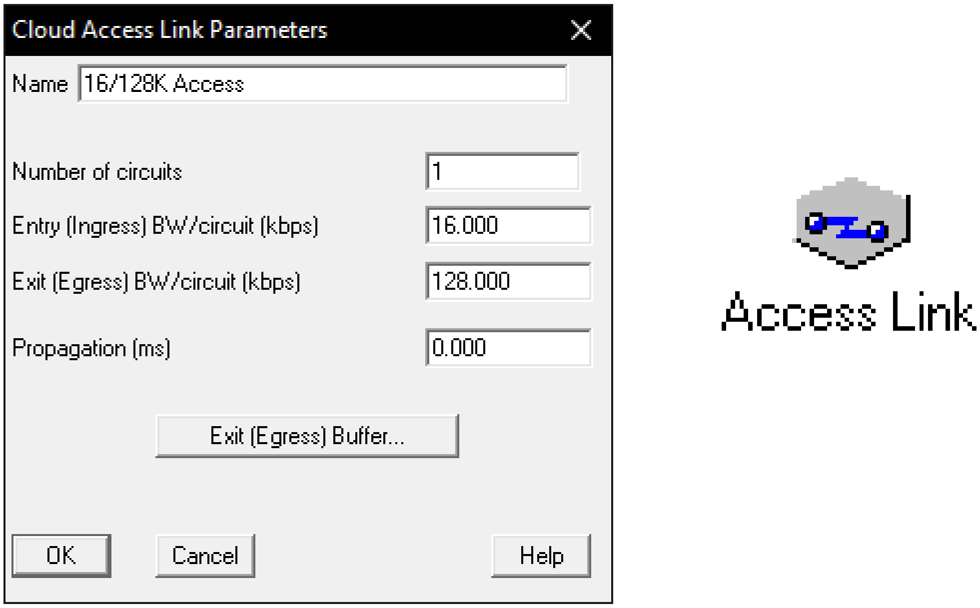
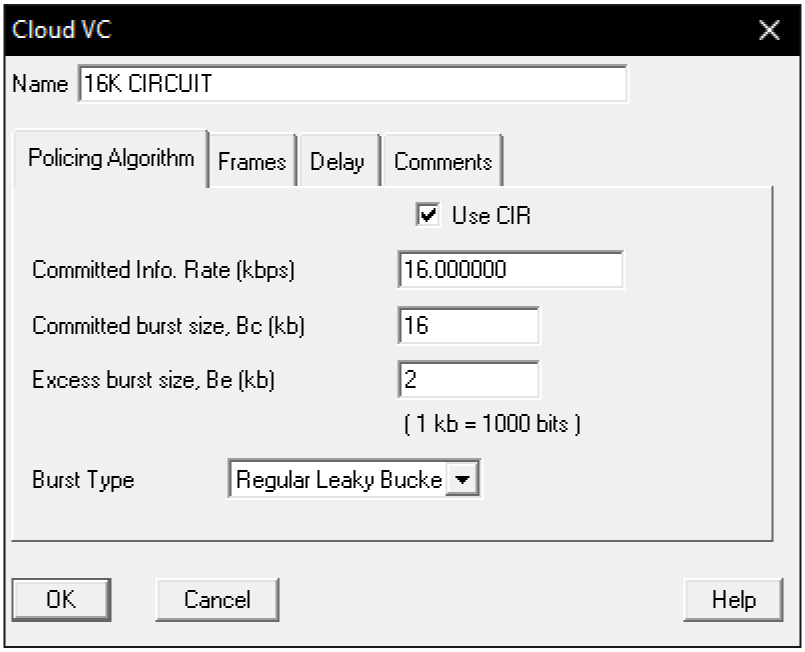


Figure 8: WAN Cloud Access Link Properties

The tunnel from the LAN to WAN and links in the WAN have a transmission rate of 16 Kbps. The tunnel from the WAN to the LAN has transmission rate of 128 kbps. Entry and exit bandwidth/circuit specifies the transmission rates of messages within the WAN cloud and messages leaving from the WAN cloud.

1.2.2.2 Virtual Circuit



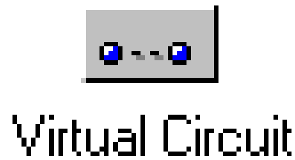


Figure 9: WAN Cloud Virtual Circuit Properties

The maximum throughput rate of the virtual circuit is set to 16kbps. In the figure, Committed burst size, Bc (kb) is the maximum amount of bits which are transmitted over a burst interval. Excess burst size, Be (kb) is the additional amount that can be transmitted in the network if bandwidth is available.

1.2.3 Ithari and Butwal LAN

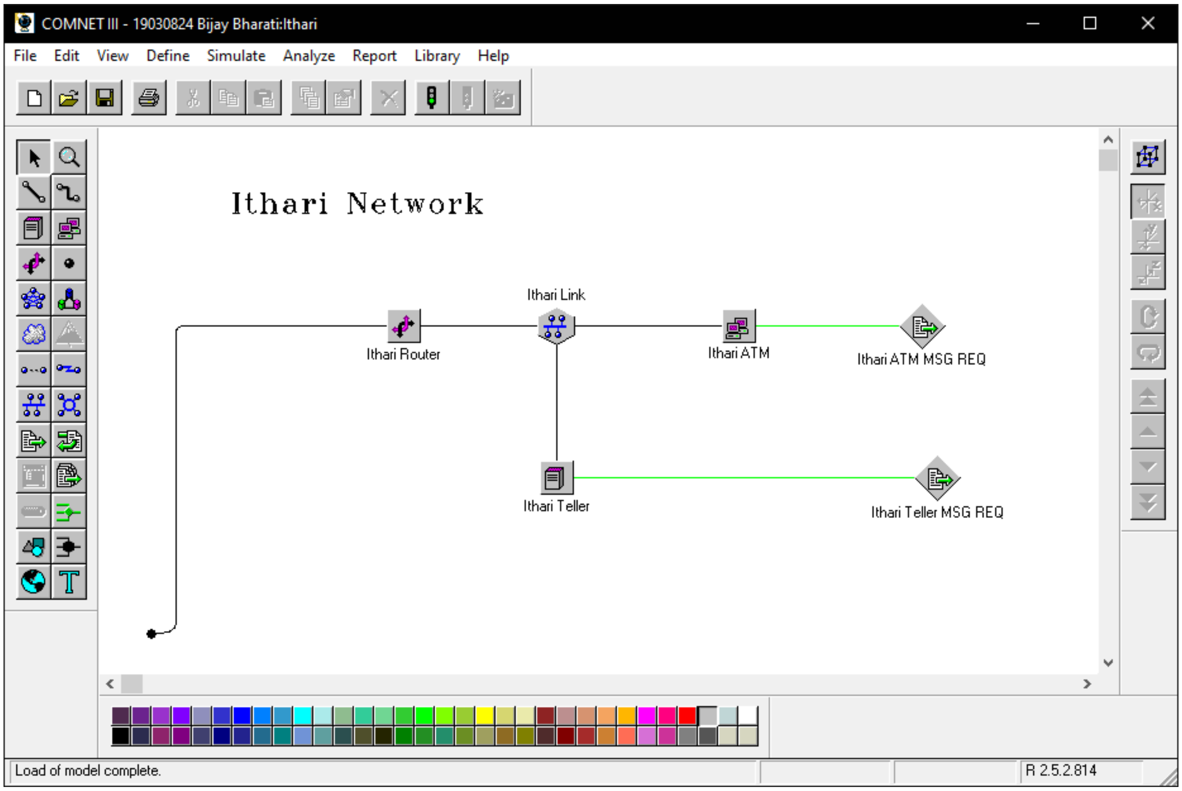


Figure 10: Ithari Lan

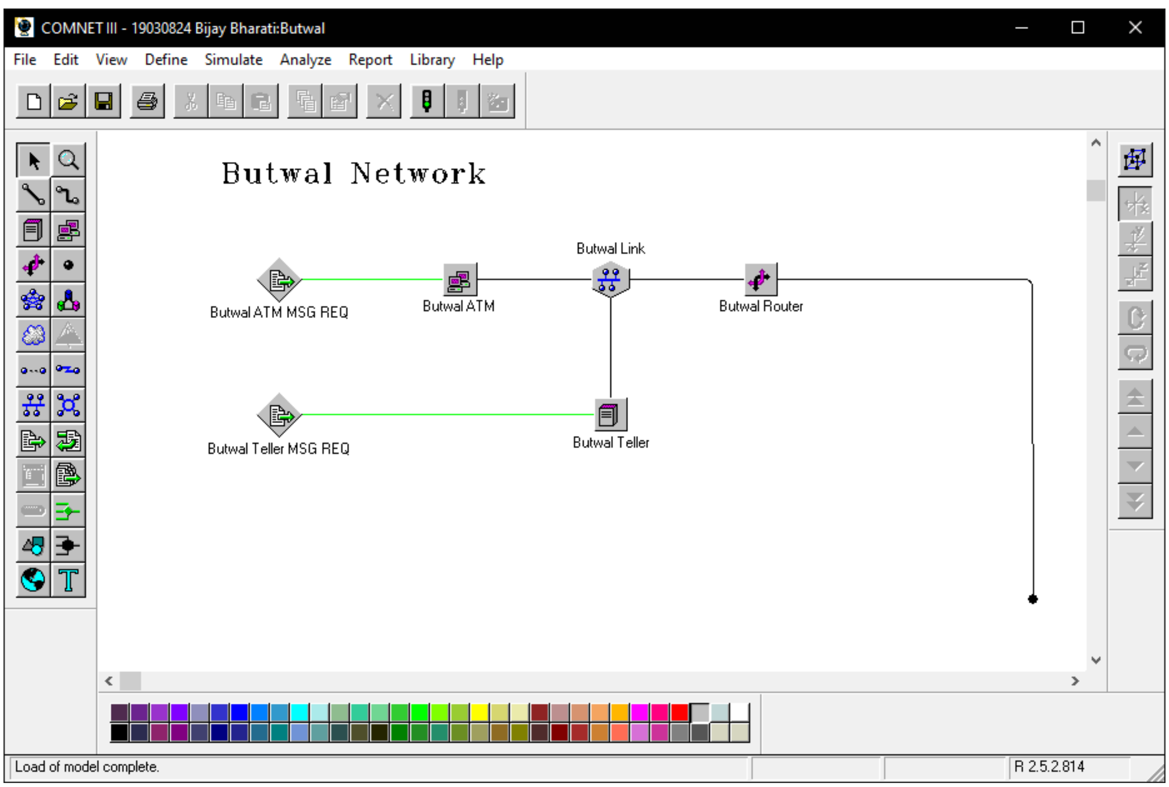


Figure 11: Butwal LAN

1.2.3.1 Network Device: Router

Both Butwal and Ithari LAN have same properties, only the name is different so to describe both the LANs, we will be looking at any one component among the LANs instead of looking at the same component each tie from both LANs.

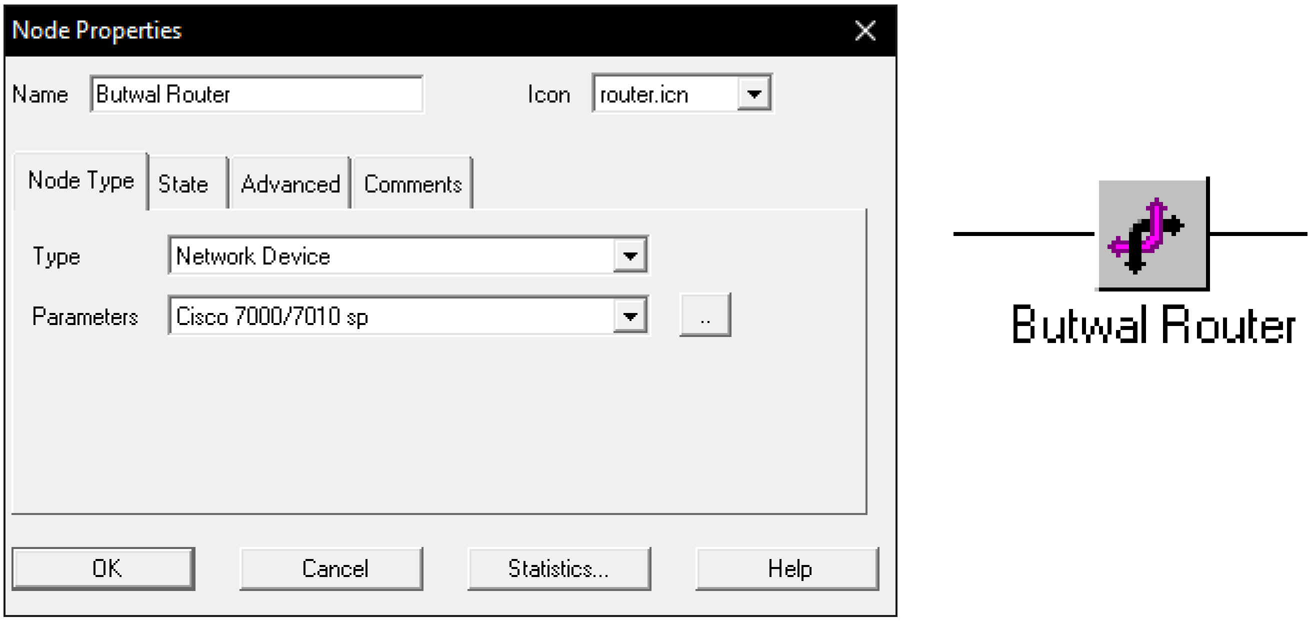


Figure 12: Butwal LAN Router

Cisco 7010 sp router is used in Butwal LAN, it is same for Ithari LAN.

1.2.3.2 CSMA/CD Link

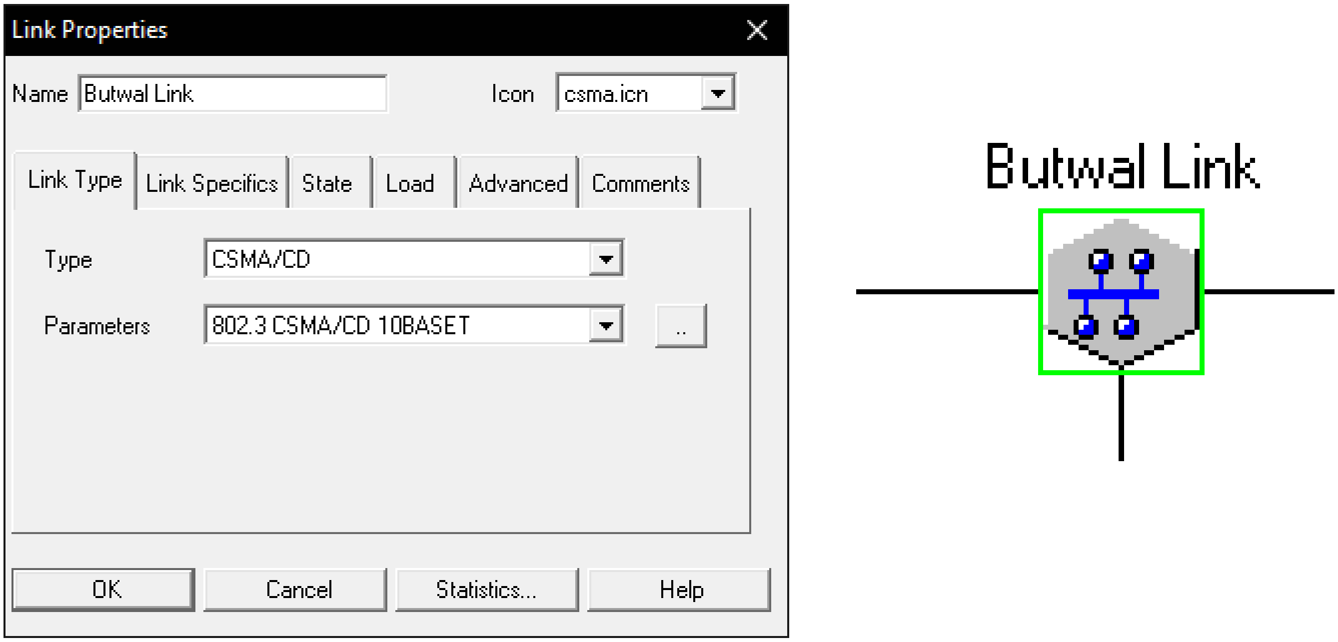
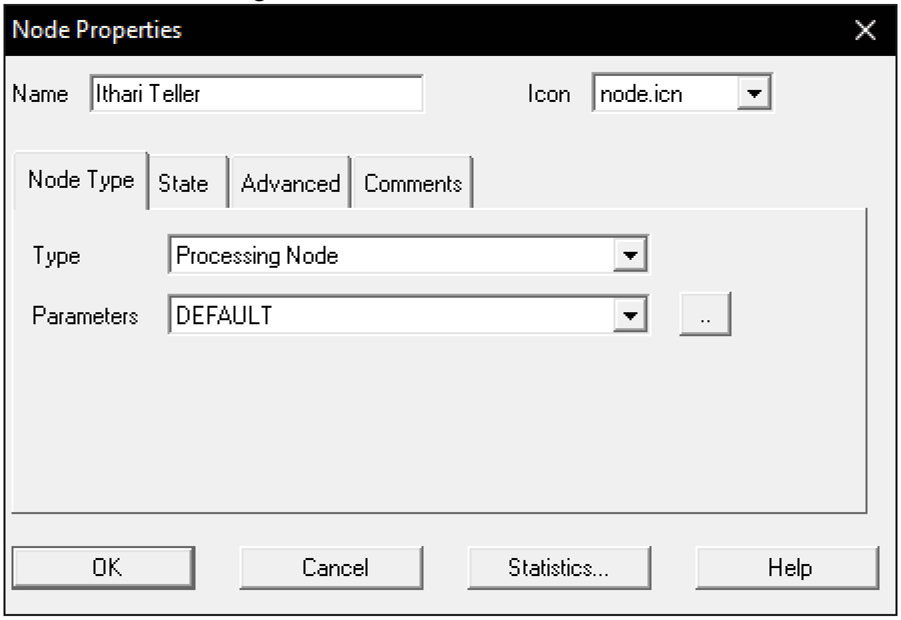


Figure 13: Butwal LAN Link

Butwal LAN is set up using IEEE 802.3 CSMA/CD 10 BaseT Ethernet network, same is true for Ithari LAN.

1.2.3.3 Processing Node



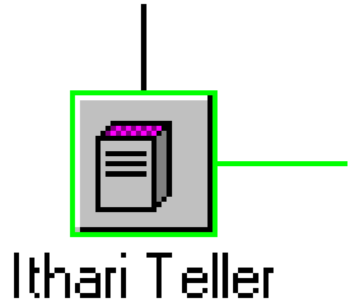


Figure 14: Teller

The tellers serve as processing nodes in the LANs in Butwal and Ithari

1.2.3.4 Computer Group

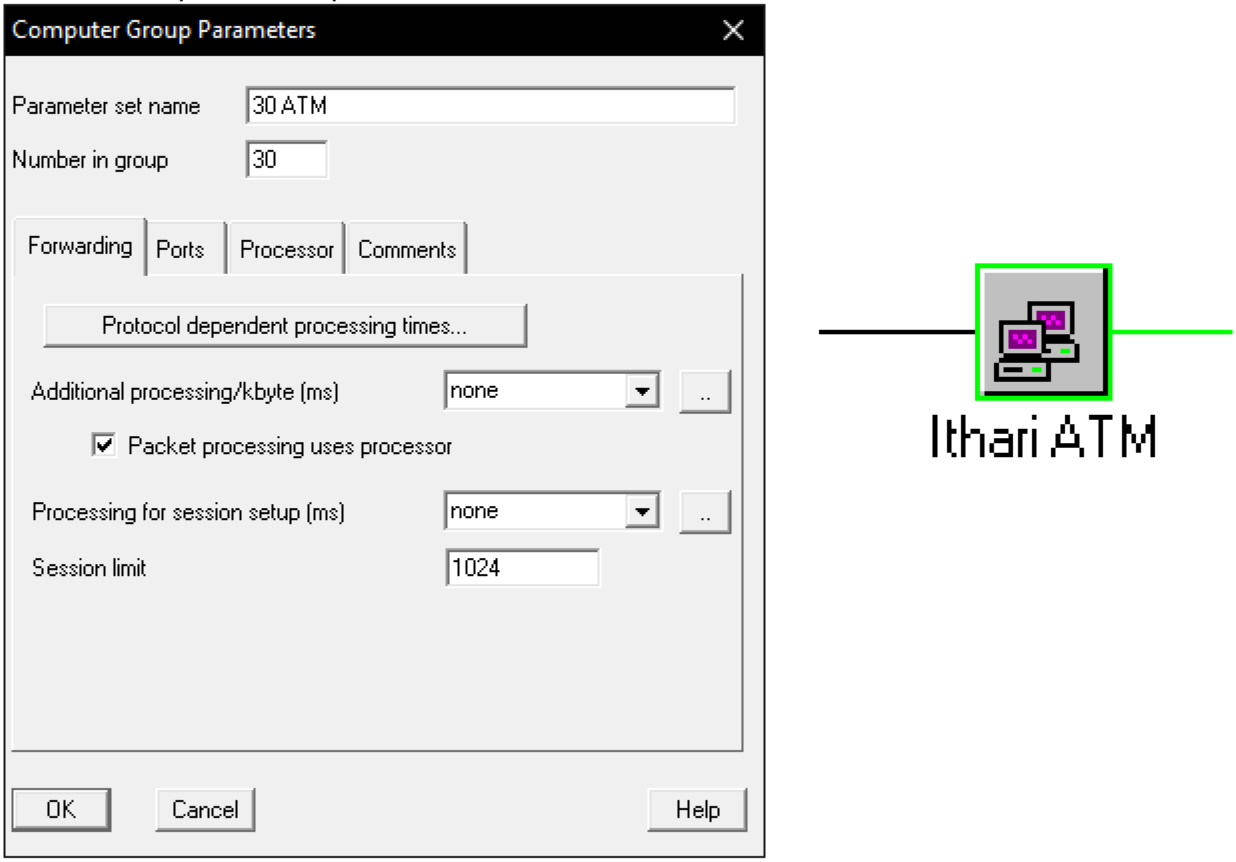


Figure 15: Computer Group Properties

There are 30 ATMs in each computer group in both Ithari and Butwal LAN.

1.2.3.5 Message Source

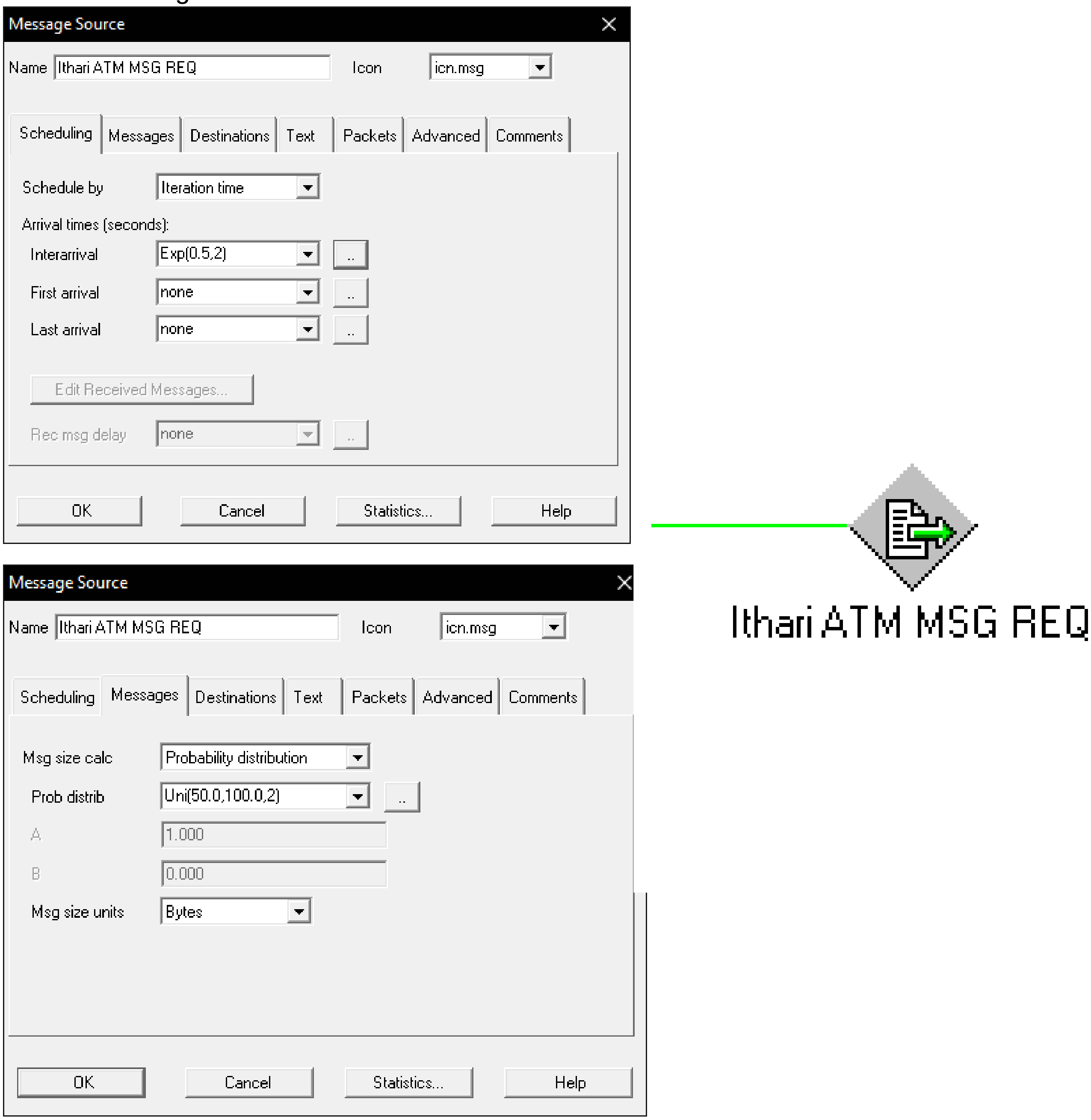


Figure 16: ATM MSG REQ properties

An Estimate is made to support a busy peak of ATM device usage which generates 2 transactions per minute in each ATM. This can be described with an interarrival time with exponential distribution 0.5 with stream 2. The size of ATM authorization requests can be described by a uniform distribution where the size is evenly dispersed over the range of 50 to 100 bytes with stream 2, this is given as scenario.

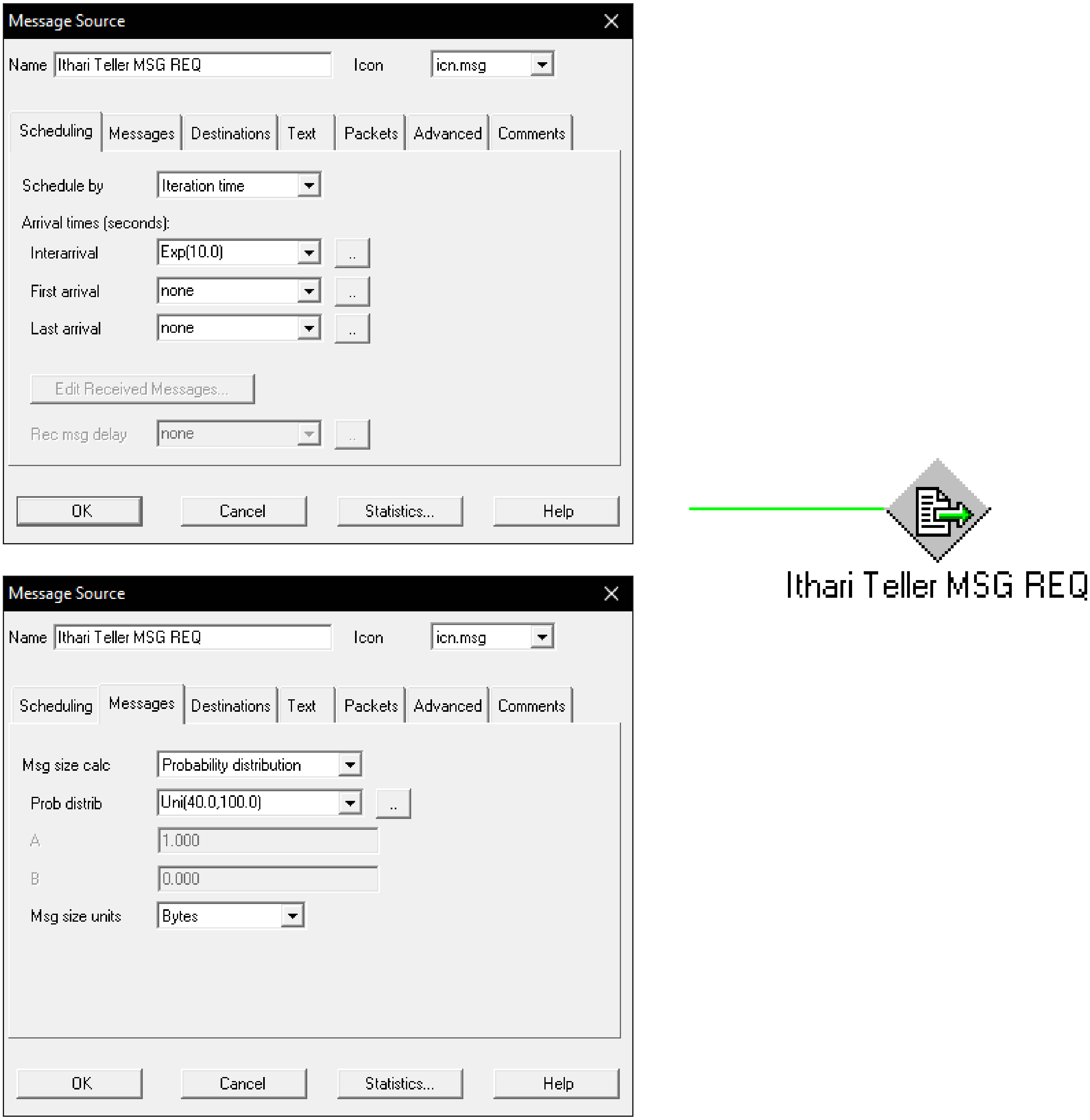


Figure 17: Teller MSG REQ Properties

The single teller machines in each LANs (Ithari and Butwal) are generated at an interarrival time that can be defined with an exponential probability distribution with mean 10 which has a size that can be explained by a uniform distribution where the size is evenly dispersed over the range of 40 to 100 bytes. For the destination list of message source and message response you need to generate random list with respective destination. The routing protocol used is TCP-IP Microsoft V1.0 with 10 ms Packetize time. All systems use the routing class defined with a hop count of 65535 with IGRP metric weight (k1) = 1, which is also set according to the given scenario.

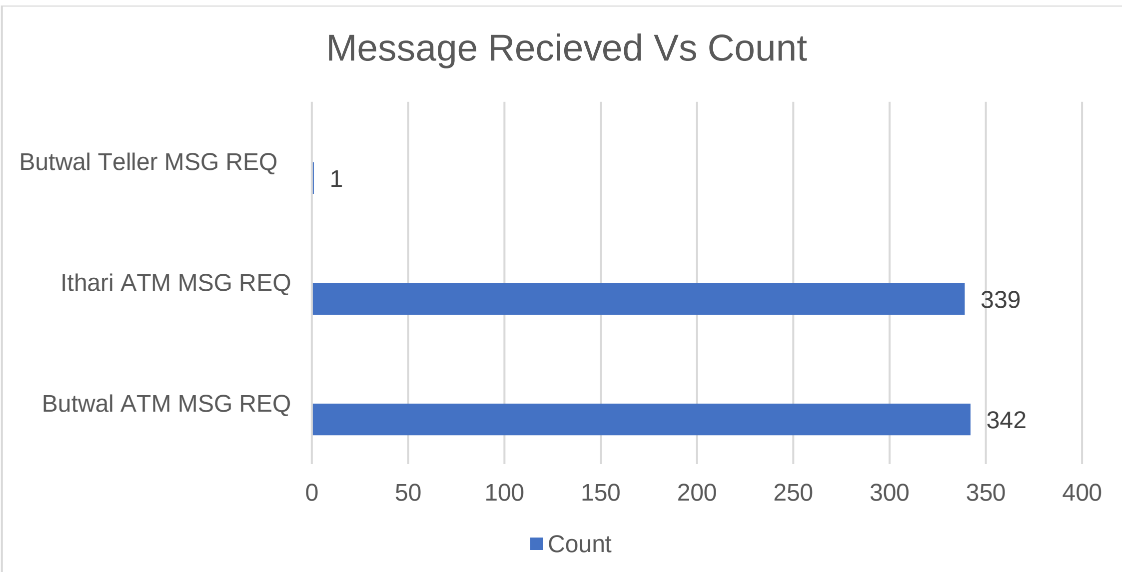
1.3 Description of Reports

1.3.1 Node Report: Received Message Count

RECEIVER	COUNT	MESSAGE NAME
Edinburg.ATM Server	342	Butwal ATM MSG REQ
Edinburg.ATM Server	339	Ithari ATM MSG REQ
Edinburg.ATM Server	1	Butwal Teller MSG REQ

Table 1: NODES: RECEIVED MESSAGE COUNTS

The receivers are the servers to receive message, count is the number of times they received message during simulation. Message name is the message received by the receivers.

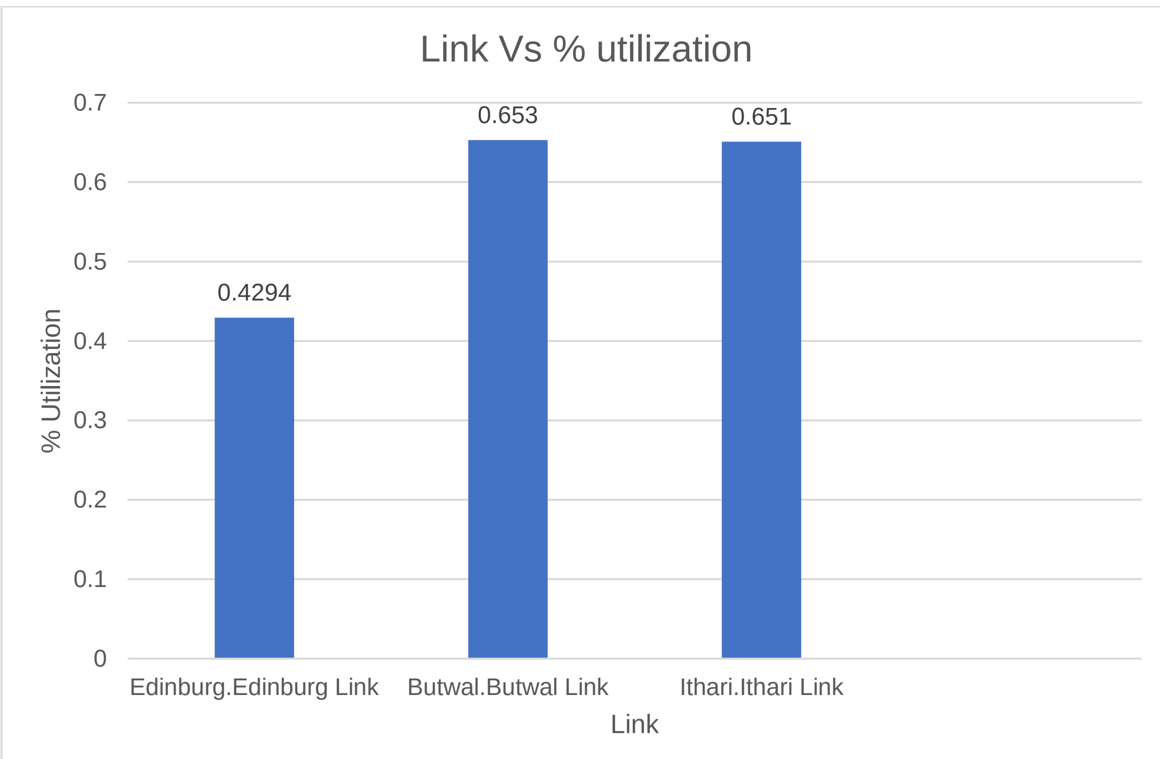


1.3.2 Link Report: Channel Utilization

LINK	FRAMES		TRANSMISSION DELAY (MS)			% UTIL
	DELIVERED	RST/ERR	AVG	STD DEV	MAXIMUM	
Edinburg.Edinburg Link	7249	0	0.036	0.011	0.082	0.4294
Butwal.Butwal Link	5904	0	0.067	0.023	0.491	0.6530
Ithari.Ithari Link	5891	0	0.067	0.023	0.538	0.6510

Table 2: LINKS: CHANNEL UTILIZATION

The report after simulation gives details about how much frames were delivered, if any were not delivered or error occurred. Statistics about delay in transmission as well as utilization of each of the links in our model is also given.

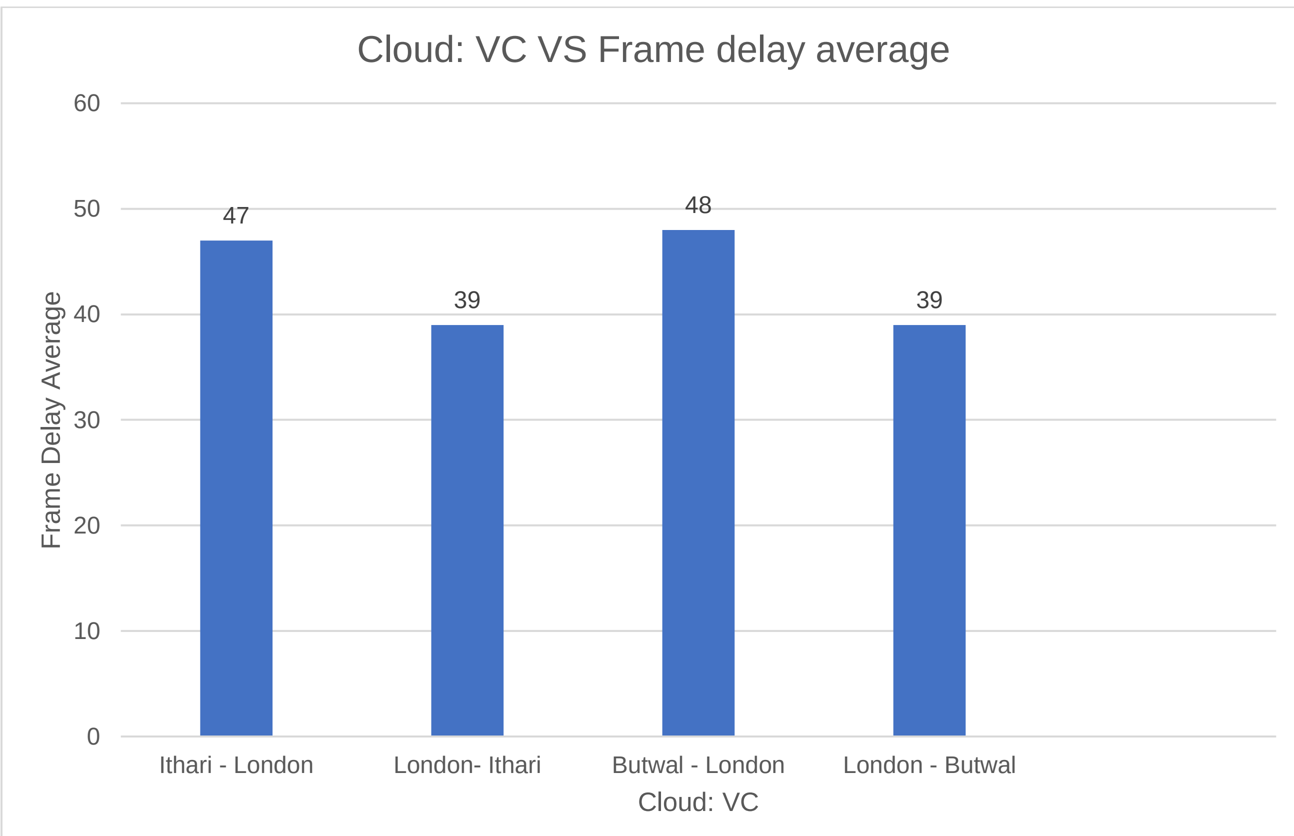


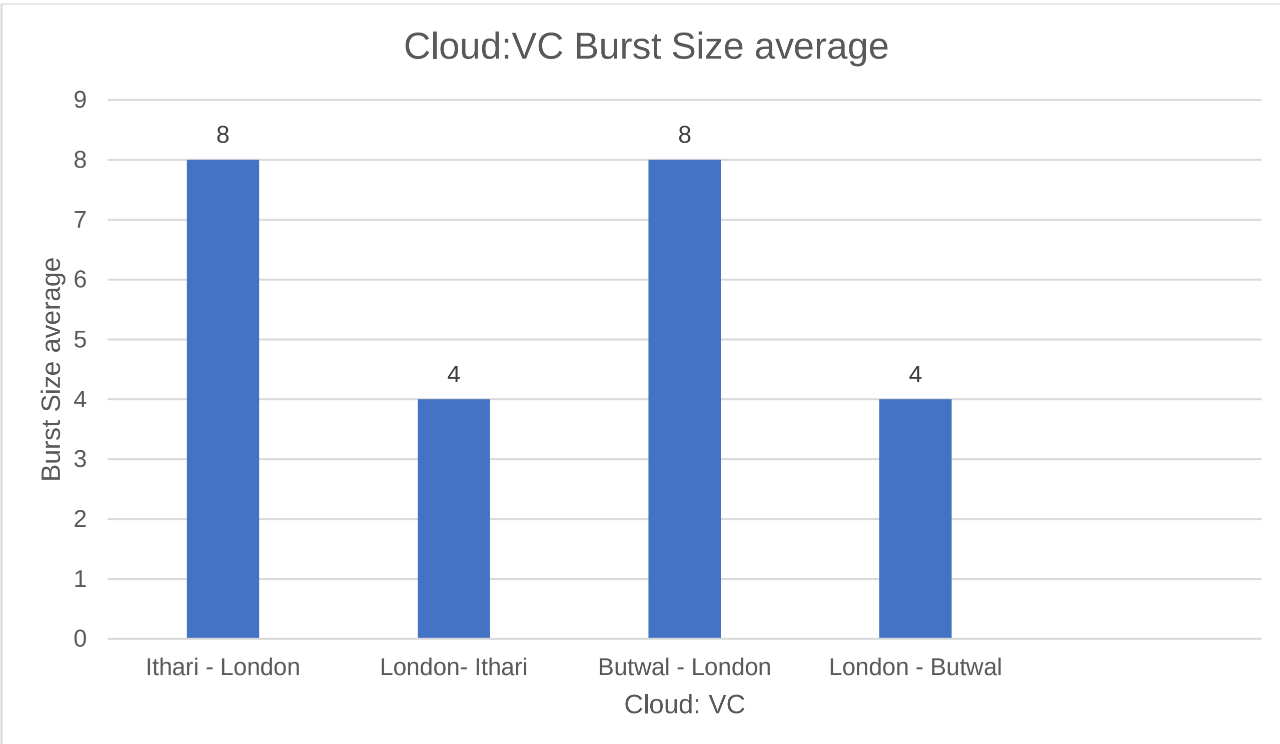
1.3.3. WAN Cloud Report: Frame Delay, Frame Count, Access Link Stat

CLOUD: VC	FRAME DELAY (MS)			BURST SIZE (kb)	
	AVG	STD	MAX	AVG	MAX
Ithari - London	47	17	100	8	17
London- Ithari	39	0	39	4	9
Butwal - London	48	17	101	8	17
London - Butwal	39	0	39	4	10

Table 3: WAN CLOUDS: FRAME DELAY BY VC

Frame delay by VC report gives the statistics for the frame delay and burst size for each virtual circuit in WAN cloud. The frame delay statistics are for all successful deliveries in the WAN cloud. Burst is the condition where multiple frames come at once. Burst size is accounted for every frame that the is accepted in the VC (virtual circuit).

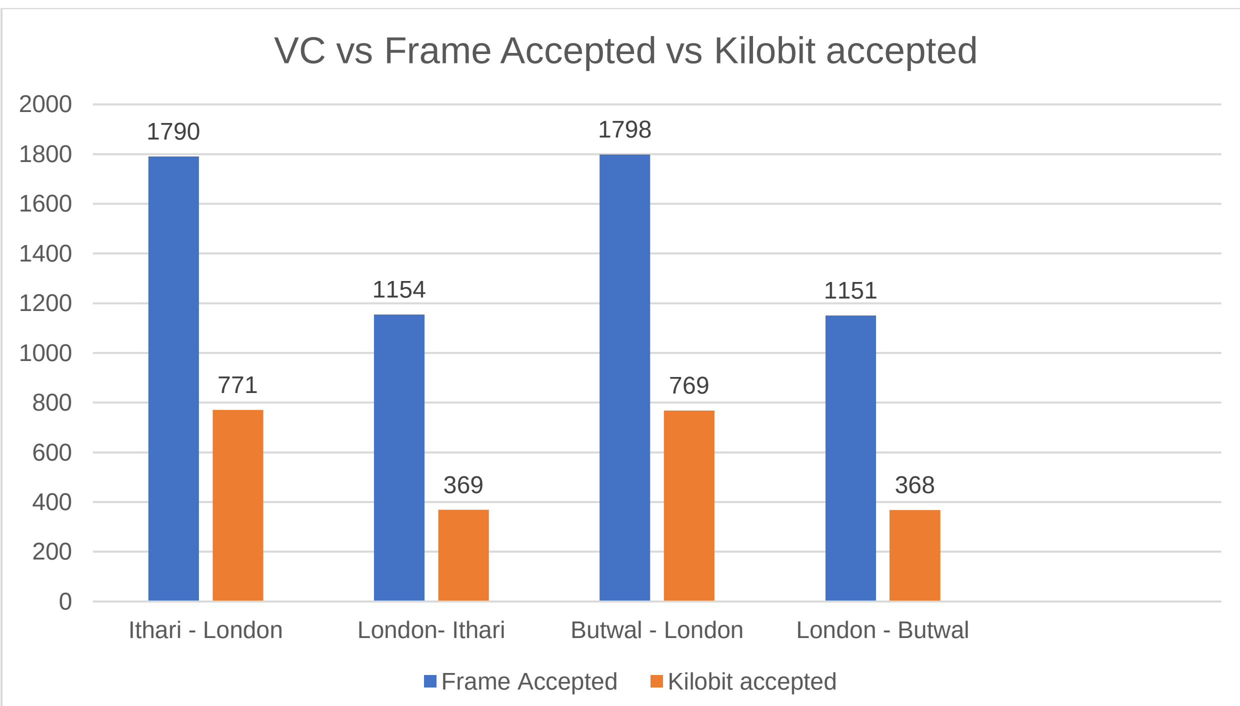



Cloud:VC Burst Size average
Burst Size average
9
8
7
6
5
4
3
2
1
0
8
4
8
4
Ithari - London
London- Ithari
Butwal - London
London - Butwal
Cloud: VC

CLOUD: VC	FRAMES KILOBITS	ACCEPTED		DROPPED	
		NORMAL	DE	NORMAL	DE
Ithari- London	Frm	1790	31	0	0
	Kb	771	14	0	0
London- Ithari	Frm	1154	0	0	0
	Kb	369	0	0	0
Butwal-London	Frm	1768	37	0	0
	Kb	769	17	0	0
London-Butwal	Frm	1151	0	0	0
	kb	368	0	0	0
WAN Cloud	(TOTAL KILOBITS TRANSMITTED =			2309)	

Table 4: WAN CLOUDS: FRAME COUNTS BY VC

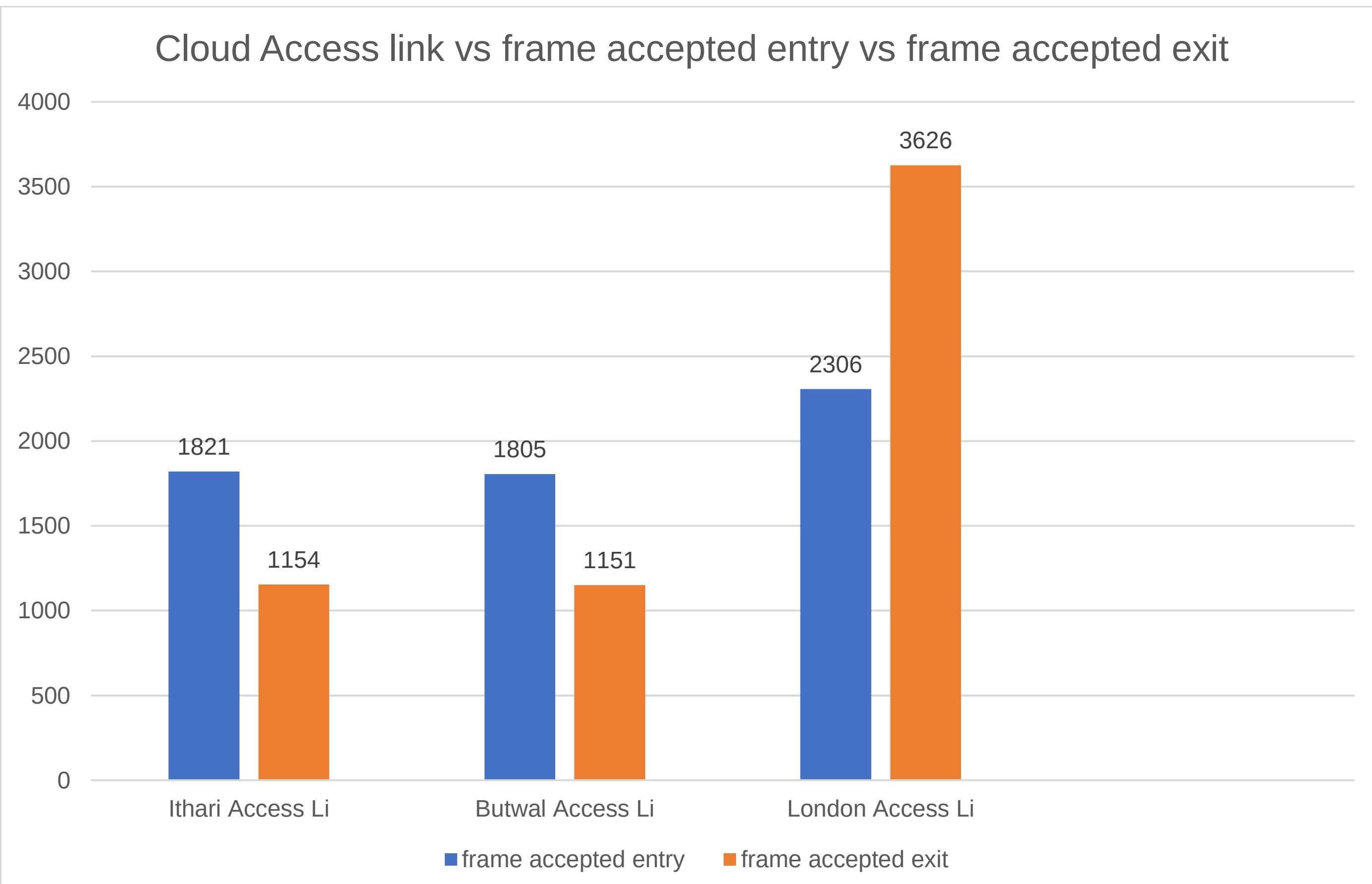
Frame counts by VC provides measures for each virtual circuit in terms of the number of frames (Frm) accepted and dropped by the VC, and the number of kilobits (Kb) accepted of dropped. These numbers are further divided between normal and discard eligible (DE) frames.



CLOUD: ACCESS LINK	ENTRY EXIT	FRAMES		BUFFER (BYTES)			% UTIL
		ACCEPTED	DROPPED	MAX	AVG	STD	
Ithari Access Li	Entry	1821	0	N/A	N/A	N/A	100.00
	Exit	1154	0	40	3	10	6.25
Butwal Access Li	Entry	1805	0	N/A	N/A	N/A	99.99
	Exit	1151	0	40	2	10	6.23
London Access Li	Entry	2306	0	N/A	N/A	N/A	99.93
	Exit	3626	0	268	18	38	24.99

Table 5: WAN CLOUDS: ACCESS LINK STATS

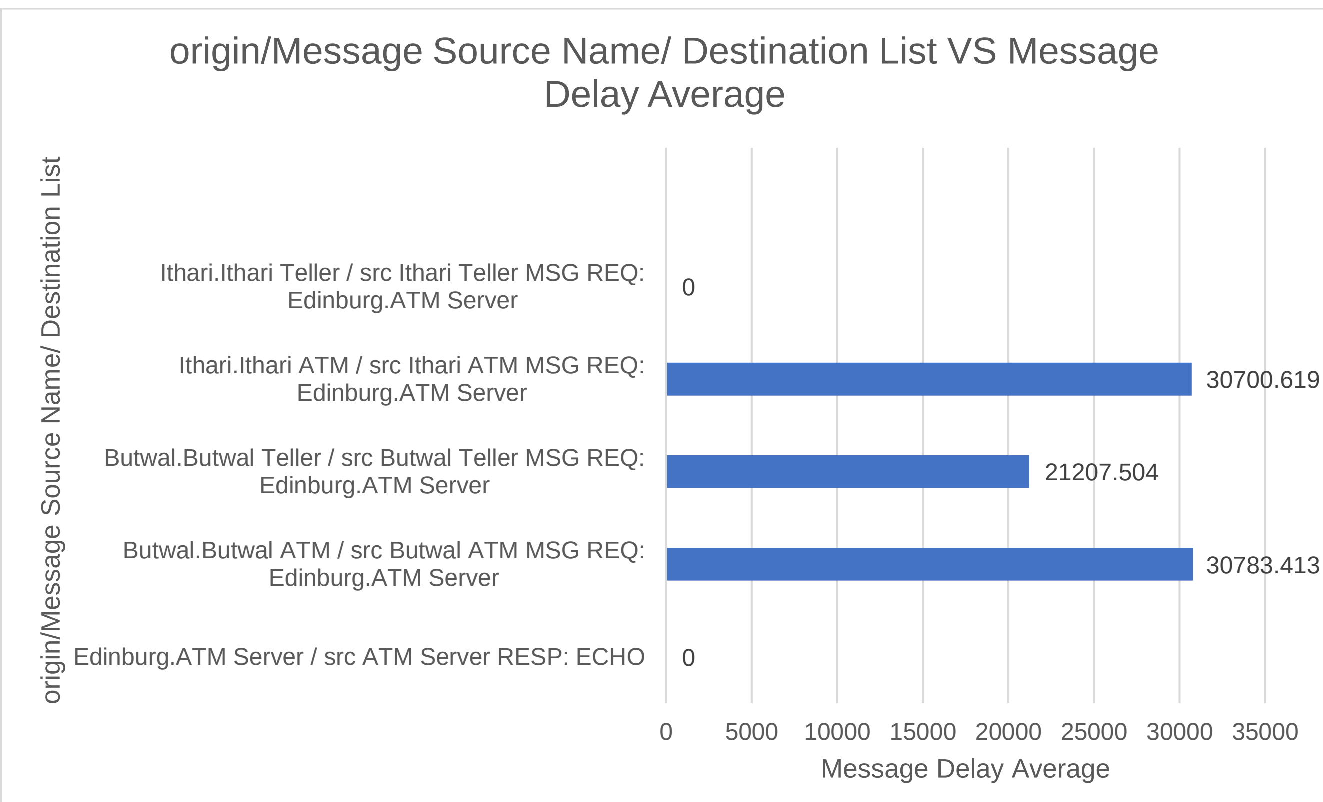
The access link stats report presents statistics for each access link in a WAN cloud. We have three access links in this report. Ithari Access Link, Butwal Access Link and London/Edinburg Access Link.



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

ORIGIN / MSG SRC NAME: DESTINATION LIST	MESSAGES ASSEMBLED	MESSAGE DELAY		
		AVERAGE	STD DEV	MAXIMUM
Edinburg.ATM Server / src ATM Server RESP: ECHO	0	0.000 MS	0.000 MS	0.000 MS
Butwal.Butwal ATM / src Butwal ATM MSG REQ: Edinburg.ATM Server	55	30783.413 MS	15901.603 MS	58057.378 MS
Butwal.Butwal Teller / src Butwal Teller MSG REQ: Edinburg.ATM Server	1	21207.504 MS	0.000 MS	21207.504 MS
Ithari.Ithari ATM / src Ithari ATM MSG REQ: Edinburg.ATM Server	50	30700.619 MS	15634.861 MS	57552.484 MS
Ithari.Ithari Teller / src Ithari Teller MSG REQ: Edinburg.ATM Server	0	0.000 MS	0.000 MS	0.000 MS

Table 6: MESSAGE + RESPONSE SOURCES: MESSAGE DELAY



1.4 Conclusion

We have successfully simulated the proposed network and generated all the necessary reports along with bar graphs for visual representation of the data for better understanding and to summaries the findings from our simulation runs.

2 Task B

2.1 Introduction

This part of the report completely focuses on wireless networks, the background and history of wireless networks, advantages and disadvantages of wireless network, architecture of wireless networks and their properties.

2.2 Background

Wireless communications are a system using radiofrequency, infrared, microwave, or other types of electromagnetic or acoustic waves in place of wires, cables, or fiber optics to transmit signals or data. Wireless devices include cell phones, two-way radios, remote garage door openers, television remote controls, and GPS receivers. Wireless modems, microwave transmitters, and satellites make it possible to access the internet from anywhere in the world. A Wireless Markup Language (WML) based on XML is intended for use in such narrow-band devices as cellular phones and pagers for transfer and display of text (ENCYCLOPEDIA Britannica©, 2013).

2.2.1 Wireless Networks

Wireless networks are group of devices that are not connected by cables or physical medium of any other kind. The use of a wireless network enables organizations to avoid the costly process of installing and maintaining cables into buildings or as a connection between different equipment in different locations. The wireless systems work on radio waves, an implementation that takes place at the physical level of network structure (Technopedia, 2020).

Any type of medium that transmits data without the need of cables and with physical connection between receivers can be considered wireless network.

2.2.1.1 History

When we talk about history of wireless communications, it can go back centuries if we consider beating drums to communicate as wireless communication, but in this report, we will only discuss about the major modern turning points in the history of wireless communication and wireless networks.

We cannot talk about wireless communications without talking about radio waves. In 1887 David Hughes communicated Morse code over a short distance. After a year, Heinrich Hertz, German physicist delivered and distinguished radio waves, demonstrating thoughts proposed by James Clerk Maxwell, but at the time, he was unaware of the practicality of his discovery. It was distinctly in 1891, when Nikola Tesla started his explores that radio innovation got famous and broad. Tesla dealt with radio for quite a while, documented a few licenses, introduced his thoughts in London, and made a working significant distance radio framework in New York. Tesla's work was only recognized in 1943 by U.S. patent office, after his death. One of the most world-changing inventions of all time, radio has given us television, mobile phone, RADAR, wireless internet access, satellite navigation, radio telescopes and even the microwave oven (Baylis, 2014).

Next comes the origin of internet.

The evolution of internet can be traced to ARPANET, which was developed in 1969 by the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense. It was the first operational packet-switching network. ARPANET started in four locations. Today the number of hosts is in the hundreds of millions, the number of users in the billions, and the number of countries participating nearing 200.The number of connections to the Internet continues to grow exponentially (Sterlings, 2014).

The network was so successful that ARPA applied the same packet-switching technology to tactical radio communication (packet radio) and to satellite communication (SATNET). Because the three networks operated in very different communication environments, the appropriate values for certain parameters, such as maximum packet size, were different in each case. Faced with the dilemma of integrating these networks, Vint Cerf and Bob Kahn of ARPA developed methods and protocols for internetworking—that is, communicating across arbitrary, multiple, packet-switched networks (Sterlings, 2014). They published a very influential paper in May 1974 [CERF74] outlining their approach to a Transmission Control Protocol. The proposal was refined and details filled in by the ARPANET community, with major contributions from participants from European networks eventually leading to the TCP (Transmission Control Protocol) and IP (Internet Protocol) protocols, which, in turn, formed the basis for what eventually became the TCP/IP protocol suite (Sterlings, 2014). This provided the foundation for the Internet.

Next comes WLAN Standard

Today's wireless networks owe much to one of the earliest computer networks, the University of Hawaii's ALOHA net. This radio-based system created in 1970, had many basic principles still in use today. Early wireless networks were bulky. It was not until 1980s, with the arrival of cheaper, more portable equipment, that wireless networking became mainstream.

There was a still a problem, by the end of the 1980s multiple companies were manufacturing and selling their own equipment, but it was all incompatible. There needed to be some standard across all devices. Step forward the Institute of Electrical and Electronic Engineers (IEEE) and Vic Hayes. Hayes did not invent any new technology, but he took charge of IEEE's wireless standards committee, and pushed for cooperation between the manufacturers. In 1996 they released the first standard wireless local area network (WLAN); its was IEEE 802.11.

Adopted in 1999 by a group of like-minded industrial leaders, who gave it the more catchy name of "Wireless Fidelity", or Wi-Fi. (Baylis, 2014).

This section contained a brief glimpse in the history of wireless networks. For further reading, links will be provided on points discussed in this section of the report.

2.2.1.2 Advantages and Disadvantages

Advantages

- The biggest advantage of wireless networks is near instantaneous communication, we can communicate with anyone at anytime from anywhere as long as both parties are connected via some medium. Wireless communication has revolutionized everything. Wireless communication is not only limited to person to person, even our devices can communicate with each other and people can remotely control robots to perform complex tasks or explore dangerous places.
- Wireless communications and networks have made many things accessible to a wide range of people. We can get access to different cultures and knowledge through internet.
- People can do a lot of tasks remotely because of invention of wireless technologies, we can shop from home, pay bills and even transfer money via online banking. Students can even learn through online as demonstrated by COVID-19 pandemic.
- Another great benefit of wireless media is expandability. Businesses can expand their needs easily if they use wireless technologies. Companies like Amazon and Google provide many services like email, online storage etc. which businesses use at low cost and expand the services when needed.
- Wireless communication also provides people freedom, people can share anything they want and even access information and resources shared by other people. Open source projects on the internet provide people with the power to choose what they want.

Disadvantages

- Wireless communications and internet have also created a lot of problems. Crimes like scam and identity theft are serious problems. Millions of people are affected every year. People are tricked into giving their personal information which is easily misused.
- It has become harder to trace criminals because of the anonymity that the internet provides. People can easily share illegal content on the internet with little to no repercussions.
- Our data may also be at risk whenever we use online medium, ransomwares and computer viruses are transmitted through internet which can cost us a lot to repair.
- Cybercrime costs include damage of data, theft, fraud, piracy, spread of misinformation and the money spent to fix these problems.
- Our privacy almost non-existent. Websites collect our data and it is sold on the internet. If we are on the internet, we are giving up our privacy unless we take extra measures to remain safe which is a lot of work and inconvenience to an average person.
- Wireless networks can also be less reliable and cause us to lose our data if the network malfunctions of gets disrupted.
- Another problem with wireless networks is range, they have limited range and speed and upgrading any network costs a lot of money and resources.

2.1.2 802.11 Architecture

this section of the report was taken from the book Data and Computer Communications to accurately explain about 802.11 Architecture.

Figure below shows the model developed by the 802.11 working group. The smallest building block of a WLAN is a basic service set (BSS), which consists of some number of stations executing the same MAC protocol and competing for access to the same shared wireless medium (Sterlings, 2014).

A BSS may be isolated, or it may connect to a backbone distribution system (DS) through an access point (AP). The AP functions as a bridge and a relay point. In a BSS, client stations do not communicate directly with one another. Rather, if one station in the BSS wants to communicate with another station in the same BSS, the MAC frame is first sent from the originating station to the AP, and then from the AP to the destination station. Similarly, a MAC frame from a station in the BSS to a remote station is sent from the local station to the AP and then relayed by the AP over the DS on its way to the destination station. The BSS generally corresponds to what is referred to as a cell in the literature (Sterlings, 2014).

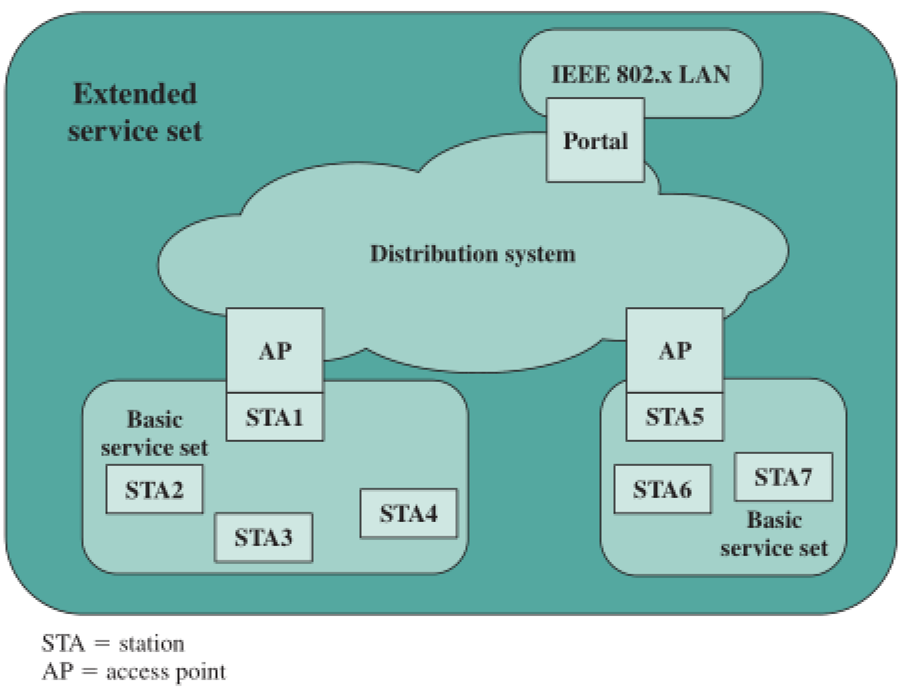


Figure 18: IEEE 802.11 (Sterlings, 2014)

The DS can be a switch, a wired network, or a wireless network. When all the stations in the BSS are mobile stations, with no connection to other BSSs, the BSS is called an independent BSS (IBSS). An IBSS is typically an ad hoc network. In an IBSS, the stations all communicate directly, and no AP is involved. (Sterlings, 2014)

Figure above shows a simplified version, in which each station belongs to a single BSS; that is, each station is within wireless range only of other stations within the same BSS. It is also possible for two BSSs to overlap geographically, so that a single station could participate in more than one BSS. Further, the association between a station and a BSS is dynamic (Sterlings, 2014).

Stations may turn off, come within range, and go out of range. An extended service set (ESS) consists of two or more BSSs interconnected by a distribution system. Typically, the distribution system is a wired backbone LAN but can be any communications network. The ESS appears as a single logical LAN to the logical link control (LLC) level Figure 18 indicates that an AP is implemented as part of a station; the AP is the logic within a station that provides access to the DS by providing DS services in addition to acting as a station. To integrate the IEEE 802.11 architecture with a traditional wired LAN, a portal is used (Sterlings, 2014).

The portal logic is implemented in a device, such as a bridge or router, that is part of the wired LAN and that is attached to the DS. (Sterlings, 2014)

2.1.3 IEEE 802.11 priorities

As with any wireless network, a WLAN using the IEEE 802.11 physical and MAC layers is subject to considerable unreliability. Noise, interference, and other propagation effects result in the loss of a significant number of frames. Even with error-correction codes, several MAC frames may not successfully be received. This situation can be dealt with by reliability mechanisms at a higher layer, such as TCP. However, timers used for retransmission at higher layers are typically on the order of seconds. It is therefore more efficient to deal with errors at the MAC level. For this purpose, IEEE 802.11 includes a frame exchange protocol. When a station receives a data frame from another station, it returns an acknowledgment (ACK) frame to the source station. This exchange is treated as an atomic unit, not to be interrupted by a transmission from any other station. If the source does not receive an ACK within a short period of time, either because its data frame was damaged or because the returning ACK was damaged, the source retransmits the frame. Thus, the basic data transfer mechanism in IEEE 802.11 involves an exchange of two frames. To further enhance reliability, a four-frame exchange may be used. In this scheme, a source first issues a Request to Send (RTS) frame to the destination (Sterlings, 2014).

The destination then responds with a Clear to Send (CTS). After receiving the CTS, the source transmits the data frame, and the destination responds with an ACK. The RTS alerts all stations that are within reception range of the source that an exchange is under way; these stations refrain from transmission in order to avoid a collision between two frames transmitted at the same time. Similarly, the CTS alerts all stations that are within reception range of the destination that an exchange is under way (Sterlings, 2014).

The RTS/CTS portion of the exchange is a required function of the MAC but may be disabled.

2.1.4 Wireless Technologies

Wireless technology refers to technology that allows us to communicate without wired media like fiber optics or cables but instead use radio waves and signals to transfer data. Explanation about wireless communications has already been covered in earlier sections of the report which are equally applicable to this section about wireless technologies.

2.1.4.1 WAP

WAP stands for Wireless Application Protocol. WAP was designed in the early days of mobile phones for displaying text or picture data in small screens.

WAP the mark-up language WML (Wireless Markup Language and not HTML), WML is defined as XML 1.0 application. It enables creating web applications for mobile devices (raman_257, 2019). In 1998, WAP Forum was founded by Ericson, Motorola, Nokia and Unwired Planet whose aim was to standardize the various wireless technologies via protocols (raman_257, 2019).

WAP protocol was possible due to the joint efforts from the various members of WAP Forum. In 2002, WAP forum was merged with various other forums of the industry resulting in the formation of Open Mobile Alliance (OMA). (raman_257, 2019)

The WAP contains a protocol suite which is briefly described below.

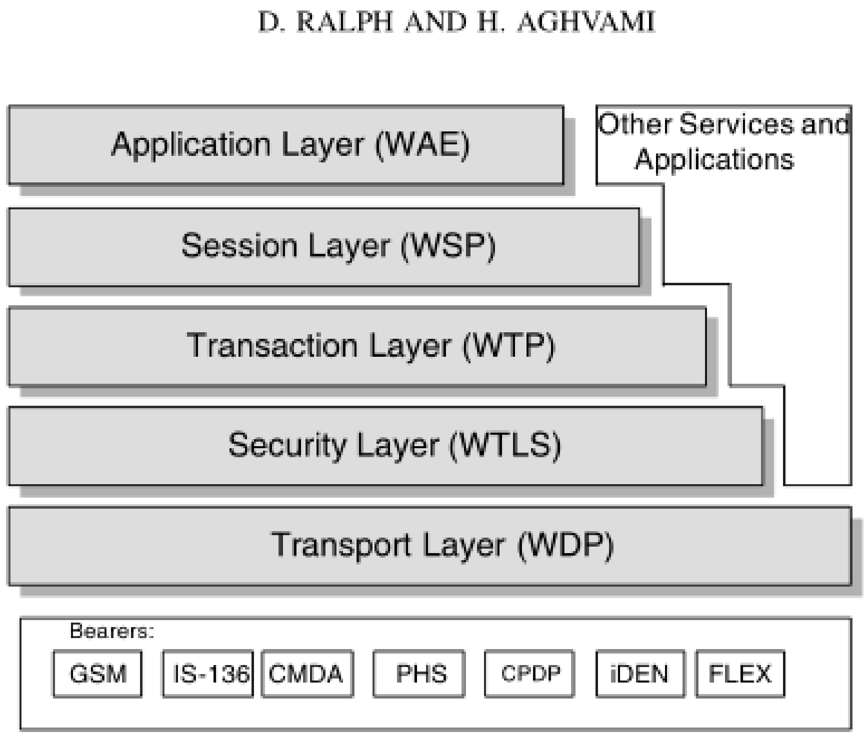


Figure 19: WAP Protocol (D. Ralph, 2001)

A model showing the protocols defined by WAP, is illustrated below in Figure 19 WAP protocols and their functions are layered in a style resembling that of the ISO OSI Reference Model (ISO7498). Layer management entities handle protocol initialization, configuration and error conditions (such as loss of connectivity due to the mobile station roaming out of coverage) that are not handled by the protocol itself. The Application Layer (WAE) specifies the WML and WML script standard and acts as a container for applications such as a browser. The Wireless Session Protocol (WSP) is designed to function on the transaction and datagram services. Security is assumed to be an optional layer above the Transport layer. The Security layer preserves the Transport service interfaces. The transaction, session or application management entities are assumed to provide the additional support that is required to establish security contexts and secure connections. This support is not provided by the WSP protocols directly. In this regard, the Security layer is modular. WSP itself does not require a Security layer; however, applications that use WSP may require it. The Wireless Datagram Protocol (WDP) supports connectionless reliable transport and bearer independence so the protocol can operate over GSM Data, Short Message Service or Unstructured

Supplementary Services Data and many other network technologies. The WSP/WTP layers combined perform the equivalent of an HTTP request against a Web Server. The session layer manages the suspend/resume and session redirection (D. Ralph, 2001).

The transaction layer primarily uses request and response to invoke functions.

2.1.4.2 WML

Wireless markup language (WML) is a markup language for wireless devices that adhere to Wireless Application Protocol (WAP) and have limited processing capability. Like HTML that renders content for desktop browsers, WML renders content for wireless devices that have limited processing capabilities. It does this by defining the protocol stack and WWW based Internet access for wireless devices. (Technopedia, 2020)

WAP also has sites written in WML like HTML-based sites is designed to handle issues like small display size, limited user input capabilities, narrowband network connection with high latency, limited memory and computational processing power. (Technopedia, 2020)

2.3 Conclusion

With this we have come to the end of the report. History of development of wireless networks, advantages and disadvantages of wireless networks and technologies in wireless networks have been described. The research for this report was very informative and helped in understanding about networks. After reading all the materials from multiple sources, it can be concluded that wireless technology is still being improved an it is still evolving. This report serves to be a brief introduction to the world of networks and wireless technologies.

3 References and Bibliography

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4 Appendix

Appendix – A Screenshot of Simulation Report

```
Compuware COMNET III  Release 2.5.2.814  Wed Dec 23 17:04:33 2020   PAGE     1

                           19030824 Bijay Bharati

                         NODES: RECEIVED MESSAGE COUNTS

                      REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

      RECEIVER           COUNT                MESSAGE NAME
______________________ __________ _________________________________________

Edinburg.ATM Server         342   Butwal ATM MSG REQ
Edinburg.ATM Server         339   Ithari ATM MSG REQ
Edinburg.ATM Server           1   Butwal Teller MSG REQ
```

Figure 20: Simulation Report page 1

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                           19030824 Bijay Bharati

                          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
______________________  _________ ______ _________ _________ _________ _____

Edinburg.Edinburg Link       7249      0     0.036     0.011     0.082 0.4294
Butwal.Butwal Link           5904      0     0.067     0.023     0.491 0.6530
Ithari.Ithari Link           5891      0     0.067     0.023     0.538 0.6510
```

Figure 21: Simulation Report page 2

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                              19030824 Bijay Bharati

                          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
  Ithari - London             47       17      100             8            17
  London- Ithari              39        0       39             4             9
  Butwal - London             48       17      101             8            17
  London - Butwal             39        0       39             4            10
```

Figure 22: Simulation Report page 3

```
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                              19030824 Bijay Bharati

                          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 =         2309 )
  Ithari - London  Frm          1790            31             0             0
                    kb           771            14             0             0
  London- Ithari   Frm          1154             0             0             0
                    kb           369             0             0             0
  Butwal - London  Frm          1768            37             0             0
                    kb           769            17             0             0
  London - Butwal  Frm          1151             0             0             0
                    kb           368             0             0             0
```

Figure 23: Simulation Report page 4

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19030824 Bijay Bharati

WAN CLOUDS: ACCESS LINK STATS

REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD: ACCESS LINK	(ENTRY) (EXIT)	FRAMES ACCEPTED	FRAMES DROPPED	BUFFER (BYTES) MAX	BUFFER (BYTES) AVG	BUFFER (BYTES) STD	% UTIL
WAN Cloud							
Ithari Access Li	Entry	1821	0	N/A	N/A	N/A	100.00
	Exit	1154	0	40	3	10	6.25
Butwal Access Li	Entry	1805	0	N/A	N/A	N/A	99.99
	Exit	1151	0	40	2	10	6.23
London Access Li	Entry	2306	0	N/A	N/A	N/A	99.93
	Exit	3626	0	268	18	38	24.99

Figure 24: Simulation Report page 5

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MESSAGE + RESPONSE SOURCES: MESSAGE DELAY

REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

ORIGIN / MSG SRC NAME: DESTINATION LIST	MESSAGES ASSEMBLED	MESSAGE DELAY AVERAGE	MESSAGE DELAY STD DEV	MESSAGE DELAY MAXIMUM
Edinburg.ATM Server / src ATM Server RESP:				
ECHO	0	0.000 MS	0.000 MS	0.000 MS
Butwal.Butwal ATM / src Butwal ATM MSG REQ:				
Edinburg.ATM Server	55	30783.413 MS	15901.603 MS	58057.378 MS
Butwal.Butwal Teller / src Butwal Teller MSG REQ:				
Edinburg.ATM Server	1	21207.504 MS	0.000 MS	21207.504 MS
Ithari.Ithari ATM / src Ithari ATM MSG REQ:				
Edinburg.ATM Server	50	30700.619 MS	15634.861 MS	57552.484 MS
Ithari.Ithari Teller / src Ithari Teller MSG REQ:				
Edinburg.ATM Server	0	0.000 MS	0.000 MS	0.000 MS

Figure 25: Simulation Report page 6

Appendix -B Additional Reading Materials

Heinrich Hertz: https://en.wikipedia.org/wiki/Heinrich_Hertz

History of radio: https://en.wikipedia.org/wiki/History_of_radio

Invention of radio: https://en.wikipedia.org/wiki/Invention_of_radio#Tesla's_boat

Vic Hayes: https://en.wikipedia.org/wiki/Vic_Hayes

Nikola Tesla: https://en.wikipedia.org/wiki/Nikola_Tesla

Priority-based Transmission in IEEE 802.11 Networks: https://www.researchgate.net/publication/225479359_Priority-based_Transmission_in_IEEE_80211_Networks

Performance Analysis of Priority Schemes for IEEE 802.11 and IEEE 802.11e Wireless LANs: https://pdfs.semanticscholar.org/b0b5/30d83992eed9e25805a8ddf74a9996e6a9fd.pdf

Appendix -C Glossary

No difficult worlds have been used in the report. If any words have been used in the report with short forms like WWW, they have been explained within the report itself.