

Campus LAN Modeling

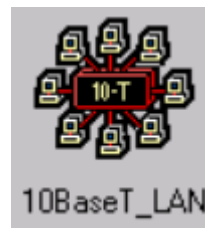
Overview

This lesson focuses on the use of LAN models and background link utilization. You will learn how to

- Configure the object palette with the models you need
- Set up application and profile configurations
- Model a LAN as a single node
- Specify background utilization that changes over time on a link
- Simulate multiple scenarios simultaneously
- Apply filters to graphs of results and analyze the results

*This lesson focuses on two features, **LAN models**, which model entire LANs, and the link **Background Utilization** attribute, which is used to model existing link traffic.*

- **LAN Models:** If you are modeling a medium or large internetwork, you may only be interested in specific aspects of the network's behavior (whether a key router will be overloaded, for example). In such cases, single nodes can model entire LANs.



- **Link Background Utilization:** Use the background utilization attribute to model existing traffic on a link instead of explicitly modeling each packet. You can also specify changes in this background traffic over the course of a simulation.

Setting Up the Scenario

In this lesson, your job is to model a “campus” LAN. The company has 3 offices located in different buildings. The offices use phone lines to connect to each other, and are therefore susceptible to delays caused by additional, unrelated traffic on the lines. This company wants you to determine how this background traffic is affecting FTP traffic on their network. To do this, you will model FTP performance on the network, first without background traffic and then with background traffic. Because you are not interested in modeling the details of each office's LAN, you will use LAN models to model the individual LANs as single nodes. The first step in setting up the campus LAN is to specify the overall context for the network with the Startup Wizard. Once that is done, you can proceed with building the network itself. This topic focuses on:

- Configuring an object palette
- Specifying a map background
- Zooming in on a background

Begin by opening a new project in Modeler and configuring the scenario context using the Startup Wizard:

1 If Modeler is not already running, start it and begin a new project (Select **File > New...** and click **OK**).

2 Name the new project **<initials>_LAN_Mod** and the scenario **no_back_util**, then click **OK**.

3 Click **Next** when the Startup Wizard opens to create an empty scenario for the **Initial Topology**.

4 Click on **Campus** as the Network Scale and then click **Next**

5 Choose **5 km** as the **Xspan** and **Yspan** and then click **Next**

6 In the Select Technologies dialog box scroll down to **LAN_Mod_Model_List** and click in the Include field to include it and then click **Next**

7 Click **OK** in the Review Dialog Box

We need to start the project by making a modification to the compiler.

1 Click **edit->Properties** bringing up a Properties dialog box

2 Scroll down to **Repositories** and click in the Value field

3 A new dialog box will pop up. **Change the value from 0 to stdmod and press Enter**

4 Click **OK** to close the Repositories box and then click **OK** again to close the Properties box

Note: This will have to be done each time you start Opnet

For this lesson, we created the **LAN_Mod_Model_List**. Now you will adapt that model list by adding the LAN node model to it:

1 Click the **Configure Palette...** button in the object palette.
The Configure Palette dialog box opens.

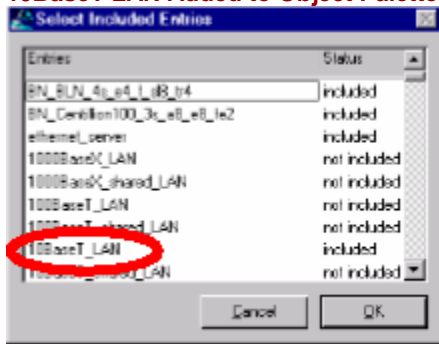
Configure Palette Dialog Box



The Configure Palette dialog box lets you change the object palette and then save it.

- 1 Click the **Node Models** button In the Configure Palette dialog box.
- 2 Find **10BaseT_LAN** in the Select Included Entries dialog box and change its status from **not included** to **included**.

10BaseT LAN Added to Object Palette



- 3 Click **OK**.
The **10BaseT_LAN** icon appears in the object palette.

- 4 Click **OK** to close the Configure Palette dialog box, then click **OK** again and to save the model list as **<initials>_LAN_Mod-no_back_util**.

Configuring Applications

It is a good idea to define the profiles and applications that will be used by the LAN before you begin constructing the network. You define the profiles in the profile definition object and applications in the application definition object.

- **A profile** is applied to a workstation, server, or LAN. It specifies the applications used by a particular group of users. You might have one profile for Marketing (heavy use of email; light use of file transfer) and another profile for Engineering (light use of email; heavy use of file transfer).
- **An application** may be any of the common applications (email, file transfer) or a custom application you define. Eight common (“standard”) applications are already defined: Database Access, Email, File Transfer, File Print, Telnet Session, Video conferencing, Voice over IP Call, and Web Browsing.

Profile Definition and Application Definition Objects



To Configure the Application Configuration Object

Follow these steps.

- 1 Open the object palette if it is not already open.
- 2 Drag an **Application Config** object to the project workspace.
- 3 Right-click on the new object and select **Edit Attributes**.
The Attributes dialog box opens.
- 4 Click on the question mark next to the **name** attribute to see a description of the attribute. Close the attribute description dialog box when done.

Application Definitions Set to Default

Click here to see a description

Attribute	Value
name	node_0
model	Application Con
+ ACE Tier Information	None
+ Application Definitions	None
+ Voice Encoder Schemes	All Schemes

- 5 Set the **name** attribute to **Application Configuration**.
- 6 Change the **Application Definitions** attribute to **Default** by clicking in the attribute's Value column and selecting **Default** from the drop-down list.
*Selecting **Default** configures the application definition object to have the eight standard applications mentioned earlier. Now you will be able to include those applications in the profile you are about to create.*
- 7 Click **OK** to accept the changes and close the **Attributes** dialog box.

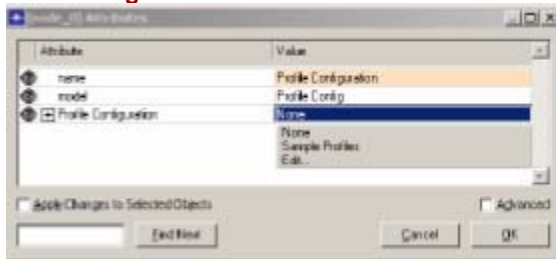
To Configure the Profile Configuration Object

Follow these steps.

- 1 Drag a **Profile Configuration** object from the object palette to the project workspace.
- 2 Right-click on the object and select **Edit Attributes**.
- 3 Set the **name** attribute to **Profile Configuration**.

4 Change the **Profile Configuration** attribute by clicking in its Value column and selecting Edit...from the drop-down list.

Selecting Edit... from the Menu



The (Profile Configuration) Table dialog box appears.

(Profile Configuration) Table Dialog Box



To Define a New Profile and Add It to the Table

Follow these steps.

1 Change the number of rows to **2**.

2 Name the first profile **Engineer** by clicking in the <Profile Name> column of the first row.

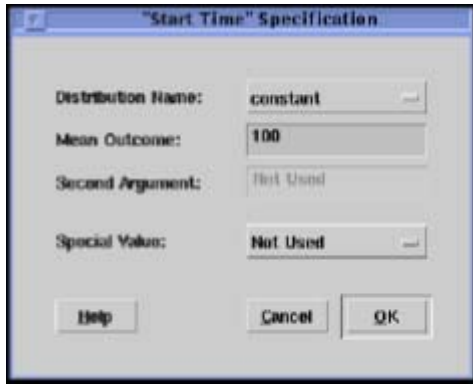
3 Name the second profile **Business** by clicking in the <Profile Name> column of the second row.

4 Change the **Operation Mode** to **Simultaneous** in both rows.

5 Click in the profile's **Start Time (seconds)** cell to open the Start Time Specification dialog box.

6 Select **constant** from the **Distribution Name** pull-down menu.

Start Time Specification Dialog Box



6 Set **Mean Outcome** to 100, then click **OK** to close the Start Time Specification dialog box.

*The Start Time attribute has a value of **constant (100)**.*

You will be modeling network traffic. Applications that will create the network traffic must now be chosen.

1 Click in the **Engineer's** Applications column and choose **Edit...** from the pop-up menu.

*The **(Applications) Table** dialog box appears.*

2 Change the number of rows to **2**.

3 Set the **name** of the first application to **File Transfer (Heavy)** by clicking in the cell and selecting the application from the drop-down list. Select **Email (Light)** as the second application.

3.1 For both of the applications in the **Engineer** profile, set the **Start Time Offset** to **Uniform (0, 300)**.

3.2 Verify that the **Distribution Name** is **uniform**.

3.3 Set the **Minimum Outcome** to **0**.

3.4 Set the **Maximum Outcome** to **300**.

Click on **OK**

4 Click in the **Business's** Applications column and choose **Edit...** from the pop-up menu.

*The **(Applications) Table** dialog box appears.*

5 Change the number of rows to **1**.

6 Set the **name** of the application to **Web Browsing (Heavy)**

6.1 Set the **Start Time Offset** to **Uniform (0, 300)**.

6.2 Verify that the **Distribution Name** is **uniform**.

6.3 Set the **Minimum Outcome** to **0**.

6.4 Set the **Maximum Outcome** to **300**.

7 Click on **OK**

The contents of the drop-down list are controlled by the Applications Configuration object. When you selected **Default** as the value for the **Application Definitions** attribute in this object, you enabled this list of applications. Note that the list includes 16 entries, a heavy and light version for each of the eight standard applications.

Completed (Applications) Table Dialog Box

8 Verify that the completed dialog box's looks like this:

Engineer



Business



9 Click **OK** to close the Applications Table dialog box.

10 Click **OK** to close the Profile Configuration Table, then click **OK** again to close the Attributes dialog box.

Building the Network

Now that you have set up the scenario, configured the application, and created a profile that uses the application, you are ready to begin constructing the LAN. Because the network contains similar offices, you can create the first office, with its nodes inside, and then copy the office for the second and third offices. You can also copy and modify it further. This topic focuses on:

- Building subnets
- Copying and pasting network objects
- Modifying subnets
- Connecting subnets

A **subnet** is a single network object that contains other network objects (links, nodes, and other subnets). Subnetworks allow you to simplify the display of a complex network through abstraction.

Subnets help you logically organize your network model. You can nest subnets within subnets to an unlimited degree. For this lesson, you can use subnets as logical containers for the offices in each of the cities. To create a subnet:

1 Open the object palette if it is not already open, and move it to the lower right corner of the screen so that it is out of the way.

2 Place a subnet in the Project field.

2.1 Click the subnet icon in the object palette and drag it to the workspace.

2.2 Right-click to turn off node creation.

A Subnet Hierarchy

Initially, a subnet's grid properties are based on its parent subnet. If the subnet's grid settings are inappropriate, you can change them to fit your network. To change the grid inside a subnet:

1 Double-click on the subnet.

2 Select **View > Set View Properties....**

Note that the display grid is in degrees, which is not appropriate for an office.

3 Set units to **Meters**.

4 Set resolution to **5 Pixels/m**.

5 Uncheck the Visible checkbox for Satellite orbits.

6 Verify that Drawing is set to **Dashed**.

7 Set division to **10**.

Set View Properties Dialog Box

8 Click the **Close** button.

Modeling the campus network does not require modeling the precise nature of each node in each subnet, so you can represent the subnets with a LAN model. To create a LAN model:

1 Place a **10BaseT_LAN** in the workspace.



2 Right-click on the **10BaseT_LAN** and choose the **Edit Attributes** menu item.

You can change a LAN model's attributes so that it accurately represents a network with a certain number of workstations and a particular traffic profile. To represent one of the East Coast company's satellite offices:

1 Change the LAN model's **name** attribute to **Engineer Office 1**.

2 Choose **Edit...** for the **Application: Supported Profiles** attribute.

3 Change the number of **rows** to **1**.

4 Change the **Profile Name** to **Engineer**, then click **OK**.

Now this LAN will use the Engineer profile you created earlier. This profile includes the File Transfer (Heavy) application and light Email. The LAN will send traffic that models heavy FTP use and Light Email.

5 Change the **Number of Workstations** attribute to **25**, then click **OK**.

You have now modeled a 25 workstation LAN inside the subnet. This single object is equivalent to a 25-workstation star topology LAN.

A Single LAN Object is Equivalent to a LAN Composed of Many Objects

Because this LAN model is composed of workstations and links only, it must be connected to a router. The router can then be connected to other routers in the network. To create a router:

1 Drag a **BN_BLN_4s_e4_f_sl8_tr4** node (a Bay Networks router) from the object palette to the workspace near the **Engineer Office 1** node.

2 Name the new node **router**.

3 Connect the **router** and the **Engineer Office 1** nodes with a **10BaseT** link. Right-click to turn off link creation.

The Engineer Office 1 subnet is now configured. Because the subnets in the other buildings are identical, you can copy the Engineer Office 1 subnet and place it appropriately. When several subnets or network objects have an identical configuration, you can copy and paste these objects.

To copy the subnet:

1 Return to the parent subnet view by clicking on the **Go to Parent Subnet** button (you can also right-click on the workspace to bring up the workspace pop-up menu, then choose **Go to Parent Subnet** from the menu).



2 Change the subnet name to **Engineer Office 1** by right-clicking on the subnet and selecting **Set Name** from the pop-up menu.

Renaming the Subnet

3 Select the subnet.

4 Select **Edit > Copy** or press **<Control>+c**. Paste the subnet to each of the four different cities. Notice that Modeler automatically names each subnet as it is placed.

Pasting the Subnet

1 Select **Edit > Paste** or press **<Control>+v** and click in the object field.

A new subnet appears.

2 Press **<Control>+v** again to paste another subnet.

3 Rename each office subnet to:

- Engineer Office 2
- Business Office

Modifying the Business Office Profile

1. Double click on the **Business Office** subnet

2. Right click on the **Engineer Office 1 10-T LAN** and select **Set Name**. Change the name to **Business Office 1**. Click **OK**

3. Right click on **Business Office 1** and select **Edit Attributes**. Click on the **Application: Supported Profiles** Value field and select **Edit**.

4. Click on the Profile field and change to **Business**. Click **OK**

5. Right Click on the background and select **Go To Parent Subnet**

Connecting the Subnets

Connect each subnet to Engineer Office 1

1 Select the **LAN_Mod_PPP_DS0** link in the object palette.



2 Draw **LAN_Mod_PPP_DS0** link from **Engineer Office 2** to **Engineer Office 1**.

A Select Nodes dialog box appears asking which nodes in each subnet are to be endpoints of the link.

3 For **node a**, choose the **Engineer Office 1.router** node.

4 For **node b**, choose the **Engineer Office 2.router** node.

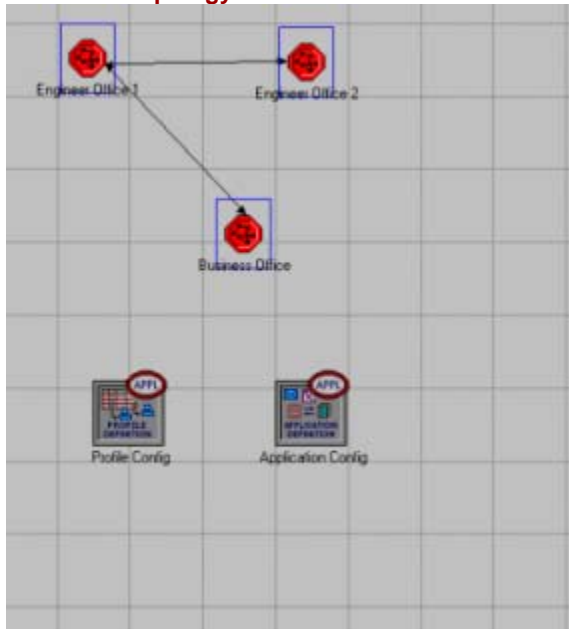
Select Nodes Dialog Box

5 Click **OK** to establish the link.

6 Repeat the process drawing a link from the Business Office to Engineer Office 1, specifying each office's router as the links' endpoints. To prevent overlapping links, you can click on intermediate points in the workspace to make a link follow a path before finally clicking on its destination node.

7 Right-click to turn off link creation. The network should resemble the following:

The Initial Topology



To complete the network, the main office in Engineer Office 1. needs to have a switch and a server added to it. To configure the network in Engineer Office 1:

- 1 Double-click on the **Engineer Office 1** subnet to enter its subnet view.
- 2 Place one **<Bay Network Accelar1050>** switch and one **ethernet_server** node in the workspace.
- 3 Rename the **<Bay Network Accelar1050>** node to **switch**.
- 4 Rename the **ethernet_server** to **Network Application Server**.
- 5 Connect the router and the server to the switch with **10BaseT** links. Right-click to turn off link creation.
- 6 Close the object palette.

Configure the Server to Support the Network Application Server

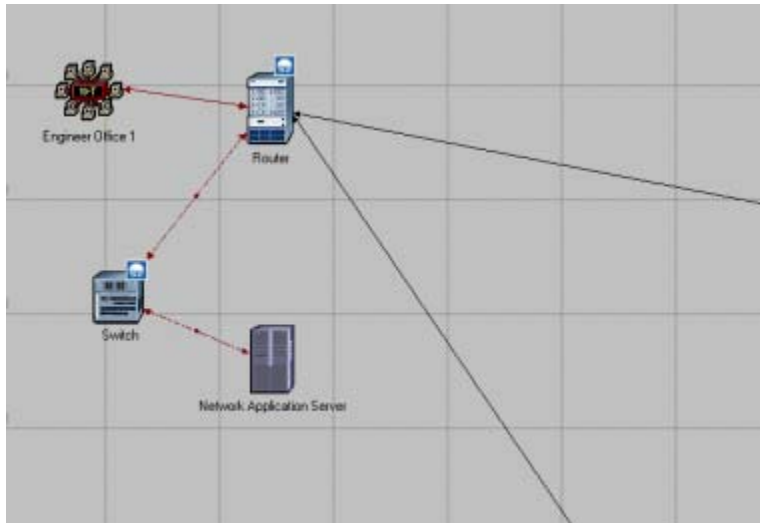
Follow these steps.

- 1 Open the Attributes dialog box for the **Network Application Server**.
- 2 Choose **Edit...** for the **Application: Supported Services** attribute.
- 3 Change the number of rows to **3**.
- 4 Select **File Transfer (Heavy)**, **Web Browsing (Heavy)**, and **Email (Light)** from the **Name** fieldcolumn pop-up menu.

Configure the Server to Support the Application

- 5 Click **OK** to close the Supported Services dialog box, and then click **OK** to close the (Network Application Server) Attributes dialog box.

The Engineer Office 1 subnet is now complete and should resemble the following diagram:



1 Use the workspace pop-up menu to return to the parent subnet view.

2 Save the project by selecting **File > Save**.

Background Utilization

Now that you have created a model to act as a baseline for the performance of the company's network, you can add background traffic to the links connecting the offices and compare the results from the two scenarios. This topic focuses on:

- Duplicating a scenario.
- Implementing background utilization on links that model low initial use, then a rapid increase in bandwidth usage, and finally a drop-off to moderate use.

Background utilization is an efficient means of modeling a known traffic load on a link. Network studies show that traffic rises gradually over the course of the day as employees arrive and begin work. You can use background link utilization to model this pattern.

Because you want to compare the performance of the network both with and without background utilization, you need to prepare two scenarios, one for each situation. You will duplicate the existing scenario, then add background traffic to it:

1 Select **Scenarios > Duplicate Scenario...**

Scenarios Menu



2 Name the scenario **back_util**. and click **OK**. **Background utilization** is an attribute of each link.

To set background utilization on the links between the offices:

1 Select the links between subnets. Right-click on the link between Engineer Office 1 and Engineer Office 2, then choose **Select Similar Links** from the pop-up menu.

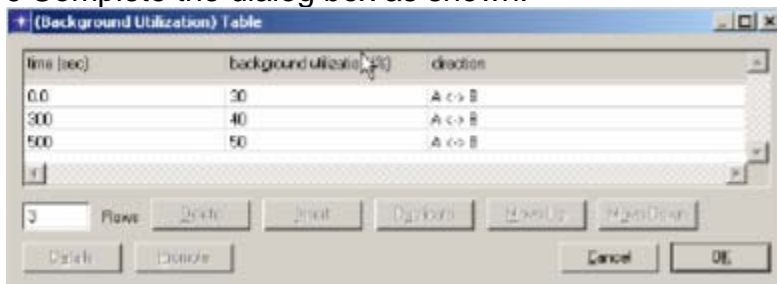
2 Display the **Edit Attributes** dialog box for the link between Engineer Office 1 and Engineer Office 2.

3 Click in the Value cell for the **Background Utilization** attribute and select **Edit...** from the pop-up menu.

*A **Background Utilization** dialog box appears.*

4 Click on the **Rows** value, change it to **3**, and press **Return**.

5 Complete the dialog box as shown.



Background Utilization Dialog Box

For the first 300 seconds of the simulation, background utilization will be 30%. For the next 200 seconds, until time 500, it will be 40%. For the last part of the simulation, it will be 50%.

6 Click **OK**.

The last step in setting background utilization is to apply the changes made to Engineer Office 1-Engineer Office 2 link to all selected links.

1 Check the **Apply Changes to Selected Objects** check box in the **Engineer**

Office 1<-> Engineer Office 2 Attributes dialog box.

Link Attributes Dialog Box

2 Click **OK** to close the Attributes dialog box.

*Note that “**2 objects changed.**” appears in the message area.*

Confirming Message

3 Save the project by selecting **File > Save**.

Collecting Statistics

Now that you have configured both scenarios (one without background utilization as a baseline, and one with background utilization), you are ready to collect data and analyze it. The relevant statistics for this network are the utilization statistics for the links, the global FTP download time, email, and web-browsing for the network. This topic focuses on:

- Specifying statistics to collect in each scenario
- Switching between scenarios
- Running multiple simulations

To Collect Statistics in the back_util Scenario

Follow these steps.

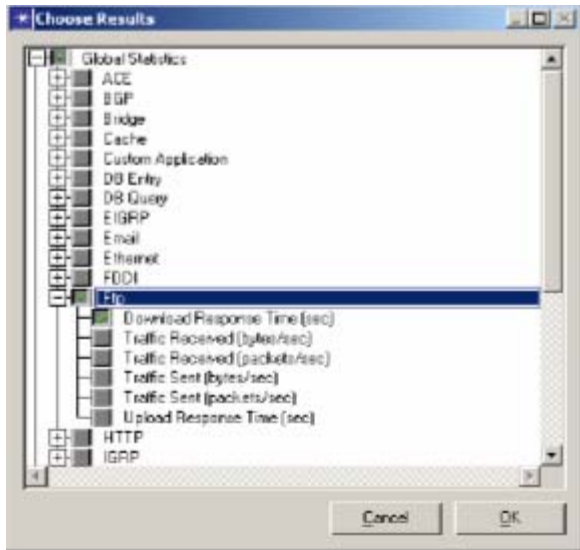
1 Right-click in the workspace to display the workspace pop-up menu, and select **Choose Individual Statistics**.

2 Select the **Global Statistics > Ftp > Download Response Time (sec)** statistic.

3 Select the **Global Statistics > Http > Object Response Time (sec)** statistic.

4 Select the **Global Statistics > Email > Download Response Time (sec)** statistic.

Selecting the Statistic



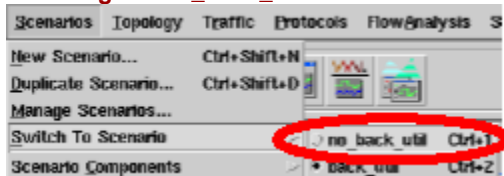
5 Select the **Link Statistics > point-to-point > utilization --> statistic**.

6 Click **OK** to close the Choose Results dialog box.

The utilization statistics that you have specified will be collected for every link in the simulation. In order to compare the statistics in the **back_util** scenario to the **no_back_util** scenario, the same statistics must be collected in the **no_back_util** scenario. To change scenarios and collect statistics:

1 Select **Scenarios > Switch To Scenario**, then choose **no_back_util**.

Selecting the no_back_util Scenario



2 Collect the same statistics that you did in the **back_util** scenario:

- Global Statistics > Ftp > Download Response Time (sec)
- Global Statistics > Http > Object Response Time (sec).
- Global Statistics > Email > Download Response Time (sec) statistic.
- ∞ Link Statistics > point-to-point > utilization -->

3 Close the **Choose Results** dialog box and save the project. You are now ready to run the simulations to collect the statistics you have specified.

Using the **Manage Scenarios** dialog box, you can rename scenarios, change their order, and run single or multiple simulations. Instead of running each simulation separately, you can batch them together to run consecutively. To run multiple simulations:

- 1 Select **Scenarios > Manage Scenarios....**
The Manage Scenarios dialog box appears.

Manage Scenarios Dialog Box



#	Scenario Name	Saved	Results	Sim Duration	Time Units
1	no_back_util	saved	uncollected	1.0	hour(s)
2	back_util	saved	uncollected	1.0	hour(s)

- 2 Click on the **Results** value for the **no_back_util** and **back_util** scenarios and change the value to **<collect>**.

- 3 Set the **Sim Duration** value for each scenario to **2,000** and the **Time Units** to **seconds**.

Running the Simulation from the Manage Scenarios... Dialog Box



#	Scenario Name	Saved	Results	Sim Duration	Time Units
1	no_back_util	saved	<collect>	2,000	second(s)
2	back_util	saved	<collect>	2,000	second(s)

- 4 Click **OK**.

Modeler runs simulations for both scenarios. A Simulation Sequence dialog box shows the simulation progress. Close the dialog box when the simulations are done.

If your simulation does not complete, if no results were collected, or if the results vary significantly from those shown, you will have to troubleshoot your simulation.

Comparing Results

You are now ready to examine the results of the two scenarios. Because you collected the same statistics in each scenario, you can use the Compare Results feature to look at them together. To view the results from two or more different scenarios against each other, you can use the **Compare Results** feature. You can also apply different built-in filters to the graphs.

This topic focuses on:

- Comparing results between scenarios
- Applying filters to graphs

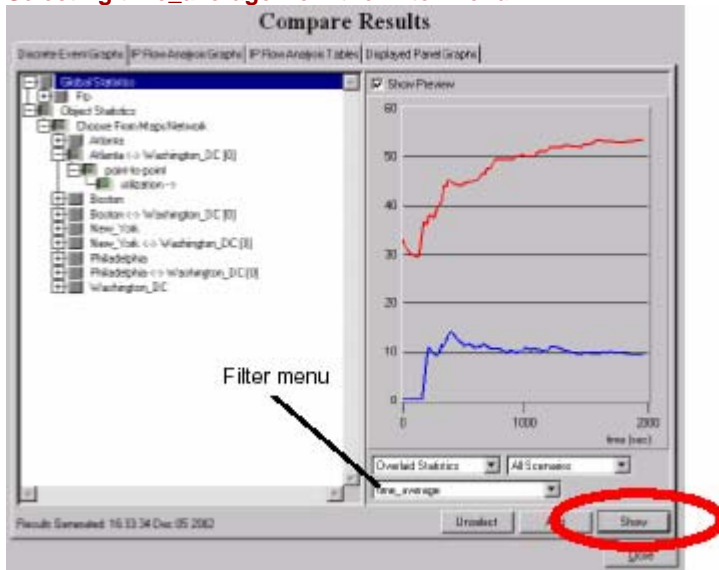
The **Compare Results** feature shows results from two or more scenarios. To look at link utilization:

- 1 Display the workspace pop-up menu and choose **Compare Results**.

2 In the Compare Results dialog box, select **Object Statistics > Campus Network > Business Office <-> Engineer Office 1 [0] > point-to-point > utilization -->**.

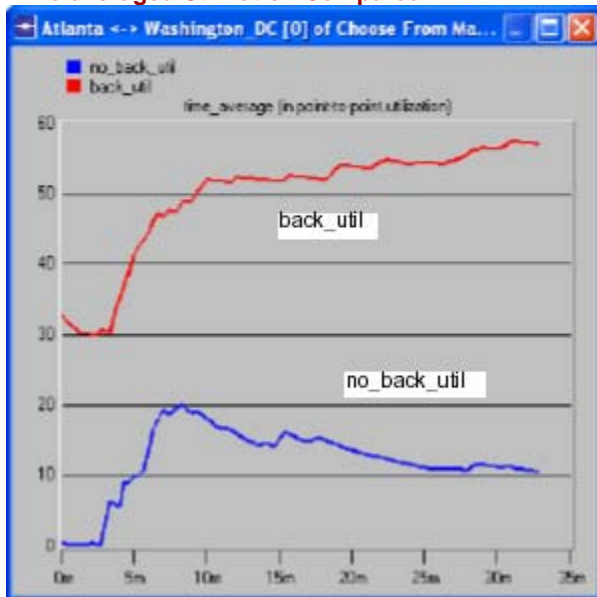
3 Because utilization varies over the course of a simulation, it is helpful to look at the time average for this statistic. Change the Filter menu from **As Is** to **time_average**.

Selecting time_average from the Filter Menu



4 Click **Show** to display the graph. Your graph should resemble the following diagram, though it will not match exactly:

Time-averaged Utilization Compared



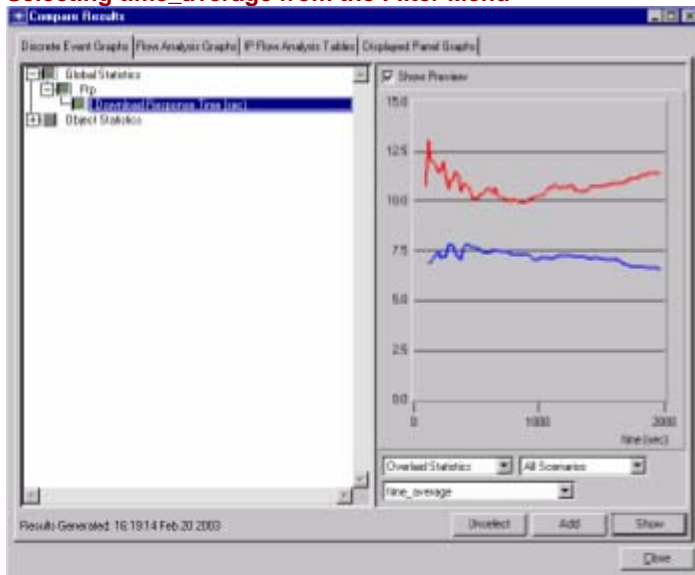
The network with the background utilization (back_util) shows higher utilization. You may want to look at the utilization of other links to determine the maximum

utilization of any link.

Next, let's look at Global FTP response time:

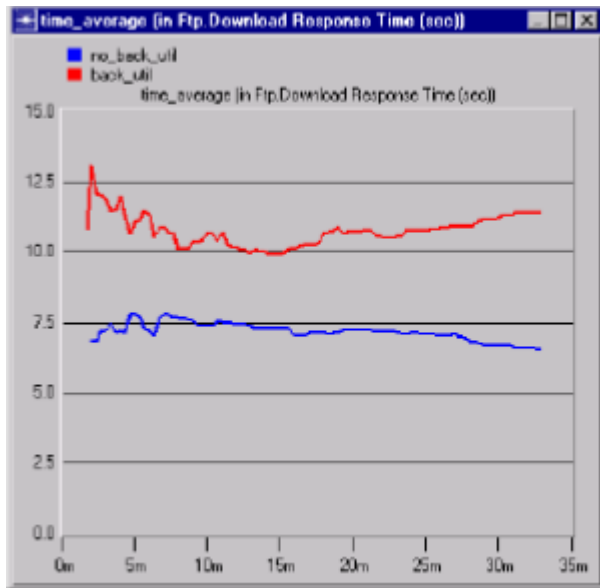
- 1 Move the link utilization graph aside and click the **Unselect** button in the Compare Results dialog box.
- 2 Check the **Global Statistics > Ftp > Download Response Time** statistic in the Compare Statistics dialog box.
- 3 Verify that the Filter menu shows **time_average**, then click **Show**.

Selecting time_average from the Filter Menu



The graph should resemble the following diagram:

Time-averaged Download Response Time Compared



This graph shows that, as steady state is reached, response time increases by several seconds when the link is heavily loaded.

1 Select **File > Close** and save changes before closing.