# NetSim™

Simulation Platform for Network R & D

# Experiment Manual

TETCOS

The information contained in this document represents the current view of TETCOS on the issues discussed as of the date of publication. Because TETCOS must respond to changing market conditions, it should not be interpreted to be a commitment on the part of TETCOS, and TETCOS cannot guarantee the accuracy of any information presented after the date of publication.

This manual is for informational purposes only. TETCOS MAKES NO WARRANTIES, EXPRESS, IMPLIED OR STATUTORY, AS TO THE INFORMATION IN THIS DOCUMENT.

**Warning! DO NOT COPY**



**Contact us at –**

TETCOS
214, 39th A Cross, 7th Main, 5th Block Jayanagar,
Bangalore - 560 041, Karnataka, INDIA. Phone: +91 80 26630624

E-Mail: sales@tetcos.com

Visit: www.tetcos.com

# Contents

**Experiment 1:** Introduction to NetSim network simulator & procedure of working in it. ..... 5

**Experiment 2:** Simulate a three nodes point – to – point network with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped ..... 20

**Experiment 3:** Simulate a three node point-to-point network with the links connected as follows: n0 → n2, n1 → n2 and n2 → n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP / UDP. (n0, n1 and n3 are nodes and n2 is router.). ..... 28

**Experiment 4:** Simulate the different types of internet traffic such as FTP, TELNET over a network and analyze the throughput. ..... 36

**Experiment 5:** Simulate the transmission of ping messages over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion. ..... 44

**Experiment 6:** Simulate an Ethernet LAN using n nodes (6-10), change error rate and data rate and compare throughput. ..... 58

**Experiment 7:** To Simulate an Ethernet LAN using n nodes and set multiple traffic nodes and determine collision across different nodes. ..... 71

**Experiment 8:** To Simulate an Ethernet LAN using n nodes and set multiple traffic nodes and plot contention window for different source/destination. ..... 75

**Experiment 9:** To simulate simple ESS and with transmitting nodes in wireless LAN by simulation and determine the performance with respect to transmission of packets. ..... 80

**Experiment 10:** Cyclic Redundancy Check -Write a program for error detecting code using CRC-CCITT (16- bits). (Note: CRC 12, CRC 16 and CRC 32 are also available in NetSim) ..... 88

**Experiment 11:** Sorting (Bubble Sort)- Write a program for frame sorting technique used in buffers ..... 97

**Experiment 12:** Distance Vector Routing - Implementation of distance vector routing algorithm ..... 102

**Experiment 13:** TCP/IP Sockets - Write Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present ..... 108

**Experiment 14:** RSA - Write a program for simple RSA algorithm to encrypt and decrypt the data ..... 116

**Experiment 15:** Hamming Code - Write a program for Hamming code generation for error detection and correction .....120

**Experiment 16:** Leaky Bucket Algorithm - Write a program for congestion control using leaky bucket algorithm. .....125

**Appendix 1: Programming exercise -How to practice without NetSim**.....131

**Appendix 2: Creating .exe file using Dev C++** .....135

# Experiment 1:
# Introduction to NetSim network simulator and procedure of working in it.

## Part A: Introduce students to network simulation through the NetSim simulation package.

## Theory:

- **What is NetSim?**

**NetSim** is a network simulation tool that enables users to virtually create a network along with its components such as devices, links, and applications etc. to study the behavior and performance of the Network.

Some examples of its applications are

- Protocol performance analysis
- Application modelling and analysis
- Network design and planning
- Research and development of new networking technologies
- Test and verification

- **What is simulation?**

A simulation is the imitation of the operation of a real-world process or system over time.

**Network simulation** is a technique where a program models the behavior of a network either by calculating the interaction between the different network entities (hosts/routers, data links, packets, etc) using mathematical formulae, or actually capturing and playing back observations from a production network.

The key features essential to any network simulation are -

- **Building the model** – Create a network scenario with devices, links, applications etc

- **Running the simulation** - Run the discrete event simulation (DES) and log different performance metrics
- **Visualizing the simulation**- Use a packet animator to view the flow of packets
- **Analyzing the results** - Examine output performance metrics such as throughput, delay, loss etc. at multiple levels - network, sub network, link, queue, application etc.
- **Developing your own protocol / algorithm** - Extend existing algorithms by modifying the simulators source C code

- **What does NetSim provide?**

  **Simulation:** NetSim provides simulation of various protocols working in various networks as follows: **Internetworks, Legacy Networks**, **BGP Networks, MPLS Networks, Advanced Wireless Networks, Cellular Networks, Wireless Sensor Networks, Personal Area Networks, LTE Networks** and **Cognitive Radio Networks**. Users can open, save, and delete experiments as desired. The different experiments can also be analyzed using the analytics option in the simulation menu.

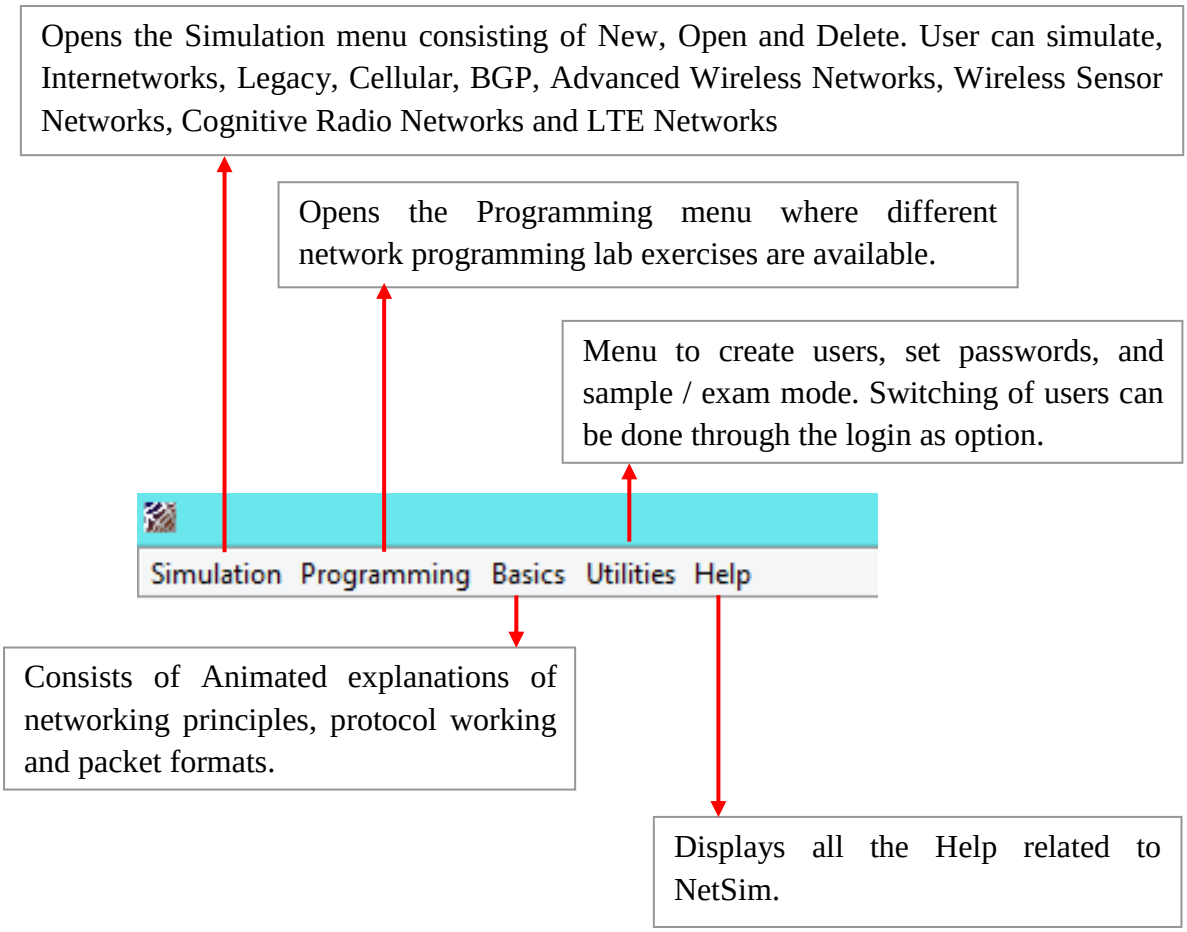
  **Programming**: NetSim covers various programming exercises along with concepts, algorithms, pseudo code and flowcharts. Users can also write their own source codes in C/C++ and can link them to NetSim.

  Some of the programming concepts are Address resolution protocol (ARP), Classless inter domain routing (CIDR), Cryptography, Distance vector routing, shortest path, Subnetting etc.

  **Utilities:** This section handles the user management section used for adding/deleting users, setting passwords etc.

  **Basics:** Consists of Animated explanations of networking principles, protocol working and packet formats.

  **Help:** Consists of NetSim User Manual which displays all the Help related to NetSim.



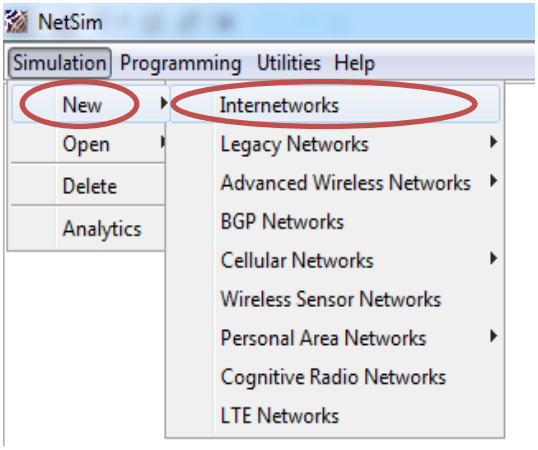

## Part B: Creating a Simple network, collecting and analyzing statistics on network performance through the use of NetSim

This section will demonstrate how to create a basic network scenario and analyze in NetSim.

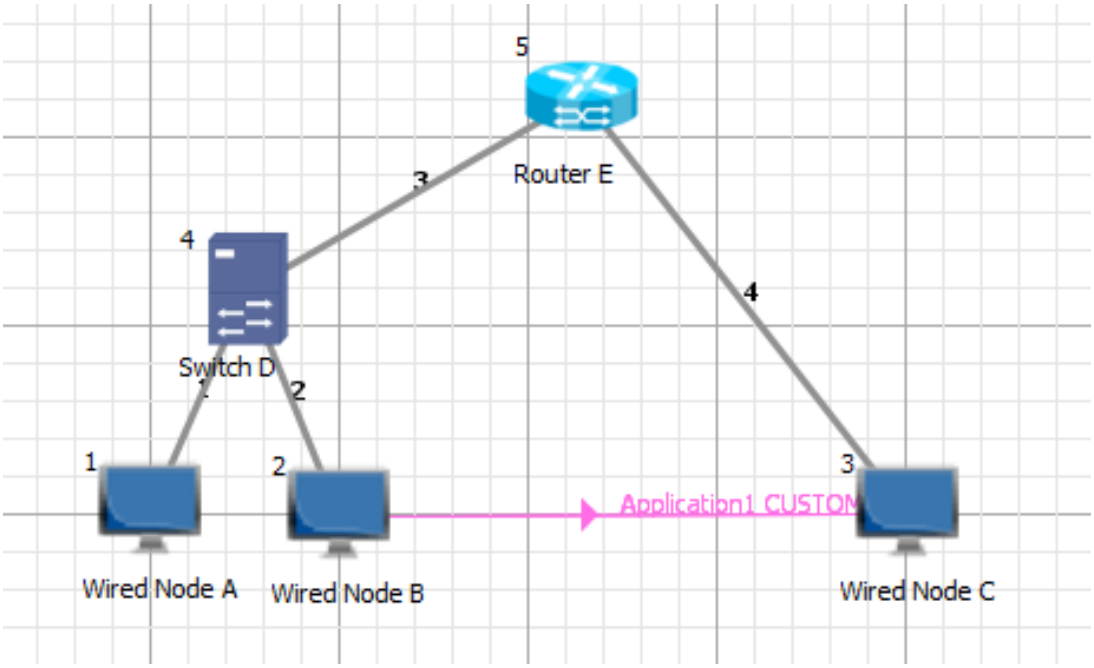
Analyzing a Network in NetSim mainly involves 5 steps

1. Create/Design the Network
2. Configure the Network
3. Model Traffic in the Network
4. Simulate
5. Analysis of Result

Let us consider Internetworks. To create a new scenario, go to Simulation → New → Internetworks

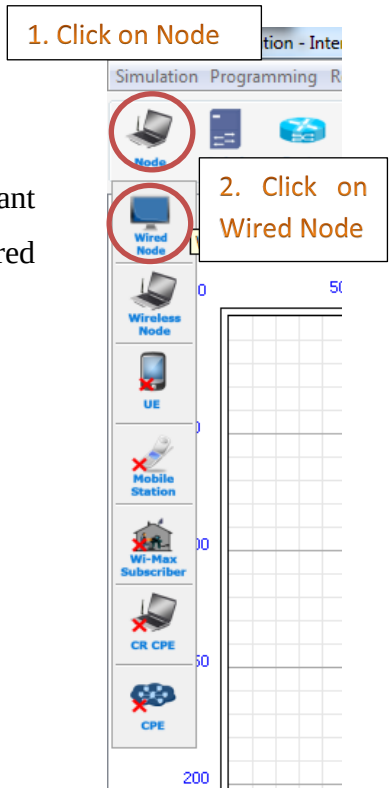



Perform the following steps to create a sample network scenario which looks like this:



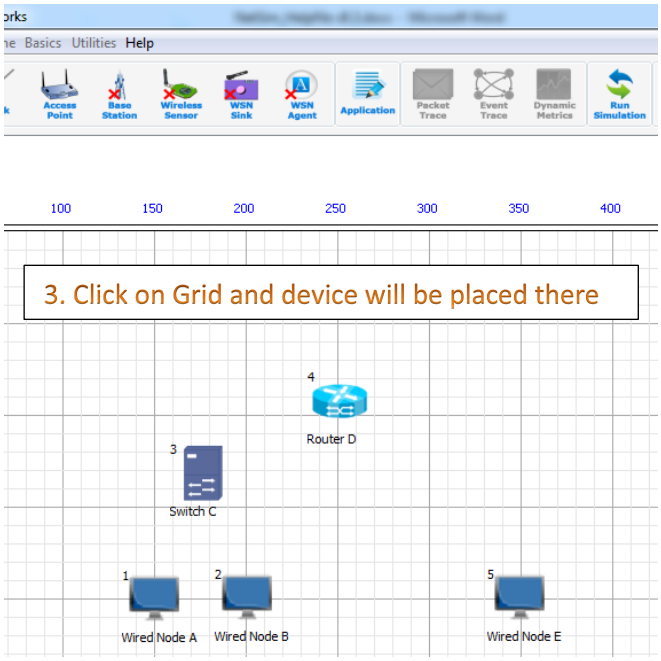
# 1. Create/Design the Network

## Step 1: Drop the devices

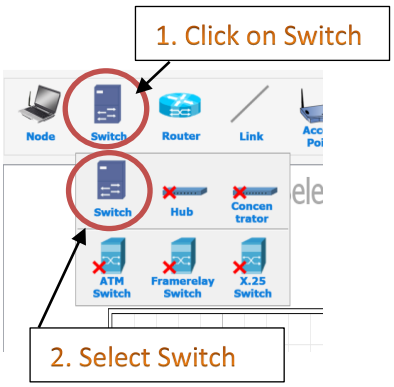


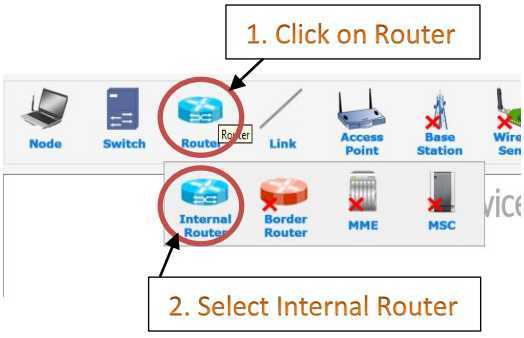

Click on Node icon and select → Wired Node

Click on the environment (the grid in the center) where you want the Wired Node to be placed. In this way, place two more wired nodes.

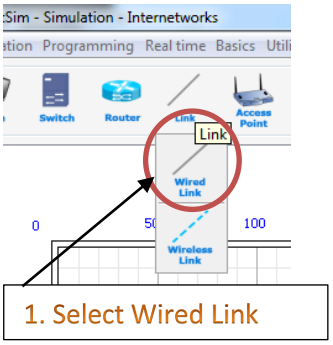



Similarly to place a **Switch** and a **Router**, click on the respective device and click on the environment at the desired location.



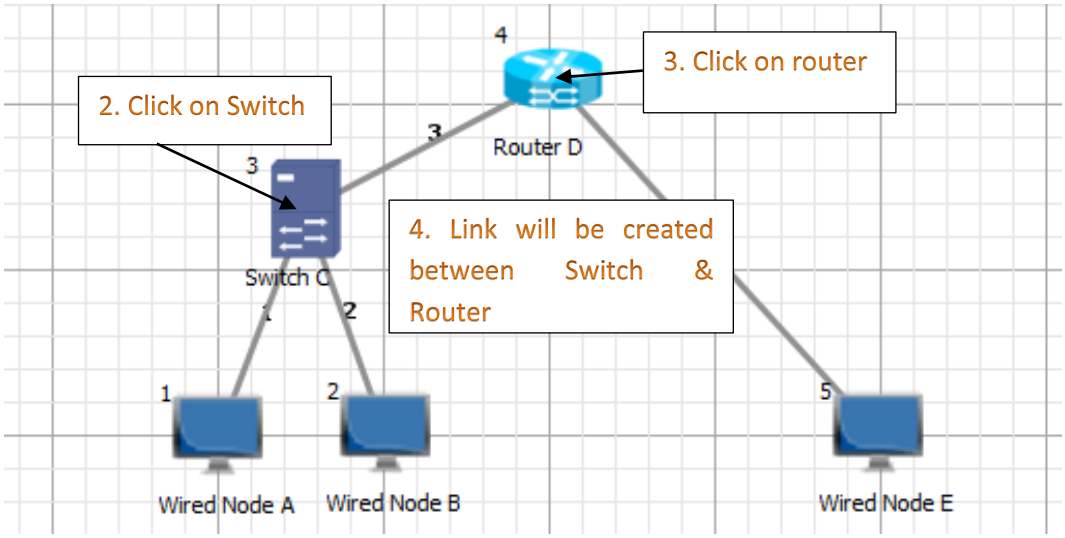



## Step 2: Connecting devices on the environment




In order to connect devices present in the environment, click on Link and select Wired Link.

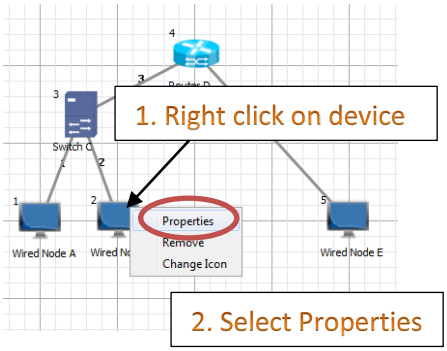
Click and select the devices successively where link is required. For example, select wired link and select Switch and Router successively to connect them. In this manner, continue to link all devices.

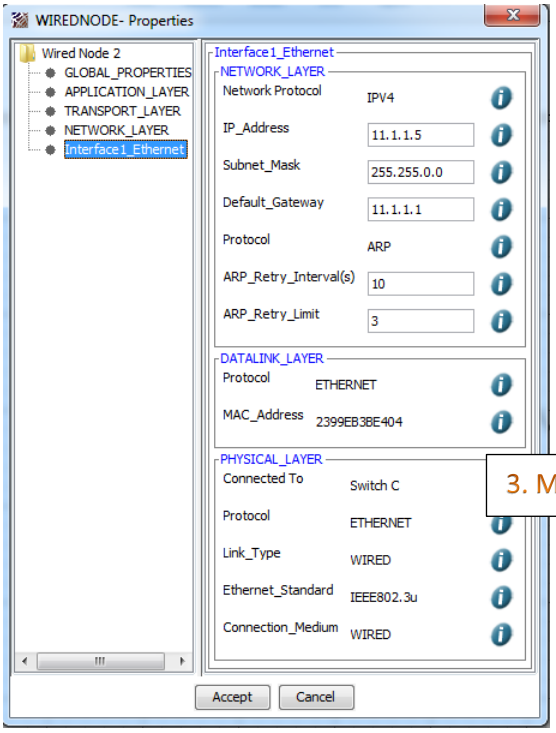



# 2. Configure the Network

## Step 1: Configure Devices

**R**ight click on the device and select properties





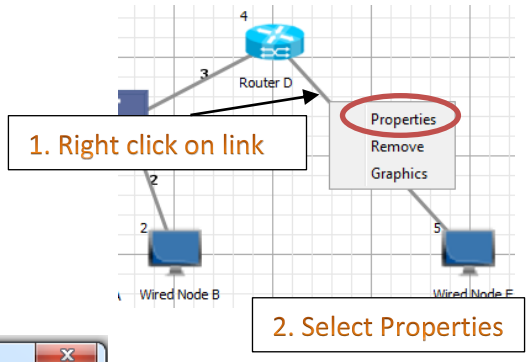

User can set values according to requirement. Modify the properties of any device and click on Accept.

In above scenario, default values already present in the properties are accepted.

3. Modify Properties

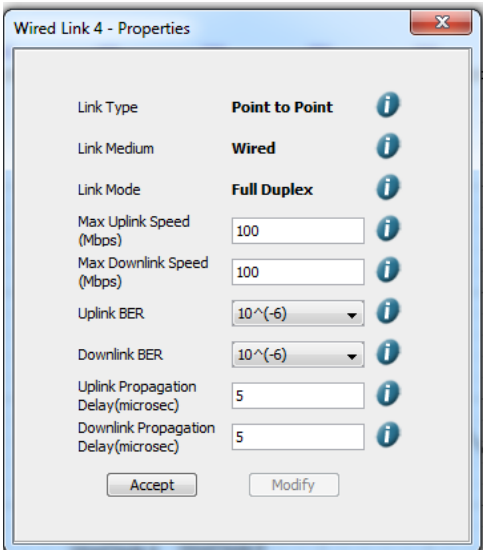
## Step 2: Configure Link

Right click on any Link and select Properties.




User can set values according to requirement.

In above scenario, default values already present in the properties are accepted.

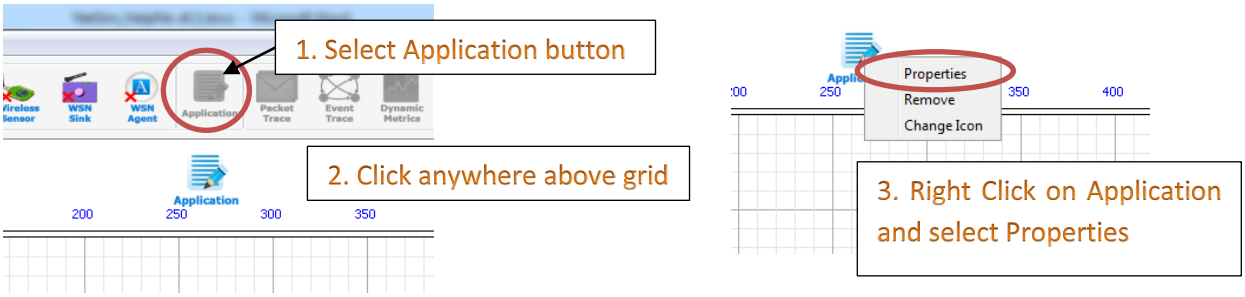



3. Modify Properties

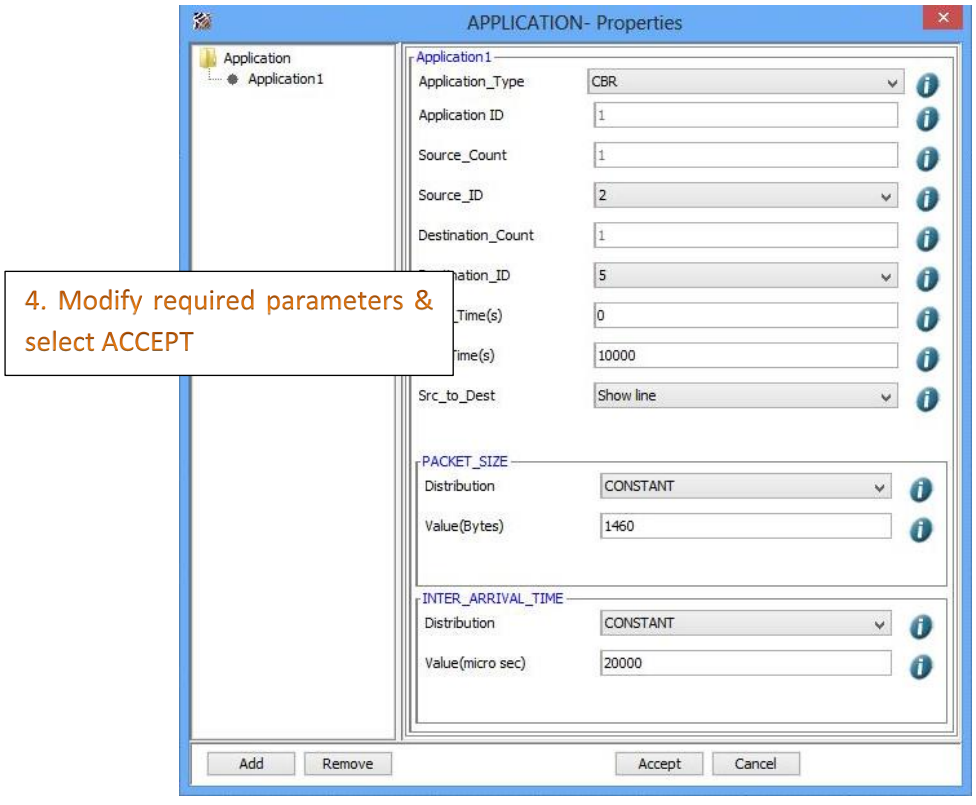
## 3. Model Traffic in the Network

After the network is configured, user needs to model traffic from Wired Node B to Wired Node E.

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

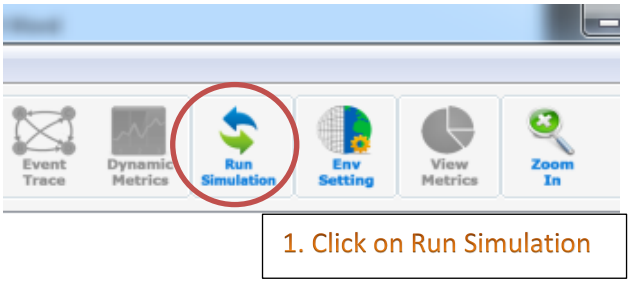



In above scenario, set Source_Id as 2(Wired Node B) and Destination_Id as 5(Wired Node E). Click on Accept.

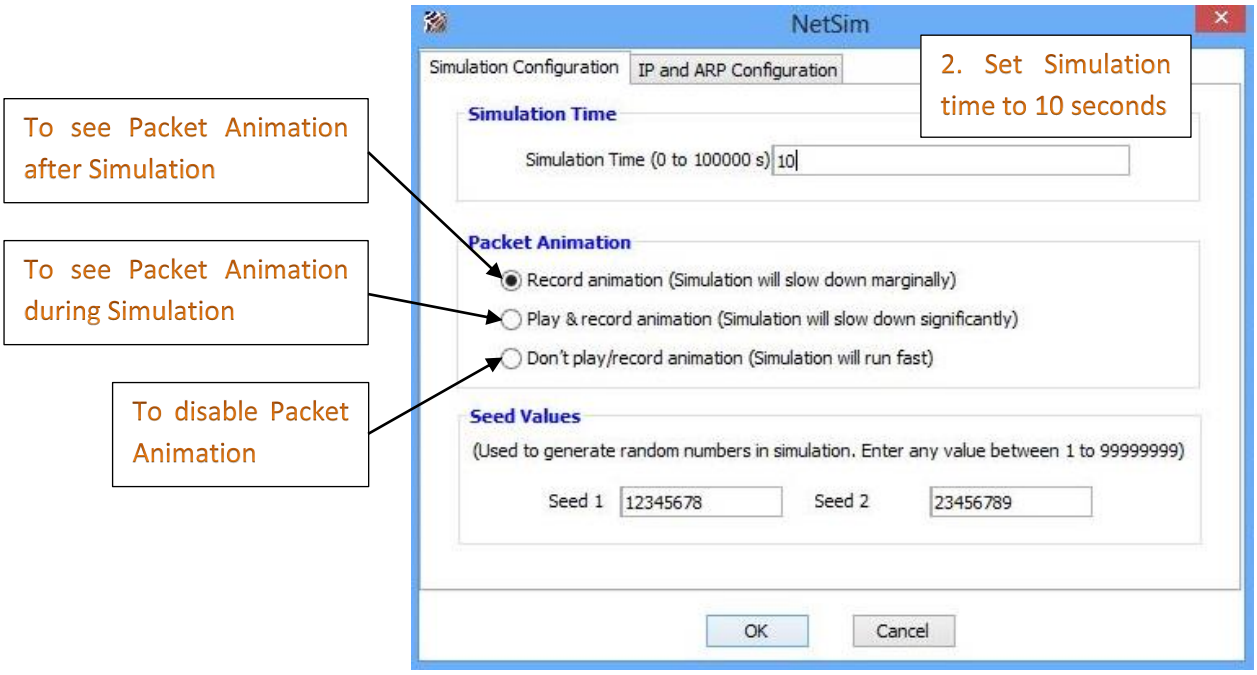


## 4. Simulate

For simulating the network scenario created, click on Run Simulation present in the Ribbon




Set the Simulation Time to 10 seconds. Select OK.



# 5. Analysis of Result

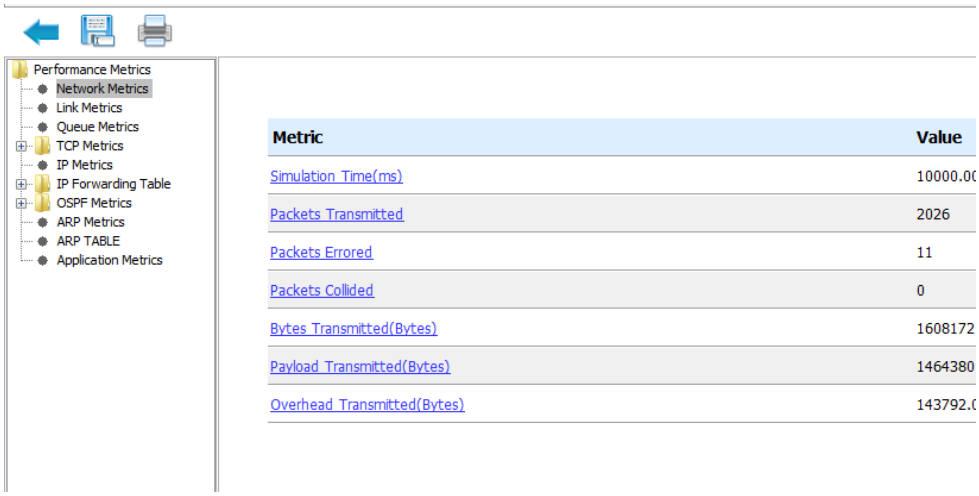
The different methods of performing analysis of Network performance in NetSim Academic Version are

- Performance Metrics
- Packet Animation
- Analytics (For multiple experiments)

## 5.1. Performance Metrics

NetSim provides distinct quantitative metrics at various abstraction levels such as Network Metrics, Link Metrics, TCP Metrics, Application Metrics, etc at the end of simulation. With the help of metrics, users can analyze the behavior of the modeled network and can compare the impact of different algorithms on end-to-end behavior.

After simulation of a scenario is performed, the NetSim Performance Metrics are shown on the screen as shown below




The Performance metrics can be further subdivided into sections

- **Network metrics**: Here users can view the values of the metrics obtained based on the overall network.
- **Link Metrics**: Displays the values of the metrics pertaining to each link like Link_Id, Packets_Transmitted, Error_Packets, Collided_Packets, Bytes_Transmitted, Payload_Transmitted, Overhead_Transmitted.

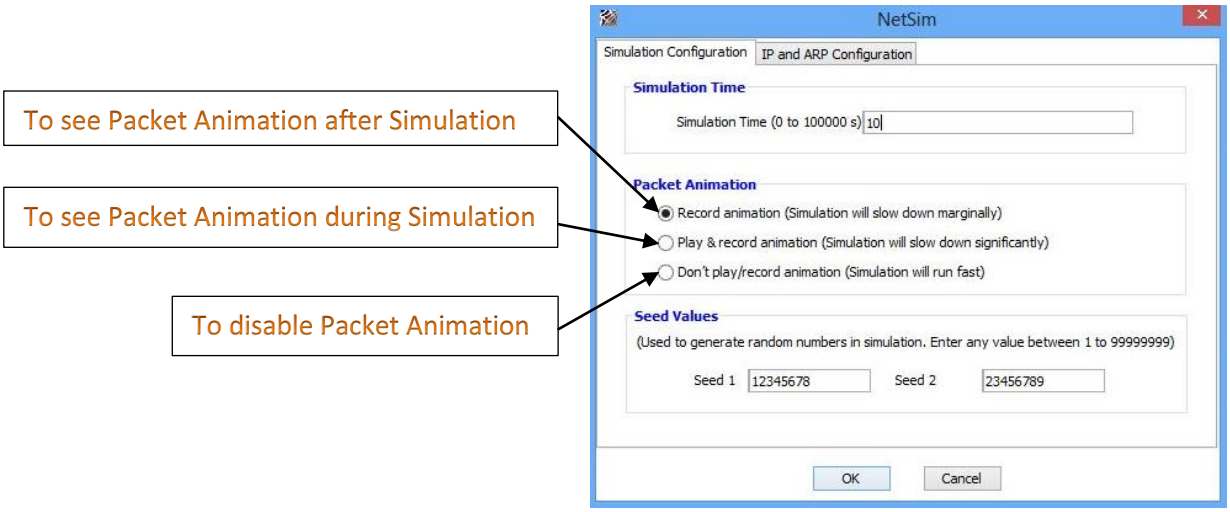
- **Queue Metrics**: Displays the values of the queue metrics for the devices containing buffer queue like routers, access points etc.
- **Protocol metrics**: Displays the protocol based metrics which are implemented in Network scenario. Metrics will vary depending upon the type of network simulated.
- **Device metrics**: Displays device related metrics like ARP table, IP forwarding tables. This is also dependent upon the type of network
- **Application Metrics**: Displays the various metrics based on the Application running in the network scenario.

## 5.2 Packet Animation

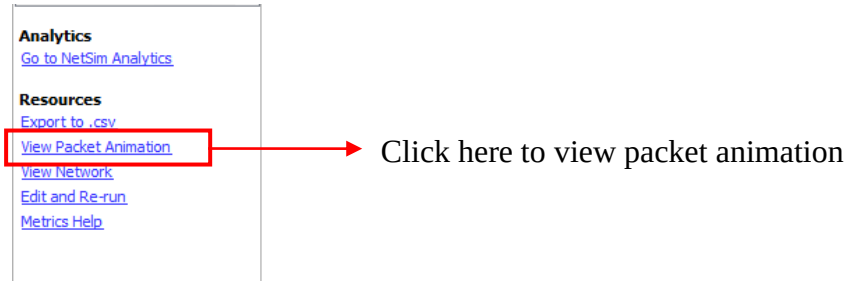
NetSim provides the feature to play and record animations to the user. Packet animation enables users to watch traffic flow through the network for in-depth visualization and analysis.

User has the following options before running simulation:

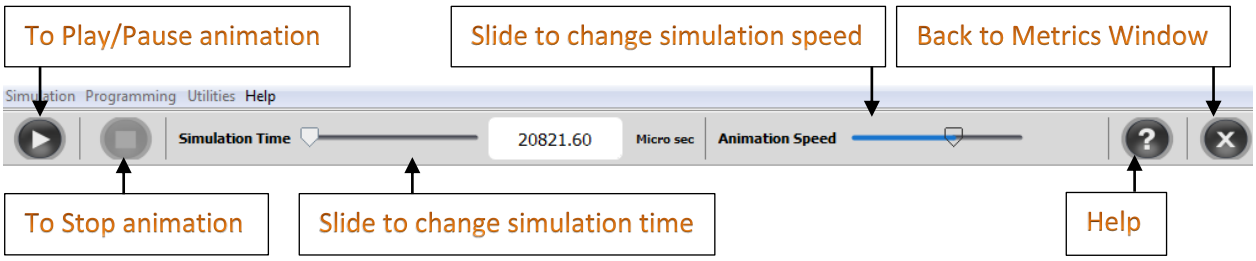
- Record the animation
- Play and record animation while running simulation
- No animation




The packet animation would then be recorded and the user can view the animation from the metrics screen as shown below:

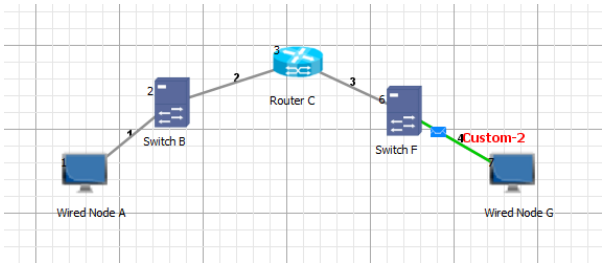


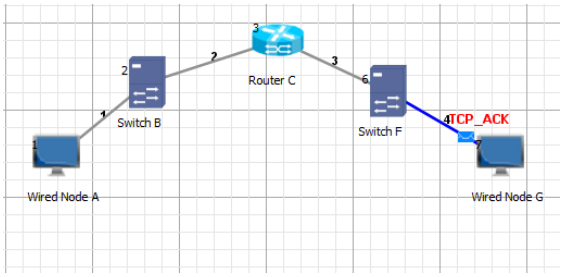

On clicking packet animation, a screen with the following toolbar appears:




While viewing packet animation, user can see the flow of packets as well as the type of packet. Blue color packet denotes control packet, green color is used for data packet and red color is error/collided packet.

**Example showing packet animation:** In first figure, Custom data packet is flowing from Switch F to Node G (green color) and TCP_ACK is sent from Node G to Switch F in second figure (blue color).

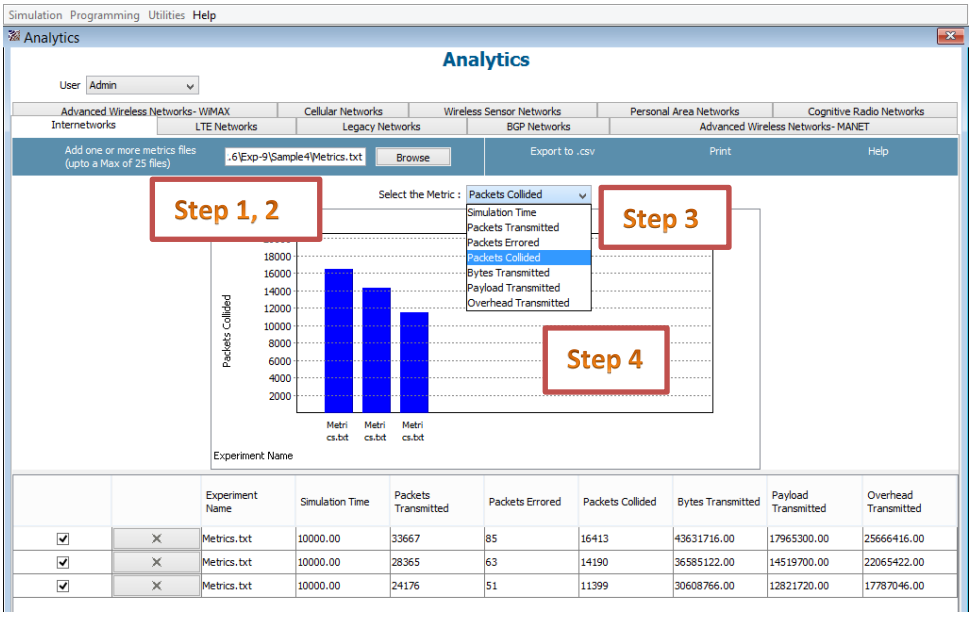


## 5.3 Analytics Menu (for multiple experiments)

Go to **Simulation → Analytics** to view the **Analytics** screen. This module is designed to enable comparison of performance metrics of multiple experiments. The metrics that can be compared are Simulation Time, Packets Transmitted, Packets Errored, Packets Collided, Bytes Transmitted, Payload Transmitted and Overhead Transmitted. Please note that other metrics cannot be directly compared in the analytics menu, and an tool like Excel is recommended.In **Tool Bar**, Click on the particular **Network tab (Ex.- Internetworks, LTE Networks etc)** for comparing the performance of protocols under that Network.

- For Internetworks, Advanced Wireless Networks – MANET, BGP Networks, Wireless Sensor Networks, Personal Area Networks, LTE networks and Cognitive Radio Networks,
  1. Click **Browse** button → select the **Metrics.txt File** inside the saved experiment folder
  2. To add more experiments, repeat the above step for other experiments.
  3. **Select the Metrics - Select** the coordinates for **Y-axis** by clicking on the dropdown menu. User can select
  4. **Graph** - Based on the **X-axis** (i.e. **Metrics File/ Experiment** selected) and **Y-axis** (i.e. **Metrics** selected by using the dropdown menu above the **graph**), a **Bar graph** will be plotted.

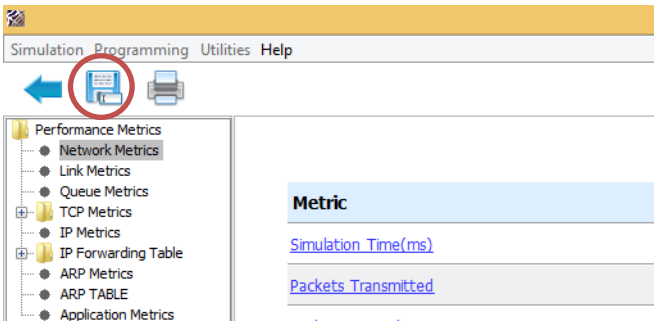



- For Other Networks, **select the Experiment** based on the tab selected. When one of the tabs is selected, all the experiments saved under the particular **Network** will be listed. Click on the Experiment Name to add it onto the Metrics Table.

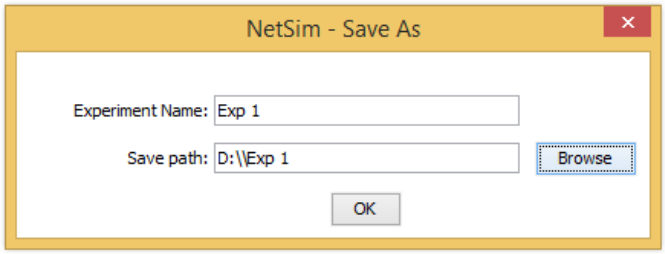
# Saving an Experiment

## For all Networks except Legacy Networks

**Step 1:** After simulation of the network, on the top left corner of Performance metrics screen, click on the "Save Network and Metric as" button

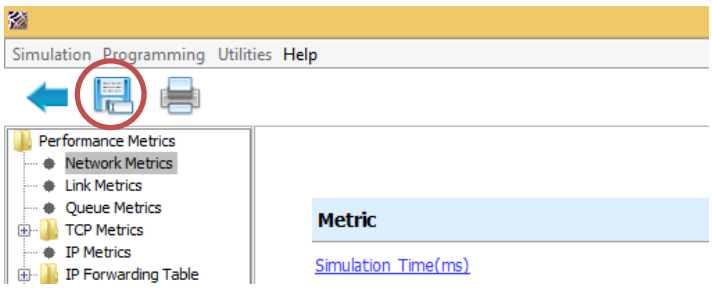



**Step 2:** Specify the **Experiment Name** and **Save Path** and click on **OK**

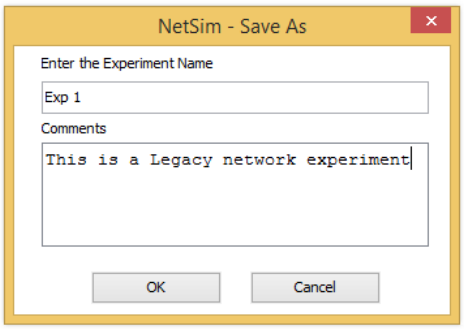



## For Legacy Networks

**Step 1:** After simulation of the network, on the top left corner of Performance metrics screen, click on the "Save Network and Metric as" button



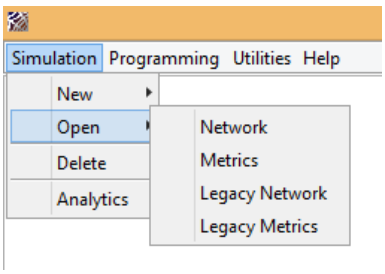

**Step 2:** Specify the **Experiment Name** and **Comments** and click on **OK**

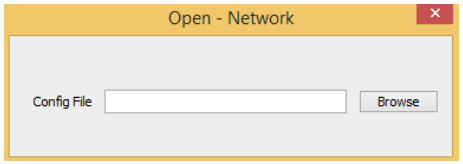


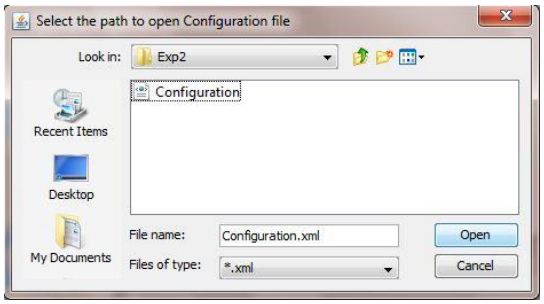
# Opening an Experiment

## Open Network – All Networks except Legacy Networks

Go to **Simulation → Open → Network** menu to open saved experiments. The following steps need to be followed:



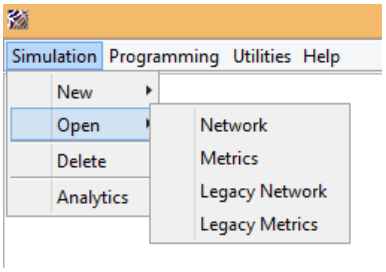



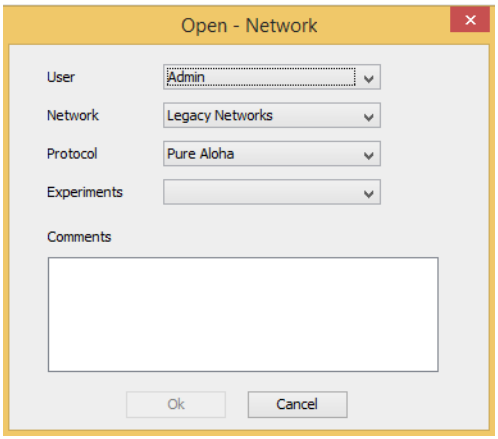




- Click on Browse
- Open the Saved experiment folder. (NetSim creates a folder with the experiment name during saving)
- Select the configuration.xml file inside the folder

## Open Network – Legacy Networks

Go to **Simulation → Open → Legacy Network** menu to open saved experiments. The following steps need to be followed:




- **Select** the **User** (*Note*: This option is available in Admin login only)
- **Select** the **Network**. Only Legacy Networks option will be present.
- **Select** the **Protocol**(*Note:* Protocols present under Legacy Network will be displayed)
- **Select** the **Experiment**
- **Click** on **Ok** button to **open** the specified **Experiment**.

# Experiment 2:
# Simulate a three nodes point – to – point network with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped.

## Theory:

Router forwards packets from one network to another network. When arrival rate of packets is greater than the service (departure) rate, packets get buffered (queued). Once the buffer (queue) is completely filled, all arriving packets will be dropped.

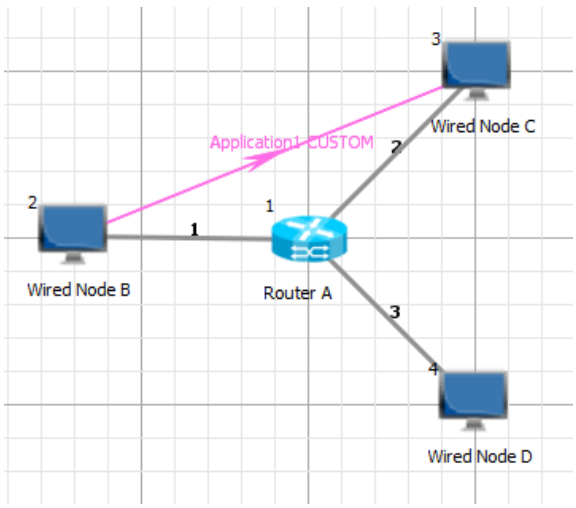
## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

### 1. Create /Design the Network

**Devices Required:** 1 Router, 3 Wired Nodes

**Network Diagram:**




Note: While creating network, first place the Router. Then place Wired Node B, C and D as shown here.

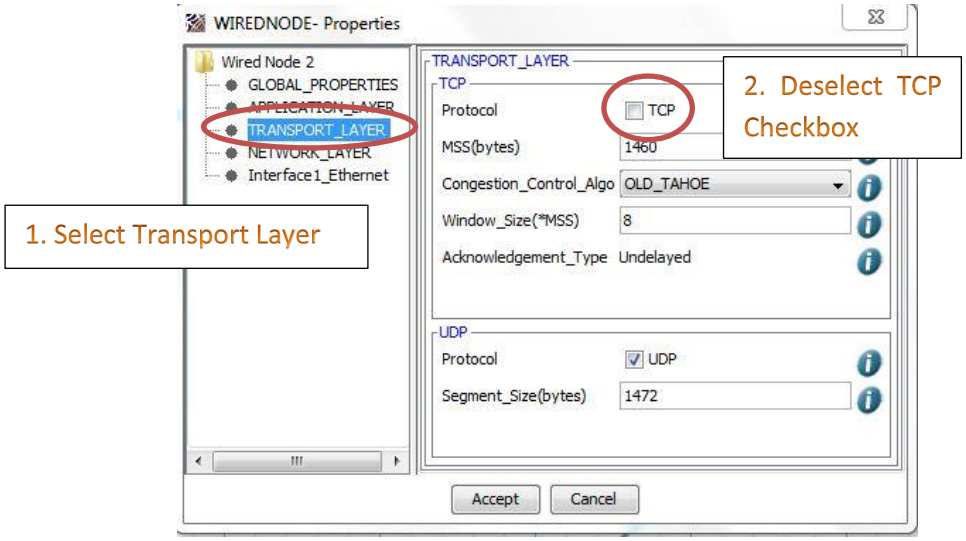
Connect Wired Node B with Router first. Then connect Wired Node C and Wired Node D with Router

## 2. Configure the Network (Sample 1)

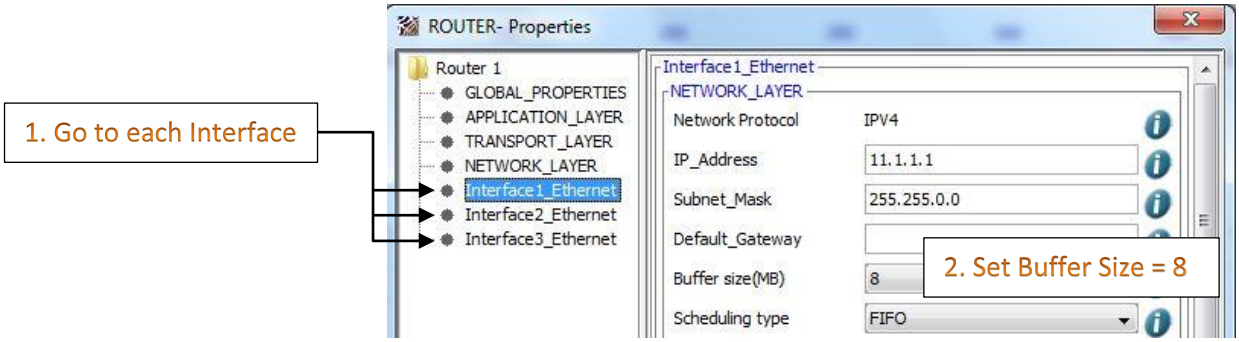
### Wired Node Properties:

Disable TCP in Wired Node B.

Right Click **Wired Node B** →Properties




**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Accept default values for remaining parameters.

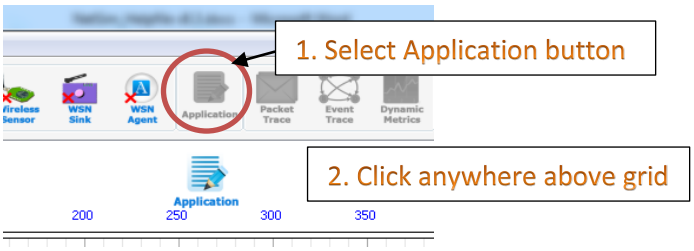


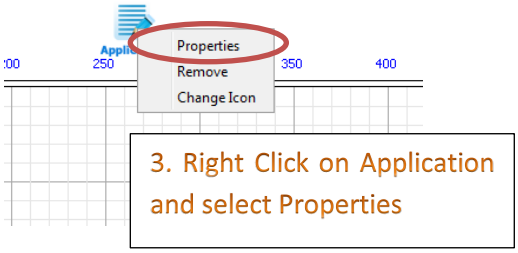

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

## 3. Model Traffic in the Network (Sample 1)

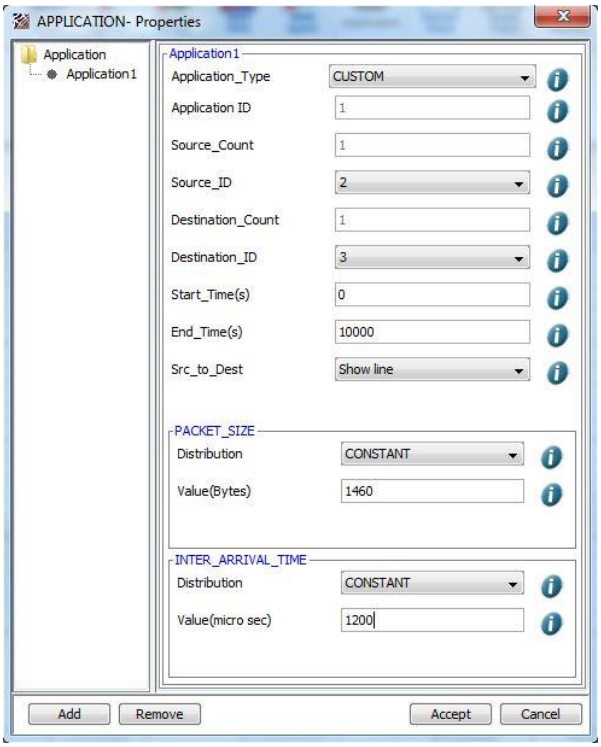
Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.




**Application Properties:** Modify the Application properties as specified in the left table.

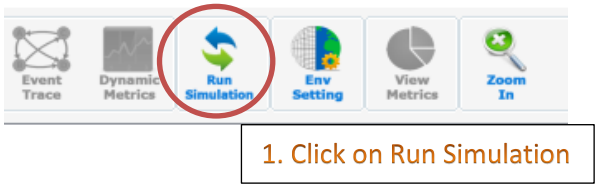
| | |
|---|---|
| **Application Type** | Custom |
| **Source ID** | 2 (Wired Node B) |
| **Destination ID** | 3 (Wired Node C) |
| **Packet Size** | |
| **Distribution** | Constant |
| **Value(Bytes)** | 1460 |
| **Inter Arrival Time** | |
| **Distribution** | Constant |
| **Value(µs)** | 1200 |




## 4. Simulate

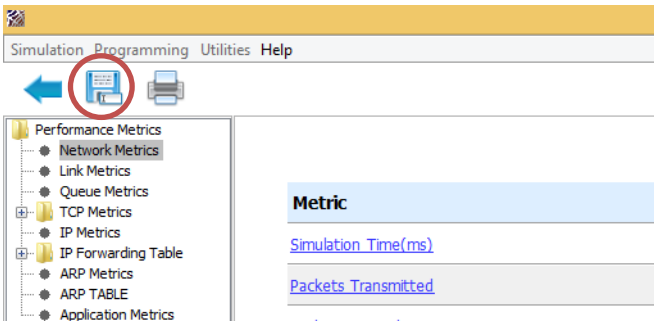
### Simulation Time - 100 Sec

After completion of the experiment, "Save" the experiment for future analysis of results.

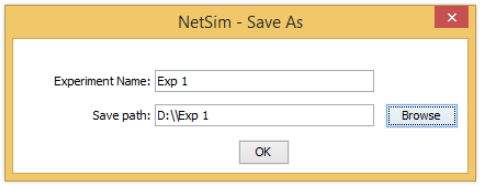


### Steps to save an experiment:

**Step 1:** After simulation of the network, on the top left corner of Performance metrics screen, click on the "Save Network and Metric as" button




**Step 2:** Specify the **Experiment Name** and **Save Path** and click on **OK**

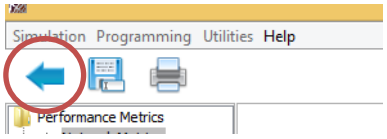


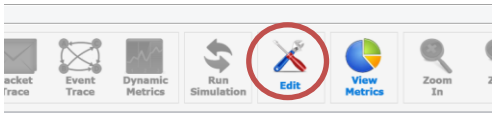

## 5. Configure the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the wired link properties as shown below.

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the wired link properties as shown below.




**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 8.448 |
| **Downlink Speed (Mbps)** | 10 | 8.448 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

## 6. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, "Save" the experiment for future analysis of results.

## 7. Configure the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the wired link properties as shown below.

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 6.312 |
| **Downlink Speed (Mbps)** | 10 | 6.312 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

## 8. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, "Save" the experiment for future analysis of results.

## 9. Configure the Network (Sample 4)

Follow all the steps as shown in Sample 1 and modify only the wired link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 2.048 |
| **Downlink Speed (Mbps)** | 10 | 2.048 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

## 10. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, "Save" the experiment for future analysis of results.

## 11. Configure the Network (Sample 5)

Follow all the steps as shown in Sample 1 and modify only the wired link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 1.54 |
| **Downlink Speed (Mbps)** | 10 | 1.54 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

## 12. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, "Save" the experiment for future analysis of results.

## 13. Configure the Network (Sample 6)

Follow all the steps as shown in Sample 1 and modify only the wired link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 |
|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 0.064 |
| **Downlink Speed (Mbps)** | 10 | 0.064 |
| **Uplink BER** | No Error | No Error |
| **Downlink BER** | No Error | No Error |

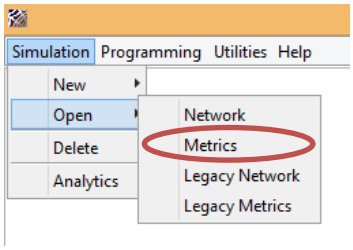
## 14. Simulate

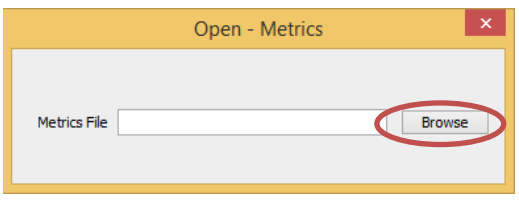
**Simulation Time - 100 Sec**

After completion of the simulation, "Save" the experiment for future analysis of results.

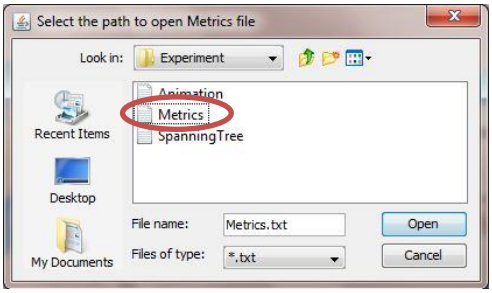
## 15. Analysis of Result

Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.

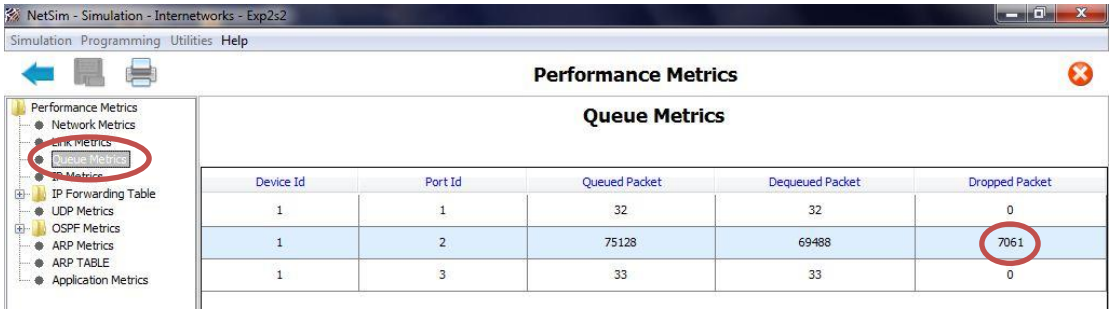


Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open




Open the Metrics.txt file of the first saved sample and note down the "**Dropped Packet"** values of Port Id=2 available under "**Queue Metrics"** in an Excel file.

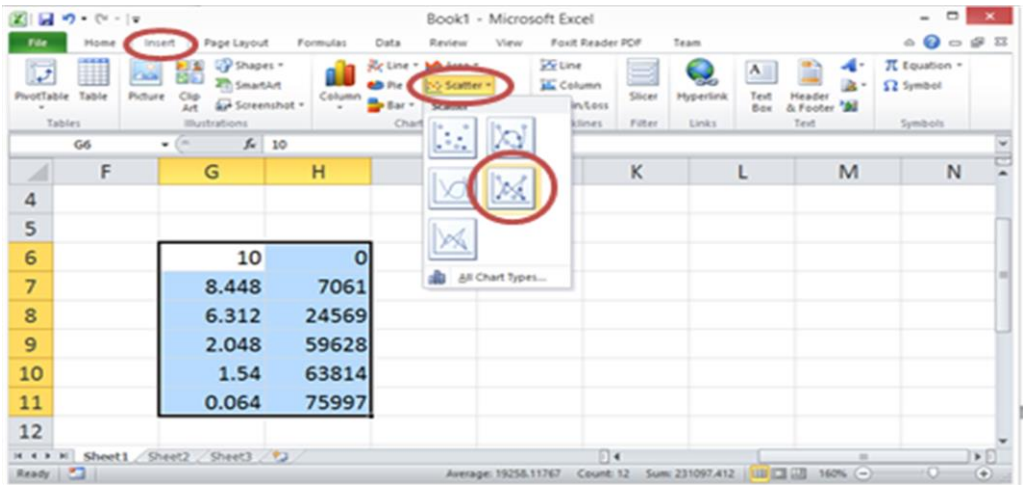



Similarly please follow the same steps for all the saved experiments and note down the Dropped Packets values and Wired Link 2 speed of that sample. It will be as shown below.

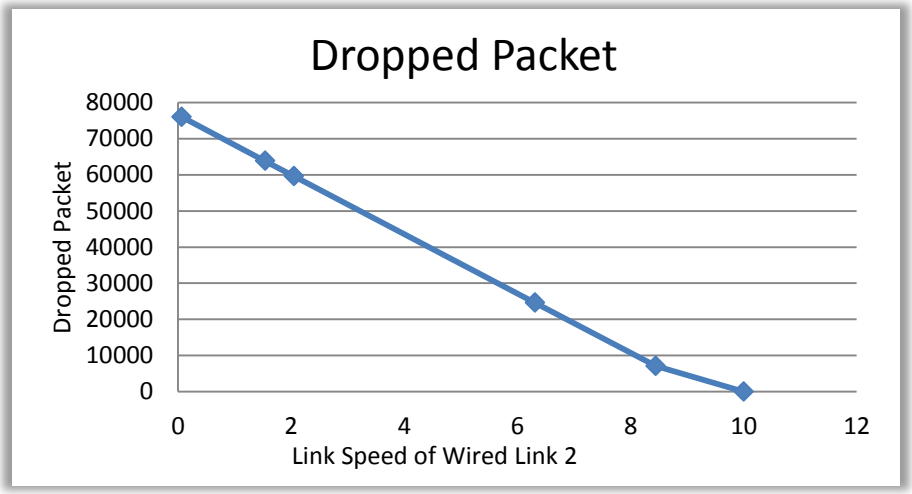
| Sample Number | Link Speed of Wired Link2 (Mbps) | Number of packets dropped |
|---|---|---|
| 1 | 10 | 0 |
| 2 | 8.448 | 7061 |
| 3 | 6.312 | 24569 |
| 4 | 2.048 | 59628 |
| 5 | 1.54 | 63814 |
| 6 | 0.064 | 75997 |

**NOTE – To create Graph in Excel 2010, follow the steps**

1. Copy the data in an Excel sheet.
2. Select the data. Go to **Insert → Scatter (under Charts) → Scatter with Straight Lines and Markers.**




**Graph I**




## 16. Inference

The number of packets dropped decreases as the link speed of wired link increases. Hence from the Graph I it can be inferred that as the link speed of second link decreases, packets arrival rate is higher than the rate at which packets are forwarded by the Router via link 2. As a result queue size increases quickly and the buffer gets filled. Hence the newly arrive packets at the queue will be dropped.

# Experiment 3:

# Simulate a three node point-to-point network with the links connected as follows: n0 → n2, n1 → n2 and n2 → n3. Apply TCP agent between n0-n3 and UDP between n1-n3. Apply relevant applications over TCP and UDP agents changing the parameter and determine the number of packets sent by TCP / UDP. (n0, n1 and n3 are nodes and n2 is router.).

## Theory:

**TCP:**

TCP recovers data that is damaged, lost, duplicated, or delivered out of order by the internet communication system. This is achieved by assigning a sequence number to each octet transmitted, and requiring a positive acknowledgment (ACK) from the receiving TCP. If the ACK is not received within a timeout interval, the data is retransmitted. At the receiver side sequence number is used to eliminate the duplicates as well as to order the segments in correct order since there is a chance of "out of order" reception. Therefore, in TCP no transmission errors will affect the correct delivery of data.

**UDP:**

UDP uses a simple transmission model with a minimum of protocol mechanism. It has no handshaking dialogues, and thus exposes any unreliability of the underlying network protocol to the user's program. As this is normally IP over unreliable media, there is no guarantee of delivery, ordering or duplicate protection.

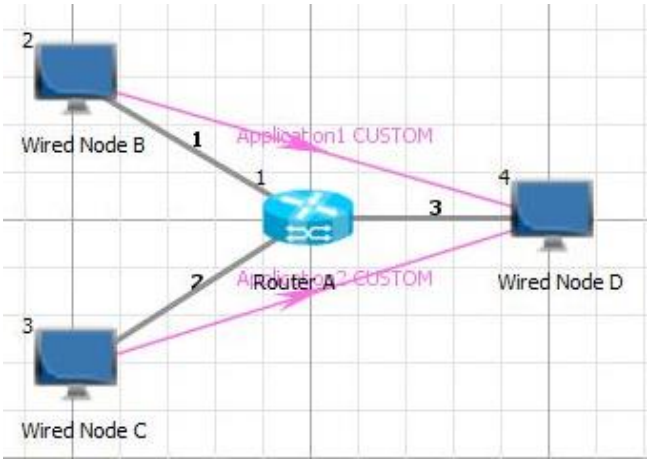
## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

## 1. Create /Design the Network

**Devices Required:** 1 Router, 3 Wired Nodes

**Network Diagram:**




Note: While creating network, first place the Router. Then place Wired Node B, C and D as shown here.

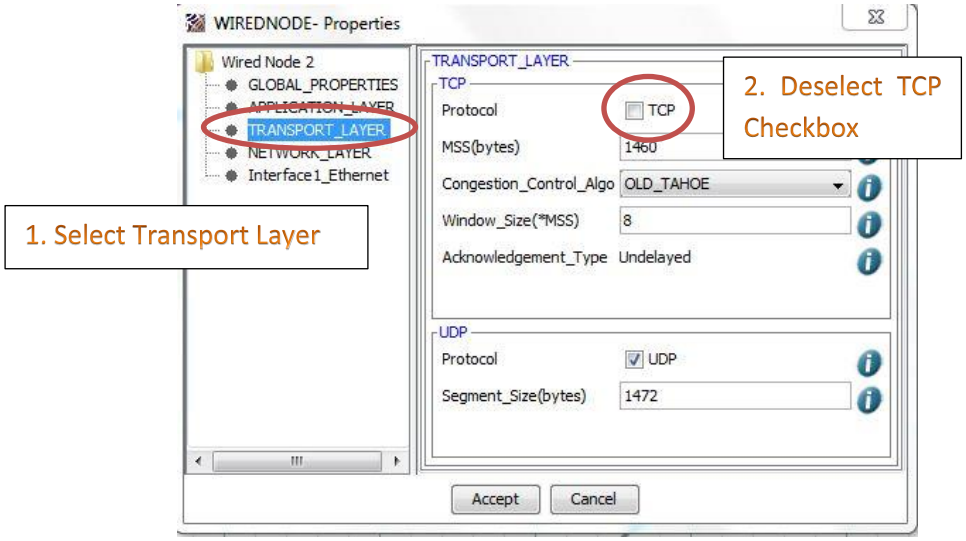
Connect Wired Node B with Router first. Then connect Wired Node C and Wired Node D with Router

## 2. Configure the Network (Sample 1)

**Wired Node Properties:**

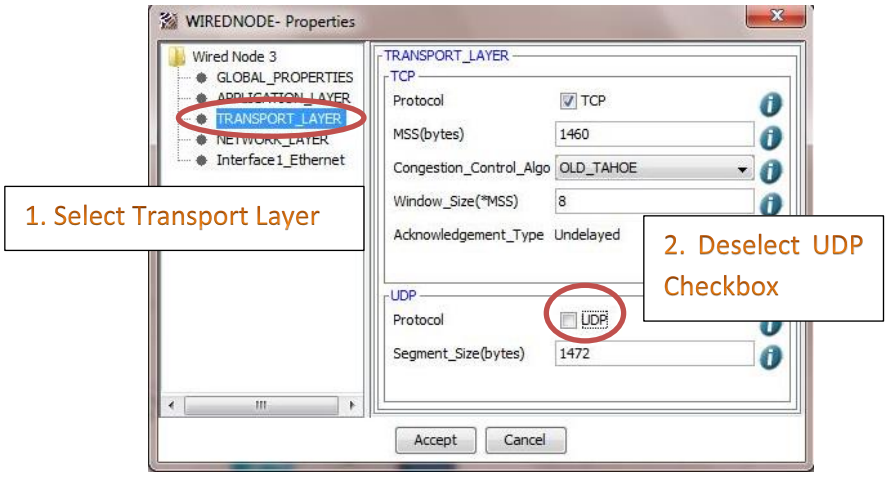
Disable TCP in Wired Node B.

Right Click **Wired Node B** →Properties



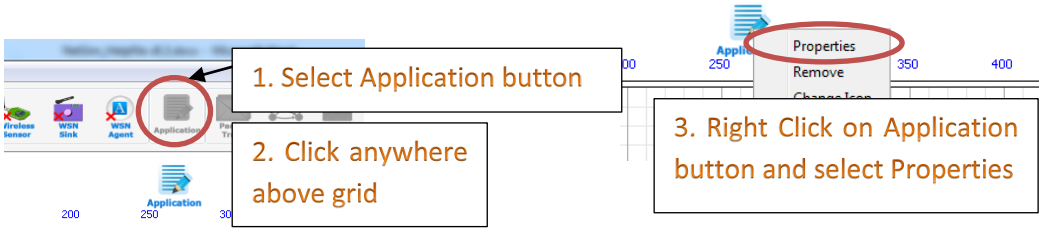

Disable UDP in Wired Node C.

Right Click **Wired Node C** →Properties



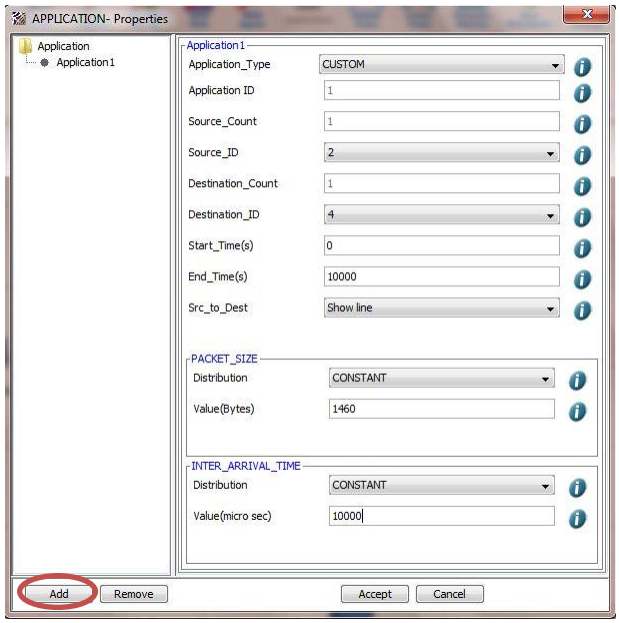

## 3. Model Traffic in the Network (Sample 1)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.




**NOTE: The procedure to create multiple applications are as follows:**

**Step 1:** Click on the ADD button present in the bottom left corner to add a new application.



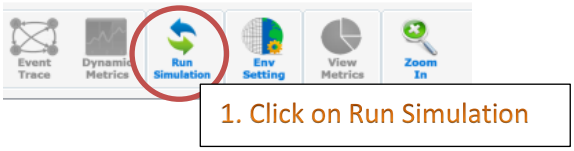
## Application Properties:

Create two (2) Application and set the values as shown below.

| | | |
|---|---|---|
| **Application Type** | Custom | Custom |
| **Source ID** | 2(Wired Node B) | 3(Wired Node C) |
| **Destination ID** | 4(Wired Node D) | 4(Wired Node D) |
| **Packet Size** | | |
| **Distribution** | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 |
| **Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Value(µs)** | 10000 | 10000 |

# 4. Simulate

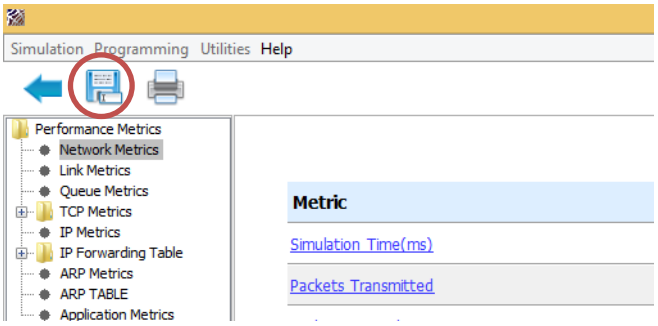
**Simulation Time - 100 Sec**



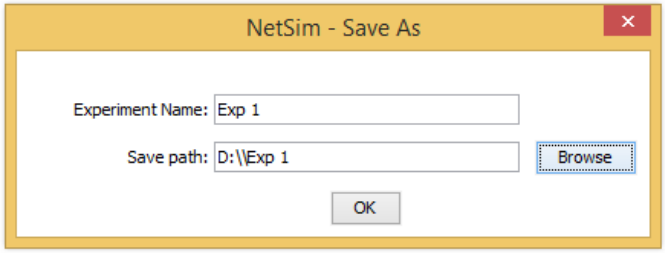

After completion of the experiment, "Save" the experiment for future analysis of results.

### Steps to save an experiment:

**Step 1:** After simulation of the network, on the top left corner of Performance metrics screen, click on the "Save Network and Metric as" button




**Step 2:** Specify the **Experiment Name** and **Save Path** and click on **OK**

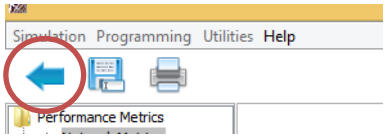


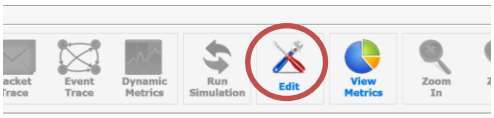
## 5. Model Traffic in the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Application properties as shown below .

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the Application properties as shown below.




### Application Properties:

Create 2 Application and set the values as shown below

| | | |
|---|---|---|
| **Application Type** | Custom | Custom |
| **Source ID** | 2(Wired Node B) | 3(Wired Node C) |
| **Destination ID** | 4(Wired Node D) | 4(Wired Node D) |
| **Packet Size** | | |
| **Distribution** | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 |
| **Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Value(µs)** | **5000** | **5000** |

## 6. Simulate

### Simulation Time - 100 Sec

After completion of the simulation, "Save" the experiment for future analysis of results.

## 7. Model Traffic in the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Application properties as shown below

## Application Properties:

Create 2 Application and set the values as shown below

| **Application Type** | Custom | Custom |
|---|---|---|
| **Source ID** | 2(Wired Node B) | 3(Wired Node C) |
| **Destination ID** | 4(Wired Node D) | 4(Wired Node D) |
| **Packet Size** | | |
| **Distribution** | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 |
| **Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Value(µs)** | **2500** | **2500** |

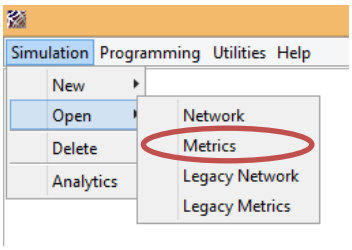
# 8. Simulate

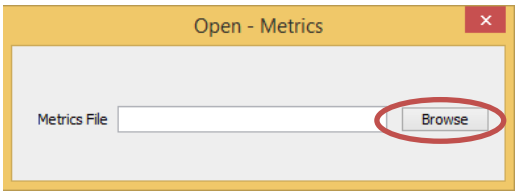
### Simulation Time - 100 Sec

After completion of the simulation, "Save" the experiment for future analysis of results.

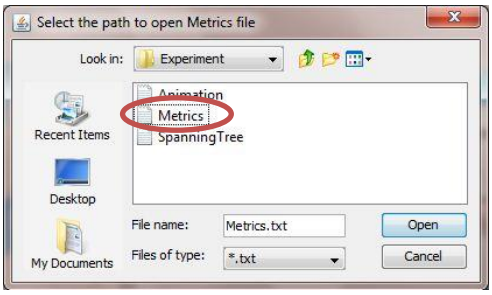
# 9. Analysis of Result

Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.

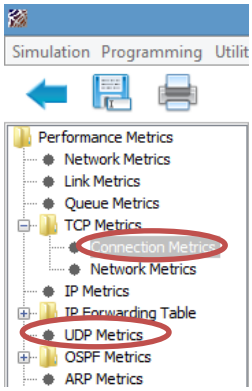



Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open

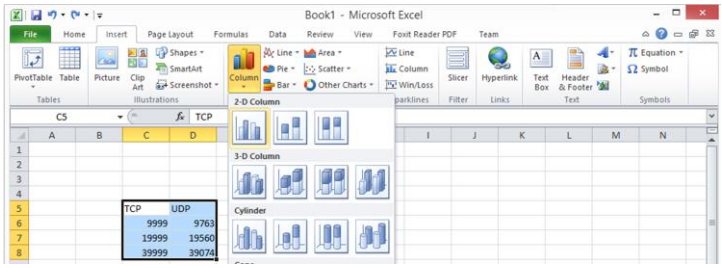


Open the Metrics.txt file and note the **Number of Segments Sent**, **Segments Received** available in the Connection Metrics under TCP Metrics and **Datagram Sent, Datagram Received** available in the UDP Metrics of "**Performance Metrics**" screen of NetSim in an Excel file. Do the same procedure for the rest 5 samples.



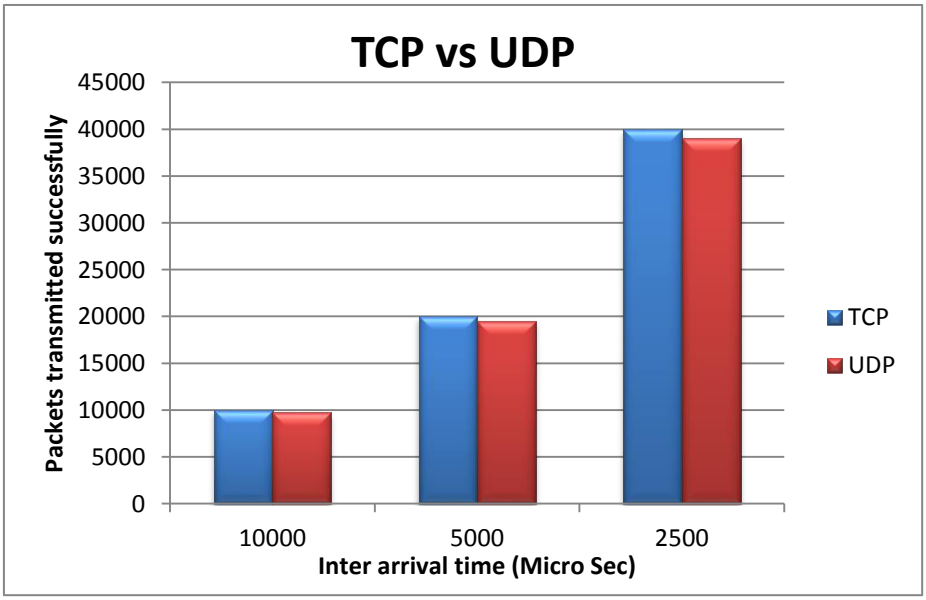

**NOTE – To create Graph in Excel 2010, follow the steps**

1. Copy the data in an Excel sheet.
2. Select the data. Go to **Insert → Column (under Charts) → Clustered Column.**




**Graph I**

**(Note:** The "Packets transmitted successfully" for TCP is **Segments Received** and for UDP is **Datagram Received** of the destination node i.e., Wired Node 3**)**

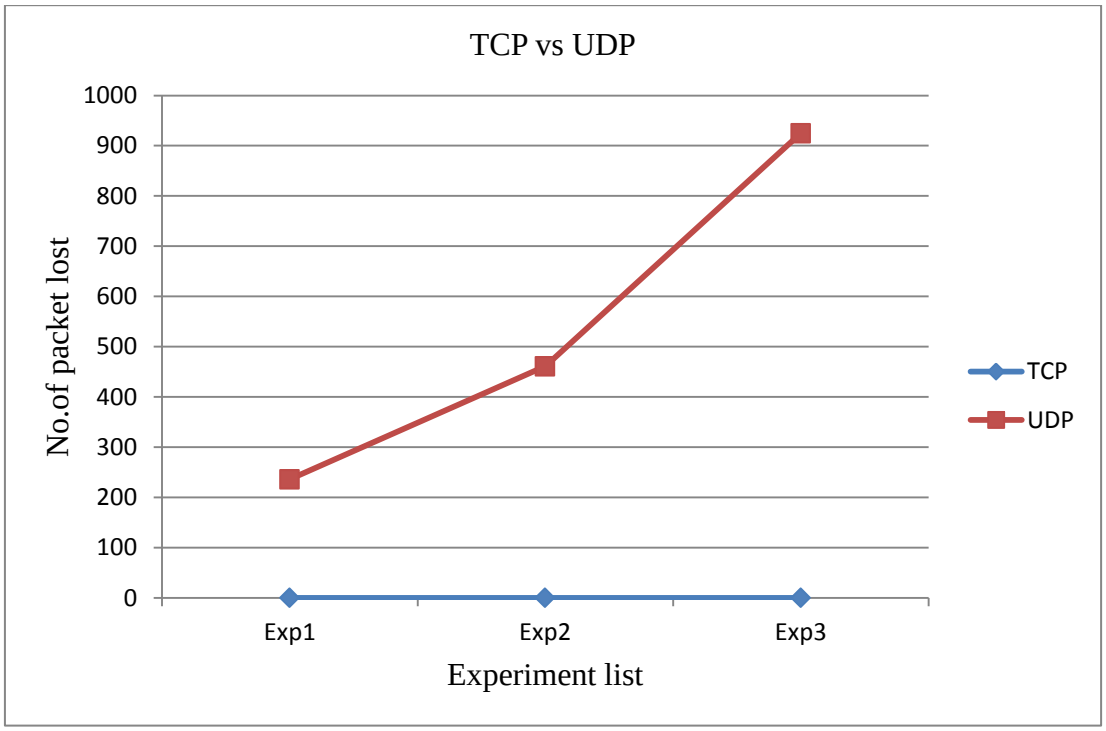



Number of packets transmitted successfully in TCP and UDP

**Graph II**

Number of lost packets in TCP and UDP

(**Note:** To get the "**No. of packet lost**", For **TCP**, get the difference between **Segments Sent** and **Segments Received** and for **UDP**, get the difference between **Datagram Sent** and **Datagram Received**)




## 10. Inference

Graph I, shows that the number of successful packets transmitted in TCP is greater than (or equal to) UDP. Because, when TCP transmits a packet containing data, it puts a copy on a retransmission queue and starts a timer; when the acknowledgment for that data is received, the segment is deleted from the queue. If the acknowledgment is not received before the timer runs out, the segment is retransmitted. So even though a packet gets errored or dropped that packet will be retransmitted in TCP, but UDP will not retransmit such packets.

As per the theory given and the explanation provided in the above paragraph, we see in Graph 2, that there is no packet loss in TCP but UDP has packet loss.

# Experiment 4:
# Simulate the different types of internet traffic such as FTP, TELNET over a network and analyze the throughput.

## Theory:

FTP is File Transfer Protocol that transfers the files from source to destination. It is an application layer protocol. The file transfer takes place over TCP.

TELNET is Terminal Network Protocol that is used to access the data in the remote machine. It is also an Application layer protocol. It establishes connection to the remote machine over TCP.

FTP, Database, Voice, HTTP, Email, Peer to Peer and Video are the traffic types available as options in NetSim. To model other applications the "Custom" option is available. TELNET application has been modeled in NetSim by using custom traffic type. Packet Size and Packet Inter Arrival Time for TELNET application is shown below:

| **Packet Size** | |
|---|---|
| **Distribution** | Constant |
| **Packet Size (Bytes)** | 1460 |
| **Packet Inter Arrival Time** | |
| **Distribution** | Constant |
| **Packet Inter Arrival Time (µs)** | 15000 |

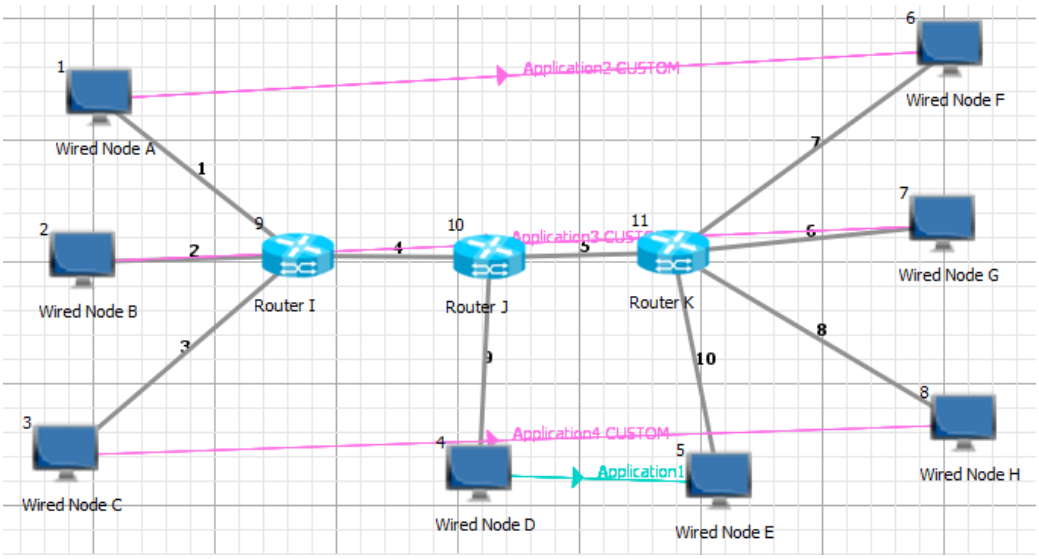
## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

### 1. Create /Design the Network

**Devices Required:** 3 Routers, 8 Wired Nodes

## Network Diagram:




Note: While creating network, place the devices according to the Node ID given in diagram above in order to easily understand the settings to be configured as provided in this manual.

For example: Figure shows Wired Node A has Node ID 1 and Wired Node B has Node ID 2.So first place a Wired Node at the location of Wired Node A and then at Wired Node B and so on.

# 2. Configure the Network (Sample 1)

## Wired Node Properties:

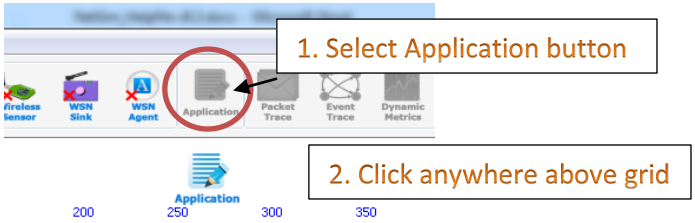
TCP should be enabled in all Wired Nodes.

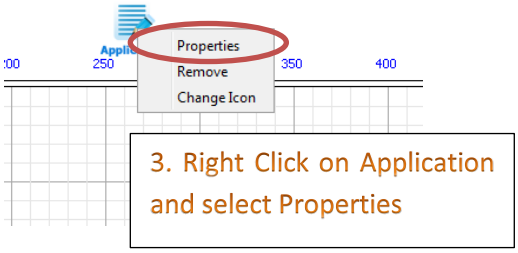
**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | All Wired Link |
|---|---|
| **Uplink Speed (Mbps)** | 1 |
| **Downlink Speed (Mbps)** | 1 |
| **Uplink BER** | No Error |
| **Downlink BER** | No Error |

## 3. Model Traffic in the Network (Sample 1)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.




### Application Properties:

| | |
|---|---|
| **Application Type** | FTP |
| **Source ID** | 4(Wired Node D) |
| **Destination ID** | 5(Wired Node E) |
| **File Size** | |
| **Distribution** | Constant |
| **Size (Bytes)** | 10000000 |
| **File Inter Arrival Time** | |
| **Distribution** | Constant |
| **Inter Arrival Time** | 10 sec |

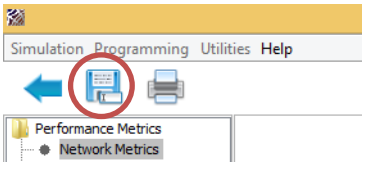
## 4. Simulate

**Simulation Time - 100 Sec**

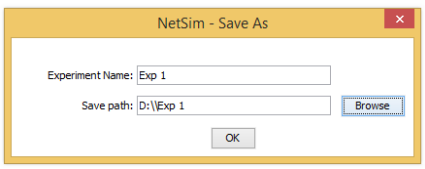
After completion of the experiment, "Save" the experiment for future analysis of results.

### Steps to save an experiment:


**Step 1:** After simulation of the network, on the top left corner of Performance metrics screen, click on the "Save Network and Metric as" button.




**Step 2:** Specify the **Experiment Name** and **Save Path** and click on **OK**

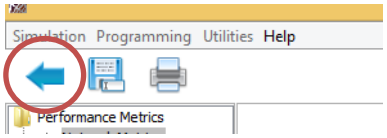


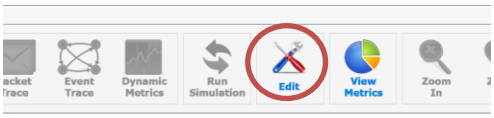
## 5. Model Traffic in the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Application properties as shown below

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the Application properties as shown below.



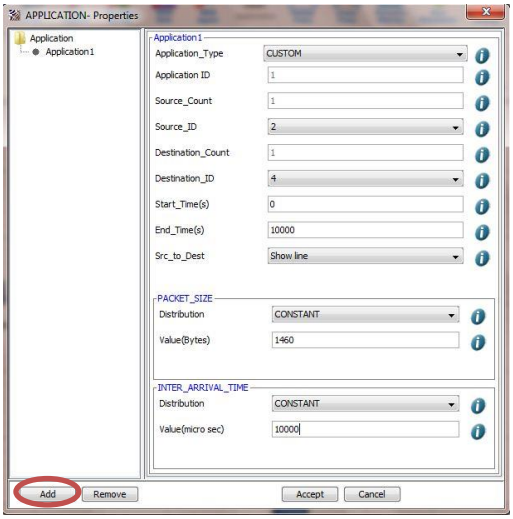




**Application Properties:**

| | | |
|---|---|---|
| **Application Type** | FTP | Custom(for TELNET) |
| **Source ID** | 4(Wired Node D) | 1(Wired Node A) |
| **Destination ID** | 5(Wired Node E) | 6(Wired Node F) |
| | **File Size** | **Packet Size** |
| **Distribution** | Constant | Constant |
| **Size (Bytes)** | 10000000 | 1460 |
| | **File Inter Arrival Time** | **Packet Inter Arrival Time** |
| **Distribution** | Constant | Constant |
| **Inter Arrival Time** | 10 sec | 15000 (µs) |

**NOTE: The procedure to create multiple applications are as follows:**

**Step 1:** Click on the ADD button present in the bottom left corner to add a new application.



## 6. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, “Save” the experiment for future analysis of results.

## 7. Model Traffic in the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Application properties as shown below

**Application Properties:**

| **Application Type** | FTP | Custom(for TELNET) | Custom(for TELNET) |
|---|---|---|---|
| **Source ID** | 4(Wired Node D) | 1(Wired Node A) | 2(Wired Node B) |
| **Destination ID** | 5(Wired Node E) | 6(Wired Node F) | 7(Wired Node G) |
| | **File Size** | **Packet Size** | |
| **Distribution** | Constant | Constant | Constant |
| **Size (Bytes)** | 10000000 | 1460 | 1460 |
| | **File Inter Arrival Time** | **Packet Inter Arrival Time** | |
| **Distribution** | Constant | Constant | Constant |
| **Inter Arrival Time** | 10 sec | 15000 (µs) | 15000 (µs) |

## 8. Simulate

**Simulation Time - 100 Sec**

After completion of the simulation, “Save” the experiment for future analysis of results.

## 9. Model Traffic in the Network (Sample 4)

Follow all the steps as shown in Sample 1 and modify only the Application properties as shown below

## Application Properties:

| **Application Type** | FTP | Custom(for TELNET) | Custom(for TELNET) | Custom(for TELNET) |
|---|---|---|---|---|
| **Source ID** | 4(Wired Node D) | 1(Wired Node A) | 2(Wired Node B) | 3(Wired Node C) |
| **Destination ID** | 5(Wired Node E) | 6(Wired Node F) | 7(Wired Node G) | 8(Wired Node H) |
| | **File Size** | **Packet Size** | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Size (Bytes)** | 10000000 | 1460 | 1460 | 1460 |
| | **File Inter Arrival Time** | **Packet Inter Arrival Time** | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Inter Arrival Time** | 10 sec | 15000 (µs) | 15000 (µs) | 15000 (µs) |

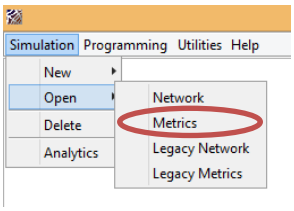
# 10. Simulate

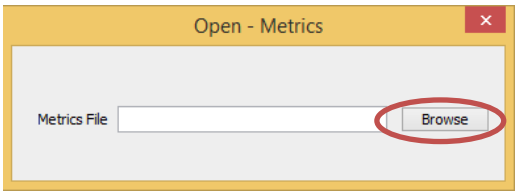
### Simulation Time - 100 Sec

After completion of the simulation, "Save" the experiment for future analysis of results.

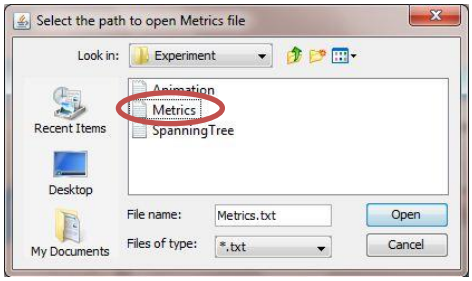
# 11. Analysis of Result

Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.




Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open

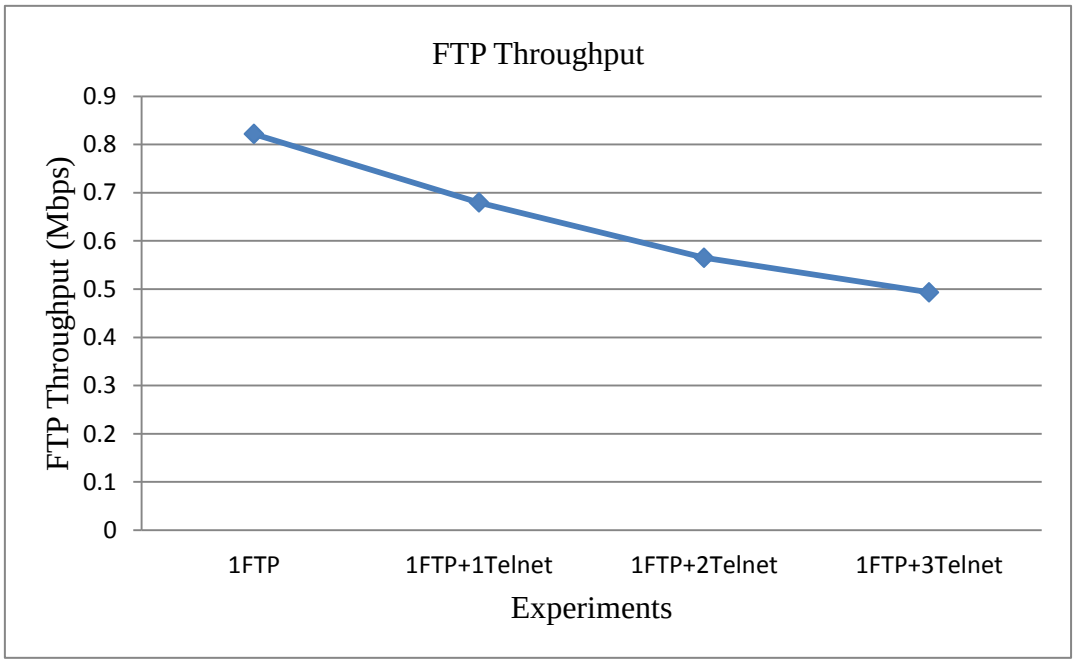


Open the Metrics.txt file of the first saved sample and note down the **Throughput values** available under Application metrics in the metrics screen of NetSim in an Excel file.

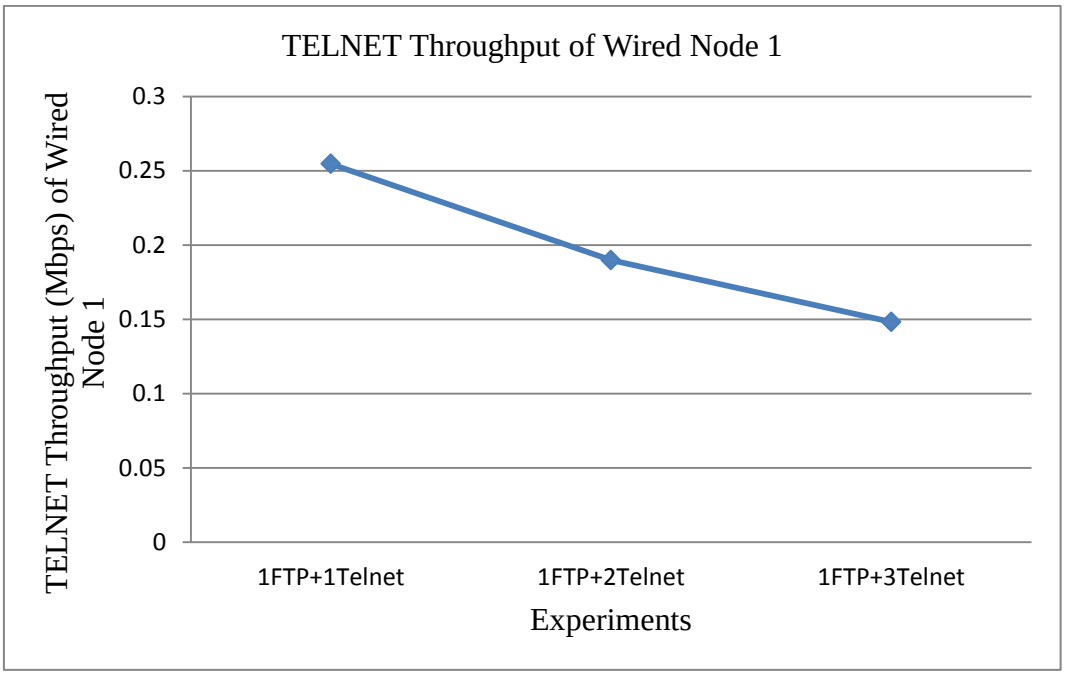
Similarly please follow the same steps for all the saved samples and note down the Throughput values .It will be as shown below.

| Experiment Number | Source | Destination | Application | Throughput |
|---|---|---|---|---|
| 1 | Wired Node D | Wired Node E | FTP | 0.824842 |
| | | | | |
| 2 | Wired Node D | Wired Node E | FTP | 0.672768 |
| 2 | Wired Node A | Wired Node F | TELNET | 0.255091 |
| | | | | |
| 3 | Wired Node D | Wired Node E | FTP | 0.562158 |
| 3 | Wired Node A | Wired Node F | TELNET | 0.187814 |
| 3 | Wired Node B | Wired Node G | TELNET | 0.193654 |
| | | | | |
| 4 | Wired Node D | Wired Node E | FTP | 0.487990 |
| 4 | Wired Node A | Wired Node F | TELNET | 0.149154 |
| 4 | Wired Node B | Wired Node G | TELNET | 0.146467 |
| 4 | Wired Node C | Wired Node H | TELNET | 0.156862 |

**Graph I**



**Graph II**




**NOTE:** The procedure to create graph is same as provided in Experiment 2.

## 12. Inference

From Graph I, it can be inferred that FTP throughput decreases as the number of transmitting nodes of TELNET application increases. Wired link 5 is used for FTP traffic. All TELNET applications in this experiment also used Wired Link 5. Hence as the TELNET traffic over wired link 5 increases the FTP throughput decreases.

From Graph II, it can be inferred that TELNET throughput of Wired Node 1 decreases as the number of transmitting nodes of TELNET application increases. TELNET traffic of wired node 1 flows through wired link 5. Other TELNET applications also used the wired link 5. Hence as the overall TELNET traffic over wired link 5 increases, the TELNET throughput of Wired Node 1 decreases.

# Experiment 5:
# Simulate the transmission of ping messages over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.

## Theory:

Ping is a computer network administration utility used to test the reachability of a host on an Internet Protocol (IP) network and to measure the round-trip time for messages sent from the originating host to a destination computer. Ping operates by sending Internet Control Message Protocol (ICMP) echo request packets to the target host and waiting for an ICMP response. In the process it measures the time from transmission to reception (round-trip time) and records any packet loss.

Congestion occurs when the amount of incoming traffic is more than what the network can handle. In such cases, routers store these packets in the buffer. All the packets that arrive after the buffer is filled are dropped.

Several traffic types available as options in NetSim are database, voice, video, FTP, E-mail, HTTP and peer to peer. To model other applications the "Custom" option is available. Ping application has been modeled in NetSim by using custom traffic type. Packet Size and Packet Inter Arrival Time for Ping application is shown below:

| **Packet Size** | |
|---|---|
| **Distribution** | Constant |
| **Packet Size (Bytes)** | 32 |
| **Packet Inter Arrival Time** | |
| **Distribution** | Constant |
| **Packet Inter Arrival Time (µs)** | 100000 |

## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

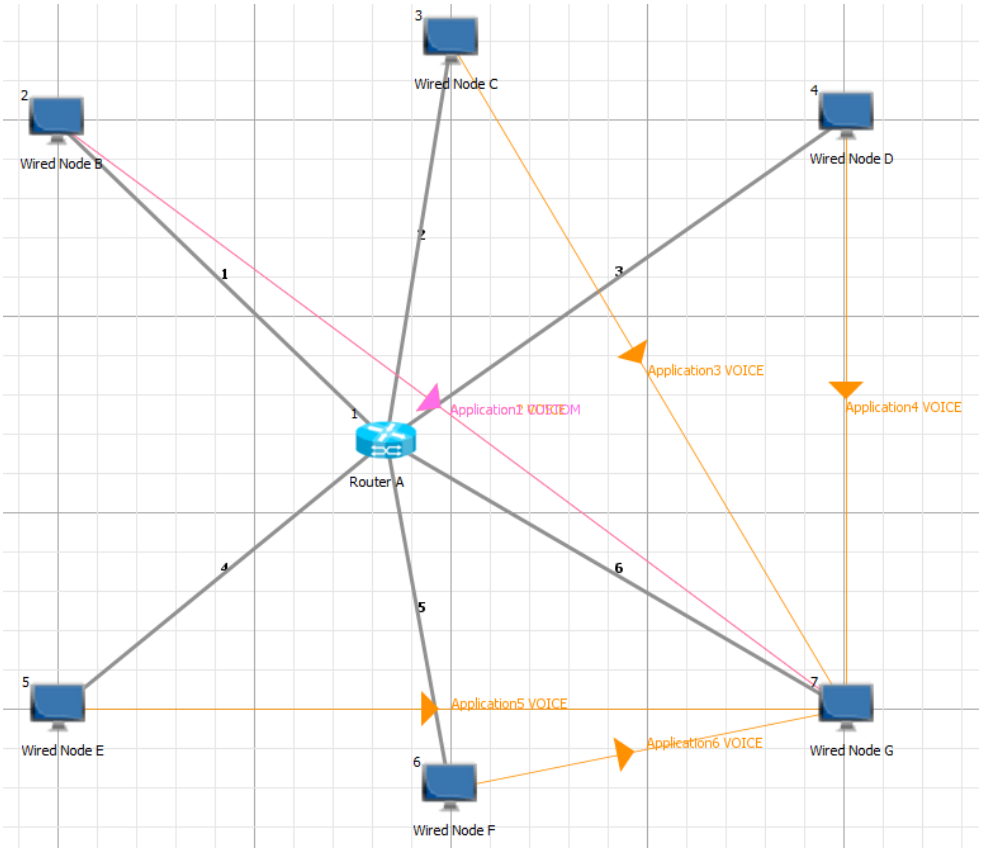
## 1. Create /Design the Network

**Devices Required:** 1 Router, 6 Wired Nodes

**Network Diagram:**

Note: While creating network, place the devices according to the Node ID given in diagram below in order to easily understand the settings to be configured as provided in this manual.

For example: Figure shows Wired Node A has Node ID 1 and Wired Node B has Node ID 2.So first place a Wired Node at the location of Wired Node A and then at Wired Node B and so on.

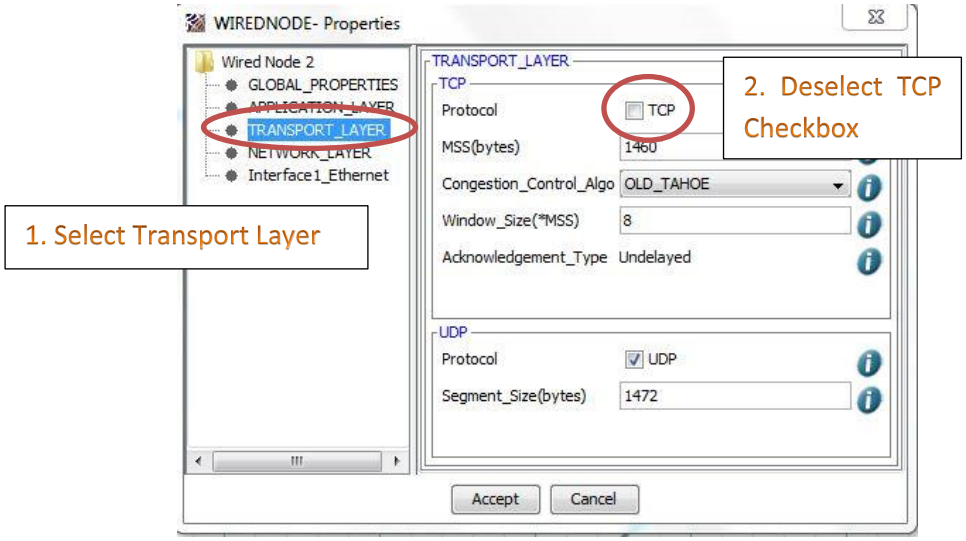



## 2. Configure the Network (Sample 1)

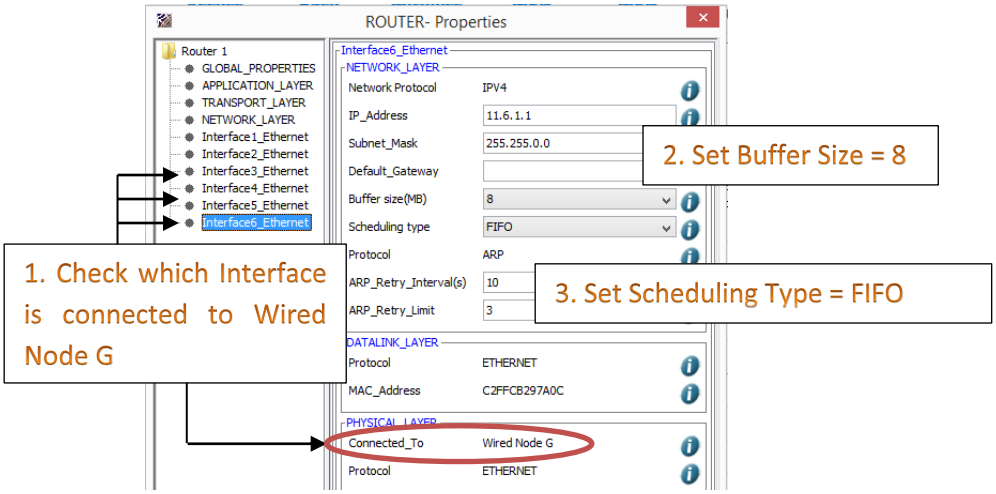
**Wired Node Properties:**

Disable TCP in Wired Node B.

Right Click **Wired Node B** →Properties




**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to FIFO.




**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 6 |
|---|---|---|
| **Uplink Speed (Mbps)** | 1.54 | 0.064 |
| **Downlink Speed (Mbps)** | 1.54 | 0.064 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ |

## 3. Model Traffic in the Network (Sample 1)

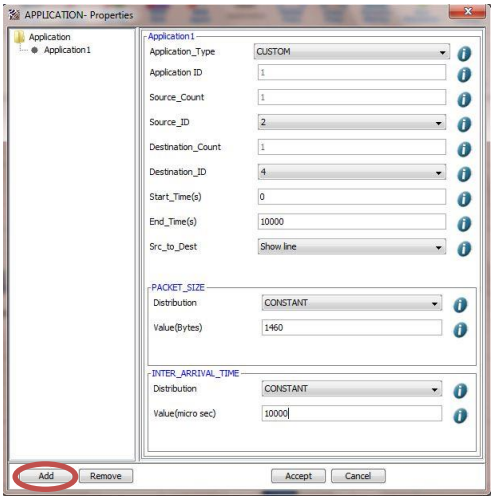
Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

### Application Properties:

| **Application Type** | Voice | Custom |
|---|---|---|
| **Source ID** | 2(Wired Node B) | 2(Wired Node B) |
| **Destination ID** | 7(Wired Node G) | 7(Wired Node G) |
| **Codec** | Custom | --- |
| **Packet Size** | | |
| **Distribution** | Constant | Constant |
| **Packet Size(Size)** | 160 | 32 |
| **Packet Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Packet Inter Arrival Time (µs)** | 10000 | 100000 |
| **Service Type** | CBR | --- |

**NOTE: The procedure to create multiple applications are as follows:**

**Step 1:** Click on the ADD button present in the bottom left corner to add a new application.




## 4. Simulate

### Simulation Time - 100 Sec

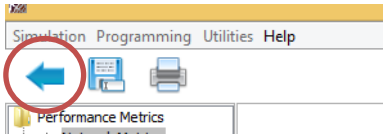
After completion of the experiment, "Save" the experiment for future analysis of results.

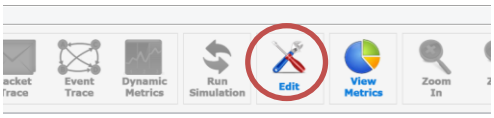
## 5. Configure the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Router properties as shown below

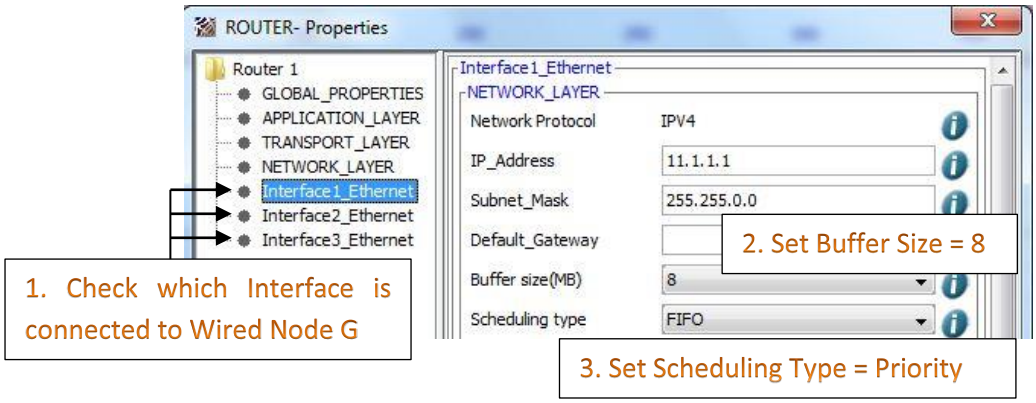
OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the Router properties as shown below.




**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to **Priority**.




## 6. Simulate

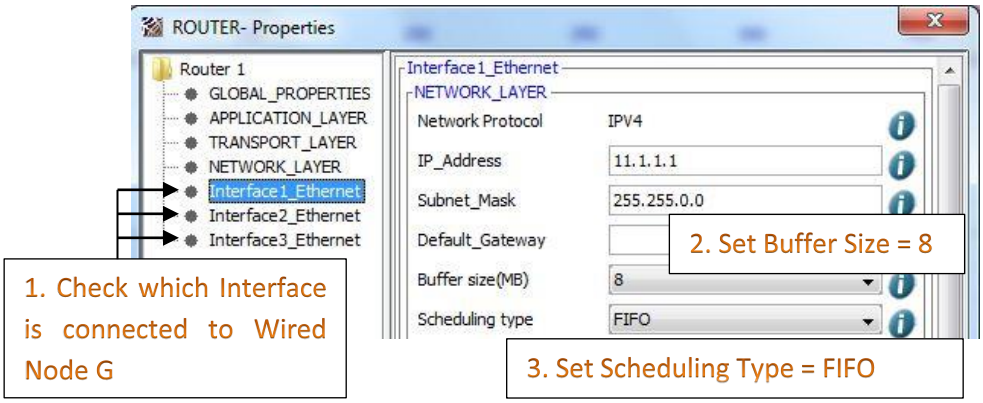
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 7. Configure the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Router properties and Wired Link properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to **FIFO**.




**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 & 2 | Wired Link 6 |
|---|---|---|
| **Uplink Speed (Mbps)** | 1.54 | 0.064 |
| **Downlink Speed (Mbps)** | 1.54 | 0.064 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ |

## 8. Model Traffic in the Network (Sample 3)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

**Application Properties:**

| **Application Type** | Voice | Voice | Custom |
|---|---|---|---|
| **Source ID** | 3(Wired Node C) | 2(Wired Node B) | 2(Wired Node B) |
| **Destination ID** | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) |
| **Codec** | Custom | Custom | --- |
| **Packet Size** | | | |
| **Distribution** | Constant | Constant | Constant |
| **Packet Size(Size)** | 160 | 160 | 32 |
| **Packet Inter Arrival Time** | | | |
| **Distribution** | Constant | Constant | Constant |
| **Packet Inter Arrival Time (µs)** | 10000 | 10000 | 100000 |
| **Service Type** | CBR | CBR | --- |

## 9. Simulate

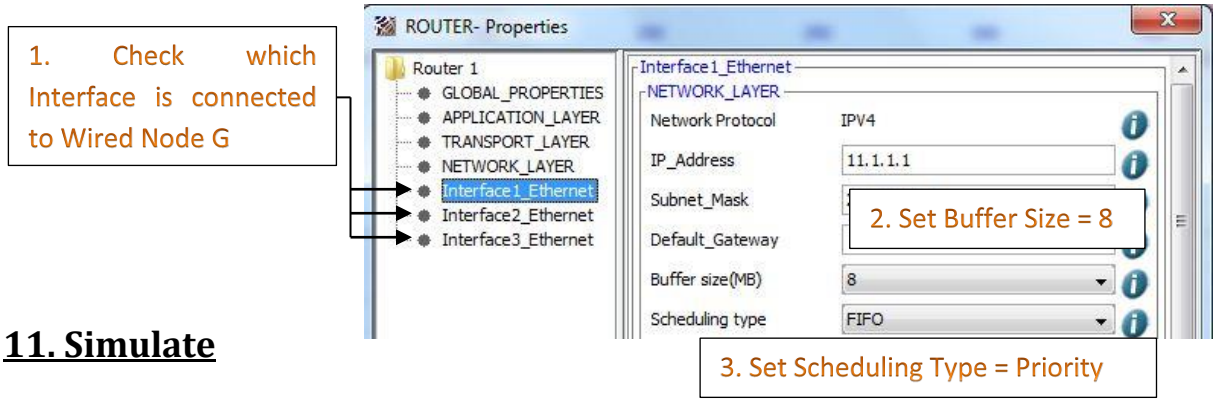
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 10. Configure the Network (Sample 4)

Follow all the steps as shown in Sample 3 and modify only the Router properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to Priority.




## 11. Simulate

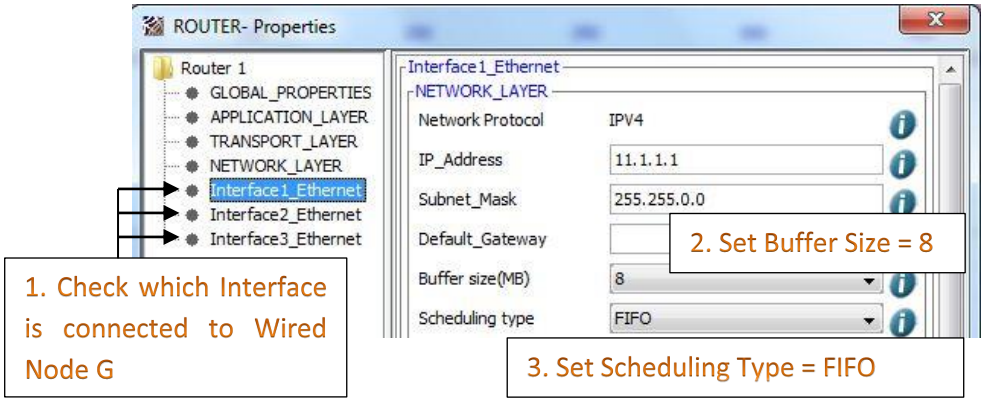
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 12. Configure the Network (Sample 5)

Follow all the steps as shown in Sample 1 and modify only the Router properties and Wired Link properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to FIFO.



**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1,2 & 3 | Wired Link 6 |
|---|---|---|
| **Uplink Speed (Mbps)** | 1.54 | 0.064 |
| **Downlink Speed (Mbps)** | 1.54 | 0.064 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ |

## 13. Model Traffic in the Network (Sample 5)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

**Application Properties:**

| **Application Type** | Voice | Voice | Voice | Custom |
|---|---|---|---|---|
| **Source ID** | 4(Wired Node D) | 3(Wired Node C) | 2(Wired Node B) | 2(Wired Node B) |
| **Destination ID** | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) |
| **Codec** | Custom | Custom | Custom | --- |
| **Packet Size** | | | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Packet Size(Size)** | 160 | 160 | 160 | 32 |
| **Packet Inter Arrival Time** | | | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Packet Inter Arrival Time (µs)** | 10000 | 10000 | 10000 | 100000 |
| **Service Type** | CBR | CBR | CBR | --- |

## 14. Simulate

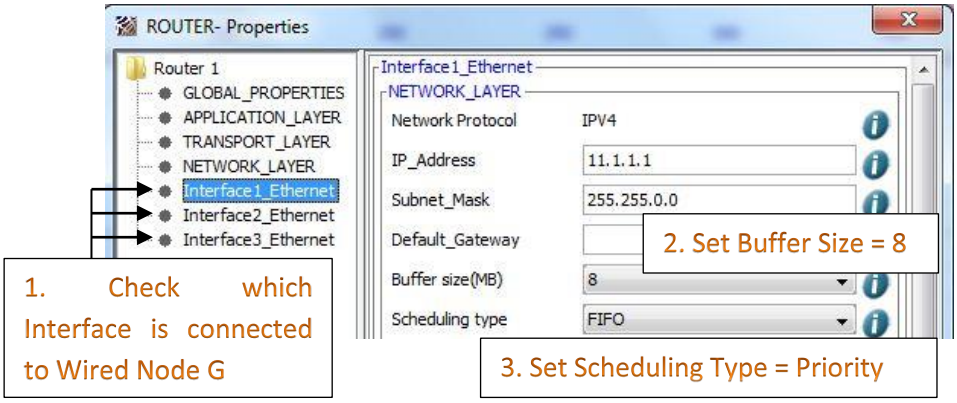
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 15. Configure the Network (Sample 6)

Follow all the steps as shown in Sample 5 and modify only the Router properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to Priority.




## 16. Simulate

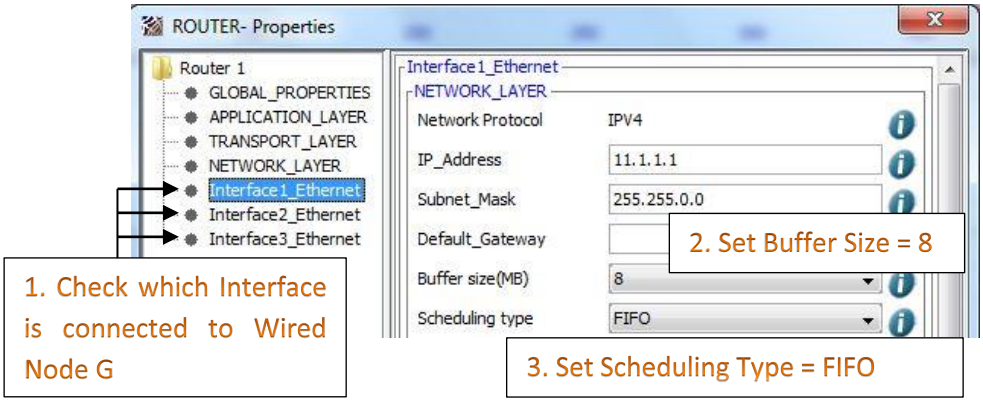
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 17. Configure the Network (Sample 7)

Follow all the steps as shown in Sample 1 and modify only the Router properties and Wired Link properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to FIFO.



**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1,2,3 & 4 | Wired Link 6 |
|---|---|---|
| **Uplink Speed (Mbps)** | 1.54 | 0.064 |
| **Downlink Speed (Mbps)** | 1.54 | 0.064 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ |

## 18. Model Traffic in the Network (Sample 7)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

**Application Properties:**

| **Application Type** | Voice | Voice | Voice | Voice | Custom |
|---|---|---|---|---|---|
| **Source ID** | 5(Wired Node E) | 4(Wired Node D) | 3(Wired Node C) | 2(Wired Node B) | 2(Wired Node B) |
| **Destination ID** | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) |
| **Codec** | Custom | Custom | Custom | Custom | --- |
| **Packet Size** | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant |
| **Packet Size(Size)** | 160 | 160 | 160 | 160 | 32 |
| **Packet Inter Arrival Time** | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant |
| **Packet Inter Arrival Time (µs)** | 10000 | 10000 | 10000 | 10000 | 100000 |
| **Service Type** | CBR | CBR | CBR | CBR | --- |

## 19. Simulate

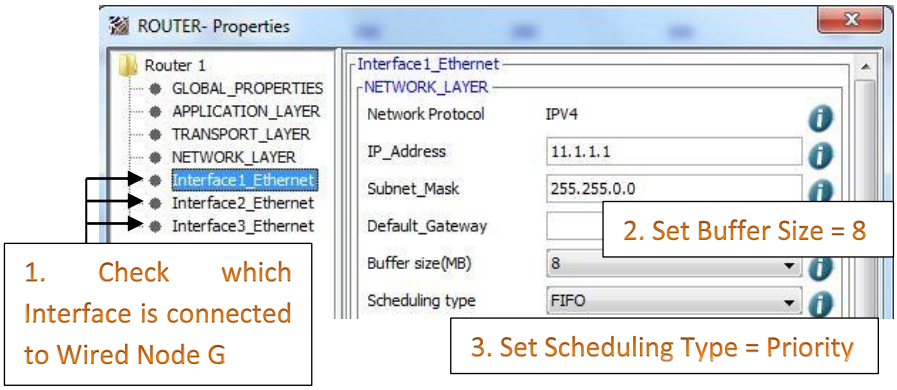
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 20. Configure the Network (Sample 8)

Follow all the steps as shown in Sample 7 and modify only the Router properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to Priority.




## 21. Simulate

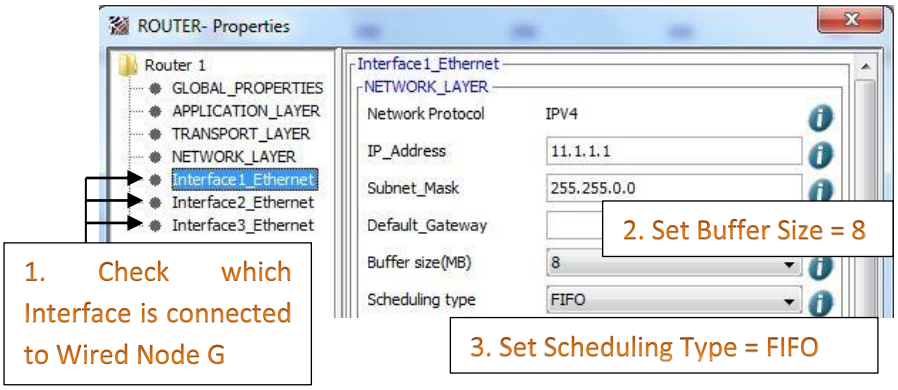
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 22. Configure the Network (Sample 9)

Follow all the steps as shown in Sample 1 and modify only the Router properties and Wired Link properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to FIFO.



**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1,2,3,4 & 5 | Wired Link 6 |
|---|---|---|
| **Uplink Speed (Mbps)** | 1.54 | 0.064 |
| **Downlink Speed (Mbps)** | 1.54 | 0.064 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ |

## 23. Model Traffic in the Network (Sample 9)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

**Application Properties:**

| **Application Type** | Voice | Voice | Voice | Voice | Voice | Custom |
|---|---|---|---|---|---|---|
| **Source ID** | 6(Wired Node F) | 5(Wired Node E) | 4(Wired Node D) | 3(Wired Node C) | 2(Wired Node B) | 2(Wired Node B) |
| **Destination ID** | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) | 7(Wired Node G) |
| **Codec** | Custom | Custom | Custom | Custom | Custom | --- |
| **Packet Size** | | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant | Constant |
| **Packet Size(Size)** | 160 | 160 | 160 | 160 | 160 | 32 |
| **Packet Inter Arrival Time** | | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant | Constant |
| **Packet Inter Arrival Time (µs)** | 10000 | 10000 | 10000 | 10000 | 10000 | 100000 |
| **Service Type** | CBR | CBR | CBR | CBR | CBR | --- |

## 24. Simulate

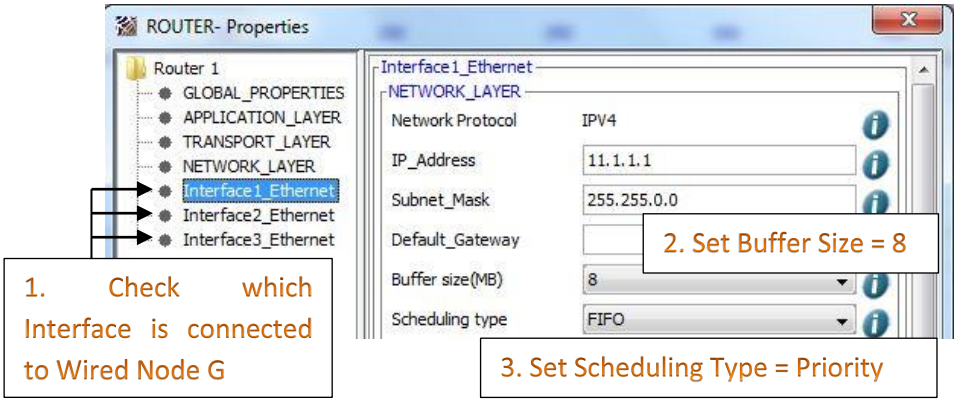
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 25. Configure the Network (Sample 10)

Follow all the steps as shown in Sample 9 and modify only the Router properties as shown below

**Router Properties:** Right click on **Router** → Properties. Set buffer size to 8 MB. Set scheduling type of interface connected to Wired Node G to Priority.



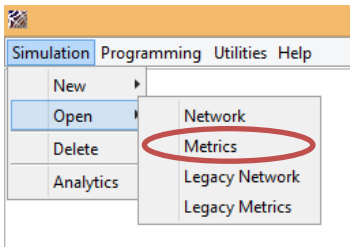

## 26. Simulate

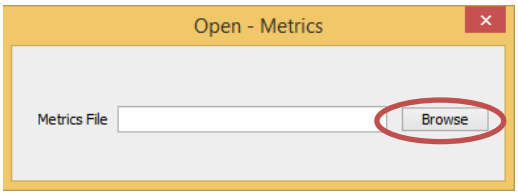
**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

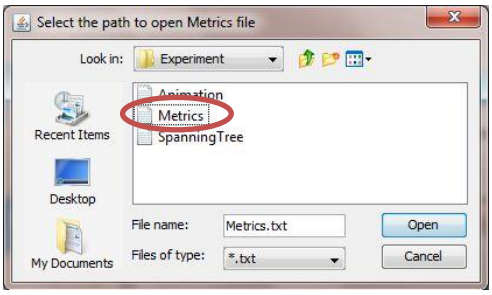
## 27. Analysis of Result

Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.




Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open



Open the Metrics.txt file of the first sample and note down the total number of **Dropped Packets** available under Queue metrics and number of ping messages (**Packets Received**) received available under Application metrics in an Excel file. Similarly please follow the same steps for all the saved samples and note down the dropped packets values .It will be as shown below.

| Sample Number | No. of voice applications | Scheduling type | Ping messages received | Total no. of dropped packets |
|---|---|---|---|---|
| 1 | 1 | FIFO | 359 | 0 |
| 2 | 1 | Priority | 0 | 0 |
| 3 | 2 | FIFO | 183 | 0 |
| 4 | 2 | Priority | 0 | 0 |
| 5 | 3 | FIFO | 123 | 0 |
| 6 | 3 | Priority | 0 | 0 |
| 7 | 4 | FIFO | 92 | 0 |
| 8 | 4 | Priority | 0 | 0 |
| 9 | 5 | FIFO | 74 | 1896 |
| 10 | 5 | Priority | 0 | 1879 |

## 28. Inference

From the table we can observe that number of ping messages received when scheduling type is Priority is less than number of ping messages received when scheduling type is FIFO. In NetSim, Voice messages have higher priority compared to ping messages. Hence when scheduling type is Priority, higher preference is given to voice messages. As a result, the number of ping messages received is lower when priority based scheduling is considered.

From the table we can observe that packets are dropped when there are five voice applications. The number of packets that arrive at the router increases when there are more number of voice applications. As a result the buffer gets filled. All the packets that arrive after the buffer is filled will be dropped.

# Experiment 6:
# Simulate an Ethernet LAN using n nodes (6-10), change error rate and data rate and compare throughput.

## Part A: To simulate an Ethernet LAN using n nodes (6-10), change error rate and compare throughput.

## Theory:

**Bit error rate (BER):**

The bit error rate or bit error ratio is the number of bit errors divided by the total number of transferred bits during a studied time interval i.e.

**BER=Bit errors/Total number of bits**

For example, a transmission might have a BER of $10^{-5}$, meaning that on average, 1 out of every of 100,000 bits transmitted exhibits an error. The BER is an indication of how often a packet or other data unit has to be retransmitted because of an error. Unlike many other forms of assessment, bit error rate, BER assesses the full end to end performance of a system including the transmitter, receiver and the medium between the two. In this way, bit error rate, BER enables the actual performance of a system in operation to be tested.

**Packet Error Rate (PER):**

The PER is the number of incorrectly received data packets divided by the total number of received packets. A packet is declared incorrect if at least one bit is erroneous.

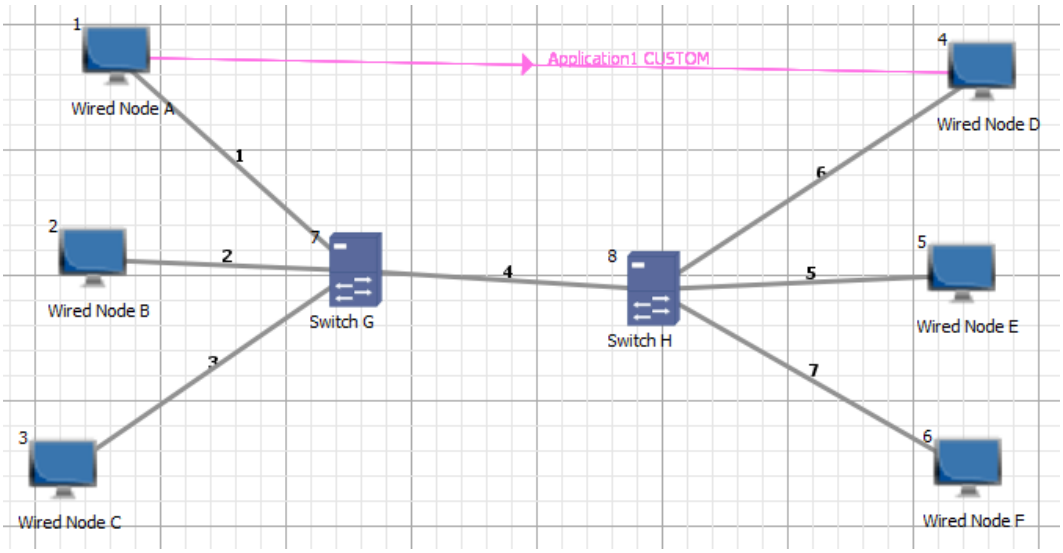
## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

# 1. Create /Design the Network

**Devices Required:** 2 Switches, 6 Wired Nodes

**Network Diagram:**



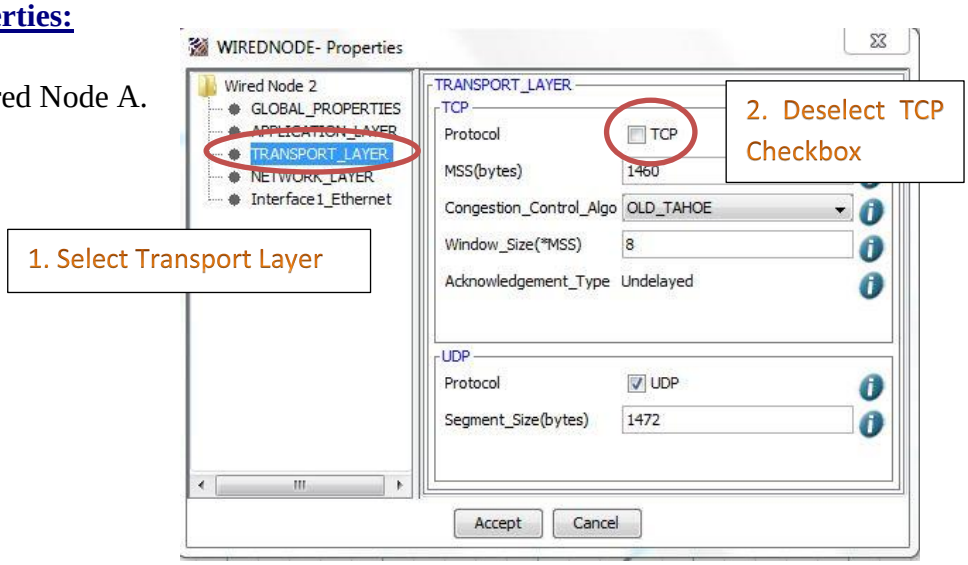

Note: While creating network, place the devices according to the Node ID given in diagram above in order to easily understand the settings to be configured as provided in this manual.

For example: Figure shows Wired Node A has Node ID 1 and Wired Node B has Node ID 2.So first place a Wired Node at the location of Wired Node A and then at Wired Node B and so on.

# 2. Configure the Network (Sample 1)

**Wired Node Properties:**

Disable TCP in Wired Node A.



**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 | Wired Link 3 | Wired Link 4 | Wired Link 5 | Wired Link 6 |
|---|---|---|---|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Uplink BER** | No Error | No Error | No Error | No Error | No Error | No Error |
| **Downlink BER** | No Error | No Error | No Error | No Error | No Error | No Error |

## 3. Model Traffic in the Network (Sample 1)

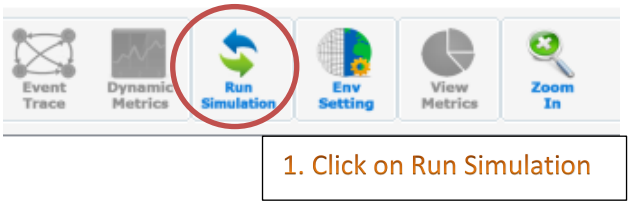
Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

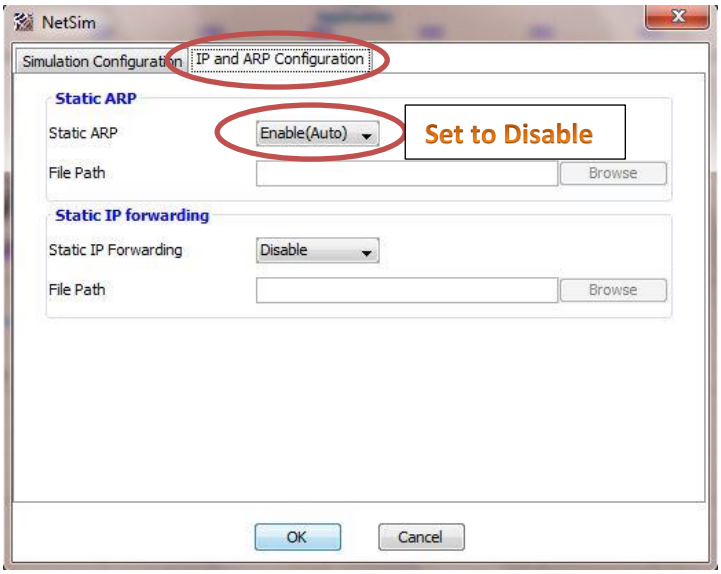
**Application Properties:**

| | |
|---|---|
| **Application Type** | Custom |
| **Source ID** | 1 (Wired Node A) |
| **Destination ID** | 4 (Wired Node D) |
| **Packet Size** | |
| **Distribution** | Constant |
| **Size (Bytes)** | 1460 |
| **Packet Inter Arrival Time** | |
| **Distribution** | Constant |
| **Inter Arrival Time** | 2500 |

## 4. Simulate(Sample 1)

Go to IP and ARP configuration and disable static ARP.






**Simulation Time - 100 Sec**

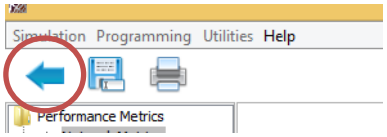
After completion of the experiment, "Save" the experiment for future analysis of results.

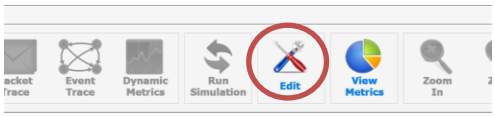
## 5. Configure the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below.

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the wired link properties as shown below.




**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 | Wired Link 3 | Wired Link 4 | Wired Link 5 | Wired Link 6 |
|---|---|---|---|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Uplink BER** | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ |
| **Downlink BER** | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ | $10^{-9}$ |

## 6. Simulate

Go to IP and ARP configuration and disable static ARP.

**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 7. Configure the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 | Wired Link 3 | Wired Link 4 | Wired Link 5 | Wired Link 6 |
|---|---|---|---|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Uplink BER** | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ |
| **Downlink BER** | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ | $10^{-8}$ |

## 8. Simulate

Go to IP and ARP configuration and disable static ARP.

**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 9. Configure the Network (Sample 4)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 | Wired Link 3 | Wired Link 4 | Wired Link 5 | Wired Link 6 |
|---|---|---|---|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Uplink BER** | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ |
| **Downlink BER** | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ | $10^{-7}$ |

## 10. Simulate

Go to IP and ARP configuration and disable static ARP.

**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

## 11. Configure the Network (Sample 5)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 2 | Wired Link 3 | Wired Link 4 | Wired Link 5 | Wired Link 6 |
|---|---|---|---|---|---|---|
| **Uplink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Downlink Speed (Mbps)** | 10 | 10 | 10 | 10 | 10 | 10 |
| **Uplink BER** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |
| **Downlink BER** | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ | $10^{-6}$ |

## 12. Simulate

Go to IP and ARP configuration and disable static ARP.

**Simulation Time - 100 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

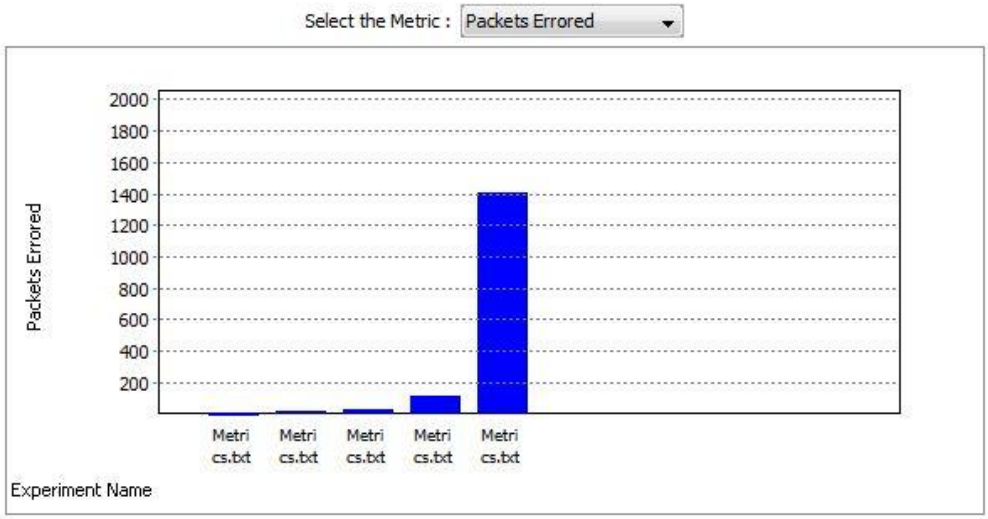
## 13. Analysis of Result

Go to NetSim Analytics(Simulation → Analytics).

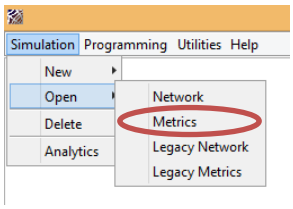
1. Click **Browse** button → select the **Metrics.txt File** inside the first saved experiment folder
2. Add the remaining 5 sample experiments by repeating the above step.
3. **Select the Metrics** - **Select** the coordinates for **Y-axis** by clicking on the dropdown menu. User should select "**Packets Errored**".

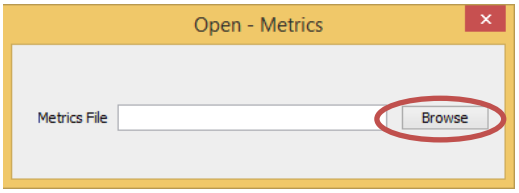
## Comparison Chart:

**Graph I:** Error Rate Vs Packets Errored

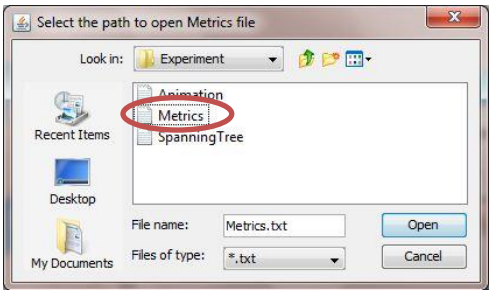



Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.



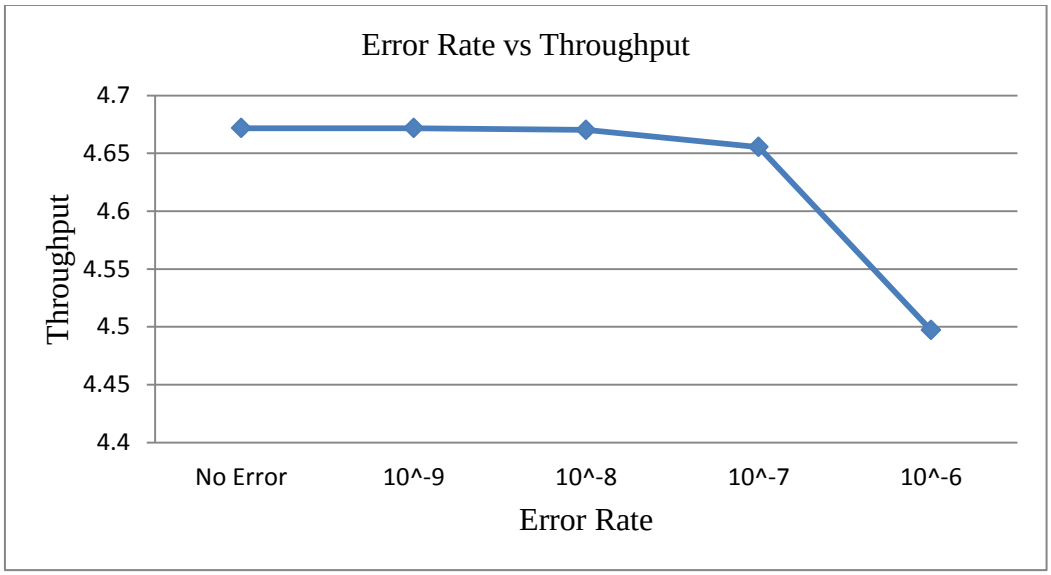




Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open




Open the Metrics.txt file of the first saved sample and note down the "**Throughput"** value available under "**Application Metrics"** in an Excel file. Similarly please follow the same steps for all the saved samples and note down the throughput values and create graph in Excel as shown below.

**Graph II:** Error Rate Vs Throughput




**NOTE:** The procedure to create graph is same as provided in Experiment 2.

# Part B: To simulate an Ethernet LAN using n nodes (6-10), change data rate and compare throughput.

## Theory:

**Data Rate:**

Data Rate is the speed at which data can be transmitted from one device to another. It is often measured in megabits (million bits) per second.

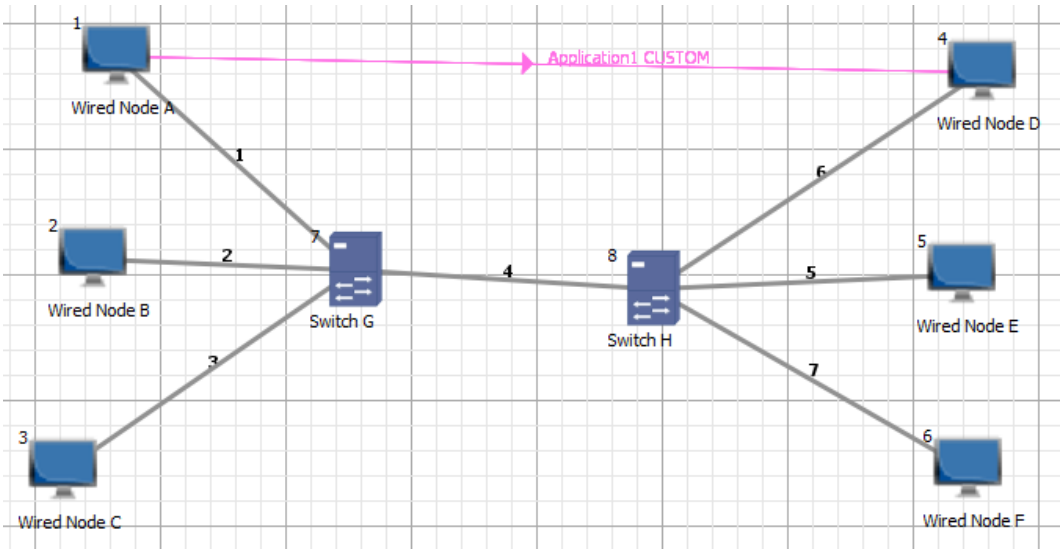
## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

### 1. Create /Design the Network

**Devices Required:** 2 Switches, 6 Wired Nodes

## Network Diagram:



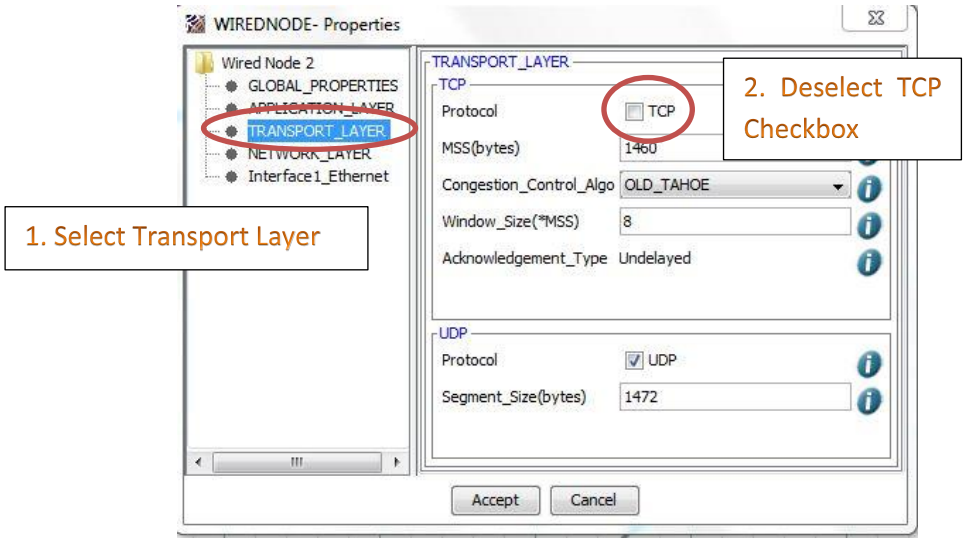

Note: While creating network, place the devices according to the Node ID given in diagram above in order to easily understand the settings to be configured as provided in this manual.

For example: Figure shows Wired Node A has Node ID 1 and Wired Node B has Node ID 2.So first place a Wired Node at the location of Wired Node A and then at Wired Node B and so on.

# 2. Configure the Network (Sample 1)

## Wired Node Properties:

Disable TCP in Wired Node A.



**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 4 | Wired Link 6 |
|---|---|---|---|
| **Uplink Speed (Mbps)** | 20 | 20 | 20 |
| **Downlink Speed (Mbps)** | 20 | 20 | 20 |
| **Uplink BER** | No Error | No Error | No Error |
| **Downlink BER** | No Error | No Error | No Error |

## 3. Model Traffic in the Network (Sample 1)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.

**Application Properties:**

| | |
|---|---|
| **Application Type** | Custom |
| **Source ID** | 1 (Wired Node A) |
| **Destination ID** | 4 (Wired Node D) |
| **Packet Size** | |
| **Distribution** | Constant |
| **Size (Bytes)** | 10000 |
| **Packet Inter Arrival Time** | |
| **Distribution** | Constant |
| **Inter Arrival Time** | 1000 |

## 4. Simulate

### Simulation Time - 10 Sec

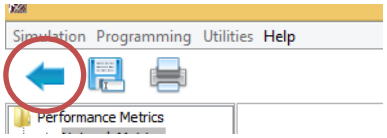
After completion of the experiment, “Save” the experiment for future analysis of results.

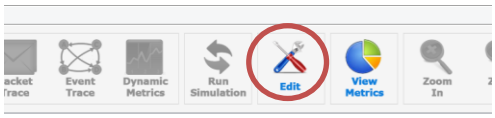
## 5. Configure the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the wired link properties as shown below.




**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 4 | Wired Link 6 |
|---|---|---|---|
| **Uplink Speed (Mbps)** | 40 | 40 | 40 |
| **Downlink Speed (Mbps)** | 40 | 40 | 40 |
| **Uplink BER** | No Error | No Error | No Error |
| **Downlink BER** | No Error | No Error | No Error |

## 6. Simulate

### Simulation Time – 10 Sec

After completion of the experiment, "Save" the experiment for future analysis of results.

## 7. Configure the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 4 | Wired Link 6 |
|---|---|---|---|
| **Uplink Speed (Mbps)** | 60 | 60 | 60 |
| **Downlink Speed (Mbps)** | 60 | 60 | 60 |
| **Uplink BER** | No Error | No Error | No Error |
| **Downlink BER** | No Error | No Error | No Error |

## 8. Simulate

### Simulation Time - 10 Sec

After completion of the experiment, "Save" the experiment for future analysis of results.

## 9. Configure the Network (Sample 4)

Follow all the steps as shown in Sample 1 and modify only the Wired Link properties as shown below

**Wired Link Properties:** Right click on **Wired Link** → Properties and set the values.

| Link Properties | Wired Link 1 | Wired Link 4 | Wired Link 6 |
|---|---|---|---|
| **Uplink Speed (Mbps)** | 80 | 80 | 80 |
| **Downlink Speed (Mbps)** | 80 | 80 | 80 |
| **Uplink BER** | No Error | No Error | No Error |
| **Downlink BER** | No Error | No Error | No Error |

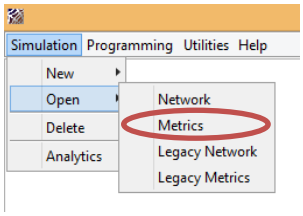
## 10. Simulate

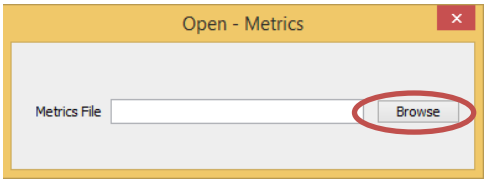
### Simulation Time - 10 Sec

After completion of the experiment, "Save" the experiment for future analysis of results.

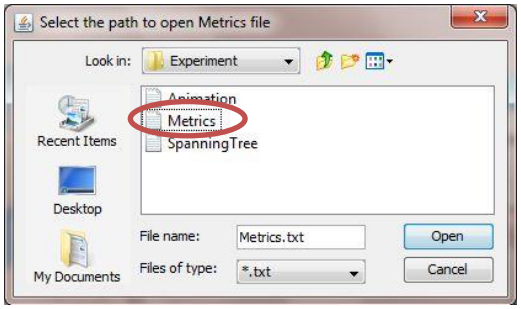
## 11. Analysis of Result

Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.



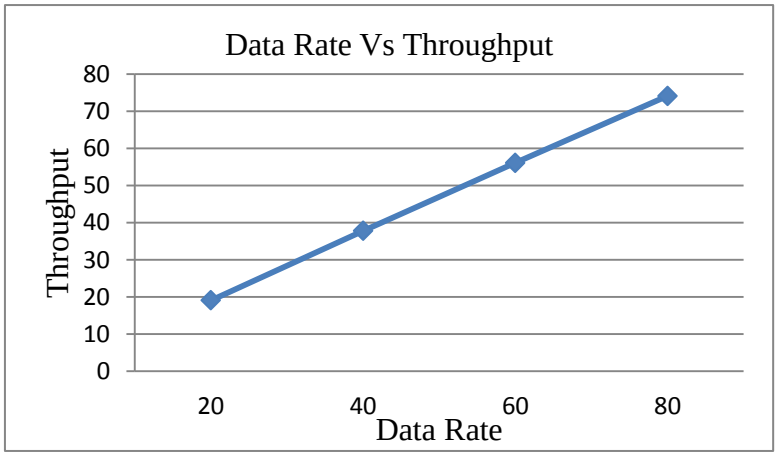

Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open



Open the Metrics.txt file of the first sample and note down the "**Throughput"** value available under "**Application Metrics"** in an Excel file. Similarly please follow the same steps for all the saved samples, note down the throughput values and create Graph in Excel as shown below.

**Graph I**

**Data Rate Vs Throughput**




**NOTE:** The procedure to create graph is same as provided in Experiment 2.

## 12. Inference

The number of packets transmitted to the destination is based on the network link's speed. So when link is forwarding more packets, the number of packets transmitted to the destination is more. Because of this throughput linearly increases when data rate (link speed) increases in Graph I.

# Experiment 7:
# To Simulate an Ethernet LAN using n nodes and set multiple traffic nodes and determine collision across different nodes.

## Theory:

**Carrier Sense Multiple Access Collision Detection (CSMA / CD)**

This protocol includes the improvements for stations to abort their transmissions as soon as they detect a collision. Quickly terminating damaged frames saves time and bandwidth. This protocol is widely used on LANs in the MAC sub layer. If two or more stations decide to transmit simultaneously, there will be a collision. Collisions can be detected by looking at the power or pulse width of the received signal and comparing it to the transmitted signal. After a station detects a collision, it aborts its transmission, waits a random period of time and then tries again, assuming that no other station has started transmitting in the meantime.

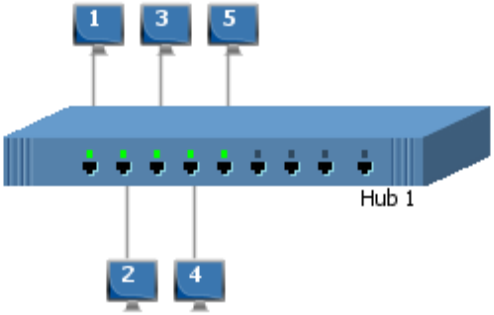
## Procedure:

In NetSim, Select "Simulation → New → Legacy Networks → Traditional Ethernet".

### 1. Create /Design the Network

**Devices Required:** 1 Hub, 5 Wired Nodes

**Network Diagram:**




Note: While creating network, first place the Hub. Then select Wired Node and click on Hub. Automatically Wired Nodes will be placed and linked with Hub.

## 2. Configure the Network

Right click on each **Wired Node** → Properties and set the values.

| Wired Node Properties | NODE 1 | NODE 2 | NODE 3 | NODE 4 | NODE 5 |
|---|---|---|---|---|---|
| **Transmission** | Point to Point | Point to Point | Point to Point | Point to Point | Point to Point |
| **Destination** | Node 2 | Node 3 | Node 4 | Node 5 | Node 1 |
| **Traffic Type** | Data | Data | Data | Data | Data |
| **Application Data Size** | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant |
| **Application Data Size (Bytes)** | 1472 | 1472 | 1472 | 1472 | 1472 |
| **Inter Arrival Time** | | | | | |
| **Distribution** | Constant | Constant | Constant | Constant | Constant |
| **Inter Arrival Time(µs)** | 1000 | 1000 | 1000 | 1000 | 1000 |

**Hub Properties:** Right click on **Hub** → Properties and set the values

| Hub Properties | Values to be Selected |
|---|---|
| **Data Rate(Mbps)** | 10 |
| **Error Rate (bit error rate)** | No error |
| **Physical Medium** | Twisted Pair |

## 3. Simulate

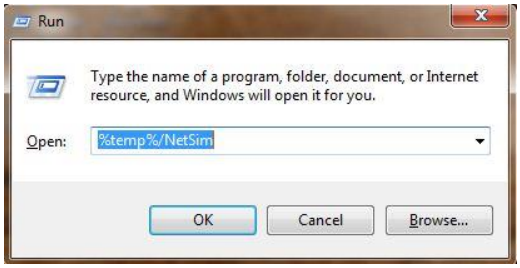

**Simulation Time - 10 Sec**

After completion of the experiment, "Save" the experiment for future analysis of results.

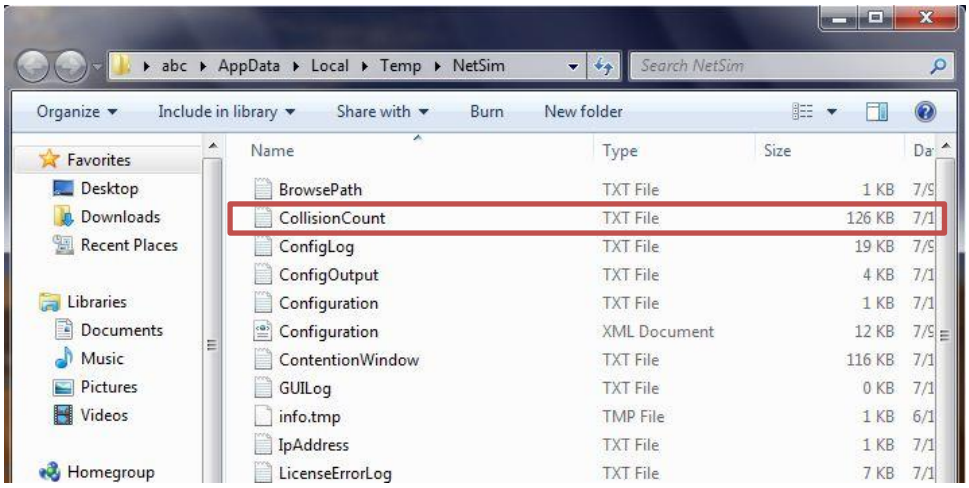
## 4. Analysis of Result

**Collision Determination:**

- Once the simulation is completed "**CollisionCount.txt**" file will be written in the temp path of the operating system. To reach the temp folder Click Start → Run and then type %temp%/NetSim

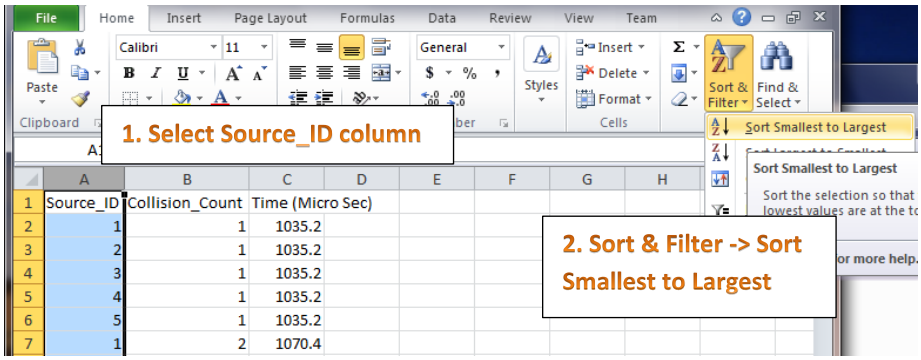


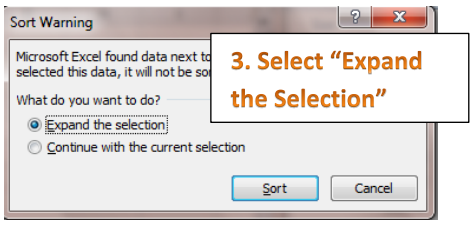

- Open the file in Excel

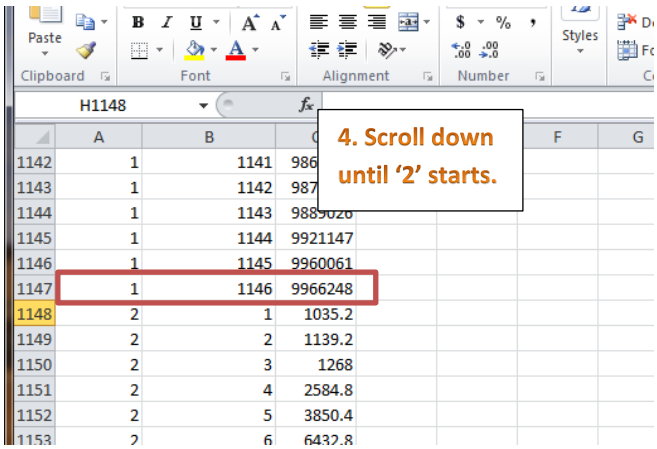



## Comparison Table:

If collision occurs, the entry will be added in the table by incrementing the "**Collision _Count**" field value by 1. So the last entry of the particular "**Source_ID**" will consist of "**Total Collision_Count**".






Likewise note down the **Collision_Count** for all the Sources as shown below.

| Source_ID | Collision_Count |
|---|---|
| 1 | 1146 |
| 2 | 1175 |
| 3 | 1188 |
| 4 | 1179 |
| 5 | 1184 |

## 5. Inference

As expected we see a large number of collisions in each node. Further, we notice that the number of collided packets in each node is approximately the same showing the inherent "fairness" of CSMA / CD.

Performance studies indicate that CSMA/CD performs better at light network loads. With the increase in the number of stations sending data, it is expected that heavier traffic have to be carried on CSMA/CD LANs (IEEE 802.3). Different studies have shown that CSMA/CD performance tends to degrade rapidly as the load exceeds about 40% of the bus capacity. Above this load value, the number of packet collision raise rapidly due to the interaction among repeated transmissions and new packet arrivals. Collided packets will back off based on the truncated binary back off algorithm as defined in IEEE 802.3 standards. These retransmitted packets also collided with the newly arriving packets.

# Experiment 8:
# To Simulate an Ethernet LAN using n nodes and set multiple traffic nodes and plot contention window for different source/destination.

## Theory:

**Carrier Sense Multiple Access Collision Detection (CSMA/CD) - Working of the truncated binary back off algorithm**

In Ethernet networks, the CSMA/CD is commonly used to schedule retransmissions after collisions. The retransmission is delayed by an amount of time derived from the slot time and the number of attempts to retransmit.

After *c* collisions, a random number of slot times between 0 and $2^c$ - 1 is chosen. For the first collision, each sender will wait 0 or 1 slot times. After the second collision, the senders will wait anywhere from 0 to 3 slot times (inclusive). After the third collision, the senders will wait anywhere from 0 to 7 slot times (inclusive), and so forth. As the number of retransmission attempts increases, the number of possibilities for delay increases exponentially.

The 'truncated' simply means that after a certain number of increases, the exponentiation stops; i.e. the retransmission timeout reaches a ceiling, and thereafter does not increase any further. For example, if the ceiling is set at $i = 10$ (as it is in the IEEE 802.3 CSMA/CD standard), then the maximum delay is 1023 slot times.

Because these delays cause other stations that are sending to collide as well, there is a possibility that, on a busy network, hundreds of people may be caught in a single collision set. Because of this possibility, after 16 attempts at transmission, the process is aborted.

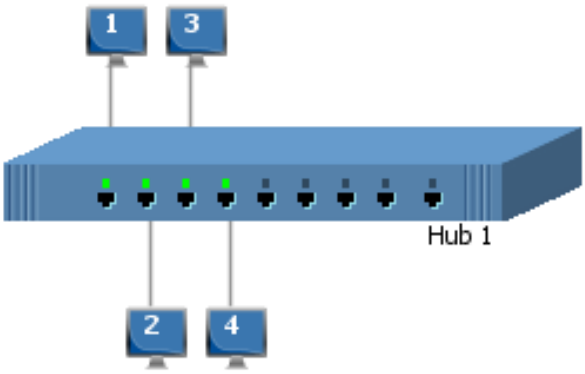
## Procedure:

In NetSim, Select “Simulation → New → Legacy Networks → Traditional Ethernet”.

## 1. Create /Design the Network

**Devices Required:** 1 Hub, 4 Wired Nodes

**Network Diagram:**




Note: While creating network, first place the Hub. Then select Wired Node and click on Hub. Automatically Wired Nodes will be placed and linked with Hub.

## 2. Configure the Network

Right click on Wired Node or Hub and select **Properties** to open the property window.

**Wired Node Properties:**

| Wired Node Properties | NODE 1 | NODE 4 |
|---|---|---|
| **Transmission Type** | Point to Point | Point to Point |
| **Destination** | Node 2 | Node 1 |
| **Traffic Type** | Data | Data |
| **Application Data Size** | | |
| **Distribution** | Constant | Constant |
| **Application Data Size (Bytes)** | 1472 | 1472 |
| **Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Inter Arrival Time(µs)** | 2000 | 2000 |

**Hub Properties:**

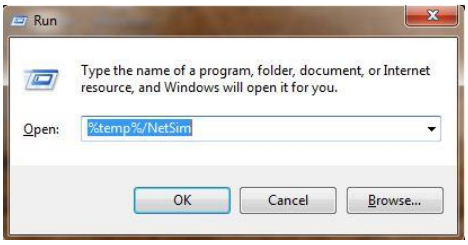
| Hub Properties | Values to be Selected |
|---|---|
| **Data Rate(Mbps)** | 10 |
| **Error Rate (bit error rate)** | No error |
| **Physical Medium** | Twisted Pair |

## 3. Simulate

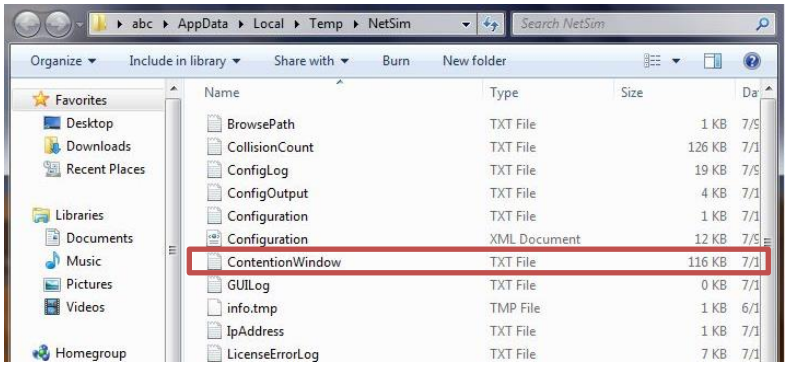
**Simulation Time - 10 Sec**


## 4. Analysis of Result

- Once the simulation is completed "**ContentionWindow.txt**" file will be written in the temp path of the operating system. To reach the temp folder, Click Start → Run or press (Windows Key) + R and then type "%temp%/NetSim".



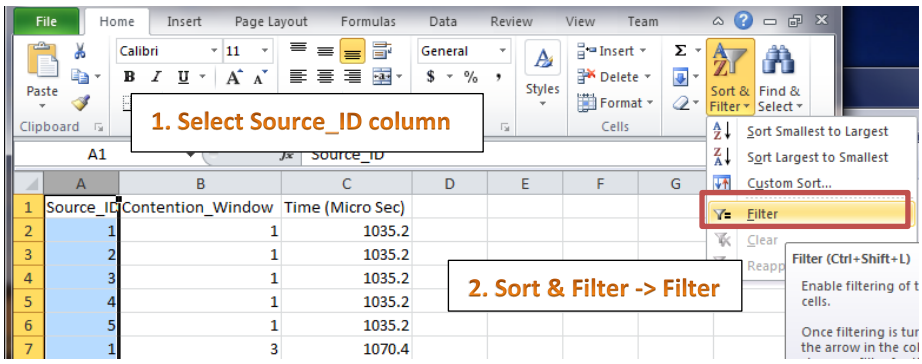

- Open the file in Excel.

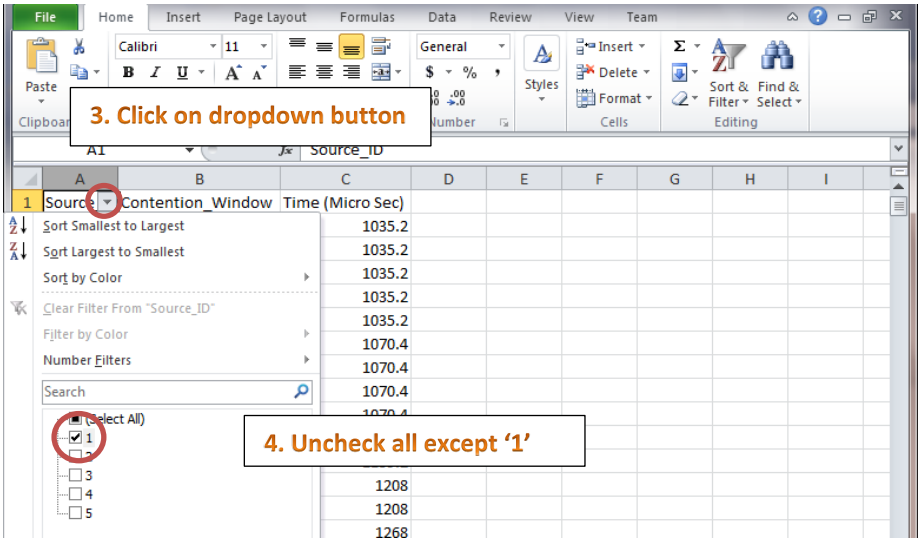



**Comparison Chart:**

**Graph I**

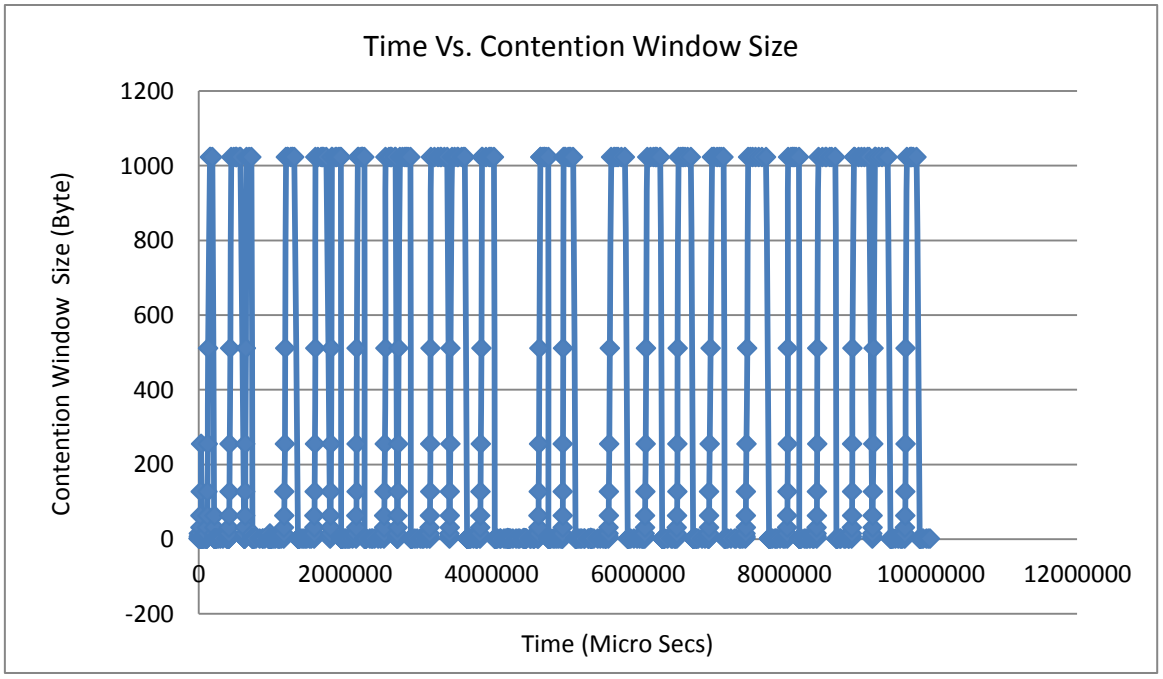
**(Note:** These charts are plotted only for **Source_ID 1.** The procedure is as follows)






## Time vs. Contention Window Size Graph

(**Note**: This graph is plotted for all rows of ContentionWindow.txt file after filtering, X-Axis is Contention_Window column and Y-Axis is Time(Micro Sec) column.)

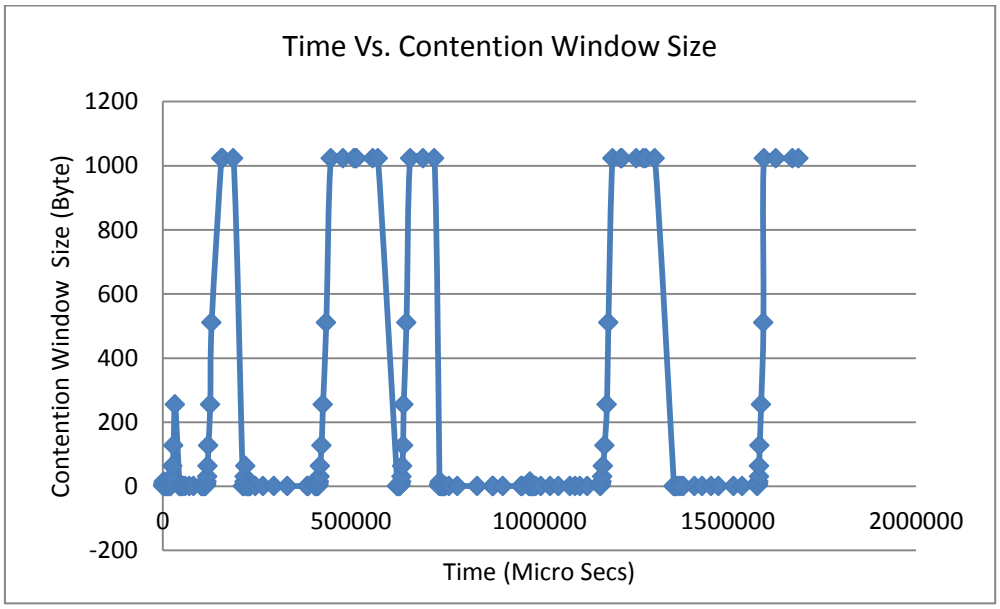



**NOTE:** The procedure to create graph is same as provided in Experiment 2.

**Graph II**

(**Note**: This graph is plotted for the first 200 rows of ContentionWindow.txt file, X-Axis is Contention_Window column and Y-Axis is Time(Micro Sec) column.)

Time vs. Contention Window Size Graph




**NOTE:** The procedure to create graph is same as provided in Experiment 2.

## 5. Inference

As explained above in the theory part, whenever a collision occurs the contention window size is calculated and a random number is generated. With more number of transmitting nodes, the contention for the medium increases, causing more collisions and more retransmission attempts. Hence the average contention window increases.

From the above graph it can be observed that, for each collision the contention window size increases, and at any time the maximum contention window size is 1023 ($2^{10}$-1). The maximum retry limit for a packet is 16, after which the packet is dropped.

# Experiment 9:
# To simulate simple ESS and with transmitting nodes in wireless LAN by simulation and determine the performance with respect to transmission of packets.

## Theory:

Wireless LAN is basically a LAN that transmits data over air, without any physical connection between devices. The transmission medium is a form of electromagnetic radiation. Wireless LAN is ratified by IEEE in the IEEE 802.11 standard. In most of the WLAN products on the market based on the IEEE 802.11b technology the transmitter is designed as a Direct Sequence Spread Spectrum Phase Shift Keying (DSSS PSK) modulator, which is capable of handling data rates of up to 11 Mbps. The underlying algorithm used in Wireless LAN is known as the CSMA/CA – Carrier Sense Multiple Access/Collision Avoidance algorithm.

## Procedure:

In NetSim, Select "Simulation → New → Internetworks".

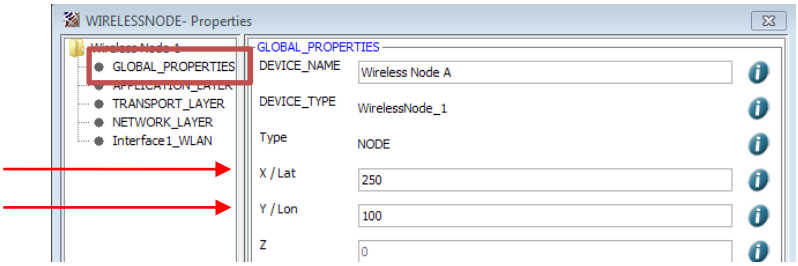
### 1. Create /Design the Network

**Devices Required:** 1 Switch, 2 Access Point, 6 Wireless Nodes.

**Device Placement:**

**NOTE:** To edit the position, change the (x, y) co-ordinates in Global Properties as shown:

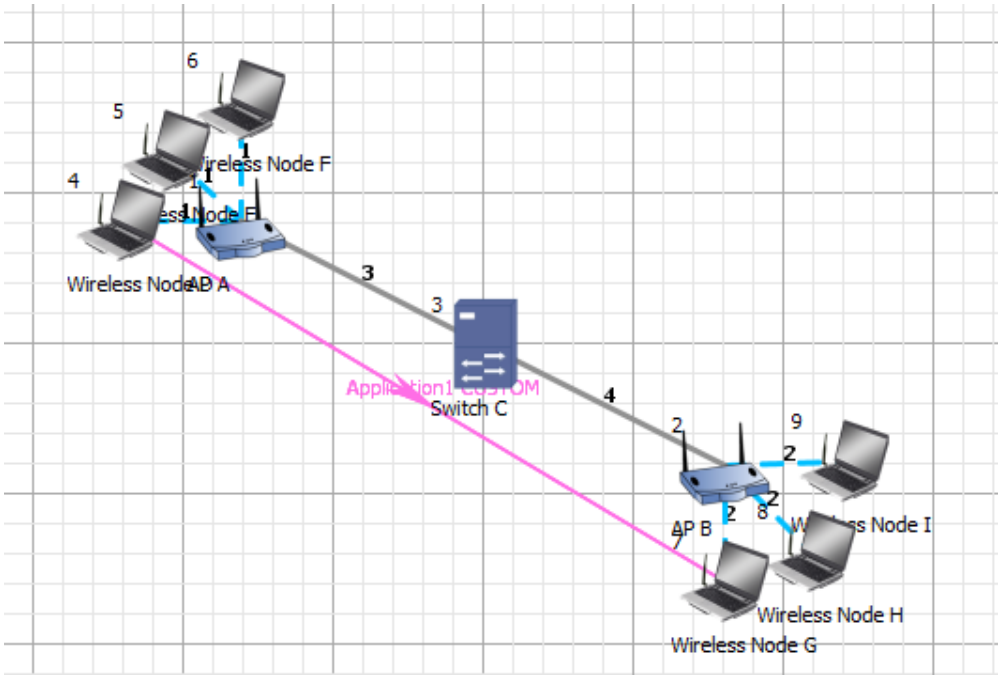
To change Co-ordinates, click & edit



Set the exact x and y co-ordinates for respective device in device property which is mentioned in the above table to get the same result as obtained in this manual.

| Device Name | X /Lat | Y /Lon |
|---|---|---|
| **Access Point A** | 170 | 110 |
| **Access Point B** | 331 | 191 |
| **Switch C** | 251 | 151 |
| **Wireless Node D** | 130 | 110 |
| **Wireless Node E** | 145 | 87 |
| **Wireless Node F** | 170 | 70 |
| **Wireless Node G** | 331 | 230 |
| **Wireless Node H** | 360 | 220 |
| **Wireless Node I** | 371 | 190 |

## Network Diagram:

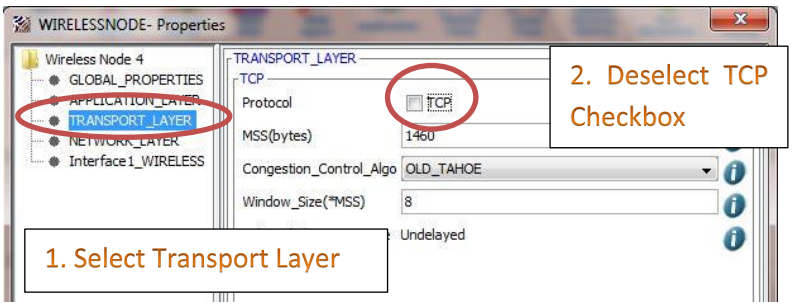



# 2. Configure the Network (Sample 1)

## Wired Node Properties:

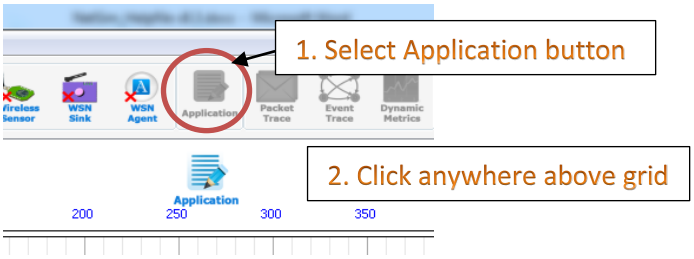
Disable TCP in Wireless Node D.

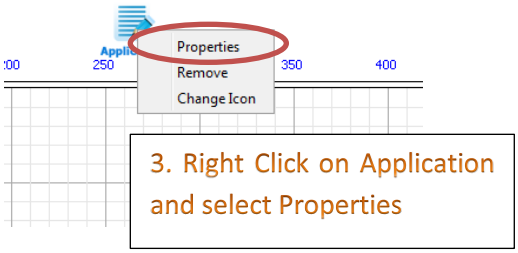
Right Click **Wireless Node D** →Properties




## 3. Model Traffic in the Network (Sample 1)

Select the Application Button and click on the gap between the Grid Environment and the ribbon. Now right click on Application and select Properties.



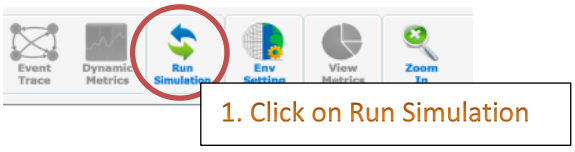

### Application Properties:

| | |
|---|---|
| **Application Type** | Custom |
| **Source ID** | 4(Wireless Node D) |
| **Destination ID** | 7(Wireless Node G) |
| **Packet Size** | |
| **Distribution** | Constant |
| **Value(Bytes)** | 1460 |
| **Inter Arrival Time** | |
| **Distribution** | Constant |
| **Value(µs)** | 2336 |

## 4. Simulate(Sample 1)

### Simulation Time - 10 Sec

After completion of the experiment, "Save" the experiment for future analysis of results.

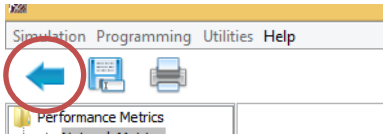


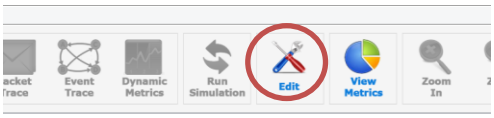
## 5. Configure the Network (Sample 2)

Follow all the steps as shown in Sample 1 and modify only the Wired Node properties and Application properties as shown below

OR

User can also select the "**Go back to Network**" option, select the **Edit** button and modify only the Wired Node properties and Application properties as shown below.




### Wired Node Properties:

Disable TCP in Wireless Node D and Wireless Node E.

All the remaining properties of the remaining devices and links are same.

## 6. Model Traffic in the Network (Sample 2)

### Application Properties:

| | | |
|---|---|---|
| **Application Type** | Custom | Custom |
| **Source ID** | 4(Wireless Node D) | 5(Wireless Node E) |
| **Destination ID** | 7(Wireless Node G) | 8(Wireless Node H) |
| **Packet Size** | | |
| **Distribution** | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 |
| **Inter Arrival Time** | | |
| **Distribution** | Constant | Constant |
| **Value(µs)** | 2336 | 2336 |

## 7. Simulate(Sample 2)

### Simulation Time - 10 Sec

After completion of the simulation, "Save" the experiment for future analysis of results.

## 8. Configure the Network (Sample 3)

Follow all the steps as shown in Sample 1 and modify only the Wired Node properties and Application properties as shown below

### Wired Node Properties:

Disable TCP in Wireless Node D, Wireless Node E and Wireless Node F.

All the remaining properties of the remaining devices and links are same.

## 9. Model Traffic in the Network (Sample 3)

### Application Properties:

| | | | |
|---|---|---|---|
| **Application Type** | Custom | Custom | Custom |
| **Source ID** | 4(Wireless Node D) | 5(Wireless Node E) | 6(Wireless Node F) |
| **Destination ID** | 7(Wireless Node G) | 8(Wireless Node H) | 9(Wireless Node I) |
| **Packet Size** | | | |
| **Distribution** | Constant | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 | 1460 |
| **Inter Arrival Time** | | | |
| **Distribution** | Constant | Constant | Constant |
| **Value(µs)** | 2336 | 2336 | 2336 |

## 10. Simulate(Sample 3)

**Simulation Time - 10 Sec**

After completion of the simulation, “Save” the experiment for future analysis of results.

## 11. Configure the Network (Sample 4)

Follow all the steps as shown in Sample 1 and modify only the Wired Node properties and Application properties as shown below

### Wired Node Properties:

Disable TCP in Wireless Node D, Wireless Node E, Wireless Node F and Wireless Node G.

All the remaining properties of the remaining devices and links are same.

## 12. Model Traffic in the Network (Sample 4)

### Application Properties:

| **Application Type** | Custom | Custom | Custom | Custom |
|---|---|---|---|---|
| **Source ID** | 4(Wireless Node D) | 5(Wireless Node E) | 6(Wireless Node F) | 7(Wireless Node G) |
| **Destination ID** | 7(Wireless Node G) | 8(Wireless Node H) | 9(Wireless Node I) | 6(Wireless Node F) |
| **Packet Size** | | | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Value(Bytes)** | 1460 | 1460 | 1460 | 1460 |
| **Inter Arrival Time** | | | | |
| **Distribution** | Constant | Constant | Constant | Constant |
| **Value(µs)** | 2336 | 2336 | 2336 | 2336 |

## 13. Simulate(Sample 4)

### Simulation Time - 10 Sec

After completion of the simulation, "Save" the experiment for future analysis of results.

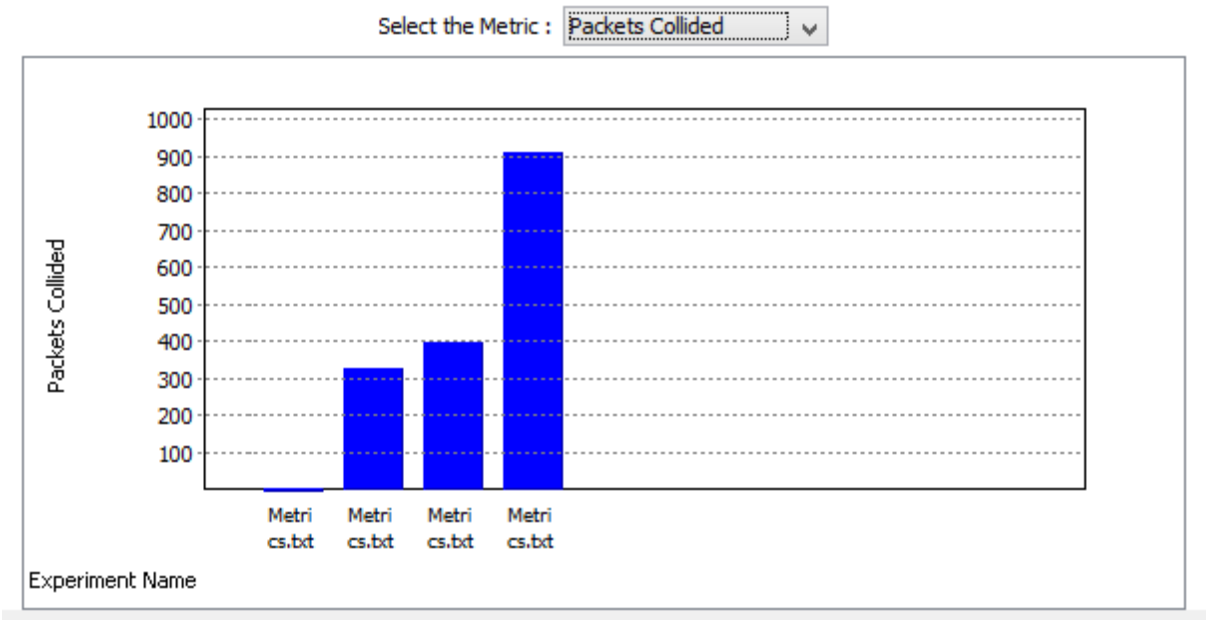
## 14. Analysis of Result

Go to NetSim Analytics (Simulation → Analytics).

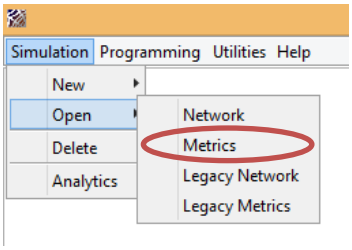
1. Click **Browse** button → select the **Metrics.txt File** inside the first saved experiment folder
2. Add the remaining 5 sample experiments by repeating the above step.
3. **Select the Metrics - Select** the coordinates for **Y-axis** by clicking on the dropdown menu. User should select "**Packets Collided**".

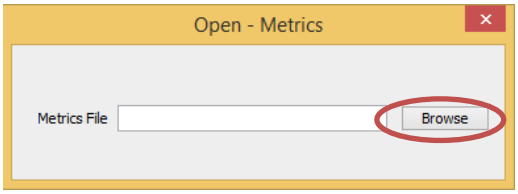
## Comparison Chart:

**Graph I:** Number of nodes generating traffic vs. Packets collided

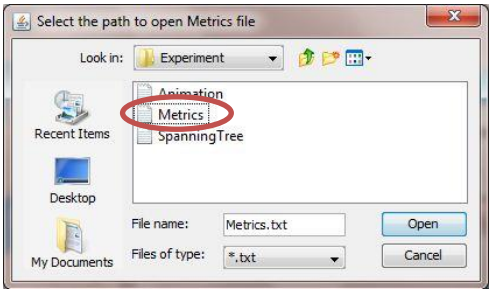



Go to **Simulation → Open → Metrics** menu to open the results of saved experiments.



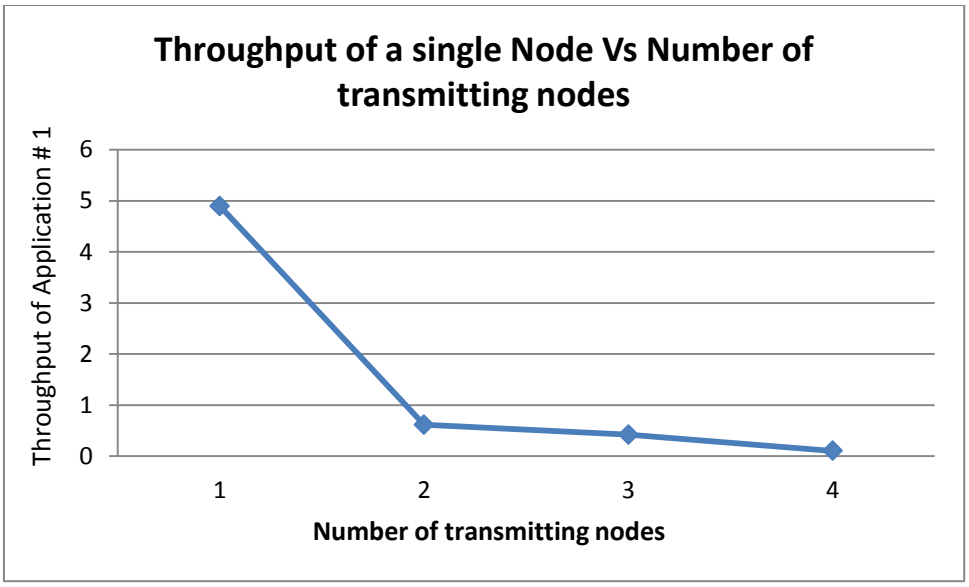




Click on Browse and select the Metrics.txt file (present with the saved experiment) you want to open




Open the Metrics.txt file of the first sample and note down the "**Throughput"** value available under "**Application Metrics"** in an Excel file. Similarly please follow the same steps for all the saved samples, note down the throughput values and create graph in Excel as shown below.

**Graph II:** Throughput of the first application vs. Number of transmitting nodes




**NOTE:** The procedure to create graph is same as provided in Experiment 2.

## 15. Inference

If the number of nodes generating data increases then the number of packets collided in the network also increases. Hence there is a gradual increase in number of packets collided when the transmitting nodes increases in Graph I. If more than one node is accessing the medium at the same time, the particular node has to wait until the completion of packet transmission in the medium. Hence Node #1's throughput decreases when number of transmitting nodes increases in Graph II.

# Experiment 10: Cyclic Redundancy Check
# Write a program for error detecting code using CRC-CCITT (16- bits). (Note: CRC 12, CRC 16 and CRC 32 are also available in NetSim)

## Theory:

Cyclic redundancy check (CRC) is a type of function that takes a data stream of any length as input, and produces an output. Bit strings are treated as representation of polynomials with coefficients of '0' and '1'.

The Sender and Receiver must agree upon the Generator Polynomial in advance. Both the high and low order of the generator must be '1'. The size of data must be greater than the size of the Generator polynomial to compute the checksum.

The computed checksum is appended to the transmitting frame. If the receiver gets the frame it tries dividing it by Generator polynomial, if there is a reminder there has been a transmission error, else no error.

The Generator polynomial for CRC CCITT is given below,

$x^{16}+x^{12}+x^5+1$

The Binary equivalent of CRC - CCITT is 10001000000100001

## Algorithm:

### No Error Case

#### Sender side

- Get the input from "**Input.txt**". Parse the file content.

- Call the In-built function readFile (szfilename). It returns the stored value to the local variable ‘szcrc’.
- Convert the data string (szcrc) that has to be transmitted into a binary representation.

    1. Get ASCII value of the first character.
    2. Divide the ASCII value by 2 and append the remainder to a string. The quotient is taken as the next number for the division.
    3. Repeat the above division until the quotient of the number is less than 2.
    4. Finally a remainder string having 1’s and 0’s is obtained. This reminder is the binary representation of that character.
    5. Continue the above process for all the characters in the data string (szcrc).

- Append 16 ‘0’s to the final binary string formed by the above step.
- Divide the binary converted data string using the Generator Polynomial (as given above in Concept).

    1. Take the MSB 17 bits from the binary data string,
    2. If the leading bit of the binary data string is ‘0’, do an XOR operation with the 17 bits of ‘0’s and get the remainder which is also 17 bits.
    3. Else, if the leading bit of the binary data string is ‘1’, do an XOR operation with the 17 bits with binary converted CRC - CCITT polynomial and get the remainder which is also 17 bits.
    4. The first bit of the remainder is left out and the remainder is made to 16 bits.
    5. If there are successive bits in the data, make the previous remainder bit to 17 bits by bringing down the next bit into the data

- Convert the final remainder into HEXA equivalent character.

    1. Divide the final remainder at the end of step 5.4 into blocks of 4 bits.
    2. Convert each block into equivalent HEXA character.
    3. Thus the output of this whole process will be a 4 - nibble checksum that is attached to the transmitting frame.

**Receiver side CRC Coding**

- Repeat the Steps 1 to 4 of the **Sender side CRC coding** and get the ‘szcrc ’ value for the data.
- Convert the HEXA equivalent string ‘szSender’ to its binary format. This is the Hexadecimal to binary conversion process.
- Append the binary format of the above step to the ‘szcrc ’ variable. Then append 16 ‘0s’ to the ‘szcrc ’ variable.
- Repeat the Steps 5 and 6 of the **Sender Side CRC coding** to calculate the CRC value for the receiver side. The output is stored in the variable ‘szReceive’ (array of characters with size 10).

## Error Case

**Sender side**

- Get the input from "**Input.txt"**. Parse the file content.
- Call the In-built function readFile (szfilename). It returns the stored value to the local variable ‘szcrc ’.
- Convert the data string (szcrc ) to be transmitted into binary representation.

    1. Get ASCII value of the first character.
    2. Divide the ASCII value by 2 and append the remainder to a string. The quotient is taken as the next number for the division.
    3. Repeat the above division until the quotient of the number is less than 2.
    4. Finally we get the remainder string having 1’s and 0’s, which is the binary representation of that character.
    5. Continue above process for all the characters in the data string (szcrc ).

- Append 16 ‘0’s to the final binary string formed by the above step.
- Divide the binary converted data string using the Generator Polynomial (as given above in Concept).

    1. Take the MSB 17 bits from the binary data string,

2. If the leading bit of the binary data string is ‘0’, do an XOR operation with the 17 bits of ‘0’s and get the remainder which is also 17 bits.
3. Else if the leading bit of the binary data string is ‘1’, do an XOR operation with the 17 bits with binary converted CRC - CCITT polynomial and get the remainder which is also 17 bits.
4. The first bit of the remainder is left out and the remainder is made to 16 bits.
5. If there are successive bits in the data, make the previous remainder bit to 17 bits by bringing down the next bit in the data

- Convert the final remainder into HEXA equivalent character.

1. Divide the final remainder at the end of step 5.4 into blocks of 4 bits.
2. Convert each block into equivalent HEXA character.
3. Thus the output of this whole process will be a 4-nibble checksum that is attached to the transmitting frame.

**Receiver side**

- Repeat the Steps 1 to 4 of the **Sender side CRC coding** and get the ‘szcrc ’ value for the data.
- Make some errors in the string ‘szcrc ’ by changing certain characters. The error string is stored in the variable ‘szcrc ’.
- Write the Error string ‘szcrc ’ into the file ‘Input.txt’. The file path for the file ‘Input.txt" is the path where you have installed the NetSim application. (Compulsory).
- Convert the HEXA equivalent string ‘szSender’ to its binary format. This is the Hexadecimal to binary conversion process.
- Append the binary format of the above step to the ‘szcrc ’ variable. Then append 16 ‘0s’ to the ‘szcrc ’ variable.
- Repeat the Steps 5 and 6 of the Sender Side CRC coding to calculate the CRC value for the receiver side.

# Procedure:

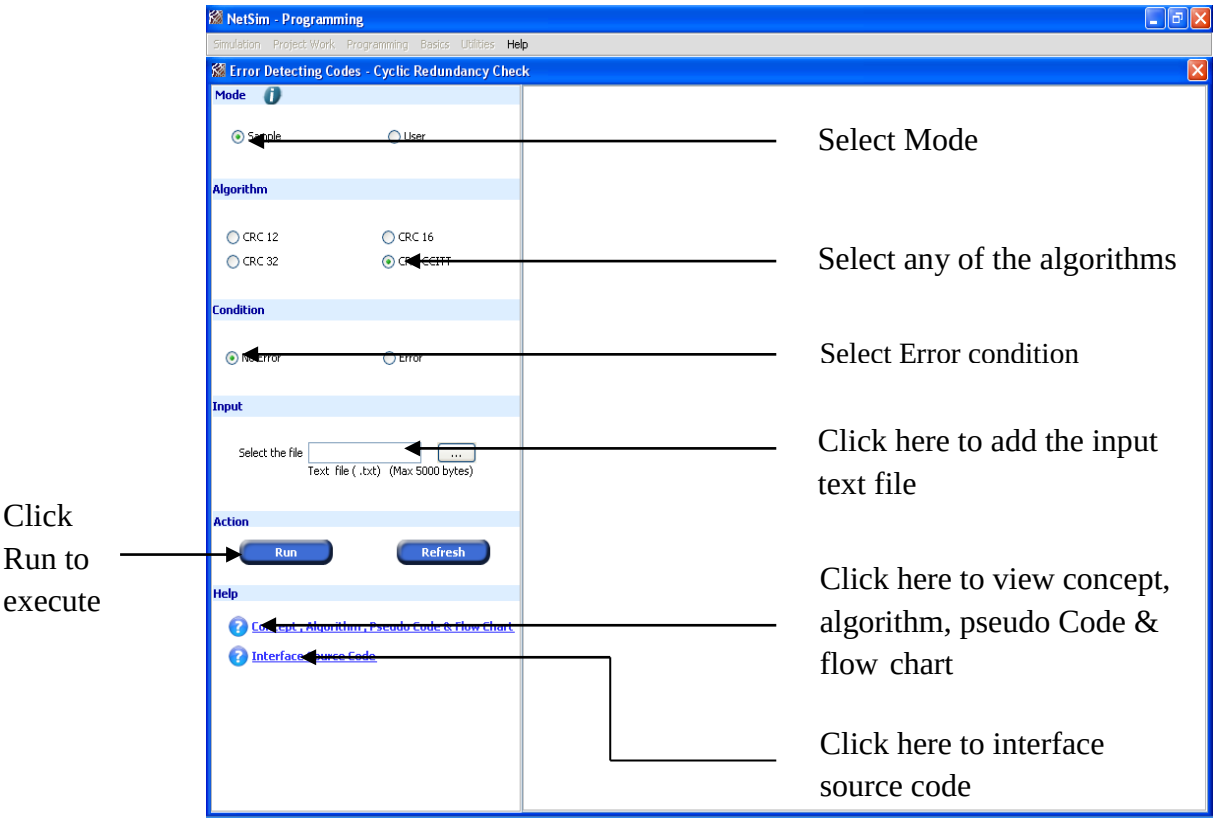
To begin with the experiment, open NetSim.Click on *Programming* in the menu bar, select *Error Detecting Codes* and then select *Cyclic Redundancy Check.*

The scenario will be obtained as shown below. Follow the steps.

**Step 1:**

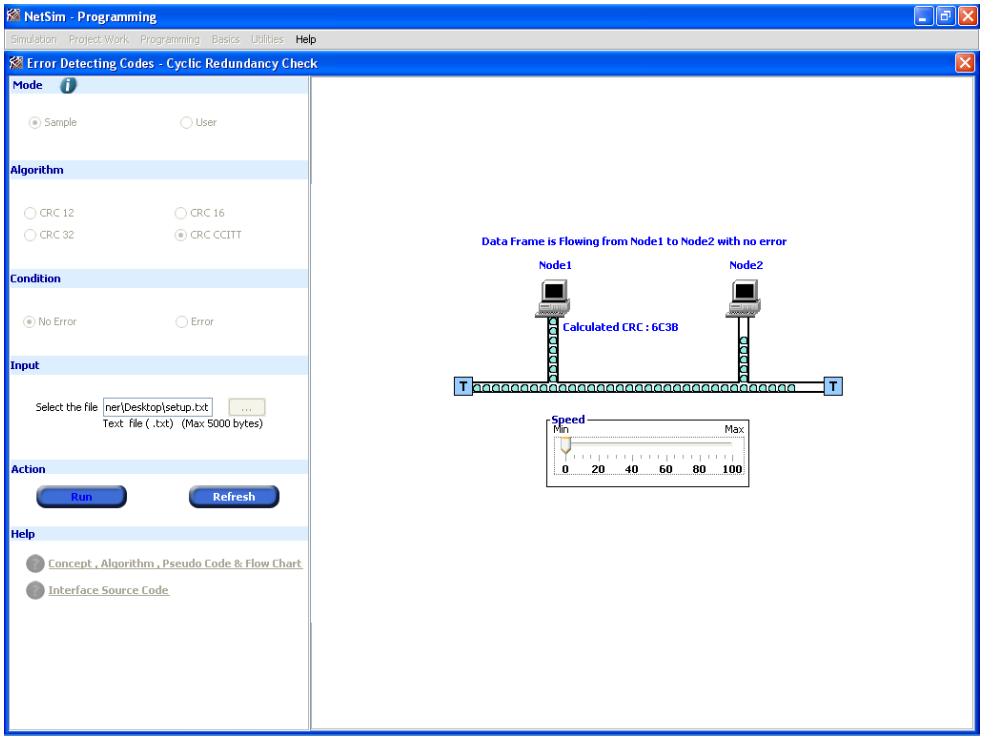
Select the ***User*** mode to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1(Help) for details on how to proceed with your own code.

The scenario will be obtained as shown below. Follow the steps.

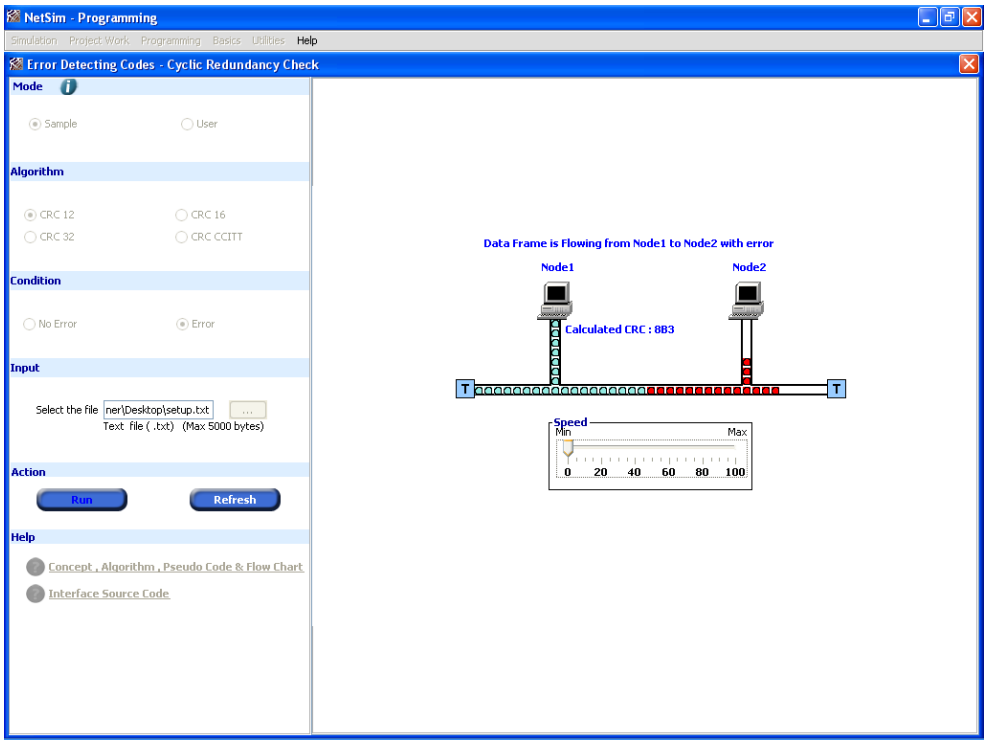


# Results:

## Error condition: No Error




## Error condition: Error



## User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
int fnCrc12(char* pszString)
{
// Write your own code here
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
int fnCrc12(char* pszString)

{
	/////* User code part start */
	char *pszParse = NULL;	//Parsing Variable
	char *pszFileName = NULL;	//	To Store the File name that has been Parsed from the string
	int nErrorOrNoError = 0;	//	To Store whether the Error is Required or Not
	char *pszStorePassString = NULL;//		To the Passed String
	//Crc12 myCrc;			//	Crc12 Class Variable
	char szOrginalCrc[10];		//	A variable to Store the Orginal Crc Value
	char szFileContent[5500];	//	A variable to Get the File Content
	char szReceivedCrc[10];		//	A variable to Get CRC in the Receiving Side
	FILE* fp = NULL;		//	A variable to get the File Pointer

					//	Allot the memory location and store the passed variable value
	pszStorePassString = (char*) malloc(((int) strlen(pszString) + 2));

	strcpy(pszStorePassString, pszString);

					//	Parse the Passed String
	pszParse = strtok(pszStorePassString, ">");
	pszFileName = (char*) malloc(((int) strlen(pszParse) + 2));
	strcpy(pszFileName, pszParse);

	pszParse = strtok(NULL, ">");
	nErrorOrNoError = atoi(pszParse);

					//	Read the Content of the file
	strcpy(szFileContent, fnReadFile_Crc12(pszFileName));
					//	Get the Origianal Crc for the data read from the file

	strcpy(szOrginalCrc, getCrc12(szFileContent, ""));
	if (nErrorOrNoError == 1)	//	No Error case for the Coding
	{
	} else				//	Error case for the Coding
	{
		strcpy(szFileContent, fnMakeError_Crc12(szFileContent));
	}
```

```
                                    //    Get the Received Crc for the string
        strcpy(szReceivedCrc, getCrc12(szFileContent, szOrginalCrc));
                                    //    Make the Output to the Output file
        strcpy(szPath_Crc12, szPath1_Crc12);

#ifndef _NETSIMDLL
        strcat(szPath_Crc12, "/Output.txt");
#else
        strcat(szPath_Crc12, "/Temp.txt");
#endif
                                    //    Open the File for Writing
        szOutput_path_Crc12 = (char *) malloc(200 * sizeof(char));

        strcpy(szOutput_path_Crc12, szTempPath_Crc12);

#ifndef _NETSIMDLL
        strcat(szOutput_path_Crc12, "/Output.txt");
#else
        strcat(szOutput_path_Crc12, "/Temp.txt");
#endif

        fp = fopen(szOutput_path_Crc12, "w");
        fprintf(fp, "%s\n%s\n", szOrginalCrc, szReceivedCrc);
        fclose(fp);

                                    //delete [] pszStorePassString;
                                    //delete [] pszFileName;
        free(pszStorePassString);
        free(pszFileName);
        /////* User code part end */
        return 1;

}
```

**Note- How to practice this experiment without using NetSim:**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below.

First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code. The Output.txt file will vary based on the Data_file. In this case, the Data_File file contains the text “a”.

**Input.txt file contents**

Algorithm=CRC_12
Condition=No_Error
File_Path=C:\Users\TETCOS\Desktop\New Text Document.txt>

*Note- Create any file of size <5000 Byte. Type the location of the file in Data_File.

**Output.txt file contents**

BCF
000

*Note- Output.txt content will vary depending on the file contents.

# Experiment 11: Sorting (Bubble Sort)
# Write a program for frame sorting technique used in buffers.

## Theory:

Sorting is the ordering of data in either an increasing or decreasing order. One of the fundamental challenges of computer science is ordering a list of items. Sorting algorithms are designed with the following objectives:

1. Minimize exchange or wholesale movement of data.
2. Move data from secondary storage to main memory in large blocks. This is done because larger the data blocks, more the efficiency of the algorithm. This is a key part of external sorting.
3. If possible, retain all the data in main memory. In this case, random access into an array can be effectively used. This is a key part in **internal sorting**.

There are three important considerations that will affect a programmer's decision to choose from a variety of sorting methods.

1. Time to write the program.
2. Execution time of the program.
3. Memory or auxiliary space needed for the program's environment.

In this exercise, we will look at the "Bubble" sort algorithm.

By selecting '**Sample**' option, user can visualize the sorting for the given input data and understand the concept of Sorting.

## Algorithm:

Bubble sort derives its name from the fact that the smallest data item bubbles up to the top of the sorted array.

The algorithm begins by comparing the top item of the array with the next, and swapping them if necessary. After *n – 1* comparisons, the largest among a total of *n* items descends to the bottom of the array, to the *nth* location.

The process is then reapplied to the remaining *n – 1* items of the array. For *n* data items, the method requires *n (n – 1)/2* comparisons and, on the average, almost one-half as many swaps. The bubble sort, therefore, is inefficient in large sorting jobs.

## Procedure:

To begin with the experiment, open NetSim

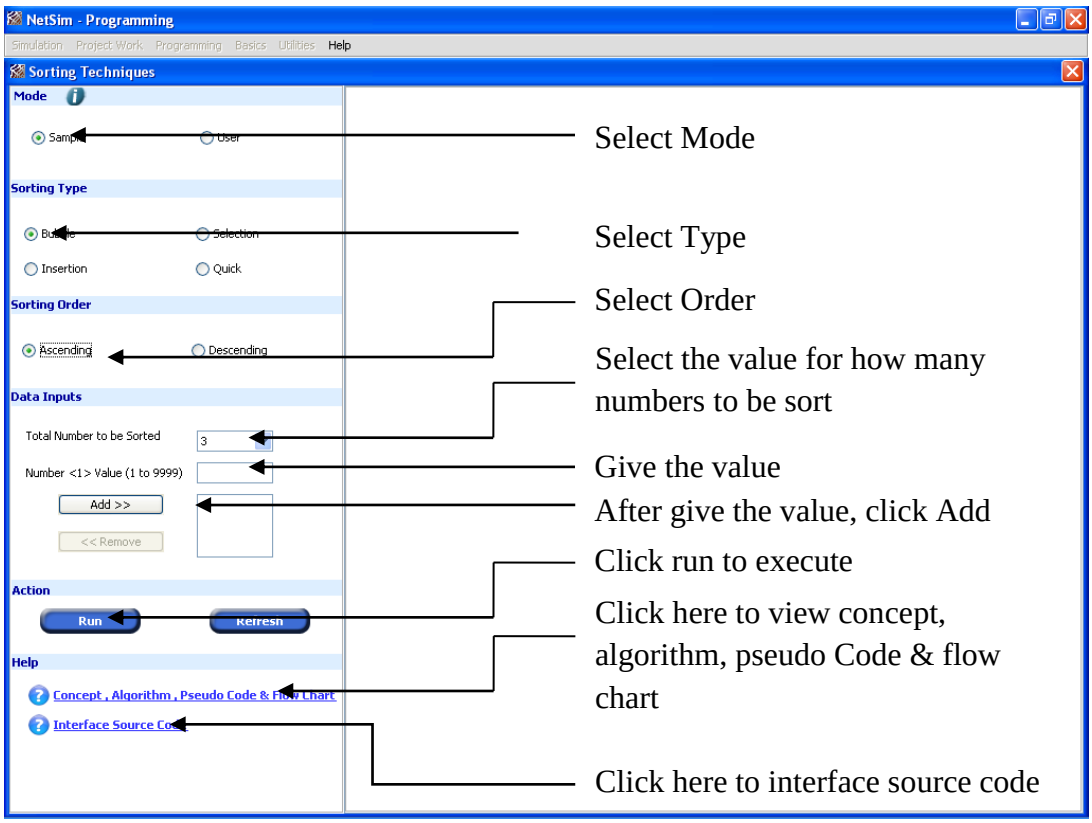
Click on *Programming* in the menu bar, select *Sorting Techniques* and then select *Bubble.*

The scenario will be obtained as shown below. Follow the steps.

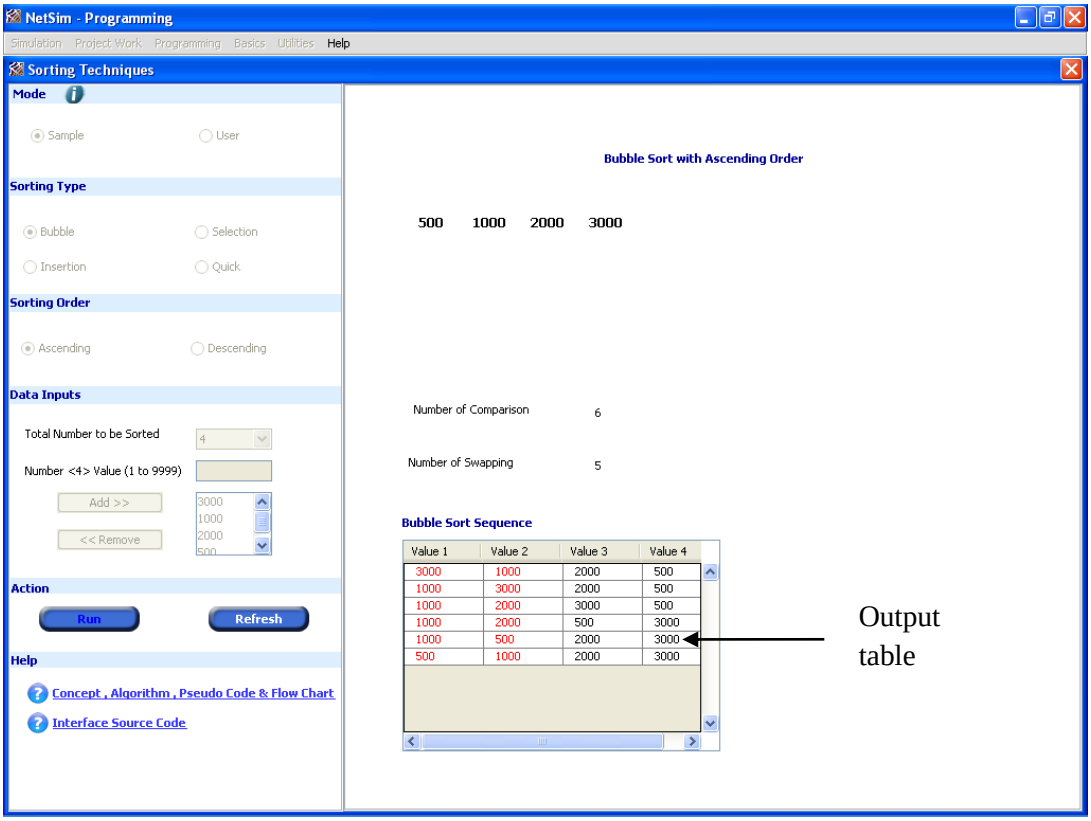
### Step 1:

Select the ***User*** mode to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1(Help) for details on how to proceed with your own code.

The scenario will be obtained as shown below. Follow the steps.



# Results:




# User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
void fnBubblesort(int iNoElement)
{
// Write your own code here
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
void fnBubblesort(int iNoElement)

{
	/////* User code part start */
	int iNoOfExch=0;
	szOutput_path_BS=(char *)malloc(200 * sizeof(char));
	strcpy(szOutput_path_BS,szTempPath_BS);
#ifndef _NETSIMDLL
	strcat(szOutput_path_BS,"/Output.txt");
```

```
#else
	strcat(szOutput_path_BS,"/Temp.txt");
#endif
	fp_BS=fopen(szOutput_path_BS,"w");

	for(nLoop1_BS = 0;nLoop1_BS<iNoElement-1;nLoop1_BS++)// Outer Loop
	{
		iNoOfExch=0;
		for(nLoop2_BS = 0;nLoop2_BS<iNoElement-(nLoop1_BS+1);nLoop2_BS++)  //
Inner Loop
		{
			fprintf(fp_BS,"1>%d>%d>\n",nLoop2_BS,nLoop2_BS+1);            //
Comparing

			//Ascending Order
			if(nOrder_BS == 1)         //Ascending Order
			{
				if (nArray_BS[nLoop2_BS] > nArray_BS[nLoop2_BS+1] )
				{
					fprintf(fp_BS,"2>%d>%d>\n",nLoop2_BS,nLoop2_BS+1);
// Swapping
					nTemp_BS = nArray_BS[nLoop2_BS];
					nArray_BS[nLoop2_BS] = nArray_BS[nLoop2_BS+1];
					nArray_BS[nLoop2_BS+1] = nTemp_BS;
					iNoOfExch++;
				}
			}
			//Descending Order
			if(nOrder_BS == 2)         //Descending Order
			{
				if (nArray_BS[nLoop2_BS] < nArray_BS[nLoop2_BS+1] )
				{
					fprintf(fp_BS,"2>%d>%d>\n",nLoop2_BS,nLoop2_BS+1);
// Swapping
					nTemp_BS = nArray_BS[nLoop2_BS];
					nArray_BS[nLoop2_BS] = nArray_BS[nLoop2_BS+1];
					nArray_BS[nLoop2_BS+1] = nTemp_BS;
					iNoOfExch++;
				}
			}
		}//end of inner FOR LOOP
		if(iNoOfExch==0)
			break;
	}//end of outer FOR LOOP
	fclose(fp_BS);
	/////* User code part end */
}//end of bubble function
```

**Note- How to practice this experiment without using NetSim:**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below.

First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run

window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code. The Output.txt file will vary based on the Data_file. In this case, the size of Data_File file is 11,264 bytes.

**Input.txt file contents**

Sorting_Type=Bubble
Sorting_Order=Ascending
Total_Number=3
Number_to_Sort=258,996,12

**Output.txt file contents**

1>0>1>
1>1>2>
2>1>2>
1>0>1>
2>0>1>

# Experiment 12: Distance Vector Routing
# Implementation of distance vector routing algorithm

## Theory:

Distance Vector Routing is one of the routing algorithms used in a **Wide Area Network** for computing shortest path between source and destination. The router is one of the main devices used in a wide area network. The main task of the router is routing. It forms the routing table and delivers the packets depending upon the routes in the table – either directly or via an intermediate device (perhaps another router).

Each router initially has information about its all neighbors (i.e., it is directly connected). After a period of time, each router exchanges its routing table among its neighbors. After certain number of exchanges, all routers will have the full routing information about the area of the network. After each table exchange, router re-computes the shortest path between the routers. The algorithm used for this routing is called Distance Vector Routing.

## Algorithm:

Repeat the following steps until there is no change in the routing table for all routers.

- Take the Next Router routing table and its neighbor routing table.
- Add the router entry that is not in your own routing table, but exists in any one of the other routing tables. If the new router entry exists in more than one neighbor, then find the minimum cost among them. The minimum cost value details are taken as a new entry: such as source router, intermediate router, destination router and cost value, etc.
- Update the source router routing table cost value if both the destination router and the intermediate router field value have the same value as any one of the neighbors' routing entry.
- Update the source router's routing table entry with the new advertised one if the intermediate router value in the source table is not same, but the cost value is greater than the its neighbor's entry.
- Write the next stage of routing table into the file.

Repeat steps 1 to 5 for all routers.

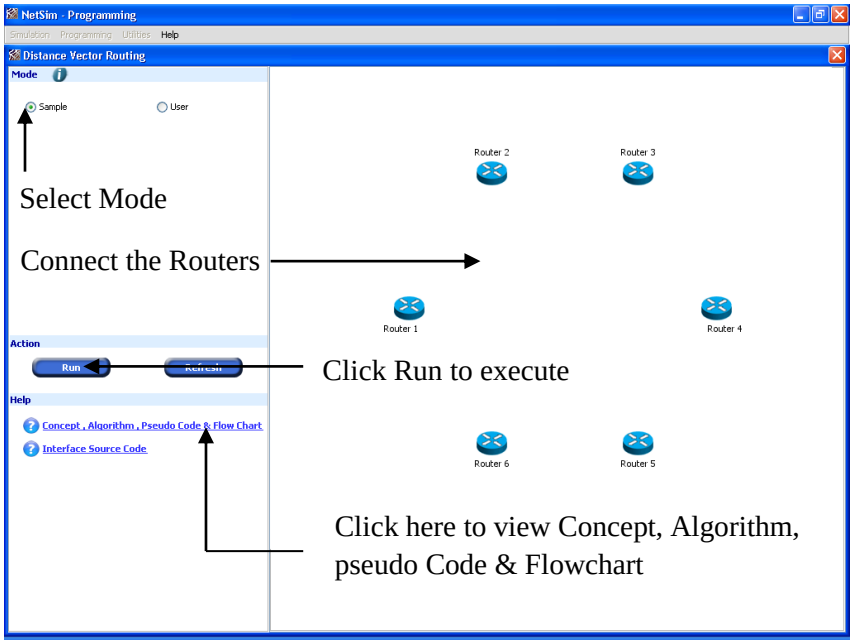
Check whether any changes are made in any of the routers. If yes, then repeat the above steps, otherwise, quit the process.

## Procedure:

To begin with the experiment, open NetSim

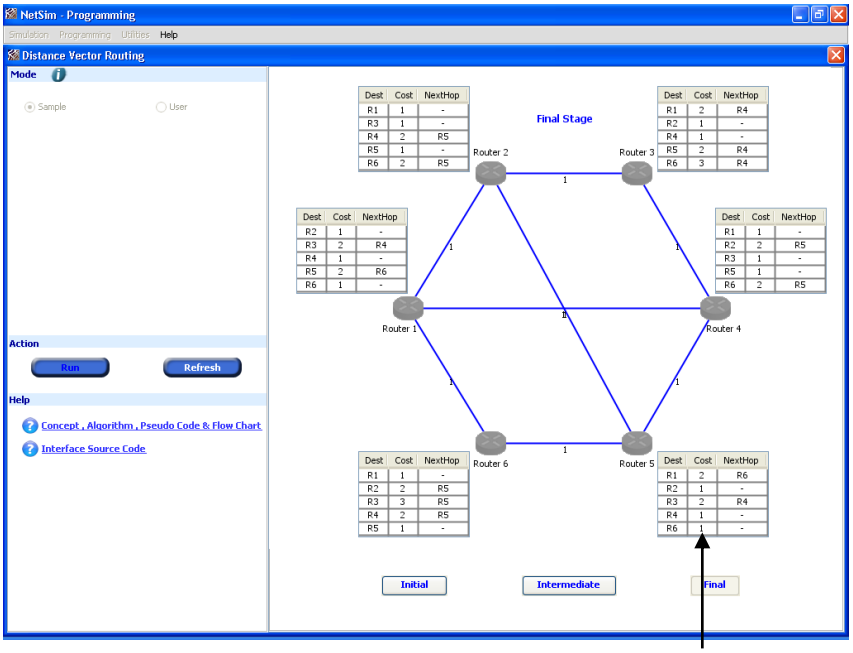
Click on *Programming* from the menu bar and select *Distance Vector Routing*

The scenario will be obtained as shown below. Follow the steps.




When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1 (Help) for details on how to proceed with your own code.

## Results:




Output Table

## User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
void fnDistVectAlgorithm()
{
// Write your own code here
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
void fnDistVectAlgorithm()

{
/////* User code part start */
            do// This do while... loop is to  update the table information till it
knows all the router's information present in the network.
       {
       //     I for//To go to No of router
                     for(nRouterTable=1;nRouterTable<=g_nNoOfRouters;nRouterTable++)
                     {// II for //Select the source router

       for(nNeighbour=1;nNeighbour<=g_nNoOfRouters;nNeighbour++)
                           {// III  for//move to all router
                                  if(Table[nRouterTable].nCostID[nNeighbour]==1)
                                  {// I if //select the neigh router
                                         int nDestID=1;
```

```
        for(nDestID=1;nDestID<=g_nNoOfRouters;nDestID++)
                                        {// IV for //select the routing table of
neigh
                                                if(nDestID!=nRouterTable)
                                                {// II if

        if((Table[nRouterTable].nDestID[nDestID]          ==          0)          &&
(Table[nNeighbour].nDestID[nDestID]!=0))// ||
                                                        {// III if //This loop is to
check whether the neighbour router is DESTINATION or not.

        Table[nRouterTable].nDestID[nDestID] = nDestID;
        Table[nRouterTable].nNextHop[nDestID]  = nNeighbour;
         Table[nRouterTable].nCostID[nDestID]=(Table[nNeighbour].nCostID[nDestID]+1);
                                                        }
                                                        else
if((Table[nRouterTable].nNextHop[nDestID]!=nDestID||Table[nRouterTable].nCostID[nDe
stID]!=1)&&(Table[nNeighbour].nDestID[nDestID]!=0))
                                                        {// else if
                                                        //  This  loop  is  to  check
whether the neighbour router is the destination or not and also check whether the
cost ID is 1 or not.

        if(Table[nRouterTable].nCostID[nDestID]>Table[nNeighbour].nCostID[nDestID])
                                                                {//IV if
                                                                //This loop is to find
the least cost path

        Table[nRouterTable].nDestID[nDestID] = nDestID;
        Table[nRouterTable].nNextHop[nDestID]  = nNeighbour;
        Table[nRouterTable].nCostID[nDestID]=(Table[nNeighbour].nCostID[nDestID]+1);
                                                                }//end IV if
                                                        }//end else if
                                                }// end II if
                                        }//end IV for
                                }// end I if
                        }//end III for
                }// end II for
              nStage++;

              fnDisplay(nStage);
        }while(nStage<2);
/////* User code part end */
}
```

## Note- How to practice this experiment without using NetSim

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below.

First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run

window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code

**Input.txt file contents**

Router_ID=1>Router_Name=Router_1>No_Of_Neighbour=1>Neighbours_ID=2
Router_ID=2>Router_Name=Router_2>No_Of_Neighbour=4>Neighbours_ID=1>3>6>5
Router_ID=3>Router_Name=Router_3>No_Of_Neighbour=2>Neighbours_ID=2>4
Router_ID=4>Router_Name=Router_4>No_Of_Neighbour=2>Neighbours_ID=3>6
Router_ID=5>Router_Name=Router_5>No_Of_Neighbour=1>Neighbours_ID=2
Router_ID=6>Router_Name=Router_6>No_Of_Neighbour=2>Neighbours_ID=4>2

**Output.txt file contents**

0>1>2>1>0
0>2>1>1>0
0>2>3>1>0
0>2>5>1>0
0>2>6>1>0
0>3>2>1>0
0>3>4>1>0
0>4>3>1>0
0>4>6>1>0
0>5>2>1>0
0>6>2>1>0
0>6>4>1>0
1>1>2>1>0
1>1>3>2>2
1>1>5>2>2
1>1>6>2>2
1>2>1>1>0
1>2>3>1>0
1>2>4>2>6
1>2>5>1>0
1>2>6>1>0
1>3>1>2>2
1>3>2>1>0
1>3>4>1>0
1>3>5>2>2
1>3>6>2>4
1>4>1>3>3

1>4>2>2>6
1>4>3>1>0
1>4>5>3>3
1>4>6>1>0
1>5>1>2>2
1>5>2>1>0
1>5>3>2>2
1>5>4>3>2
1>5>6>2>2
1>6>1>2>2
1>6>2>1>0
1>6>3>2>4
1>6>4>1>0
1>6>5>2>2
2>1>2>1>0
2>1>3>2>2
2>1>4>3>2
2>1>5>2>2
2>1>6>2>2
2>2>1>1>0
2>2>3>1>0
2>2>4>2>6
2>2>5>1>0
2>2>6>1>0
2>3>1>2>2
2>3>2>1>0
2>3>4>1>0
2>3>5>2>2
2>3>6>2>4
2>4>1>3>6
2>4>2>2>6
2>4>3>1>0
2>4>5>3>6
2>4>6>1>0
2>5>1>2>2
2>5>2>1>0
2>5>3>2>2
2>5>4>3>2
2>5>6>2>2
2>6>1>2>2
2>6>2>1>0
2>6>3>2>4
2>6>4>1>0
2>6>5>2>2

# Experiment 13: TCP/IP Sockets
# Write Using TCP/IP sockets, write a client – server program to make the client send the file name and to make the server send back the contents of the requested file if present

## Theory:

The socket is a fundamental concept to the operation of TCP/IP application software. It is also an interface between the application and the network. The exchange of data between a pair of devices consists of a series of messages sent from a socket on one device to a socket on other.

Once the socket is configured, the application can send the data using sockets for network transmission and receive the data using sockets from the other host. A socket communication can be connection oriented (TCP sockets) or connectionless (UDP sockets).

There is a receiver (TCP) server, which listens to the sender (TCP) client communications. There can be two-way communication.

## Algorithm:

- Create a socket using address family (AF_INET), type (SOCK_STREM) and protocol (TCP)
- Initialize the address family, port no and IP address to communicate using sockets
- Bind a local address and port number with a socket
- Listen for an incoming socket connection
- Accept an incoming connection attempt on a socket
- Receive an incoming message
- Write that incoming message to Output.txt
- Send ACK to received socket

- Call step 5 to receive the message once again
- Close file
- Close socket

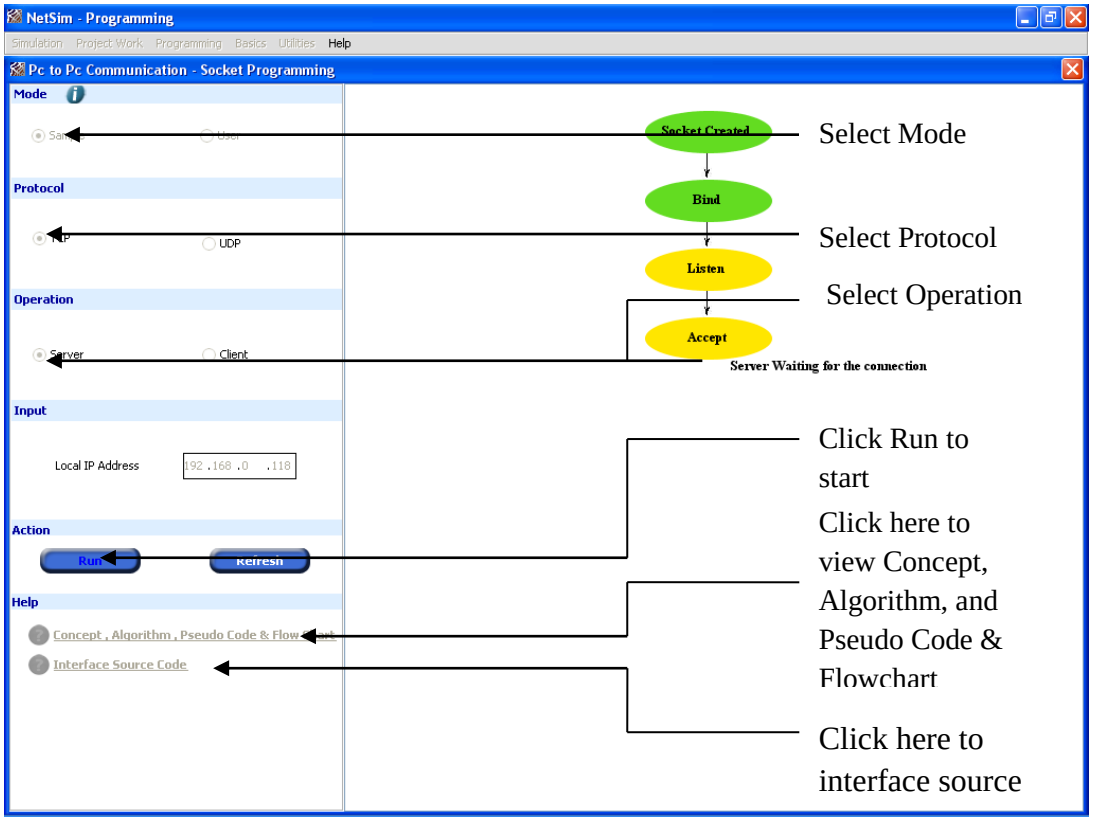
## Procedure:

To begin with the experiment, open NetSim

Click on *Programming* from the menu bar and select *PC to PC Communication* and then select *Socket Programming*

When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1 (Help) for details on how to proceed with your own code.

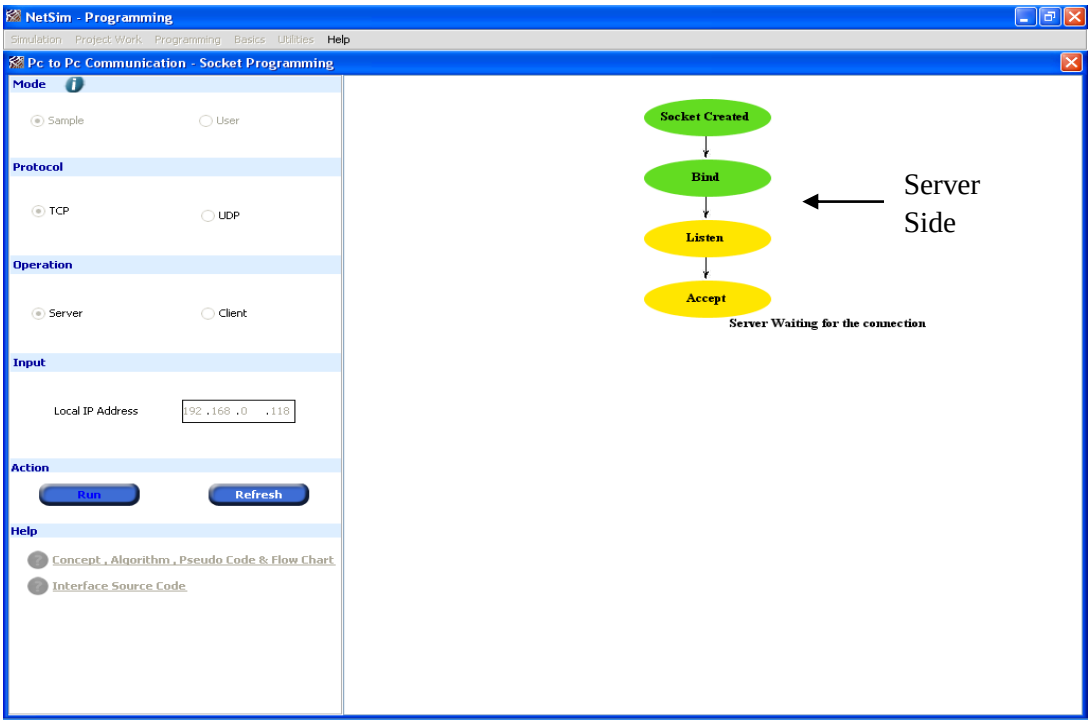
The scenario will be obtained as shown below. Follow the steps



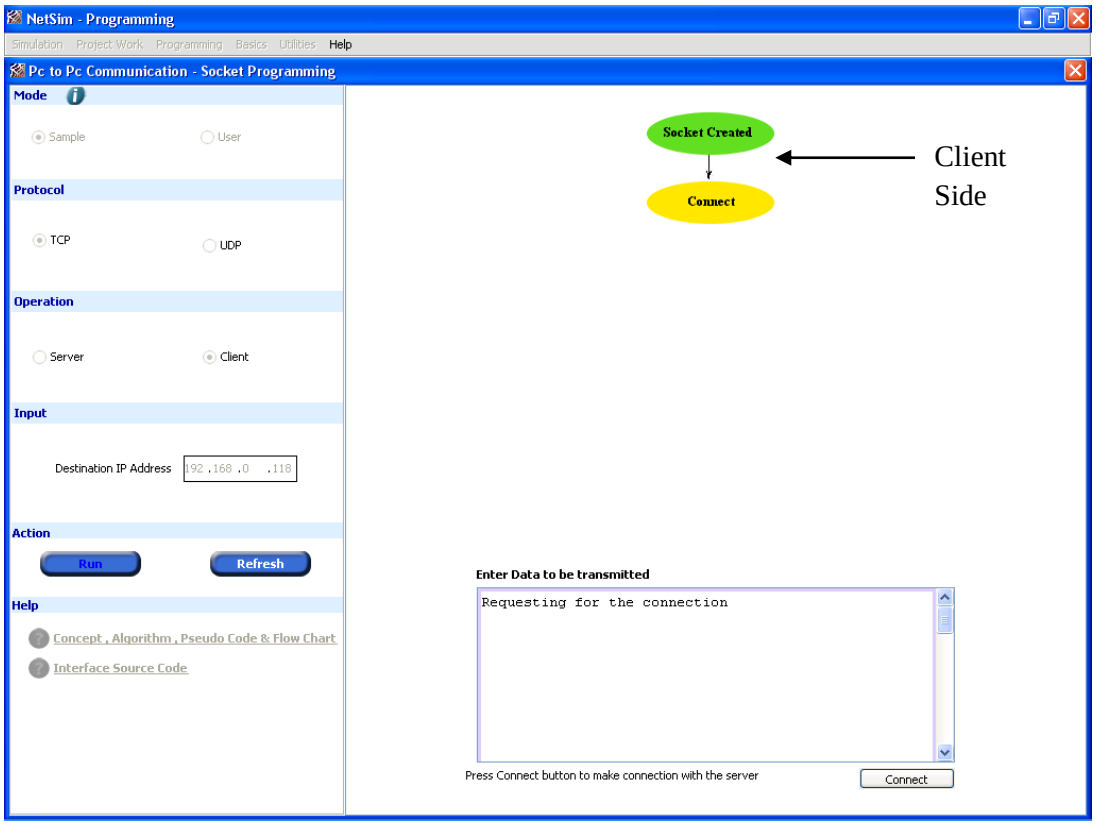

- Under **Input** there are two things,
  1. When **Operation** is **Client**, then the **Server's IP Address** (Ex: 192.168.1.2) should be given in the **Server** IP **Address** field.

2. When **Operation** is **Server**, then the **Server's IP Address** (Ex: 192.168.1.2) would be automatically filled in the **Local IP Address** field.

If the Operation is **Server**, the scenario will be obtained as shown below,




If the Operation is **Client,** the scenario will be obtained as shown below,

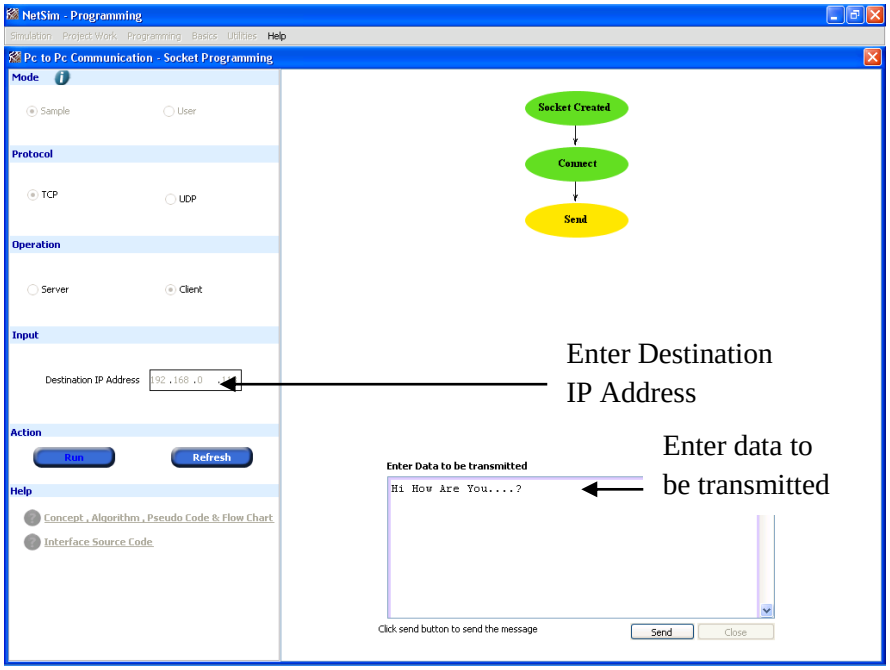


## TCP

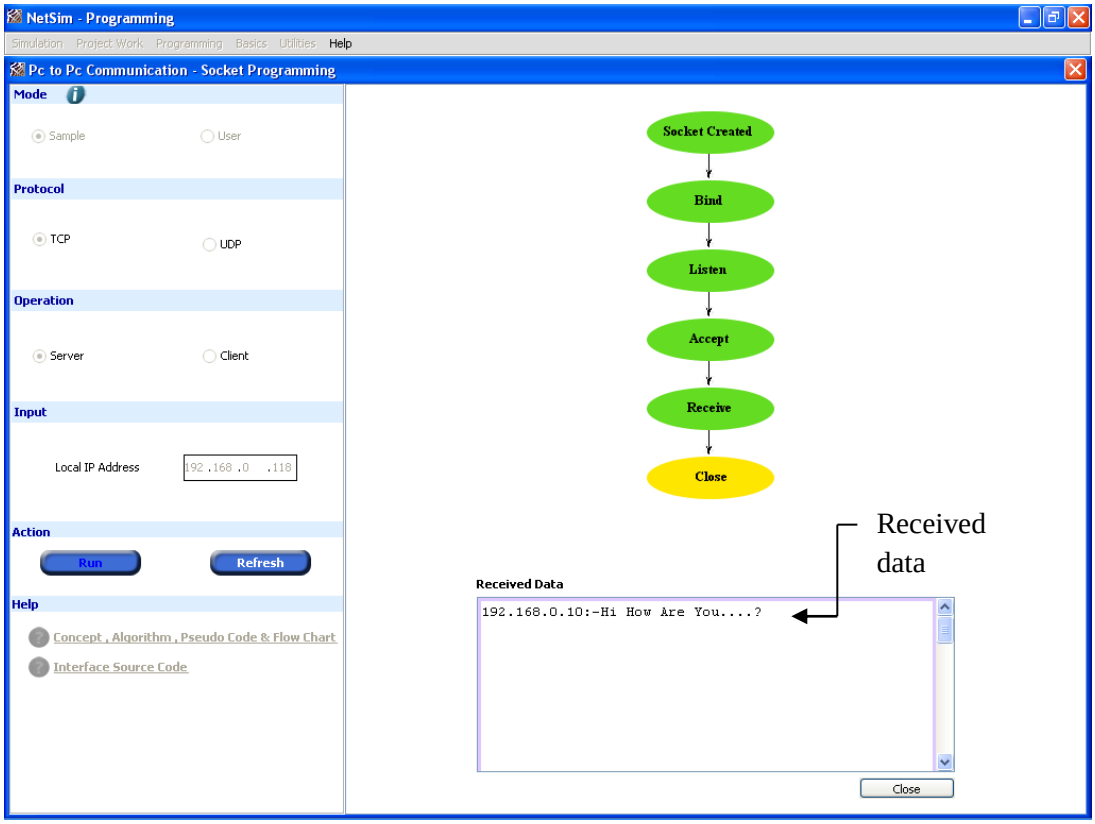
- First the **Server** should **click** on the **Run** button after which the **Client** should click on the **Run** button to **Create the socket**
- **Client** should click on the **Connect** button to **establish the connection with server**.
- The **Client** should click on the **Send** button to transmit the data to the **Server.**
- The **Client** should click on the **Close** button to terminate the Connection with **Server.**
- If the **Data** is successfully transmitted then the **Sent Data** would be **Received** in the **Server System**.

## UDP

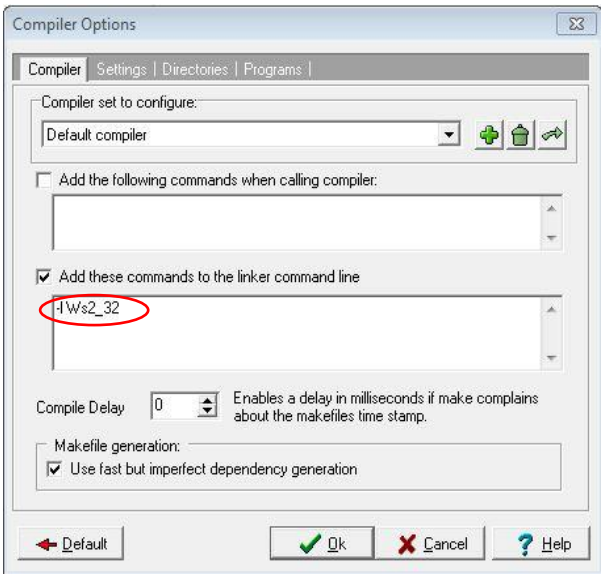
- First the **Server** should **click** on the **Run** button after which the **Client** should click on the **Run** button to **Create the socket**
- The **Client** should click on the **Send** button to transmit the data to the **Server.**
- The **Client** should click on the **Close** button to terminate the Connection with **Server.**
- If the **Data** is successfully transmitted then the **Sent Data** would be **Received** in the **Server System**.



# Results:




Note- If using Dev C++ IDE, go to Tools->compiler options and add -lws2_32 as follows before executing:



## User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
int fnTcpServer()
{
// Write your own code here
return 0;
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added for **TCP** is given below

```
int fnTcpServer()
{
	/////* User code part start */

	nSocketfd =(int) socket(AF_INET,SOCK_STREAM, 0);
	serv_addr.sin_family = AF_INET;
	serv_addr.sin_port = htons(SERVER_PORTNUMBER);
	serv_addr.sin_addr.s_addr = htonl(INADDR_ANY);

	nBindfd	=	bind(nSocketfd,	(struct	sockaddr	*)	&serv_addr,
sizeof(serv_addr));

#ifndef _NETSIM_SAMPLE
	nListenfd = listen(nSocketfd, 5);
#else
	nListenfd = listen(nSocketfd, 1);
#endif

	nServerLen = sizeof(serv_addr);
	if (fnWriteOutput() == 1)
	{	/*if socket creation,bind and listen failed function will terminate*/
		closesocket(nSocketfd);
		return 0;
	}

#ifndef _NETSIM_SAMPLE
	nNewsocketfd =(int) accept(nSocketfd, (struct sockaddr *) &cli_addr,
		&nServerLen);
	nLoopCount++;

	memset(szData, 0, sizeof(szData)); /*Clear the array*/

	nReceivedbytes =(int) recv(nNewsocketfd, szData, sizeof(szData), 0);
	fnWriteOutput();
	nSendbytes =(int) send(nNewsocketfd, pszBuffer, strlen(pszBuffer), 0);
#else
	while (1)
	{
		nNewsocketfd =(int) accept(nSocketfd, (struct sockaddr *) &cli_addr,
			&nServerLen);
```

```
            nLoopCount++;

            memset(szData, 0, sizeof(szData)); /*Clear the array*/

            nReceivedbytes =(int) recv(nNewsocketfd, szData, sizeof(szData), 0);
            fnWriteOutput();
            nSendbytes  =(int)  send(nNewsocketfd,  pszBuffer,  strlen(pszBuffer),
0);

            if(   nTCPServerCloseFlag == 1) /*break  the  loop  when  user  send
close the connection*/
                  break;
      }
#endif

      closesocket(nSocketfd);

      /////* User code part end */
      return 0;
}
```

The User code which is to be added for **UDP** is given below

```
int fnUdpServer()
{
      /////* User code part start */
      nSocketfd  =  (int)socket(AF_INET,SOCK_DGRAM,  0);  /*Server  side  socket
creation*/
      serv_addr.sin_family = AF_INET;
      serv_addr.sin_addr.s_addr = htonl(INADDR_ANY);
      serv_addr.sin_port = htons(SERVER_PORTNUMBER); /* Server port number 6000*/
      nServerLen = sizeof(serv_addr);

      nBindfd      =    bind(nSocketfd,    (struct    sockaddr    *)    &serv_addr,
sizeof(serv_addr));
      fnWriteOutput();

#ifndef _NETSIM_SAMPLE
      memset(szData, 0, sizeof(szData)); //Clear the array

      nReceivedbytes  =  recvfrom(nSocketfd,  szData,  sizeof(szData),  0,(struct
sockaddr *) &serv_addr, &nServerLen);

      fnWriteOutput();
#else
      while(1)
      {
      memset(szData, 0, sizeof(szData)); //Clear the array

      nReceivedbytes  =  recvfrom(nSocketfd,  szData,  sizeof(szData),  0,(struct
sockaddr *) &serv_addr, &nServerLen);

      fnWriteOutput();
      }
#endif
      closesocket(nSocketfd);
```

```
        /////* User code part end */
        return 0;
}
```

**Note- How to practice this experiment without using NetSim:**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below.

First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code. The Output.txt file will vary based on the Data_file. In this case, the size of Data_File file is 11,264 bytes.

**For TCP**

**Input.txt file contents at Server system**

Protocol=TCP
Operation=Server

**Input.txt file contents at Client system**

Protocol=TCP
Operation=Client
Destination IP Address=192.168.0.130
192.168.0.147:-Hello World

**Output.txt file contents at Server system**

Socket Created
Bind Succeed
Listen Succeed

**For UDP**

**Input.txt file contents at Server system**

Protocol=UDP
Operation=Server

**Input.txt file contents at Client system**

Protocol=UDP
Operation=Client
Destination IP Address=192.168.0.130
192.168.0.147:-Hello World

**Output.txt file contents at Server system**

Socket Created
Bind Succeed

# Experiment 14: RSA
# Write a program for simple RSA algorithm to encrypt and decrypt the data

## Theory:

The Application Layer takes care of network security. Different encryption and decryption techniques are used to provide security to the data that is to be transmitted.

Among these, is the public-key cryptography. Public-key cryptography requires each user to have two keys: a public key, used by the entire world for encrypting messages to be sent to the user; and a private key which the user needs for decrypting messages.

RSA algorithm was discovered at the Massachusetts Institute of Technology (MIT). RSA stands for the initials of the three who discovered the algorithm: Rivest, Shamir and Adleman.

## Algorithm:

The technique followed is:

1. Choose two large primes, *p* and *q*, (typically greater than $10^{100}$).
2. Compute n = p * q and z = ( p - 1 ) * ( q - 1 ).
3. Choose a number *relatively prime* to z and call it Kp.
4. Find Ks such that (Ks * Kp) mod z = 1.

To encrypt a message, P, compute $C = P^{Ks} \pmod n$. To decrypt C, compute $P = C^{Kp} \pmod n$. It can be proven that for all P in the specified range, the encryption and decryption functions are inversed. To perform the encryption, we need *Ks* and *n.* To perform the decryption, we need *Kp* and *n.* Therefore, the public key consist of the pair (Ks,*n*) and the private key consist of (Kp,*n*).

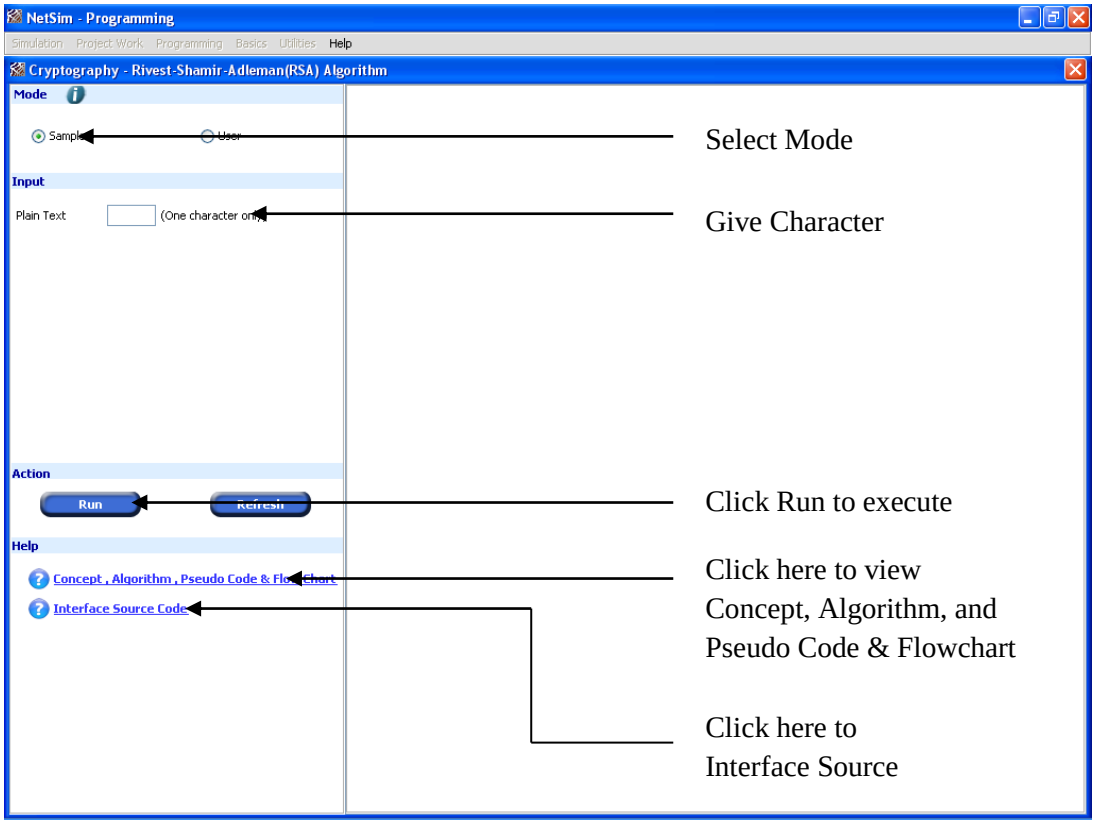
## Procedure:

To begin with the experiment, open NetSim

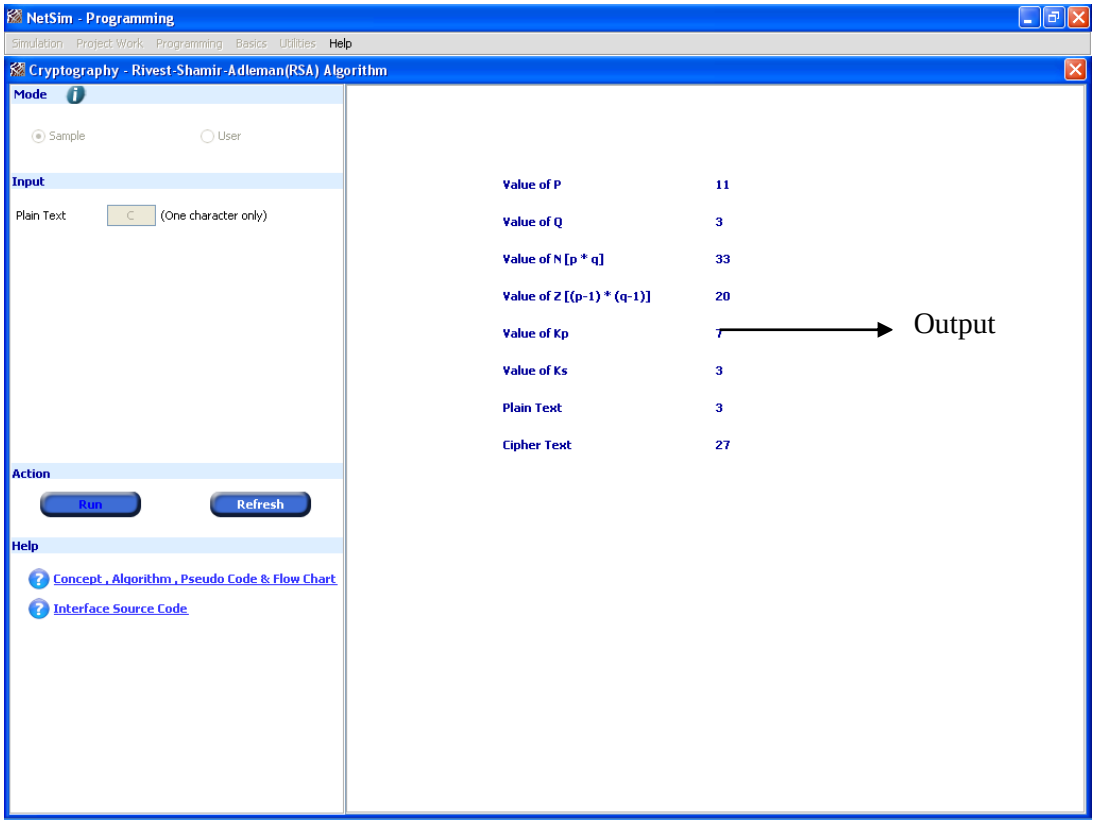
Click on *Programming* from the menu bar and select *Cryptography* and then select *Advanced→RSA*

When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1 (Help) for details on how to proceed with your own code.

The scenario will be obtained as shown below. Follow the steps



# Results:




# User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
void fnRSA()
{
// Write your own code here
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
void fnRSA()

{
	/////* User code part start */
	// Write you own code for  Rivest-Shamir-Adelman Algorithm  HERE.

	nRsaQ = 3;
```

```
        nRsaP = 11;
        nNVal = nRsaQ * nRsaP;
        nZVal = (nRsaQ - 1) * (nRsaP - 1);
        nKp = 7;
        nKs = 3;

        cChr = szStr[0];
        //To get the Integer Equivalent Position of the Alphabets
        // A=1, a=1, B=2, b=2, c=3, d=4 .......
        nChr = cChr;
        if ((nChr>=65) && (nChr<=90))
               nChr = nChr - 64;
        else if((nChr>=97) && (nChr<=122))
               nChr= nChr - 96;

        lCypTxt = fmod((long double) pow (nChr,nKs), (long double)nNVal);
        lPlnTxt = fmod((long double) pow (lCypTxt,nKp), (long double)nNVal);
/////* User code part end */
}
```

**Note- How to practice this experiment without using NetSim:**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below.

First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code. The Output.txt file will vary based on the Data_file. In this case, the size of Data_File file is 11,264 bytes.

**Input.txt file contents**

Plain_Text=N

**Output.txt file contents**

11>3>33>20>7>3>5>14>

# Experiment 15: Hamming Code
# Write a program for Hamming code generation for error detection and correction

## Theory:

Hamming code is for Single Bit Error Detection and Correction. It is based on Parity (Even / Odd Parity).

It allows any single bit error to be detected and corrected. It involves adding one or four check bits (depending on the formula) to the data for error detection as well as error correction. These bits are called **Check Bits.** In order to find the number of check bits introduced in the message bits, there is a general formula.

For a message of size **m** bits and **r** check bits, then the condition **(m + r + 1) < = 2 $^{r}$** should be valid**.**

**Example:**

Consider the message size (m) of 4 bits and we will find out the number of check bits according to the formula,

When r = 3 we have, 4 + 3 + 1 = 8 and 2 $^{3}$ is 8 and so the number of **Check Bits** to be introduced is 3.

## Algorithm:

Read the contents of the input file i.e. the input data, type of parity and the error data from the 'Input.txt' and store it in variables like the above method.

1. Get the length of the input data and calculate the number of Check Bits to be introduced according to the condition (m + r + 1) <= $2^{r}$. Where **m** is length of the original data and **r** is the number of check bits to be introduced in the string.
2. If the passed flag (type of parity) is 2, then it is **Even** parity, else it is **Odd** parity.

3. Place the Check Bits at the appropriate position according to the principle explained above (Calculation and Placement of Check Bits in Hamming Code) for the Input data and for the Error data.
4. Compare the Check Bits values of the Original Input Data and the Error Data values. Keep a note of the Check Bit Position where the value differs.
5. Add all the position of the Check Bits where the values differ. The resultant value gives the position of the error bit in the Error Data of length ( m + r ) i.e. the total length which includes the length of the Input Data Bits and the Check Bits.

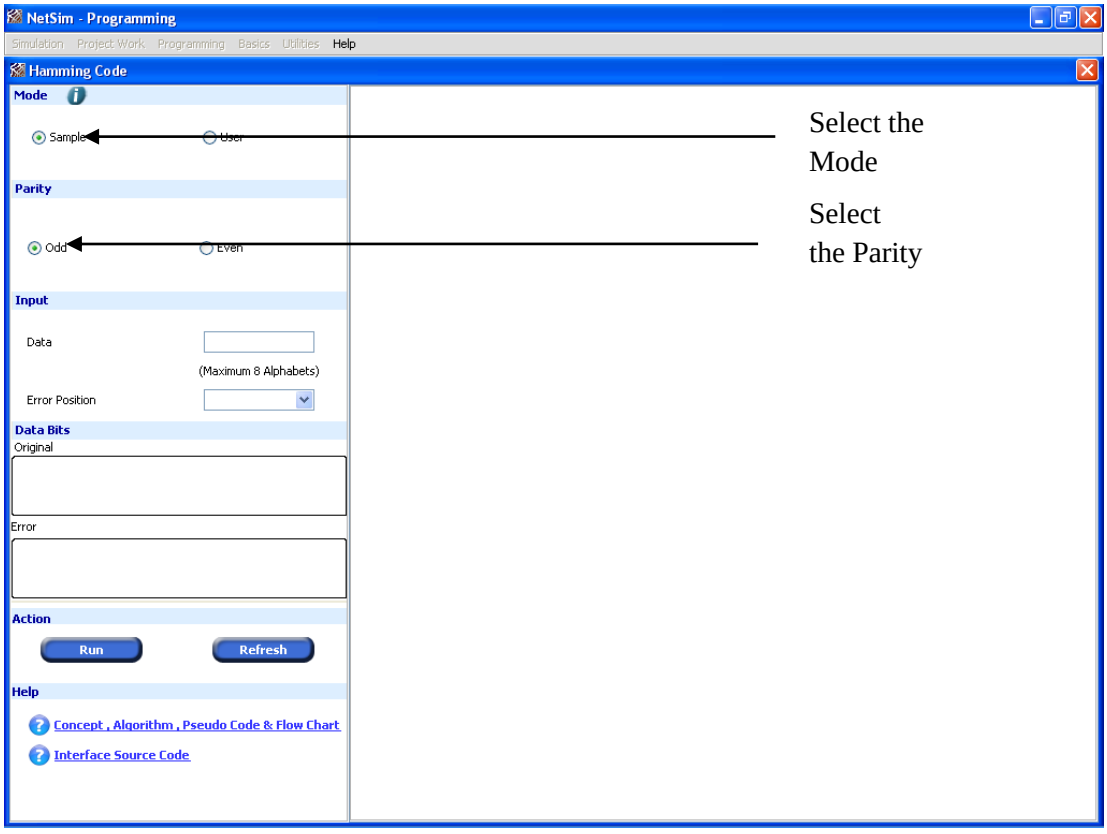
## Procedure:

To begin with the experiment, open NetSim

Click on *Programming* from the menu bar and select *Error Correcting Code* and then select *Hamming Code*

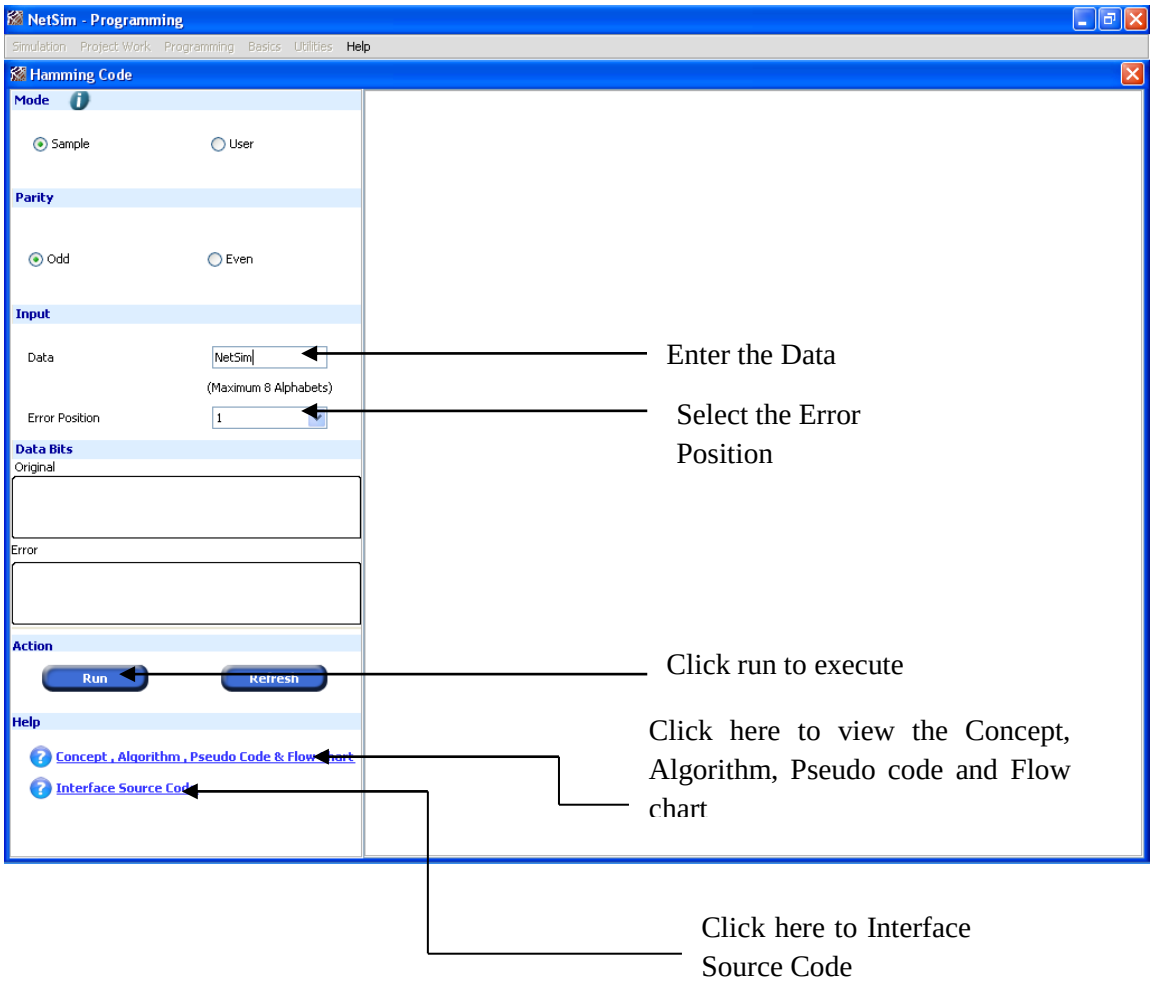
When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1 (Help) for details on how to proceed with your own code. The scenario will be obtained as shown below. Follow the steps

**Step 1:**



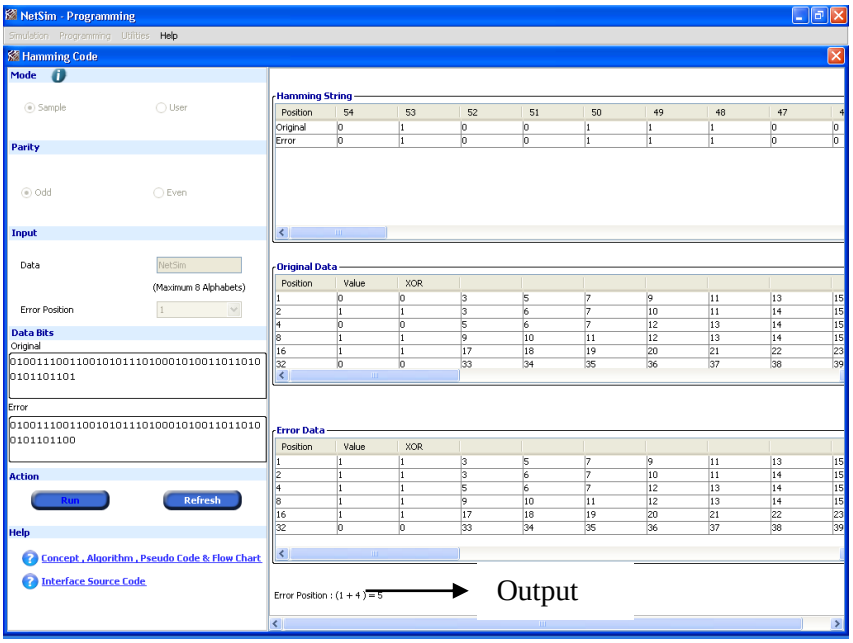
**Step 2:**

After that you can type the input in the Textbox and Select the error position which is shown below



## Results:

After you click RUN button you can see the Hamming string, Original data and Error data in binary format as shown in the following screen shots




## User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
int fnHamming()
{
// Write your own code here
       return iErrorPosition;
}// End of Function fnhammingErrorPosition.
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
int fnHamming()
{
       /////* User code part start */
       iMessageLength = strlen(szOriginalString); // Get the Input Length
       iCheckCount = fnGetCheckbitscount(iMessageLength);
       // Allocate the Required Memory for Original Hamming String
       szHammingOriginal = malloc(iMessageLength + iCheckCount + 1);
       // Position the Check Bits into the Original Hamming String
       szHammingOriginal = fnPositionCheckBits(iMessageLength, iCheckCount,
                     iParitytype, szOriginalString, '0');
       // Allocate the Required Memory for Error Hamming String
       szHammingError = malloc(iMessageLength + iCheckCount + 1);
       // Position the Check Bits into the Error Hamming String
       szHammingError = fnPositionCheckBits(iMessageLength, iCheckCount,
```

```
                    iParitytype, szErrorString, 'E');
        // Get the error position
        iErrorPosition = fnErrorPosition(szHammingOriginal, szHammingError, strlen(
                    szHammingOriginal), iCheckCount);
        /////* User code part end */
        return iErrorPosition;
}// End of Function fnhammingErrorPosition.
```

**Note- How to practice this experiment without using NetSim**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below. First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.
User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code

**Input.txt file contents**

Parity=Odd
Data=ABC
Error_Position=1
Data_Bits_Original=010000010100001001000011
Data_Bits_Error=010000010100001001000010

**Output.txt file contents**

5
3>5>7>9>11>13>15>17>19>21>23>25>27>29>1>1>
3>6>7>10>11>14>15>18>19>22>23>26>27>30>1>1>
5>6>7>12>13>14>15>20>21>22>23>28>29>30>1>1>
9>10>11>12>13>14>15>24>25>26>27>28>29>30>1>1>
17>18>19>20>21>22>23>24>25>26>27>28>29>30>1>1>
3>5>7>9>11>13>15>17>19>21>23>25>27>29>0>0>
3>6>7>10>11>14>15>18>19>22>23>26>27>30>1>1>
5>6>7>12>13>14>15>20>21>22>23>28>29>30>0>0>
9>10>11>12>13>14>15>24>25>26>27>28>29>30>1>1>
17>18>19>20>21>22>23>24>25>26>27>28>29>30>1>1>
1>4>5>

# Experiment 16: Leaky Bucket Algorithm
# Write a program for congestion control using leaky bucket algorithm.

## Theory:

1. This is a type of traffic shaping algorithm. Traffic shaping allows control of the traffic in the network to improve performance of the network.
2. An application before transmitting, agrees upon a peak cell rate. This algorithm will not allow packets more than the agreed peak cell rate.
3. This algorithm will also avoid burst of data arrival which could lead to congestion.
4. One of the major reasons for congestion is the burst kind of data arrival in the network. This algorithm is used to avoid the burst traffic.
5. Burst input data is stored in a buffer and output at a constant rate. If the input rate is larger than the output rate and the buffer is full, the extra data is discarded and not transmitted.

## Algorithm:

1. Read data '***Input.txt***' file, which has the required data.
2. Parse the content of the file from which you get the input rate for each second, buffer size, output rate per second and store in separate variables.
3. Follow the steps outlined below for time starting from 0 to 10.
4. If input rate is larger than the output rate, less the output rate (store the rate of packet output for the corresponding second) and for the remaining input packets, check for buffer availability.
5. If the buffer value is larger than or equal to the remaining input packets, store the remaining packets in the buffer. Else, if the buffer capacity is lesser, then store up to the capacity of the buffer and discard the rest of the packets. Increment timer.

6. If the input rate is equal to the output rate, no packet is stored in the buffer. (Store the output rate, discard packet as zero, for the corresponding second). Increment timer.
7. If the input rate is less than the output rate, no packet is stored in the buffer. (Store the input rate as output rate, discard packet as zero, for the corresponding second). Increment timer.
8. Follow the steps outlined below until buffer capacity is zero.
9. If the buffer value is non-zero, reduce the buffer capacity by the output rate – if the buffer value is more than the output rate. (Store the output rate, discard packet as zero, for the corresponding second). Increment timer.
10. If the buffer value is non-zero, reduce the buffer capacity to 0 if the buffer value is less than or equal to the output rate. (Store the buffer capacity; discard the packet as zero for the corresponding second). Increment timer.
11. Store the total time value.
12. Write the required values to the output file 'Output.txt'.

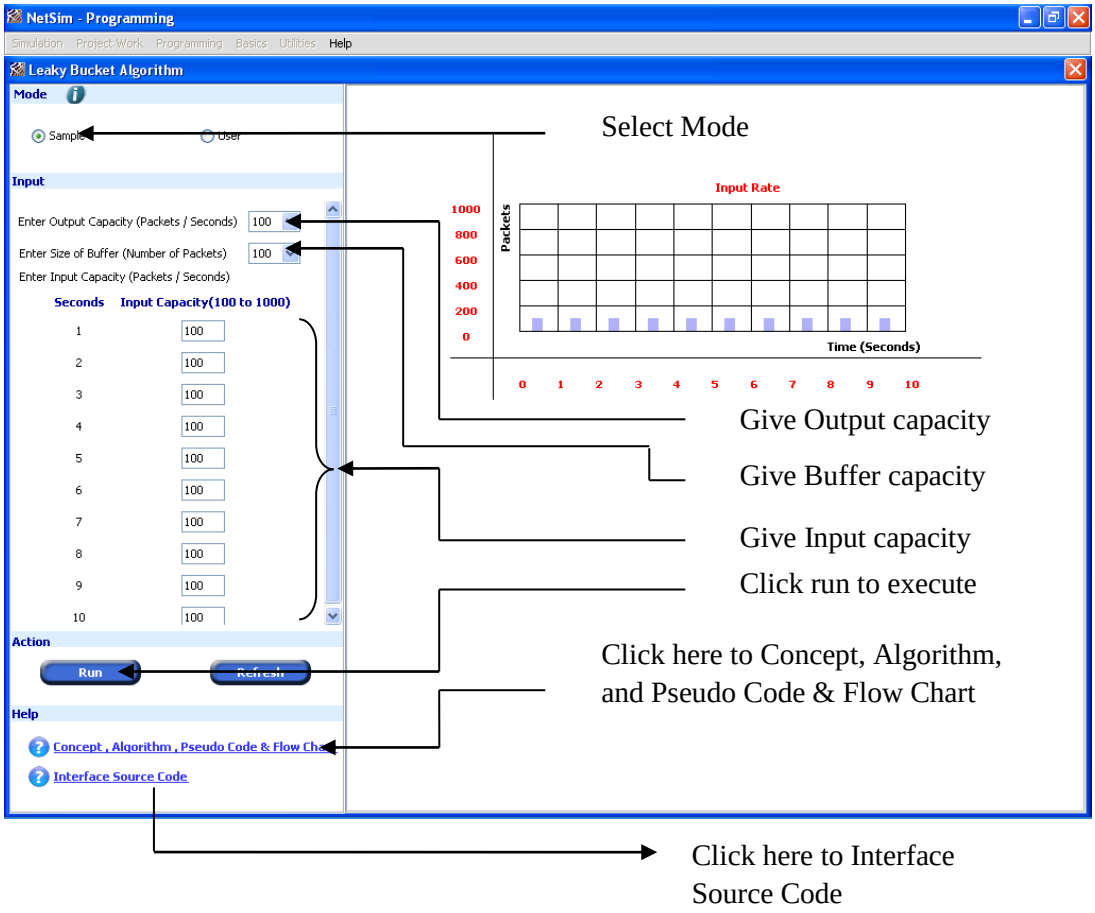
## Procedure:

To begin with the experiment, open NetSim

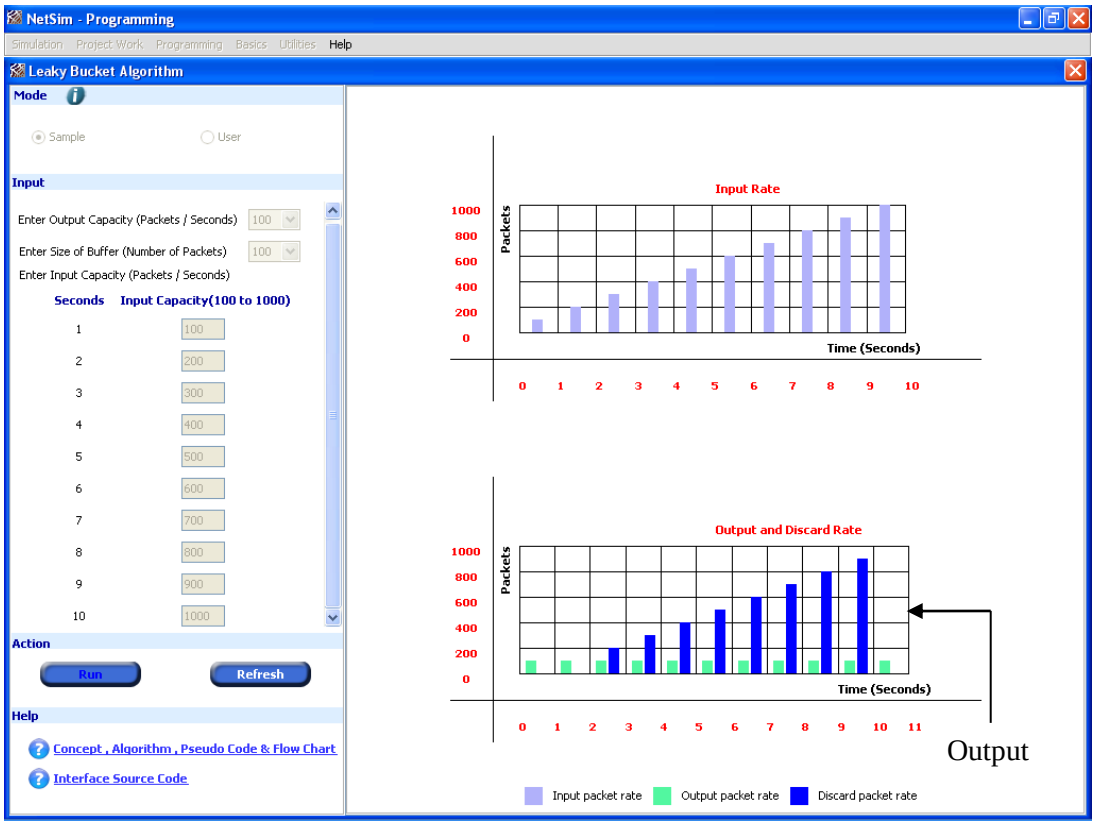
Click on *Programming* from the menu bar and select *Leaky Bucket Algorithm.*

When you select the *User* mode, you have to write your own program in C/C++, compile and link to NetSim software for validation. Click on the F1 (Help) for details on how to proceed with your own code.

The scenario will be obtained as shown below. Follow the steps


NetSim - Programming
Leaky Bucket Algorithm
Mode
Sample
User
Input
Enter Output Capacity (Packets / Seconds)
Enter Size of Buffer (Number of Packets)
Enter Input Capacity (Packets / Seconds)
Seconds
Input Capacity(100 to 1000)
Action
Run
Refresh
Help
Concept , Algorithm , Pseudo Code & Flow Chart
Interface Source Code
Input Rate
Packets
Time (Seconds)
Select Mode
Give Output capacity
Give Buffer capacity
Give Input capacity
Click run to execute
Click here to Concept, Algorithm, and Pseudo Code & Flow Chart
Click here to Interface Source Code

## Results:


NetSim - Programming
Leaky Bucket Algorithm
Mode
Input
Action
Run
Refresh
Help
Concept , Algorithm , Pseudo Code & Flow Chart
Interface Source Code
Input Rate
Output and Discard Rate
Packets
Time (Seconds)
Input packet rate
Output packet rate
Discard packet rate
Output

## User Mode:

In User Mode, the user needs to edit the Interface Source Code at the following location.

```
void fnLBA()
{
// Write your own code here
}
```

So the user needs to add the user code, create exe and attach it with NetSim to run.

The User code which is to be added is given below

```
void fnLBA()
{
	/////* User code part start */
	// Write you own code for Leaky Bucket algorithm HERE.
	int nBufferValue = 0;
	int nInterval = 0;
	nSeconds = 0;

	for (nInterval = 0; nInterval < 10; nInterval++) {
		if ((nInputRate[nInterval] - nOutputRate) > 0) // the input is more
than the output rate
		{

			if ((nBufferValue + (nInputRate[nInterval] - nOutputRate))
					>= nBufferSize) // All put together the value is
more or equal than the buffer size
			{
				if	((nBufferValue	+	(nInputRate[nInterval]	-
nOutputRate))
						> nBufferSize) // more than case where we
have discard
					nDiscardRate[nSeconds] = (((nInputRate[nInterval]
						-	nOutputRate)	+	nBufferValue)	-
nBufferSize);// the discard rate is recorded
				nBufferValue = nBufferSize;
			} else
				// this equal case is where we have no discard
				nBufferValue = nBufferValue + (nInputRate[nInterval]
					- nOutputRate); // the exces is stored in
the buffer
			// for both case the output and buffer level is  recorded
			nOutputRates[nSeconds] = nOutputRate;

		} else if ((nInputRate[nInterval] - nOutputRate) == 0) // the output
is equal to input rate
		{

			nBufferValue = nBufferValue;
			nOutputRates[nSeconds] = nOutputRate;
```

```
            } else if ((nInputRate[nInterval] - nOutputRate) < 0) // input is
less than output rate
            {


                  if (nInputRate[nInterval] > 0) {
                        if    ((nBufferValue    +    (nInputRate[nInterval]    -
nOutputRate))
                                    >=  nBufferSize)//  All  put  together  the
value is more or equal than the buffer size
                        {
                              if   ((nBufferValue   +   (nInputRate[nInterval]   -
nOutputRate))
                                          >   nBufferSize)//   more   than   case
where we have discard
                                    nDiscardRate[nSeconds]                    =
(((nInputRate[nInterval]
                                                - nOutputRate) + nBufferValue)
- nBufferSize);// the discard rate is recorded
                              nBufferValue = nBufferSize;
                              nOutputRates[nSeconds] = nOutputRate;
                        } else {
                              if   ((nBufferValue   +   (nInputRate[nInterval]   -
nOutputRate))
                                          <= 0) {
                                    nOutputRates[nSeconds] = nBufferValue
                                                + nInputRate[nInterval];
                                    nBufferValue = 0;

                              } else {
                                    nOutputRates[nSeconds] = nOutputRate;
                                    nBufferValue      =      nBufferValue      +
(nInputRate[nInterval]
                                                - nOutputRate);

                              }
                        }

                  } else {

                        if ((nBufferValue - nOutputRate) > 0) {
                              nBufferValue = nBufferValue - nOutputRate;
                              nOutputRates[nSeconds] = nOutputRate;
                        } else {

                              nOutputRates[nSeconds] = nBufferValue;
                              nBufferValue = 0;
                        }

                  }

            }
            nBufferLevel[nSeconds] = nBufferValue;
            nSeconds++;
      }

      while (nBufferValue != 0)// this sends the remaining data in the buffer
```

```
	{

		if (nBufferValue > nOutputRate) // buffer is more than the output
		{
			nBufferValue = nBufferValue - nOutputRate;
			nOutputRates[nSeconds] = nOutputRate;
		} else
		{
			nOutputRates[nSeconds] = nBufferValue;

			nBufferValue = 0;

		}
		nBufferLevel[nSeconds] = nBufferValue;
		nSeconds++;
	}
	// Write you own code for Leaky Bucket algorithm HERE.
	/////* User code part end */
}
```

**Note- How to practice this experiment without using NetSim:**

Users who do not have a licensed version of NetSim in their PC's, can practice as explained below. First, run the exercise in sample mode. The user would see that an Input.txt file is created in Win OS temp folder (this can be reached by typing %temp%/NetSim in Windows run window). This input file should be read by the user code and it should generate an Output.txt. This Output.txt file is read by NetSim and shown graphically to the user.

User can follow the steps provided in Appendix 1: Programming exercise - How to practice without NetSim.

Given below are sample Input.txt and Output.txt files for this experiment for users to verify & validate their code. The Output.txt file will vary based on the Data_file. In this case, the size of Data_File file is 11,264 bytes.

**Input.txt file contents**

Output_Capacity=100
Buffer_Size=100
Input_Capacity=100,200,120,400,100,600,100,100,100,100,

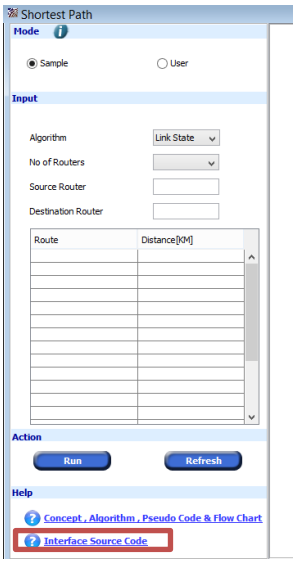
**Output.txt file contents**

100>100>100>100>100>100>100>100>100>100>100>
0>0>20>300>0>500>0>0>0>0>0>
11>

# Appendix 1: Programming exercise -How to practice without NetSim

## Step 1: Copy Interface Source Code

Click on Interface Source Code and save the code in a text file.

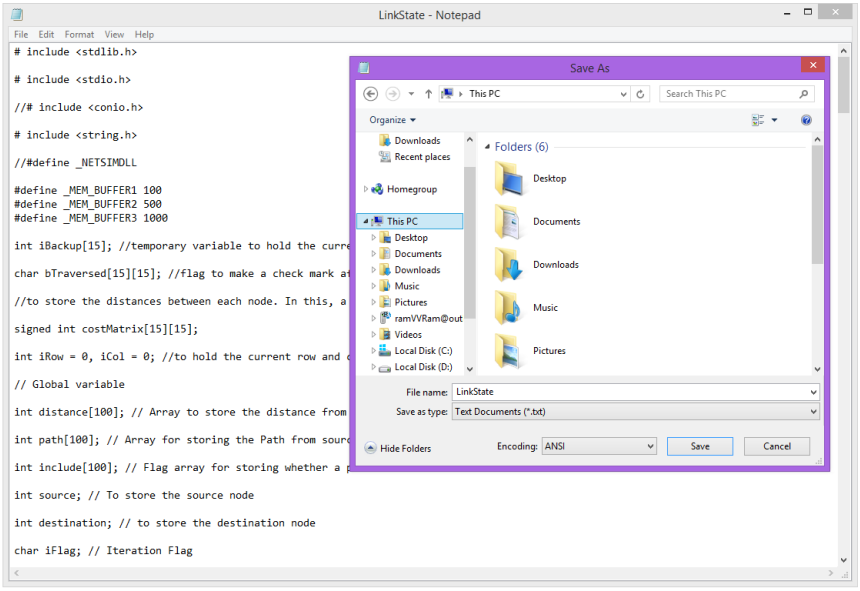



**For Example**:

As an example, Shortest Path programming exercise is being considered.

Open the programming exercise and select **Interface Source Code.**

Save the Interface source code in another txt file.




## Step 2: Create Input.txt file

Create a new text file with the name Input.txt.

The contents of the file will vary for each programming exercises and are specified in NetSim User Manual under programming topic.

**For Example**: Copy the input file contents from NetSim user manual and save it in a file called Input.txt

Sample:

Algorithm=Link_State
No_of_Router=3
Distance:
999>6>5>
6>999>7>
5>7>999>
Source_Router=1
Destination_Router=2

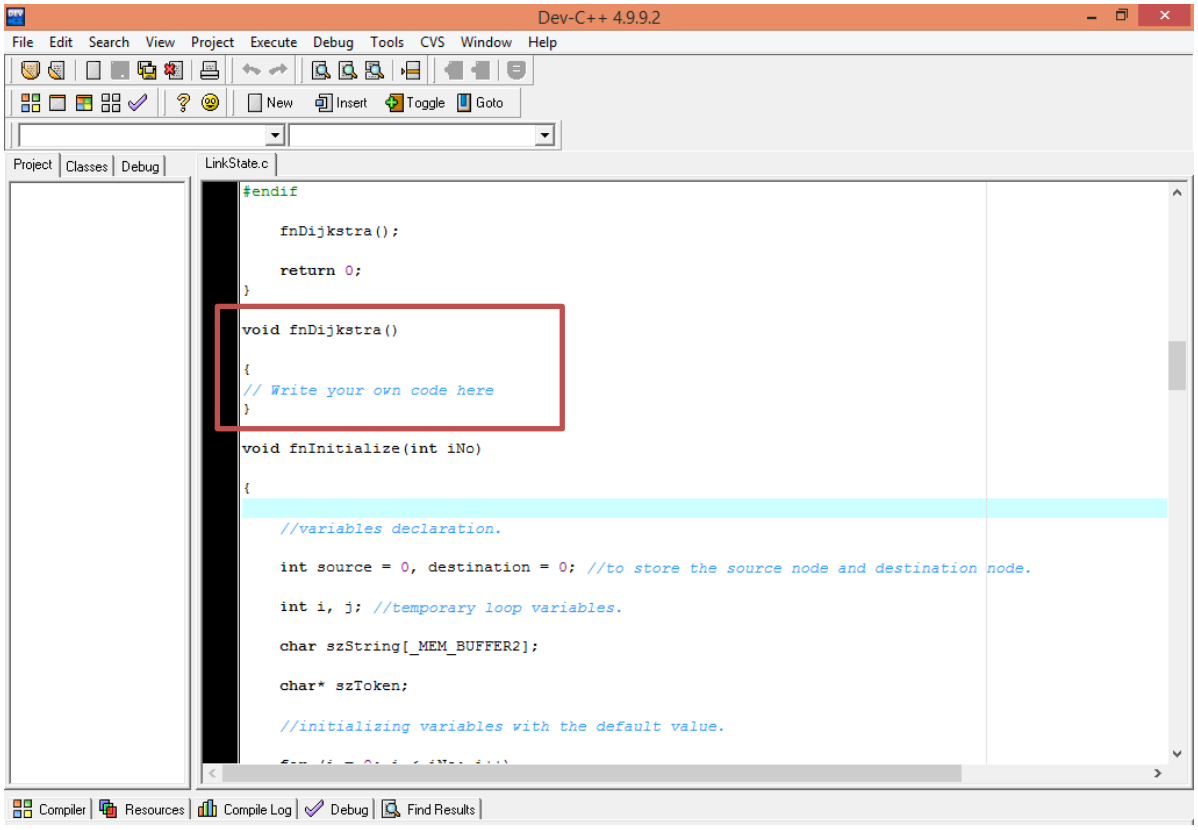
Save it in some other location. In this example, it is saved at D:\New.

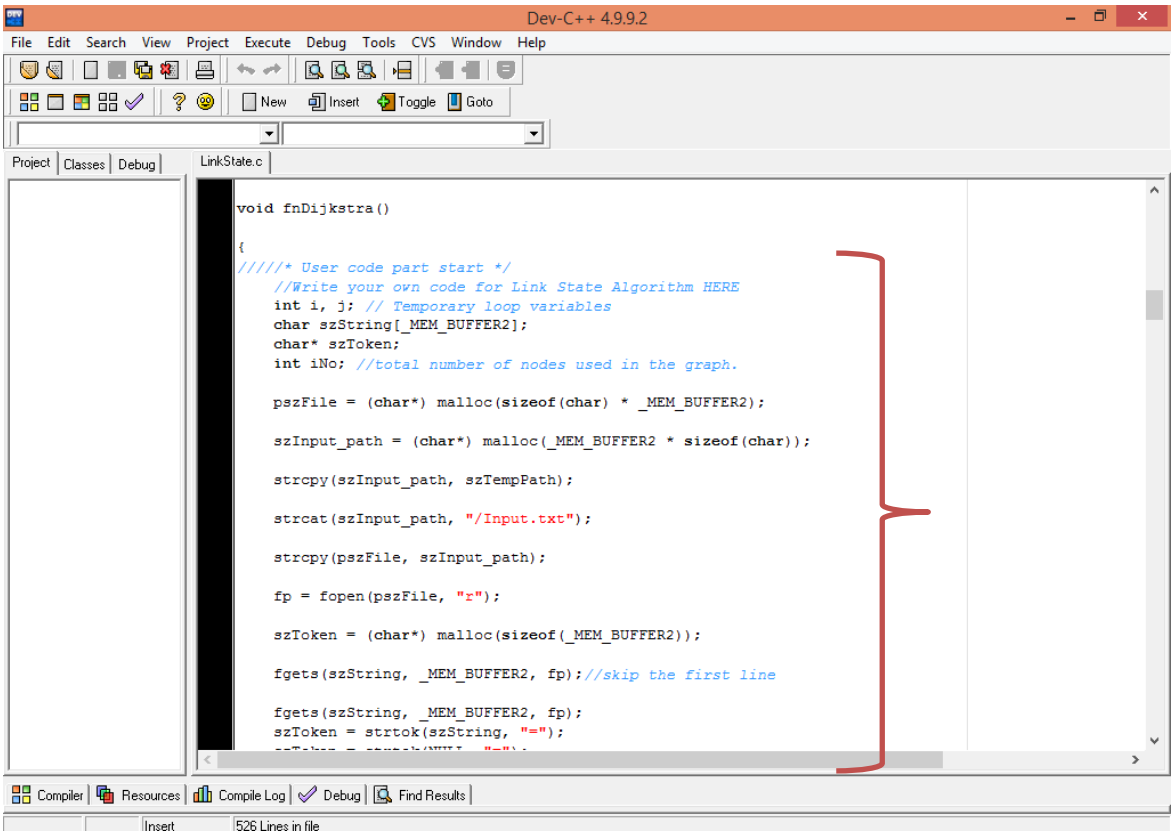
### Step 3: Create .exe file

Open C editor (Turbo C, Dev C++, etc) and write the Interface source code which was saved in the first text file. Also add the code to be written by the user in the specific sections and compile it. Keep the .exe file.

**For Example**:

Now in C editor (Dev C++ IDE is used here), copy the interface source code. In the interface source code, void fnDijkstra() is not implemented.






After writing the code for the function void fnDijkstra(), create .exe file. The procedure to create .exe file is explained in Section 9.2 of NetSim User Manual.

In this example, the exe file created is **LinkState.exe**

## Step 4: Run in command prompt

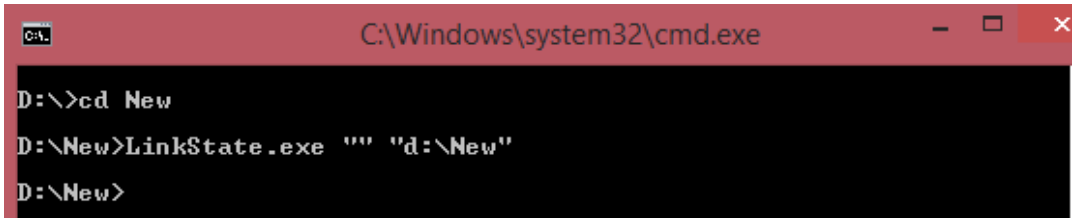
Open command prompt, and go to the folder where the .exe file is saved.

There type

<EXE Name> "<blank>" "<Path where Input.txt is saved>";

**For Example**:

In this example, the exe file **LinkState.exe** and **Input.txt** is present at "D:\New". So in command prompt go to the folder where exe file is saved.




**NOTE:** For Chat programming exercise (**Experiment 6**), type

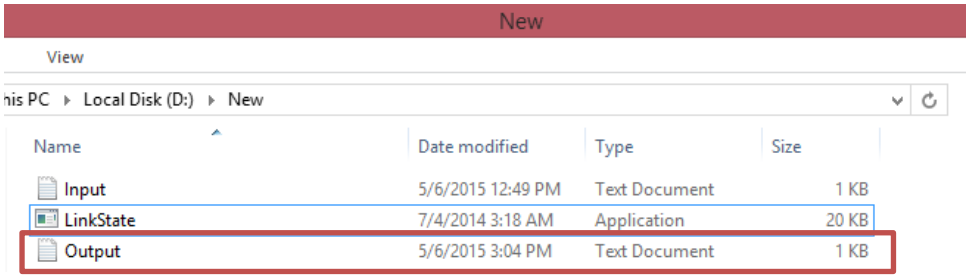
For Sender: <EXE Name> "<blank>" "<Path where Input.txt is saved>" "send"

For Receiver: <EXE Name> "<blank>" "<Path where Input.txt is saved>" "receive"

## Step 5: Check the output.txt file

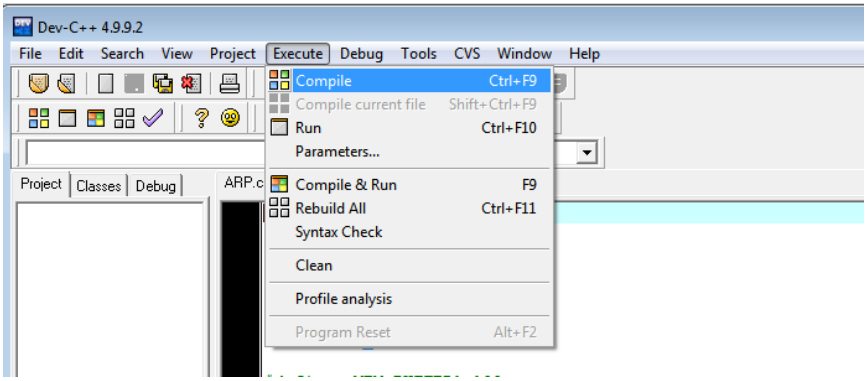
After running in the command prompt, Output.txt file will be created at the same location where Input.txt file is saved. User can compare and check the content of Output.txt file with the NetSim user manual.

**For Example**: Here according to this example, the Output.txt file will be created at "D:\New" folder. User can open the file and compare the content with NetSim user manual Output.txt content.



# Appendix 2: Creating .exe file using Dev C++

1. Open the C source code file in Dev C++. Then go to Execute → Compile.




Dev C++ will create the exe file in the same location where the C source code file is located

**2.** Once exe file is created , link that exe file with NetSim → Programming → User mode

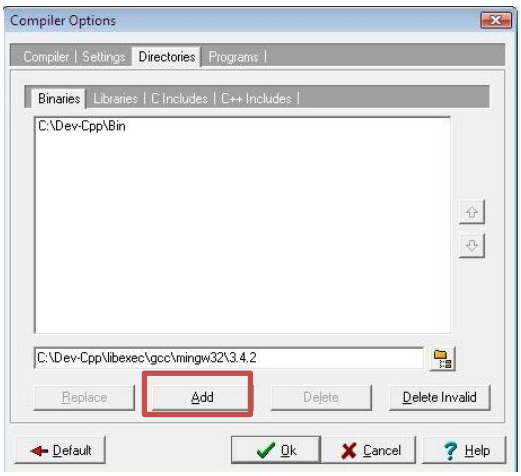
**Note: For Windows 8 and above, use Dev C++ v 5.11**

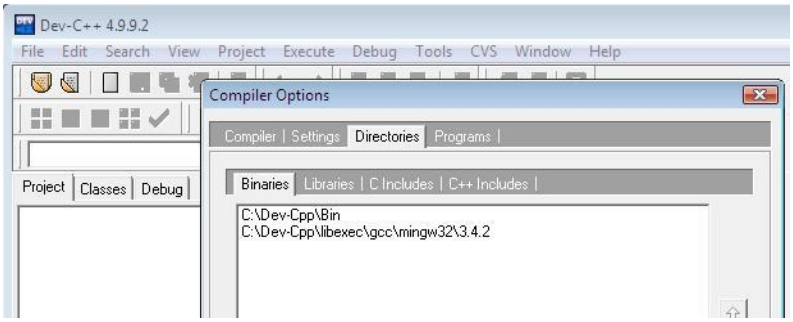
**Note: For Windows Vista, set up Dev C++ as shown below**

In Dev C++ 4.9.9.2.exe, go to Tools->Compiler Options->Directories tab->Binaries tab

Add the following path as per your installation directory in the text box provided and click on add button.

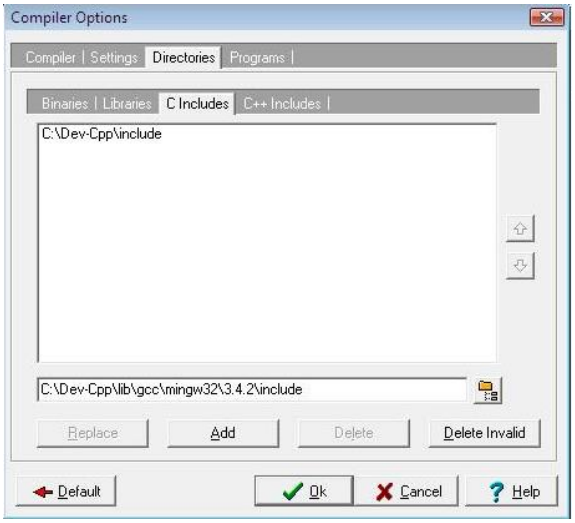
C:\Dev-Cpp\libexec\gcc\mingw32\3.4.2

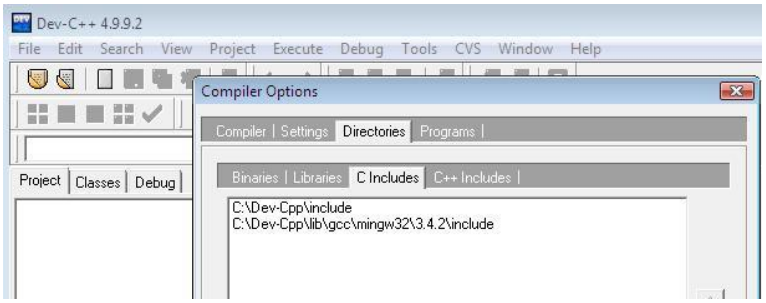




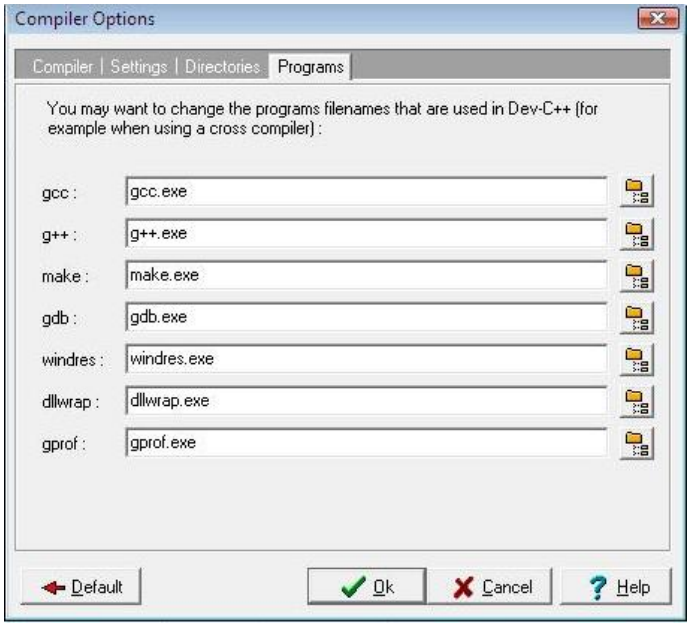

In the C Includes tab add the follwing path in the text box provided and click on add button.

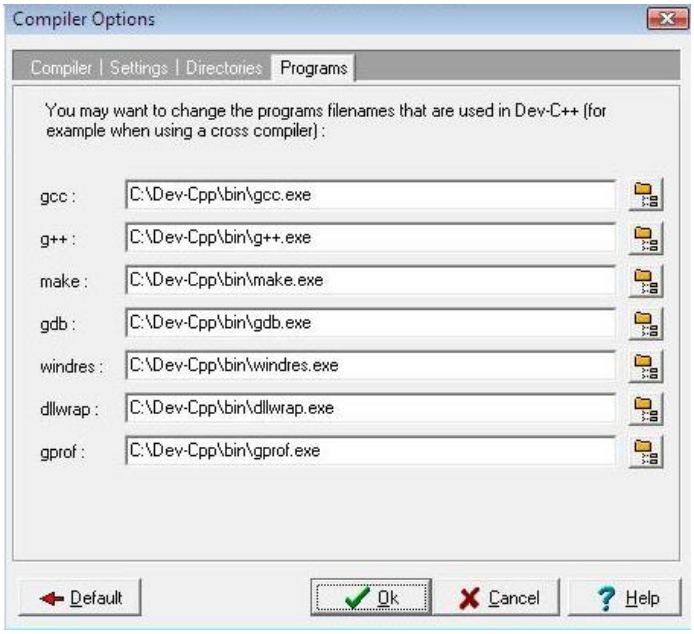
C:\Dev-Cpp\lib\gcc\mingw32\3.4.2\include




In the programs tab edit the following paths as shown in screenshot.


Compiler Options
Compiler | Settings | Directories | Programs
You may want to change the programs filenames that are used in Dev-C++ (for example when using a cross compiler) :
gcc : gcc.exe
g++ : g++.exe
make : make.exe
gdb : gdb.exe
windres : windres.exe
dllwrap : dllwrap.exe
gprof : gprof.exe
Default
Ok
Cancel
Help


Compiler Options
Compiler | Settings | Directories | Programs
You may want to change the programs filenames that are used in Dev-C++ (for example when using a cross compiler) :
gcc : C:\Dev-Cpp\bin\gcc.exe
g++ : C:\Dev-Cpp\bin\g++.exe
make : C:\Dev-Cpp\bin\make.exe
gdb : C:\Dev-Cpp\bin\gdb.exe
windres : C:\Dev-Cpp\bin\windres.exe
dllwrap : C:\Dev-Cpp\bin\dllwrap.exe
gprof : C:\Dev-Cpp\bin\gprof.exe
Default
Ok
Cancel
Help