



Emerging Network Technologies

Riverbed Modeler Additional Exercises

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1.0. Introduction and Objectives Riverbed Modeler (former OPNET) uses a project-and-scenario approach to model networks. Project is a collection of network-related scenarios, each of which explores a particular aspect of the network design. All projects contain at least 1 scenario. Scenario is a single instance of a network. Typically, a scenario presents a unique configuration for the network. The term "configuration" can refer to different aspects such as topology, protocols, applications, traffic, and simulation settings

This lab file consists of a number of hands-on labs practice to be completed for this semester. Below will provide labs to practice and give you experience with Modeler especially for those who are planning to use this simulation tool for final year project.

Lab: Using The Project Editor

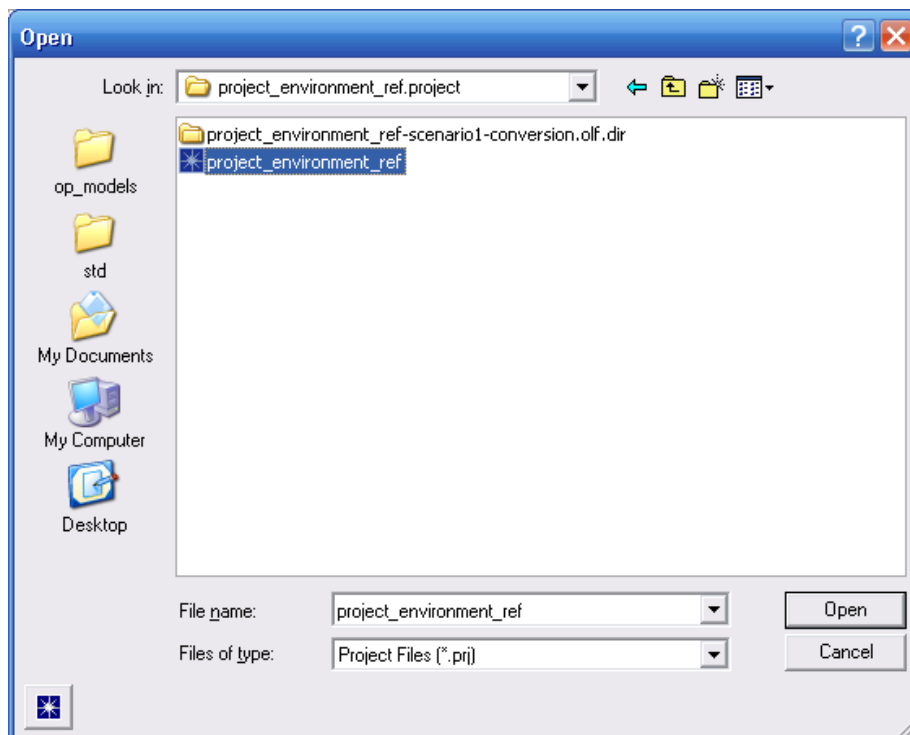
Objectives

1. Play with the different features of the Project Editor.
2. Use the “Device Creator” and model derivation to create new node models.
3. Modify attributes’ values in order to reflect particular behavior.
4. Use the online documentation.

Instructions

Browse the Topology

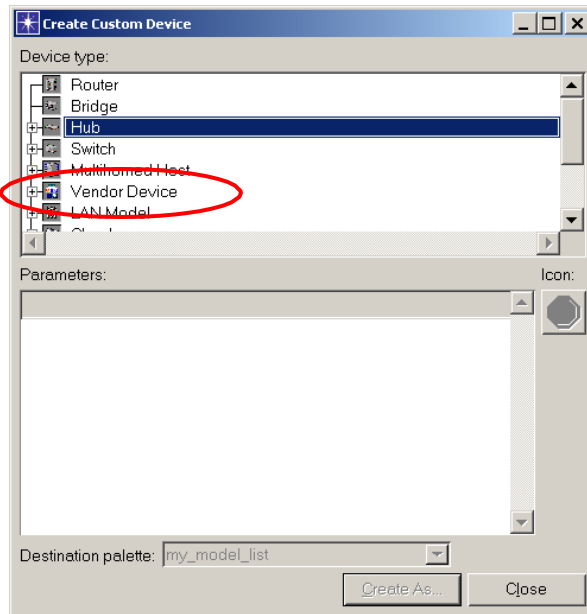
1. Open an existing project.
 - a. Select **File / Open...**
 - b. Browse to the folder **C: \op_models\project_environment_ref.project**
 - c. Choose the project file project_environment_ref



2. Practice moving between subnets.
 - a. Double-click on the **North America** subnet icon to enter it.
 - b. Then right-click anywhere in the workspace and choose **Go To Parent Subnet** to return.
3. Use zooming features to identify U.S. cities.
 - a. From the top level, enter the subnet labeled **North America**; then enter the **United States** subnet; now use the various zoom features to identify each subnet.
 - b. Use the **Zoom +** toolbar button to zoom to a rectangle.
 - c. Use the **Zoom –** toolbar button to return to the previous zoom level.
 - d. Use the **Page Up** and **Page Down** buttons on the keyboard to incrementally zoom in and out.
4. Experiment with adjusting the sizes of the icons
 - a. Select a groups of objects by drawing a rectangle around them
 - b. Select **View / Layout / Scale Node Icons Interactively...**
 - c. By adjusting the slider bar and other settings, you can change the sizes of the icons, and how they scale as you zoom out and how they change as they overlap with each other.
5. Label the Los Angeles subnet with an annotation.
 - a. Select **Topology / Open Annotation Palette**.
 - b. Press the “**T**” button to add a text box.
 - c. Type in **Los Angeles** and click **File / Close**.
 - d. Place the annotation on the workspace by drawing a box to represent the size of the annotation box.
 - e. Right-click anywhere in the workspace to end the Annotation operation.
 - f. Close the annotation palette window.

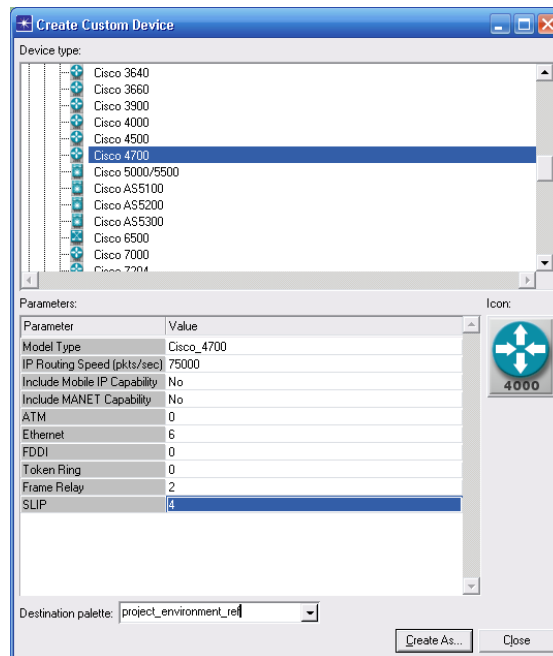
Using the Device Creator

1. Open device creator.
 - a. Select **Topology / Create Custom Device Model...**
 - b. The following dialog box appears.

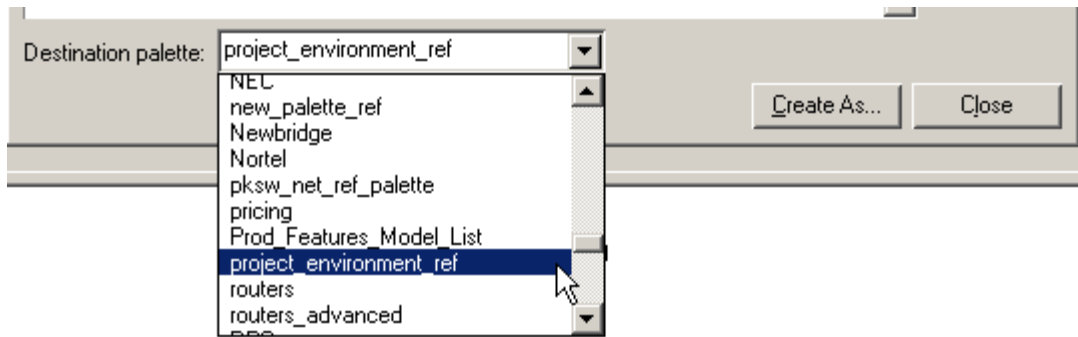


2. Configure settings for the device to be created.
 - a. Select a device category: click **Vendor Device**.
 - b. Select vendor: click **Cisco**.
 - c. Select the type of Cisco device you would like to create: click **Cisco 4700**.
 - d. Set the parameters as follows: Leave all other values at their defaults.

ATM	:	0
Ethernet	:	6
FDDI	:	0
Token Ring	:	0
Frame Relay	:	2
SLIP	:	4



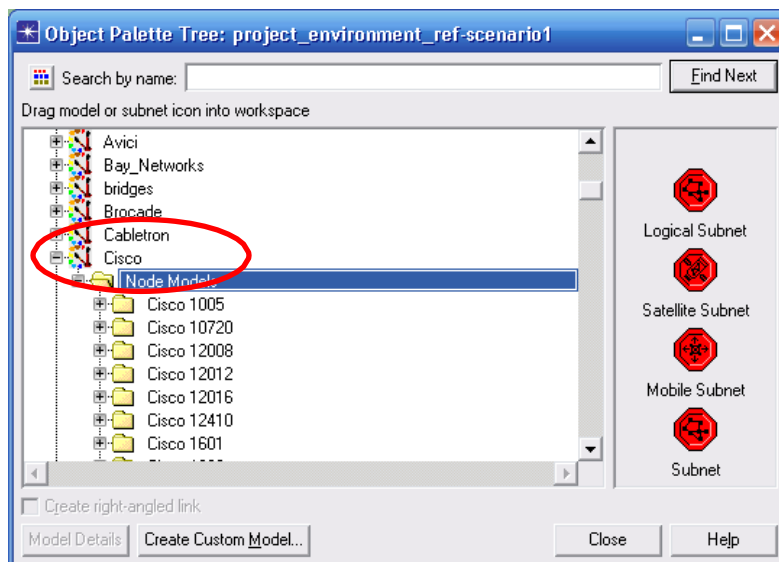
3. Make sure to change the Destination palette to: “project_environment_ref”



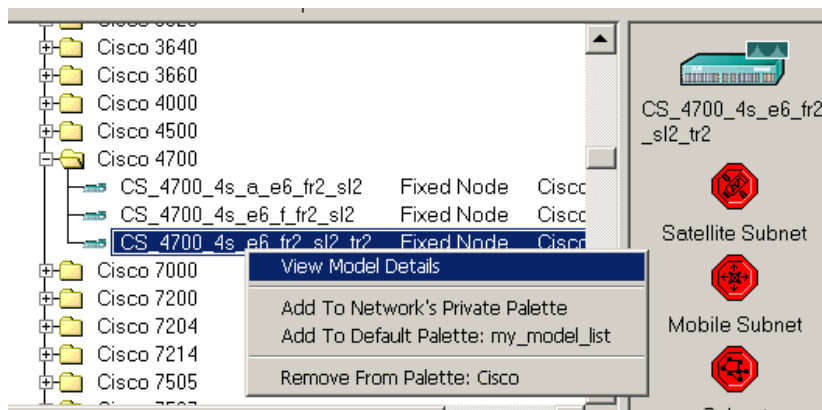
4. Create the device.
 - a. Click **Create As...** button.
 - b. Name the device **CS_4700_4s_e6_fr2_sl4** and click **OK**.
 - c. When it is finished, check the box for launching the object palette
 - d. Close the “Create Custom Device” dialog box

Deriving a New Model

1. Choose the desired model in the object palette.
 - a. Open the Object Palette if it is not already open: 
 - b. Select **Cisco** in the Object Palette list, and expand it by clicking on the plus sign



- c. Scroll down the list until you see the **Cisco 4700** listing, and expand that list too.
- d. Select the model from which to derive a new device model.
 - i. Right-click on the **CS_4700_4s_e6_fr2_sl2_tr2** entry, and choose “View Model Details”



- ii. In the resulting dialog box, click the **Derive New...** button.
2. Set a particular attribute value in the derived model.
 - a. Change the IP Datagram Switching Rate. Find the attribute **IP Processing Information** in the **Attributes** Table.
 - b. Left click in the **Initial Value** column and change the value from (...) to **Edit...**
 - c. In the **IP Processing Information Table** dialog box that appears, change the value for **Datagram Switching Rate (packets/sec)** to **250,000**.
 - d. Click **OK**.
 3. Save the derived model.
 - a. Click the **Save...** button.
 - b. Ensure you are saving to c:\op_models
 - c. Name the model **CS_6000_4s_e6_fr2_sl2_tr2**.
 - d. Click **Save**.
 - e. Click **Close** on all open dialog boxes.

Configuring the Palette

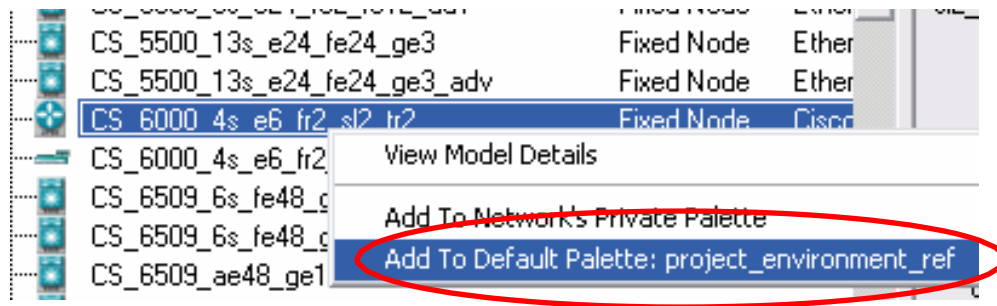
Add your two new models to a palette.

1. Open the Object Palette

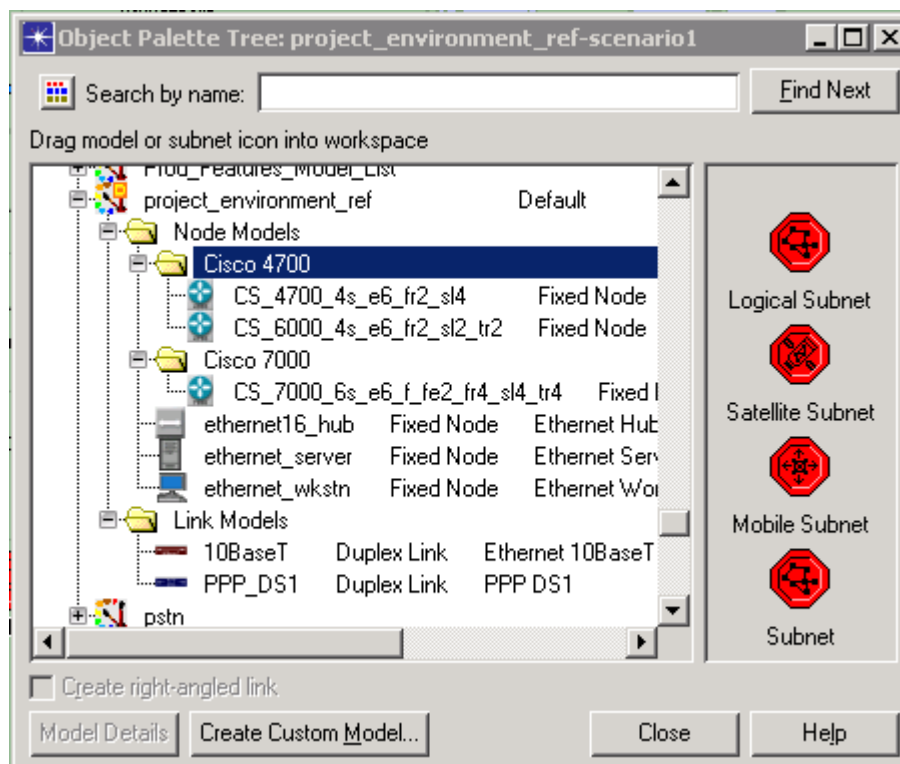


2. Configure the **project_environment_ref** palette to include other models.
 - a. Scroll up to the top of the Object Palette Tree
 - b. Expand the **Node Models / Fixed Node Models / By Name** tree
 - i. Under "CS*" find the device you created in the previous step, named **CS_6000_4s_e6_fr2_sl2_tr2** (not the one ending with _ref)

- ii. Right click it, and choose to add it to the **project_environment_ref** palette



- c. In the **Node Models / Fixed Node Models / By Name** tree, expand the branch **ethernet***, and add the following nodes to the **project_environment_ref** palette
 - i. ethernet_server
 - ii. ethernet_wkstn
- d. In the **Link Models / Duplex Link Models / By Name** tree find these two link models and add them to the **project_environment_ref** palette
 - i. 10BaseT
 - ii. PPP_DS1
- e. Under Shared Object Palettes, select “**project_environment_ref**” and verify it has the correct set of models included

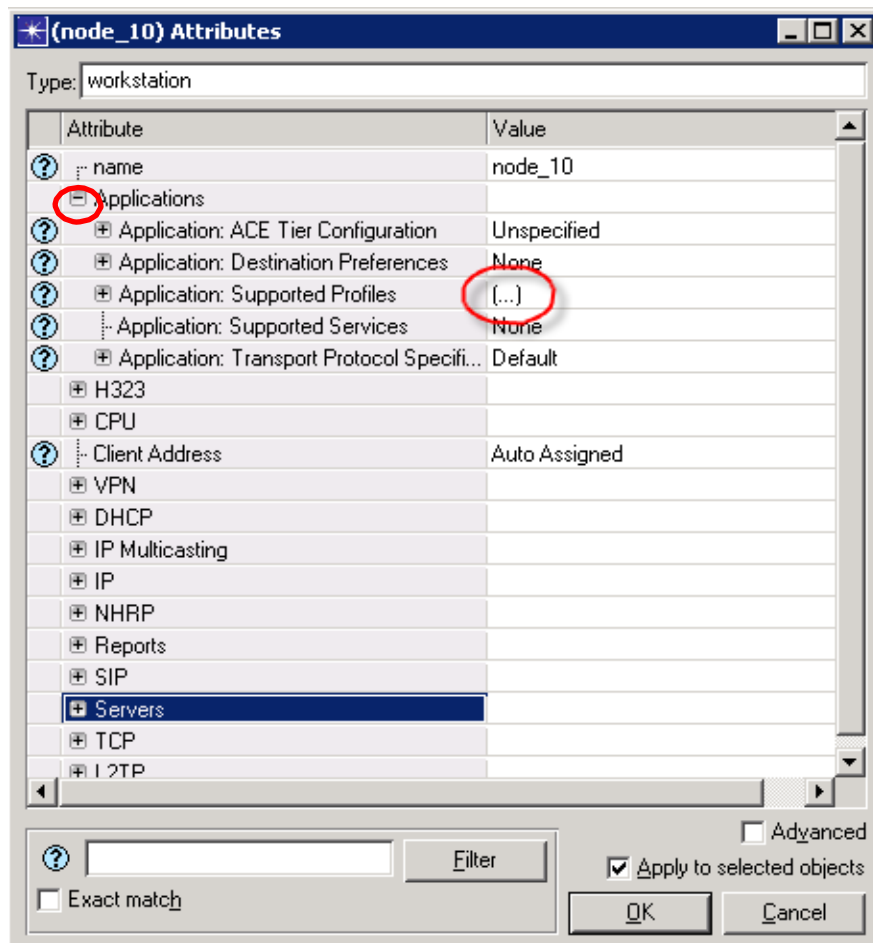


- f. Close the Object Palette

Setting Attribute Values

Locate an object model in the Chicago subnet.

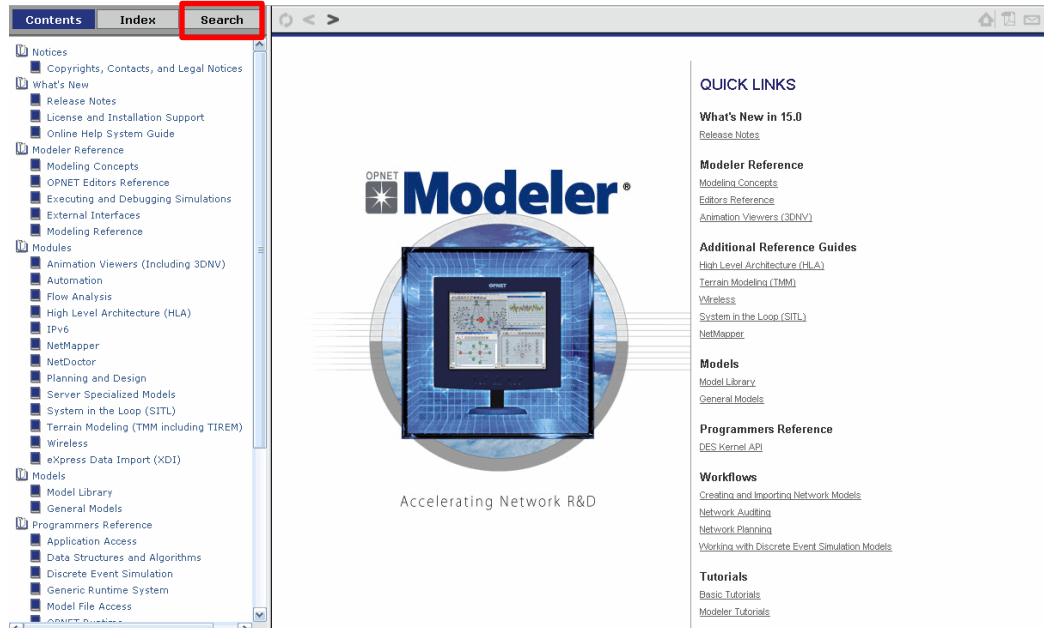
1. In your project, you should be in the United States network. If you do not see the various US city names, follow the steps in the beginning of the lab to return to this view.
2. Enter the subnet named **Chicago** by double-clicking it.
3. View attributes of each model.
 - a. Right-click on a model.
 - b. Select **Edit Attributes**. (Note that there are different attributes for different devices.)
4. Practice changing attributes of multiple devices at once. Configure all workstations.
 - a. Right-click on any workstation and choose **Select Similar Nodes**.
 - b. With all workstations selected, again right-click on any one, and choose **Edit Attributes**.
 - c. **Important:** check the **Apply changes to selected objects** box.
 - d. Expand **Applications**.
 - e. Click on the Value column in the **Application: Supported Profiles** row; Choose **Edit**.



- f. In the **Application: Supported Profiles Table**, set the number of **rows** to **1**.
 - g. Under **Profile Name**, click on **None** and select **Engineer**. This profile will automatically be created.
 - h. Click **OK** until both attribute dialog boxes are closed (Click “Yes” in the confirmation dialog box)
5. Configure the server to support all applications:
 - a. Right-click the server and select **Edit Attributes**.
 - b. Expand **Applications** and change the value for **Application: Supported Services** from **None** to **All**.
 - c. Click **OK**.

Using the Product Documentation

1. Under the **Help** menu, select **Product Documentation**.
2. Press the **Search** link



3. Enter a string of text for which to search.
 - a. Type in the string “**background traffic**”.
 - b. Click the **Search** button.
4. View the list of results, and click on one of them to jump to that section of the documentation.

Summary

You have learned some of the basics of navigating through a scenario. You’ve used the Device Creator and derived a new node object to create your own version of some devices, then added them to your own object palette.

You have also learned some of the basics of editing attributes, including how to apply your changes to multiple objects.

END OF LAB

Lab: Building a First Network

Overview

Lansing Hotel Reservation Services is a hotel reservation company headquartered in Dallas, Texas. Lansing employees are experiencing high delays using the company's proprietary hotel reservation application, and customers are threatening to use other services if the problem is not fixed. Your task is to identify the problem and propose a solution.

Lansing's current network consists of four offices, three of which contain 28 interconnected Dell workstations. The offices are connected via 56K lines. The Application Servers, which all users access to run Lansing's proprietary software (as well as other important applications), are located in the company's Dallas HQ.

Objectives

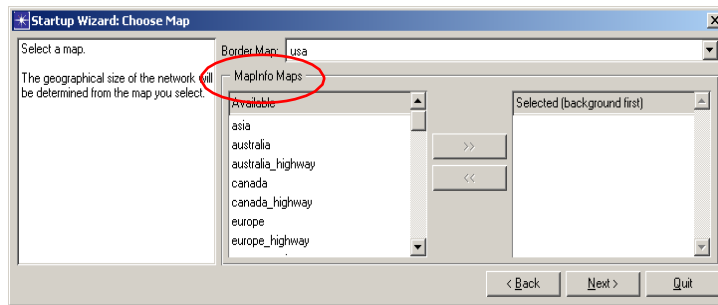
1. Build the topology.
2. Choose results.
3. Run a simulation.
4. View the results.

Instructions

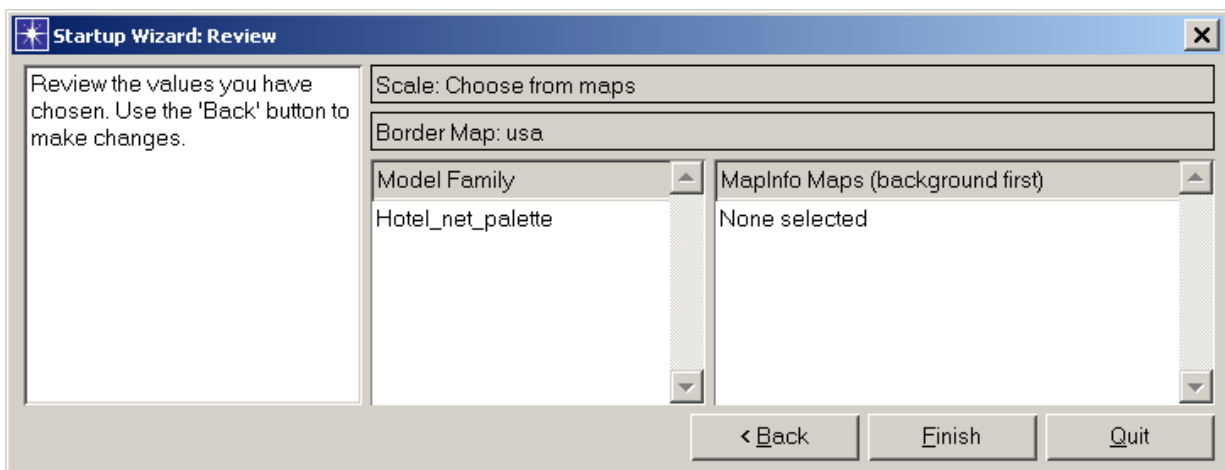
Build the Topology

1. Create a new project
 - a. Select **File / New... / Project**; click **OK**.
 - b. Set Project Name = **Hotel_net**; set Scenario name = **56K**; click **OK**.
2. Configure project settings in the Startup Wizard; set up an empty scenario with the map of the US in the background.
 - a. In the Initial Topology dialog box, click on **Create empty scenario**; click **Next**.
 - b. In the Choose Network Scale dialog box, click on **Choose from maps**; click **Next**.

- c. In the Choose Map box, select **usa** from the MapInfo maps list; click **Next**.



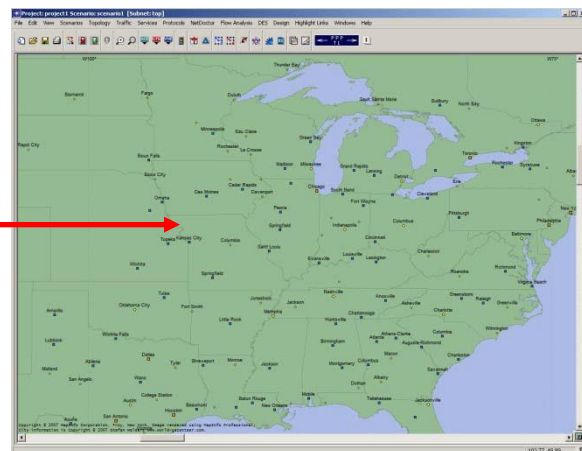
- d. In the Select Technologies box, scroll down and include **Hotel_net_palette** by changing the **No** to **Yes**; click **Next**.
- e. In the Review box, review the settings. If they do not appear like the following, use the Back button and correct it. When it is correct, click **Finish**.



3. Zoom to the Midwest US.



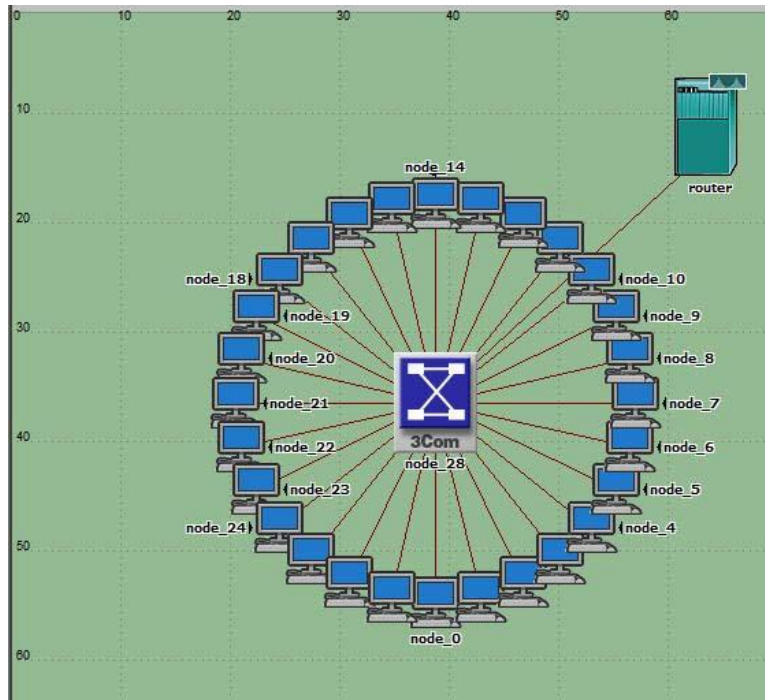
- a. Click on the **Zoom +** button on the toolbar.
- b. Click and drag a rectangle over the Midwestern portion of the US. If you are unhappy with this zoom level, you can use the **Page Up** and **Page Down** keys on the keyboard to incrementally zoom out or in.



4. Deploy a subnet to Minneapolis.

- a. Open the **Object Palette**; if it is not already open, either click on the **Object Palette** button, or select **Topology / Open Object Palette**.
 - b. Click on the **subnet** icon in the **object palette**.
 - c. Click on **Minneapolis**, which will place the subnet on Minneapolis.
 - d. Right-click anywhere in the workspace to stop deploying additional subnets.
5. Configure the subnet settings.
 - a. Enter the subnet by double-clicking on it.
 - b. Change **Grid Properties** so that you are zoomed in on a building-sized area:
 - i. Select **View / Background / Set Properties...**
 - ii. Change **Units** from **Degrees** to **Feet**.
 - iii. Close the **Background Properties** dialog box by clicking on **Close** at the bottom.
 - iv. Zoom into Minneapolis until you see gridlines every 10 feet
 - c. Exit out of the subnet; either right-click on the workspace and choose **Go To Parent Subnet**, or click on the **Go To Parent Subnet** button.
6. Deploy a similar subnet in Dallas.
 - a. Copy the **Minneapolis** subnet by selecting it and hitting **Ctrl-C**.
 - b. Paste another subnet on **Dallas** by hitting **Ctrl-V** on the keyboard and then clicking on Dallas.
 - c. You now have an empty subnet to represent the Corporate HQ in Dallas.
7. Use Rapid Configuration to create a LAN in Minneapolis.
 - a. Enter the Minneapolis subnet by double-clicking it.

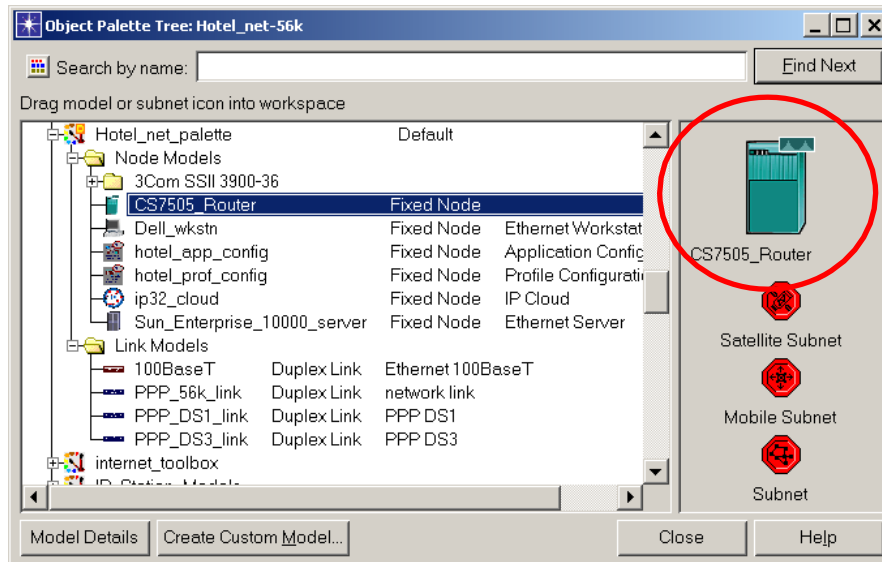
- b. In the Minneapolis subnet, create a LAN consisting of 28 Dell workstations connected to a 3Com switch in a star topology and connect the switch to a router as shown below using the following instructions.



- i. Select **Topology / Rapid Configuration...**
- ii. Change **Configuration** from **Bus** to **Star**.
- iii. Press **Next**.
- iv. In the Rapid Configuration dialog box, enter the following information (if you do not see these choices, ask an instructor for assistance):
 1. Center node model = **3C_SSII_3900_4s_ae36_ge3**
 2. Periphery node model = **Dell_wkstn**
 3. Link model = **100BaseT**
 4. Number = **28**
 5. Radius = **20**
 6. For the placement of the center, choose an appropriate intersection near Minneapolis
 7. Click **OK**.

8. Add a router to the LAN.

a. Click on the **CS7505_Router** router icon in the **Object Palette**.



b. Click on some empty area in the workspace to deploy the router at that location.

c. Right-click to stop deploying more routers.

d. Change name of the router to “router”:

i. Right-click on the router.

ii. Choose **Set Name**.

iii. Type **router** and click **OK**.

e. Connect the Router to the switch in the center of the LAN with a 100BaseT link:

i. Click on the **100BaseT** link in the object palette.

ii. Click on the **router** and then on the **switch** in the middle.

iii. Right-click in the workspace to stop deploying new links.

9. Deploy similar LANs in Detroit and Atlanta.

a. Go back to WAN view of network: Right-click in workspace and select **Go To Parent Subnet**.

b. Copy the Minneapolis subnet to Detroit and Atlanta.

i. Select the Minneapolis subnet.

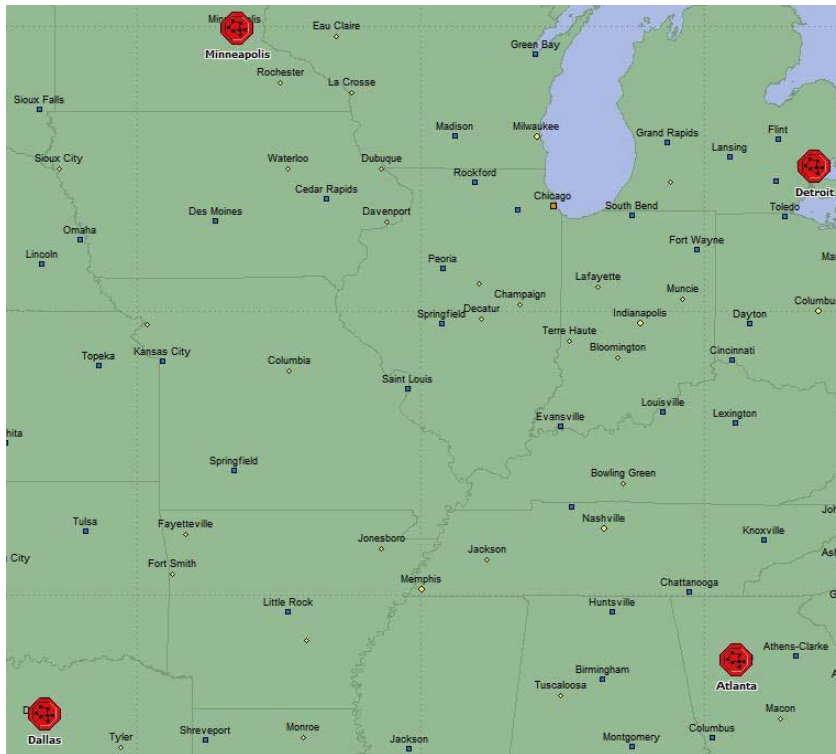
ii. Copy it using **Edit / Copy** or **Ctrl-C**.

iii. Choose **Edit / Paste** or **Ctrl-V**.

iv. Click on Detroit.

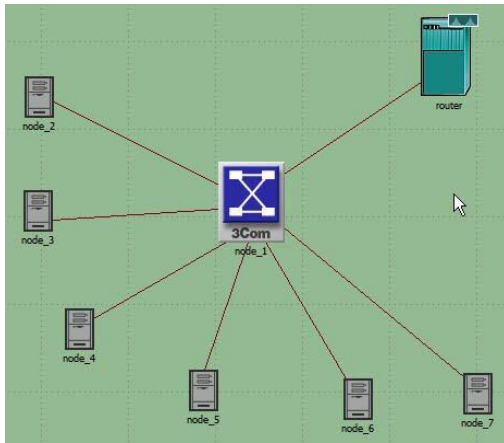
v. Repeat these steps to copy this subnet to Atlanta.

10. Rename the subnets. Name the subnets “Minneapolis”, “Detroit”, “Atlanta” and “Dallas”.
- Right-click on the subnet; choose **Set Name**.
 - Enter the appropriate name and then click **OK**.

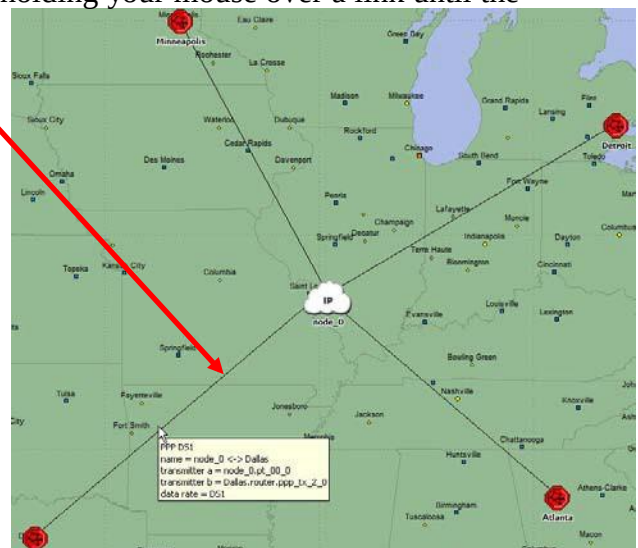


11. Deploy a LAN to the Dallas subnet consisting of six Sun servers, a switch in the center, and a router as shown in the steps below.
- First add the six Sun servers to the Dallas subnet.
 - Double-click on **Dallas subnet**.
 - Open the **Object Palette** (if it is not already open).
 - Click on **Sun_Enterprise_10000_server** and click in the workplace **6** times to deploy six servers.
 - Right-click in the workspace to stop deploying more servers.
 - Deploy a **3C_SSII_3900_4s_ae36_ge3** switch in the middle of the servers.
 - Place a **CS7505_Router** on the workspace, and set it's name to **router**.
 - Connect the router and each server to the switch using **100BaseT** links.

Your topology should look something like the picture below. They do not have to be in the same positions, but double-check that the connectivity is the same (all of the devices are connected to the switch, not to each other)



12. Go back to WAN view of network.
 - i. Right-click in the workspace.
 - ii. Select **Go to Parent Subnet**.
13. Place an IP Cloud (**ip32_cloud**) in the middle of the 4 subnets, to represent the wide area network.
14. Connect the **Dallas** subnet to the cloud with a **PPP_DS1_link**.
15. **Important:** When prompted for which node within the subnet to connect the link to, choose the node name ending in **router** and click **OK**.
16. Connect the cloud to the other 3 subnets using a **PPP_56K_link**.
17. Again, when prompted for which node within the subnet to connect the link, choose the node name ending in **router** and click **OK**.
18. Choose **File / Save**, leave the default filename and click **Save**.
19. Double-check you used the right links by holding your mouse over a link until the tooltip shows up, and look at the data rate
 - a. The link to Dallas should be a DS1
 - b. The other 3 should be 56,000

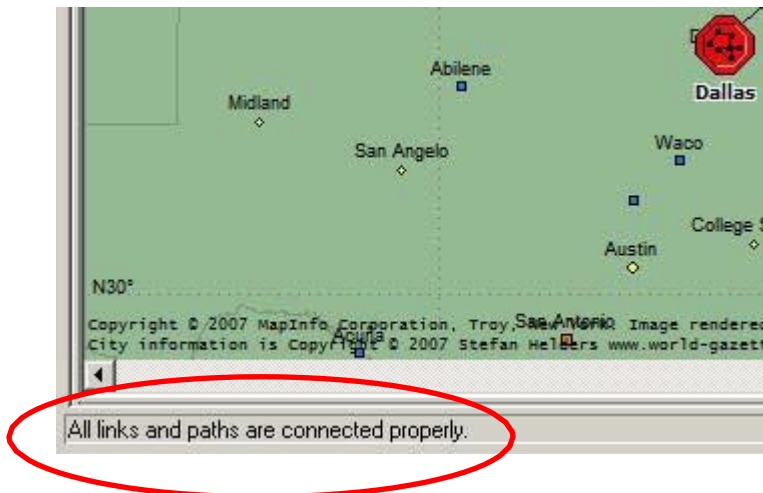


20. Traffic for this network has been preconfigured. Two gray “utility” boxes can be found in the object palette. The utility “hotel_app_config” represents some application traffic to be sent across the network. The utility “hotel_prof_config” represents users of these applications.

- a. Deploy one **hotel_app_config** object onto the workspace, and name it **App Config**
- b. Deploy one **hotel_prof_config** object onto the workspace, and name it **Prof Config**.



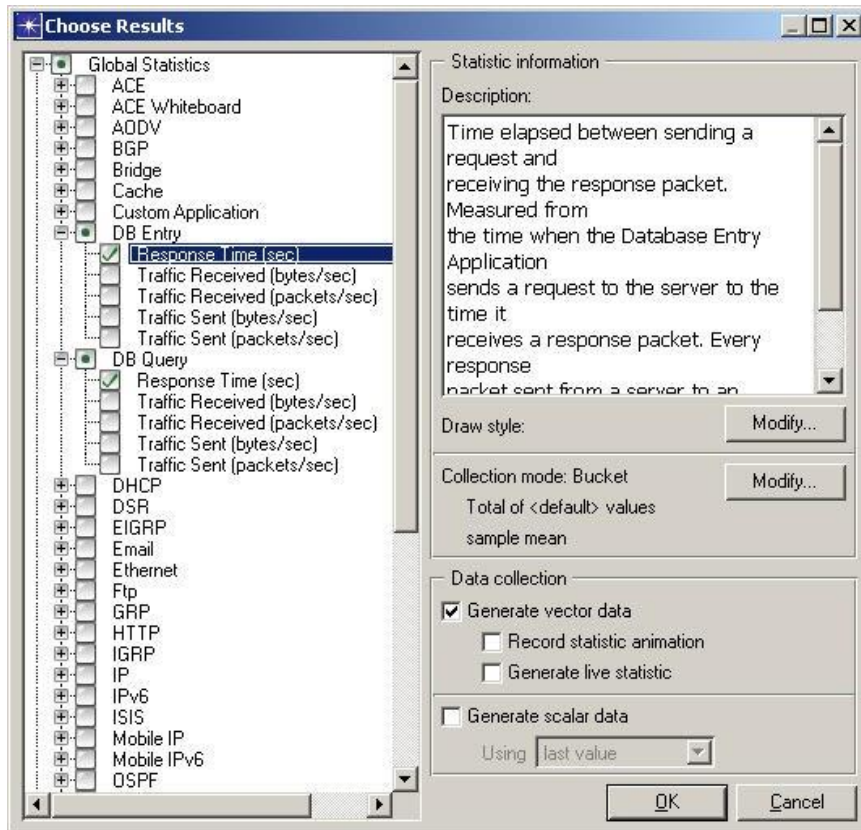
21. Verify Links: select **Topology / Verify Links...**; Alternatively, you can use the hotkey **Ctrl-L**. Once the verify links dialogue box opens, click **OK**. If any incorrect links are found, a red X will appear over the link. If all links are correct, a message will appear at the bottom of the screen to say that **All links and paths are connected properly**.



Save the project

Choose Results

1. Choose a set of statistics to view.
 - a. Select **DES / Choose Individual Statistics...**
 - b. Expand **Global Statistics**.
 - c. Expand **DB Entry** and select **Response Time (sec)**.
 - d. Expand **DB Query** and select **Response Time (sec)**.



- e. Click **OK**.

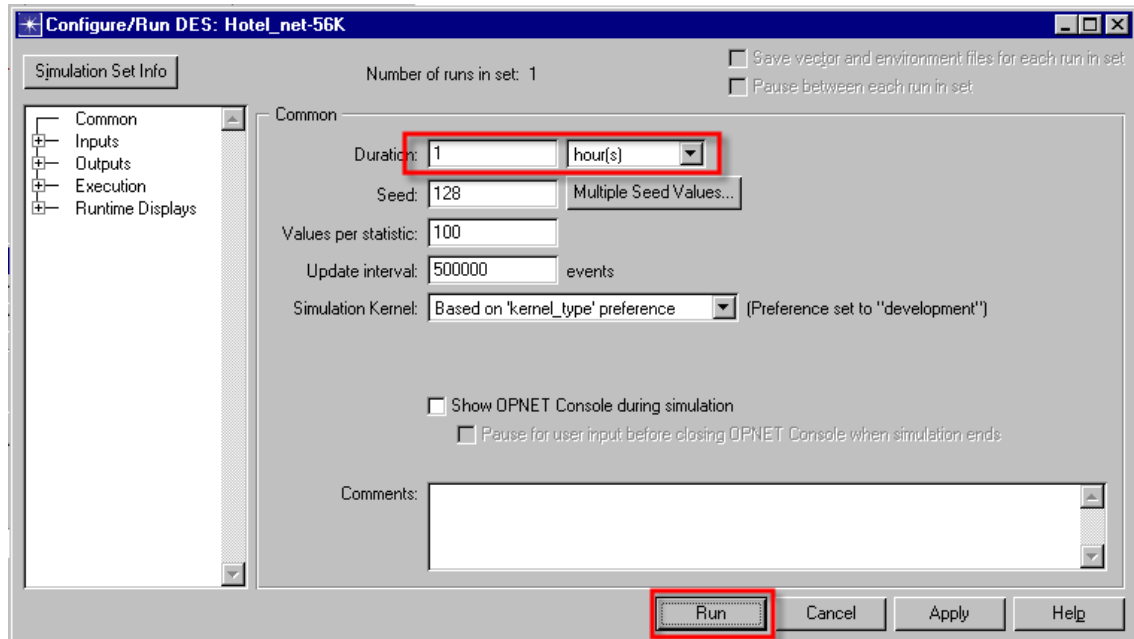
2. Save the project; press **Ctrl-S** or select **File / Save**.

Run Simulation

1. Configure the Simulation.
 - a. Select **DES / Configure/Run Discrete Event Simulation...**, or click the toolbar



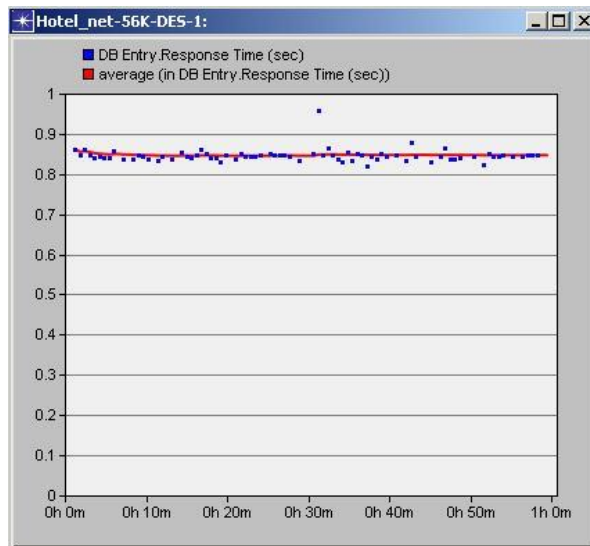
button; verify that **duration** is set to **1 hour**.



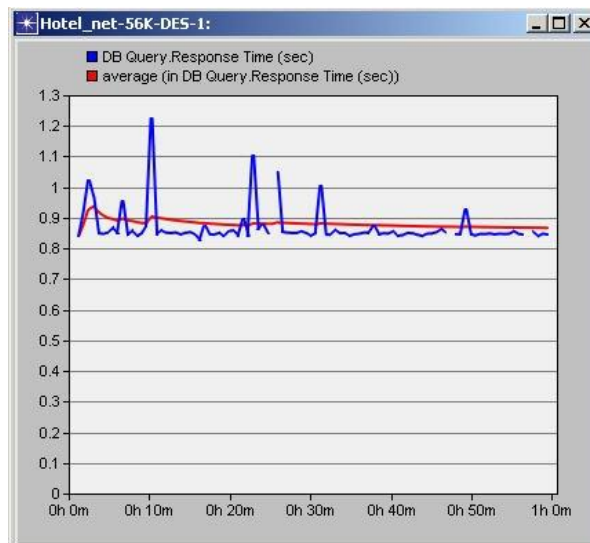
- b. Press **Run** to start the simulation.
 - c. When the simulation is complete, the **Close** button at the bottom of the box will become active. Click **Close**.
2. Save the project: press **Ctrl-S** or select **File / Save**.

View Results

1. Find out how long it took for users to complete a task called **DB Entry** during the simulation. (A database entry and query were preconfigured to run across your network during the simulation.)
 - a. Right-click on the workspace and select **View Results**.
 - b. Check the box next to **Global Statistics / DB Entry / Response Time (sec)**.
 - c. Click **Show**.
 - d. Move panel to the right (click and hold on header bar).
 - e. **NOTE:** If this graph is not available, then no database entries were successfully completed during your simulation. Check the Simulation Log (**DES / Open DES Log**) for errors and ask an instructor for assistance.
2. Add a line to this panel to show the average response time for a database entry:
 - a. In the **View Results** panel, change **As Is** to **average**.
 - b. Click on the **Add** button, and then click on the graph that was created in the previous step.



3. Follow the steps listed above to view the data points for a database query's response time. Add the average to this graph.



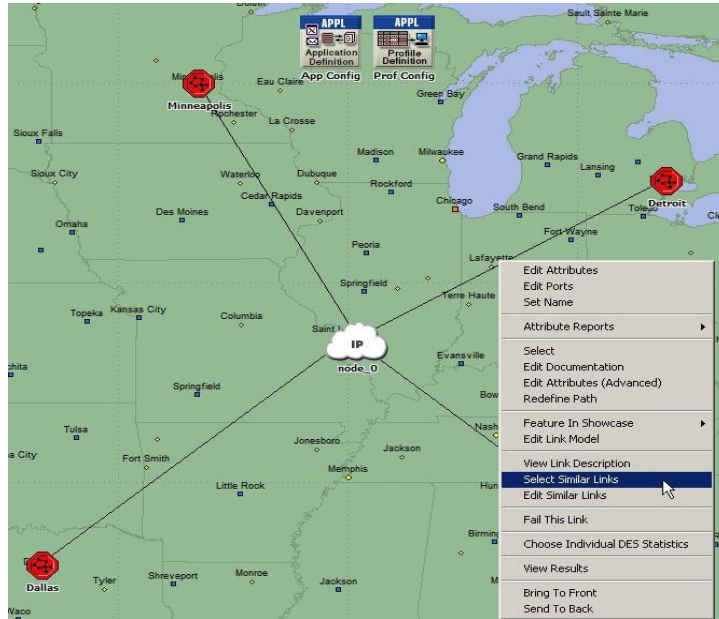
4. Check your results and then save again.
 - a. Let us assume that this response time is too high for your needs. Let's try to improve the response time of the Lansing Hotel Reservation Services by upgrading the links in the WAN.
 - b. We will determine whether Lansing should upgrade to a DS1 link or a DS3 link.
5. Click **Close** in the View Results window.

Duplicate the Scenario

1. Select **Scenarios / Duplicate Scenario...** from the Menu Bar.
2. Name the new Scenario **DS1** and then click **OK**. You now have an exact copy of the first scenario.

Upgrade the Links

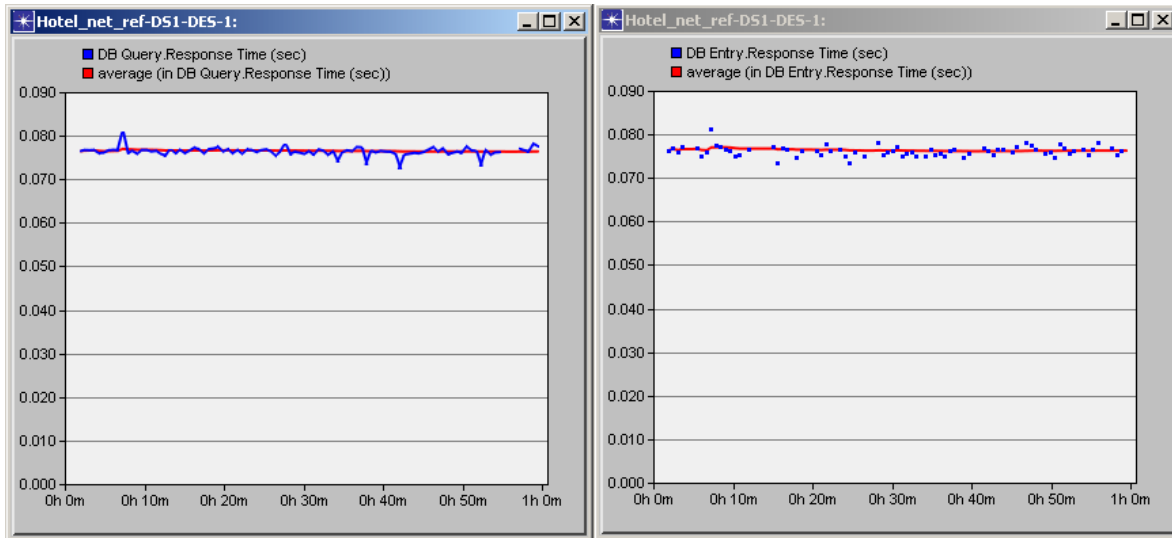
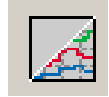
1. Upgrade the WAN links from 56K to DS1.
 - a. Right-click on the link connecting the Detroit Subnet and the IP Cloud and choose **Select Similar Links**. This selects all three 56K links in the network model.
 - b. Change the data rate of all three links to DS1.



- i. Right-click on any one of the three links again and select **Edit Attributes**.
 - ii. Change the model from **PPP_56k_link** to **PPP_DS1_link**.
 - iii. Check the box that says **Apply changes to selected objects**.
 - iv. Click **OK**.
 - v. If you get a dialog box asking “Do you want to continue?”, then click **OK**.
2. Run the simulation
 - a. Click on the simulation icon  and select **Run**, or select **DES / Configure/Run Discrete Event Simulation...** and press **Run**.
 - b. Click **Close** when the simulation finishes.
 - c. Save the project.

3. View the results.

- a. Click the **Hide/Show Graph Panels** toolbar button to display the current graphs
- b. Select **DES / Panel Operations / Reload Data Into All Panels** (or just use Ctrl-F5)



- c. An upgrade to DS1 links would greatly help Lansing Hotel Reservation Services. Surely upgrading to DS3 links would be even better, wouldn't it? Let's find out.

Duplicate the Scenario

1. Select **Scenarios / Duplicate Scenario...** from the Menu Bar.
2. Name the new Scenario **DS3** and click **OK**.

Upgrade the Links

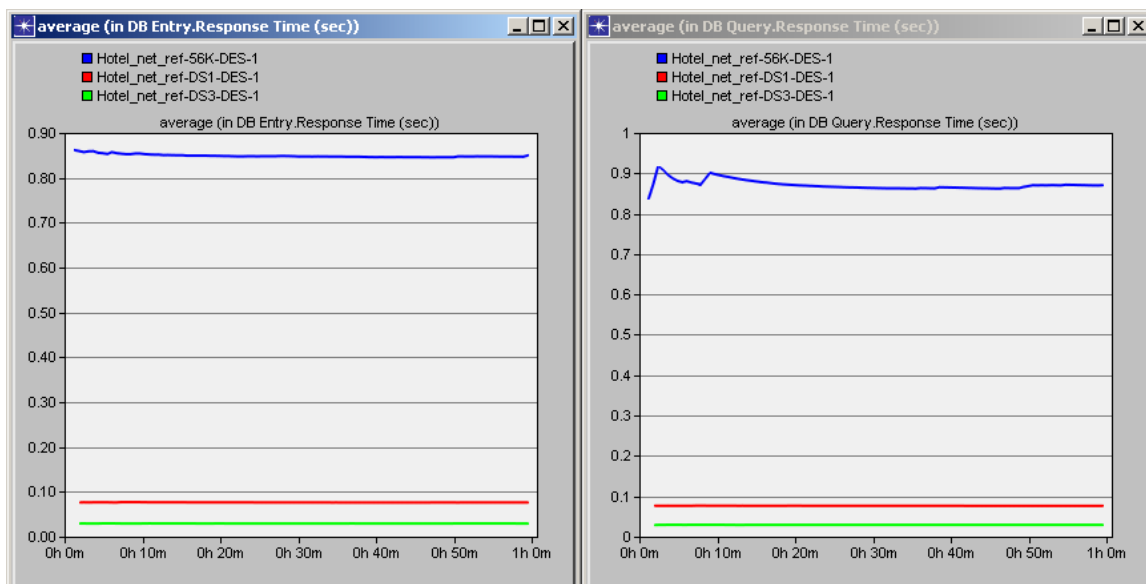
1. Upgrade the links from DS1 to DS3.
 - a. Right-click on the link connecting the Detroit Subnet and the IP Cloud and choose **Select Similar Links**.
 - b. Change the data rate of the links to DS3 links.
 - i. Right-click on the link again and select **Edit Attributes**.
 - ii. Change the model from **PPP_DS1_link** to **PPP_DS3_link**.
 - iii. Then check the box that says **Apply changes to selected objects**.
 - iv. Click **OK**.
2. Run the simulation.
 - a. To simply re-run a simulation, use the keyboard shortcut **Ctrl-Shift-r**
 - b. Click **Close** when the simulation finishes.

- c. Save the project.

Instead of simply looking at the results for this simulation run, let's compare the results from all 3 scenarios together in one graph

3. Compare the DB Query Response Time averages.
 - a. Right-click in an empty area in the workspace and select **View Results**. b. Select: Results for: **Current Project**.
 - c. Check **DB Query Response Time**
 - d. Change **As Is** to **average** and results to **Overlaid Statistics**
 - e. Click **Show**.
4. Compare the DB Entry Response Time averages:
 - a. Unselect the statistic previously selected. b. Check **DB Entry Response Time**.
 - c. Click on **Show**.

Take note of the results. By comparing the results from these scenarios, we are going to see if adding bandwidth improved response time.

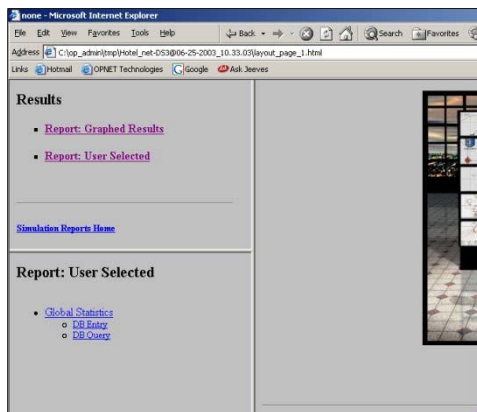


- d. Note the average response time is fairly similar for both the PPP_DS1_link and the PPP_DS3_link.

- e. It is clearly visible that an improvement of the links in Lansing Hotel Reservation Services' WAN will greatly help the response time of the DB application, reducing it by more than half.
 - f. It is also evident that it is much more cost effective to upgrade to a DS1 link rather than a DS3 link, for the response time difference is minimal.
 - g. Therefore by modeling their network, Lansing Hotel Reservation Services can now make an informed decision on how to upgrade their network, and still save money.
5. Click **Close** in the **View Results** window.
 6. Click on the **Hide/Show Graph Panels** Button to hide all the graphs.

Generating Web Reports

1. Generate a Web report for the **DS3** scenario; since we have already run the simulation, select **DES / Results / Generate Web Report...**, then press **OK**. When the report is generated, it will be written in the status bar at the bottom of your window.
2. Launch Web browser by selecting **DES / Results / Launch Last Web Report**.
3. View **DB Query Response Time**; if you have more than one Web report, you will start at your **Simulation Reports Home Page** and would then have to select the simulation report you wish to view. (If this is the first report ever generated, you will bypass this home page).



4. In the Results window in the top left corner, select **Report: User_Selected**.
5. In Report window in bottom left, select **Global Statistics / DB Query** and then on the right, select **DB Query Response Time (sec)**.
6. Exit the browser.

Additional Exercise (Optional)

Suppose the Dallas and Minneapolis subnets are instead located in Los Angeles and Seattle. What effect would have on the DB query and response time? Make the appropriate changes in the simulation, and compare the results.

The following steps provide a good workflow to model this scenario Duplicate the current scenario.

1. Create a duplicate of the DS3 scenario.
2. Move the Dallas subnet to Los Angeles, and the Minneapolis subnet to Seattle.
3. Select the appropriate statistics and run the simulation
4. Compare the average results obtained between the two scenarios a.
Do the results make sense?

END OF LAB