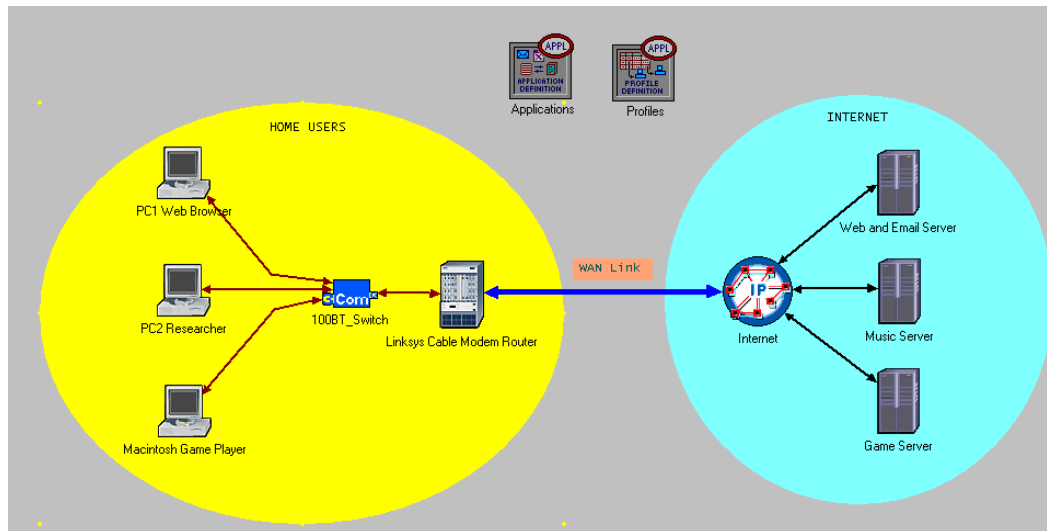


LAB 1:

Evaluating Internet Connection Choices for a Small Home PC Network

This lab has been originally designed as supplemental material for Prof. Panko's textbook "Business Data Networks and Telecommunications".



Download and Install Lab Files

1. Click on the following link: http://www.cse.yorku.ca/course/3213/Home_LAN_3213_2015.zip.
2. Save the zip file to the desktop.
3. Double-click the zip file and extract the files to a directory on the desktop.
4. To add the file to Riverbed Modeler, open Riverbed Modeler Academic Edition.
5. Select *File* → *Manage Model Files* → *Add Model Directory*.
6. Select the directory where you unzipped the lab files (on the desktop) and click OK.
7. In the *Confirm Model Directory* window select *Include all subdirectories*.

Objective

This lab teaches the basics of using Riverbed Modeler network simulator. Riverbed Modeler's user-friendly interface with drag-and-drop features enable students to effectively model, manage, and troubleshoot real-world network infrastructures.

The goal of this lab is to investigate application performance and capacity planning, by changing the link speed between a home LAN and its ISP.

Overview

Riverbed Modeler provides a Virtual Network Environment that models the behavior of networks, including its routers, switches, protocols, servers, and individual applications. The Virtual Network Environment allows IT managers, network and system planners, and operation's staff to more effectively diagnose difficult problems, validate changes before they are implemented, and plan for future scenarios such as traffic growth and network failures. Riverbed Modeler eliminates the need to build real test setups to design and evaluate various protocols and algorithms, ultimately saving time and money.

To create a network simulation (called a **project** in Riverbed Modeler), you specify the nodes (computers, switches, routers, etc.) in your network, the links between nodes, and the applications that will be running on the nodes.

In this exercise, the initial simulation (project) has been built for you. It models a family's home PC network, which has three PCs connected to the Internet for game playing, web browsing, E-mail, audio streaming, and FTP (file transfer protocol). Your objective will be to conduct a series of what-if simulations (scenarios) to see how performance differs if the family connects to the Internet using 1) a slow modem downloading at 56 kbps, 2) a cable modem or DSL line downloading at 512 kbps, or 3) a T1 line with download speed of 1.544 Mbps. Throughout the exercise you should keep in mind, nevertheless, that higher speed provided by the ISP is always associated with higher service cost.

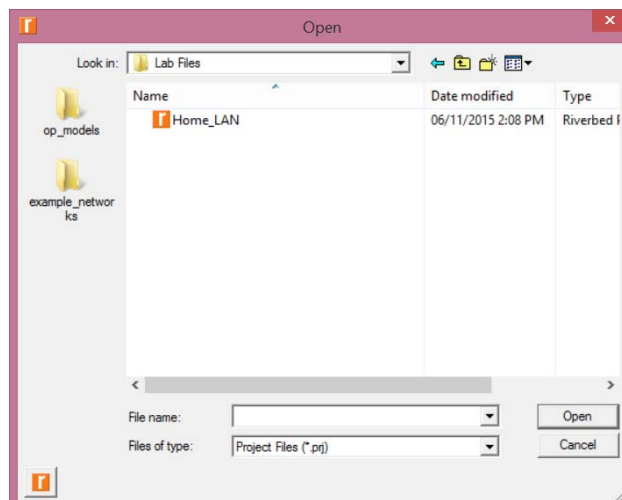
For each scenario, you will set the download speed in the simulation model, run a simulation, and view the results. The ultimate goal of this lab is to address the question of whether faster connections are worth higher prices for the home network.

Lab Instructions

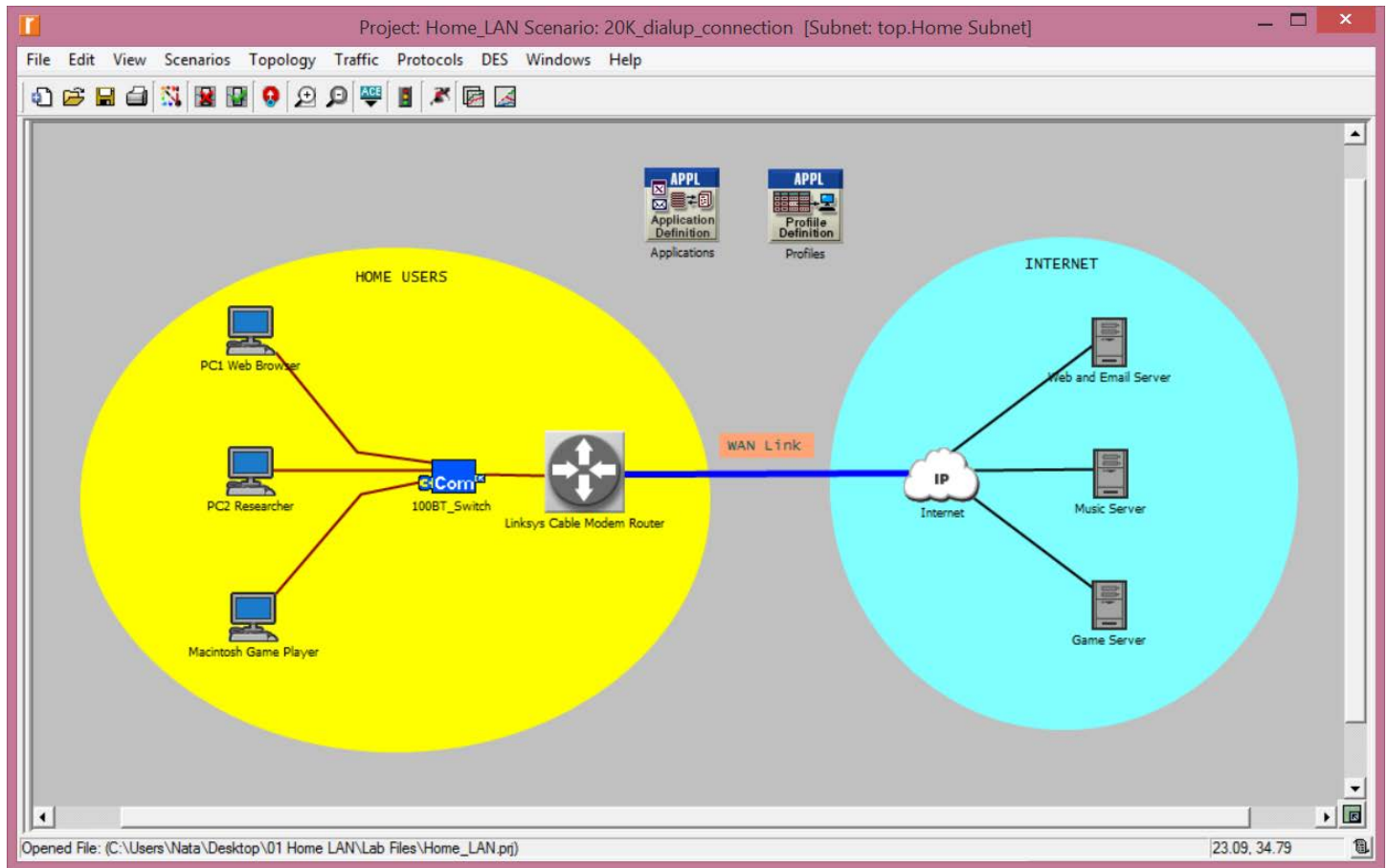
Step 1: Open Lab 1

Riverbed Modeler consists of **projects** and **scenarios**. Each scenario represents a different **what-if** analysis performed by the users. Scenarios may contain different versions of the same network or models of different networks. A project consists of one or more network scenarios. In this lab, you will create 3 different scenarios comparing application performance with different connection speeds to the ISP.

1. Start Riverbed Modeler.
2. Select **File** → **Open...** In **Look in** scroll down to the directory **Home_LAN_3213_2015**, select **Home_LAN_3213_2015** Riverbed Modeler file. Click **Open**.



Note: If you do not see the project file, then make sure you have downloaded the lab files. Then unzip the file, add the unzipped lab files directory by going to **File** → **Manage Model File** → **Add Model Directory** and select **Home_LAN_3213_2015**. The project should now be added.



The above picture shows the simulated network. Each of the network's PCs connects to the family's 100 Mbps Ethernet switch via a UTP connection. The switch connects to the router, also via UTP. A WAN link connects the home PC network to the Internet. Three Internet servers provide different services to the client PCs.

Near the top of the figure are two boxes that do not represent physical components: Applications and Profiles. The Applications node contains data about the applications used in the network, such as Web browsing. More specifically, traffic is associated with each application, so there is a difference between "light Web browsing" and "heavy Web browsing." Internal file service and print service traffic are not shown; these would be too light to make a difference in performance because the Internet WAN connection is the weak link in this network. In the Profiles icon, different applications are associated with different PCs.

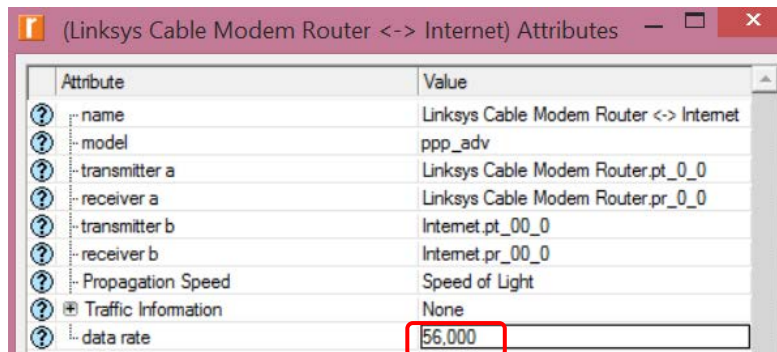
The complete topology of the simulated network is laid out and the attributes for all the objects are preconfigured except the link data rate between the Router and the Internet cloud - this is our WAN link.

Step 2: Configure the WAN Link to 56 kbps

In your first scenario, you will configure the WAN link as a 56 kbps dial-up line.


1. Right-click on the WAN link and select **Edit Attributes**. Here we can see the different link attributes. We will be changing the **data rate** attribute of this link.

2. Click in the Value field of the **data rate** attribute and select **Edit...**
3. Enter **56,000**; press **Enter** and then click **OK**.



Step 3: Configure and Run the Simulation

To simulate this network, we will use high fidelity discrete event simulation. The model simulates client/server application packets, which represent real world network traffic.

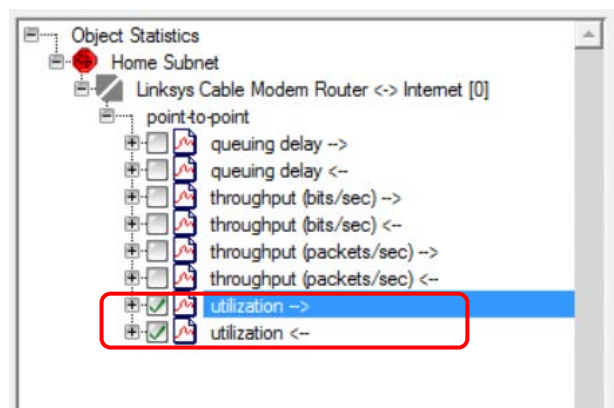
1. Click on the **configure/run simulation** button. 
2. Make sure the Simulation **Duration** is set to **8 hours** to represent a typical day.
3. Click **Run**, monitor the progress bar as the simulation proceeds.
4. When the simulation completes, Click **Close**.

Step 4: View Results

We can now view various statistics including the web application **Response Time** experienced by the Researcher and the WAN **link utilization**. Follow the instructions below to view the statistics.


Performance for the WAN link

1. Right-click on the WAN link and select **View Results** to view the **utilization** results for this link.
2. In the Object Statistics pane expand **point-to-point** and select **utilization** in both directions, as shown below.



3. Select **Stacked Statistics** from the pull-down menu on the bottom right-hand corner to see the results in two separate plots.
4. Select **Show** and then click **Close** in the **View Results** window.

Performance for PC2 (Researcher PC)

5. Right-click on the **PC2 Researcher** client and select **View Results** to view the web **Response Time**.
6. Expand **Client Http** and select the first entry - **Page Response Time (seconds) <Researcher / Web Browsing (Heavy)>**. Also make sure that the pull-down menu on the bottom right-hand corner is set to **As Is**.
7. Select **Show** and then click **Close** in the **View Results** window.
8. You can use the **hide or show all graphs** button  to hide/show the graphs.

EXERCISE 1

Your task is to take a screenshot of your own two (sets of) graphs obtained by performing Steps 4.1 to 4.8, and include them in the final report. You are also required to comment on the obtained graphs, i.e. answer the following questions:

- a) How much are the average download and upload **utilization** on the WAN link in the first obtained graph? How do you explain the difference between the two values?
- b) What is the average **Response Time** experienced by the Researcher in the second obtained graph? In your experience in using the Internet and WWW, is this time acceptable?

Step 5: 512 kbps Scenario

Implement a fast modem connection downloading a 512 kbps. This is realistic throughput for a cable modem or DSL line.

1. Select **Scenarios** → **Duplicate Scenario...** and name the new scenario as **512K_DSL**.
2. Click **OK**. This creates a copy of the existing scenario.

Step 6: Configure the Link to 512 kbps

Right-click on the **WAN link**, select **Edit Attribute**, and change the **data rate** attribute to 512,000.

Step 7: Run the 512 kbps Simulation

Rerun the simulation. You can refer to the steps given previously for setting the duration and running the simulation.

Step 8: View Results for 512 kbps Scenario

Follow the same steps mentioned before to view the **link utilization** on the WAN link, and **Response Time** for the researcher PC.

EXERCISE 2

As in EXERCISE 1, your task is to take a screenshot of your results obtained by running the **512 kbps Scenario**, and include them in the final report. Once again, you are required to comment on the obtained graphs by answering the following questions:

- What are the new observed values of average **utilization** and average **Response Time**?
- How do these values compare to those collected in EXERCISE 1?

Step 9: Set the link as T1 line and run the simulation

In the third scenario, you will simulate a 1.544 Mbps (T1 line) download speed. For this WAN connection:

- Duplicate the scenario as before and name it **T1_Line**.
- Set the **data rate** for the **WAN link** to 1,544,000.
- Rerun the simulation.
- View the results for the **link utilization** on the WAN link and **Response Time** for the Researcher PC.

EXERCISE 3

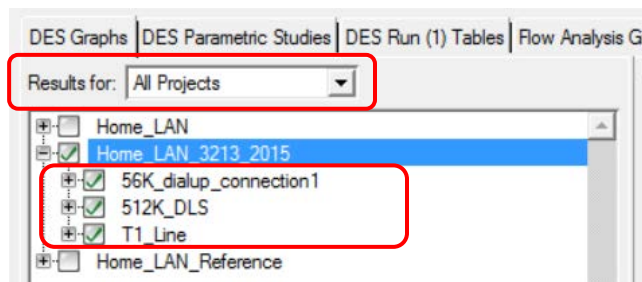
As in earlier exercises, your task is to take a screenshot of your results obtained by running the **T1 Line Scenario**, and include them in the final report. You are also required to comment on the obtained graphs by answering the following questions:

- What are the new observed values of average **utilization** and average **Response Time**?
- How do these values compare to those collected in EXERCISE 1 and 2?

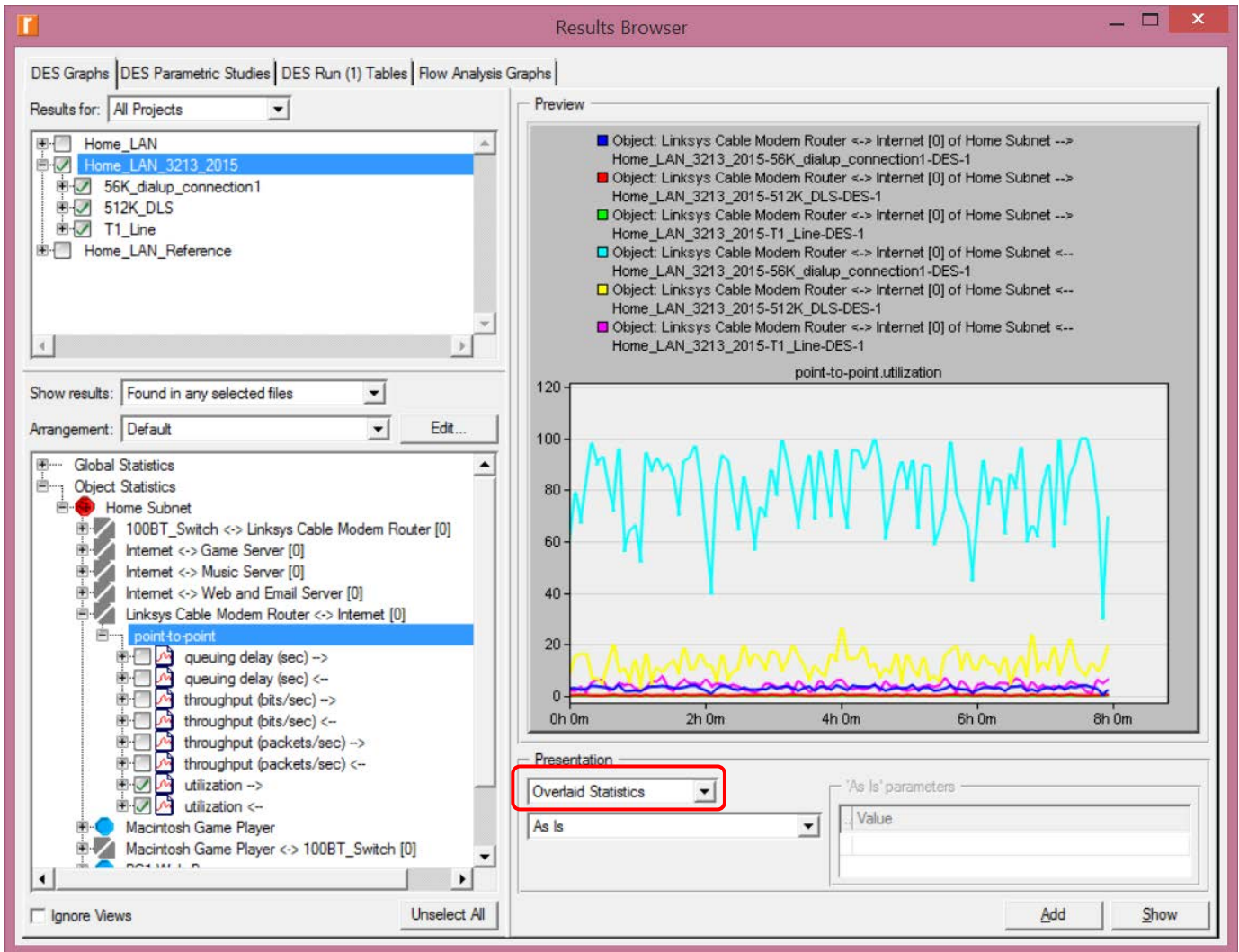
Step 10: Compare Results

Rather than viewing the results for the T1 link alone, let us **compare** the results of **utilization** and **Response Times** for **all 3 scenarios**. This will give us a broader picture of the effects of changing the data rate.

- Select **Results**. Under Results for select All Projects, and then check all three scenarios as shown below.

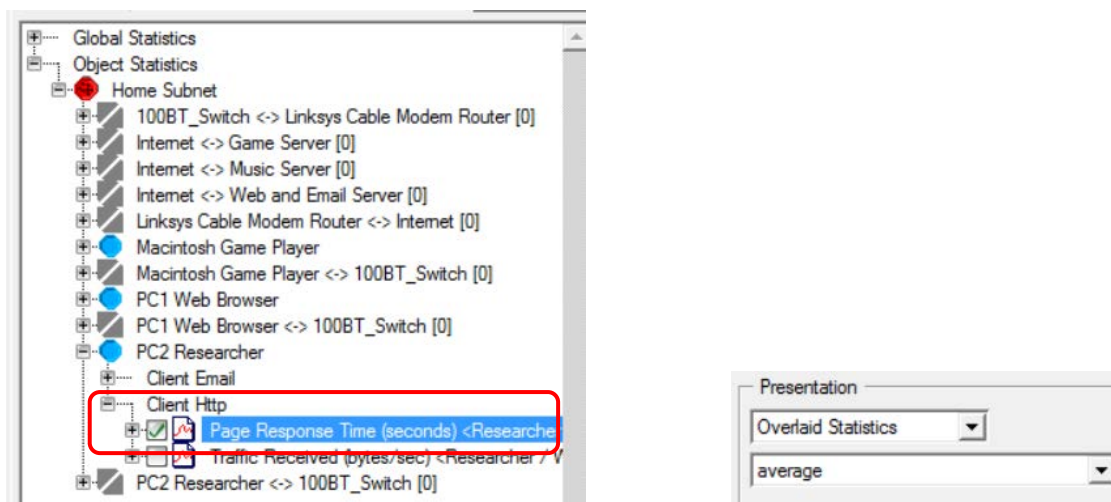


- To compare the **utilization** statistics, choose the following statistics:



3. Make sure to select **Overlaid Statistics** under **Presentation**.

4. To compare the **Response Time**, choose **PC2 Researcher -> Client Http -> Page Response Time (seconds)** under Home Subnet:



5. Make sure to select **average** under **Presentation**.

EXERCISE 4

Once again, your task is to take a screenshot of the results obtained by performing Steps 10.1 to 10.5. After studying the obtained graphs, answer the following questions:

- a) How do the results of T1 scenario compare to the results of the earlier three scenarios?
- b) Which of the three WAN link options would you recommend to the family owning the network in question, and why? Justify your answer.

So far, every exercise had step-by-step instructions. Now, here are some advanced exercises for you to run.

EXERCISE 5

In each of the three scenarios, many additional statistics - like the throughput [bps] and the queuing delay - are also being collected on the WAN link. View these 2 results for the three scenarios and prepare a brief report of your observation.

EXERCISE 6

Create a duplicate scenario. Change the data rate of the WAN link between the Router and the ISP to get a response time of under 1 sec. What WAN speed did you find to give this response time?

EXERCISE 7

(In this exercise, make sure you are back in **T1_Line** scenario.)

There is continuous streaming between the music server and PC1 defined by a traffic demand object. You can view this object by selecting **View** → **Demands** → **Show All** in the menu. Try changing the download traffic volume for this demand. Specifically, change **Traffic (bits/sec)** attribute of the '**Music Server** → **PC1 Web Browser**' component of the Demand Object to the following values, respectively: a) 50,000 [bps], b) 250,000 [bps], c) 500,000 [bps]. Briefly describe the effect of the traffic volume increase(s) on the web response time for PC2 Researcher. (Take, and include in your report, all necessary screenshots of the obtained results.)

EXERCISE 8

Keep the setup parameters as in Exercise 7.c). Now, what would happen if 4 more PCs were added to the home network? To investigate this, create a duplicate scenario and name it **4MoreResearchers**. Select and Copy the Researcher PC. Then paste the PC 4 times into the home network field. (On every 'paste' operation, make two clicks - one on the copied icon, and the other on the 100BTSwitch. This will automatically create a connection between the new PC and the Home_LAN switch.) Run the simulation and view the web Response Time of PC2 Researcher. What did you find?