Laboratory
4

Network Design

Planning a Network with Different Users, Hosts, and Services

Objective

The objective of this lab is to demonstrate the basics of designing a network, taking into consideration the users, services, and locations of the hosts.

Overview

Optimizing the design of a network is a major issue. Simulations are usually used to analyze the conceptual design of the network. The initial conceptual design is usually refined several times until a final decision is made to implement the design. The objective is to have a design that maximizes the network performance, taking into consideration the cost constraints and the required services to be offered to different types of users. After the network has been implemented, network optimization should be performed periodically throughout the lifetime of the network to ensure maximum performance of the network and to monitor the utilization of the network resources.

In this lab you will design a network for a company that has four departments: Research, Engineering, E-Commerce, and Sales. You will utilize a LAN model that allows you to simulate multiple clients and servers in one simulation object. This model dramatically reduces both the amount of configuration work you need to perform and the amount of memory needed to execute the simulation. You will be able to define a profile that specifies the pattern of applications employed by the users of each department in the company. By the end of this lab, you will be able to study how different design decisions can affect the performance of the network.

Procedure

Create a New Project

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

2. Select **Project** and click **OK** ⇒ Name the project **<your initials>_NetDesign**, and the scenario **SimpleNetwork** ⇒ 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 **Campus** from the *Network Scale* list ⇒ Click **Next** ⇒ Choose **Miles** from the **Size** drop-down menu and assign **1** for both **X Span** and **Y Span** ⇒ Click **Next** twice ⇒ Click **Finish**.

Create and Configure the Network

Initialize the Network:

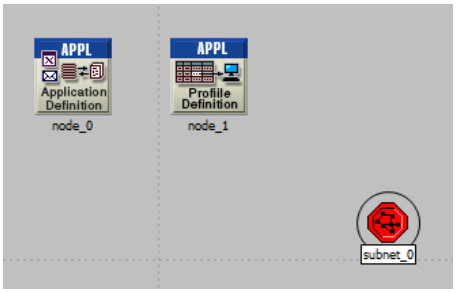
Application Config is used to specify applications that will be used to configure users profiles.

1. The *Object Palette* dialog box should be now on the top of your project space. If it is not there, open it by clicking  . Make sure that the **internet_toolbox** is selected from the pull-down menu on the object palette.

2. Add to the project workspace the following objects from the palette: **Application Config**, **Profile Config**, and a **subnet**.

Profile Config describes the activity patterns of a user or group of users in terms of the applications used over a period of time. You must define the applications using the **Application Config** object before using this object.

   a. To add an object from a palette, click its icon in the object palette ⇒ Move your mouse to the workspace ⇒ Left-click to place the object. Right-click when finished. The workspace should contain the following three objects:



3. Close the *Object Palette* dialog box and save your project.

Configure the Services:

1. Right-click on the **Application Config** node ⇒ **Edit Attributes** ⇒ Change the **name** attribute to **Applications** ⇒ Change the **Application Definitions** attribute to **Default** ⇒ Click **OK**.

2. Right-click on the **Profile Config** node ⇒ **Edit Attributes** ⇒ Change the **name** attribute to **Profiles** ⇒ Change the **Profile Configuration** attribute to **Sample Profiles** ⇒ Click **OK**.

   Sample Profiles provides patterns of applications employed by users such as engineers, researchers, salespeople, and multimedia users.

Configure a Subnet:

1. Right-click on the **subnet** node ⇒ **Set Name** ⇒ Change the **name** attribute to **Engineering** and click **OK**.

2. Double-click on the **Engineering** node. You get an empty workspace, indicating that the subnet contains no objects.

3. Open the object palette  and make sure it is still set to **internet_toolbox**.

4. Add the following items to the subnet workspace: **10BaseT_LAN**, **ethernet16_switch**, and a **10BaseT_link** to connect the LAN with the Switch ⇒ Close the palette.

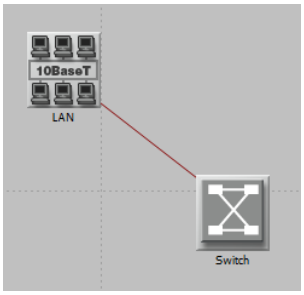
5. Right-click on the **10BaseT_LAN** node ⇒ **Edit Attributes** ⇒ Change the **name** attribute to **LAN** ⇒ Expand **LAN** ⇒ Observe that the **Number of Workstations** attribute has a value of 10 ⇒ Expand **Application** ⇒ Expand **Application: Supported Profiles** ⇒ Set the number of **rows** to **1** ⇒ Expand **None** ⇒ Set the **Profile Name** to **Engineer**.
   Note: **Engineer** is one of the "sample" profiles provided within the **Profile Config** object.

7. Click **OK**.
   The object we just created is equivalent to a 10-workstation star topology LAN. The traffic generated from the users of this LAN resembles that generated by "engineers."

8. Rename the **ethernet16 Switch** to **Switch.**

9. The subnet should look like the shown one.

10. Save your project.



Configure All Departments:

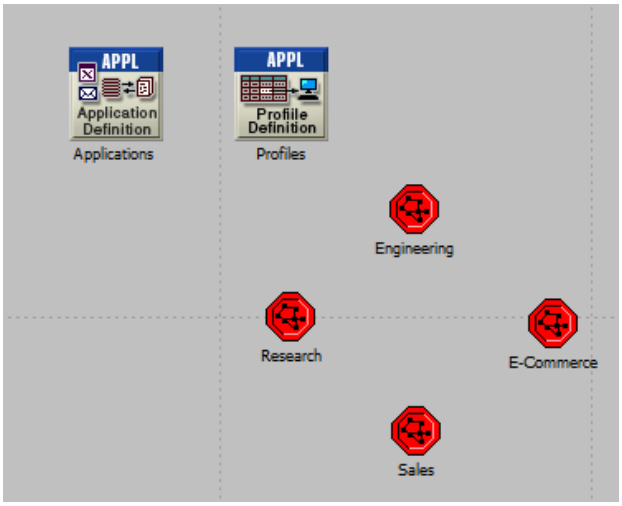
1. Now you have completed the configuration of the Engineering department subnet.

   To go back to the main project space, click the **Go to the Parent Subnet** button.

   The subnets of the other departments in the company should be similar to the engineering one except for the supported profiles.

2. Make three copies of the **Engineering** subnet we just created: Click on the **Engineering** node ⇒ From the **Edit** menu, select **Copy** ⇒ From the **Edit** menu, select **Paste** three times, placing the subnet in the workspace after each, to create the new subnets.

3. Rename (right-click on the subnet and select **Set Name**) and arrange the subnets as shown below:



4. Double-click the **Research** node ⇒ **Edit** the attributes of its **LAN** ⇒ **Edit** the value of the **Application: Supported Profiles** attribute ⇒ Change the value of the **Profile Name** from **Engineer** to **Researcher** ⇒ Click **OK** ⇒ Go to the parent subnet by clicking the button.

5. Repeat step 4 with the **Sales** node and assign to its **Profile Name** the profile **Sales Person**.

6. Repeat step 4 with the **E-Commerce** node and assign to its **Profile Name** the profile **E-commerce Customer**.

7. Save your project.

Configure the Servers:

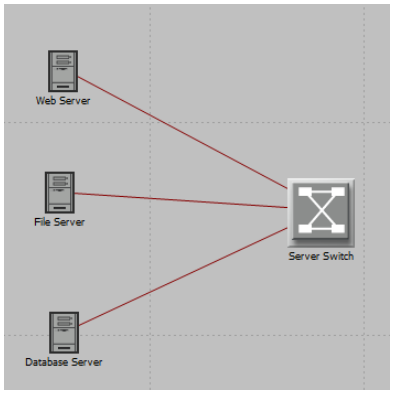
Now we need to implement a subnet that contains the servers. The servers have to support the applications defined in the profiles we deployed. You can double-check those applications by editing the attributes of our **Profile** node. Inspect each row under the **Applications** hierarchy, which in turn, is under the **Profile Configuration** hierarchy. You will see that we need servers that support the following applications: Web browsing, Email, Telnet, File Transfer, Database, and File Print.

1. Open the **Object Palette**  and add a new **subnet** ⇒ Rename the new subnet to **Servers** ⇒ Double-click the **Servers** node to enter its workspace.

2. From the **Object Palette**, add three **ethernet_servers**, one **ethernet16_switch**, and three **10BaseT** links to connect the servers with the switch.

3. Close the **Object Palette**.

4. Rename the servers and the switch as follows:



5. Right-click on each one of the above servers and **Edit** the value of the **Application: Supported Services** attribute under **Application**.

   i. For the *Web Server* add 4 rows to support the following services: **Web Browsing (Light HTTP1.1)**, **Web Browsing (Heavy HTTP1.1)**, **Email (Light)**, and **Telnet Session (Light)**.
   ii. For the *File Server* add two rows to support the following services: **File Transfer (Light)** and **File Print (Light)**.
   iii. For the *Database Server* add one row to support the following service: **Database Access (Light)**.

6. Go back to the project space by clicking the **Go to the Parent Subnet**  button.

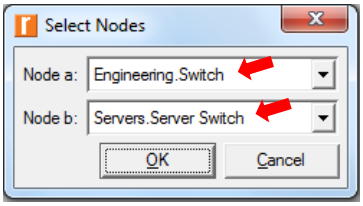
7. Save your project.

Connect the Subnets:

Now all subnets are ready to be connected together.

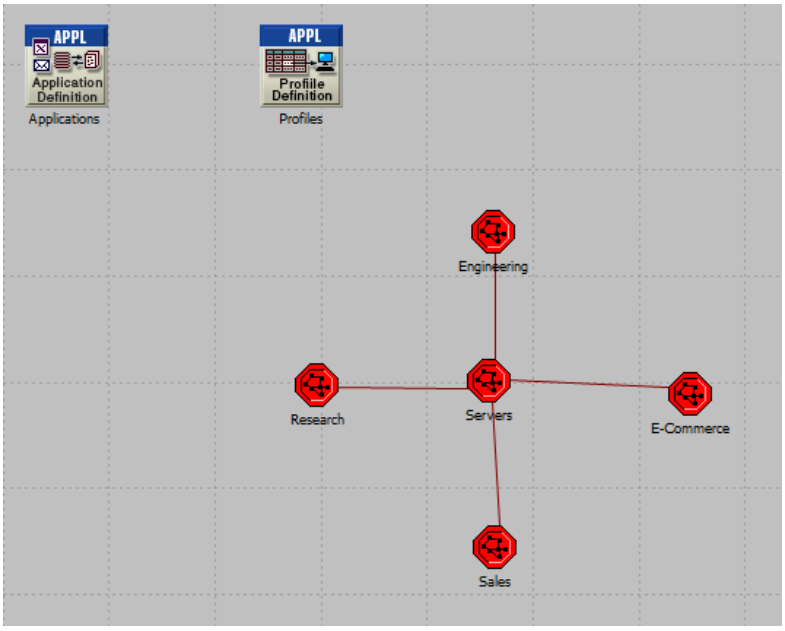
1. **Open** the **Object Palette**  and add four **100BaseT** links to connect the subnets of the departments to the **Servers** subnet.

   As you create each link, make sure that it is configured to connect the "switches" in both subnets to each other. Do this by choosing them from the drop-down menus as follows:



2. Close the **Object Palette**.

3. Now your network should resemble the following one:



4. Save your project.

Duplicate the Scenario

In the network we just created we assumed that there is no background traffic already in the links. In real networks, the links usually have some existing background traffic. We will create a duplicate of the **SimpleNetwork** scenario but with background utilization in the 100BaseT links.

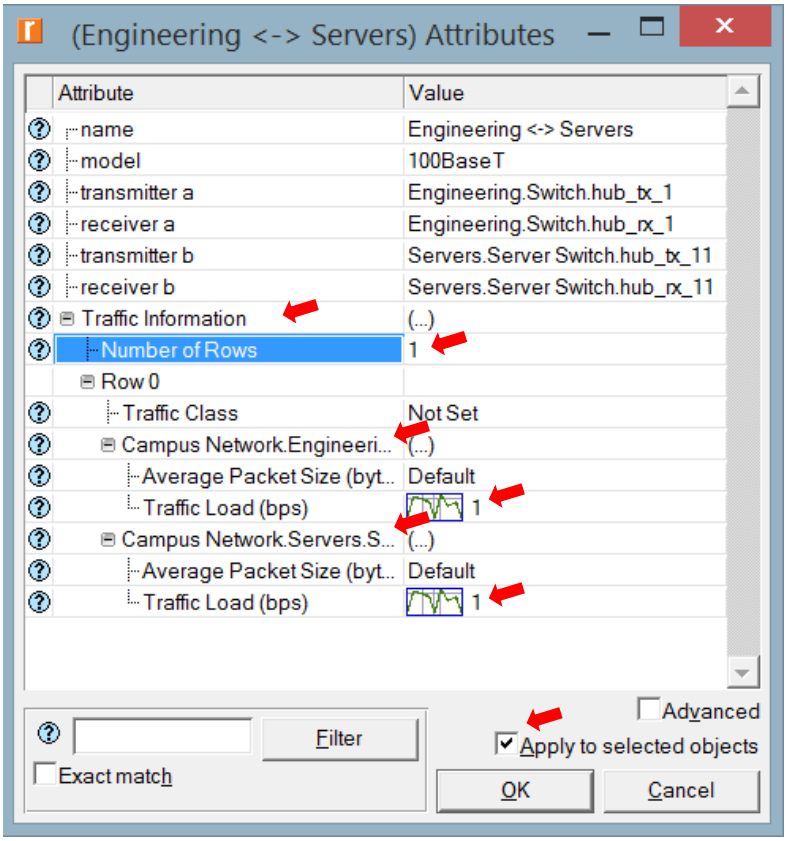
Link utilization is the percentage of the used link bandwidth.

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

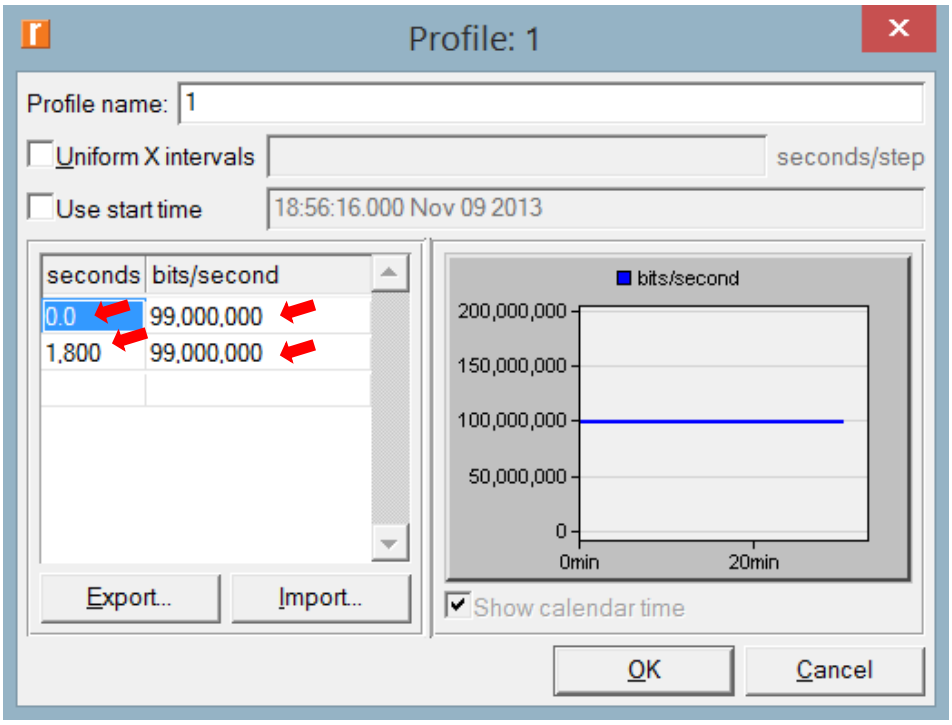
2. Select all the 100BaseT links simultaneously (click on all of them while holding the **Shift** key) ⇒ Right-click on anyone of them ⇒ **Edit Attributes** ⇒ Check the **Apply Changes to Selected Objects** check box.

3. Expand the hierarchy of the **Traffic Information** attribute ⇒ Click on the value of **Number of Rows** and assign **1** ⇒ Click **enter**.

4. Expand the hierarchy of the **Row 0** attribute ⇒ Expand the hierarchy of the **2 Campus Network.***** attribute ⇒ Click on the value of **Traffic Load** of the first and choose **1** ⇒ Click **enter**.



We now wish to add a background utilization of **99%**. That means that we want the **Link Load (bps)** to be **99000000 bps** and since our simulation will last **30 minutes** we will do the following:



5. Click **OK**.

6. Save your project.

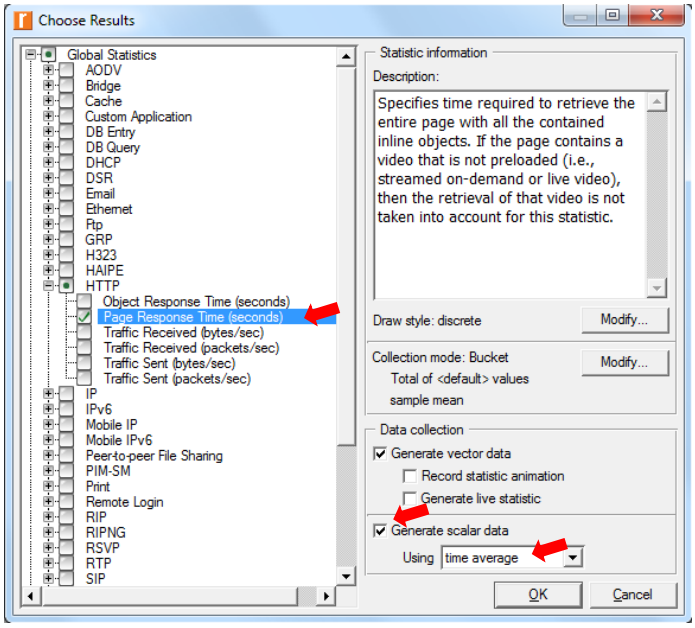
Choose the Statistics

To test the performance of our network we will collect one of the many available statistics as follows:

1. In each scenario, 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 statistic:

Page Response Time is the required time to retrieve the entire page.



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 **30.0 minutes**.
3. Press **Run**. Repeat for both simulations.

View the Results

To view and analyze the results:

1. Select **Compare Results** from **Results** in the **DES** menu.
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 **SimpleNetwork** and **BusyNetwork**.
5. Expand **Global Statistics** ⇒ expand **HTTP**.
6. Select the **Page Response Time (seconds)** statistic and click **Show**.

Questions

1) Analyze the result we obtained regarding the HTTP page response time. Collect four other statistics, of your choice, and rerun the simulation of the *Simple* and the *Busy* network scenarios. Get the graphs that compare the collected statistics. Comment on these results.

2) In the **BusyNetwork** scenario, study the **utilization%** of the CPUs in the servers (Right-click on each server and select **Choose Individual Statistics** ⇒ **CPU** ⇒ **Utilization**).

3) Create a new scenario as a duplicate of the **BusyNetwork** scenario. Name the new scenario **Q3_OneServer**. Replace the three servers with only one server that supports all required services. Study the **utilization%** of that server's CPU. Compare this utilization with the three CPU utilizations you obtained in the previous question.

4) Create a new scenario as a duplicate of the **BusyNetwork** scenario. Name the new scenario **Q4_FasterNetwork.** In the **Q4_FasterNetwork** scenario, replace all **100BaseT** links in the network with **10Gbps Ethernet** links and replace all **10BaseT** links with **100BaseT** links. Study how increasing the bandwidth of the links affects the performance of the network in the new scenario (e.g., compare the HTTP page response time in the new scenario with that of the **BusyNetwork**).

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.