NETWORK LABORATORY SYLLABUS
PART A – SIMULATION EXERCISES
(Covered in this manual)

The following experiments shall be conducted using either NS228/OPNET or any other simulator.

1. Simulate a 3 node point to point network with duplex links between them. Set the Queue size and vary the bandwidth and find the number of packets dropped.
2. Simulate a 4 node point to point network and connect the links as follows :-
   n0 – n2, n1 – n2 and n2 – n3. Apply TCP agent between n0 – n3 and UDP n1 – n3. Apply relevant applications over TCP and UDP agents changing the parameters and determine the no. of packets sent by TCP / UDP.
3. Simulate the different types of internet traffic such as FTP and TELNET over network and analyze the throughput.
4. Simulate the transmission of PING message over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion.
5. Simulate an Ethernet LAN using N nodes (6-10), change error rate and data rate and compare throughput.
6. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and determine collision across different nodes.
7. Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and plot congestion window for different source / destination.
8. Simulate simple ESS and with transmitting nodes in WIRELESS LAN by simulation and determine the performance with respect to transmission of packets.

PART – B
(Refer PART B Programs Manual)

The following experiments shall be conducted using C/ C++

1. Write a program for error detection code CRC-CCITT (16 bits)
2. Write a program for frame sorting technique used in buffers.
3. Write a program for distance vector algorithm to find suitable path for transmission.
4. Write a program for spanning tree algorithm (Kruskal's / Prims) to find loop less path.
5. Using TCP/IP sockets, write a client server program to make client sending the file name and the server to send back the contents of the requested file if present.
6. **Implement** the above program using a message queue or FIFOs as IPC channels.
7. Write a program for simple RSA algorithm to encrypt and decrypt the data.
8. Write a program for Hamming Code generation for error detection and correction.
9. Write a program for Congestion Control using Leaky Bucket algorithm.

INTRODUCTION

Why do we need a Network Simulator?

Networking systems have become very complex and expensive. Therefore, hands-on experiments based on networking simulation have become essential for learning computer networking topics. Therefore, simulation approach is highly useful because it provides a virtual environment for an assortment of desirable features such as modeling a network based on a specific criteria and analyzing its performance under different scenarios.

OPNET Simulator:

OPNET (Optimized Network Engineering Tool) is a comprehensive development environment for the specification, simulation and performance analysis of communication networks. Discrete event simulations are used as the means of analyzing system performance and their behavior. OPNET provides solutions for various problems which involves application performance troubleshooting, application deployment planning, systems capacity planning, network configuration auditing, network capacity and resiliency planning, and network technology R&D. OPNET has wide range of products supporting various wired and wireless networking technologies. It includes OPNET IT Guru, OPNET Modeler, OPENET Commander, OPNET Panorama, WDM Guru, ODK etc. For more information visit: http://www.opnet.com .

OPNET IT Guru:

IT Guru is a product which is sold with OPNET modules to provide solutions in the areas of application performance analysis, network configuration analysis, and predictive capacity planning with network, application, server, and mainframe models.

How to install OPNET IT Guru Academic Edition?

1. If your computer meets the system requirements, shown below, then register yourself and download the software from: https://enterprise37.opnet.com/4dcgi/SIGNUP_NewUserOther
2. Complete the form.
3. You will get an email containing a username and password and a link for downloading the software. Follow the instructions on the website for downloading the software.
4. After downloading the software, double-click on the file which you just downloaded.
5. Follow the on screen instructions to install the software.

System Requirements:

- Intel Pentium III, 4 or compatible (500 MHz or better)
- 256 MB RAM
- 400 MB disk space
- Display: 1024x768 or higher resolution, 256 or more colors
- The English language versions of the following operating systems are supported:
  - Microsoft Windows NT (Service Pack 3, 5, or 6a (Service Packs 4 and 6 are not supported)),
  - Windows 2000 (Service Pack 1 and 2 are supported but not required),
  - Windows XP (Service Pack 1 is required).

How to start OPNET IT Guru Academic Edition?

1. Click on **Start/ Programs/OPNET IT Guru Academic Edition/ OPNET IT Guru Academic Edition**. (OPNET

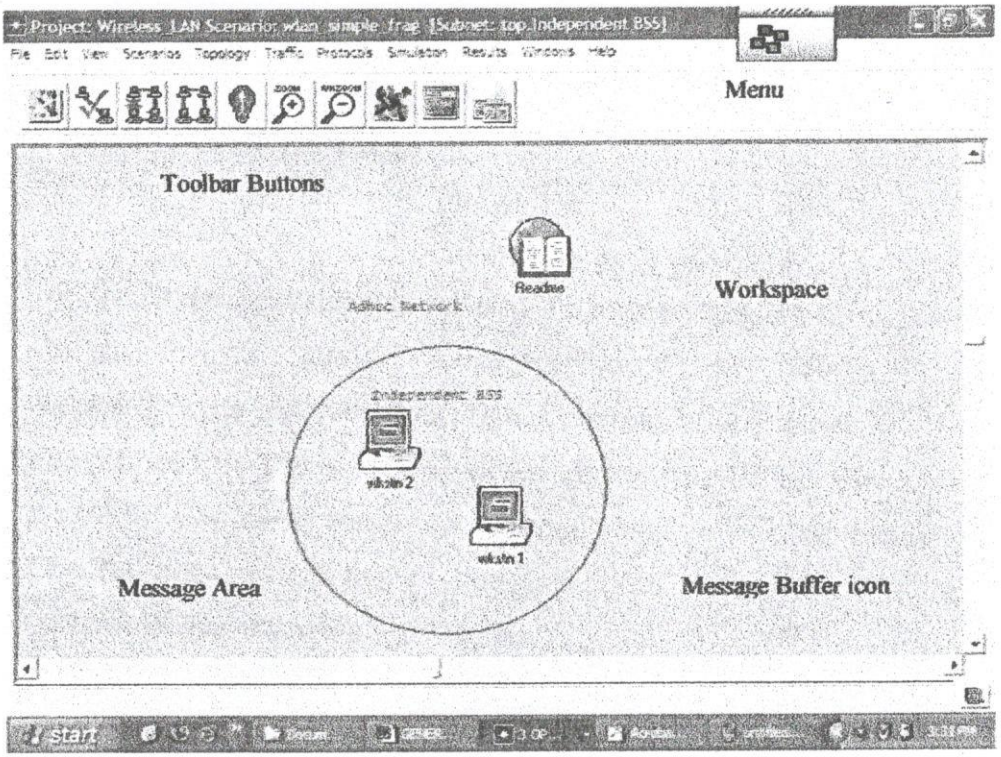
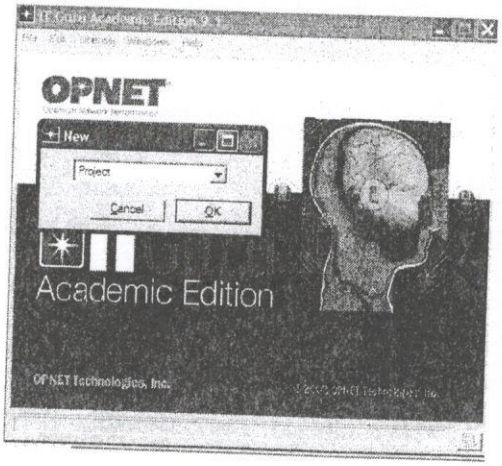
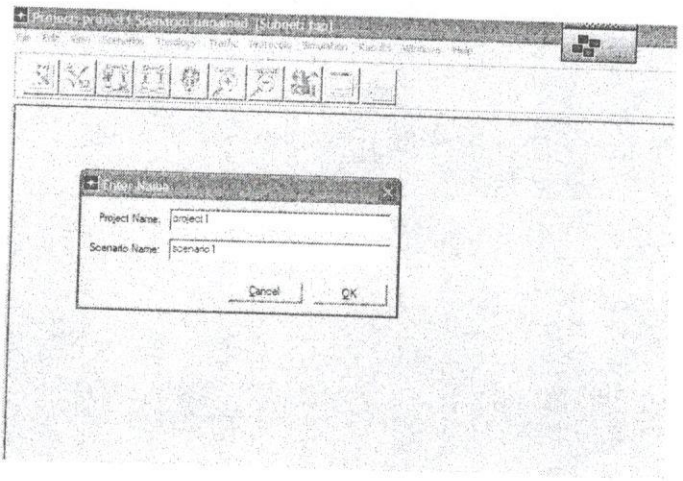


Fig1. OPNET Environment

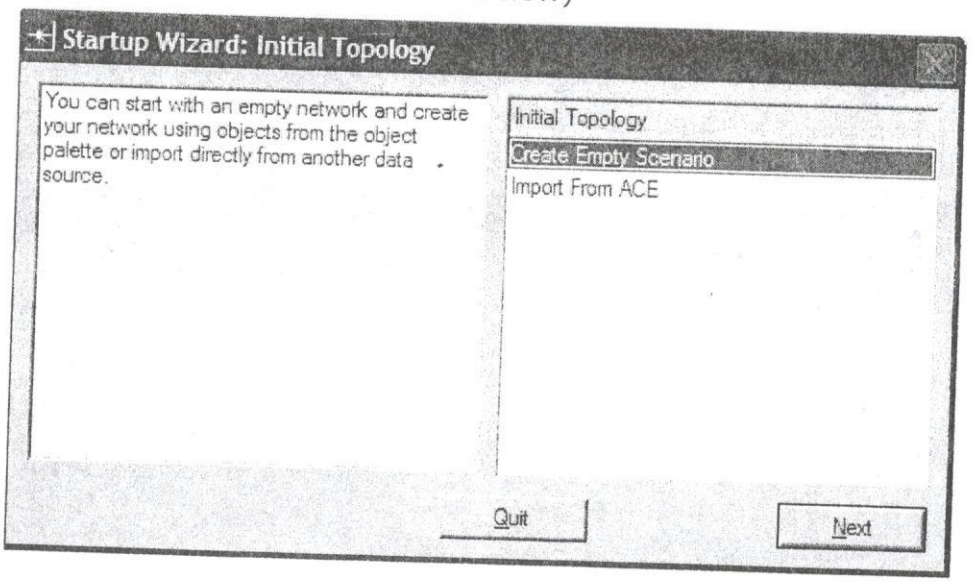
To create a New Project

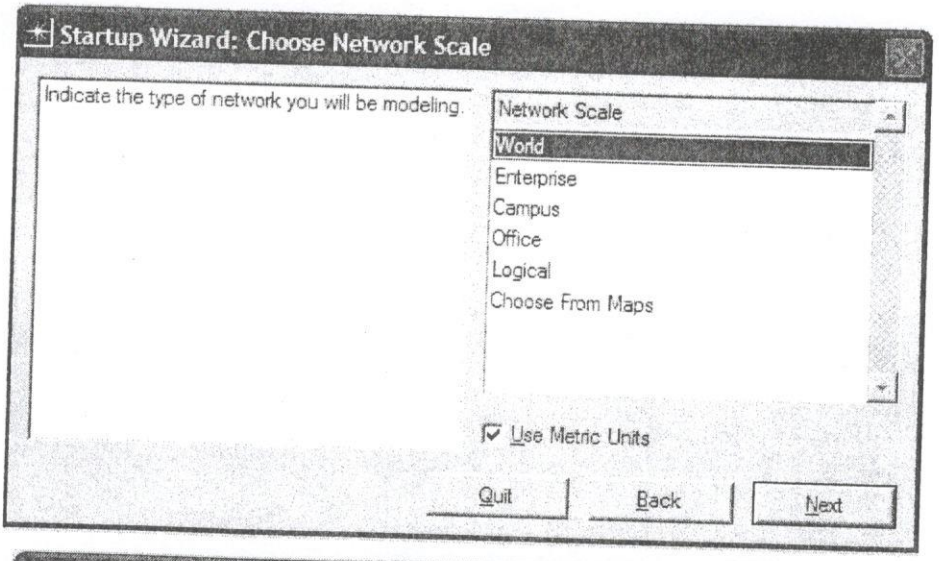
1. Choose **New** from **File** menu.
2. Select **Project** => click **Ok** => name the project and the scenario => click **Ok**.

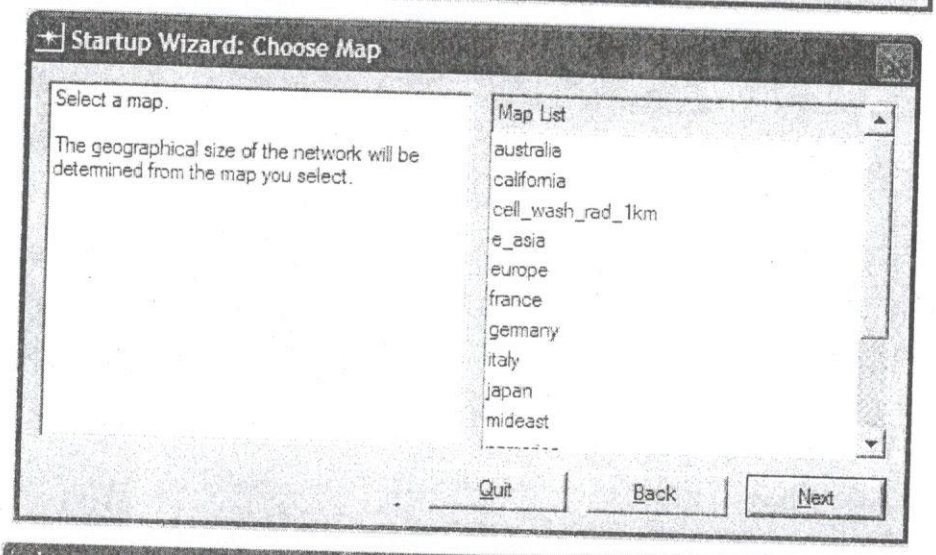


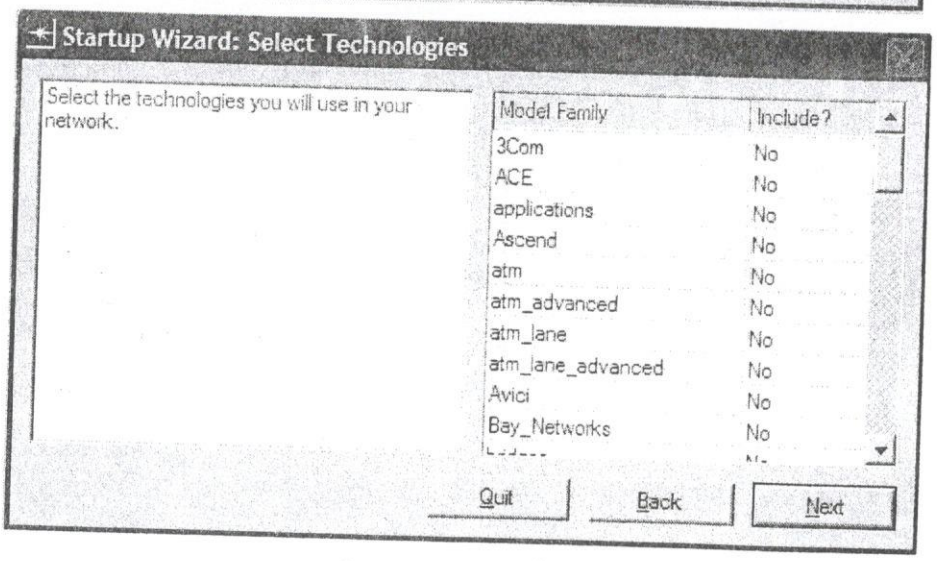


3. In the **Startup Wizard: Initial Topology** dialog box, select Create Empty Scenario =>Click next => choose from Network Scale list World / Office / Logical or any other choices depending on the network scale requirement for the given problem => click Next => choose map => click twice=> Choose networking technology => click next => click Ok. (stepwise events are shown below)




Startup Wizard: Choose Network Scale
Indicate the type of network you will be modeling.
Network Scale
World
Enterprise
Campus
Office
Logical
Choose From Maps
Use Metric Units
Quit
Back
Next


Startup Wizard: Choose Map
Select a map.
The geographical size of the network will be determined from the map you select.
Map List
australia
california
cell_wash_rad_1km
e_asia
europe
france
germany
italy
japan
mideast
Quit
Back
Next


Startup Wizard: Select Technologies
Select the technologies you will use in your network.
Model Family
Include?
3Com No
ACE No
applications No
Ascend No
atm No
atm_advanced No
atm_lane No
atm_lane_advanced No
Avici No
Bay_Networks No
Quit
Back
Next

4. Further procedures would involve creating network model, configuration of different entities of the network model, making simulation settings, choosing the statistics, running simulation and viewing results.

Note: A brief description of each component used in OPNET is available to the user. This can be accessed by placing the object and right clicking on it, then selecting the "View Node Description" option. This helps the user understand the various aspects of the object.

Some Common Objects Used in simulation using OPNET:

1. **Application Configuration**: This is used to define the applications that are generating traffic in the network. We have a wide range of choices with some being ftp, video conferencing, telnet (remote login), voice etc. Most of the experiments make use of it for generating traffic.

2. **Profile Configuration**: This is used to set the profile for the application. It sets the other features of the application such as, repetition rate, start time, etc. The repetition rate follows a distribution such as uniform, exponential, etc. The user needs to define what kind of probability distribution to apply to the traffic generation. So we apply **exponential distribution** if we want a **steep rise** in number of packets generated. If a **constant generation rate** is required then we apply **constant**. The number gives the mean (for other distribution) and the time for constant.

General Steps to work on any OPNET Simulation Exercises in the syllabus.

Step 1: Open the Object Palette and drag and drop into the workspace, the components you will need for the network you want to simulate.

Step 2: Create the network topology based on the problem given.

Step 3: Drag and drop the *application configuration* and *profile configuration* objects for the network from the object palette. In some problems you don't need them. For e.g.: Problem 5, 8 etc.

Step 4: Close the Object palette. Configure each of the objects taken from the object palette.

Step 5: Right click on the workspace and give the parameters you need to measure for the network in the Global, Node or Link Statistics.

Step 6: Run the simulation

Step 7: View / Compare the results of the scenarios. In some cases we will need to duplicate the scenario and change the Profile Configuration or each of the individual objects or the Statistics.

Please Note: It is told to change the Results representation as 'Sample Sum' or 'As Is' or 'Average' etc. This is to ensure that the results are viewed in the best possible way, so that we can interpret the results very easily.

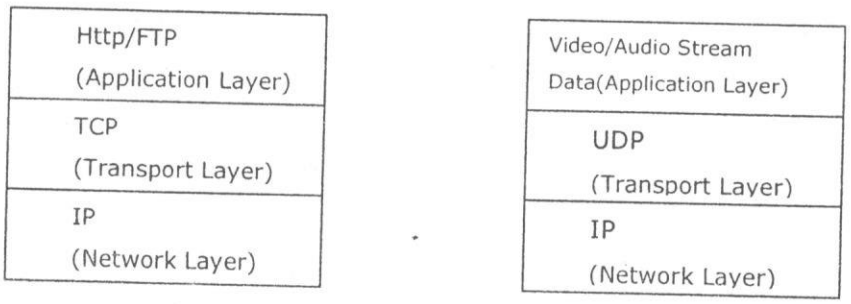
Revision of Concepts and Terms that are used in the Simulation Exercises

1. 10 Base T: This is a Link Model we usually choose. It stands for 10 Mbps Base band transmissions. The 'T' stands for Twisted Pair. The maximum segment length is 100m and it is usually used for a 'Star' Topology with the nodes connected via twisted pair to a hub. Other Link Models are:

a) **10 Base 5** --- Thick Coaxial Cable 500 meters, usually in a 'Bus' Topology.

b) **10 Base 2**--- Thin Coaxial Cable 200 Meters usually in a 'Bus' Topology.

2. TCP Transport Protocol would guarantee high reliability of data transmitted, but low data rate, whereas **UDP** gives very high data rate, but low reliability.



3. Throughput: The actual rate at which information is sent over a channel. It is measured in bits/second or frames/second. When the load is high, the number of collisions increases, therefore retransmissions increases decreasing the throughput.

4. Congestion Window: The maximum number of bytes that a TCP sender is allowed to transmit with the assumption that congestion will not be triggered with the given amount of data. In simple words, it is the amount of data that the sender can transmit without creating congestion in the network.

Practically, the sender ***adjusts*** the congestion window according to the current condition of the network.

Problem 1:

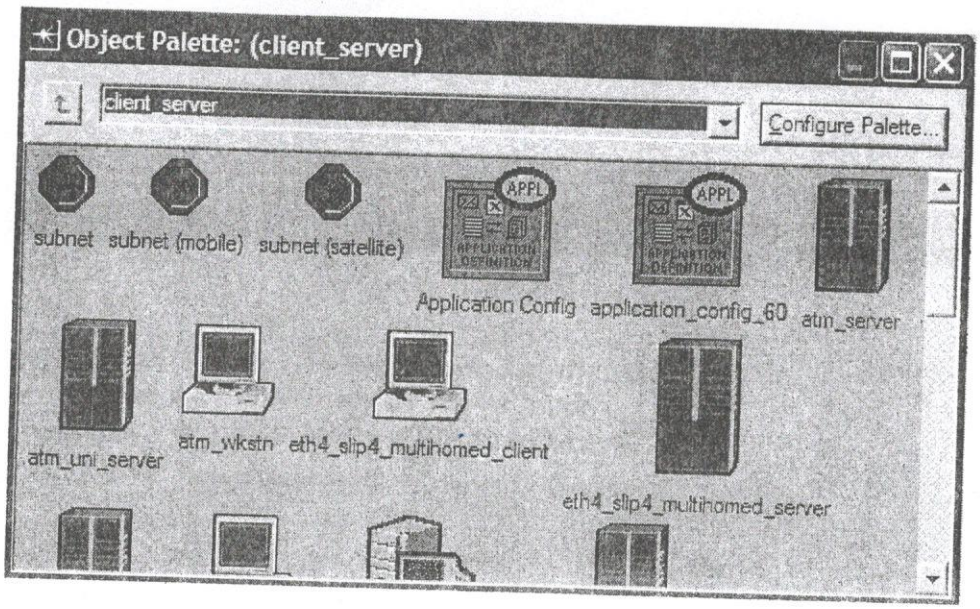
Simulate three nodes point-to-point networks with duplex links between them. Set the queue size and vary the bandwidth and find the number of packets dropped.

Solution:

Step 1: Create a New Project

Step 2: Create the Network

- Select **Object Palette** box.
- Select **Client_server** from drop down menu.



- Choose **eth4_slip4_multihomed_client objects** (3 numbers).
- Choose **Application Config**, and **Profile Config** objects.
- Select **ethernet** from **Object Palette**.
- Choose **10baseT** link and connect the client nodes. (as shown in Fig 2.)
- Close the **Object Palette** box.

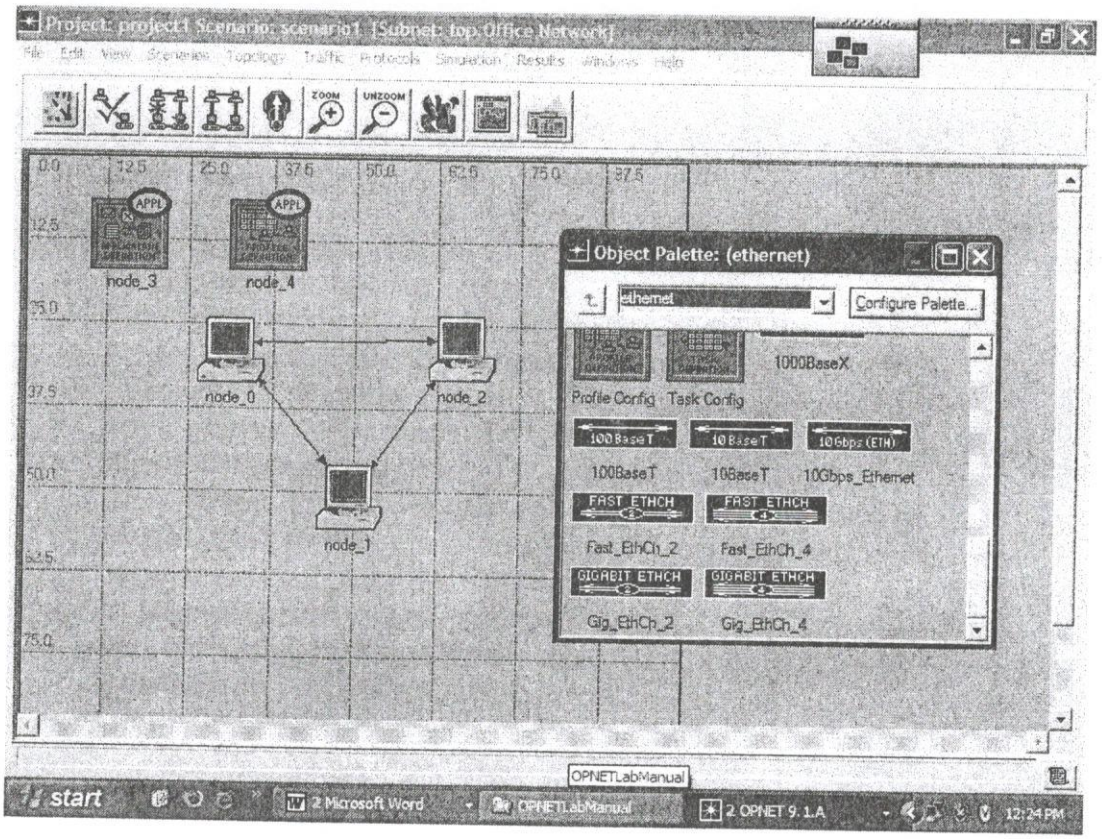
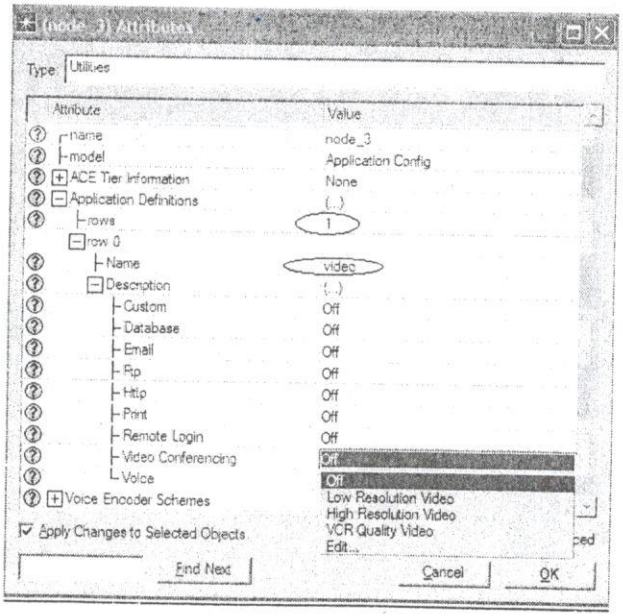


Fig 2. Point-to-Point Network

Step 3: Configure the Network Application

- Select **Application config** object.
- Right click and select **Edit Attributes**.

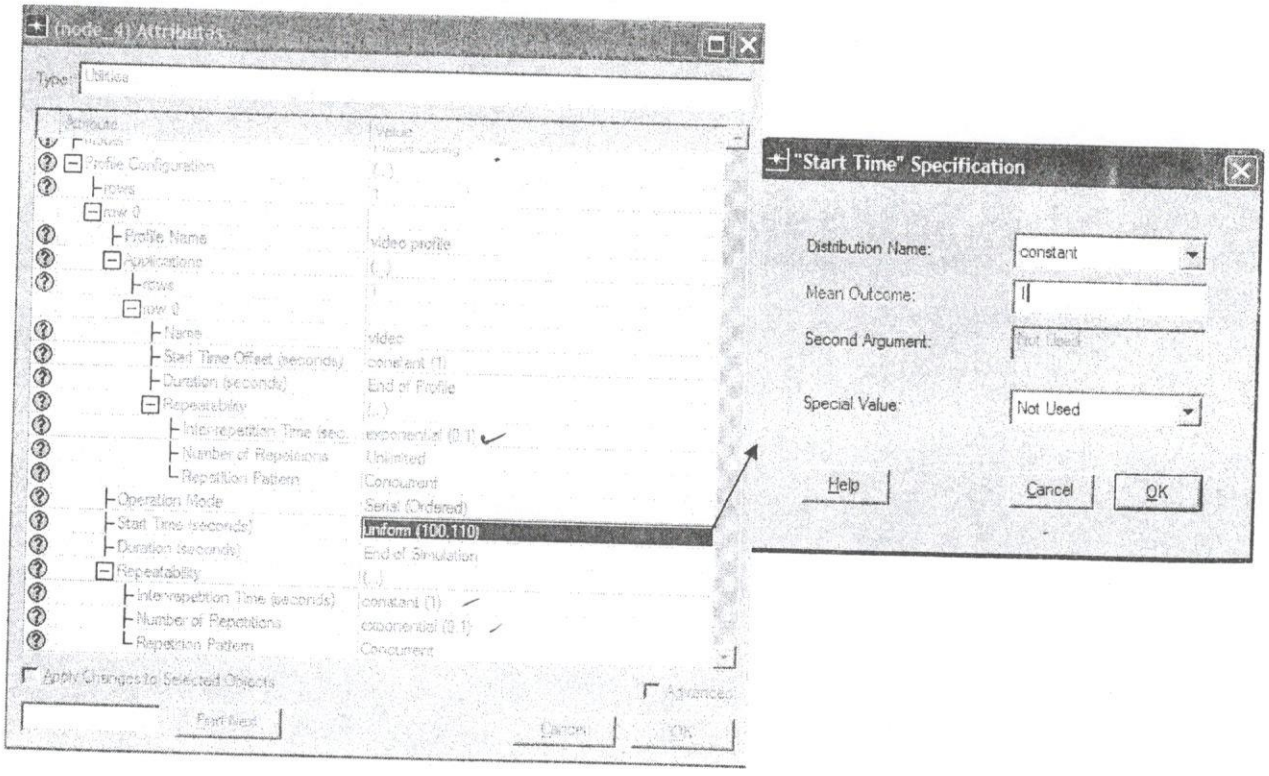


- Select **Application Definitions** => set row = 1.
- In row go to row0 => set **Name** = video. Select **description** => set **Video Conferencing** = **High Resolution Video**.
- Click **Ok**.

Step 4: Configure the Profile

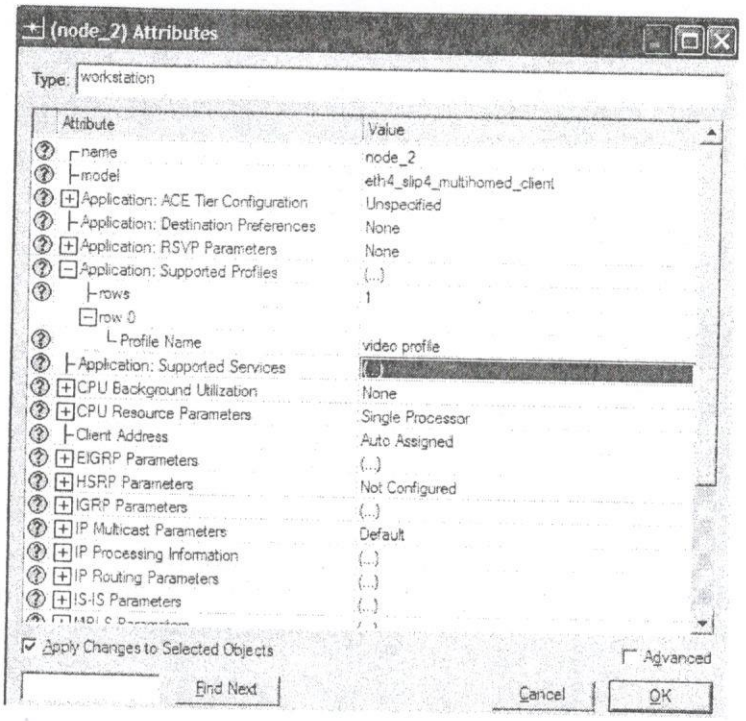
- Select **Profile config** object.
- Right click and select **Edit Attributes**.
- Select **Profile Configuration**. Set row = 1.
- In row0, set **Profile Name** = video profile. Select Applications. Set row=1.Go to row0 set **Name** = video, **Start Time Offset** to constant(1), in **Repeatability**, **Inter Repetition Time** to exponential(0.1) and **Number of Repetition** to unlimited and **Repitation Pattern** to concurrent.
- In **Repeatability**, **Inter Repetition Time** to constant (1) and **Number of Repetition** to exponential (0.1) and **Repitation Pattern** to concurrent.
- Click **Ok**.

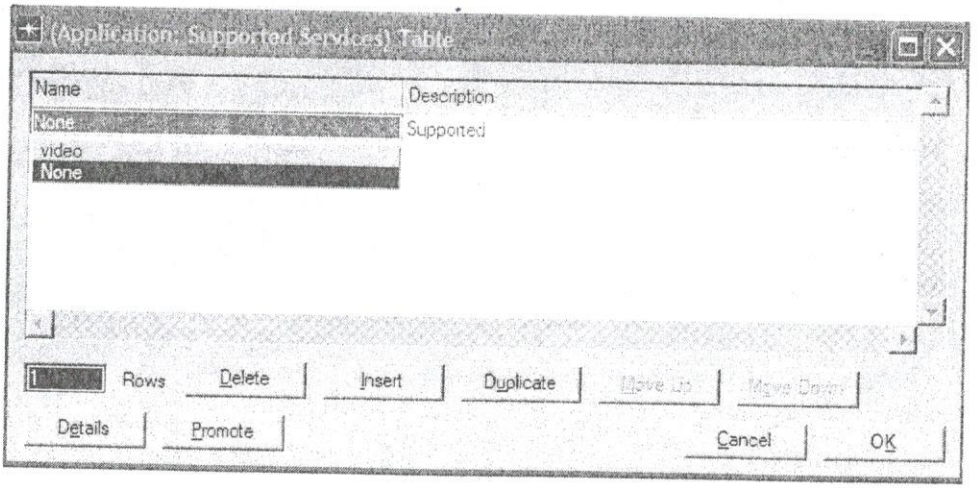
For any ambiguity in the above steps, please refer to the diagram below.



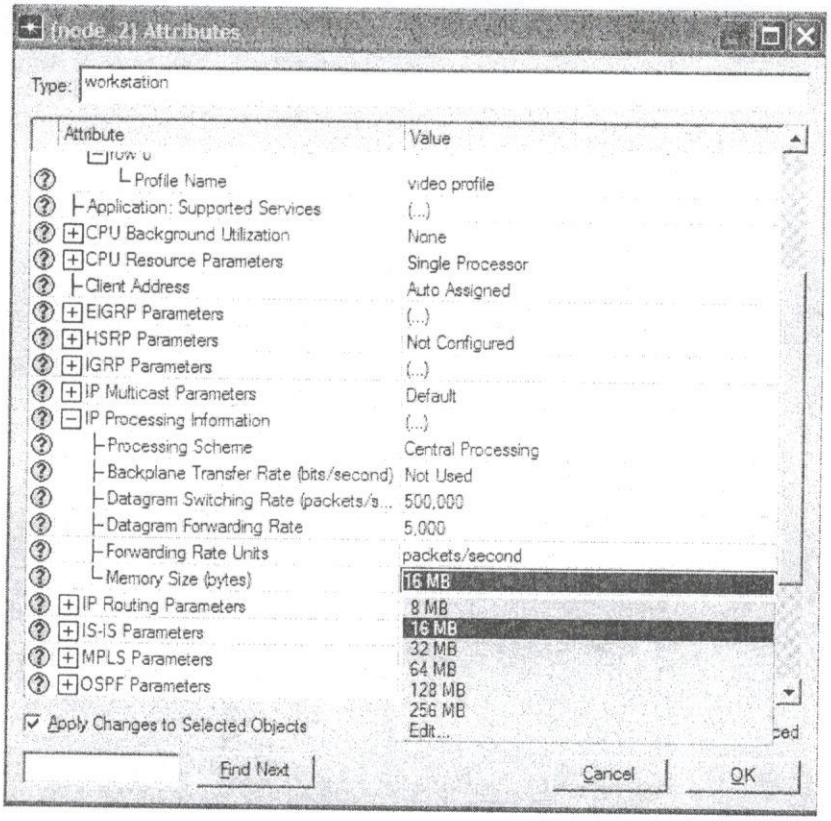
Step 5: Configure Network Objects

- Select any **eth4_slip4_multihomed_client**.
- Right click and **Select Similar Nodes**.
- Right click and **select Edit Attributes**.
- Select **Application Support Profiles** => set rows to 1.
- In rows => go to row0 => set **Profile Name** = video profile.
- Select **Application Support Services**. Select edit => set rows =1. Set Name = video for that row.





- Select **IP Processing Information** => set **Memory Size** to 8MB => set **Datagram Forwarding Rate** to 5000.
- Check **Apply Changes to Selected Objects**.
- Click **Ok**.



Step 6: Selecting Statistics for viewing results

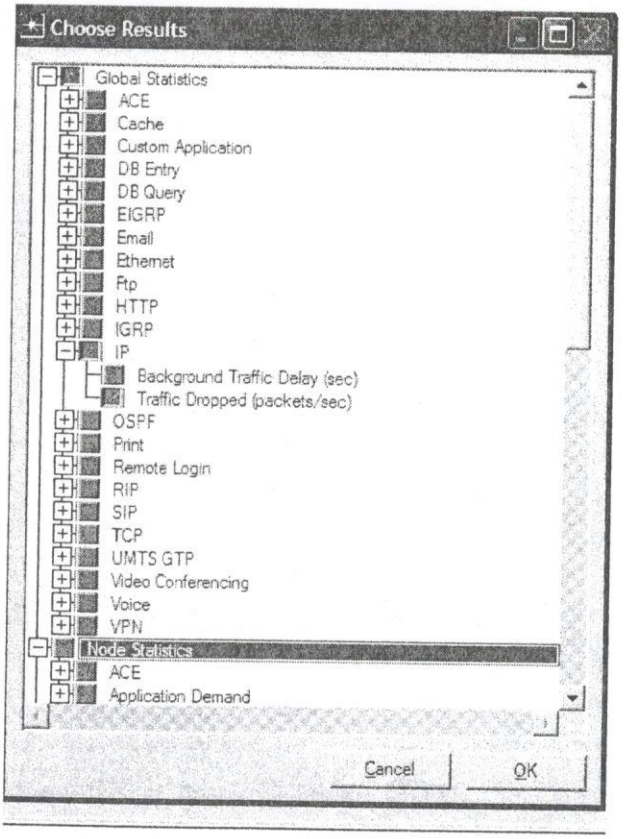
- Right click on the work space and select choose individual statistics => in **Global Statistics** go to **IP**, select **traffic dropped**.
- In **Node Statistics** => select **IP** =>**Traffic Dropped (Packets/Sec)**, **Traffic Received (Packets/Sec)** and **Traffic Sent (Packets/Sec)**.
- Click **Ok**.

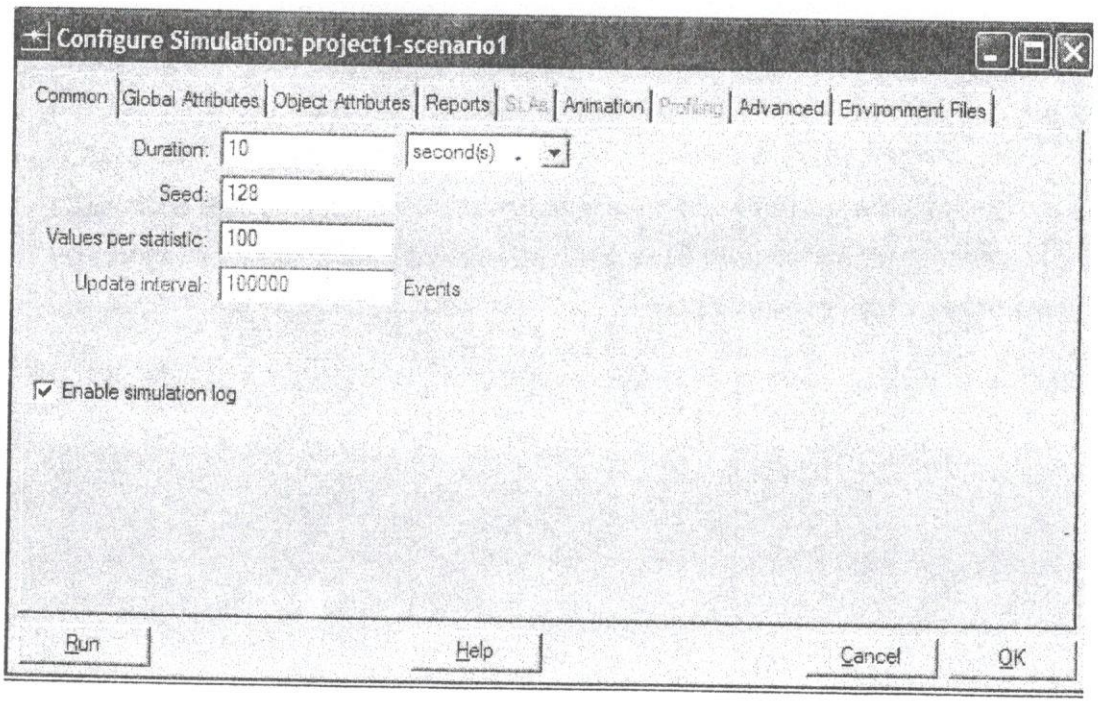
Step 7: Run the simulation

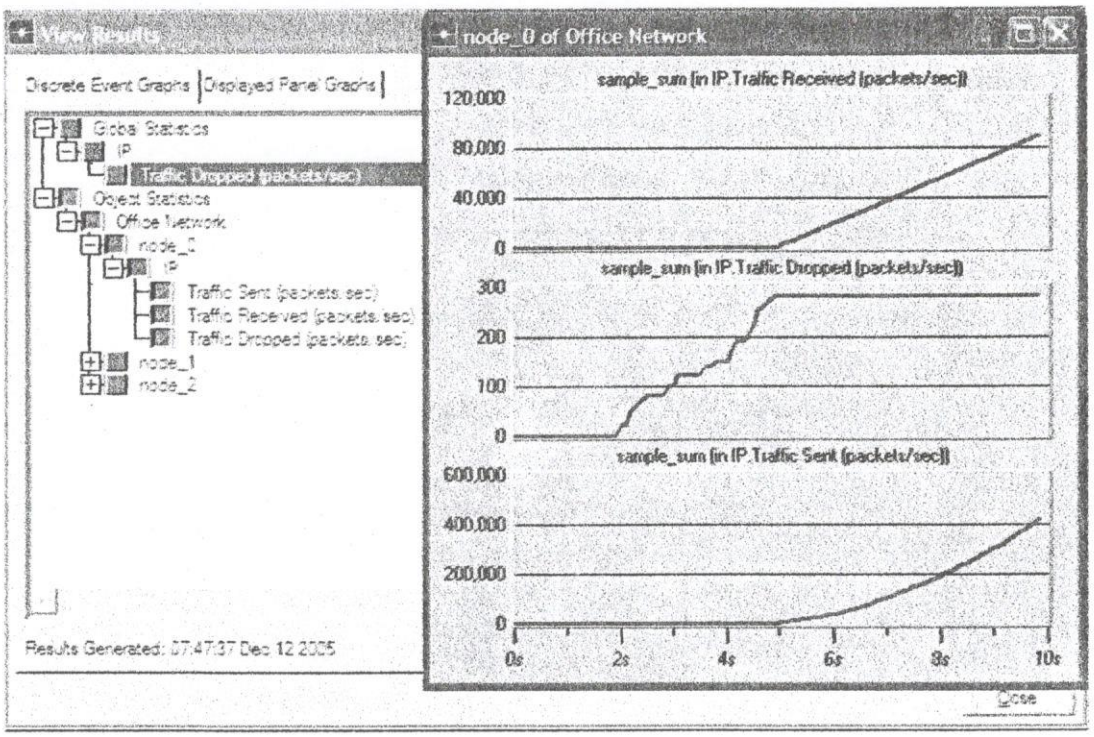
- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 10 seconds.
- Click **Run**.

Step 8: View Results

- Right click on the work space and select **View Results**.
- Select the statistics from the **View Results**.
- Select **Sample Sum** instead of **As Is**.
- Click **Show** button to view the graphs.

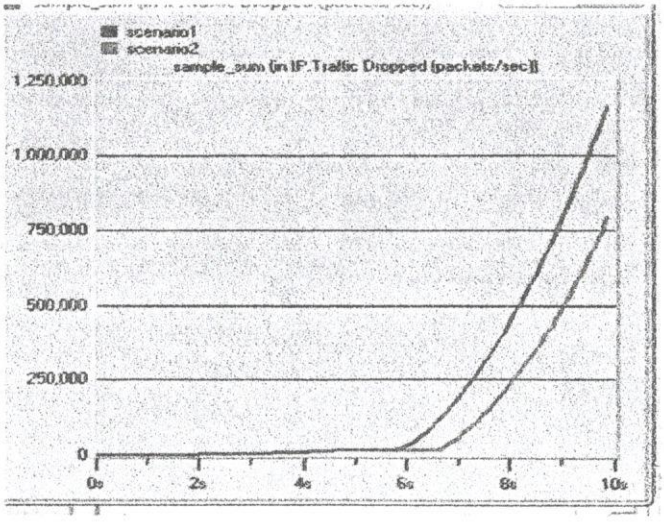

Choose Results
Global Statistics
ACE
Cache
Custom Application
DB Entry
DB Query
EIGRP
Email
Ethernet
Ftp
HTTP
IGRP
IP
Background Traffic Delay (sec)
Traffic Dropped (packets/sec)
OSPF
Print
Remote Login
RIP
SIP
TCP
UMTS GTP
Video Conferencing
Voice
VPN
Node Statistics
ACE
Application Demand
Cancel
OK


Configure Simulation: project1-scenario1
Common
Global Attributes
Object Attributes
Reports
Animation
Advanced
Environment Files
Duration:
10
second(s)
Seed:
128
Values per statistic:
100
Update interval:
100000
Events
Enable simulation log
Run
Help
Cancel
OK



To Vary Bandwidth and Queue Size:

1. Select **Duplicate Scenario** from **Scenario** menu. Name the scenario.
2. You can vary the queue size and bandwidth by changing the values of **Memory size** and **Datagram Forwarding Rate** as in Step 5 of the procedure above. Change it to 16 Mb and 10000 respectively.
3. Run the Simulation. You can compare the results by clicking on **Compare Results** from the **Results** menu. ***Ideally the number of packets dropped must be less and should resemble this graph.***



Problem 2:

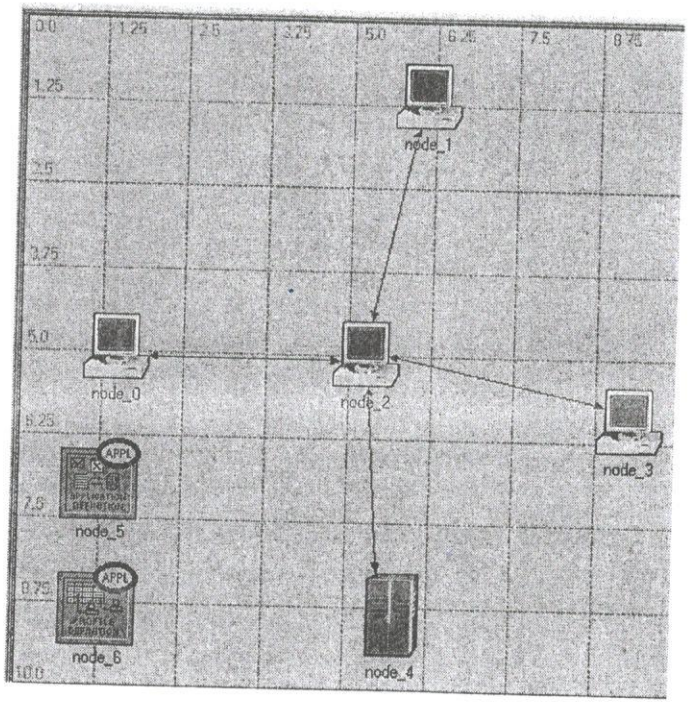
Simulate a four-node point-to-point network, and connect the links as follows: n0->n2, n1->n2 and n2->n3. Apply TCP agent changing the parameters and determine the number of packets sent/received by TCP/UDP.

Solution:

Step 1: Create a New Project

Step 2: Creating network topology:

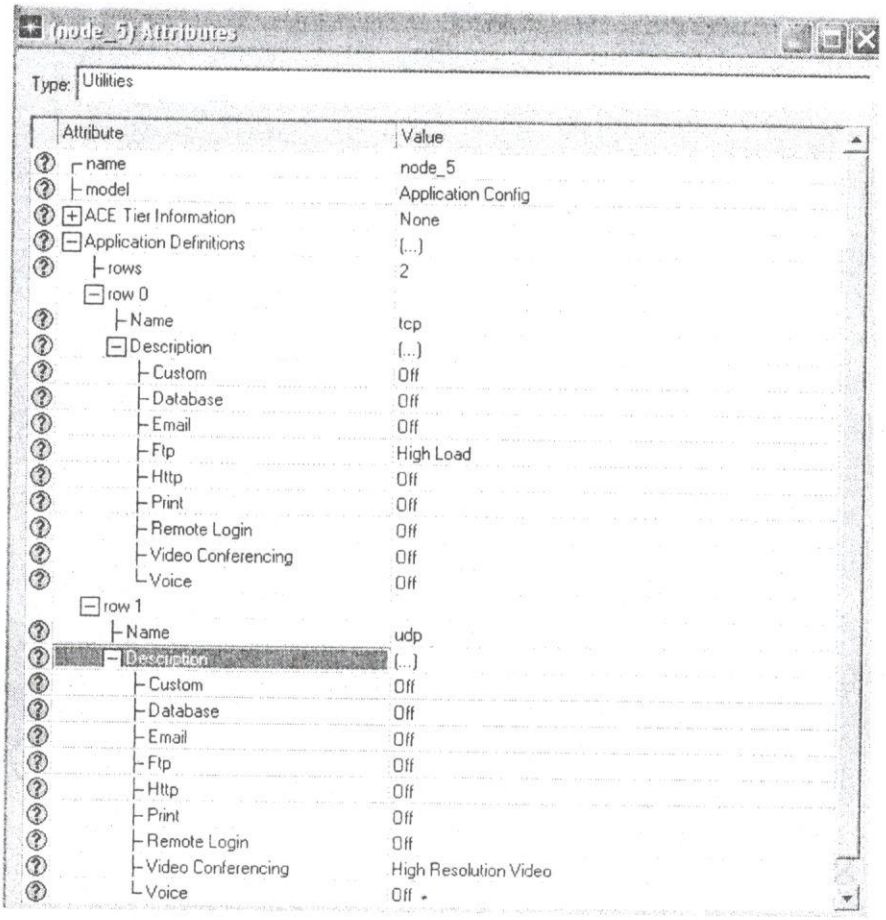
- Select **eth4_slip4_multihomed_client** (4 numbers) from the **client_server** tool in Object Palette.
- elect an **ethernet_server**.
- Select **ethernet** from Object Palette.
- Connect them using the **10BaseT** links.
- Select **Application Config** and **Profile config** objects.



Step 3: Configuring network application

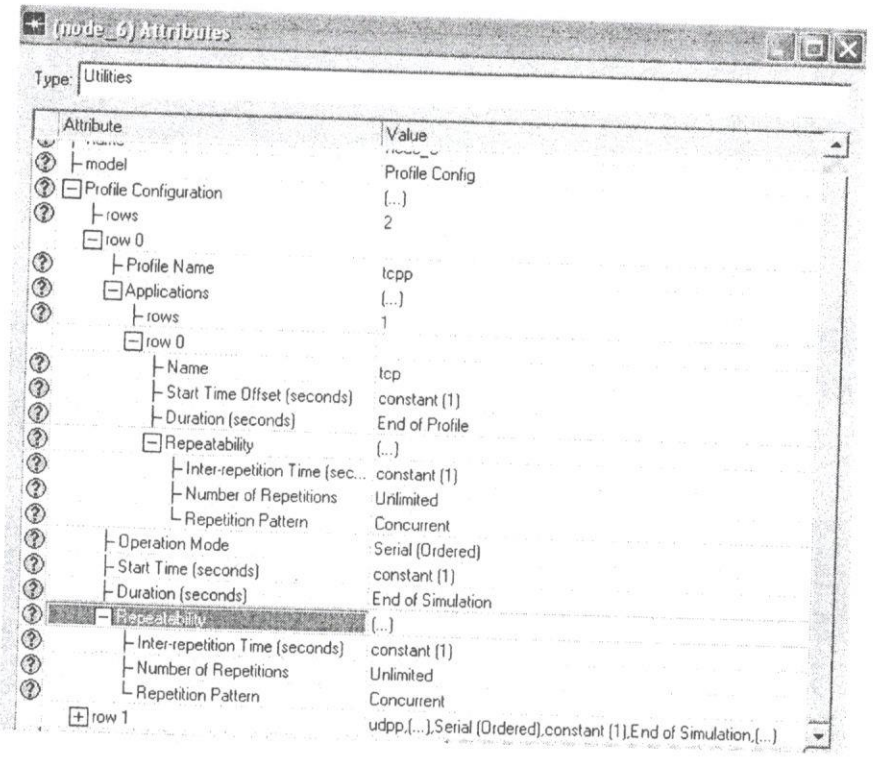
- Right click on the **Application definition** object.
- Select **Edit Attributes**.
- Select 2 rows for applications
- Select the FTP application for TCP traffic and set the traffic to High Load.

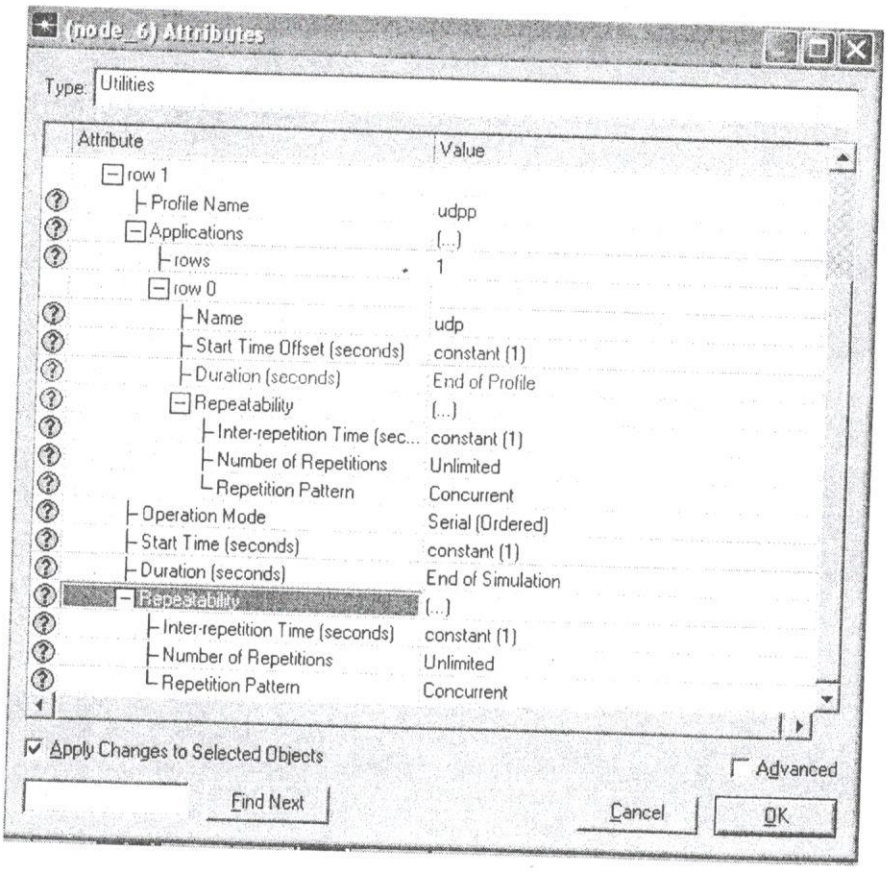
- Select the video conferencing application for UDP traffic and set the traffic to High-Resolution Video.
- Check **Apply Changes to Selected Objects** and click **Ok**.



Step 4: Configure profile

- Right click on **Profile Definition** object and select **Edit Attributes**.
- TCP profile: Assign the values for the various fields as shown in the Fig. below.
- Click on **Apply Changes to Selected Objects** and click on **OK**.


(node_6) Attributes
Type: Utilities
Attribute
Value
model
Profile Config
Profile Configuration
(...)
rows
2
row 0
Profile Name
tcpp
Applications
(...)
rows
1
row 0
Name
tcp
Start Time Offset (seconds)
constant (1)
Duration (seconds)
End of Profile
Repeatability
(...)
Inter-repetition Time (sec...
constant (1)
Number of Repetitions
Unlimited
Repetition Pattern
Concurrent
Operation Mode
Serial (Ordered)
Start Time (seconds)
constant (1)
Duration (seconds)
End of Simulation
Repeatability
(...)
Inter-repetition Time (seconds)
constant (1)
Number of Repetitions
Unlimited
Repetition Pattern
Concurrent
row 1
udpp,(...),Serial (Ordered),constant (1),End of Simulation,(...)

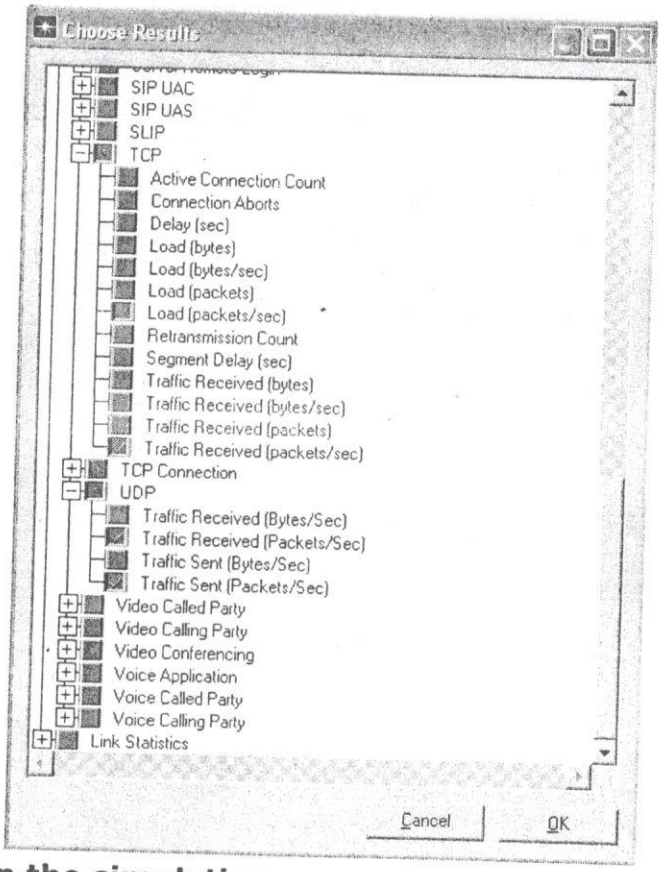

(node_6) Attributes
Type: Utilities
Attribute
Value
row 1
Profile Name
udpp
Applications
(...)
rows
1
row 0
Name
udp
Start Time Offset (seconds)
constant (1)
Duration (seconds)
End of Profile
Repeatability
(...)
Inter-repetition Time (sec...
constant (1)
Number of Repetitions
Unlimited
Repetition Pattern
Concurrent
Operation Mode
Serial (Ordered)
Start Time (seconds)
constant (1)
Duration (seconds)
End of Simulation
Repeatability
(...)
Inter-repetition Time (seconds)
constant (1)
Number of Repetitions
Unlimited
Repetition Pattern
Concurrent
Apply Changes to Selected Objects
Advanced
Find Next
Cancel
OK

Step 5: Configure the network objects

- Right click on the appropriate object i.e. client node or ethernet server.
- Select **Edit Attributes**.
- Click on **Application Supported Profiles** and choose edit.
- Apply both the profiles to the client nodes.
- Click **Ok**.
- Click on **Application Supported Services** and choose edit.
- Apply the FTP application in case of Ethernet server object and for client nodes select the Video application.
- This is to simulate FTP-TCP-IP for Server and Video-UDP-IP for client nodes.
- Click **Ok**.
- Check **Apply Changes to Selected Objects** and click on **Ok**.

Step 6: Choose statistics:

- Right click on the workspace and Select **Choose Individual Statistics** from Node **Statistics** as shown below.

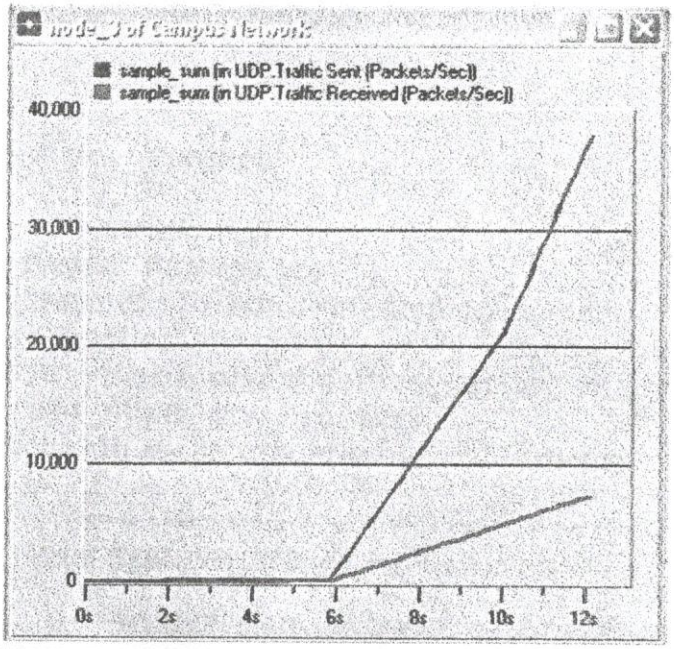


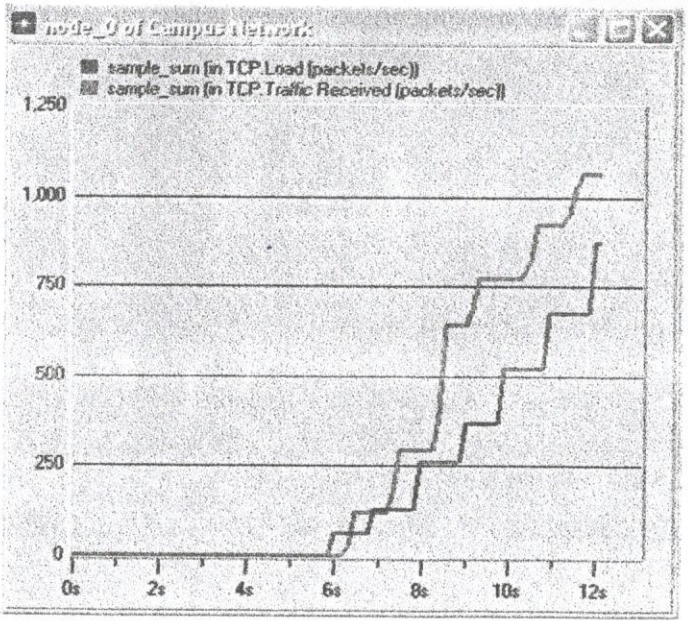
Step 7: Run the simulation

- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 15 seconds.
- Click **Run**.

Step 8: View Results

- Right click on the work space and select **View Results**.
- Select the statistics from the **View Results**.
- Click **Show** button to view the graphs.





Interpretation:

Notice the difference in scale in the Y-Axis. For TCP the range is in 1000s and in UDP in 10000s. This means the amount of data sent and received in UDP is much higher than that in UDP, which implies a higher data rate and therefore a higher data loss.

These graphs show that for UDP the loss rate is high especially since this is a video conferencing application with high data rate. However for TCP, since congestion control is applied the loss rate is less and we see a more even graph with less loss.

Problem 3:

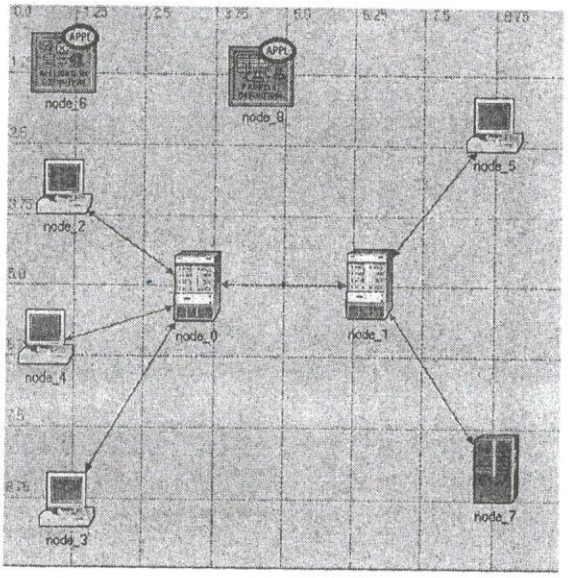
Simulate the different types if internet traffic such as FTP, TELNET over a network and analyze the throughput.

Solution:

Step 1: Create a New Project

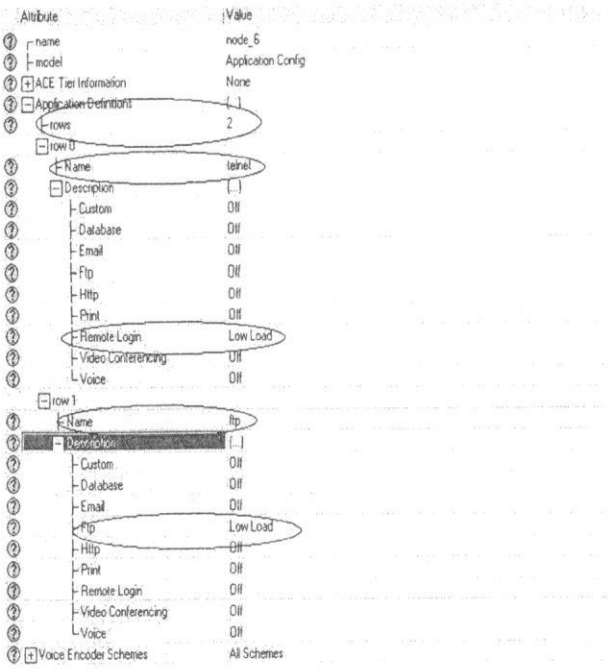
Step 2: Create the Network

- Select **Object Palette** box.
- Select **Intenet toolbox** from drop down menu.
- Choose **Application config**, **profile Config**, **four ethernet_wkstn, one ethernet_server**, and **two ethernet4_slip8_gtwy routers.**
- Connect both routers together with a **bidirectional PPP_DS1 link.**
- Connect the workstations and the server to the routers using bidirectional **10Base_T** links as shown below



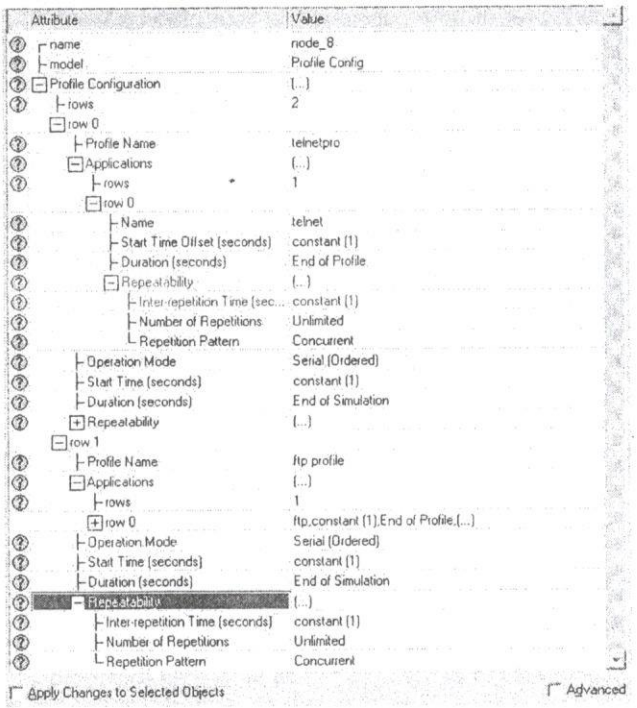
Step 3: Configure the Network Application

- Select **Application config** object.
- Right click and select **Edit Attributes**.
- For another **scenario** change the load of the application.
- For **FTP** change **low load** to **high load**
- For **Remote login** change **low load** to **high load.**



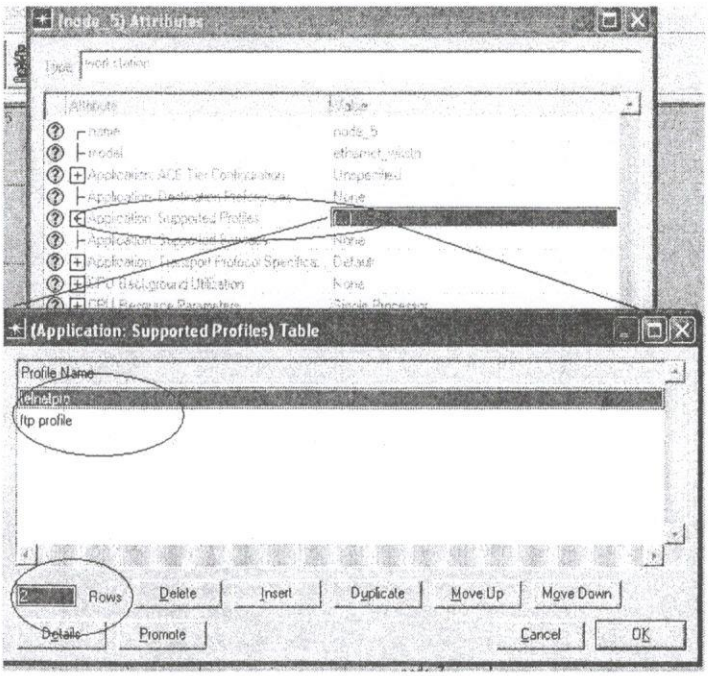
Step 4: Configure the Profile

- Select **Profile config** node.
- Right click and select **Edit Attributes**.

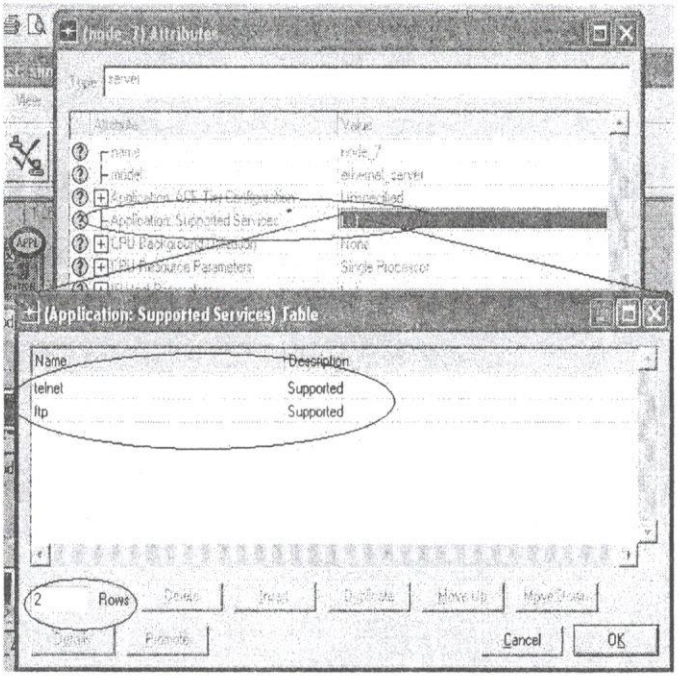


Step 5: Configure Network Objects

- Select similar **Ethernet work station** for configuring the profile

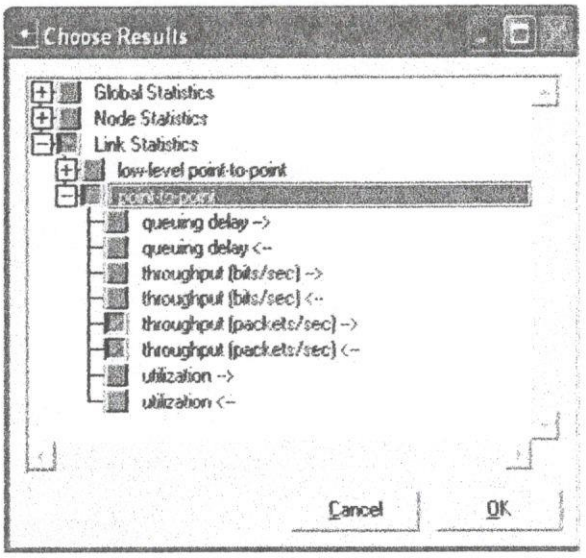


- **Configure the server for supporting the FTP and Telnet Service.**



Step 6: Selecting Statistics for viewing

- Right click on the work space and select choose individual statistics => in **Link Statistics** go to **point to point,** select **Throughput(packets/sec)**
- Click **Ok.**

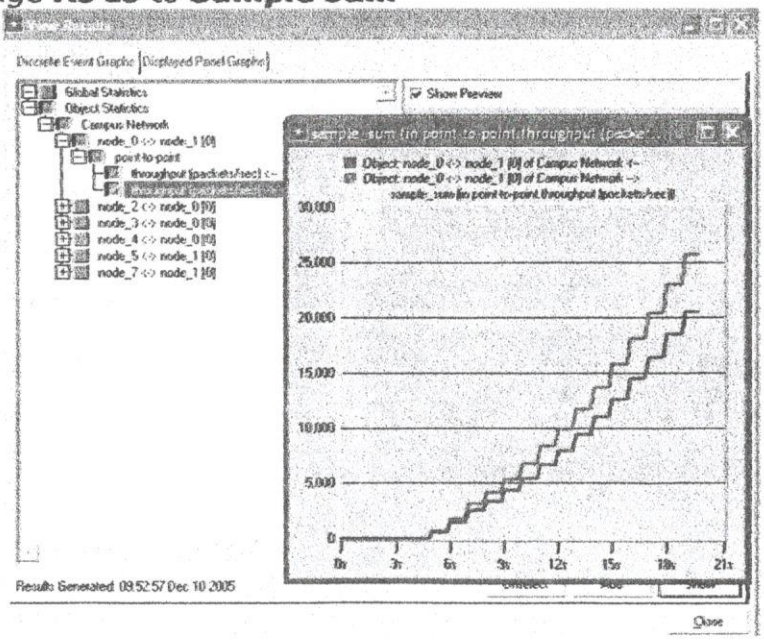


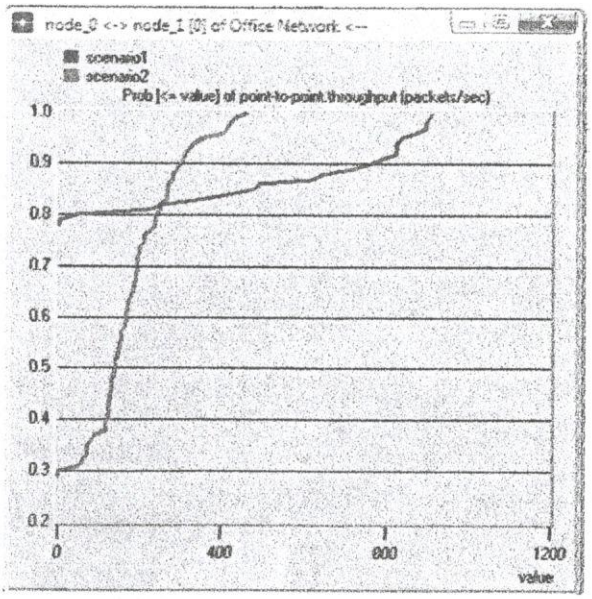
Step 7: Run the simulation

- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 20 seconds.
- Click **Run.**

Step 8: View Results

- Right click on the work space and select **View Results.**
- Change **As Is** to **Sample sum**





Please Note: If you do not get the shape of the graph as above, increase the duration of the simulation.

Result Interpretation:

Throughput: The actual rate at which information is sent over a channel. It is measured in bits/second or frames/second.

1. Compare the results of the low load and high load scenarios and select **Cumulative Distribution Function** instead of **As Is** to get a graph which looks like above.

2. We see that in the low load scenario (**Scenario 2**) the throughput is distributed in the 200-400 region, whereas in high load scenario (**Scenario 1**) the throughput is very much limited in the 0-200 region (80% probability).

3. Thus, when the load is increased, the data rate is increased, causing more collisions, therefore data loss , which in turn causes retransmissions. So we see due to high traffic throughput is reduced due to collision.

Problem 4:

Simulate the transmission of ping messages over a network topology consisting of 6 nodes ad find the number of packet dropped.

Solution:

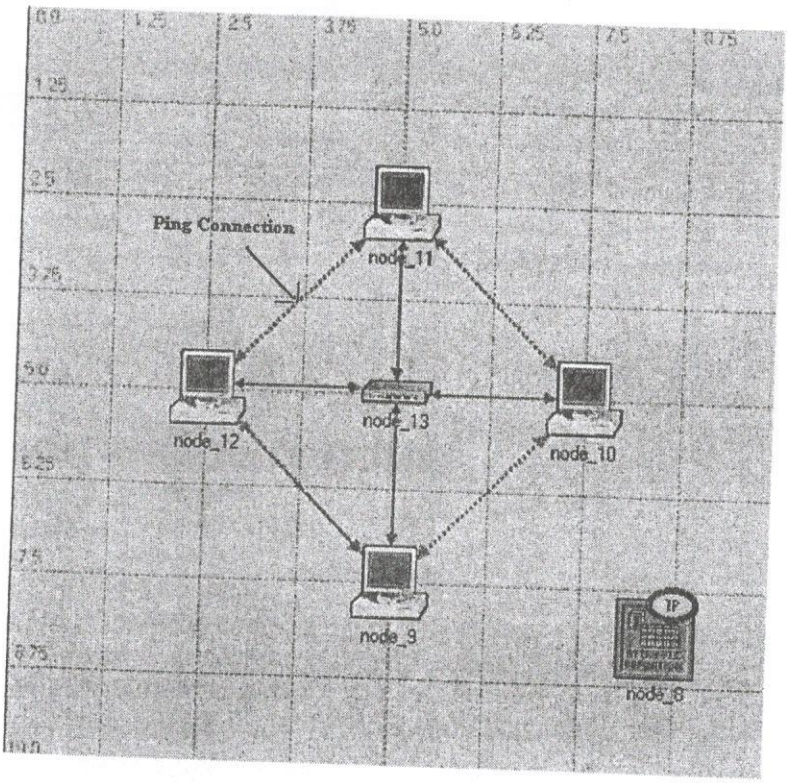
Please Note: The Topology below shows only 4 nodes. If you increase it to six nodes as given in the question, the results remain as depicted in the manual.

Step 1: Create a new Project.

Step 2: Create the network:

- Select four **Ethernet work stations** from **Ethernet tools** in **object palette**.
- Select an **Ethernet16 hub** from **Ethernet tools** in **object palette**.
- Connect the components using **10Base_T** links.
- Select the **IP attribute definition** from **Ethernet tools** in **object palette**.
- Select **IP_ping_traffic** 

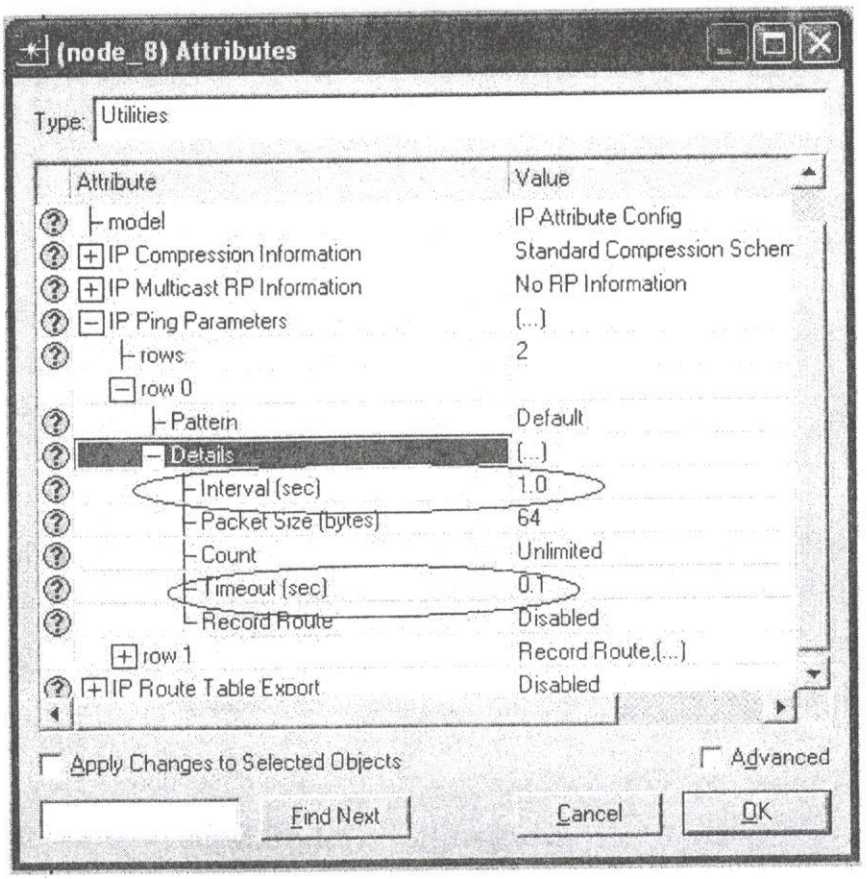
from **internet tools** in **object palette**.
- **The Scenario would like as shown below** :



Step 3: Configuring the IP Attribute Definition object.

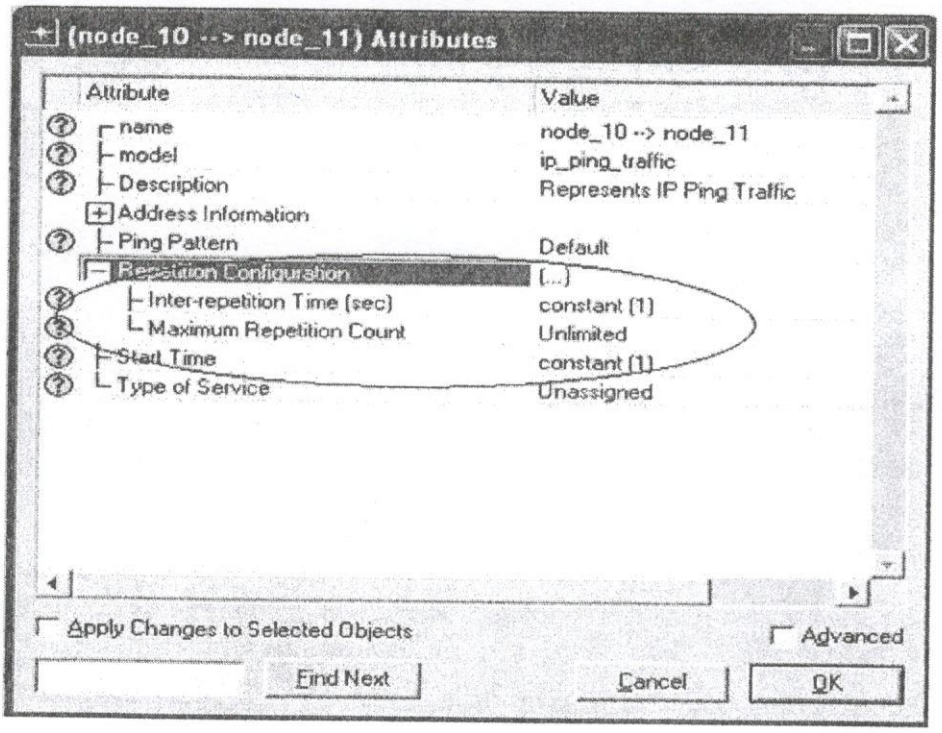
- **Right Click** on **IP Attribute Definition** object in work space.
- Select **Edit Attribute=>IP Ping Parameters**.
- Set parameters as shown below.

Please Note: It is 10Base T Connection between the nodes and the hub in a Star Topology. It is a PING Model between the nodes. You need to connect to and from the node to simulate a bi-directional ping as is required in this question.



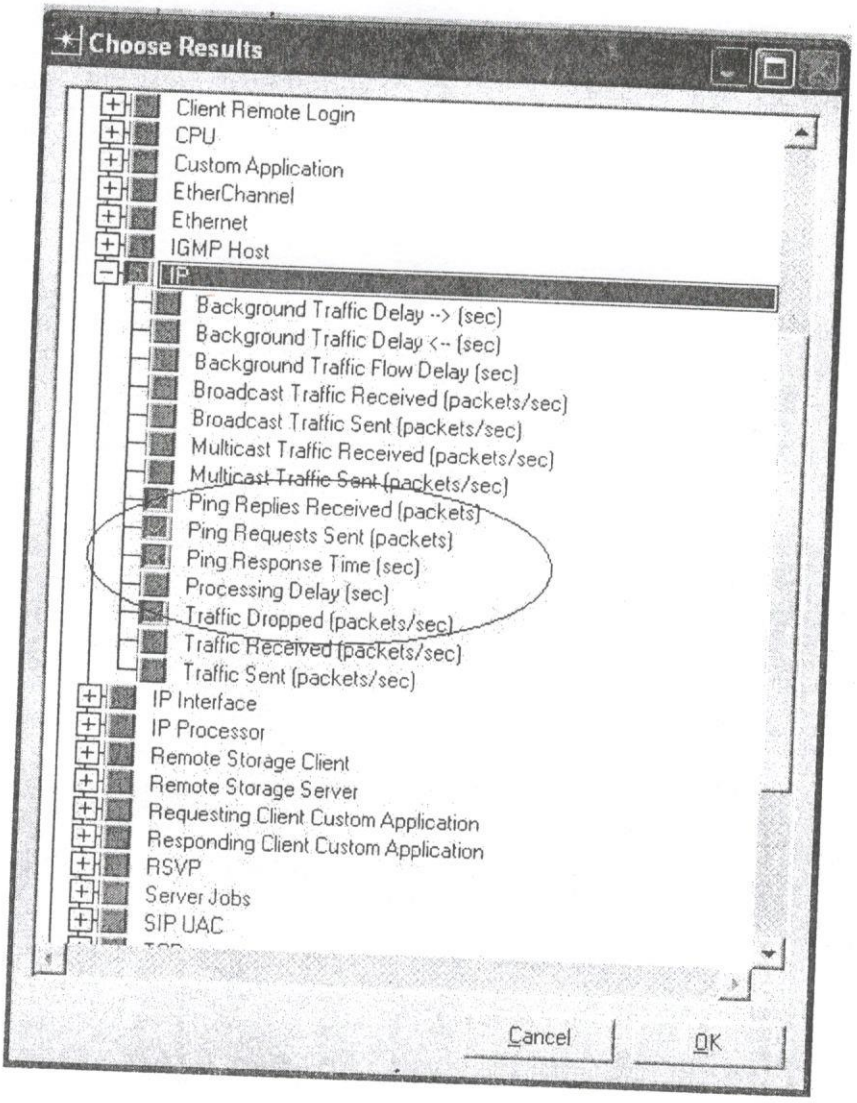
Step 4: Configuring IP Ping Links:

- **Right Click** on any one **IP ping link** and select **similar Demands**.
- Select any **one Ping link** and **Edit** its **attributes** as below:



Step 5: Choose Individual Statistics:

- **Right click** on the work space and **choose individual statistics.**
- **Node Statistics => IP => (Ping Replies, Ping Request Sent, Ping Response Time, Traffic Dropped)**



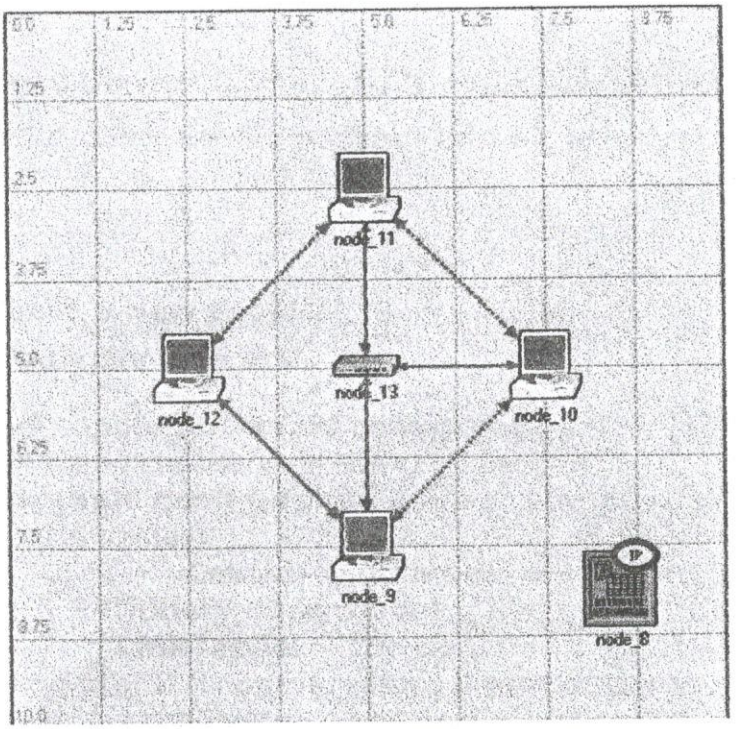
Step 6: Duplicate the scenario

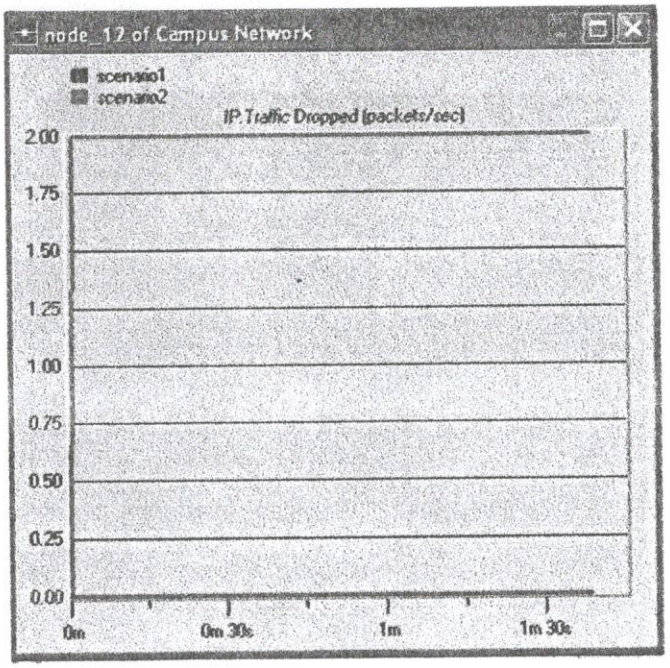
- **In this scenario remove any link between the hub and workstation. The scenario may look like this:**

Step 7.Run the Simulation:

- Click on **Run Button** 
- Set **Duration** to **100 seconds**.
- Click on **Run.**

Step 8: View and Compare the results:





Result Interpretation:

When node 12 is disconnected both the ping packets are dropped. This is shown in justified by the graph. We see similar results for node 11 and node 9 which must drop 1 packet. However there should be no change for node 10. Packet generation rate is 1 ping packet per destination per second.

Problem 5:

Simulate an Ethernet LAN using N nodes (6-10). Change the data rate and compare throughput and bit error rate.

Solution:

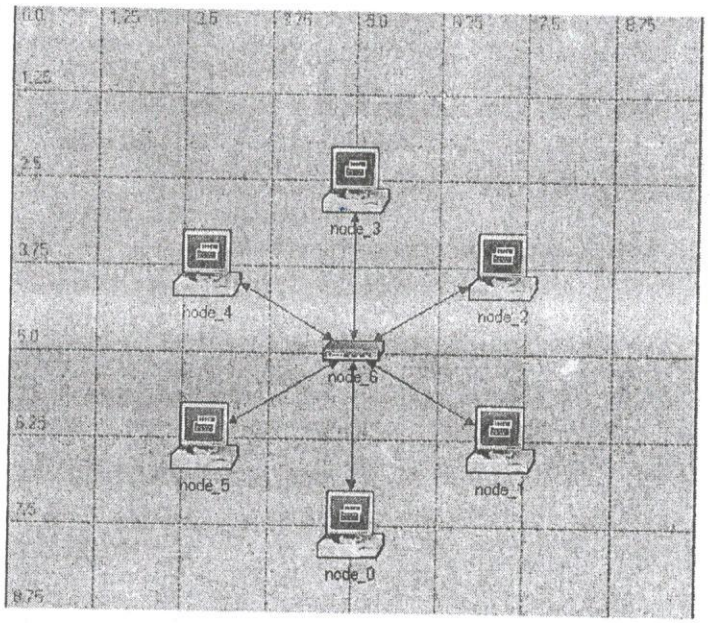
Step 1: Create a New Project

Step 2: Create the network

- Select **topology=>rapid configuration**. From the drop down menu choose **star** and click **Ok**.
- In the **rapid configuration dialog : star** box , set the following values:

  Central node model = ethernet16_hub,
  Periphery node model = Ethernet _station,
  Link model = 10baseT.

  Please Note: If for some reason, these components do not appear in the configuration box, you can choose it from the object palette as usual.
- **The scenario would look like as shown below:**



Step 3: Configuring Ethernet Stations:

- **Right click** on any **Ethernet station** => **Select similar nodes** => **Edit Attributes**
- Set **Traffic generation parameters** and **Packet Generation Arguments**.
- Check **Apply changes to selected objects**.
- Click **Ok.**

Problem 5:

Simulate an Ethernet LAN using N nodes (6-10). Change the data rate and compare throughput and bit error rate.

Solution:

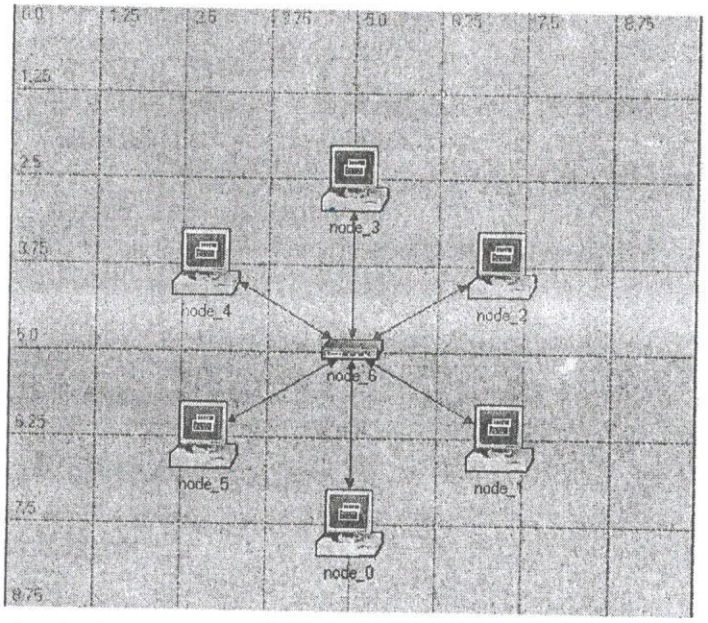
Step 1: Create a New Project

Step 2: Create the network

- Select **topology=>rapid configuration**. From the drop down menu choose **star** and click **Ok**.
- In the **rapid configuration dialog : star** box , set the following values:

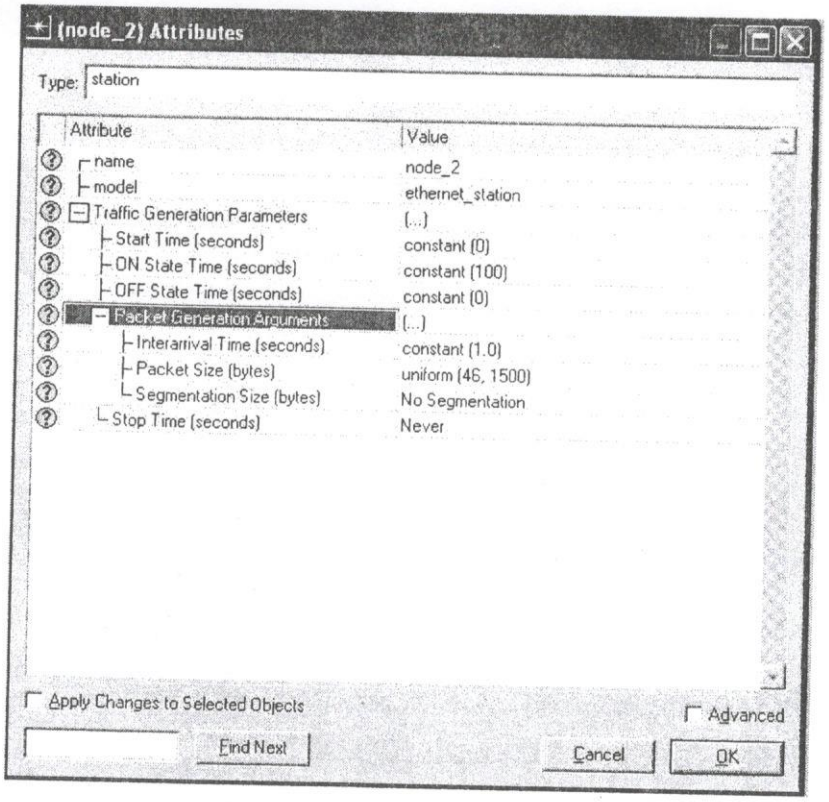
  Central node model = ethernet16_hub,
  Periphery node model = Ethernet _station,
  Link model = 10baseT.

  Please Note: If for some reason, these components do not appear in the configuration box, you can choose it from the object palette as usual.
- **The scenario would look like as shown below:**



Step 3: Configuring Ethernet Stations:

- **Right click** on any **Ethernet station** => **Select similar nodes** => **Edit Attributes**
- Set **Traffic generation parameters** and **Packet Generation Arguments**.
- Check **Apply changes to selected objects**.
- Click **Ok.**



Step 4: Choose Statistics

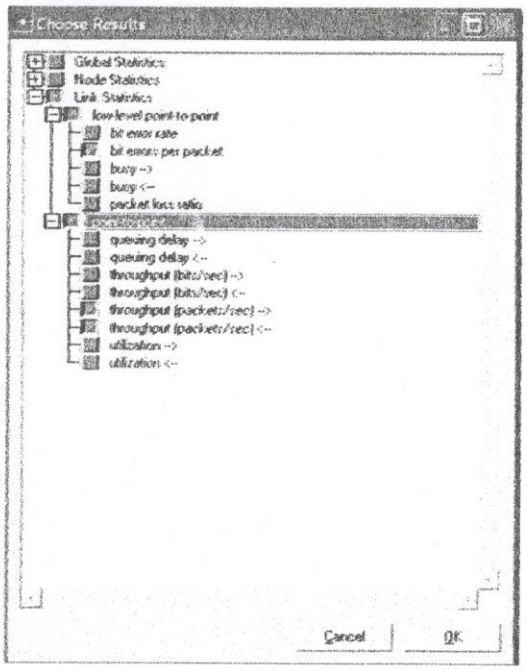
- **Right Click** on **work space** => **Choose Individual Statistics**
- In **Link Statistics** => **low level point-to-point**=> **bit error per packet**
- => **point-to-point** =>**throughput[packets/sec] ->** & **<-**
- Click **OK**

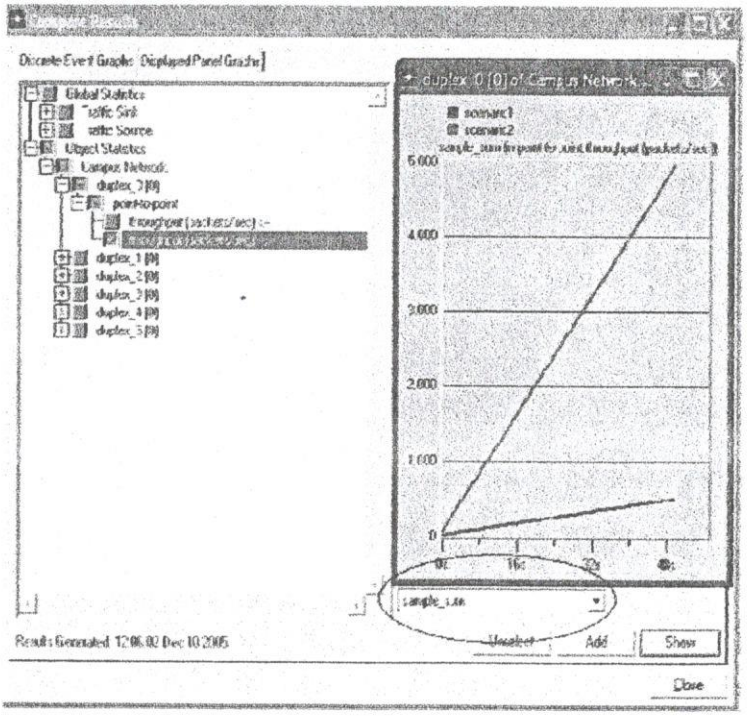
Step 5: Run Simulation

- Click on **Run Button**  .
- Set **Duration** to **70 seconds**
- Click **Run**

Step 5: View & Compare results:

- Change the **data rate** by changing the **inter arrival time**
- **Scenario 1 : inter arrival time** is **constant 1**
- **Scenario 2 : inter arrival time** is **constant 0.1**





Result Comparison:

The data rate is changed by changing the Inter Arrival Rate.

First Scenario Constant 1 implies the interarrival rate is less than Constant 0.1, Second Scenario.

When Interarrival time increases, data rate increases implying that the throughput is increased as long as there is no collision.
Therefore, the results should be similar to the results of problem 3.

Problem 6.

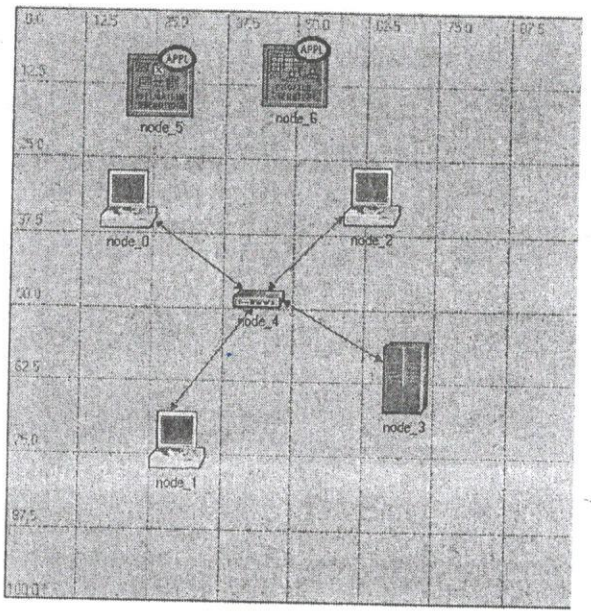
Simulate a Ethernet LAN using N nodes and set multiple traffic nodes and determine the collisions across different nodes.

Solution:

Step 1: Create a New Project

Step 2: Create the Network

- Select **Object Palette** box.
- Select **Intenet toolbox** from drop down menu.
- Choose **Application config**, **profile Config**, **four ethernet_wkstn, one ethernet_server**, and **one ethernet16 hub(from Ethernet menu).**
- Connect the **Ethernet workstation** and the **Ethernet server** to the **Ethernet16 hub** using bidirectional **10Base_T** links as shown below.

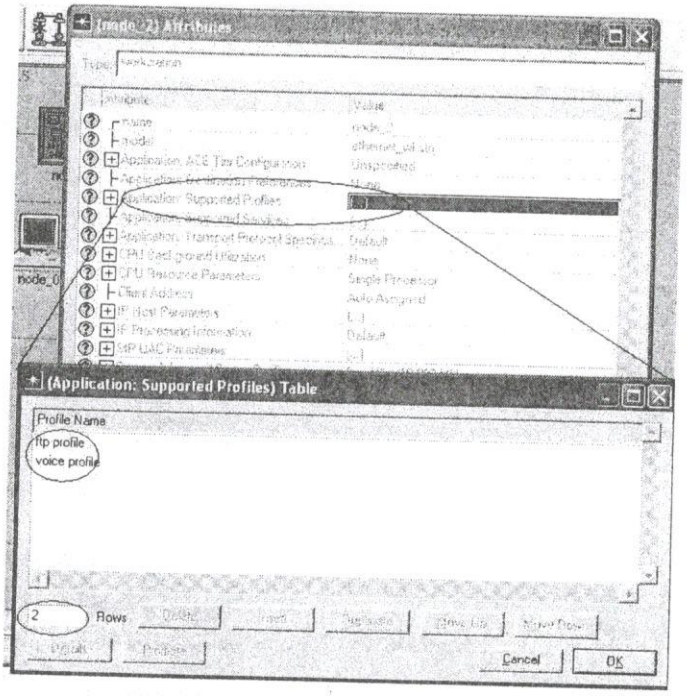


Step 3: Configure the Network Application

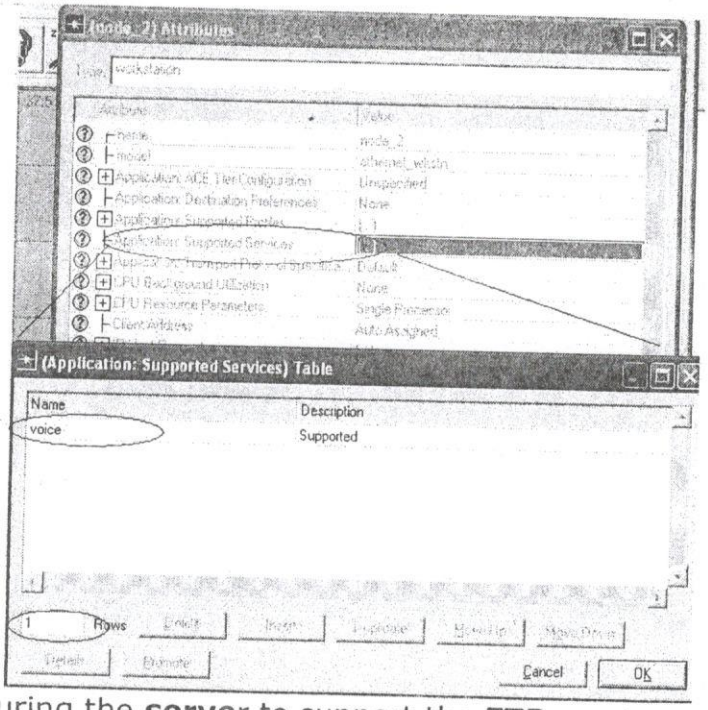
- Select **Application config** object.
- Right click and select **Edit Attributes**.

Step 5: Configure Network Objects

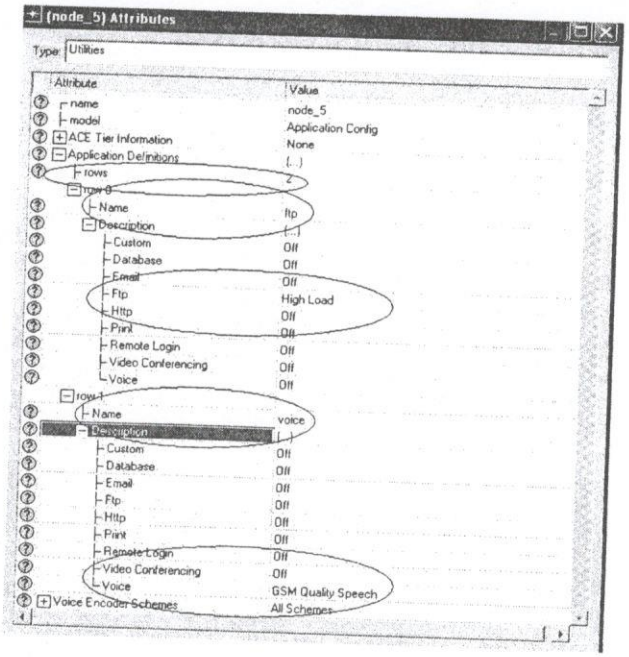
- Configuring the **Ethernet work station** for supporting profiles:



- Configuring the **node 2** for **voice** service support

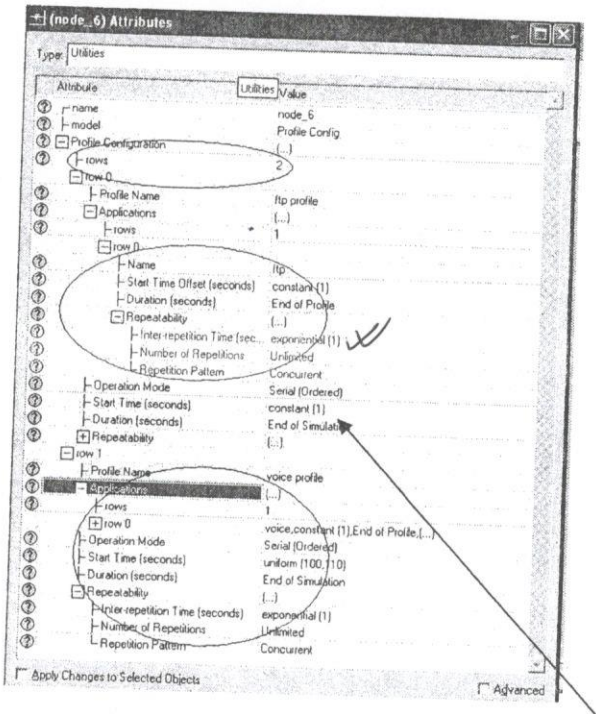


- Configuring the **server** to support the **FTP** service

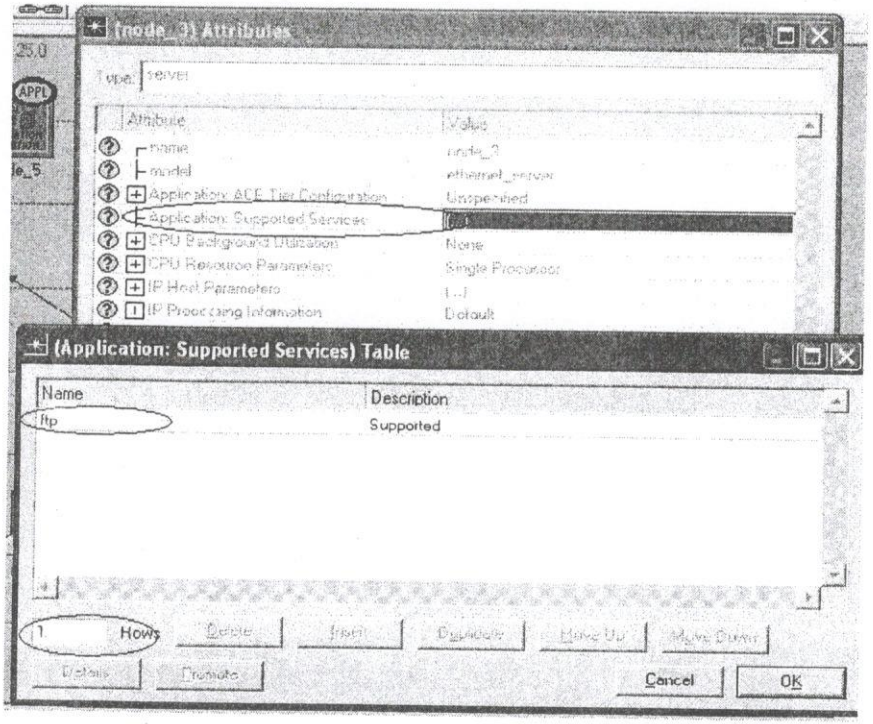


Step 4: Configure the Profile

- Select **Profile config** node.
- Right click and select **Edit Attributes.**



Please Note: Be careful to set Start Time as Constant 1, otherwise you would get a blank graph.



Step 6: Selecting Statistics for viewing

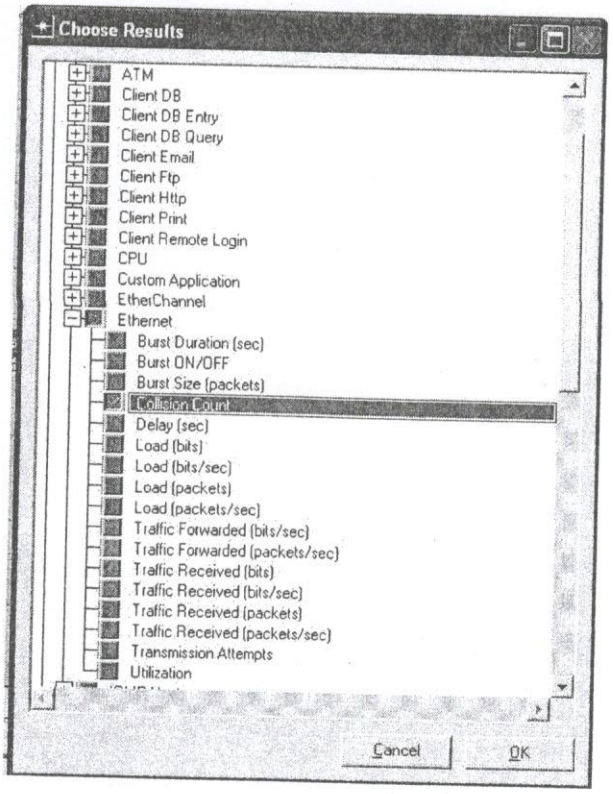
- Right click on the work space and select choose individual statistics => in **Node Statistics** go to **Ethernet** select **Collision Count**
- Click **Ok**.

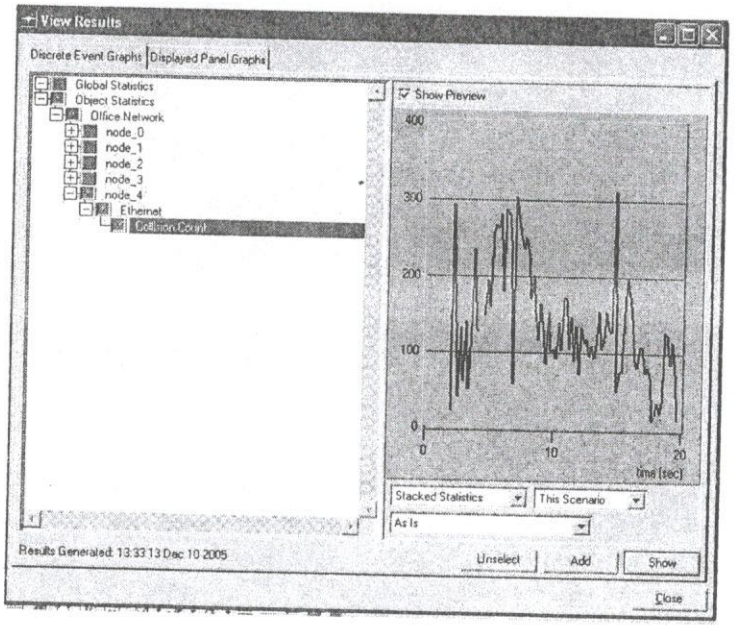
Step 7: Run the simulation

- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 20 seconds.
- Click **Run**.

Step 8: View Results

- Right click on the work space and select **View Results**.

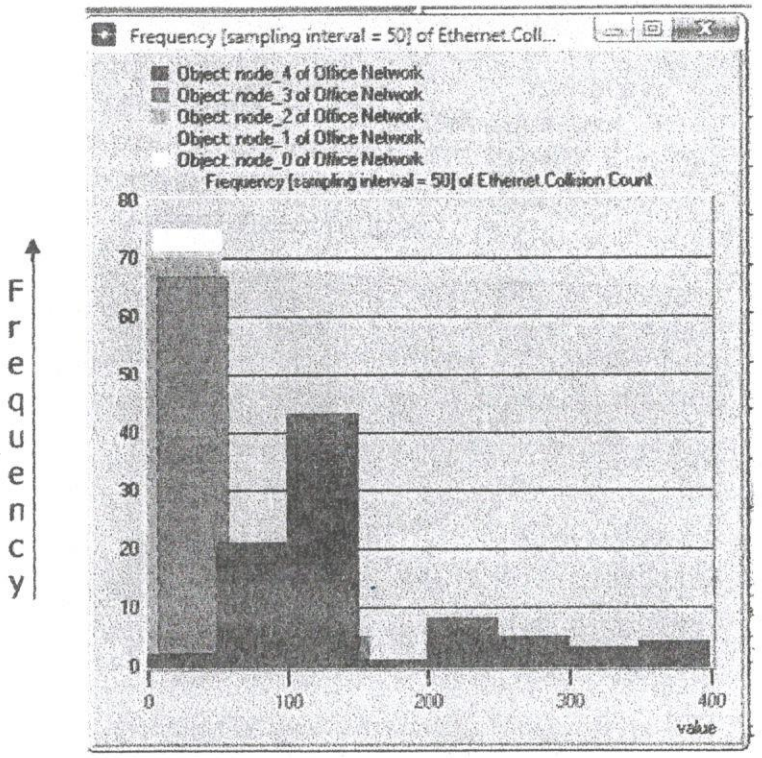

Choose Results
ATM
Client DB
Client DB Entry
Client DB Query
Client Email
Client Ftp
Client Http
Client Print
Client Remote Login
CPU
Custom Application
EtherChannel
Ethernet
Burst Duration (sec)
Burst ON/OFF
Burst Size (packets)
Collision Count
Delay (sec)
Load (bits)
Load (bits/sec)
Load (packets)
Load (packets/sec)
Traffic Forwarded (bits/sec)
Traffic Forwarded (packets/sec)
Traffic Received (bits)
Traffic Received (bits/sec)
Traffic Received (packets)
Traffic Received (packets/sec)
Transmission Attempts
Utilization
Cancel
OK


View Results
Discrete Event Graphs
Displayed Panel Graphs
Global Statistics
Object Statistics
Office Network
node_0
node_1
node_2
node_3
node_4
Ethernet
Collision Count
Show Preview
400
300
200
100
0
0
10
20
time (sec)
Stacked Statistics
This Scenario
As Is
Results Generated: 13:33:13 Dec 10 2005
Unselect
Add
Show
Close

Result Interpretation:

- Choose **Overlaid Statistics** instead of **Stacked Statistics.**
- Select the collision counts of all nodes.
- Choose **Histogram(Sample distribution)** instead of **As Is.**
- Press **Show** you will be prompted for **sampling interval.** Enter 50.

You should get a graph similar to this.



Result Interpretation:

This shows that for all other nodes the collision count is less compared to the server. This is because the FTP application uses TCP and therefore demands retransmission whereas the voice application uses UDP and retransmission is not required.

This graph shows that less than 50 collisions were recorded around 80 times for the nodes (except node 4). However around 150-200 collisions was recorded around 50 times for node 4. Hence we can say that TCP traffic faces high collision per packet in a n/w compared to UDP per packet.

Problem 7:

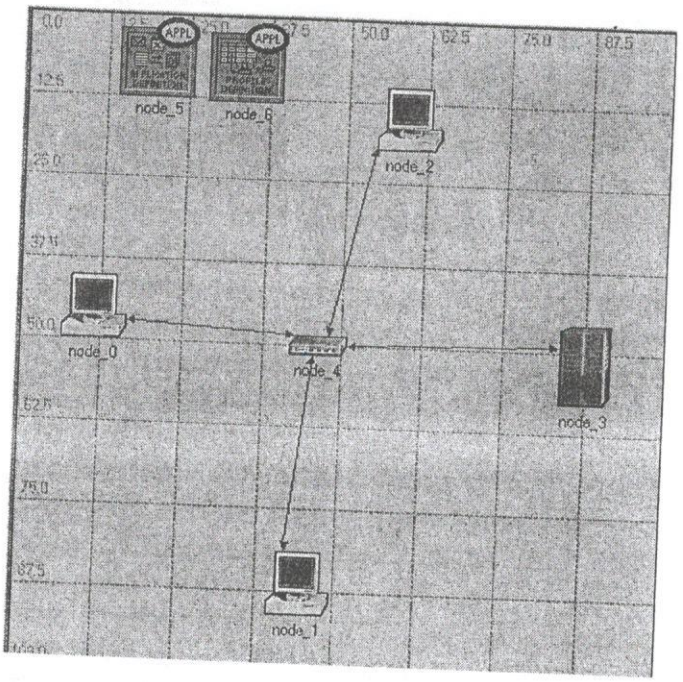
Simulate an Ethernet LAN using N nodes and set multiple traffic nodes and plot the congestion window for different source/destination.

Solution:

Step 1: Create a New Project

Step 2: Create the Network

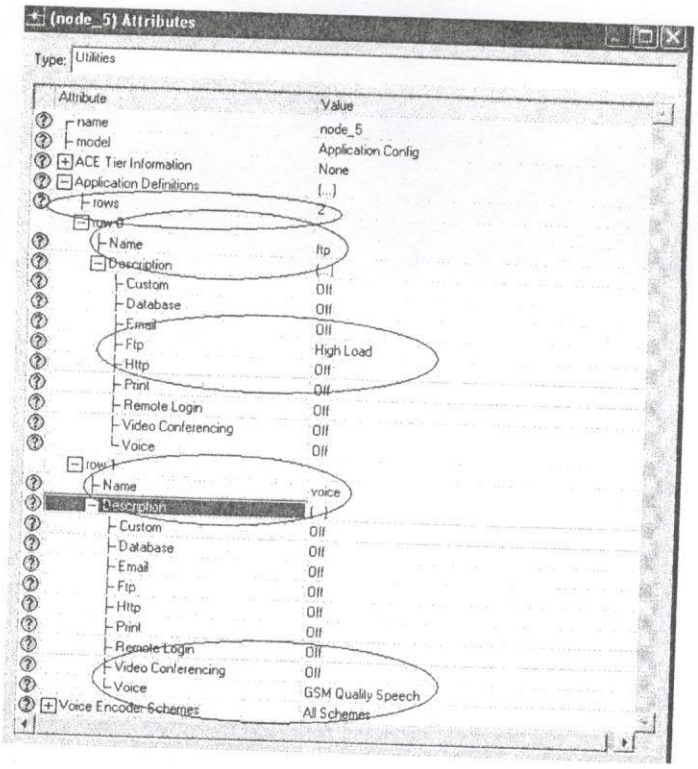
- Select **Object Palette** box.
- Select **internet_toolbox** from drop down menu.
- Choose **ethernet_wkstn objects** (3 numbers).
- Choose **ehternet_server** object (1 number). Ethernet16hub(1) from **Ethernet tool box**
- Choose **Application Config**, and **Profile Config** objects.
- Choose **10baseT** link and connect the nodes.
- Close the **Object Palette** box.



Step 3: Configure the Network Application

- Select **Application config** object.
- Right click and select **Edit Attributes**.
- Select **Application Definitions** => set row = 2.
- In row go to row0 => set **Name** = ftp. Select **description** => set ftp = > **High Load.**
- In row go to row1 => set **Name** = voice. Select **description** => set **voice** = > **GSM Quality Speech.**
- Check **Apply Changes to Selected Objects**.

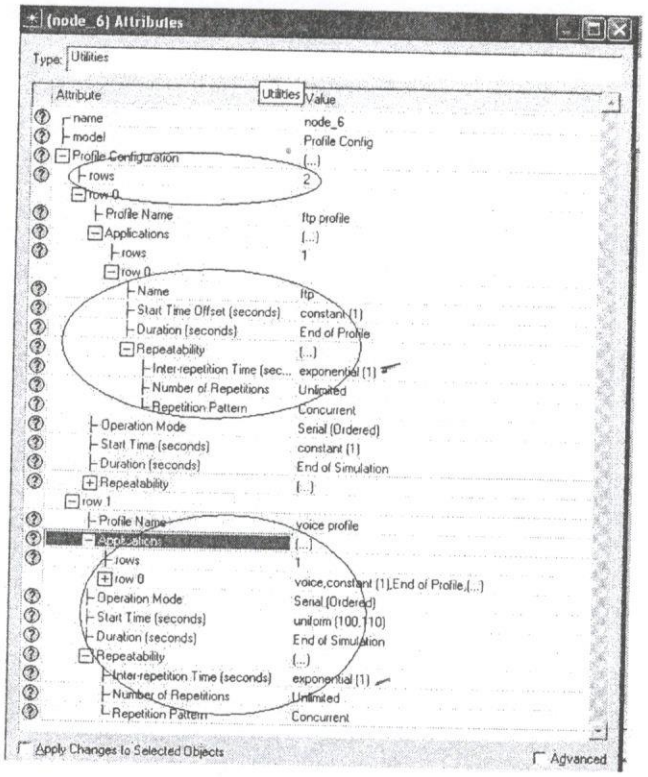
- Click **Ok**.



Step 4: Configure the Profile

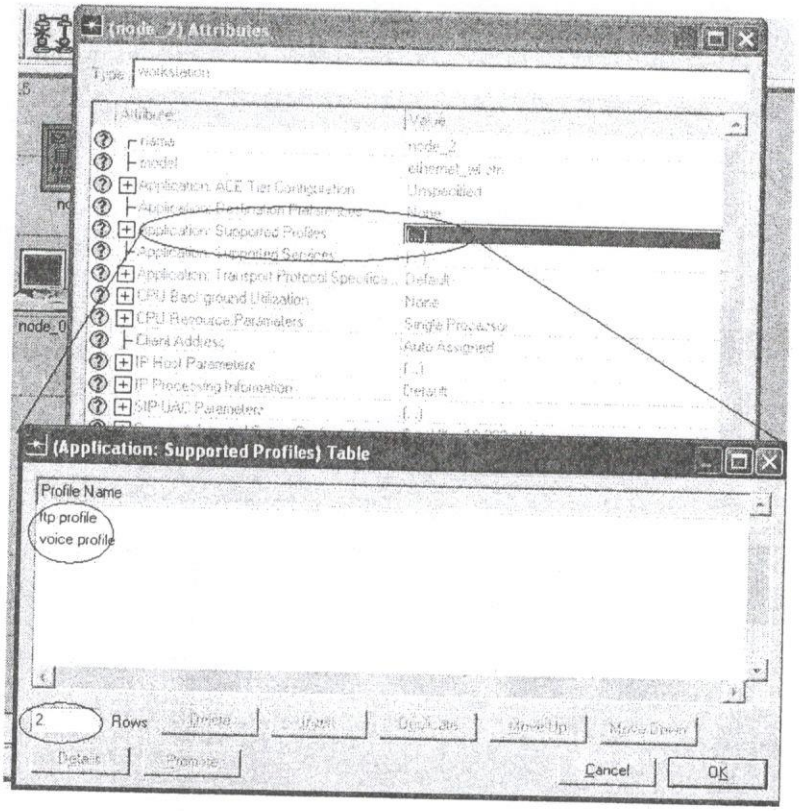
- Select **Profile config** node.
- Right click and select **Edit Attributes**.
- Select **Profile Configuration**. Set row = 2.
- In row0, set **Profile Name** = ftp profile. Select Applications. Set row=1.Go to row0 set **Name** = ftp, **Start Time Offset** to constant(1), in **Repeatability**, **Inter Repetition Time** to exponential(0.1) and **Number of Repetition** to unlimited and **Repetition Pattern** to concurrent.
- At row0 set **Name** = ftp, **Start Time Offset** to constant(1), in **Repeatability**, **Inter Repetition Time** to exponential(0.1) and **Number of Repetition** to unlimited and **Repetition Pattern** to concurrent.
- In row1, set **Profile Name** = voice profile. Select Applications. Set row=1.Go to row1 set **Name** = voice, **Start Time Offset** to constant(1), in **Repeatability**, **Inter Repetition Time** to exponential(0.1) and **Number of Repetition** to unlimited and **Repetition Pattern** to concurrent.
- At row1 set **Name** = video, **Start Time Offset** to constant(1), in **Repeatability**, **Inter Repetition Time** to exponential(0.1) and **Number of Repetition** to unlimited and **Repetition Pattern** to concurrent.
- Check **Apply Changes to Selected Objects**.

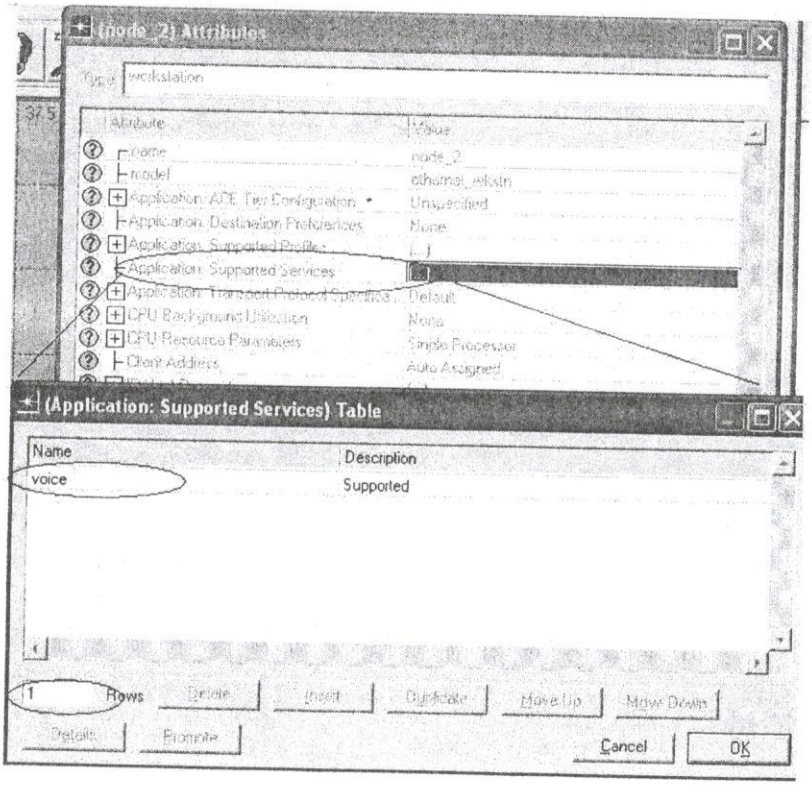
- Click **Ok**.



Step 5: Configure Network Objects

- Select any **Ethernet_wskt**.
- Right click and **Select Similar Nodes**.
- Right click and **select Edit Attributes**.
- Select **Application Support Profiles** => set rows to 2.
- In rows => go to row0 => set **Profile Name** = ftp profile
- In rows => go to row1 => set **Profile Name** = voice profile.
- Select **Application Support Services**. Select edit => set rows =1. Set Name = voice for that row.
- Check **Apply Changes to Selected Objects**.
- Click **Ok**.



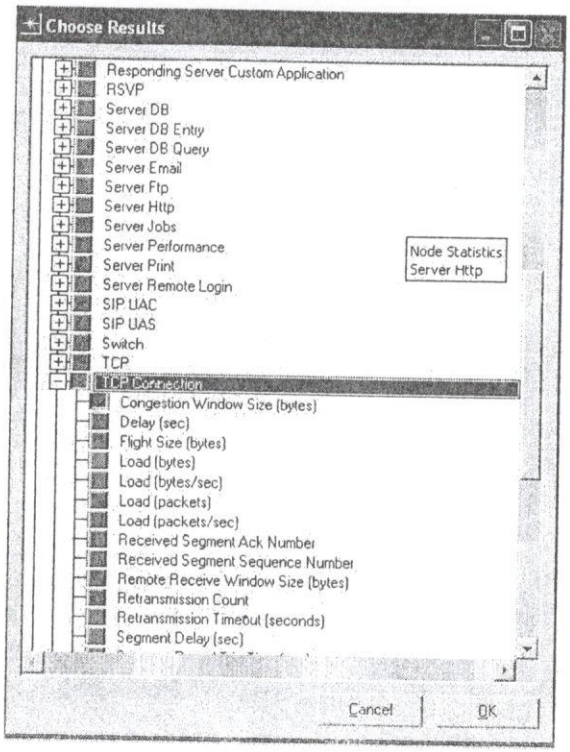


- Select **ethernet_server** object.
- Right click and select **Edit Attributes**.

- Select **Application Support Services**. Select edit => set rows =1. Set Name = ftp for that row.
- Check **Apply Changes to Selected Objects**.
- Click **Ok**.

Step 6: Selecting Statistics for viewing :

- In **Node Statistics** => select **TCP Connection** => select **Congestion Window Size (bytes).**
- Click **Ok**.



Step 7: Run the simulation

- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 20 seconds.
- Click **Run**.

Problem 8:
Simulate simple BSS and with transmitting nodes in wireless LAN by simulation and determine the performance with respect to transmission of packets.

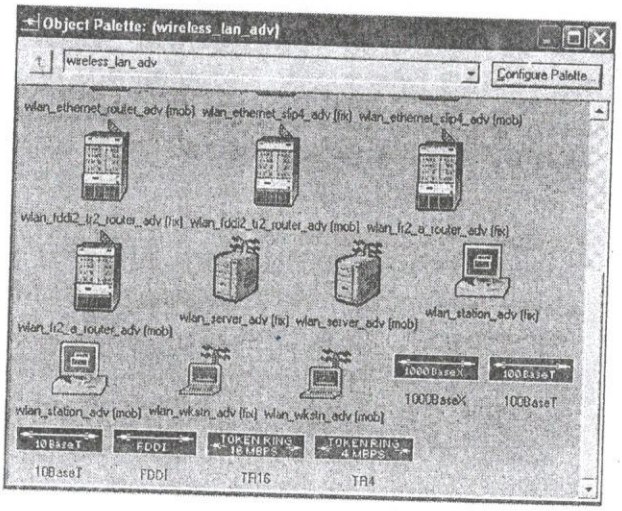
Solution:

Please Note: Make sure to choose **Meters** while creating the Topology. If not, the messages will be sent by the Wireless LAN (Adhoc Network)nodes, but not received by other nodes as the physical geographic range of wireless transmission by the nodes in the adhoc network via Bluetooth is limited.

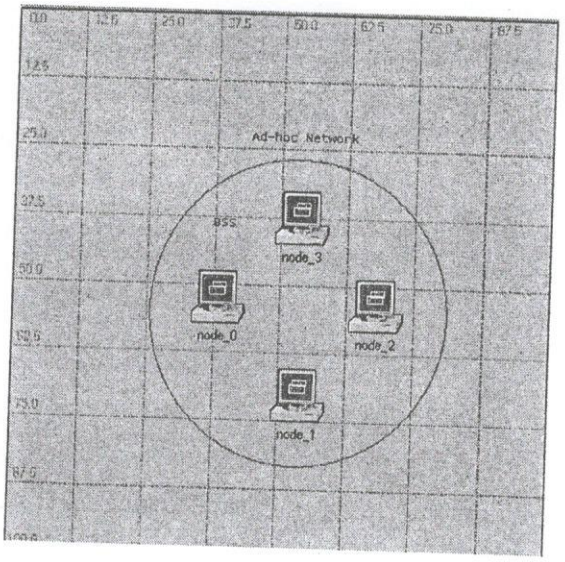
Step 1: Create a New Project

Step 2: Create the Network

- Select **Object Palette** box.
- Select **wireless_lan_adv** from drop down menu.



- Choose **wlan_station_adv(fix)** object (4 numbers).

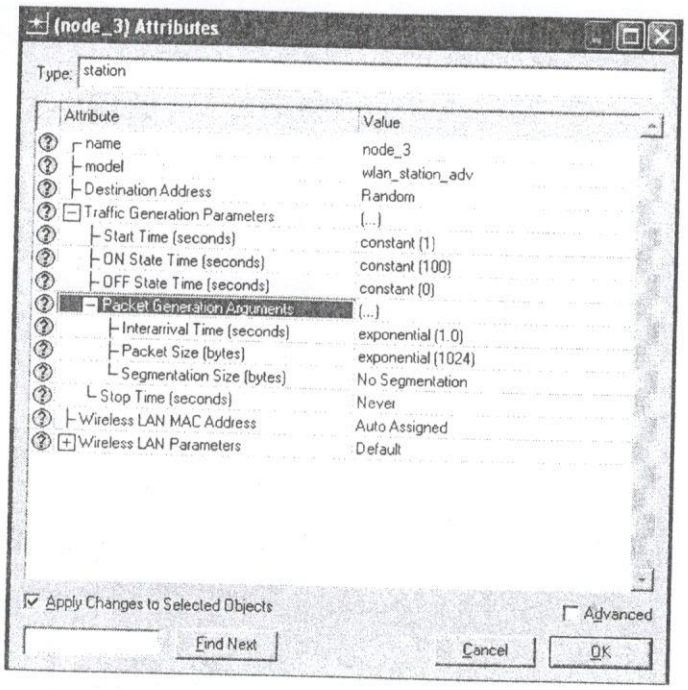


Step 3: Configure the Network Application (Select Topology icon ->open Annotation Palette ->(choose circle) and include all 4 nodes in a circle annotation.)

- Select any **wlan_station_adv** object in the workspace.
- Right click on the selected object and **Select Similar Nodes.**
- Right click and **select Edit Attributes**.
- Select **Traffic Generation Parameters =>** set **Start Time** to constant (1) => set **ON State** to constant (100) => set **OFF State** to constant (0).

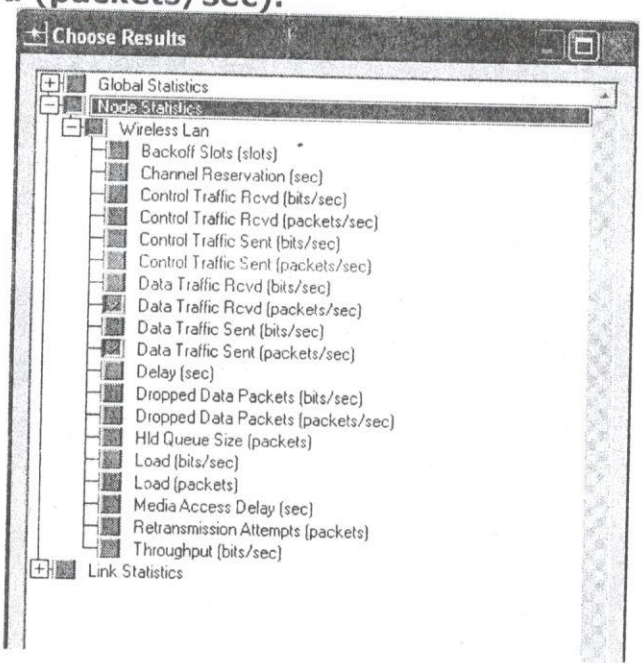
Please Note: If the field to set Start Time to constant(1) is disabled for some reason, please change the value from 'Never' to 'Not Used'.

- Select **Packet Generation Arguments** =>set **Interarrival Time** to exponential(1).
- Check **Apply Changes to Selected Objects**.
- Click **Ok**.



Step 4: Selecting Statistics for viewing:

- Right click on the workspace and select **Choose Individual Statistics.**
- In **Node Statistics** => select **Wireless LAN** => select Data **Traffic Rcvd (packets/sec)** and select **Data Traffic send (packets/sec).**

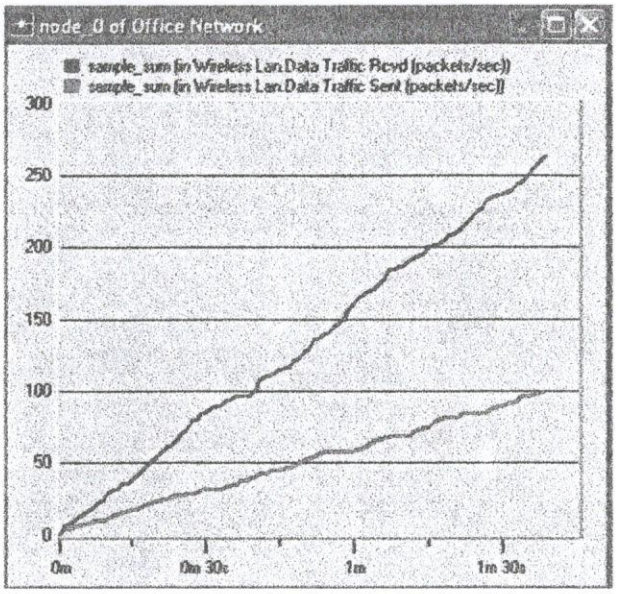


Step 5: Run the simulation

- Click **run simulation** icon from the toolbar.
- Set the **Duration** to 100 seconds.
- Click **Run**.

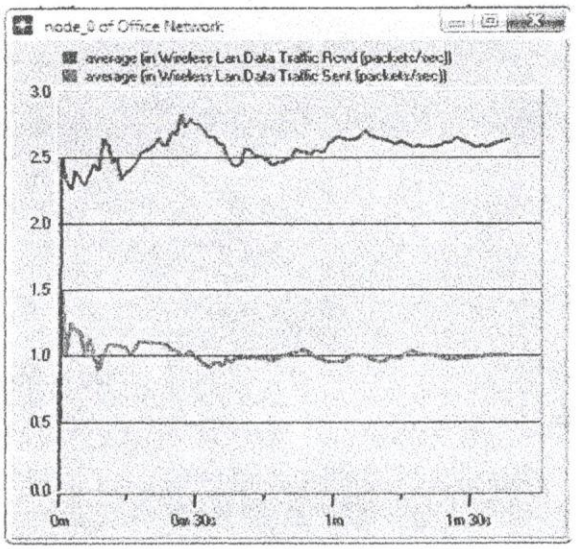
Step 6: View Results

- Right click on the work space and select **View Results.**
- Change **As Is** to **Sample_Sum.**



Result Interpretation:

In the result panel change **As Is** to **Average.**



We see that on an average 1 packet is sent per second and around 2.5 packets are received per second. This is because the transmissions of the other 3 stations are also being received by this station. There are some losses as well which can be seen by including global statistics (bit/sec).