Student Name	Date

NETWORKS AND PROTOCOLS

Assignment Question

Objective

This laboratory exercise is designed to compare the performances of shared and switched Ethernet LANs under different scenarios.

You should produce a report that will contain the graphs produced by the simulation runs requested for each model, and the answers to the questions as requested in this document. Make sure you collect all graphs during the laboratory session.

Lab Procedure:

In this lab you will set up Ethernet LANs using two different devices: hubs and switches. A hub forwards the packet that arrives on any of its inputs on all the outputs regardless of the destination of the packet. On the other hand, a switch forwards incoming packets to one or more outputs depending on the destination(s) of the packets. You will study how the throughput and delay of packets in a network are affected by the configuration of the network and the types of switching devices that are used.

Create a New Project

1. Start **OPNET Modeler** Choose **New** from the **File** menu.

2. Select **Project** and click **OK**. Name the project <**your initials>_SwitchedLAN**, and the scenario **HubOnly.** Click **OK**.

3. In the *Startup Wizard: Initial Topology* dialog box, select **Create Empty Scenario**. Click **Next.** Choose **Office** from the *Network Scale* list. Click **Next.** Click **Next** again to accept the size **100mx100m.** Click **Next** again and then click **Finish**.

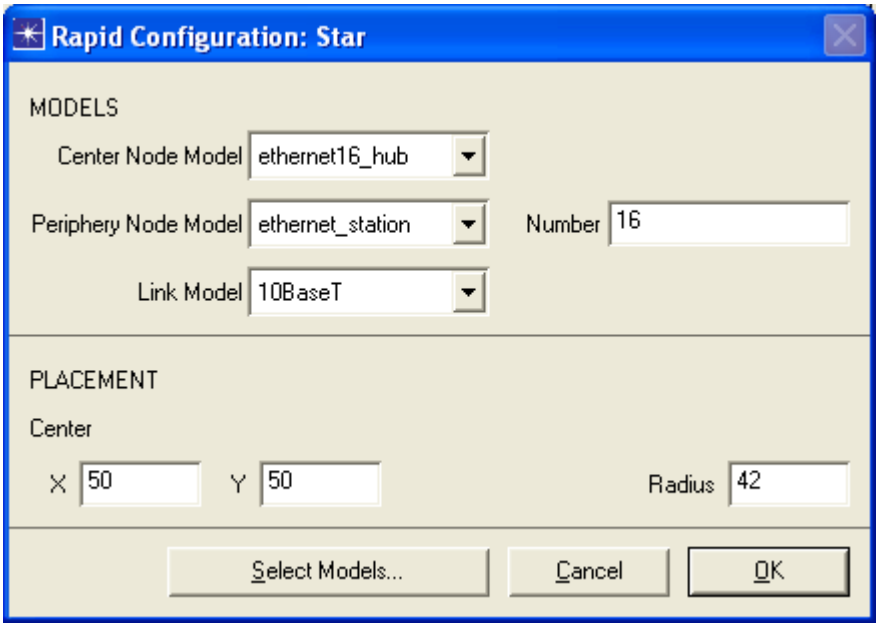
4. **Close** the *Object Palette* dialog box.

Create the Network

To create the Shared LAN:
1. Select **Topology**, **Rapid Configuration**. From the drop-down menu choose **Star** and click **Next**.

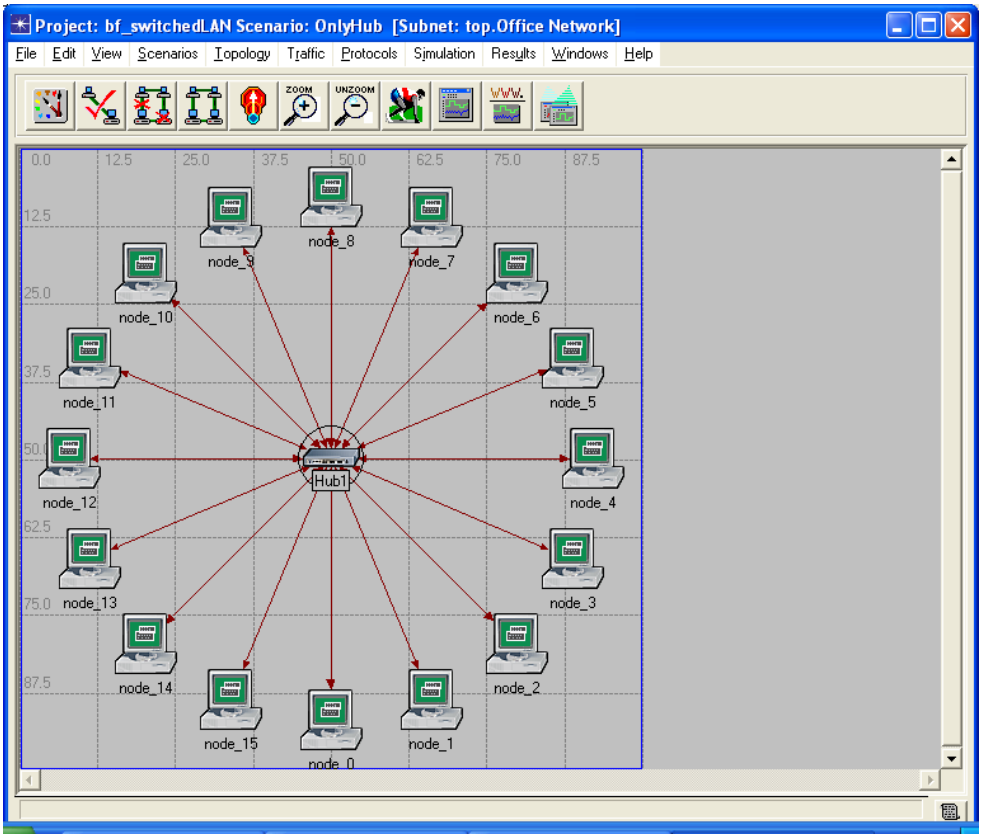
2. Click the **Select Models** button in the *Rapid Configuration* dialog box. From the *Model List* drop-down menu choose **ethernet** and click **OK**.

3. In the Rapid Configuration dialog box, set the following values: Center Node Model = ethernet16_hub, Periphery Node Model = ethernet_station, Link Model = 10BaseT, Number=16, X=50, Y=50, and Radius = 42. Click **OK**.



4. Right-click on **node_16**, which is the hub, choose **Edit Attributes.** Change the **name** attribute to **Hub1** and click **OK**.

5. The network should look like the one below. Save your project.



Configure the Network Nodes

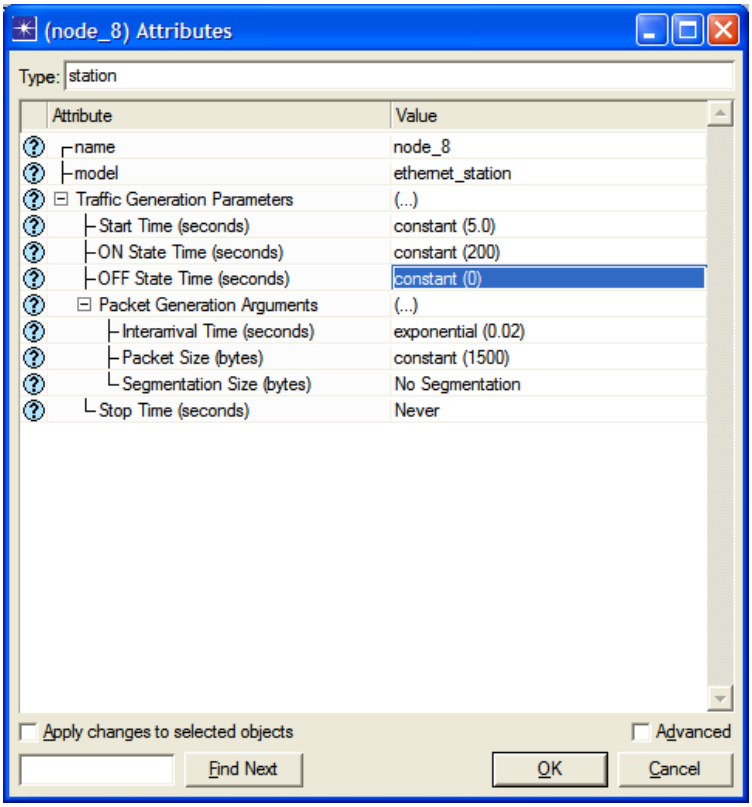
Configure the traffic generated by the stations.

1. Right-click on any of the 16 stations (node_0 to node_15). Choose **Select Similar Nodes**

2. Right-click on any of the 16 stations, choose **Edit Attributes.**

Check the **Apply to Selected Objects** check box. This is important to avoid reconfiguring each node individually.

3. Expand the hierarchies of the **Traffic Generation Parameters** attribute and the **Packet Generation Arguments** attribute. Set the following four values:*ON State Time* = constant (200), *OFF State Time* = constant (0), *Interarrival Time* = exponential (0.02), *Packet Size* = Constant (1500).



Calculate the average Traffic that each node will generate, and the total traffic in the network. (Document Results)

4. Click **OK** to close the attribute editing window. Save your project

Choose Statistics

To choose the statistics to be collected during the simulation:
1. Right-click anywhere in the project workspace and select **Choose Individual DES Statistics** from

the pop-up menu.

2. In the Choose Results dialog box;

in *Global Statistics* choose the following statistics:

In *Ethernet*, **Ethernet Delay** representing the end to end delay of all packets received by all the stations

In *Traffic Sink*, **Traffic Received (in bits/sec)** by the traffic sinks across all nodes.

In *Traffic Source*, **Traffic Sent (in bits/sec)** by the traffic sources across all nodes.

in *Node Statistics*, *Ethernet*, choose the following statistics:

Collision Count: number of collisions encountered by the hub during packet transmissions.

3. Click **OK**.

Configure the Simulation

The duration of the simulation must be configured:
1. From the **Scenarios** menu select **Manage Scenarios**.
2. Set the **sim duration** and **time units** to respectively **2.0** and **minutes**.
3. Click **OK**.

Analysis 1

Duplicate the Scenario

We can derive a new scenario where each Ethernet station will generate less traffic.

1. Select **Duplicate Scenario** from the **Scenarios** menu and give it the name **Hub_Low_Load.** Click **OK**.

2. Right-click on any of the 16 stations and choose **Select Similar Nodes**

3. Right-click on one of the stations and choose **Edit Attributes.**

Check the **Apply to Selected Objects** check box. This is important to avoid reconfiguring each node individually.

3. Expand the hierarchy of the **Traffic Generation Parameters** attribute and the **Packet Generation Arguments** attribute. Set the following value: *Interarrival Time* = exponential (0.08), and click **OK**.

Calculate the average Traffic that each node will generate in this scenario, and the total traffic in the network. (Document Results)

Save your project.

Run the Simulation

To run the simulation for both scenarios simultaneously:
1. Select **Manage Scenarios** from the **Scenarios** menu.
2. Change the values under the **Results** column to **<collect>** (or **<recollect>**) for both scenarios.
3. Click **OK** to run the two simulations.
4. After the two simulation runs complete, one for each scenario, click **Close**.
5. Save your project.

Results I

1- In the **Scenarios** menu, select **switch to Scenario**, and choose **Hub_Low_Load**.

To view and analyze the results, right-click anywhere in the project workspace and select **View results**.

In **Global Statistics**, **Traffic Source**, select the **Traffic Sent (bits/sec)** statistic.
In **Global Statistics**, **Traffic Sink,** select the **Traffic Received (bits/sec)** statistic.

You can use the display option **Overlaid Statistics**, from the drop down menu showing **Stacked Statistics**, to superpose the 2 graphs. Click **Show**. Use **Time Average** rather than **As Is**.

Copy the graph(s) in your report. Compare the 2 statistics. (Document Results)

2- Now switch to scenario **HubOnly** and display the same statistics as for **Hub_Low_Load**.

Copy the graph(s) in your report. Compare the 2 statistics. (Document Results)

3- From one of the scenarios, right click in the project work space, select View Results, and expand **Object Statistics > Office Network > Hub > Ethernet**, and select **Collision Count**.

Use the display option **Overlaid Statistics**, from the drop down menu showing **Stacked Statistics**.

Choose "**This scenario**" from the drop down menu showing **Results for: "Current Scenario"**, and select both scenarios in the panel.

Click **Show**.

Copy the graph(s) in your report. Compare the 2 statistics. (Document Results)

How does this result help to explain the difference between the received and sent traffic in the 2 scenarios? (Document Results)

4- Finally display the **Delay** statistic found in **Global Statistics, Ethernet**, for both **HubOnly** and **Hub_Low_Load** in **Overlaid Statistics**.

Copy the graph(s) in your report. Compare the results and suggest an explanation for the difference between the 2 scenarios. Calculate the expected delay for a packet transmission. (Document Results)

Analysis 2

Duplicate the Scenario

The network we just created utilizes only one hub to connect the 16 stations. In order to see how using a switch would affect the performance of the network, we will create a duplicate of the current network in which we add a hub and a switch.

You should first switch to the Scenario **HubOnly**.

1. Select **Duplicate Scenario** from the **Scenarios** menu and give it the name **HubAndSwitch.** Click **OK**.

2. Select **Topology** => **Open Object Palette**. Verify that **ethernet** node models are listed in the object palette.

3. Select **ethernet16_hub** in the list, then click and drag the icon in the object palette to the workspace. Click to drop the hub at the desired location. Right-click to abandon this object.

4. Similarly, add the **Switch**, identified as **ethernet16_switch** in the list in the **object palette.**

5. Close the **Object Palette**.

6. Right-click on the new hub, choose **Edit Attributes.** Change the **name** attribute to **Hub2** and click **OK**.

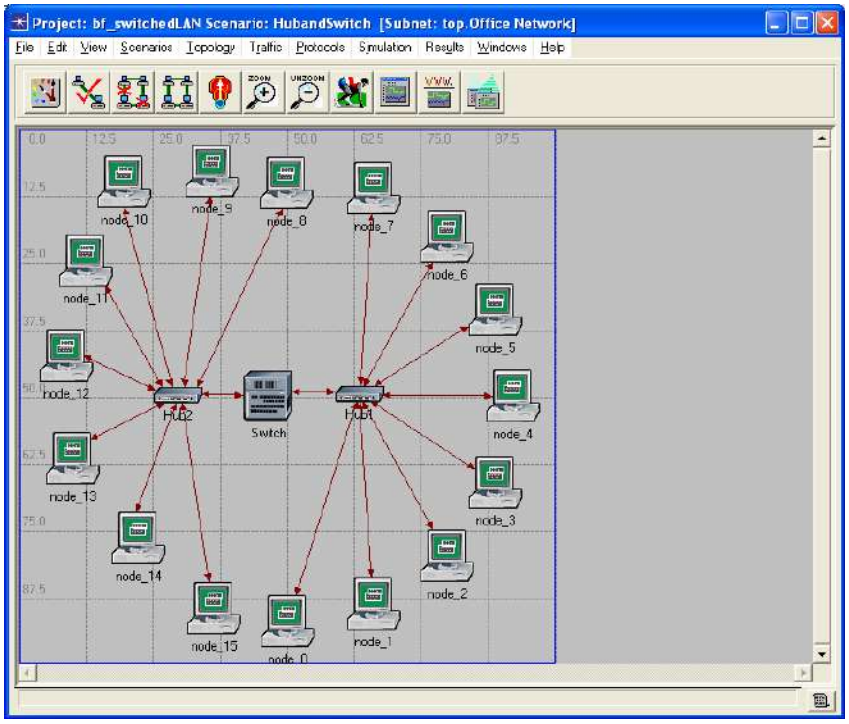
7. Right-click on the switch, choose **Edit Attributes.** Change the **name** attribute to **Switch** and click **OK**.

8. Reconfigure the network of the **HubAndSwitch** scenario so that it looks like the one below.

   a. To remove a link, select it and choose **Cut** from the **Edit** menu (or simply hit the **Delete** key). You can select multiple links and delete all of them at once.

   b. To add a new link, use the **10BaseT** link available in the **Object Palette**.

9. Save your project.



Run the Simulation

To run the simulation for this new scenario:
1. Select **Manage Scenarios** from the **Scenarios** menu.
2. Change the values under the **Results** column to **<collect>** (or **<recollect>**) for the scenario.
3. Click **OK** to run the simulation.
4. After the simulation is completed, click **Close**.
5. Save your project.

View the Results

To view and analyze the results:

1. To view and analyze the results, in the **DES** menu, select **Results**, then select **Compare results**.

2. Change the drop-down menu in the lower-right part of the *Compare Results* dialog box from **As Is** to **time_average**.
Use the display option **Overlaid Statistics**, and choose "**Current Project**" in the drop down menu **Results for**. Select the scenarios **HubOnly** and **HubAndSwitch** in the panel below.

4. Select the **Collision Count** statistic for Hub1 in Object Statistics and click **Show**, selecting the same 2 scenarios.

On the resulting graph right-click anywhere on the *graph area.* Choose **Add Statistic.** Expand the hierarchy for **HubAndSwitch**, select **Object Statistics, Office Network, Hub2, Ethernet**. Select the **Collision Count** statistic for **Hub2.** Change **As Is** to **time_average.** Click **Add.**

Copy the graph(s) in your report. Compare and explain the results. (Document Results)

Identify how many collision domains you have in each scenario. Justify your answer. (Document Results)

5. Select the **Traffic Received (bits/sec)** statistic and click **Show**, selecting the same 2 scenarios.

Copy the graph(s) in your report. Compare and explain the results. (Document Results)

6. Under **Ethernet** select the **Delay (sec)** statistic and click **Show**, selecting the same 2 scenarios.

Copy the graph(s) in your report. Compare and explain the results. Consider the expected delay for a packet transmission. (Document Results)

Analysis 3

Create two new scenarios.

- the first one, called **SwitchOnly**, is the same as the **HubOnly** scenario, but replace the hub with a switch and change its name.
- the second new scenario, called **TwoSwitches**, is the same as the **HubAndSwitch** scenario but replace both hubs with two switches, remove the old switch, and connect the two new switches with a 10BaseT link and change their names.

Note: to replace a hub with a switch, right-click on the hub, choose **Edit Attributes (Advanced)**, and assign **ethernet16_switch** to its **model** attribute

Run the simulation for the new scenarios.

Copy the graphs showing the two new networks into your report. (Document Results)

Compare the difference in performance, in terms of **delay**, and **collision count**, between the 4 scenarios (omit the HubLowLoad scenario). (Document Results)

Copy the graph(s) in your report. Compare and explain the results. For the delay, refer again to the expected network delay. (Document Results)