Switched LANs

A Set of Local Area Networks Interconnected by Switches

Objective

This lab is designed to demonstrate the implementation of switched local area networks. The simulation in this lab will help you examine the performance of different implementations of local area networks connected by switches and hubs.

Overview

There is a limit to how many hosts can be attached to a single network and to the size of a geographic area that a single network can serve. Computer networks use switches to enable the communication between one host and another, even when no direct connection exists between those hosts. A switch is a device with several inputs and outputs leading to and from the hosts that the switch interconnects. The core job of a switch is to take packets that arrive on an input and forward (or switch) them to the right output so that they will reach their appropriate destination.

A key problem that a switch must deal with is the finite bandwidth of its outputs. If packets destined for a certain output arrive at a switch and their arrival rate exceeds the capacity of that output, then we have a problem of contention. In this case, the switch will queue, or buffer, packets until the contention subsides. If it lasts too long, however, the switch will run out of buffer space and be forced to discard packets. When packets are discarded too frequently, the switch is said to be congested.

In this lab you will set up switched LANs using two different switching 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 collision of packets in a switched network are affected by the configuration of the network and the types of switching devices that are used.

Create a New Project

1. Start the **Riverbed Modeler Academic Edition** ⇒ Choose **New** from the **File** menu.

2. Select **Project** and click **OK** ⇒ Name the project **<your initials>_SwitchedLAN**, and the scenario **OnlyHub** ⇒ Make sure that the Use Startup Wizard is checked ⇒ Click **OK**.

3. In the *Startup Wizard: Initial Topology* dialog box, make sure that **Create Empty Scenario** is selected ⇒ Click **Next** ⇒ Choose **Office** from the *Network Scale* list ⇒ Click **Next** three times ⇒ Click **Finish**.

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

Create the Network

To create our switched 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**.

The prefix **ethernet16_** indicates that the device supports up to 16 Ethernet connections.

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

The **10BaseT** link represents an Ethernet connection operating at 10 Mbps.
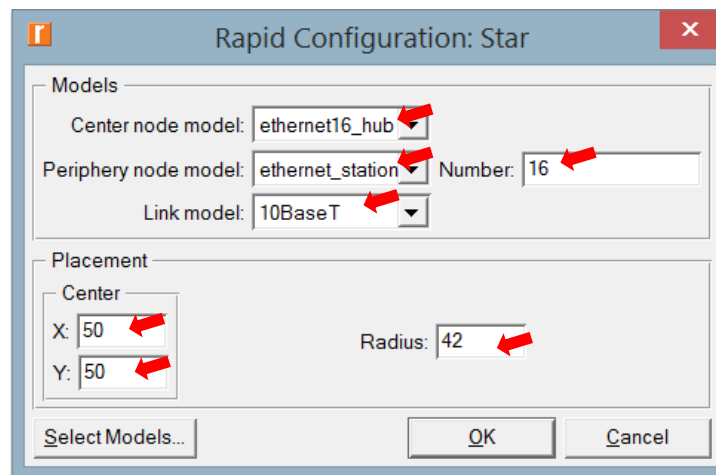
4. Right-click on **node_16**, which is the hub ⇒ **Set Name** ⇒ Change the **name** attribute to **Hub1** and click **OK**.

5. Now that you have created the network, it should look like the following one.

6. Make sure to save your project.
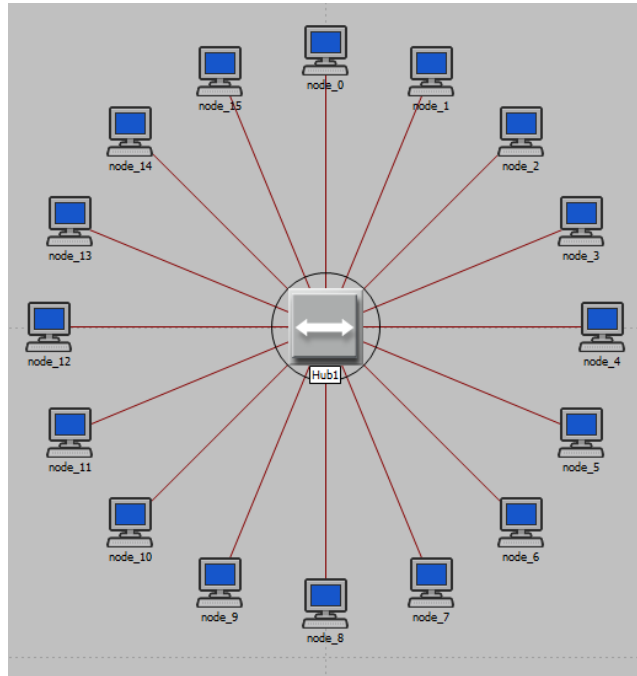
Configure the Network Nodes

Here you will configure the traffic generated by the stations.

1. Right-click on any of the 16 stations (node_0 to node_15) ⇒ **Select Similar Nodes**. Now all stations in the network are selected.

2. Right-click on any of the 16 stations ⇒ **Edit Attributes.**
   a. Check the **Apply Changes 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:
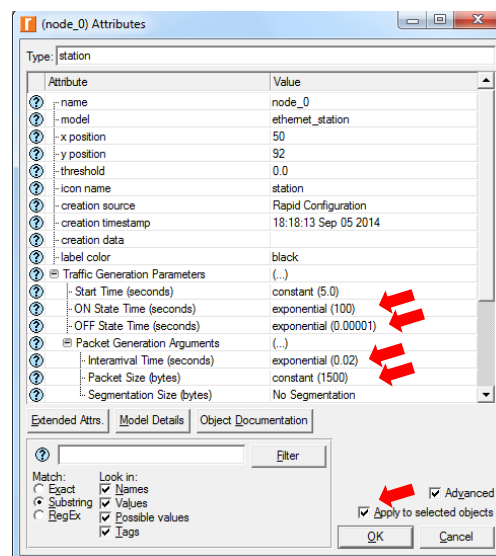
4. Click **OK** to close the attribute editing window(s). Save your project.

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, choose the following four statistics:

The **Ethernet Delay** represents the end to end delay of all packets received by all the stations.

Traffic Received (in packets/sec) by the traffic sinks across all nodes.

Traffic Sent (in packets/sec) by the traffic sources across all nodes.

Collision Count is the total number of collisions encountered by the hub during packet transmissions.
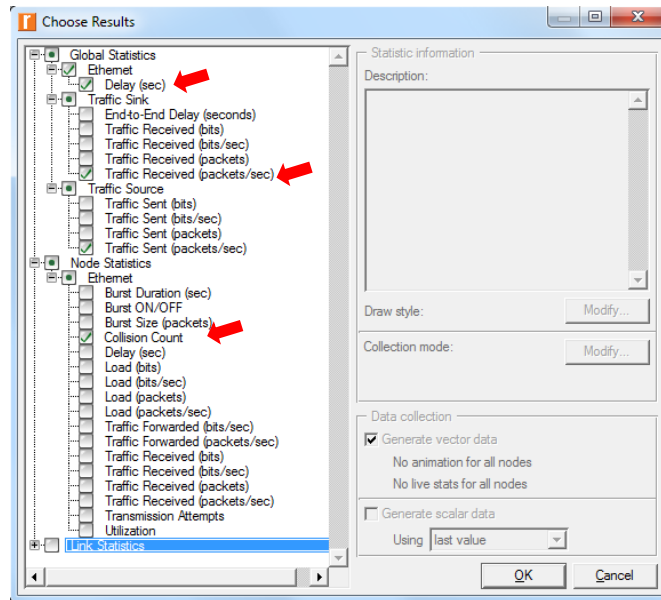
3. Click **OK**.

Configure and Run the Simulation

Here we need to configure the duration of the simulation:

1. Click on the **Configure/Run Simulation** button:

2. Set the duration to be **2.0 minutes**.

3. Click **Run**.

Duplicate the Scenario

The network we just created utilizes only one hub to connect the 16 stations. We need to create another network that utilizes a switch and see how this will affect the performance of the network. To do that we will create a duplicate of the current network:

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

2. Open the **Object Palette** by clicking on . Make sure that **Ethernet** is selected in the pull-down menu on the object palette.

3. We need to place a hub and a switch in the new scenario. (They are circled in the following figure.)
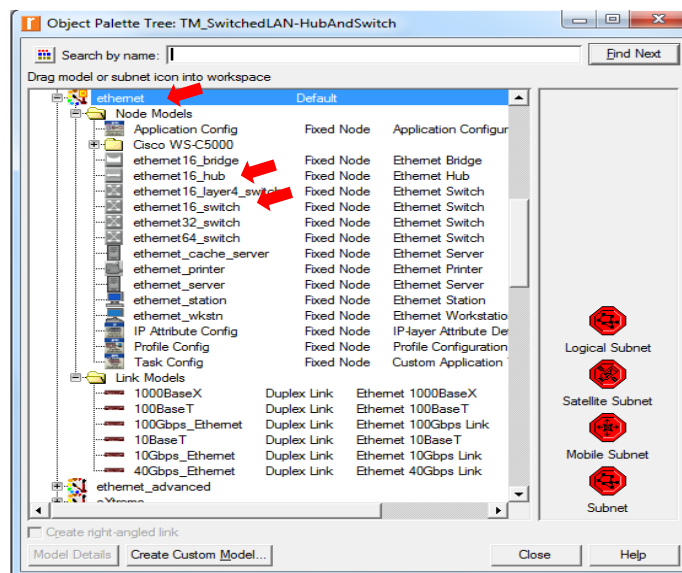
4. To add the **Hub**, click its icon in the object palette ⇒ Move your mouse to the workspace ⇒ Click to drop the hub at a location you select. Right-click to indicate you are done deploying hub objects.

5. Similarly, add the **Switch**.

6. Close the **Object Palette**.

7. Right-click on the new hub ⇒ **Set Name** ⇒ Change the **name** attribute to **Hub2** and click **OK**.

8. Right-click on the switch ⇒ **Set Name** ⇒ Change the **name** attribute to **Switch** and click **OK**.

9. Reconfigure the network of the **HubAndSwitch** scenario so that it looks like the following one:
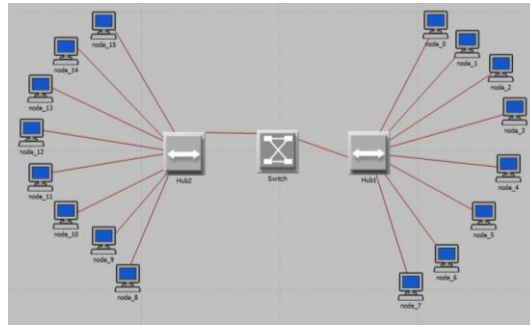
10. Remove **All** links by selecting them and hitting the **Delete** key.

11. Add a new links, using the **10BaseT** link available in the **Object Palette**.

12. Save your project.

Configure and Run the Simulation

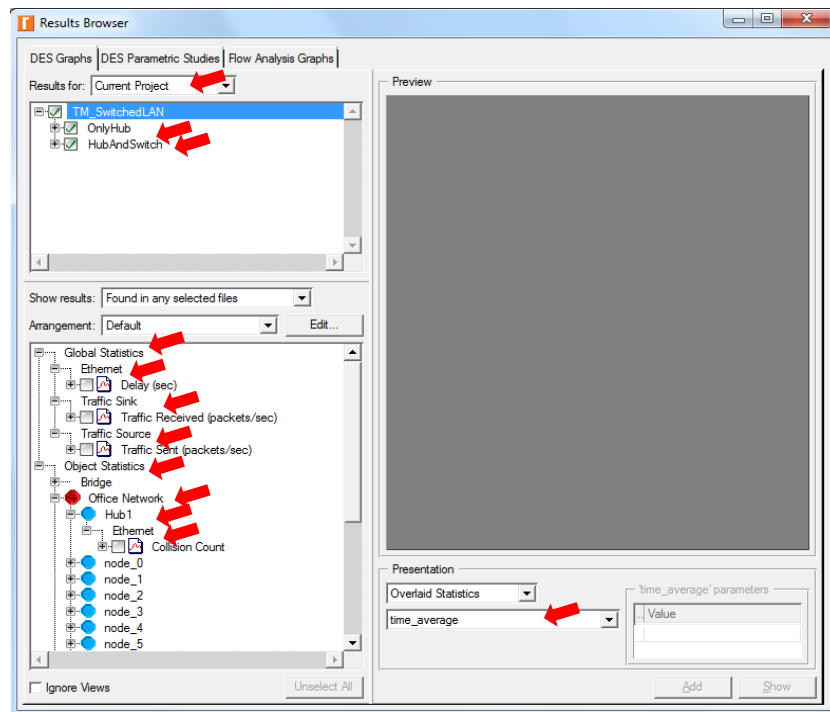Here we need to configure the duration of the simulation:

1. Click on the **Configure/Run Simulation** button:

2. Set the duration to be **2.0 minutes**.

3. Click **Run**.

View the Results

To view and analyze the results:

1. Select **Compare Results** from **Results** in the **DES** menu.

time_average is the average value over time of the values generated during the collection window. This average is performed assuming a "sample-and-hold" behavior of the data set (i.e., each value is weighted by the amount of time separating it from the following update and the sum of all the weighted values is divided by the width of the collection window). For example, suppose you have a 1-second bucket in which 10 values have been generated. The first 7 values were generated between 0 and 0.3 seconds, the 8th value at 0.4 seconds, the 9th value at 0.6 seconds , and the 10th at 0.99 seconds. Because the last 3 values have higher durations, they are weighted more heavily in calculating the time average.

2. Change the drop-down menu in the lower-right part of the *Compare Results* dialog box from **As Is** to **time_average,** as shown.

3. From the *Results for* drop-down menu, select **Current Project**.

4. Check **OnlyHub** and **HubAndSwitch**.

5. Expand **Global Statistics** ⇒ expand **Ethernet** ⇒ expand **Traffic Sink** ⇒ expand **Traffic Source**.

6. Expand **Object Statistics** ⇒ expand **Office Network** ⇒ expand **Hub1** ⇒ expand **Ethernet**.

7. Select the **Traffic Sent (packets/sec)** statistic and click **Show**. The resulting graph should resemble the one below. As you can see, the traffic sent in both scenarios is almost identical.

time_average (in Traffic Source.Traffic Sent (packets/se...)
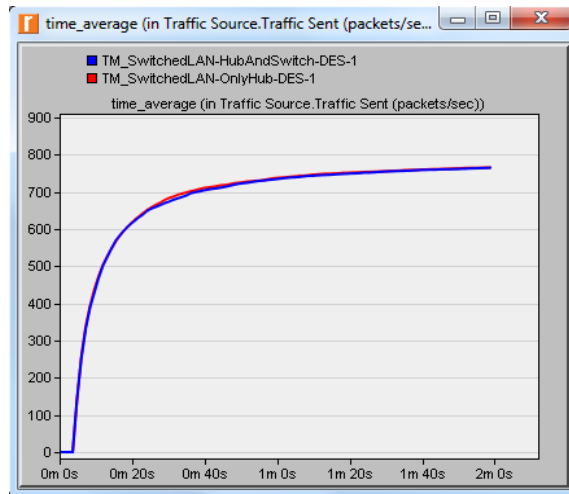
8. Select the **Traffic Received (packets/sec)** statistic and click **Show**. The resulting graph should resemble the one below. As you see, the traffic received with the second scenario, **HubAndSwitch**, is higher than that of the **OnlyHub** scenario.


time_average (in Traffic Sink.Traffic Received (packets/s...)
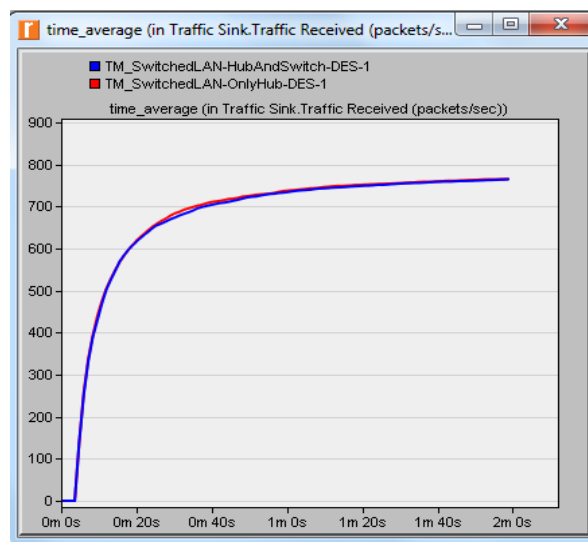
9. Select the **Delay (sec)** statistic and click **Show**. The resulting graph should resemble the one below. (*Note:* Result may vary slightly due to different node placement.)
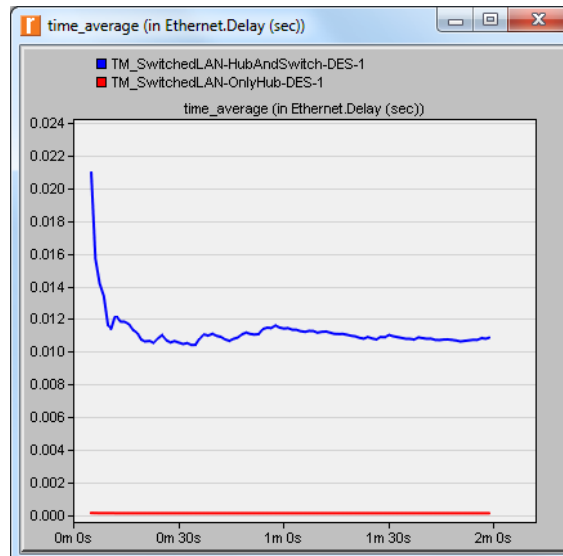
10. Select the **Collision Count** statistic for **Hub1** and click **Show**.

7. On the resulting graph right-click anywhere on the *graph area* ⇒ Choose **Add Statistic** ⇒ Expand the hierarchies as shown below ⇒ Select the **Collision Count** statistic for **Hub2** ⇒ Change **As Is** to **time_average** ⇒ Click **Add.**
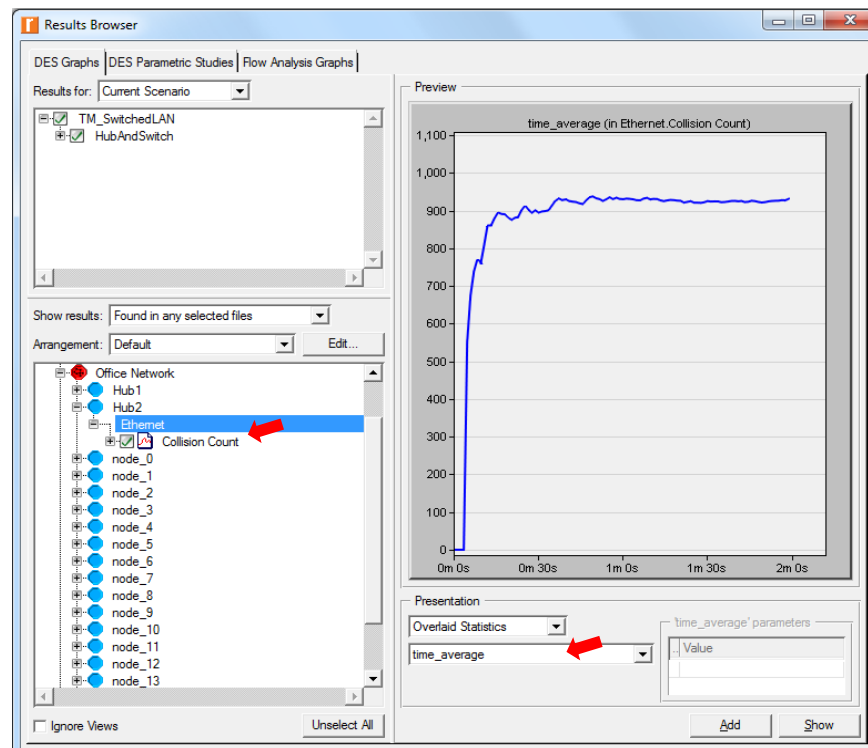
8. The resulting graph should resemble the one below.
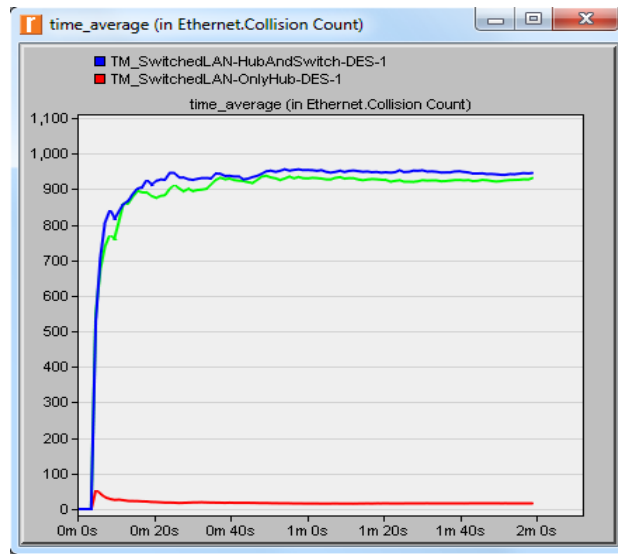
9. Save your project.

1) Explain why adding a switch makes the network perform better in terms of throughput and delay.

2) We analyzed the collision counts of the hubs. Can you analyze the collision count of the "Switch"? Explain your answer.

3) Create two new scenarios. The first one is the same as the **OnlyHub** scenario but replace the hub with a switch. The second new scenario is the same as the **HubAndSwitch** scenario but replace both hubs with two switches, remove the old switch, and connect the two switches you just added together with a 10BaseT link. Compare the performance of the four scenarios in terms of delay, throughput, and collision count. Analyze the results.
Note: To replace a hub with a switch, right-click on the hub and assign **ethernet16_switch** to its **model** attribute.

Lab Report

Prepare a report that follows the guidelines explained in Lab 0. The report should include the answers to the above questions as well as the graphs you generated from the simulation scenarios. Discuss the results you obtained and compare these results with your expectations. Mention any anomalies or unexplained behaviors.