Module Code & Module Title

CS5001NA Networks and Operating System

Assessment Weightage & Type

30% Individual Coursework

Year and Semester

2018-19 autumn

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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 mark of zero will be awarded.

Table of Contents

Table of figures

Table of Table

Introduction

This is the first coursework of Network Operating System in which we are assigned to design the basic network architecture for ATM network. The coursework is divided into two parts task A, and task b. In task A we are assigned to create a network simulation model for the atm network, verify the model and run the simulation. Likewise, in task B we are assigned to make a report the coursework by including how the model was built its screenshot and explaining about the TCP/IP and OSI layer. We have solved a lot of similar question to the coursework in our tutorial classes so it was not that difficult for us.

The designing part of task A is done in the COMNET III desktop application which is a great application for designing network model. In task A, we have implemented the scenario, described the WAN model and discussed the nodes report of the model. In task B we have described how data operate in the network layer, datalink layer, and the physical layer. The coursework is very much informative and we will gain a lot of knowledge after finishing this coursework. Overall the coursework is not that difficult but in some cases, there are in which a research can be done. I find this coursework a lot more fruitful for our career.

Task A

1. Implementation of the scenario.

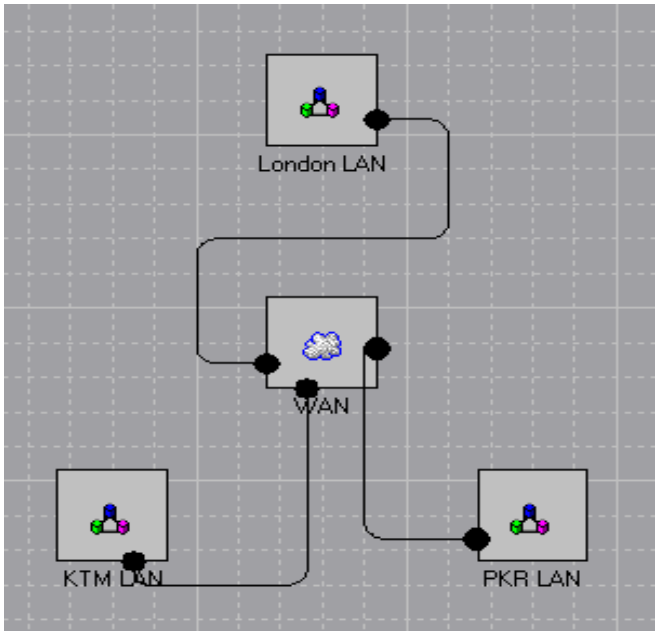


Figure 1: Main Architecture

This is the outermost or the main architecture of the WAN model. In this model, we have three LAN (London, Pokhara, and Kathmandu). Each LAN are connected to the WAN cloud using the access points.

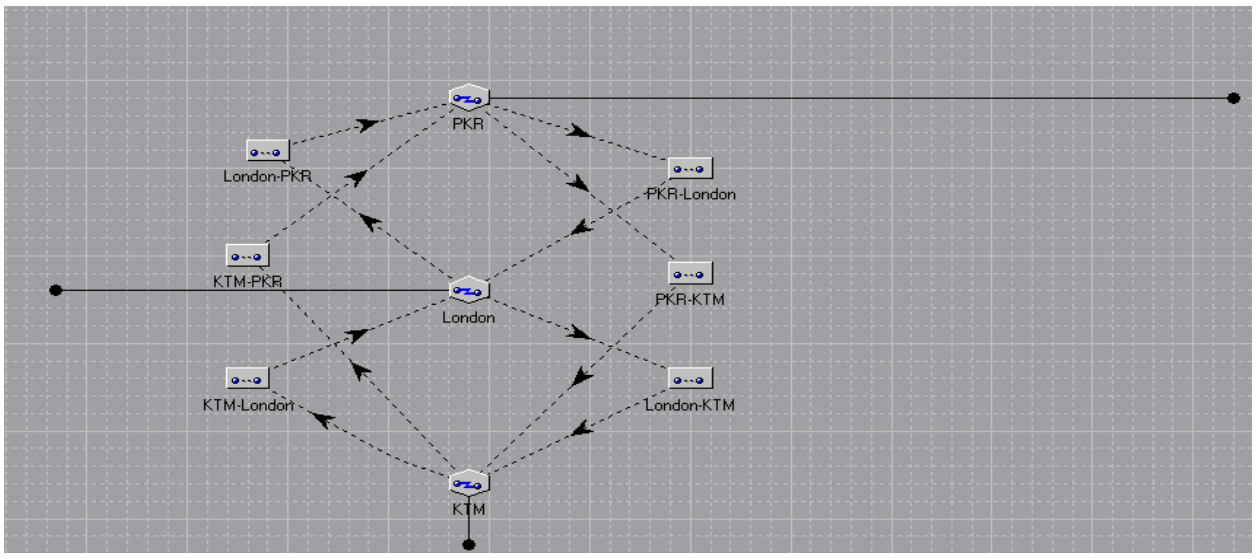


Figure 2:Wan Cloud

The figure above is the design inside the WAN Cloud where all the LAN are connected together using point to point links and WAN link or VC.

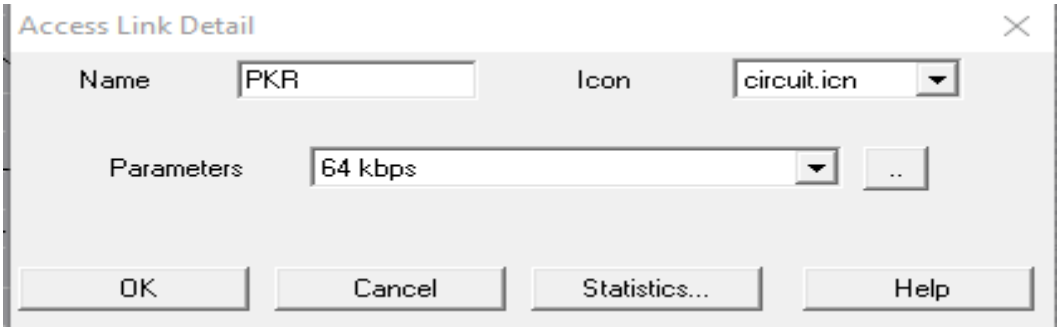


Figure 3: Access link detail

The above figure illustrate the structure or details of access link which is used in the wan cloud to access the LAN. All the LAN have access link and the parameters inside each access link are same as above.

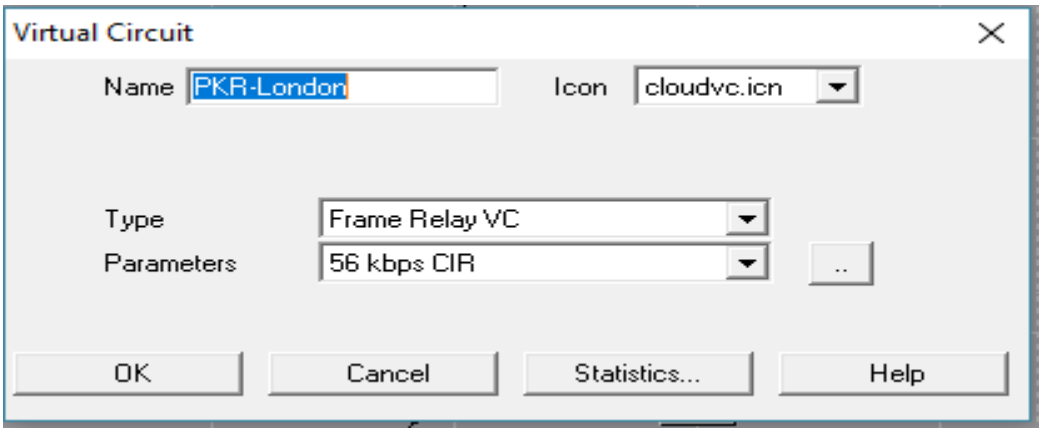


Figure 4: Virtual Circuit

The above figure show the details of virtual circuit which is used in the WAN to connect LANs to each other. All the virtual circuit inside the wan cloud have a same parameters and type as shown in the figure above.

KTM LAN

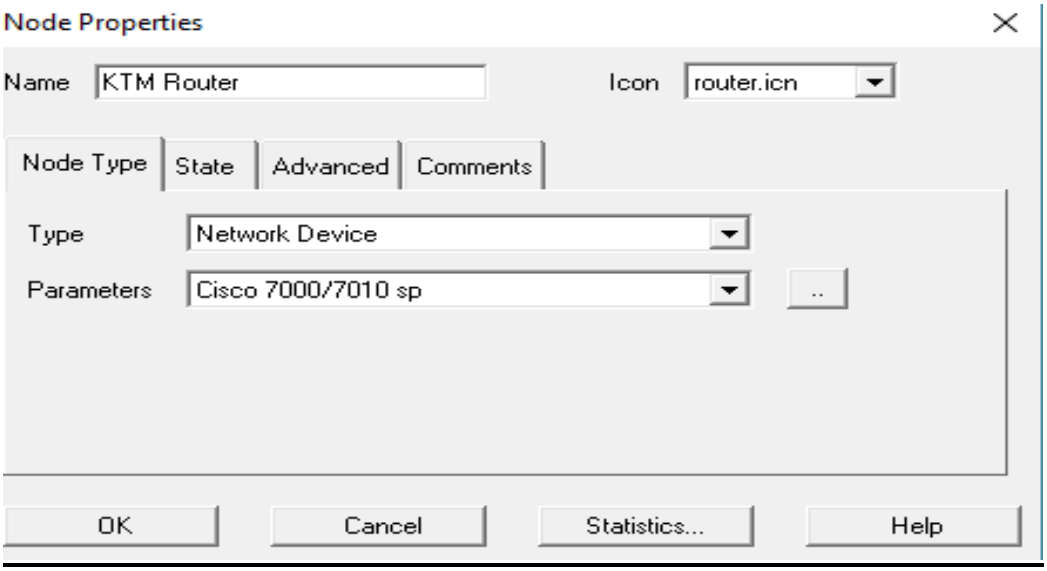


Figure 5: Ktm Router

In the KTM LAN, we have set up the router with Cisco 7000/7010sp parameter and has a type set to the network device.

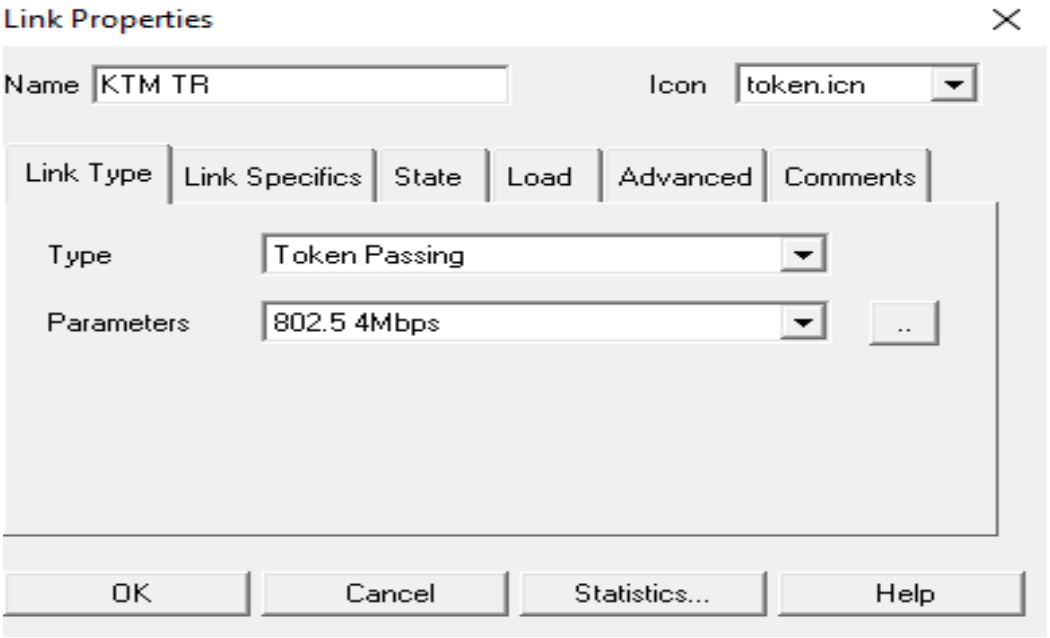


Figure 6: Ktm Token Ring

In KTM LAN we have set up the token ring which has a type token passing and 802.3 4 Mbps parameter.

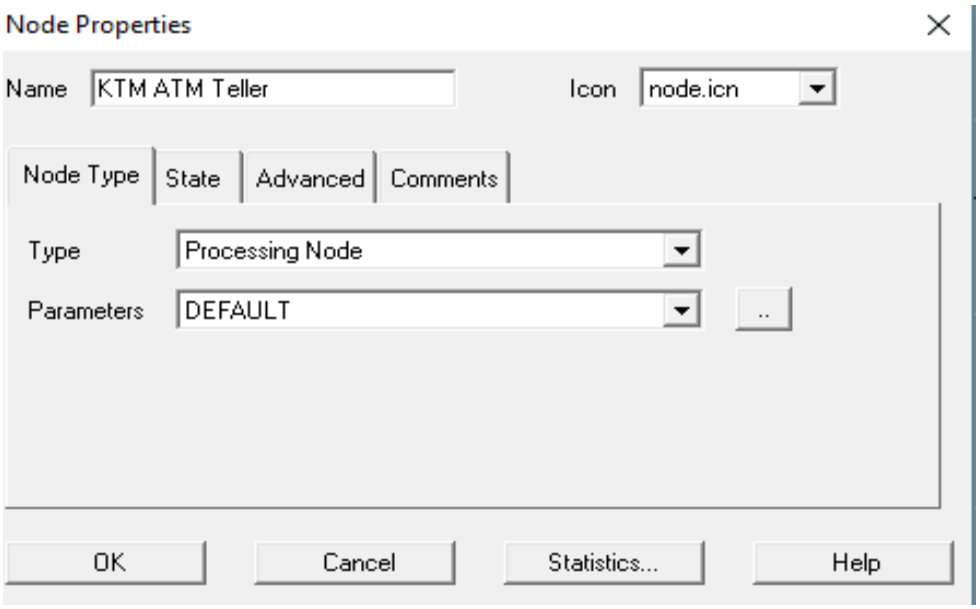


Figure 7 :KTM ATM Teller

The ATM Node inside KTM LAN is set up using default parameter and has a type set to the processing node.

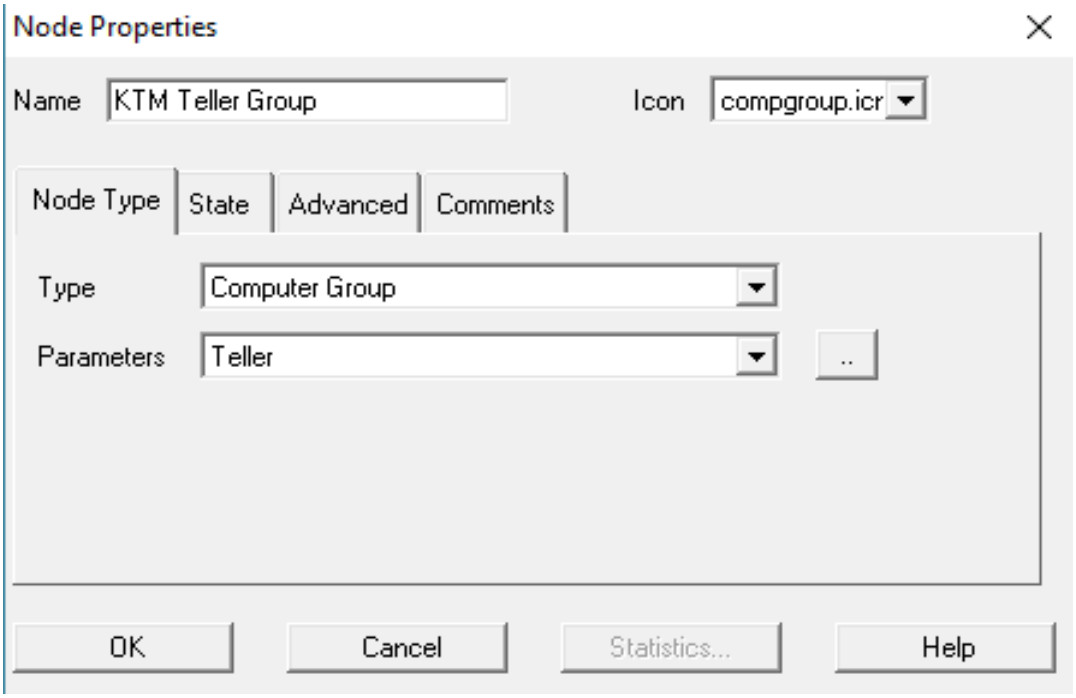


Figure 8: KTM Teller Group

The teller group of the KTM LAN has it type set to Computer Group and has a parameter named Teller which consist of 60 nodes.

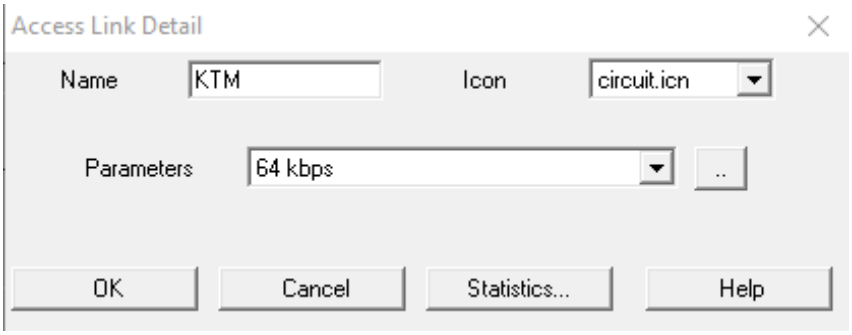


Figure 9: KTM Access Link

The name of Access Link in KTM LAN is KTM which has a parameter 64 kbps.

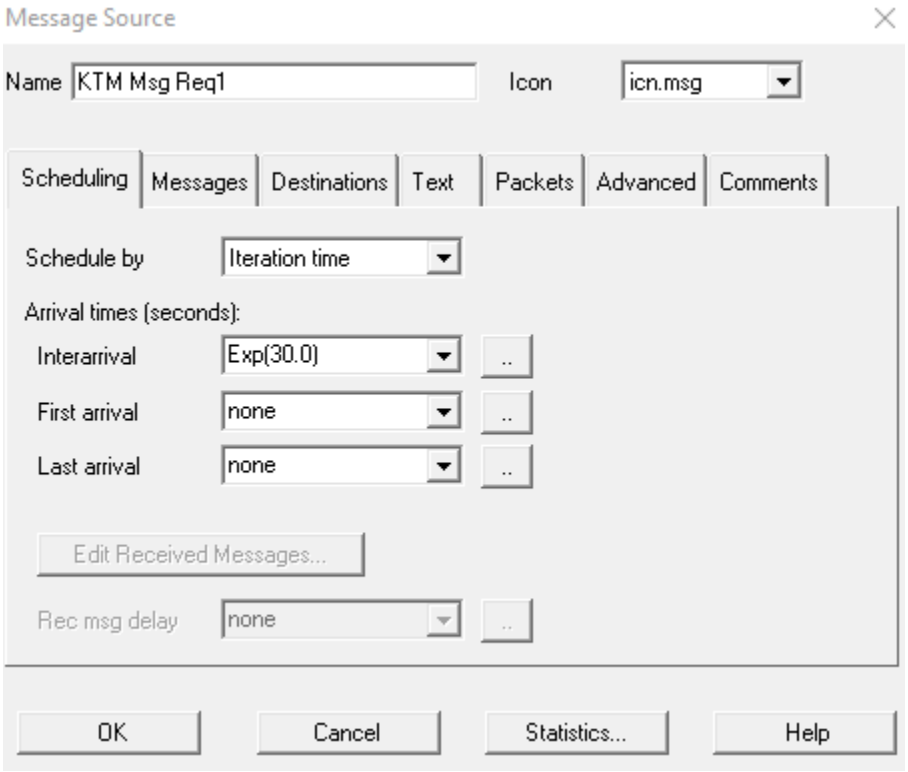


Figure 10: Ktm Teller Message Source1

The above figure is the Message Source of ATM teller of KTM Lan which has a schedule by iteration time and has an interarrival time of Exponential mean 30 and stream set to 0.

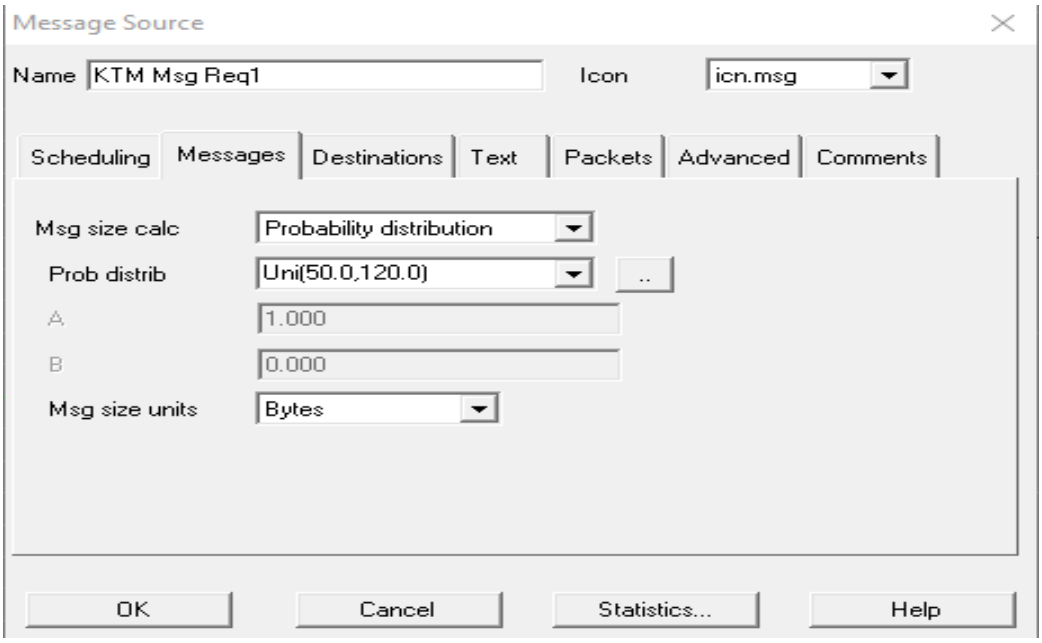


Figure 11:Ktm Teller Message source2

The above figure is the Message Source of ATM teller of KTM Lan which has a message size calculation set to Probability distribution with minimum 50 maximum 120 and stream set to 0.

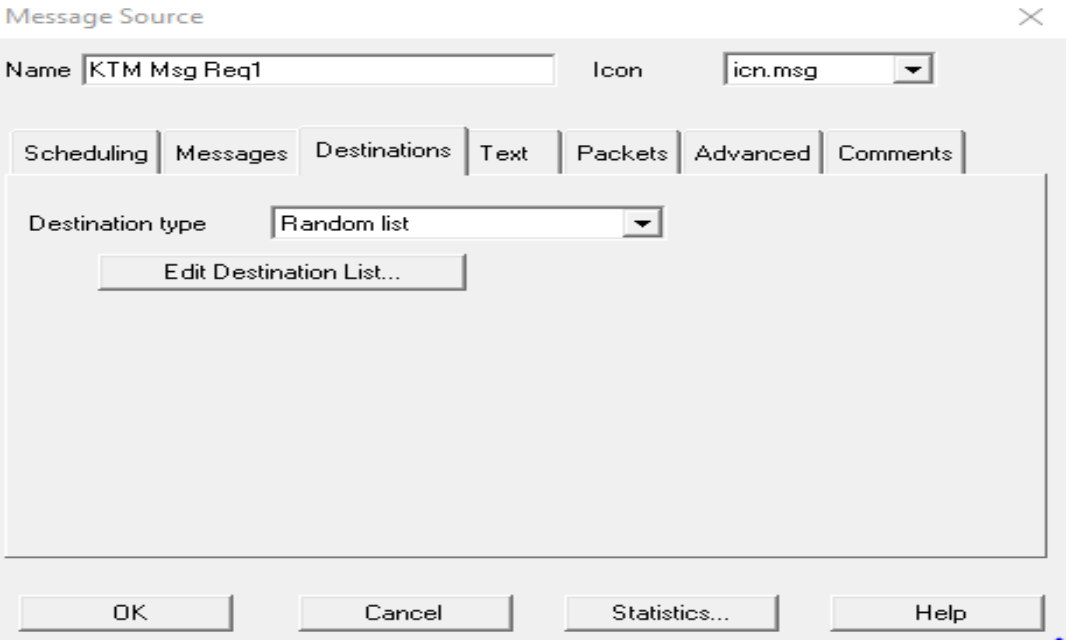


Figure 12: Ktm Teller Message Source3

The above figure is the Message Source of ATM teller of KTM Lan which has a destination type set to random list.

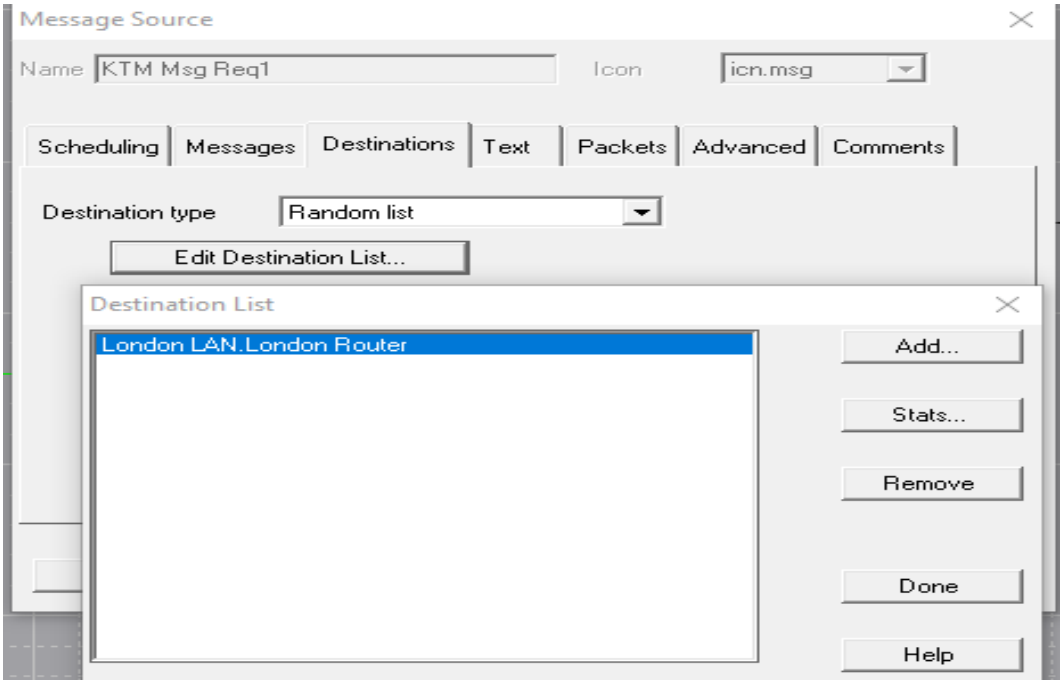


Figure 13: Ktm Teller Message Source4

The above figure is the Message Source of ATM teller of KTM Lan which has destination type with the random list and the destination list contains the LondonLAN.LondonRouter.

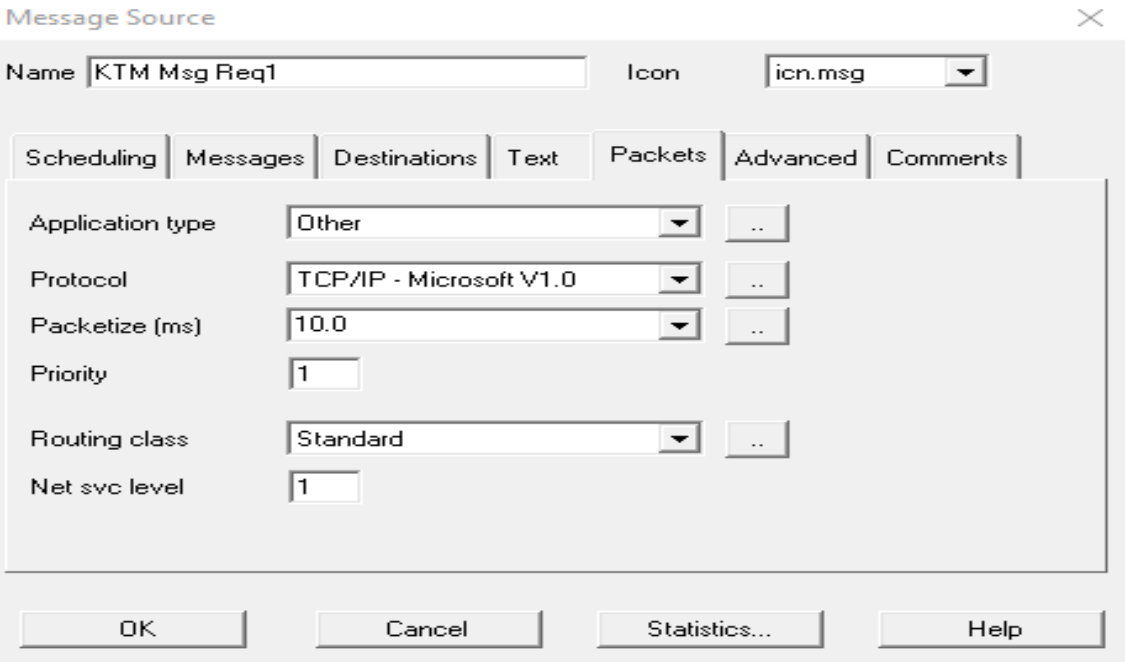


Figure 14: Ktm Teller Message source5

The above figure is the Message Source of ATM teller of KTM Lan which has a Packets protocol set with TCP/IP Microsoft v1.0 and has a packet size 10.0 with standard routing class.

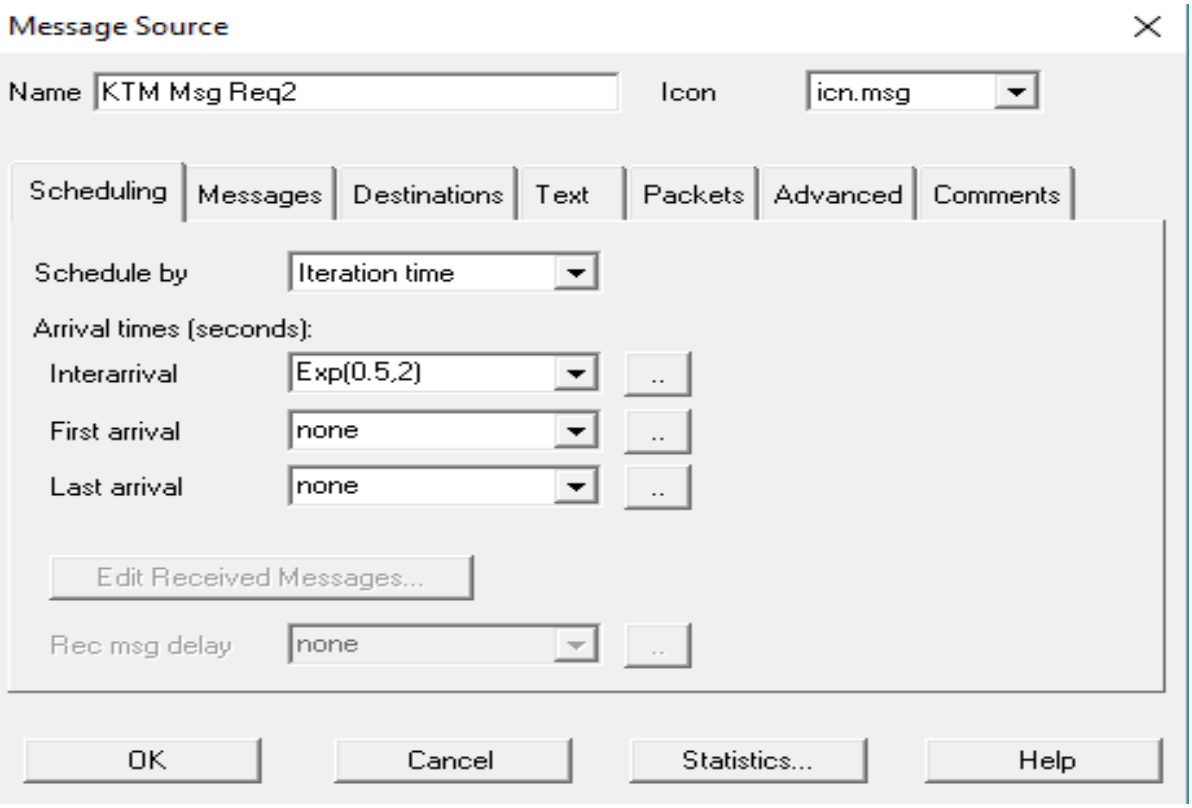


Figure 15: KTM ATM Message Source 1

The above figure is the Message source of teller group of KTM Lan which has a schedule by iteration time and has an interarrival time with exponential distribution 0.5 with stream 2.

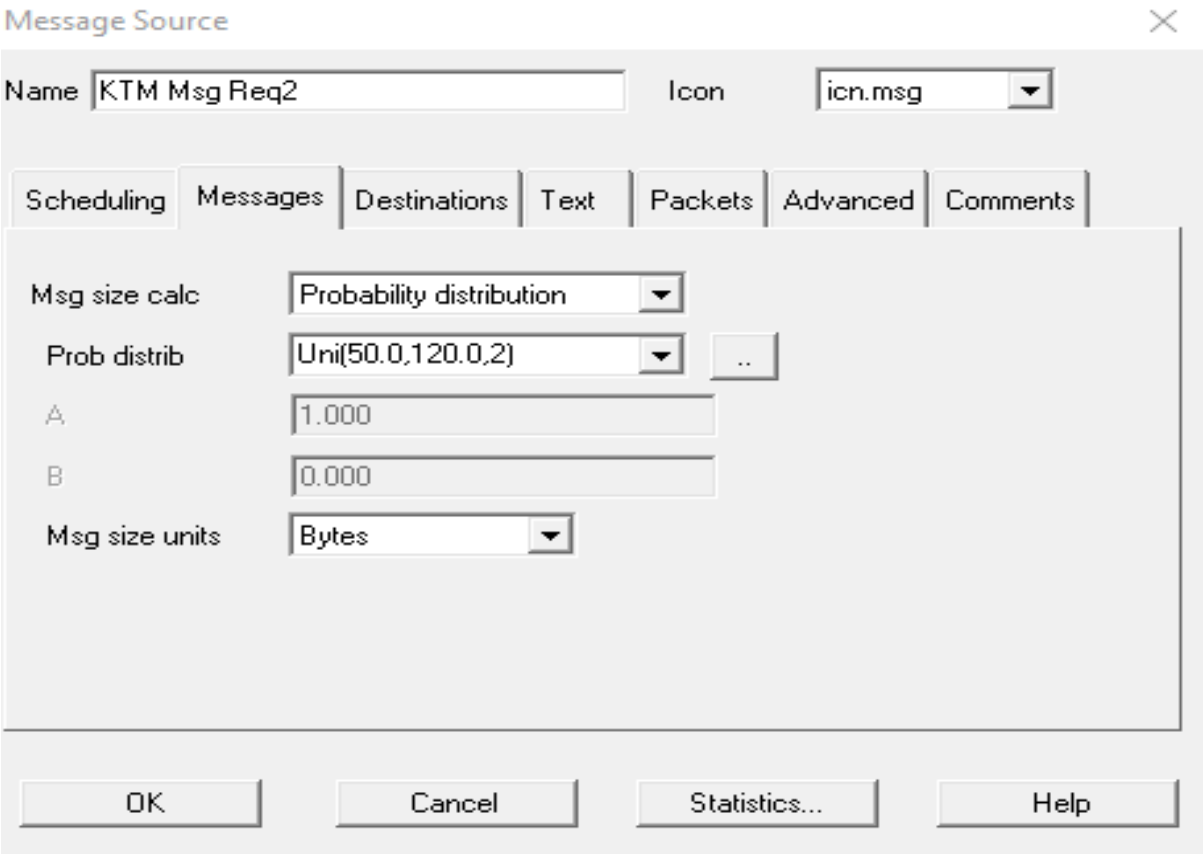


Figure 16: ktm ATM Message Source 2

The above figure is the Message Source of teller group of KTM Lan which has a message size calculation set to Probability distribution with minimum 50 maximum 120 and steam set to 2.

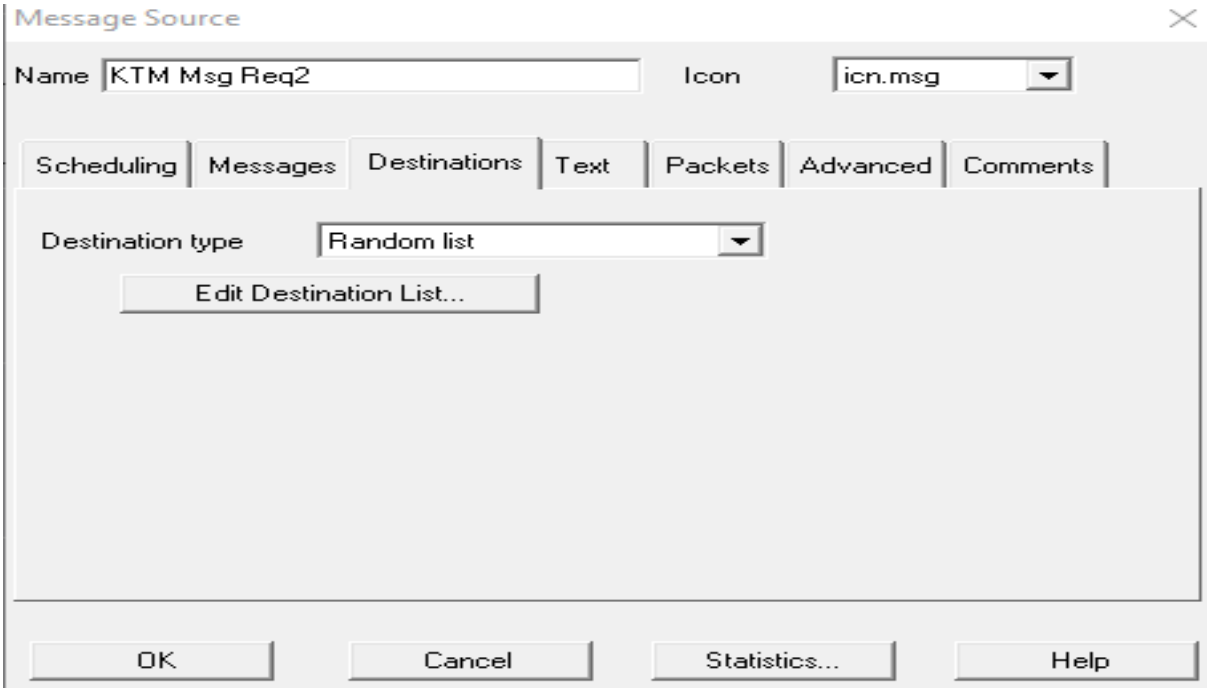


Figure 17: Ktm ATM Message source 3

The above figure is the Message Source of teller group of KTM Lan which has a destination type set to random list.

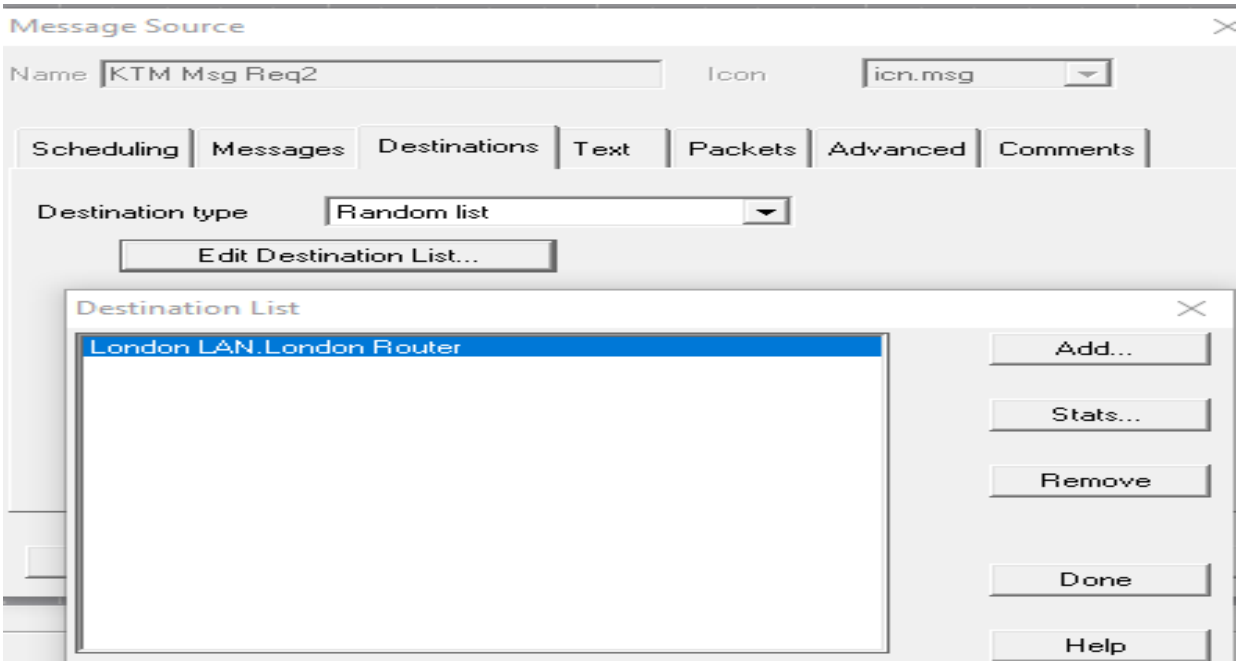


Figure 18: KTM ATM Message source 4

The above figure is the Message Source of teller group of KTM Lan which has destination type with random list and the destination list contains the LondonLan.LondonRouter.

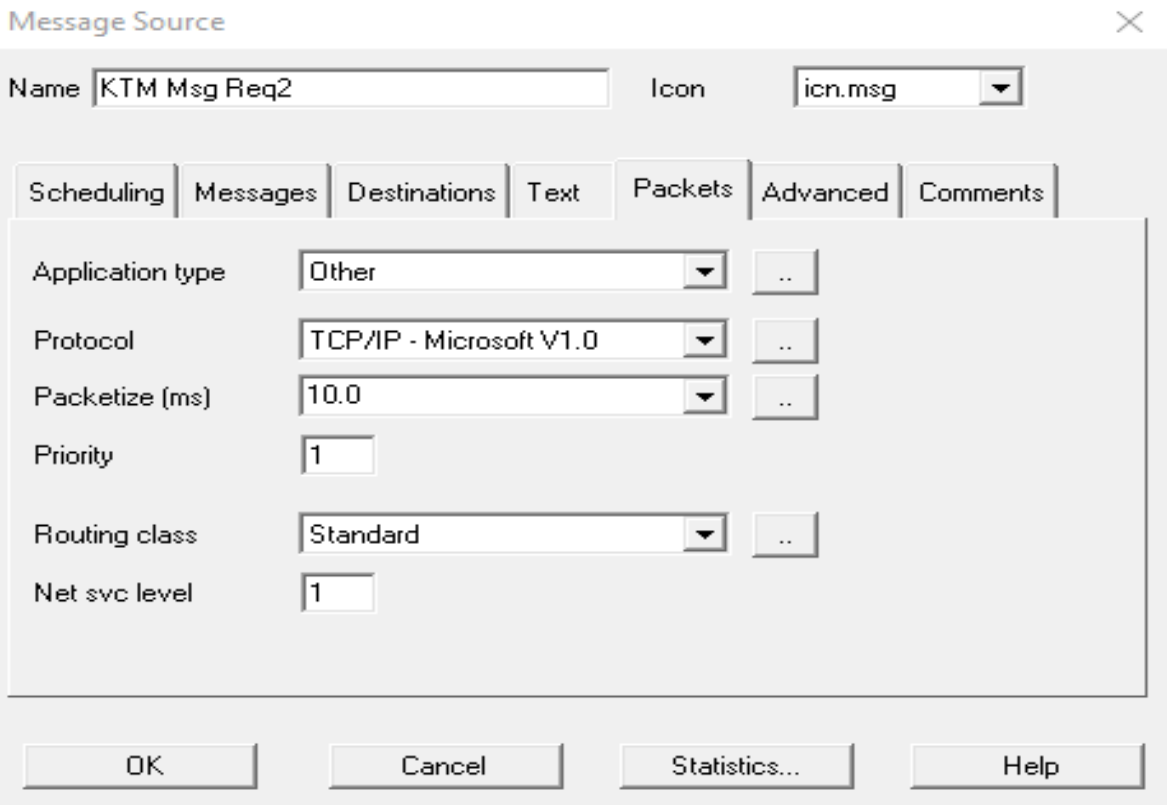


Figure 19: : KTM ATM Message source 5

The above figure is the Message Source of ATM teller of KTM Lan which has a Packets protocol set with TCP/IP Microsoft v1.0 and has a packet size 10.0 with standard routing class.

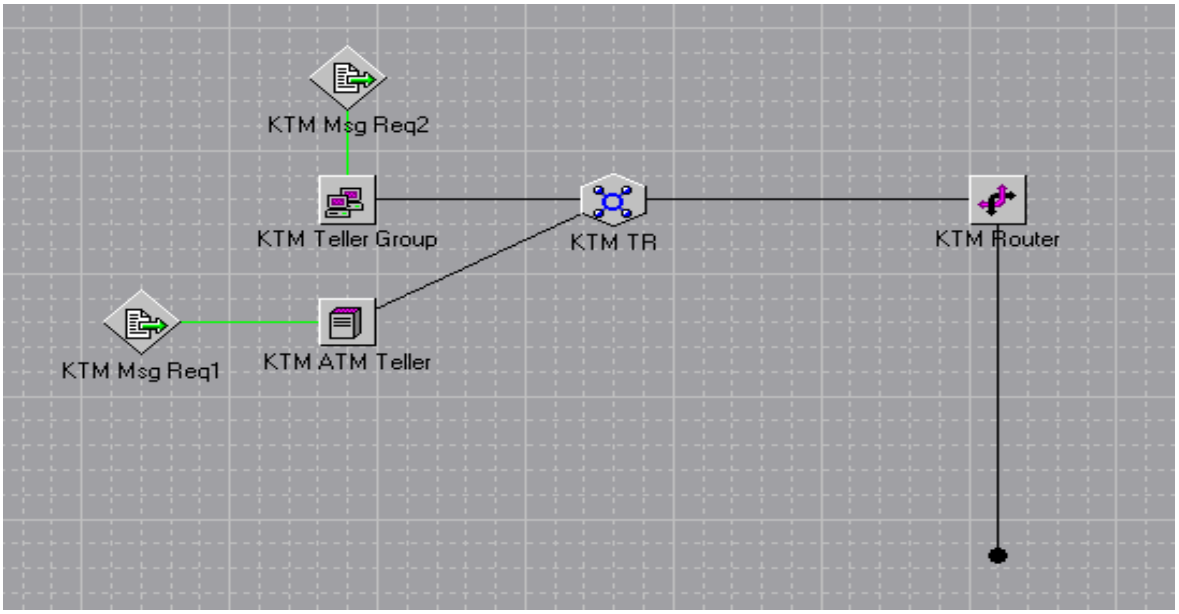


Figure 20: KTM LAN Structure

This is the design in the KTM Lan which consist of one token passing ring, a router, access point, processing node with a message request and a computer group with message request.

London LAN

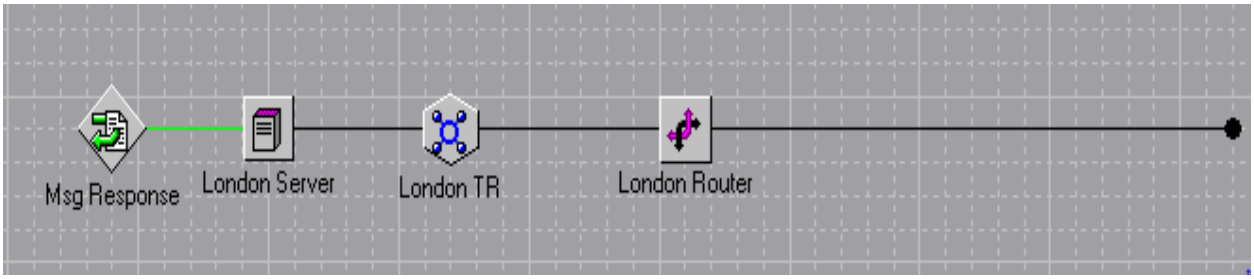


Figure 21: London LAN Structure

This is the structure of the London LAN. It consists of a token passing ring, a router, access points and a server (processing node) with message response source.

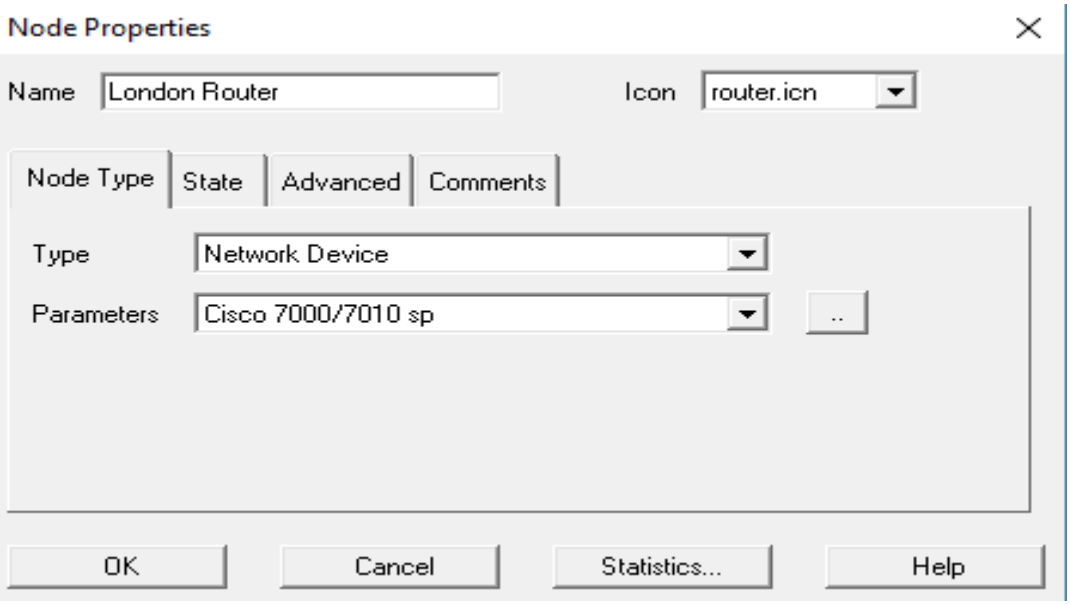


Figure 22: London LAN Router

The above figure is the router of the London LAN which has a parameter set with Cisco 7000/7010sp and has typeset as the network device.

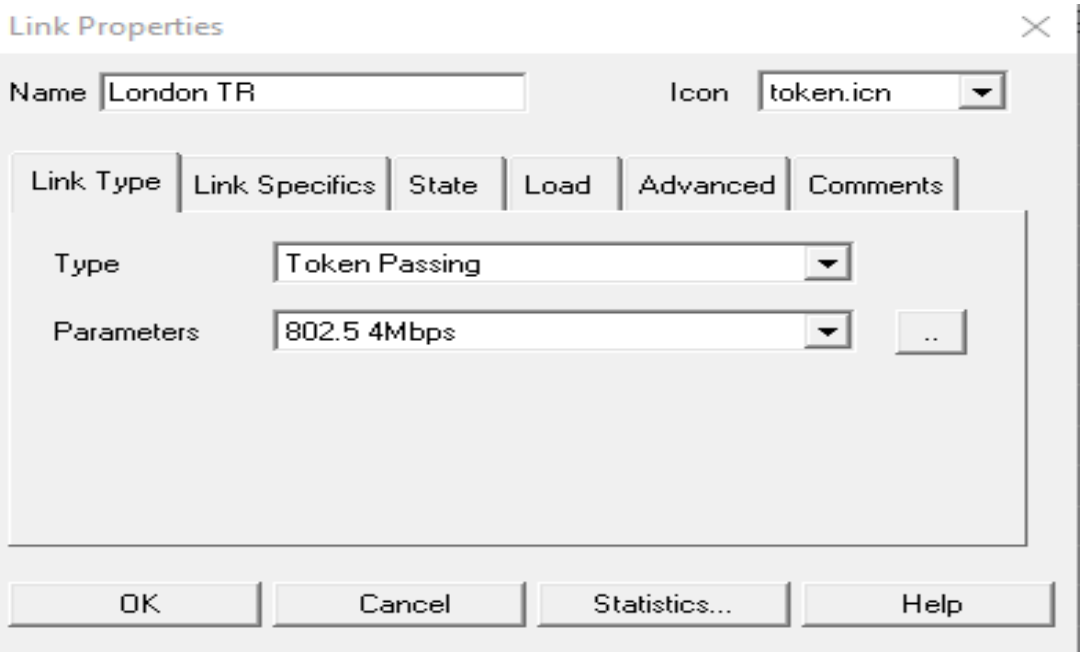


Figure 23: London LAN Token Ring

The above figure show the Token Ring of the London LAN which has a type set to token passing and has a parameter set with 802.5 4Mbps.

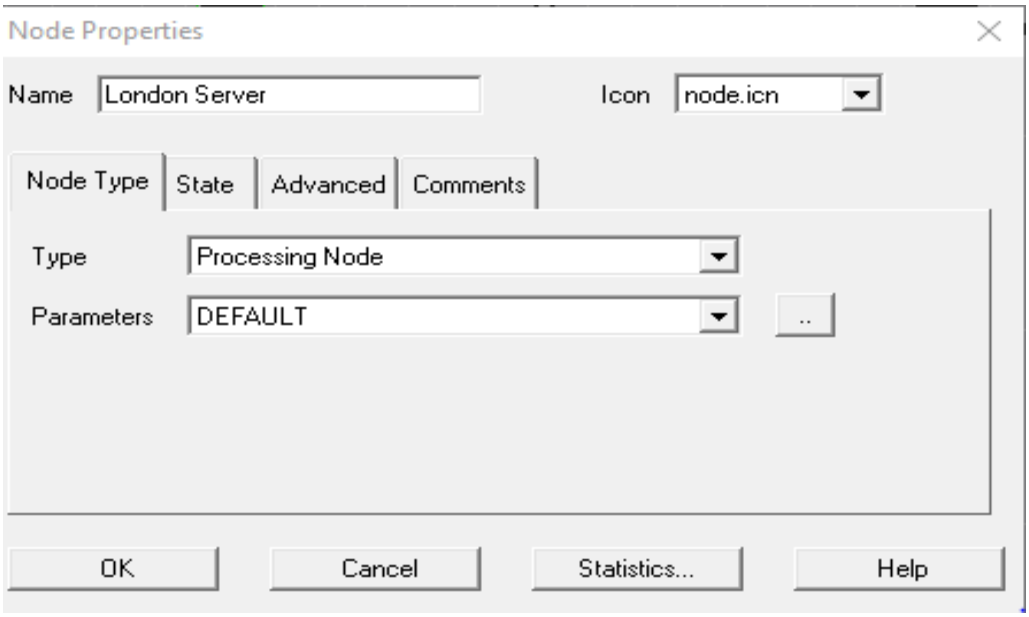


Figure 24: London LAN Server

The above figure is of the London Server of the London LAN which has a type set to processing node and has a default parameter.

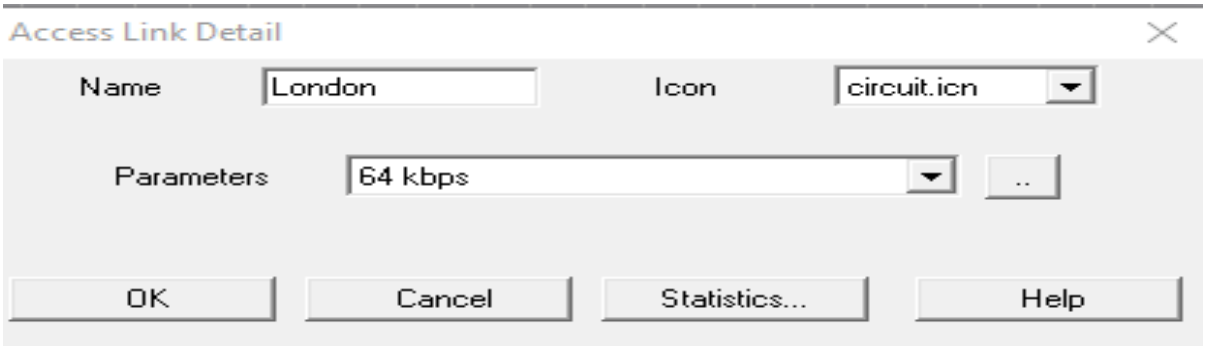


Figure 25: London LAN Access Link

The above figure shows the Access Link Details of the London LAN which name is London and has a parameter 64 Kbps.

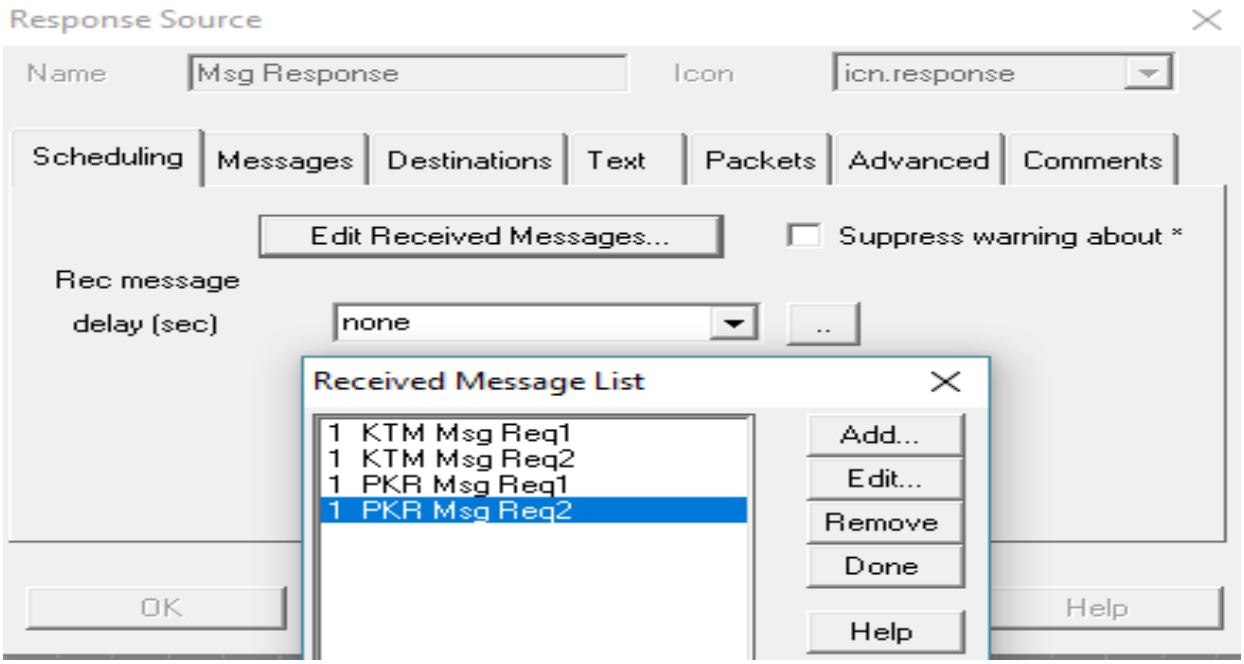


Figure 26: London LAN Message Response

The above figure shows the Message Response Source of the London LAN which has received message list set with the four message request shown in the figure.

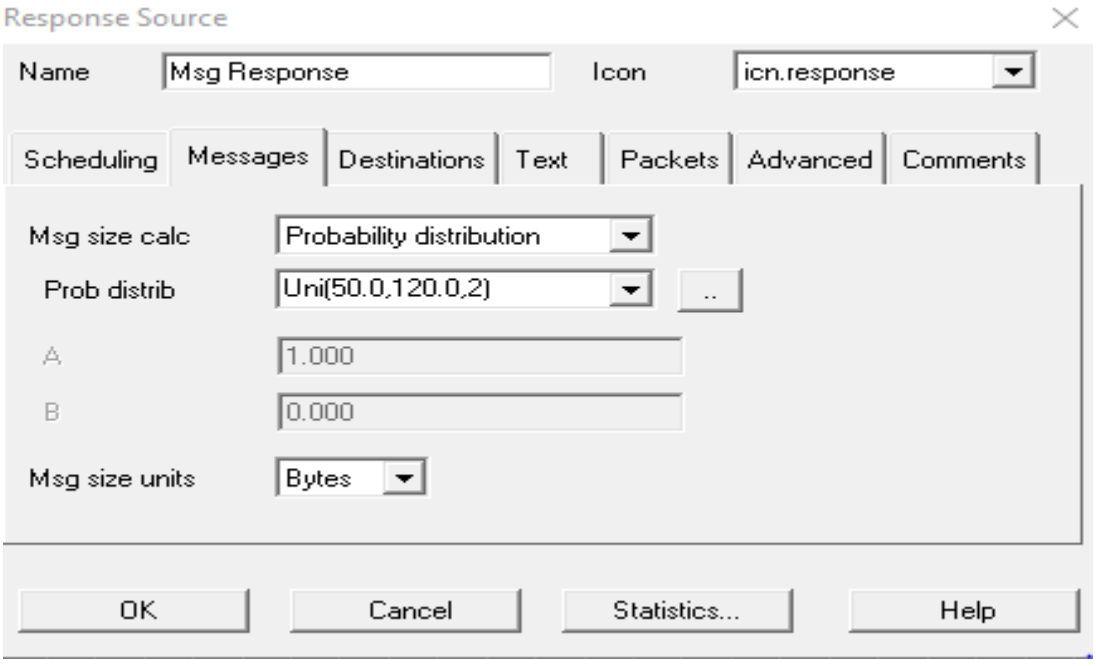


Figure 27: London LAN Message Response 2

The above figure shows the Message Response Source of the London LAN which has message size calculation set to probability distribution with uniform (minimum 50 and maximum 120 with stream 2.

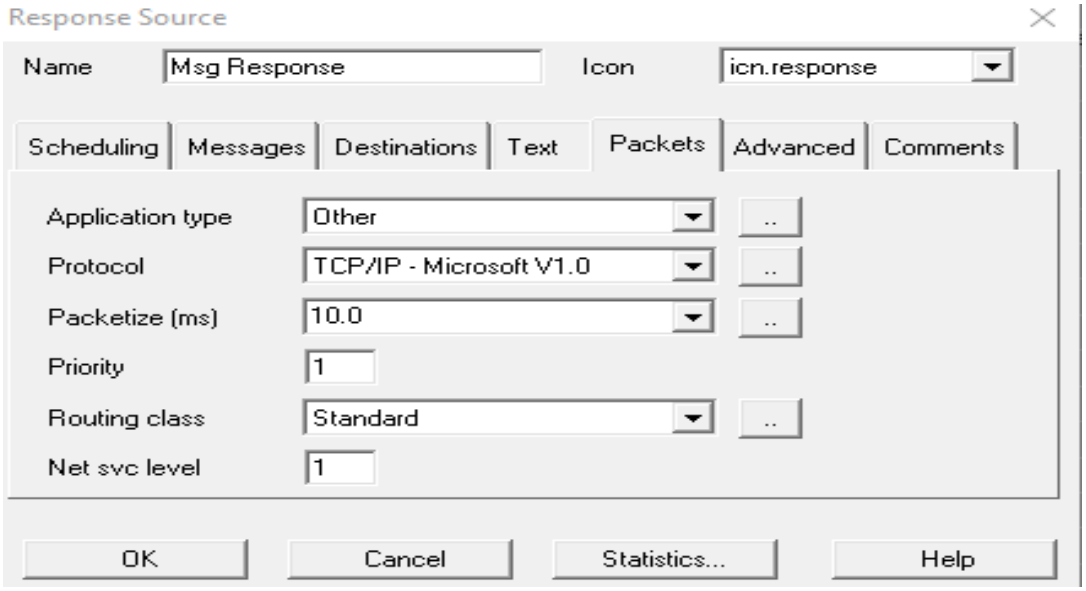


Figure 28: London LAN Message Response 3

The above figure shows the Message Response Source of the London LAN which has packet protocols set up with TCP/IP Microsoft v1.0, a packet size of 10.0 and has a standard routing class.

Pokhara LAN

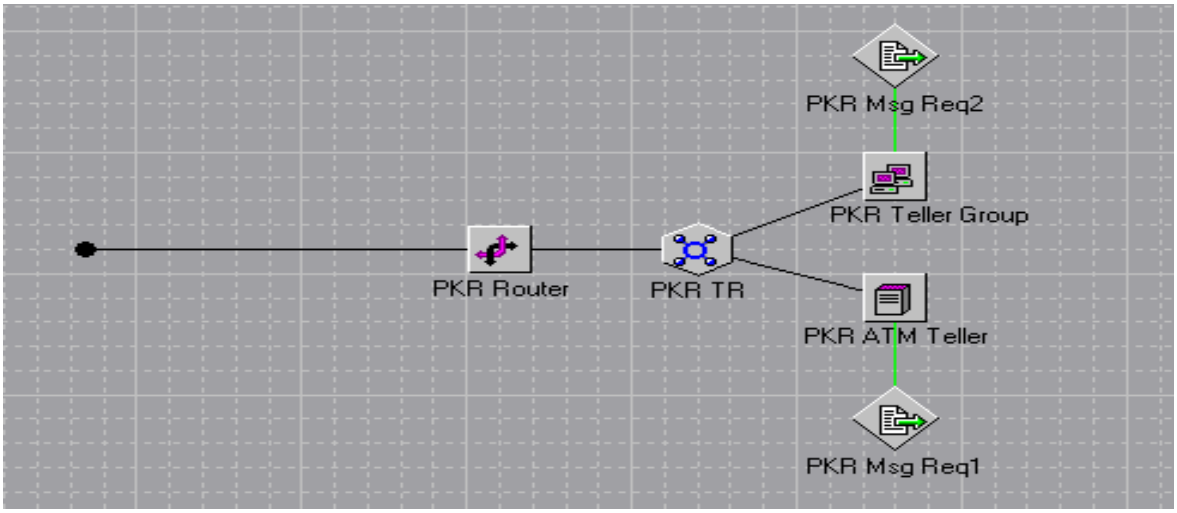


Figure 29: Pokhara LAN

The above figure shows the structure of the Pokhara LAN. The LAN consists of a router, token ring, processing node with message request, computer group with message request and an access point.

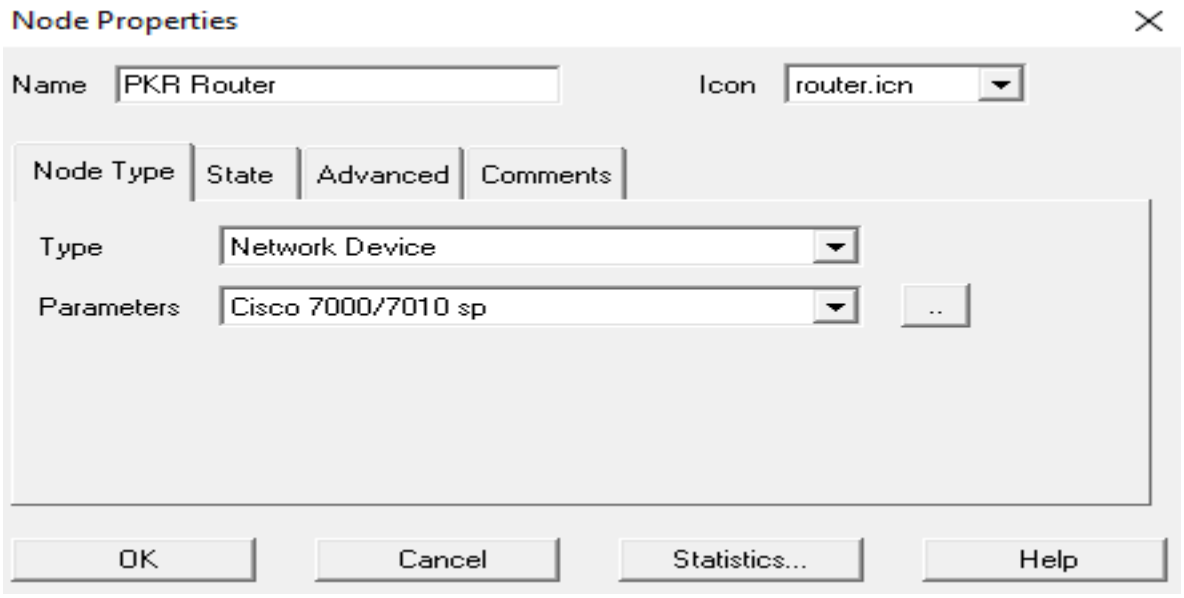


Figure 30: PKR Router

The above figure shows the router of the PKR LAN. It has a type set to network device and has a parameter Cisco 7000/7010sp.

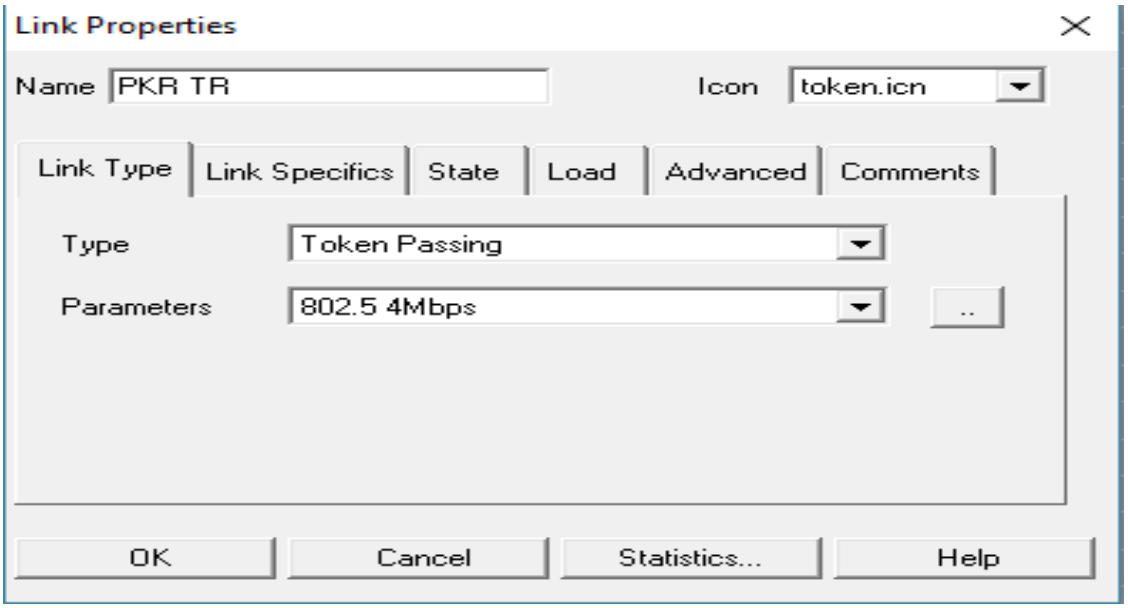


Figure 31: PKR Token Ring

The above figure is of the token ring of the PKR LAN which has typeset as Token Passing and has a parameter 802.5 4Mbps.

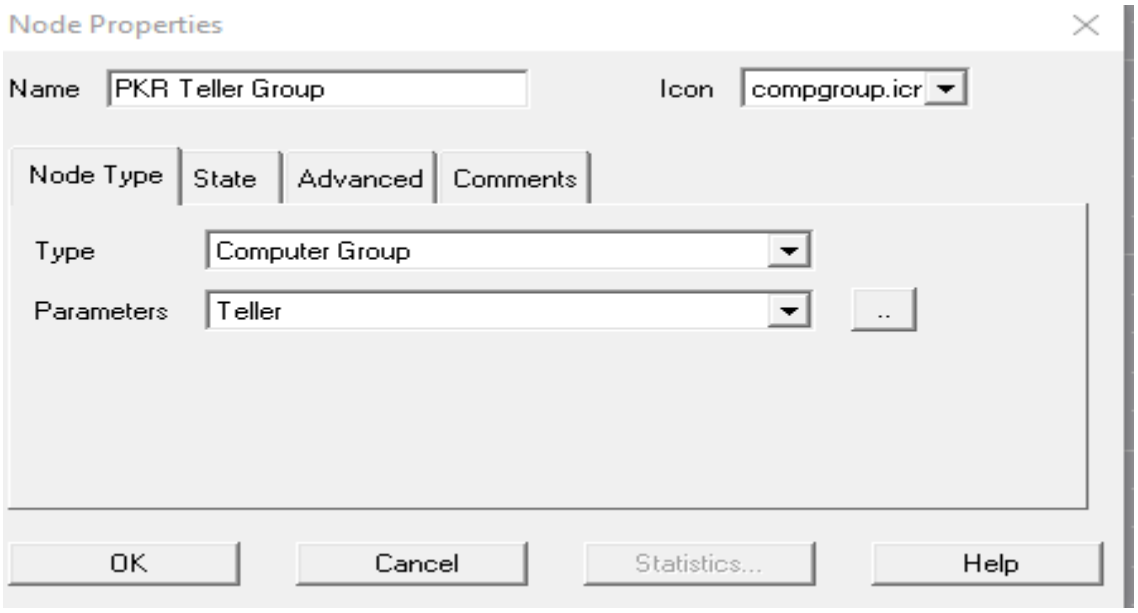


Figure 32: PKR Teller Group

The above figure shows the Computer Group of the PKR LAN which has parameter Teller that consist of 60 processing node.

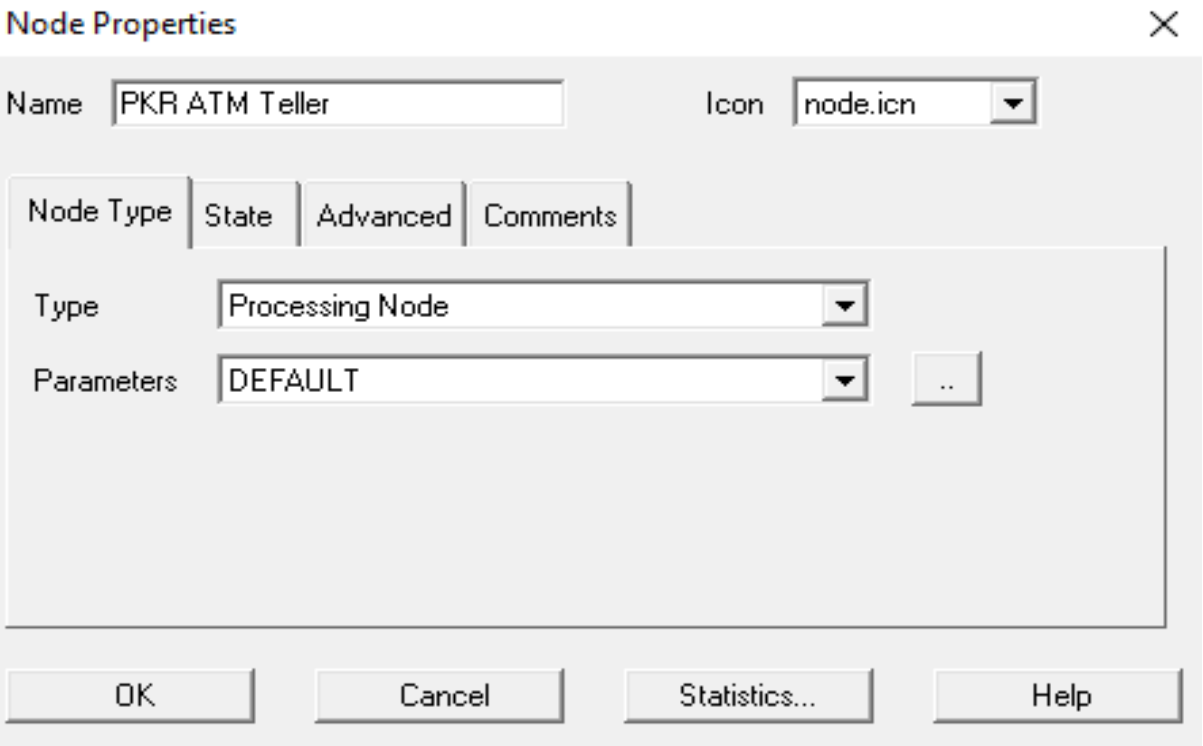


Figure 33: PKR ATM Teller

This is the figure of the ATM teller or processing node of PKR LAN which has the type set to processing Node and has a default parameter.

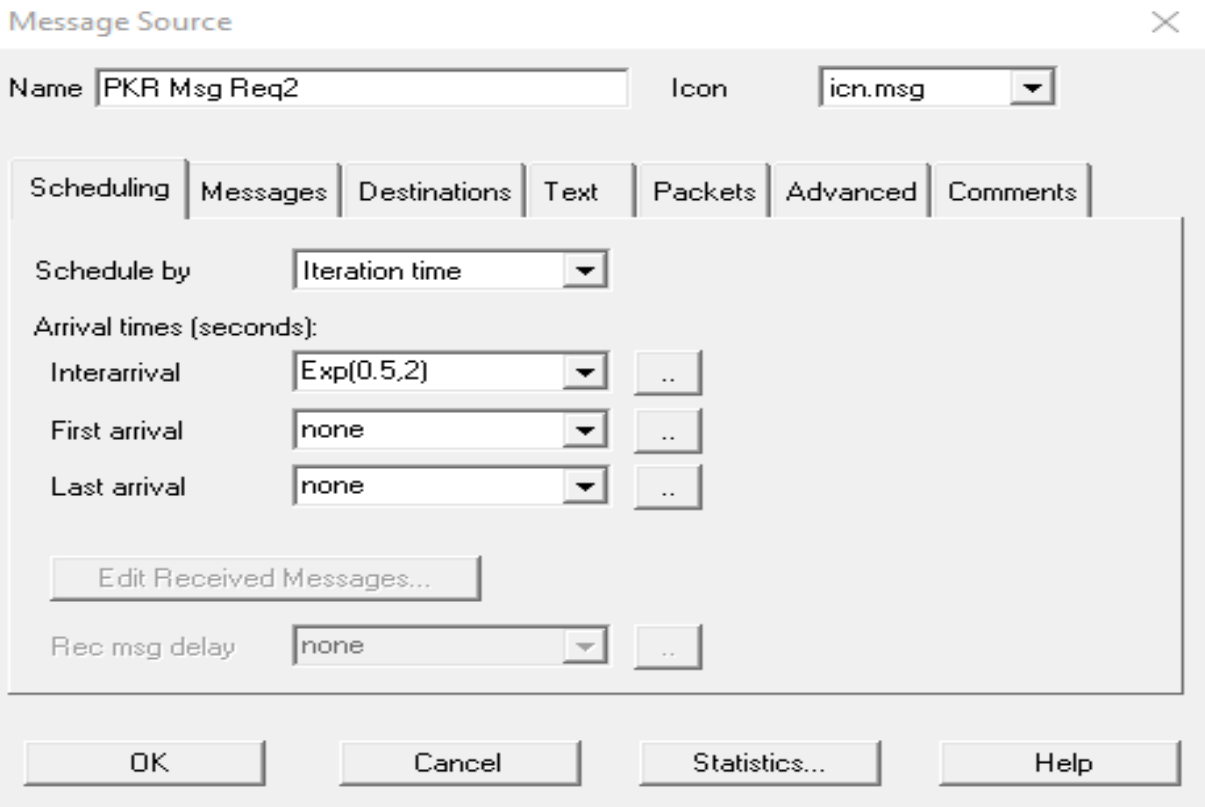


Figure 34: PKR Teller Group Message source 1

The above figure is the Message source of teller group of PKR Lan which has a schedule by iteration time and has an interarrival time with exponential distribution 0.5 with stream 2.

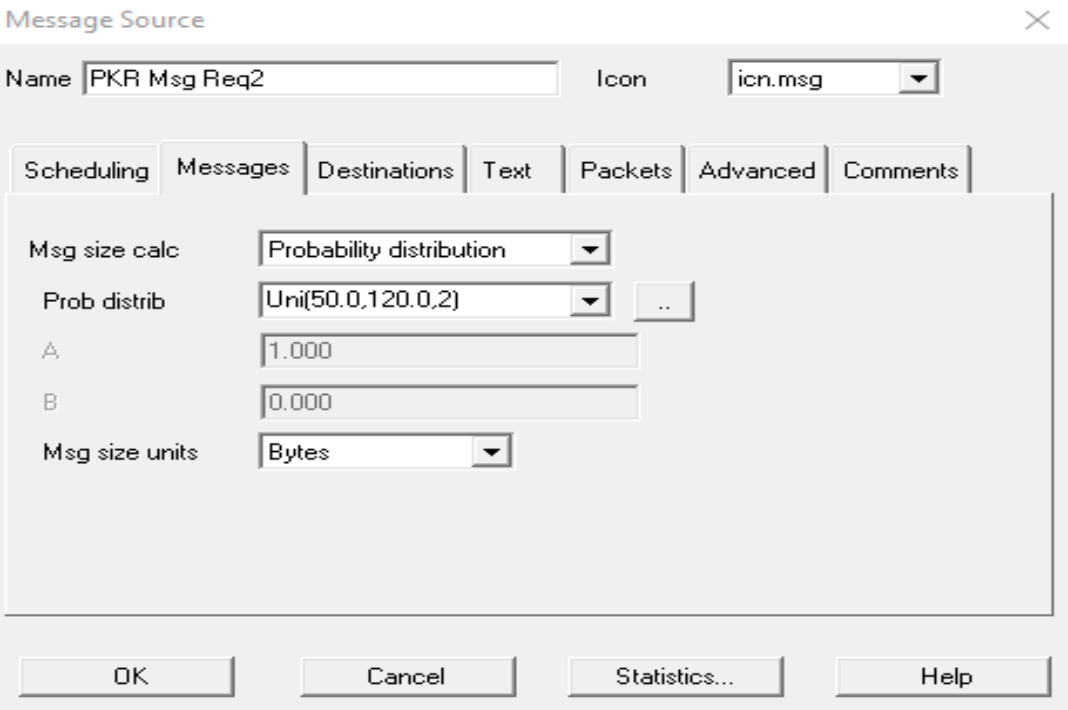


Figure 35: PKR Teller Group Message source 2

The above figure is the Message Source of ATM Teller of PKR Lan which has a message size calculation set to Probability distribution with minimum 50 maximum 120 and steam set to 2.

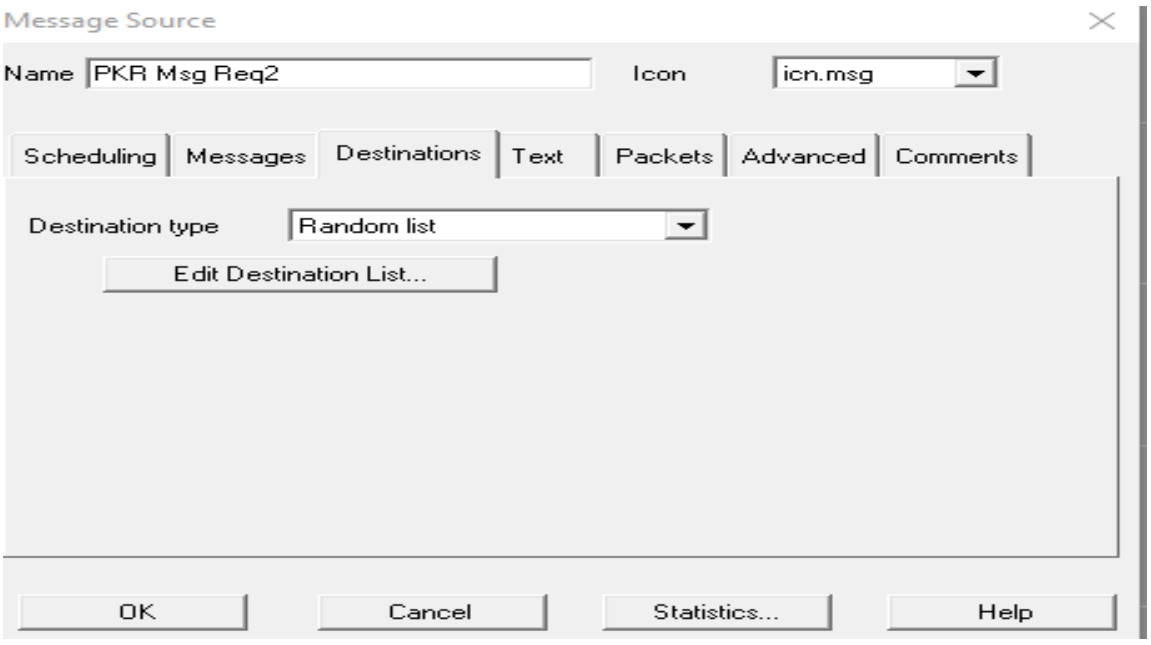


Figure 36: PKR Teller Group Message source 3

The above figure is the Message Source of teller group of PKR Lan which has a destination type set to random list.

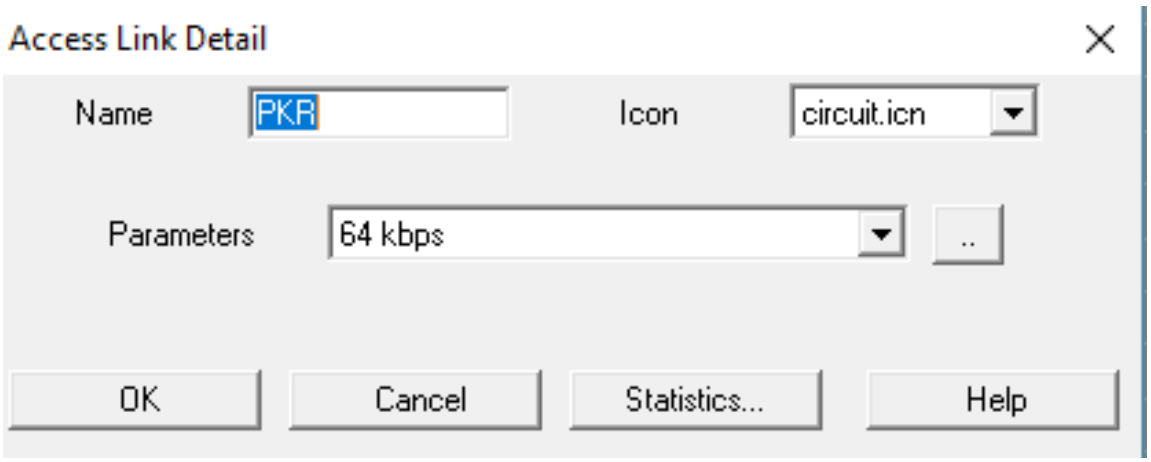


Figure 37: PKR Access link

The above figure shows the Access Link Details of the PKR LAN which name is London and has a parameter 64 Kbps.

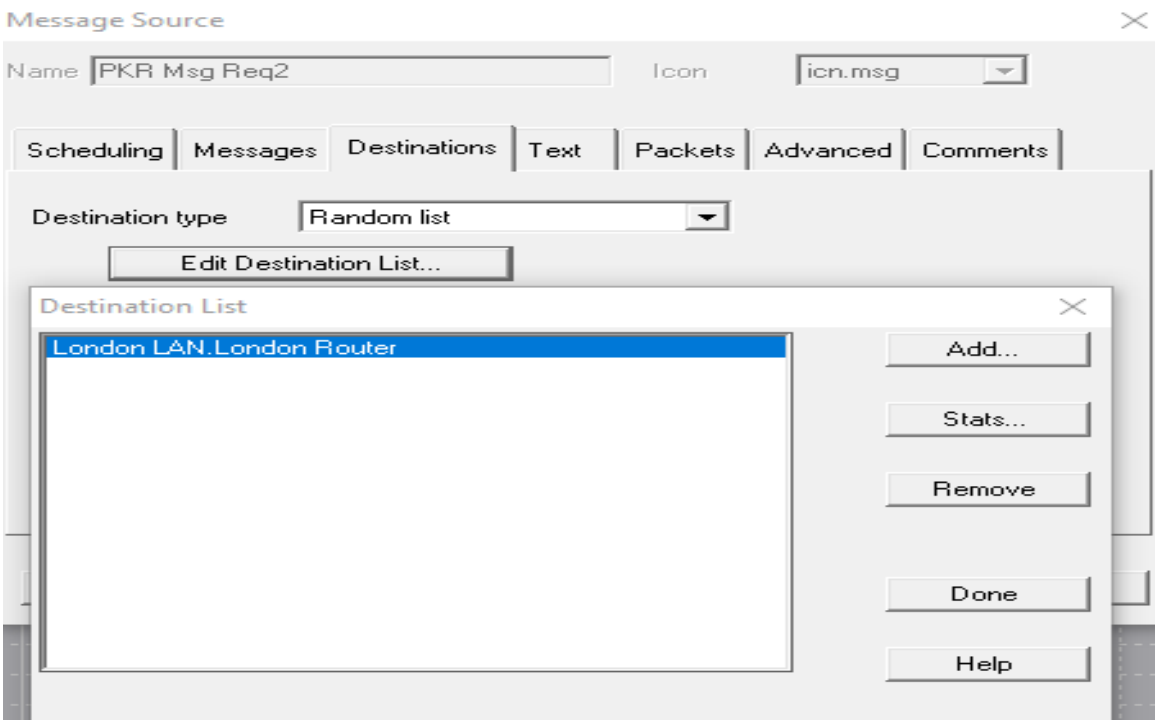


Figure 38: PKR Teller Group Message source 4

The above figure is the Message Source of teller group of PKR Lan which has destination type with the random list and the destination list contains the LondonLan.LondonRouter.

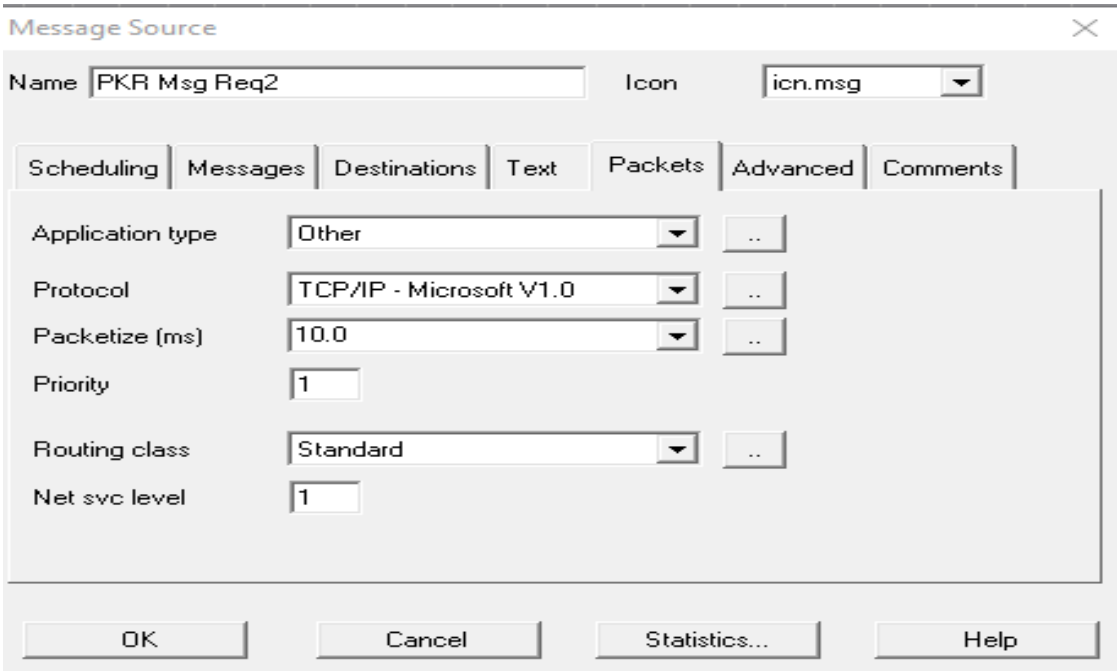


Figure 39: PKR Teller Group Message source 5

The above figure is the Message Source of teller group of PKR Lan which has a Packets protocol set with TCP/IP Microsoft v1.0 and has a packet size 10.0 with standard routing class.

Figure 40: PKR ATM Group Message source1

The above figure is the Message Source of ATM teller of PKR Lan which has a schedule by iteration time and has interarrival time of Exponential mean 30 and stream set to 0. .

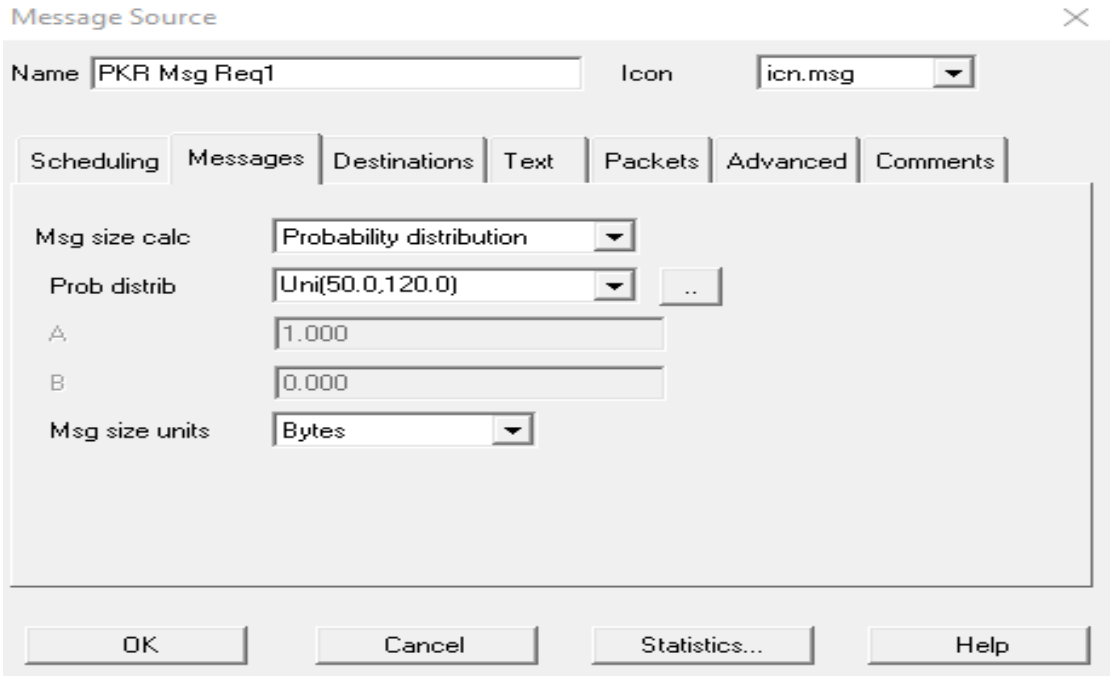


Figure 41: PKR ATM Group Message source 2

The above figure is the Message Source of ATM teller of KTM Lan which has a message size calculation set to Probability distribution with minimum 50 maximum 120 and stream set to 0.

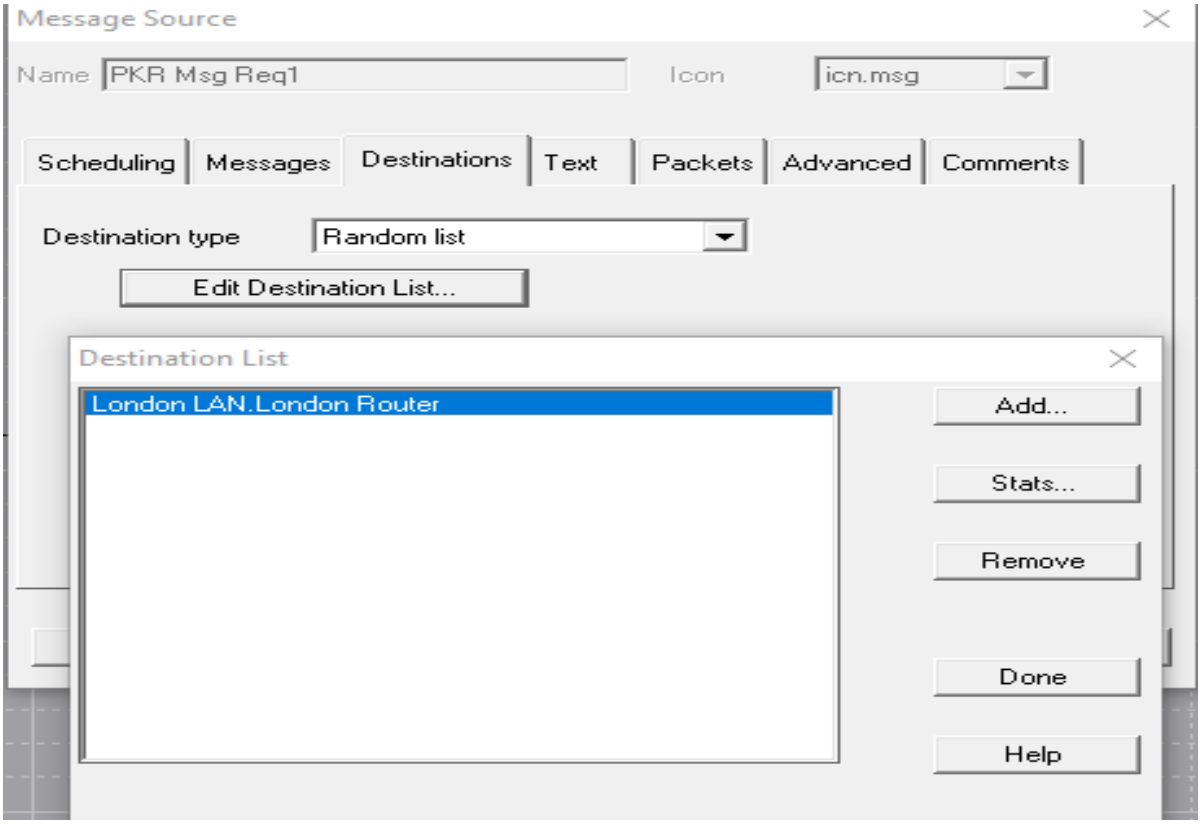


Figure 42: PKR ATM Group Message source 3

The above figure is the Message Source of ATM teller of PKR Lan which has destination type with random list and the destination list contains the LondonLan.LondonRouter.

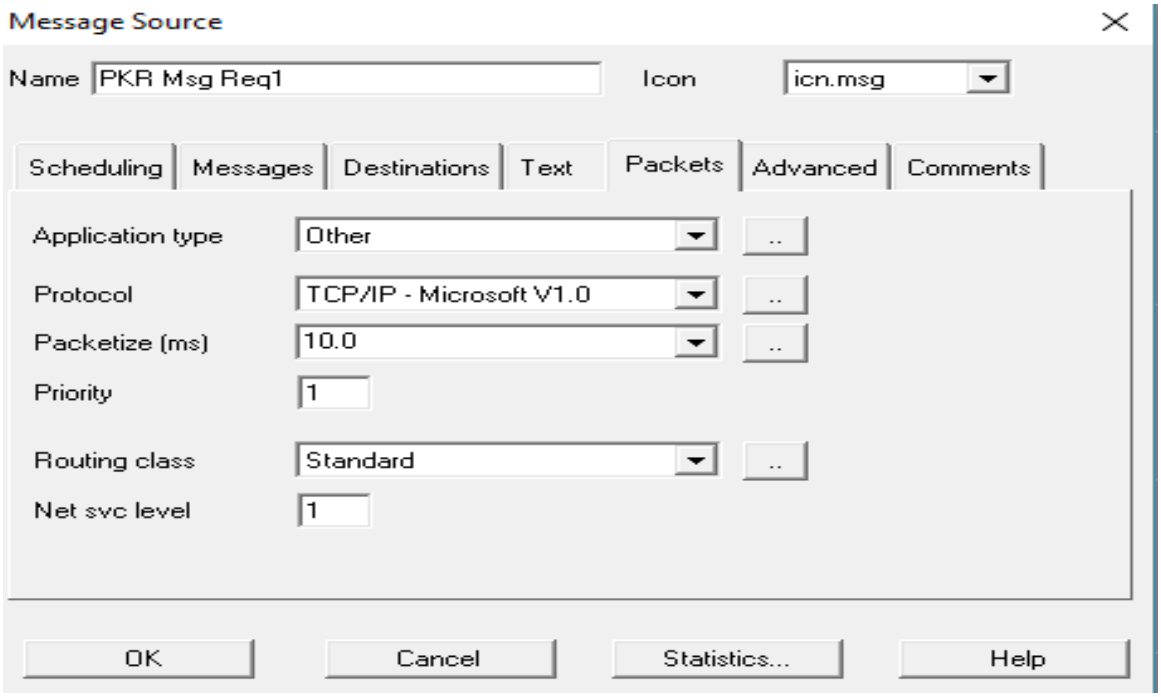


Figure 43: PKR ATM Group Message source 4

The above figure is the Message Source of ATM teller of PKR Lan which has a Packets protocol set with TCP/IP Microsoft v1.0 and has a packet size 10.0 with standard routing class.

2. Description of WAN module.

In this wan module, there are three LAN and a WAN Cloud connected together. The LANs are connected to each other inside the WAN cloud using Frame Relay VC, Access Link, and Access Points. The name of the LANs are KTM LAN, PKR LAN, and London LAN. The main server where all the message source process is at London Server. It also has Message Response which gives a response to all the message request or source.

All the LANs of the WAN module has a networking device (Router) which has been set with parameter Cisco 7000/7010sp. The TCP/IP Microsoft v1.0 protocol is used in all the message source and the message response. In each LAN there is a Token Passing Ring set up with parameter 802.5 4Mbps. The PKR and KTM LANs each of them have 60 teller group (computer Group with 60 computers) and ATM teller (Processing node) which has the Message source. The message source from both the LAN are sent to the London LAN router then it is processed in the London server and sent back the message response to both LAN. Each LAN has an access point which is used to connect the LAN to the WAN cloud.

3. Discussion of the Reports

3.1 Node Report

3.1.1 Receive Message count for all nodes

Table:

Recieiver	Count	Message Name
London LAN.London Rout	749	PKR Msg Req2
London LAN.London Rout	760	KTM Msg Req2

Table 1: Receive Message Count

Graph

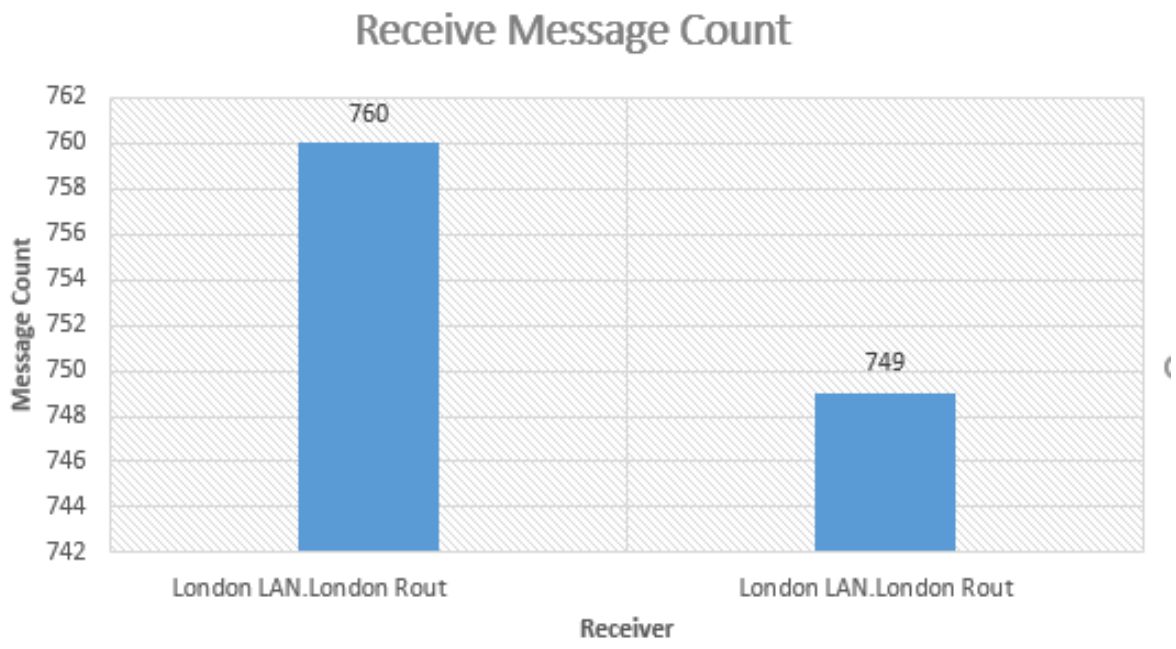


Figure 44: Receive Message Count Graph

Description: The above graph represent the message count by London Router form PKR and KTM LAN. From the above figure, we can know that KTM LAN's message is received more than PKR message request by London Router.

3.2 Link Reports

3.2.1 Channel Utilization for all links.

Table:

LINK	% Utilizaiton
London LAN.London TR	0
PKR LAN.PKR TR	3.6123
KTM LAN.PKR TR	3.6206

Table 2: Channel utilization

Graph

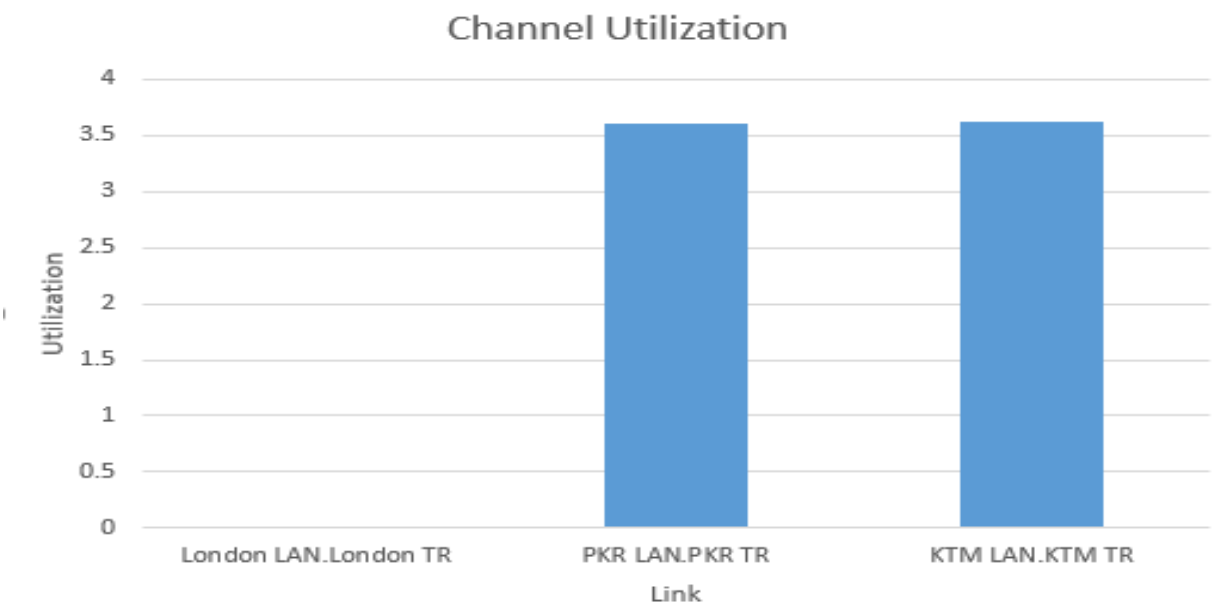


Figure 45: Channel Utilization Graph

Description: The above graph illustrate the channel utilization by London, PKR and KTM LAN. London Lan has the lowest almost no utilization of the channel while KTM and PKR LAN have a similar amount of channel utilization.

3.3 WAN Cloud Reports

3.3.1 Frame Delay by VC

Table:

CLOUD:VC	Frame Delay AVG
WAN	
PKR-London	12891
KTM-London	12911
PKR-KTM	0
KTM-PKR	0
London-KTM	23
London-PKR	23

Table 3: Frame Delay by VC

Graph

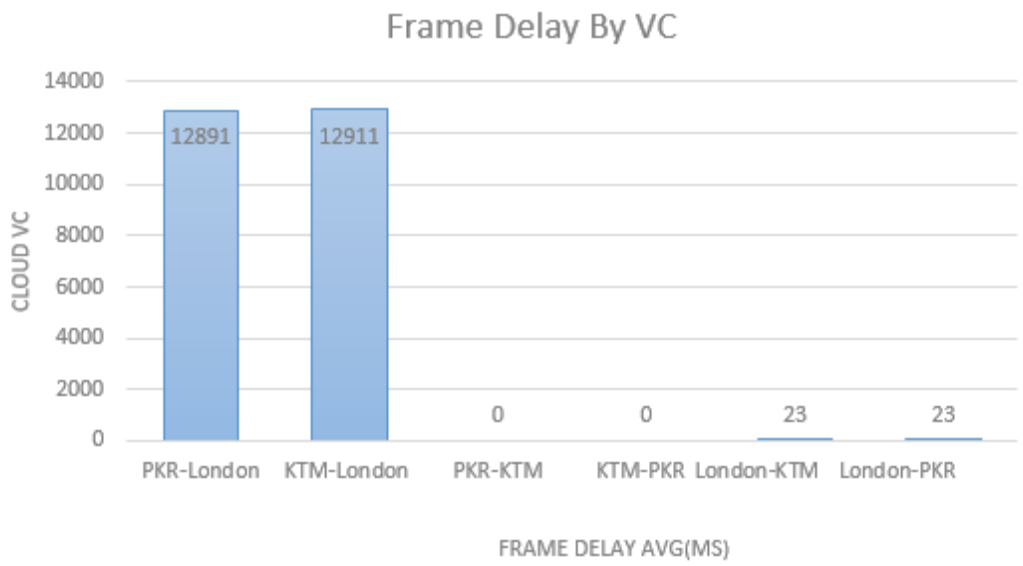


Figure 46: Frame Delay by VC Graph

Description: The above graph represent the Frame Delay VC average from one LAN to another in the network. From the above figure, it is clear that frame delay by average is more in PKR-London and KTM-London. There is the bare amount of frame delay by VC in London –KTM and London-PKR LAN and no frame delay by VC between PKR-KTM and KTM-PKR LAN.

3.3.2 Access Link Stats

Table

Cloud :Access Link	% Utilization
PKR Entry	100
PKR exit	36.69
London entry	73.21
London exit	99.97
KTM entry	100
KTM exit	36.5

Table 4: Access Link Stats

Graph

Figure 47: Access Link Stats Graph

Description: The above graph illustrate the access link utilization by each LAN. In the above figure, almost all LAN (PKR Entry, London Entry, and KTM Entry) have familiar result except PKR exit, KTM exit and London Exit.

3.3.3 Frames Count by VC

Table

CLOUD: VC	Frames/KB Accepted
WAN	
PKR-London	3390/1594
KTM-London	3374/1596
PKR_KTM	0/0
KTM_PKR	0/0
London-KTM	3369/1078
London_PKR	3386/1084

Table 5: Frame Count by VC

Graph

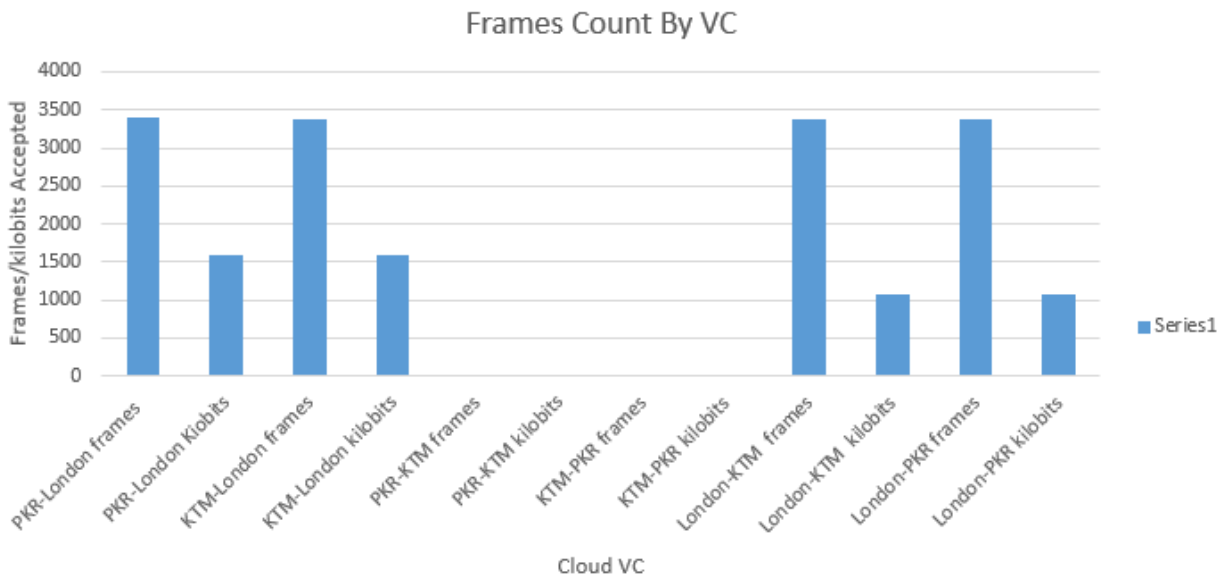


Figure 48: Frame Count by VC Graph

Description: The above graph represent the number of frames and kilobits accepted by VC. Analyzing the above graph we can find that all the frames accepted are almost equal to each other. The kilobits accepted by VC are also similar to each other. We can clearly see that frames are more accepted than the kilobits from the above figure.

3.4 Message and Report Response

3.4.1 Message Delay

Table

ORIGIN / MSG SRC NAME: Destination List	Message Delay Avg
London LAN.London Server / src Msg Response: Echo	0.00 ms
PKR LAN.PKR ATM Teller / src PKR Msg Req1: London LAN.London Ro	0.00 ms
PKR LAN.PKR Teller Group / src PKR Msg Req2: London LAN.London Ro	57045.909 ms
KTM LAN.KTM Teller Group / src KTM Msg Req2: London LAN.London Ro	57045.899 ms
KTM LAN.KTM ATM Teller / src KTM Msg Req1:London LAN.London Ro	0.00 ms

Table 6: Message Delay

Graph

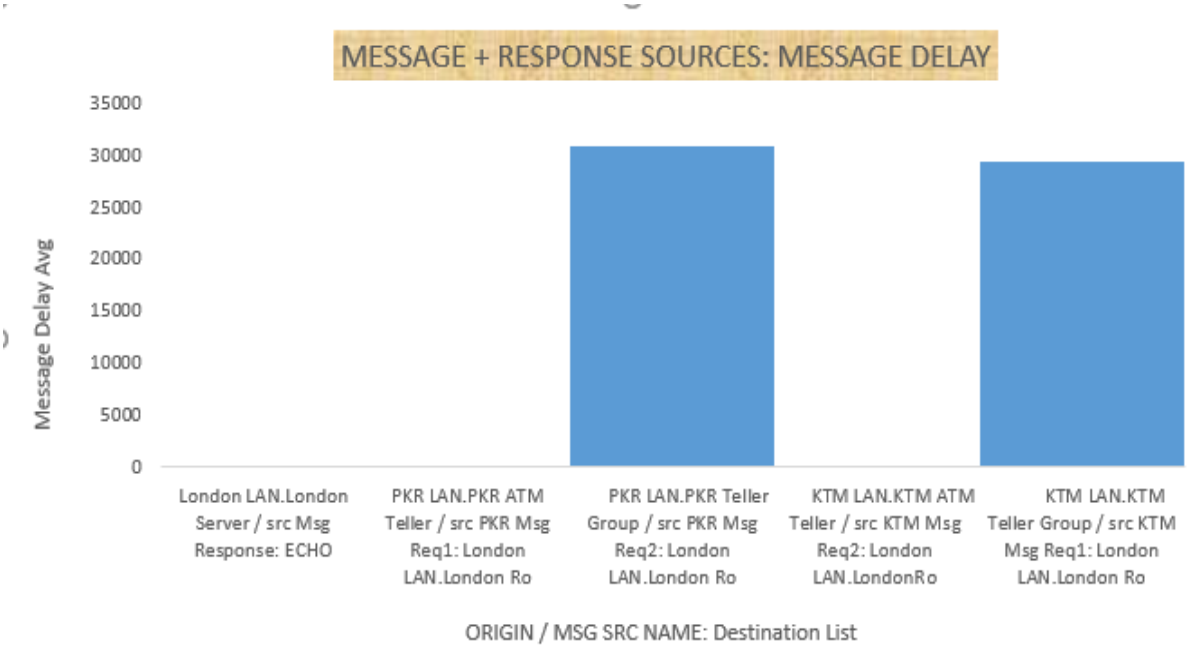


Figure 49: Message Delay Graph

Description: The above graph shows the Message Delay Average between source Teller and the destination London router. The message delay between PKR teller group London router and between KTM Teller and London router is the highest among all.

TASK B

Introduction

This is the task B portion of the coursework in which the technical report of the coursework is written. This report includes data operation in the network, a datalink, and physical layer. It also contains the relationship between of TCP/IP and OSI network rreference model. This part of the coursework has been much fruitful. While doing research over the internet for the coursework I have gained much more information about the TCP/IP and OSI reference model. I also learned about the process of data operation in a different layer while transmitting the data over the internet using this layer. This section would be incomplete without the resource over the internet and help of the module leaders.

Aims

The main aim of the coursework is to give a brief knowledge about using COMNET III and its tools. It also aims to make student able to use the application and build a simple network architecture design. It also aims to help the student to understand how data operate in a different layer of TCP/IP and OSI reference model. By the completion of the coursework, it aims to be able to understand TCPI/IP and OSI model more briefly with less confusion and also help the student understanding the tool of COMNET III. Although coursework has asked to design a wan cloud model it indirectly aims the student to get knowledge about setting parameters, using message response and source and so much more.

Objectives

To meet all the aims of the coursework, it has assigned us different task based on the module. It has assigned us task to build a wan module using comnet. To contrast the clear information about the TCP/IP and OSI reference model we have written about the TCP/IP and OSI model in brief and also about the data operation in network, datalink, and physical layer. We are also assigned to illustrate the relationship between TCP/IP and OSI layer. And last but not least we described the node report by making grapn.

Network Layer

The network layer is one of the most important layer of the OSI (Open System Interconnection) model. The role of the network layer is to transfer packets between sending host and the receiving host across multiple links. It routes the signal through different channels to the other end and acts as a network controller. There are two main functions of the network layer and they are routing and logical addressing. The network layer is responsible for packet forwarding /routing, Connectionless communication and breaking down of data packets. (Jain, et al., 2018) (Ahlawat, 2018).

1. Routing

In the OSI model network layers determine the best or suitable route to transmit data from source to destination. This function of the network layer is known as routing. The routing process goes through the routing table which contains all the records of the routes in the network. There are different types of routing in the network layer. They are (AHIRLABS, 2018) **Continue Reading….**

2. Logical Addressing:

All the nodes in the network are assigned with a unique address for identifying each device uniquely. In each packet's header, the IP also known as logical address and mac address of the receiver is placed by the network layer. This process makes it possible to send packets to the specific node in the network. The logical addresses are created by network layer protocols such as IP or IPX. The logical address is a 32 bit IP address that is not embedded in the network card but is assigned to it for the purpose of routing between networks. (Ahlawat, 2018) (John Wiley & Sons, Inc, 2018)

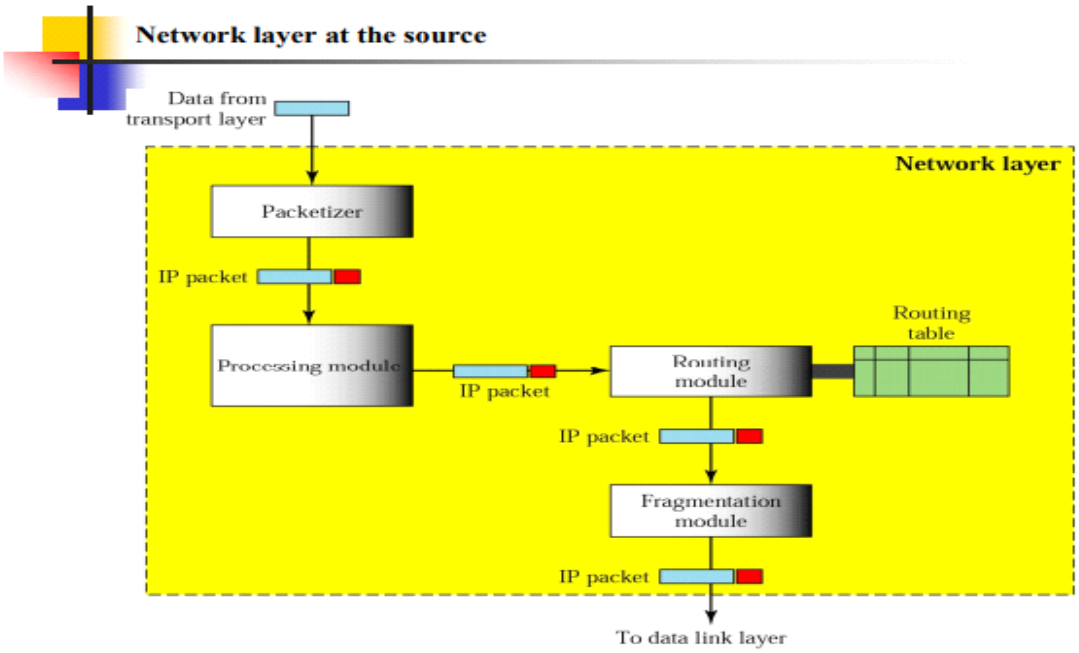
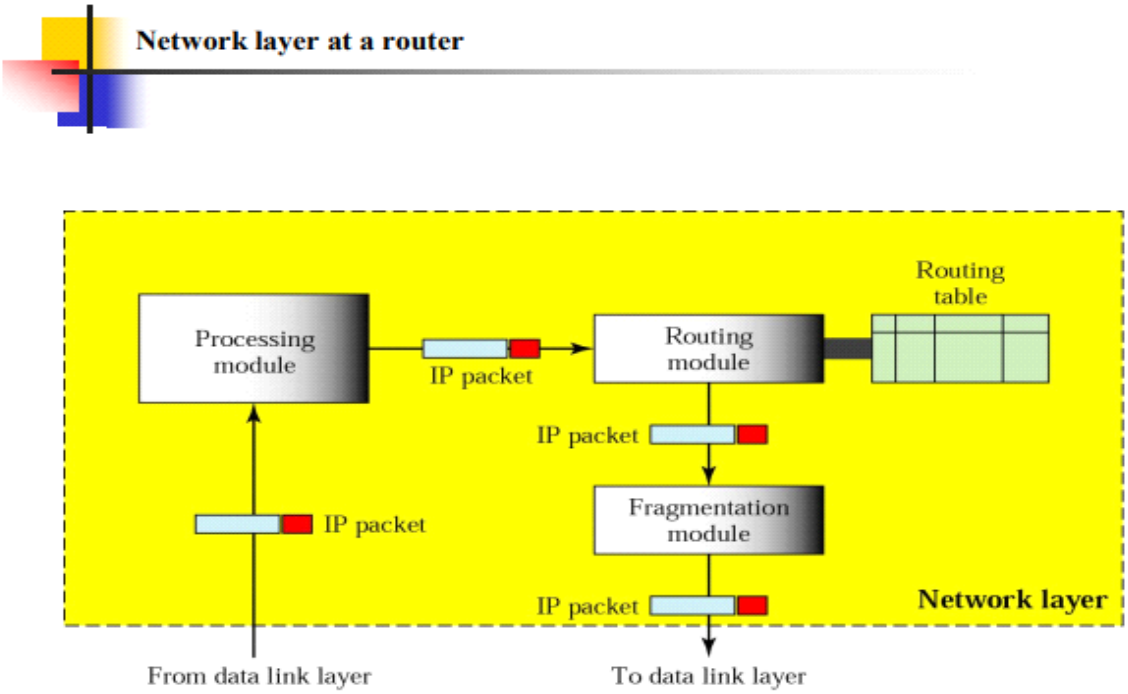


Figure 50:Network Layer source

(Andrei , 2018)

Figure 51 : Network Layer Source



(Andrei , 2018)

Figure 52 : Network Layer Router

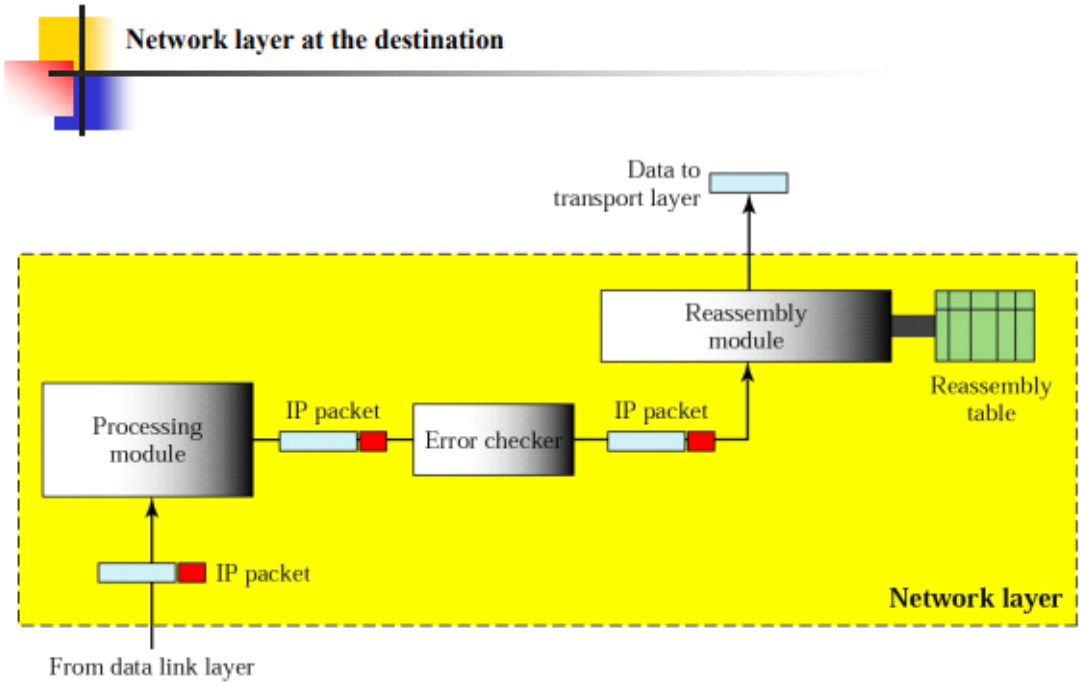


Figure 53 : Network Layer Destination

(Andrei , 2018)

Data link Layer

The data link layer is responsible for the node delivery of the message. In this layer, data are converted from one form to another particular form (encoded, decoded) and organized before they are transported as frames between two similar nodes on the same LAN or WAN. The main function of this layer is to make the data transfer error free and if an error occurs then it is handled. It is also responsible to transmit the received data to the host using its MAC address. The data link layer frame includes source and destination addresses, data length, start signal or indicator and other related Ethernet information to enhance communication. (Tech Target, 2018) Continue Reading.....

The data link layer is divided into two sublayers: continue Reading…

The architecture of Data Link Layer.

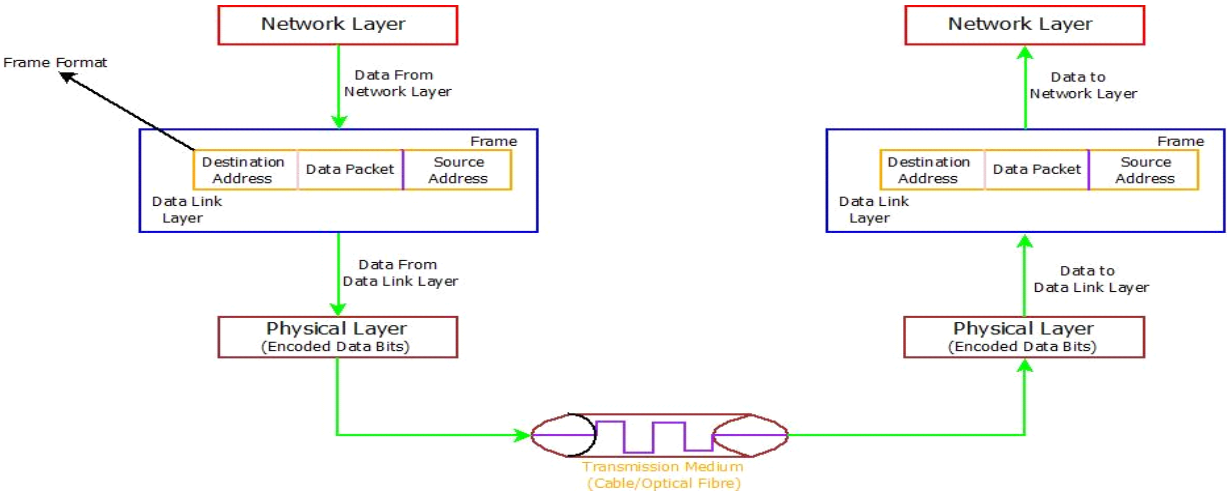


Figure 54 : Data Link Layer Architecture

(Upreti, 2018)

Structure of Data Link Layer:

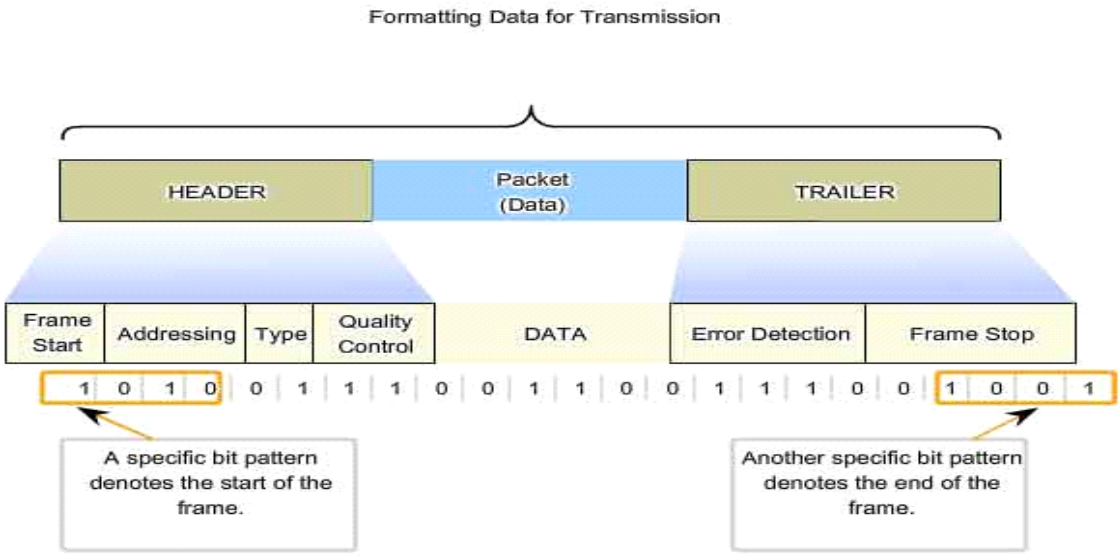


Figure 55 : Structure of Data Link Layer

(Harris, 2017)

Physical Layer

The physical layer is the first layer of the OSI (Open System Interconnection) reference network model. This layer manages the physical connection between the devices. It also contains the information in the form of bits. When the data is received in this layer it converts in into 0s and 1s and sends them to the Data Link Layer which puts the frame back together. It is concerned with the structure of physical connection to the network and transmission and receiving of the signals. (Jain, et al., 2018) (Ahlawat, 2018)

Continue Reading...

Data Operation in Physical Layer of OSI model.

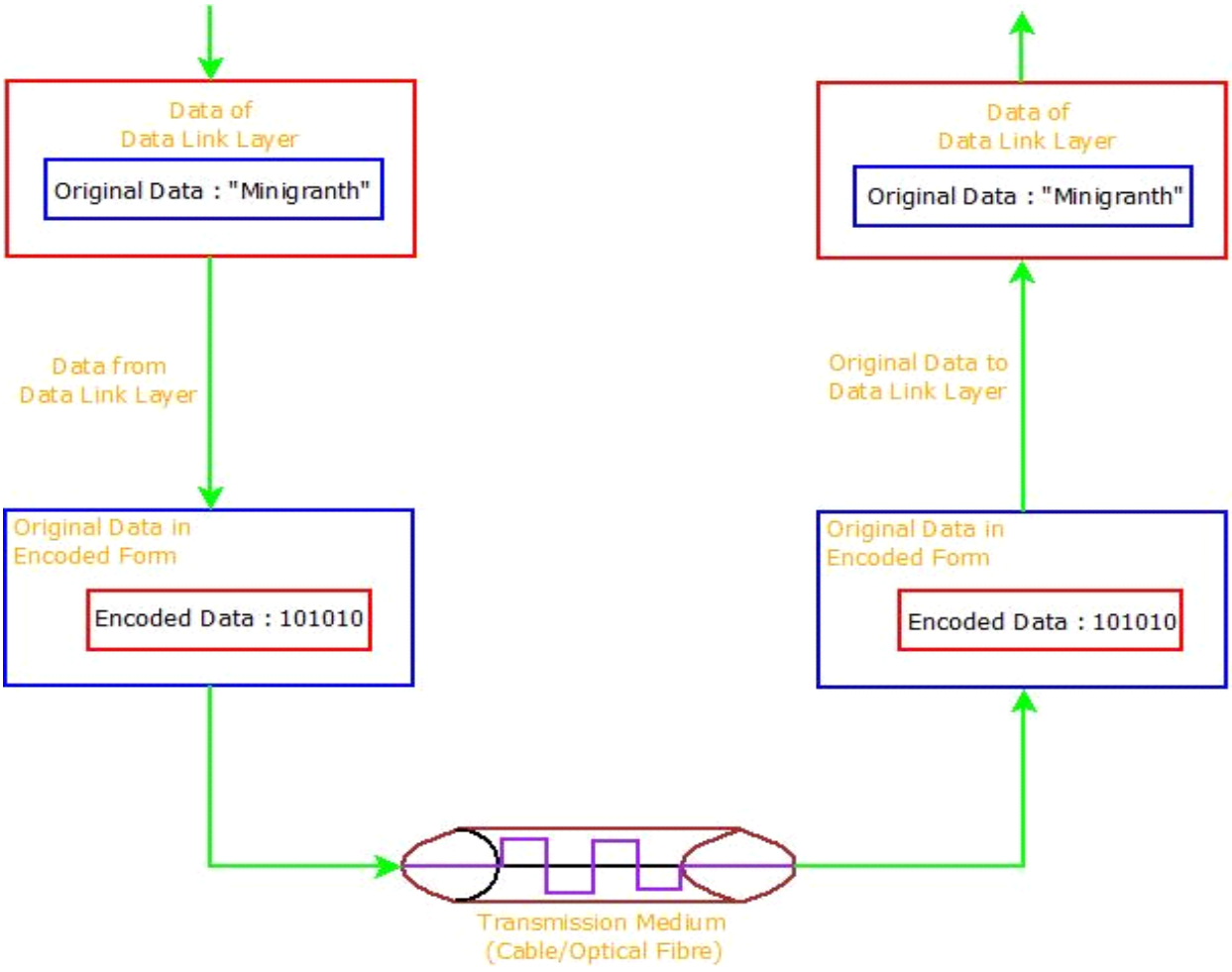


Figure 56: Data operation in the physical layer

(Upreti, 2018)

Transmission Control Protocol/Internet Protocol

TCP/IP stands for Transmission Control Protocol and Internet Protocol. It was developed first by ARPA (advanced research Projects Agency and later by the Department of Defence's Project Research Agency (DARPA). It is a conceptual network model with a set of communication rules and format (protocol) which is used for communication between devices in the network. It is widely used in the modern Internet setup as well. The protocol in the TCP/IP model defines the transmission of data between source and destination in a network. In TCP/IP model TCP split the message or file into packets before sending to the destination and again reassemble when the file is received. IP is responsible for addressing the packet which makes it possible to send data to the correct device. There are four layers in the TCP/IP network model. They are (Ahlawat, 2018)

1. Application Layer

2. Transport Layer

3. Internet Layer

4. Network Access Layer

Continue reading……

The relationship between TCP/IP and OSI model.

TCP/IP and OSI both network models is a suite of communications protocols which is used to interconnect network devices on the internet for the purpose of communication. Despite having a different number of the layer in each model they have many similar functions. The application layer of the TCP/IP model corresponds to the session, presentation and application layer of the OSI model. In both models, these layer performs end to end communication and have the same protocols such as FTP, Telnet, SMTP, DNS etc. The transport layer of the TCP/IP model corresponds to the transport layer of the OSI model. The internet layer of the TCP/IP model corresponds to the network layer of the OSI model. Both of them defines the route to transmit the data to the destination. Packet switching is used in both models rather than circuit switching. The host-to-host layer or Network access layer of the TCP/IP model corresponds to the Physical and data link layer of the OSI model. In these layer of both model are responsible for sending the packets from source to the destination and also deals with the physical setup of the network. (Ahlawat, 2018)

This image shows the relationship between the TCP/IP and OSI reference model.

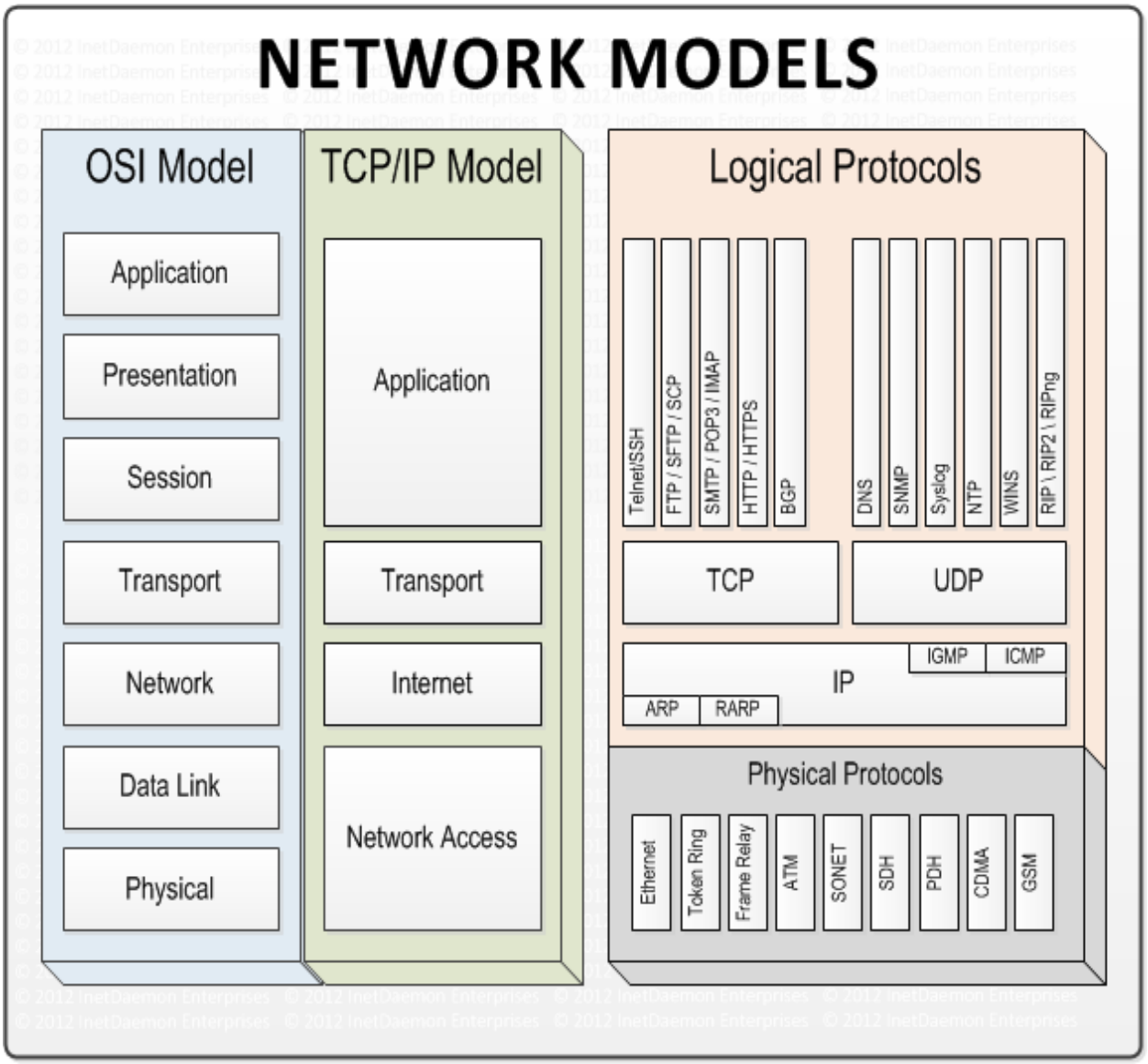


Figure 57: TCP/IP and OSI model

(InetDaemon, 2018)

Conclusion

With all the hard work, effort and research finally I was able to complete the coursework in the given time. I would not have finished the coursework without the help of my teacher and colleagues. After accomplishing the coursework I was able to understand more clearly about the model of the network. By the end of coursework, I have been more familiar with using the comnet and its tools.

At the beginning, I was very much confused with coursework. I did not know where to begin from. But after consulting with the module leader and friends I got some idea about where, to begin with. From this coursework, I have understood in brief about the TCP/IP and OSI reference model and how the data operates in each layer of these models. I did not know what to do with a report but later on after the module leader explained I came to understand the contents of the reports and prepare a graph from that report. It was a lot of fun too while doing this coursework and the best part was seeing our network design working. At first, I had very much problem with designing the network and setting the parameters. But after completing with all the research I came to understand how those parameters work and how is the design working. I had no idea what we were designing in the comnet but after completing and discussing about the topic I had some idea with how the company set up their network, why these networks become slower and how to improve the overall performance of the network. After finishing the coursework I was able to grab the knowledge on how these tasks is done and the importance of TCP/IP and OSI reference model. The Coursework was very much suits for my level and I got so much to explore and understand from this coursework.

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Appendix

Appendix 1

- **Static Routing**

Static routing is a type of routing technique which is not a protocol but instead, it's a manual configuration and selection of a network route from the routing table that is managed by the administrator. This type of routing is only best for a few situations. It is only implemented when the routes to network in the routing table are limited or there is only a default route available. It is suitable for only a few devices to need route configuration where there is no need for a route to change in the future. (Janssen & Janssen , 2018)

- **Dynamic Routing**

Dynamic routing is a networking ability which provides best data routing. It enables a router to select paths according to real-time logical network layout changes. The protocol in dynamic routing is responsible for creation, maintenance, and updating of the dynamic routing table. Comparing to static routing all these jobs are manually done by the administrator. It uses multiple algorithms and protocols. Among them, the most popular are Routing Information Protocol (RIP) and Open Shortest Path First (OSPF). It is less expensive to implement. (Janssen & Janssen , 2018)

Appendix 2

The functions of the data link layer are:

a. Framing: This function of data link layer provides a way for a sender to transmit a set of bits that are meaningful to the receiver which can be done by adding special bit patterns to the beginning and end of the frame.

B .Physical Addressing: This function adds physical addresses (MAC address) of sender and or receiver in the header of each frame.

c. Error Control: Another function of the data link layer is to detect the error and then retransmits damaged or lost frames.

d. Flow Control: The data rate needs to be regular over a period of time on both sides else data may get damaged so the flow control match that amount of data that can be sent before receiving acknowledgment.*(Tech Target, 2018)*

Appendix 3

1. Logical Link Control (LLC)

It is the sublayer of data link layer which plays a role in controlling the frame synchronization, flow control, and error checking. This layer also provides multiplexing mechanisms which make it possible for several network protocols (e.g. IP, IPX, and Decent) to coexist within a multipoint network and to be transported over the same network medium. The LLC acts as an interface

between media access control (MAC) sublayer and the Network Layer. (Janssen & Janssen, 2019)

2. Media Access Control (MAC)

MAC is the sublayer of the data link layer in the OSI network model. It is responsible for the transmission of the data packets and to provide an addressing mechanism and channel access so that each node available on a network can communicate with others nodes on same networks. IT provides flow control and multiplexing for the transmission medium. It also works as an interface between logical link control and physical layer. It uses MAC protocols to prevent collisions. The MAC provides addressing and channel access control mechanisms that enable several terminals or network nodes to communicate in a network. (Janssen & Janssen , 2018) (Juniper Networks, 1999)

Appendix 4

The role of the physical Layer are of the OSI model are:

a. Representation of Bits: In this layer, data consists of a stream of bits which much be converted into signals for transmission.

b. Data Rate: The physical layer defines the rate of transmission which is also called bits per second.

c. Synchronization: This layer work on the synchronization of the transmitter and receiver where the sender and receiver are carried out at the same time at a bit level.

d. Interface: It works as a bridge between the devices and the transmission medium.

e. Line Configuration: This layer connects the devices with the medium through point-to-point and Multipoint configuration.

f. Topologies: It specifies the technique or way in which the nodes/devices are arranged in a network. I.e. bus topology, a star topology or mesh topology.

g. Transmission Modes: The physical layer specifies the type of communication mode. Such as simplex mode, half duplex mode, and the full duplex mode. (Ahlawat, 2018) (Jain, et al., 2018)

Appendix 5:

- **Application layer**

  Application layer has a standard protocol for exchanging the data between applications. Some of the protocol used in this layer are HTTP, FTP, POP3, SMTP, TELNET and SNMP. Some of the protocols are defined below.

  a. TELNET: This protocol is used to connect to as remote machine and run application in it. This is two-way communication protocol.

  b. FTP: (File Transfer Protocol) allows sharing the file reliably, simply and efficiently among the computer over a network.

  c. SMTP: (Simple Mail Transfer Protocol) allows transmitting e-mail between the computers in a network directly via a route.

d. DNS: (Domain Name Server) is used to convert an IP address to human-readable text address.

e. There are two end to end protocols defined in this layer. They are

-TCP (Transmission Control Protocol): TCP is a connection-oriented protocol which is used to control the byte-stream making it error free and maintain flow control from source to destination.

-UDP (User Datagram Protocol): UDP is a connectionless protocol which is not as reliable as TCP. It has no sequencing and flow control, not like TCP.

- **Transport layer**

It is another layer of TCP/IP model which explains whether a data transmission should be in the parallel path or a single path. The Transport layer has functions such as multiplexing, segmenting or splitting into data. In this layer, applications can read and write. Some header informations are added to the data in this layer. It is also responsible for breaking the data into small packets for handling the data more efficiently by network layer. It also arranges packets sequentially which are to be sent. (Ahlawat, 2018)

- **Internet Layer**

It is another important layer of the TCP/IP model. Internet layer is based on a connectionless internetwork layer. The Internet is responsible to support or hold the whole architecture together. In this layer, the packets are transmitted independently to the destination. The arrangement of packets sent is different from the packets that are received. IP (Internet Protocol) is used in the layer so addressing the packets is done in this network. This layer is responsible for (Ahlawat, 2018)

a. Delivering IP packets

b. Performing Routing

c. Avoiding traffic jam (Congestion) (Ahlawat, 2018)

- **Network Access Layer**

It is the lowest layer of the TCP/IP model. Protocols in this layer provide or allow to send data to other devices on a directly attached network. This layer is used for connecting a host to send packets. It explains how the IP datagram is transmitted over the network. This layer needs to know the details of the packets such as packet structure, addressing etc. to format the data in right or correct way which are to be transmitted to comply with the network constraints. This layer also responsible for encapsulating the IP datagrams into the frame which are transmitted by the network also the mapping of physical addresses used by the network. (O'Reilly Media Inc., 2018)

Node Report Screenshot

Stat1 - Notepad

File Edit Format View Help

```
Compuware COMNET III  Release 2.5.2.814  Tue Dec 25 18:35:23 2018   PAGE     1

                                  CourseWork

                          NODES: RECEIVED MESSAGE COUNTS

                       REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

      RECEIVER              COUNT                  MESSAGE NAME
_____________________  __________  ____________________________________________

London LAN.London Rout        760    KTM Msg Req2
London LAN.London Rout        749    PKR Msg Req2


Compuware COMNET III  Release 2.5.2.814  Tue Dec 25 18:35:23 2018   PAGE     2

                                  CourseWork

                          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
_____________________  _________ ______  _________  _________  _________  _____

London LAN.London TR           0      0      0.000      0.000      0.000 0.0000
PKR LAN.PKR TR             13749      0      0.158      0.067      0.368 3.6123
KTM LAN.KTM TR             13841      0      0.157      0.066      0.368 3.6206


Compuware COMNET III  Release 2.5.2.814  Tue Dec 25 18:35:23 2018   PAGE     3
```

CourseWork

WAN CLOUDS: FRAME DELAY BY VC

REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD: VC	FRAME DELAY (MS) AVG	STD	MAX	BURST SIZE (kb) AVG	MAX
WAN					
PKR-London	12891	7368	25587	32	65
KTM-London	12911	7365	25608	32	65
PKR-KTM	0	0	0	0	0
KTM-PKR	0	0	0	0	0
London-KTM	23	0	23	12	27
London-PKR	23	0	23	12	26

Compuware COMNET III Release 2.5.2.814 Tue Dec 25 18:35:23 2018 PAGE 4

CourseWork

WAN CLOUDS: FRAME COUNTS BY VC

REPLICATION 1 FROM 0.0 TO 60.0 SECONDS

CLOUD: VC: FRAMES KILOBITS		FRAMES / KILOBITS ACCEPTED NORMAL	DE	DROPPED NORMAL	DE
WAN		(TOTAL KILOBITS TRANSMITTED =	5351)		
PKR-London	Frm	3390	0	0	0
	kb	1594	0	0	0
KTM-London	Frm	3374	0	0	0
	kb	1596	0	0	0
PKR-KTM	Frm	0	0	0	0
	kb	0	0	0	0
KTM-PKR	Frm	0	0	0	0
	kb	0	0	0	0
London-KTM	Frm	3369	0	0	0
	kb	1078	0	0	0
London-PKR	Frm	3386	0	0	0
	kb	1084	0	0	0

Compuware COMNET III Release 2.5.2.814 Tue Dec 25 18:35:23 2018 PAGE 5

CourseWork

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	STD DEV	MAXIMUM
London LAN.London Server / src Msg Response:				
ECHO	0	0.000 MS	0.000 MS	0.000 MS
PKR LAN.PKR ATM Teller / src PKR Msg Req1:				
London LAN.London Ro	0	0.000 MS	0.000 MS	0.000 MS
PKR LAN.PKR Teller Group / src PKR Msg Req2:				
London LAN.London Ro	239	30708.189 MS	15845.787 MS	57045.909 MS
KTM LAN.KTM Teller Group / src KTM Msg Req2:				
London LAN.London Ro	253	29363.539 MS	16311.893 MS	57045.899 MS
KTM LAN.KTM ATM Teller / src KTM Msg Req1:				
London LAN.London Ro	0	0.000 MS	0.000 MS	0.000 MS

CourseWork

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							
PKR	Entry	6714	0	N/A	N/A	N/A	100.00
	Exit	3387	0	80	15	19	36.69
London	Entry	6757	0	N/A	N/A	N/A	73.21
	Exit	13464	0	399635	199555	115298	99.97
KTM	Entry	6752	0	N/A	N/A	N/A	100.00
	Exit	3369	0	80	15	19	36.50

Compuware COMNET III Release 2.5.2.814 Tue Dec 25 18:35:23 2018 PAGE 6