NETWARS

Traffic Modeling and Importing Traffic

2005-1 Final User's Guide (OPNET 235)

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Identification

Document Identification

Document Title: Traffic Modeling and Importing Traffic
Version: Final (OPNET 235)

Software Identification

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Product Release: 5.1

Documentation Conventions

This documentation uses specific formatting and typographic conventions to present the following types of information:

- Objects, examples, and system I/O
- Object hierarchies
- Computer commands
- Lists and procedures

Objects, Examples, and System I/O

- Directory paths and file names are in standard Courier typeface:

`C:\Netwars\User_Data\Projects`

- Function names in body text are in italics:

op_dist_outcome()

- The names of functions of interest in example code are in bolded Courier typeface:

```
/* determine the object ID of packet's creation module */
src_mod_objid = op_pk_creation_mod_get (pkptr);
```

- Variables are enclosed in angle brackets (< >):

`<NETWARS path>\Scenario_Builder\op_admin\err_log`

Object Hierarchies

Menu hierarchies are indicated by right angle brackets (>); for example:

Edit > Preferences > Advanced

Computer Commands

These conventions apply to Windows systems and navigation methods that use the standard graphical-user-interface (GUI) terminology such as click, drag, and dialog box.

• Key combinations appear in the form “press **<button>+x**”; this means press the **<button>** and **x** keys *at the same time* to do the operation.

• The mouse operations *left-click* (or *click*) and *right-click* indicate that you should press the left mouse button or right mouse button, respectively.

Lists and Procedures

Information is often itemized in bulleted (unordered) or numbered (ordered) lists:

• In bulleted lists, the sequence of items is not important.

• In numbered lists, the sequence of items is important.

Procedures are contained within procedure headings and footings that indicate the start and end of the procedure. Each step of a procedure is numbered to indicate the sequence in which you should do the steps.

Document Revision History

Release Date	Product Version	Chapter	Description of Change
September 2, 2005	5.1 Final	3 & 4	Changed file name paths from C:\op_models\... to C:\Netwars\... Verified that NetDoctor and Virtual CLI are available in NETWARS if you have the appropriate license.
June 22, 2005	5.1 Draft	All	Preliminary version.

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1 Introduction

NETWARS Overview

The Command, Control, Communications, and Computer Systems Directorate of the Joint Staff, in partnership with the Defense Information Systems Agency, Directorate for Technical Integration Services, developed Network Warfare Simulation (NETWARS). NETWARS provides modeling and simulation (M&S) capabilities for measuring and assessing information flow through strategic, operational, and tactical military communications networks. Analyzing the results from NETWARS can provide considerable utility in determining which communication systems might be overloaded during selected times in a particular scenario, and can assist with making prudent acquisition planning decisions.

Document Overview

NETWARS provides several options for representing, generating, and simulating traffic. Understanding the available options and selecting the appropriate traffic modeling technique is crucial to simulation performance. This user's guide, *Traffic Modeling and Importing Traffic,* describes how you can tune the fidelity of traffic being modeled using different traffic representations. How you choose to model traffic depends on the type of study being done.

This guide also provides example scenarios to show you how to import network traffic using the Multi-Vendor Import (MVI) module, which extends the built-in traffic and topology import features of NETWARS.

Note—For additional information about MVI, refer to the MVI User Guide (packaged with the IT Guru product documentation) available in NETWARS via the System Editor or Scenario Builder's **Help** menu.

Referenced Documents

- *MVI User Guide*, OPNET Technologies.

Traffic Modeling Techniques

This section presents guidelines for selecting the appropriate traffic modeling method given the type of study you are doing.

The following topics are covered:

- Traffic types in NETWARS: Explicit (packet-by-packet) traffic, and aggregated traffic, and
- Simulation techniques in NETWARS: Analytical simulation, discrete event simulation, and hybrid simulation.

Refer to chapter 2 in this guide for example scenarios that compare different traffic modeling approaches.

Traffic Types

There are several types of traffic (WAN, LAN, application traffic) represented in NETWARS. Your choice of representation depends on your modeling purpose (see Table 1-1 below.)

Table 1-1 Traffic Types

Traffic Type	NETWARS Representation	Modeling Purpose
Packet-by-Packet	Explicit Traffic	End-to-end delays, protocol details, segmentation effects
Aggregated Traffic	Traffic Flows (routed background traffic), Device/Link Loads (static background traffic)	Capacity planning, steady-state routing analysis

Sources of Explicit Traffic

Explicit traffic injected at the application layer includes email, HTTP, FTP, etc., and ACE, app_demands. Explicit traffic at the network layer includes IP traffic flows and RPG (self-similar traffic generator.) Explicit traffic at the lower layers includes native protocol sources (Ethernet, ATM, Frame Relay, etc.)

Sources of Aggregated Traffic

One type of aggregated traffic is traffic flows (or routed background traffic.) Traffic flows are injected at the application layer as app_demands. Aggregated traffic at the network layer are IP traffic flows. Aggregated traffic at the lower layers include ATM traffic flows and ATM PVC loads. Traffic flows need to be propagated (via tracer packets) to each node in the flow path.

The second type of aggregated traffic is element loads (or static background traffic.) Element loads include CPU utilization, and link loads. They do not require source models.

Traffic Data Import

Network monitoring software samples traffic periodically using probes, and exports the data to text files or other NETWARS recognizable formats for importing into NETWARS.

You can import explicit traffic using packet traces captured using a network analyzer such as Sniffer analyzer, tcpdump, windump, or the Application Characterization Editor (ACE).

You can import aggregated traffic using link load information from Concord NetworkHealth, MRTG, or spreadsheets (text info), etc. that can be converted into traffic flows.

Simulation Techniques

The following list (and Table 1-2) provide a brief comparison of the various NETWARS traffic modeling approaches:

- Analytical simulation
  - Abstract queue performance using mathematical equations
  - Model traffic as state information in various network elements
- Discrete event simulation
  - Model all traffic (data, signaling, management) using packets
  - Account for all timers in every protocol layer
  - Perform every state/event transitions of all protocol layers

- Hybrid simulation
  - Mix of modeling approaches (discrete event + analytical)
  - Mixture of traffic types (explicit traffic + aggregated traffic)

Table 1-2 Comparison of Simulation Techniques

	Analytical	Discrete	Hybrid
Capabilities	Capacity Planning Device and Link Load Measurement	Protocol Dynamics Packet-by-packet Analysis for New Application Development End-to-end Traffic Analysis Capacity Planning Device and Link Load Measurement	All from Discrete and Analytical
Methods	Mathematical Equations to Compute Performance Metrics Tabular Data Constructed from Empirical Data	Event-based Simulation Kernel	Micro-Simulation Analytical Simulation

Analytical Simulation

Analytical simulation uses traffic flow and static device load information for its traffic input. The advantage of using analytical simulation is its fast numerical computations. Its disadvantages are in its assumptions, leading to inaccuracies, and the fact that it's not available for all systems.

Discrete Event Simulation

Discrete event simulation uses explicit traffic generator models and ACE for its traffic input. The advantage of using discrete event simulation is its accuracy and high fidelity. Its disadvantages are in its long simulation run-time and large memory requirements.

Hybrid Simulation

Hybrid simulation uses both or one of the traffic inputs used by discrete and analytical simulation techniques. The advantage of using hybrid simulation is that it is more accurate than analytical simulation and faster than discrete simulation. Its disadvantage is that it does not model all protocol dynamics such as feedback, flow control, congestion control, and policing.

Importing Traffic

Importing IP and Layer 2 Networks with MVI

The Multi Vendor Import module (MVI) allows you to import network topology using device configuration files. Chapter 3 provides example scenarios to show you how to:

- Use MVI to build a network model by importing from device configuration files,
- Use the Model Assistant to provide supplemental information such as interface data rates and device locations that do not exist in the device configuration files, and
- Evaluate the status of the configuration import, and use the information to troubleshoot the network.

Importing Network Traffic Data with MVI

The MVI module can also be used to leverage real-world traffic data and build accurate and efficient models by importing time-varying link and PVC load data as well as end-to-end flow data from various data sources. Chapter 4 provides example scenarios to show you how to:

- Perform traffic flow and link/pvc baseline load imports, and
- Learn about the workflow options available when performing network analyses using data from various sources.

2 Traffic Modeling Techniques

Comparing Traffic Modeling Approaches

In this section, we compare the speed and accuracy of different traffic representations: explicit traffic, background traffic and hybrid traffic. First we create a simple network with explicit traffic, then we replace the explicit traffic with background traffic, and finally we replace the background traffic with hybrid traffic, running simulations each time. In doing so, we can predict the delay for each class of service and compare the results obtained using the different traffic modeling approaches.

Note—The following example was presented at OPNETWORK 2004 in Session 1302, Traffic Modeling Techniques, as Lab 1. If you do not have access to the files that this procedure uses, you can still follow the procedure using the sample screens provided in this user's guide.

This section uses the following example scenario:

- The network is a model of a company that provides video-on-demand services to 100 users. The company would like to introduce three classes of service for its clients: Gold (ToS = 3), Silver (ToS = 2) and Bronze (ToS = 1). To provide differentiated treatment for the different service classes, Weighted Fair Queuing (WFQ) has been configured on the access router.

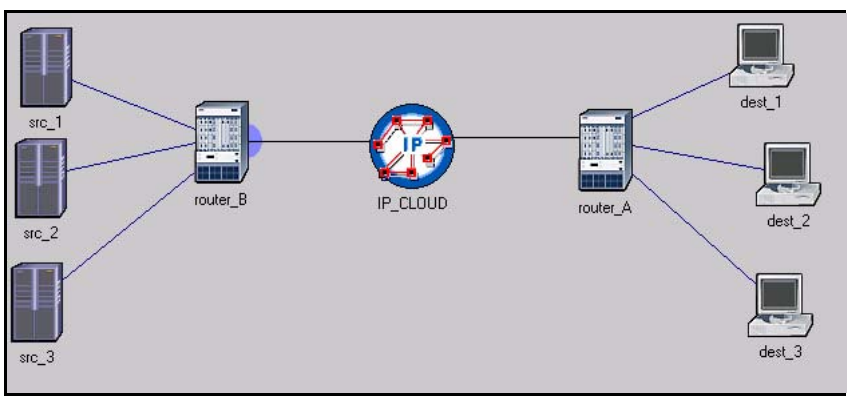


Figure 2-1 Example Network Model

Note—Source nodes (video servers) with different ToS (1,2,3) are shown on the left-hand side of the Network Model figure; destination nodes on the right. Router B provide the interface with WFQ.

Simulation with Explicit Traffic

Procedure 2-1 Create a Simple Network with Explicit Traffic

1 Open the project.

1.1 Launch NETWARS, if not already opened.

1.2 From the System Editor's **File** menu, choose **Open Editor**.

1.3 From the Open Editor drop-down menu, select **Scenario Builder**, and then click **OK**. The Scenario Builder window displays.

1.4 Select **File > Open Project**. The Open Project dialog box displays.

1.5 Select the project named `1302_lab1` (or if you want to follow along without actually performing the steps in this procedure, select the project named `1302_lab1_ref` instead), and then click **Open**.

Scenario "Explicit_traffic" appears as the first scenario.

Note—If you do not have access to these files, simply view the screens provided in this user's guide to follow along with the procedure.

2 Create explicit traffic using IP Traffic Flows.

We will create three traffic flows representing the traffic downloaded by the three classes of clients. In this scenario, all traffic will be modeled as explicit traffic.

2.1 Click the **Open Object Palette** toolbar button.

2.2 Select the "demands" object palette from the drop-down list.

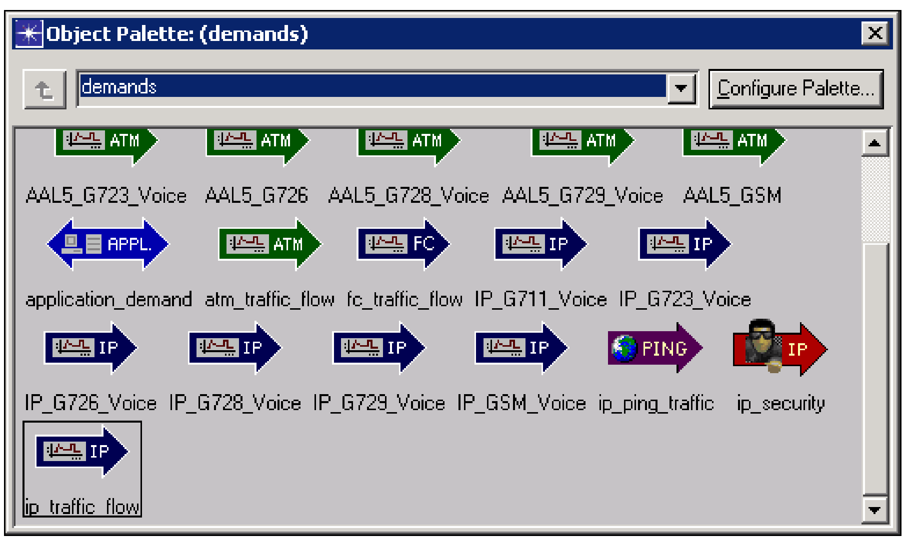


Figure 2-2 Demands Object Palette

2.3 Click on IP demand "ip_traffic_flow" to define an IP-to-IP background traffic flow.

2.4 Connect the IP demand between src_1 and dest_1 (in the same way you would create a link object).

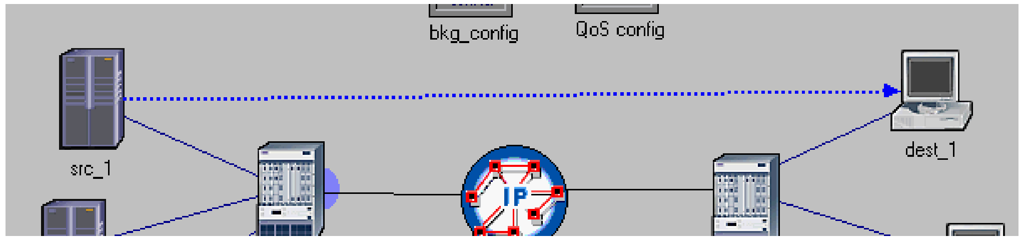


Figure 2-3 IP Demand Connected

2.5 Right-click on the workspace and select **Abort Demand Definition** to exit demand operation.

2.6 Right-click on the demand object and select **Edit Attributes**.

2.7 In the Attributes dialog box, edit the traffic specification for both bits/second and packets/second values as described below.

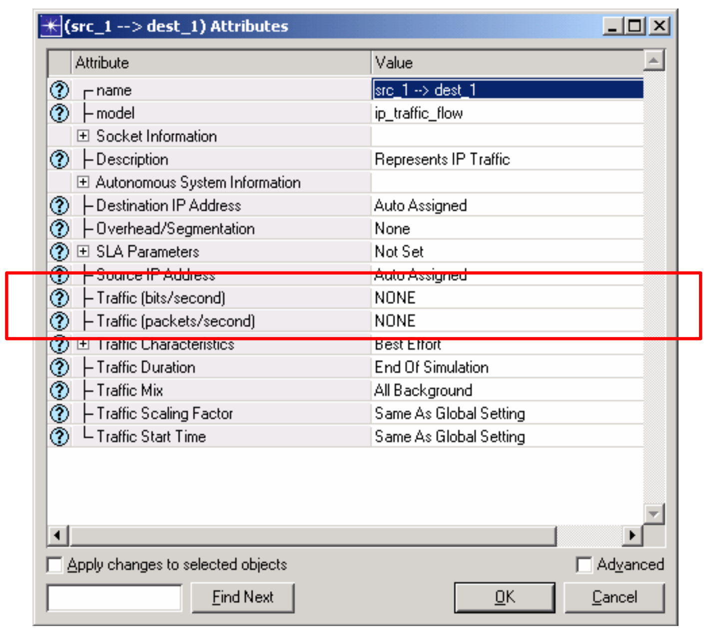


Figure 2-4 Selected Object's Attributes dialog box

- Configure the “Traffic (bits/second)” attribute with a value of 6.0 Mbps from 0 to 600 seconds. (The profile name may be different in your case.) The graph is updated when you press **Enter** after typing the values.

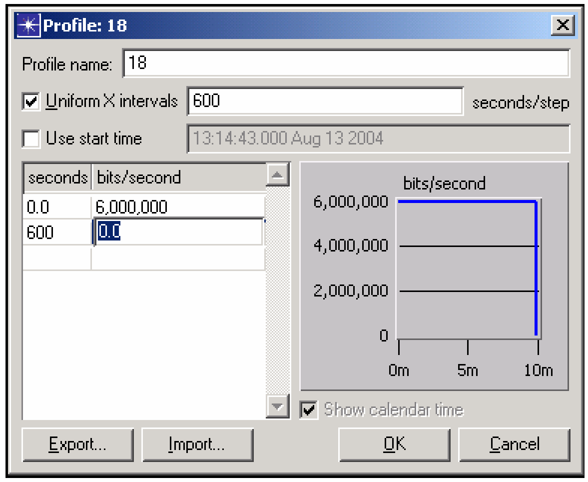


Figure 2-5 Configuring the Traffic (bits/second) Attribute

- Click **OK** to commit changes.
- Configure the “Traffic (packets/second)” attribute with a value of 500 packets/second from 0 to 600 seconds. (The profile name may be different in your case.) The graph is updated only if you press **Enter** after typing the values.

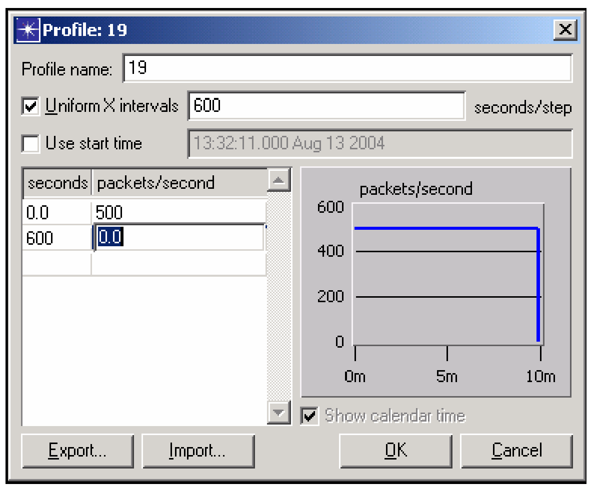


Figure 2-6 Configuring the Traffic (packets/second) Attribute

- Click **OK** to commit changes.

Note that the average packet size implied by the configured traffic volumes (6,000,000 bps and 500 pps) is 6,000,0000 bps / 500 pps = 12,000 bits = 1,500 bytes.

2.8 In the Attributes dialog box, set the “Traffic Mix” attribute to “All Explicit”.

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

2.10 Click on the demand object to select it, press **Ctrl+C** to copy it, and then press **Ctrl+V** to paste it in the same direction from src_2 to dest_2 and from src_3 to dest_3 (as shown below.)

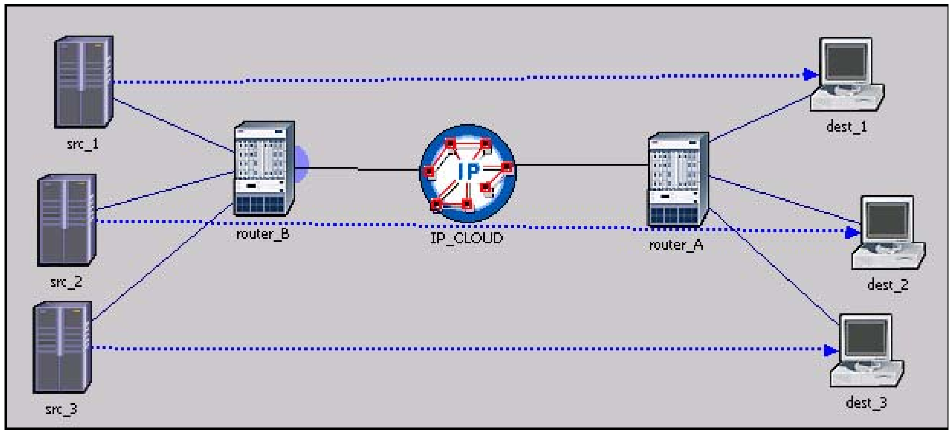


Figure 2-7 Copying/Pasting Demand Objects

3 Configure the Type of Service on each demand.

3.1 Select **Protocols > IP > Demands > Characterize Traffic Demands**.

3.2 Set the Type of Service for the demands originating from WFQ_net.src_1, WFQ_net.src_2, and WFQ_net.src3 to “Background (1)”, “Standard (2)” and “Excellent (3),” respectively.

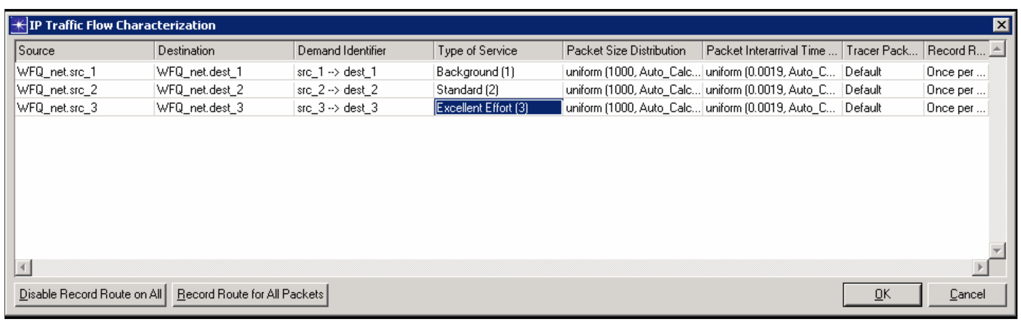


Figure 2-8 IP Traffic Flow Characterization dialog box

3.3 Click **OK**.

4 Configure the packet size and packet inter-arrival time distributions.

Next we will configure additional traffic generation parameters, such as statistical distributions used for packet sizes and packet inter-arrival times. Note that these can be configured either individually for each demand, under the “Traffic Characteristic” attribute, or globally for all the demands using the Background Traffic Config utility. We will use the latter approach in this lab and configure the distributions by modifying the global settings.

4.1 Right-click on the “bkg_config” node and select **Edit Attributes**.

4.2 Set the “Packet Inter-arrival Time Variability” to “exponential ”.

4.3 Set the “Packet Size Variability” to “constant”.

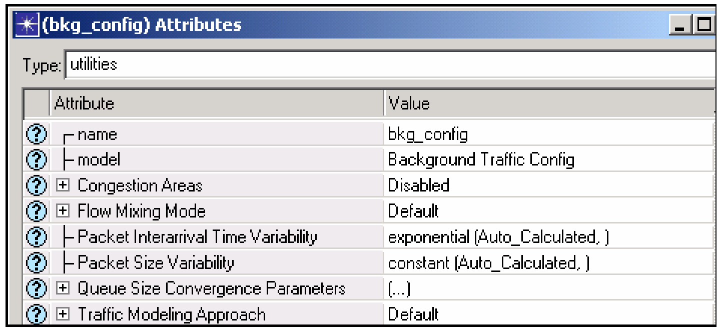


Figure 2-9 Node’s Attributes dialog box

Note that the average values for both distributions are already determined by the settings in the traffic profile and therefore appear as “Auto_Calculated”. The traffic volume of 500 packets/second in the profile translates into an average packet inter-arrival time of 0.002 seconds. The average packet size is also already determined to be 1,500 bytes.

4.4 Click **OK** to commit changes.

5 Choose statistics.

We will monitor the queuing delay statistics for each service class on the outgoing interface of “router_B”. This interface is the access interface to the core network and has WFQ scheduling enabled to provide QoS treatment to different service classes. We will also collect the packet end-to-end delay statistics for all the traffic flows.

5.1 Right-click anywhere in the project editor and select **Choose Individual DES Statistics**.

5.2 Expand “Demand Statistics” by clicking on the (+) next to it, and select the “Packet ETE Delay (sec)” statistic.

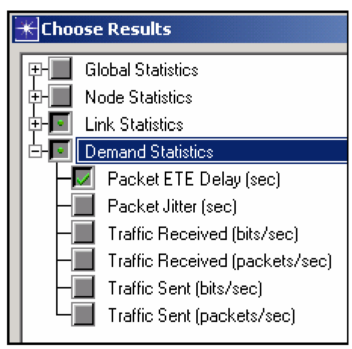


Figure 2-10 Selecting the Packet ETE Delay (sec) Statistic

5.3 Expand “Node Statistics” by clicking on the (+) next to it, and select the “IP Interface / Queuing Delay (sec)” statistic.

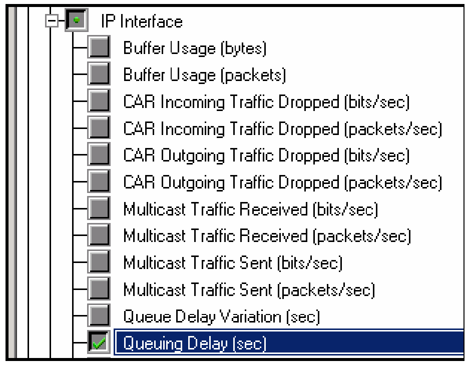


Figure 2-11 Selecting the IP Interface / Queuing Delay (sec) Statistic

5.4 Click **OK**.

6 Run the simulation.

6.1 Click the **Configure/Run Simulation** toolbar button. The simulation is set to run for 10 minutes.

6.2 Click **Run** to start the simulation. (The simulation runs for about 3 minutes.)

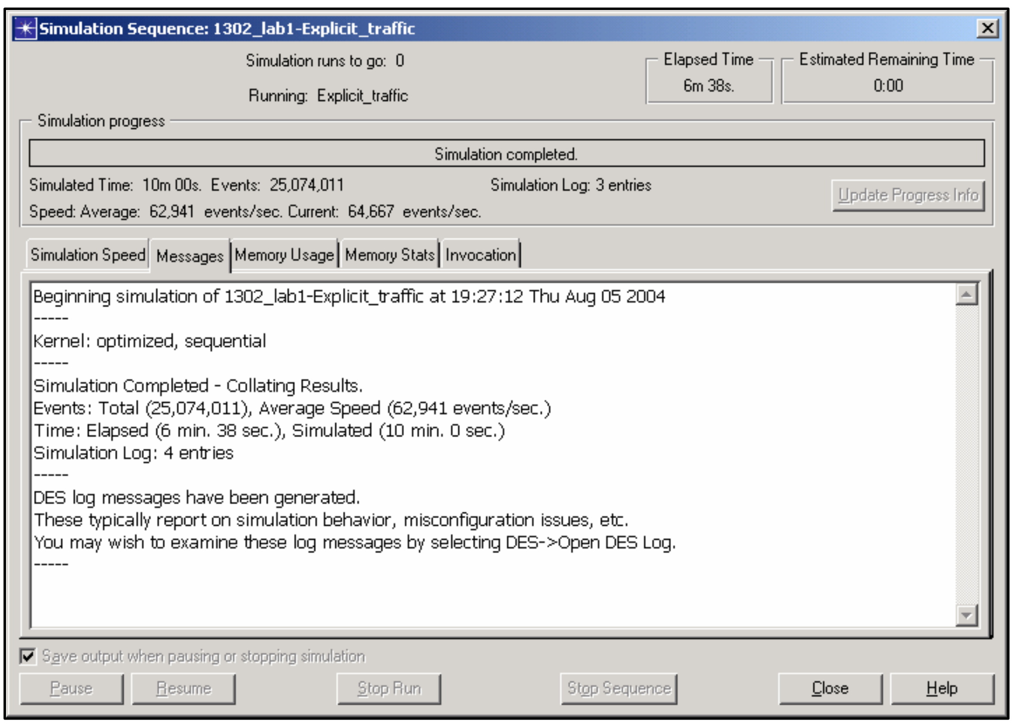


Figure 2-12 Simulation Sequence dialog box

6.3 Close the Simulation Sequence dialog box after the simulation runs.

7 View the results.

7.1 Right-click on the “router_B ↔ IP_CLOUD” link, and select **View Results**.

7.2 Expand the “point-to-point” group and select the “throughput (packets/sec) ←” and “throughput (bits/sec) ←” statistics. Click **Show**.

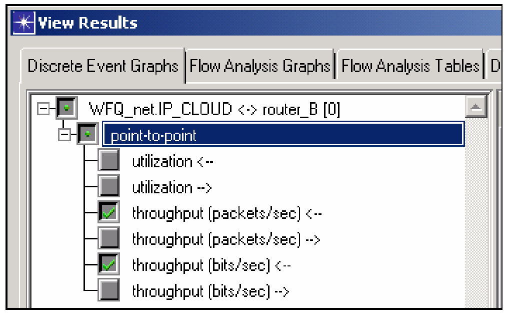


Figure 2-13 Selecting Throughput Statistics to Show

The graph shows that the total traffic entering the IP cloud is 18 Mbps at the rate of 1500 packets per second (pps) – remember each of the three flows is sending traffic at 6 Mps and 500 pps.

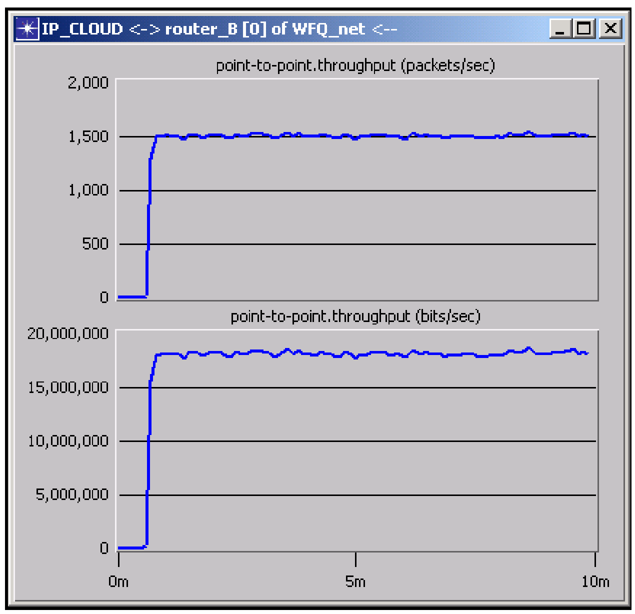


Figure 2-14 Throughput Results Graph

7.3 Click **Close** to close the View Results dialog box.

7.4 Right-click on “router_B”, and select **View Results**.

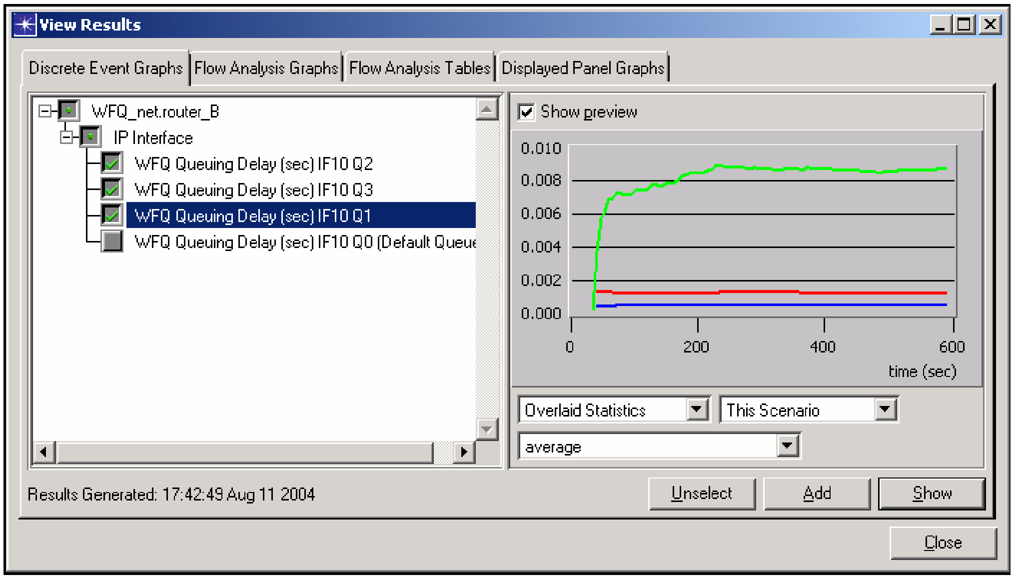


Figure 2-15 View Results dialog box

7.5 Expand the “IP Interface” group, and select the statistics below in the following order:

- “WFQ Queuing Delay (sec) IF10 Q3”
- “WFQ Queuing Delay (sec) IF10 Q2”
- “WFQ Queuing Delay (sec) IF10 Q1”

7.6 Change the display mode from “Statistics Stacked” to “Overlaid Statistics”.

7.7 Change the “As Is” filter to “average”.

7.8 Click **Show**.

As expected, the queues with higher priority (ToS) exhibit smaller queuing delays at the access router “router_B”.

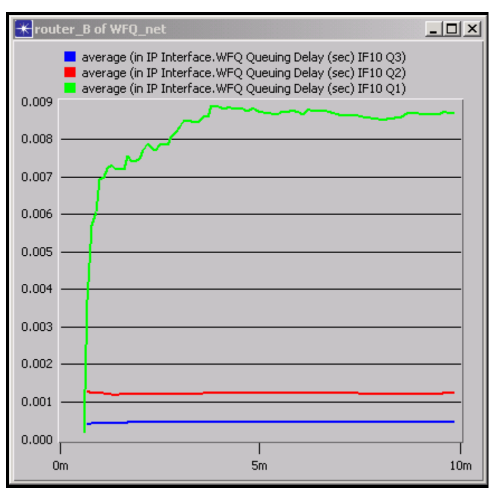


Figure 2-16 Showing Queuing Delay Results

7.9 Click **Close** to close the View Results dialog box.

7.10 Right-click on the demand going from “src_2” to “dest_2”, and select **View Results**.

7.11 Select the “Packet ETE Delay (sec)” statistic, and click **Show**.

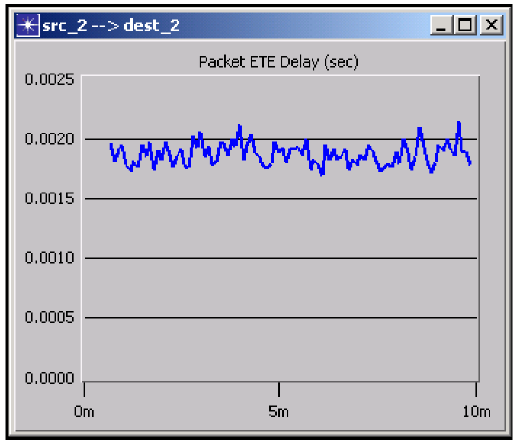


Figure 2-17 Showing the Packet ETE Delay (sec) Statistic Graph

The graph shows that the packet end-to-end delay for the “src_2→dest_2” demand is about 0.0019 seconds.

End of Procedure 2-1

Simulation with Background Traffic

In the following scenario, we replace the explicit traffic with purely background traffic, run the simulation, and compare the results and the simulation speed.

Procedure 2-2 Configure Demands with Background Traffic

1 Replace explicit traffic with background traffic.

1.1 Switch to the “Background_traffic” scenario (select **Scenario > Switch to Scenario > Background_traffic**).

1.2 Right-click on the demand going from “src_1” to “dest_1” and choose **Select Similar Demands**. Note that the other two demands were also selected.

1.3 Right-click on the demand again and choose **Edit Attributes**.

1.4 Change the “Traffic Mix” attribute to “All Background”.

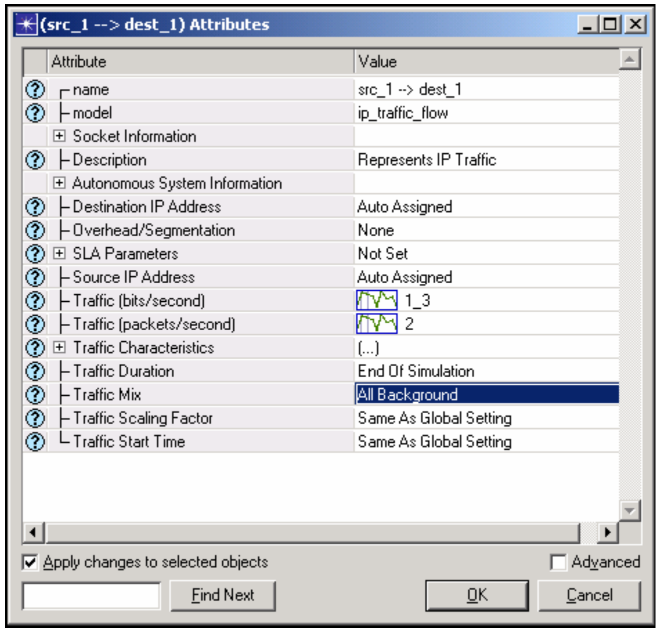


Figure 2-18 Changing the Traffic Mix Attribute

1.5 Check the **Apply changes to selected objects** checkbox, and click **OK**.

2 Run the simulation.

2.1 Click the **Configure/Run Simulation** toolbar button. The simulation is set to run for 10 minutes.

2.2 Click **Run** to start the simulation. (The simulation runs for about 10 seconds.)

2.3 Close the Simulation Sequence dialog box after the simulation runs.

3 Compare results with those of the previous scenario (with explicit traffic).

3.1 Click the **Hide/Show Graph Panels** button.

3.2 Load the panels with latest results by selecting **DES > Panel Operations > Panel Templates > Load with Latest Results**.

The first graph panel displays the queuing delays for various queues at the access router_B obtained in this scenario.

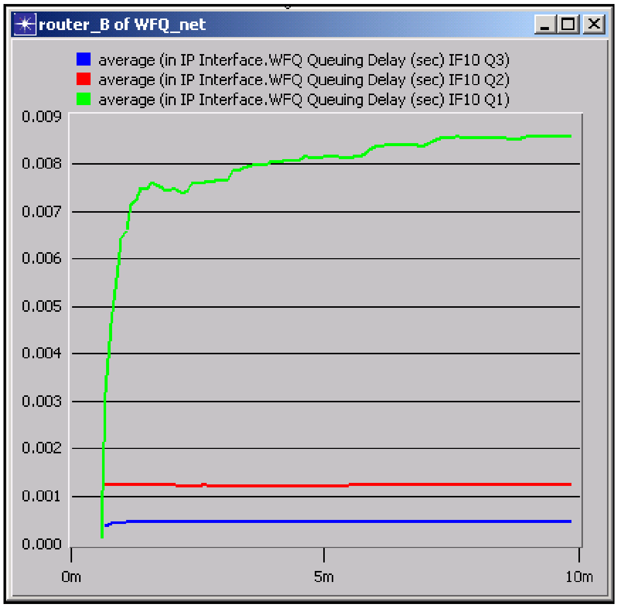


Figure 2-19 Showing Queuing Delays Graph

The second panel compares the individual queuing delays between the two scenarios. Observe that queuing delays for all the queues in both scenarios (explicit and background) are similar.

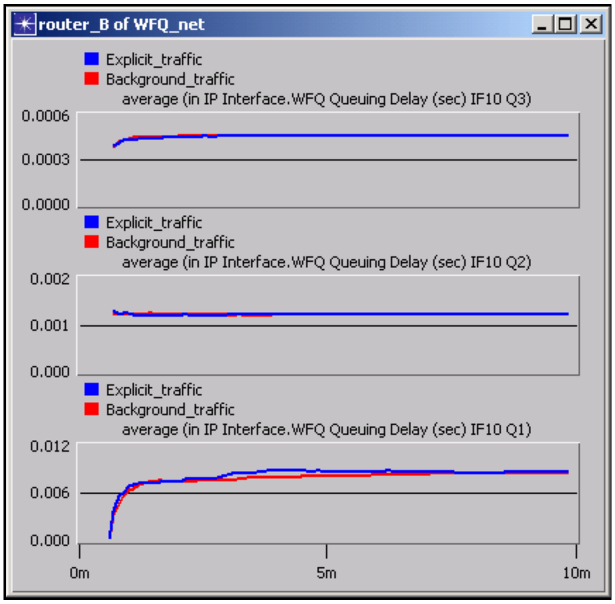


Figure 2-20 Comparing Queuing Delays

Note that using purely background traffic we were able to significantly reduce the simulation time (from 3 minutes to 10 seconds) and still obtain accurate result for the local queuing delays.

4 Compare end-to-end delay statistics.

4.1 Right-click on the demand going from “src_2” to “dest_2”and select **View Results**.

Note that the “Packet ETE Delay (sec)” statistic is shaded out and cannot be selected. The delay effects of the background traffic load are simulated only locally on each traffic element (node or link). Because of this, the purely background traffic mode does not provide for end-to-end delays.

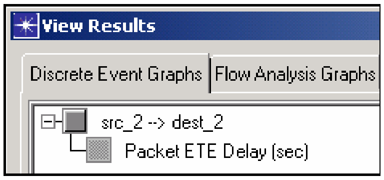


Figure 2-21 Inaccessible Packet ETE Delay (sec) Statistic

In the next scenario, we will see how we can overcome this shortcoming by using hybrid traffic (mixture of background and explicit traffic).

End of Procedure 2-2

Simulation with Hybrid Traffic

In the next scenario, we configure the demands to use a mixture of explicit traffic (1%) and background traffic (99%). This way we can obtain end-to-end statistics and still achieve significant simulation speedup (compared to the purely explicit traffic scenario).

Note that the explicit traffic is only a small fraction of the total traffic. This is the recommended configuration. For flows with large traffic volumes, very small fractions, such as 0.01% or 0.1% explicit, should be used. Configurations such as 30% explicit + 70% background traffic do not result in significant simulation speedup and should be avoided.

Procedure 2-3 Configure Demands with Hybrid Traffic

1 Replace background traffic with hybrid traffic.

1.1 Switch to the “Hybrid_traffic” scenario (select **Scenario > Switch to Scenario > Hybrid_traffic**).

1.2 Right-click on the demand going from “src_1” to “dest_1” and choose **Select Similar Demands**. Note that the other two demands were also selected.

1.3 Right-click on the demand again and choose **Edit Attributes**.

1.4 Change the “Traffic Mix” attribute to “1.0 % Explicit”.

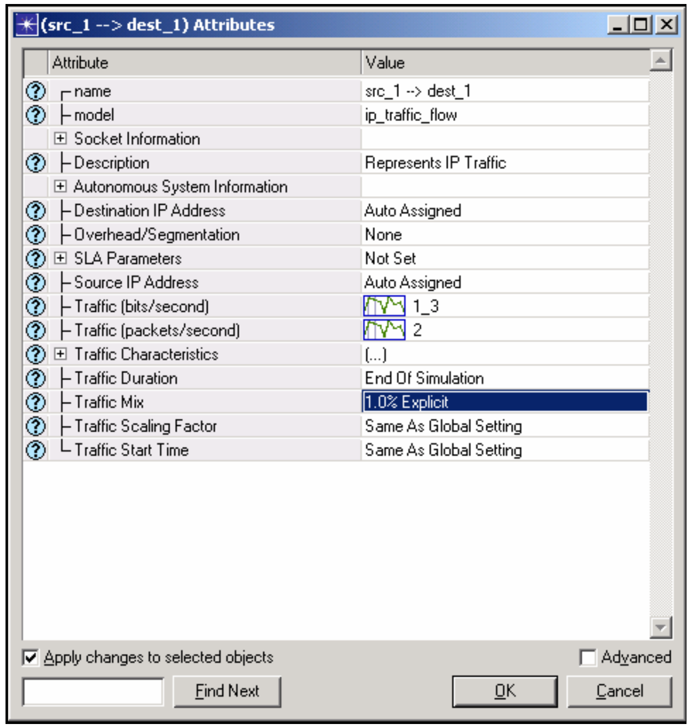


Figure 2-22 Changing the Traffic Mix Attribute

1.5 Check the **Apply changes to selected objects** checkbox, and click **OK**.

2 Run the simulation.

2.1 Click the **Configure/Run Simulation** toolbar button. The simulation is set to run for 10 minutes.

2.2 Click **Run** to start the simulation. (The simulation runs for about 15 seconds.)

2.3 Close the Simulation Sequence dialog box after the simulation runs.

3 Compare results with those of the other scenarios.

3.1 Click the **Hide/Show Graph Panels** button.

3.2 Load the panels with latest results by selecting **DES > Panel Operations > Panel Templates > Load with Latest Results**.

The first panel compares the queuing delays between the three scenarios. The queuing delays obtained in this scenario using hybrid traffic match with those from previous scenarios.

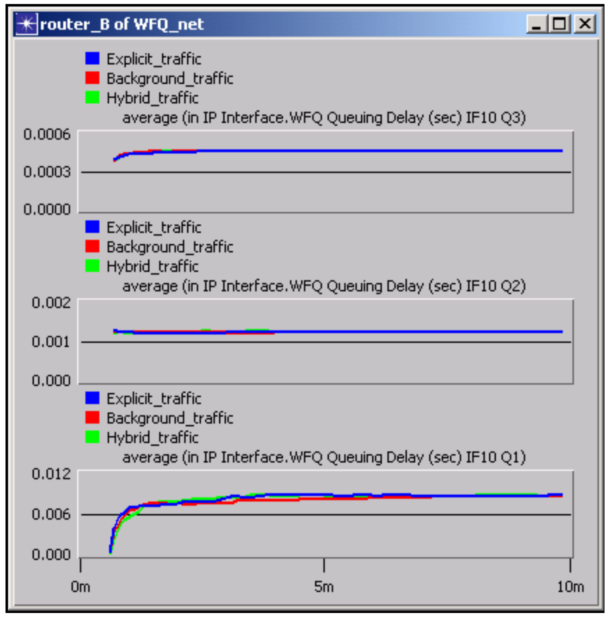


Figure 2-23 Comparing Queuing Delays

The second graph panel compares the packet end-to-end delays for the three traffic demands obtained using explicit traffic and hybrid traffic (no ETE delays were available in the purely background traffic scenario). The results obtained using the two traffic types match closely.

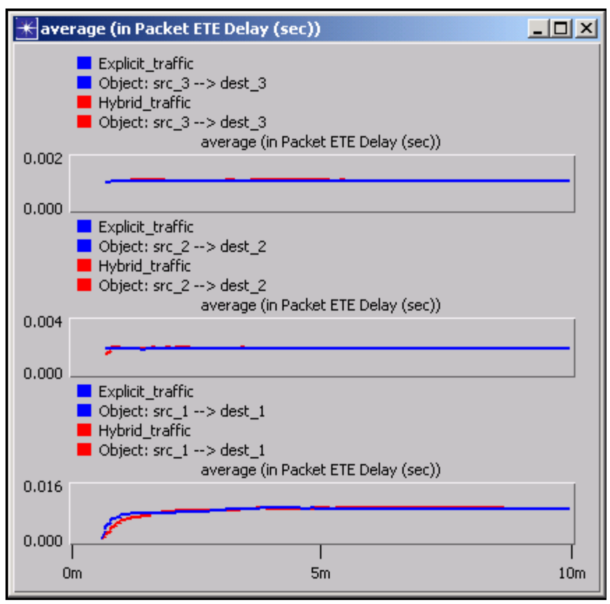


Figure 2-24 Comparing Packet ETE Delay (sec) Statistics

End of Procedure 2-3

Conclusion

In this section, we have demonstrated how using background and/or hybrid traffic can help reduce the simulation time without significant losses in the accuracy of the results.

Using Hybrid Simulation to Model New Application Performance

In this section, we study the performance of a new application deployed in a Wide Area Network (WAN). The preexisting baseline traffic in the network is modeled using link loads. The new application is recreated from an actual traffic trace and converted into OPNET application traffic using ACE.

In the first scenario, we deploy one instance of the new application in an empty network (without the baseline traffic). The application user is modeled using discrete traffic. We assess the application performance and verify whether it conforms to the Service Level Agreement (SLA) requiring that the application response time is below 30 seconds. Next we add the baseline traffic (modeled as link loads) and observe its impact on the application response time. After that, we use ACE and deploy additional application users, modeled not as discrete traffic, but using background traffic flows. We monitor the application response time and apply QoS to improve the application performance.

Procedure 2-4 Use Hybrid Simulation to Model Application Performance

1 Examine the new application trace in ACE.

1.1 Launch NETWARS, if not already opened.

1.2 From the System Editor's **File** menu, choose **Open Editor**.

1.3 From the Open Editor drop-down menu, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.

1.4 Click **Add Capture File**. The Select Capture File for Import dialog box displays.

1.5 In the Select Capture File for Import dialog box, select the file named `cwd_local`, and then click **Open**. The selected file name displays in the **Capture File** column of the ACE Import: Choose Capture File(s) dialog box.

Note—If you do not have access to this file, simply view the screens provided in this user's guide to follow along with the procedure.

1.6 Continue to follow the ACE Import Wizard screens as they are presented to you until the Treeview window displays.

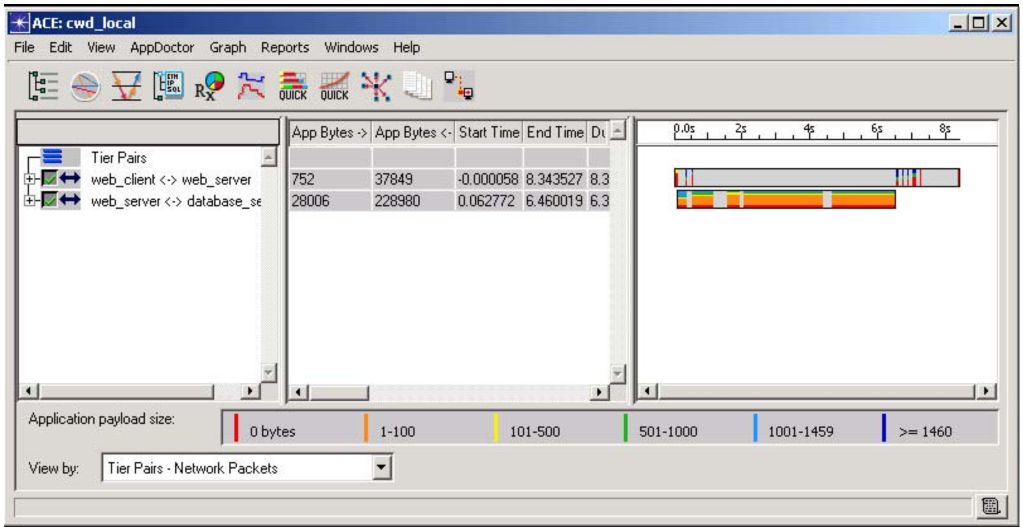
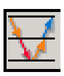


Figure 2-25 Treeview window

1.7 Click the Data Exchange Chart button.



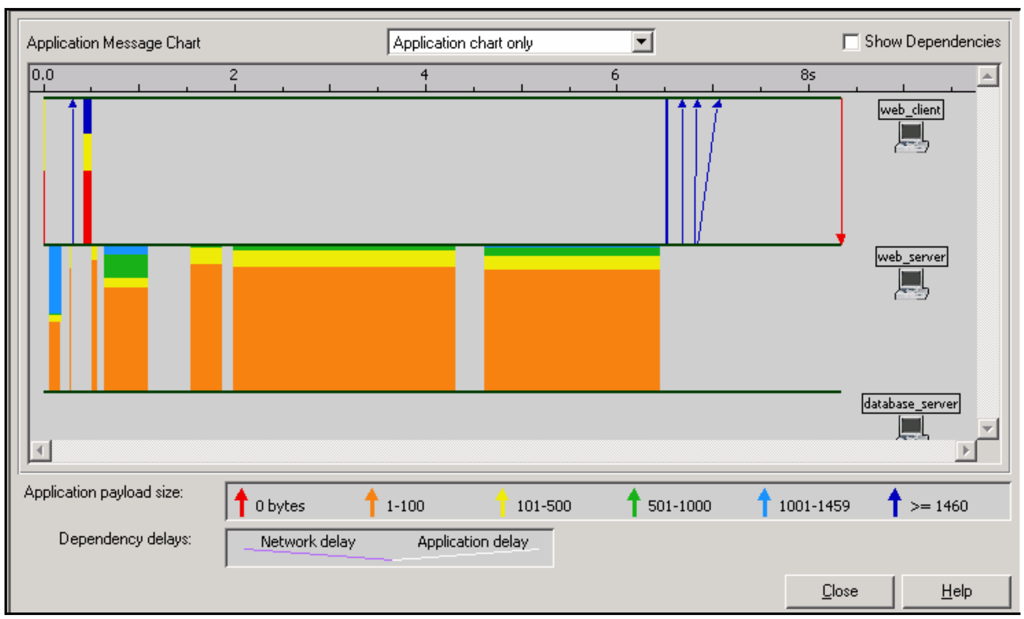


Figure 2-26 Data Exchange Chart

The Data Exchange Chart shows the application traffic patterns between the different tiers. Note that there are 3 tiers in this application: web_client, web_server and database_server. The horizontal lines represent the tiers - the topmost line corresponds to the web_client, the middle line to the web_server, and the bottom line represents the database_server. The color arrows connecting the three horizontal lines represent individual packet exchanges between the tiers. The horizontal axis visualizes the time of the transaction in seconds. The application is a typical database query. Initially the web_client contacts the web_server with a request and the two exchange several packets. After that the bulk of the traffic exchange is between the web_server and the data_server. At the end of the application the web_server sends replies to the web_client. Note that the duration of the whole application is about 8.1 seconds.

1.8 Click **Close** to close the Data Exchange Chart.

1.9 Close the ACE editor.

2 Deploy one application user running discrete traffic.

Configure the network to use one instance of the ACE application. The following nodes will be used as the application tiers: web_client → San Diego, web_server → Los Angeles, and database_server → Houston.

2.1 Launch NETWARS, if not already opened.

2.2 From the System Editor's **File** menu, choose **Open Editor**.

2.3 From the Open Editor drop-down menu, select **Scenario Builder**, and then click **OK**. The Scenario Builder window displays.

2.4 Select **File > Open Project**. The Open Project dialog box displays.

2.5 Select the project named `1302_lab2` (or if you want to follow along without actually performing the steps in this procedure, select the project named `1302_lab2_ref` instead), and then click **Open**.

Scenario "app_user_only" appears as the first scenario.

Note—If you do not have access to these files, simply view the screens provided in this user's guide to follow along with the procedure.

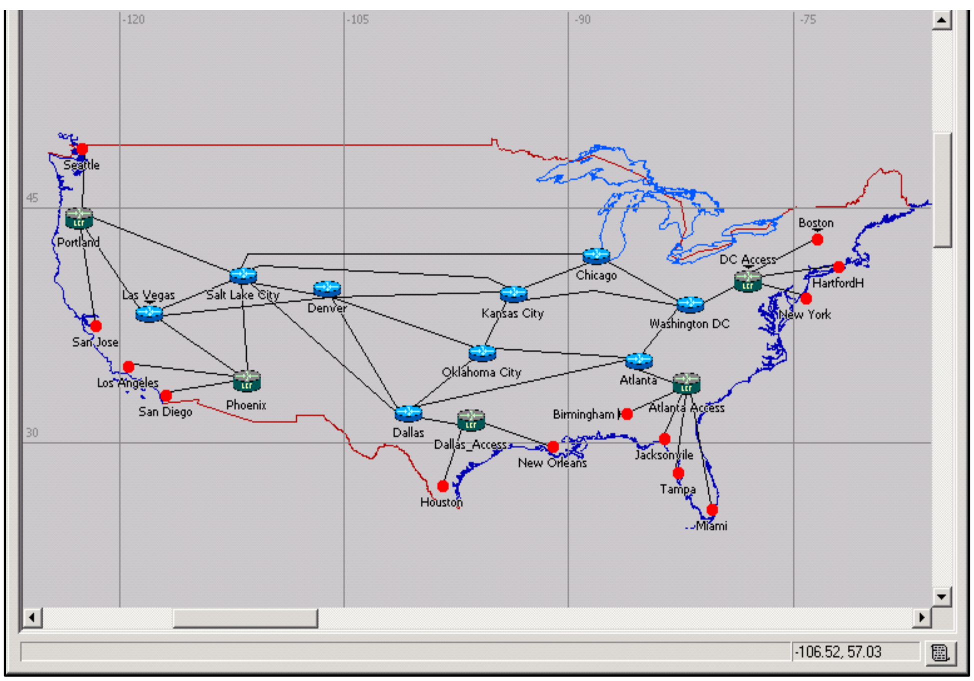


Figure 2-27 Displaying app_user_only

2.6 Click **Protocols > Applications > Deploy ACE Application on Existing Network > as Discrete Traffic**. The Configure ACE Application dialog box displays.

2.7 In the Configure ACE Application dialog box:

- Set the application “Name” to “my_app”
- Set the “Repeat” to “20 times per hour”
- Click the **Add Task** button and select the “cwd_local.atc.m” ACE trace file.

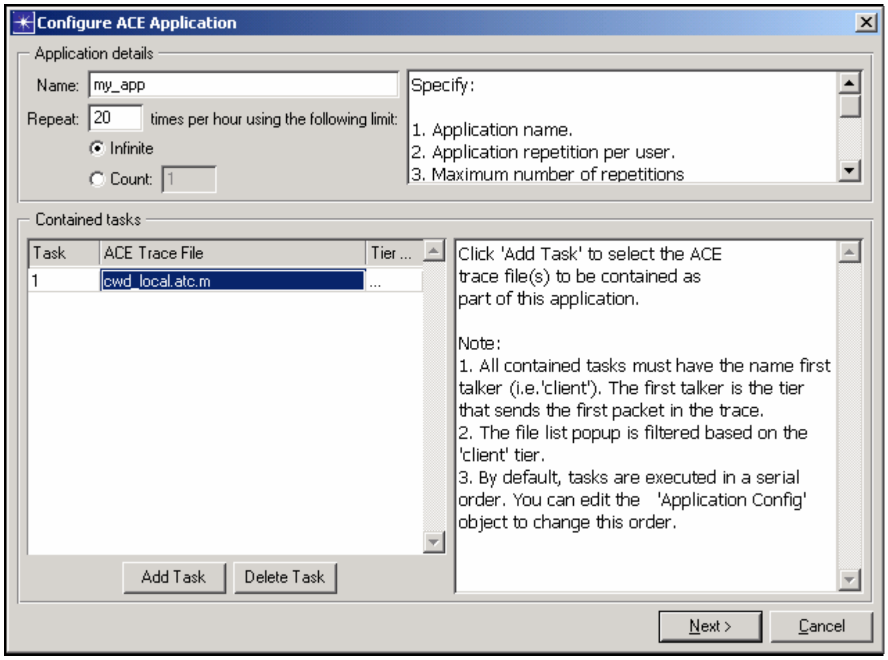


Figure 2-28 Configure ACE Application dialog box

2.8 Click **Next**.

In the next step we will assign application tier functionality to existing nodes in the network.

2.9 Click “Select Nodes” for the “web_client” tier.

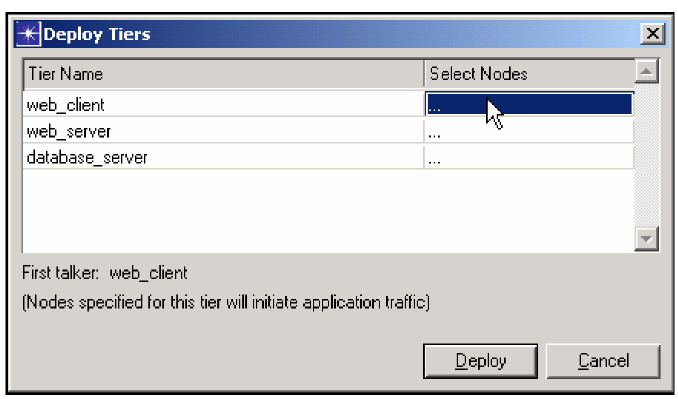


Figure 2-29 Deploy Tiers dialog box

2.10 Select “San Diego” from the node list by clicking on the “Deploy” column value.

2.11 Click **OK**.

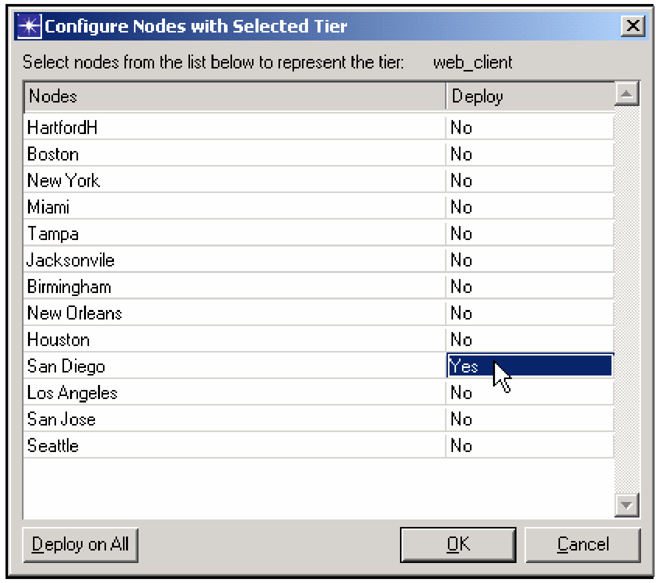


Figure 2-30 Configure Nodes with Selected Tier dialog box

2.12 In a similar fashion, choose “Los_Angeles” to function as the web_server and “Houston” to represent the database_server.

2.13 Click **Deploy**.

3 Run the simulation and view results.

3.1 Click the **Configure/Run Simulation** toolbar button. The simulation is set to run for 1 hour.

3.2 Click **Run** to start the simulation.

3.3 Close the Simulation Sequence dialog box after the simulation runs.

3.4 Click **DES > Results > View Statistics**.

3.5 In the View Results dialog box, expand "Global Statistics / ACE" and select the "Task Response Time (sec)" statistics.

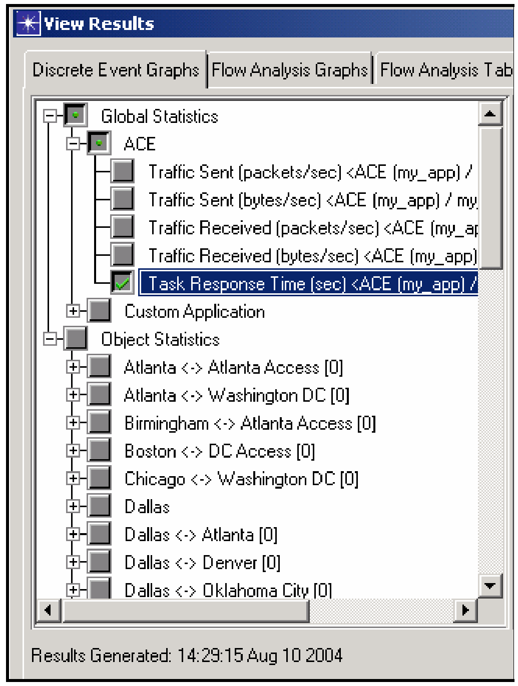


Figure 2-31 Selecting the Task Response Time (sec) Statistic

3.6 Click **Show**.

Note the application response time varies around 23.2 seconds. This conforms to the 30 second limit required by the SLA.

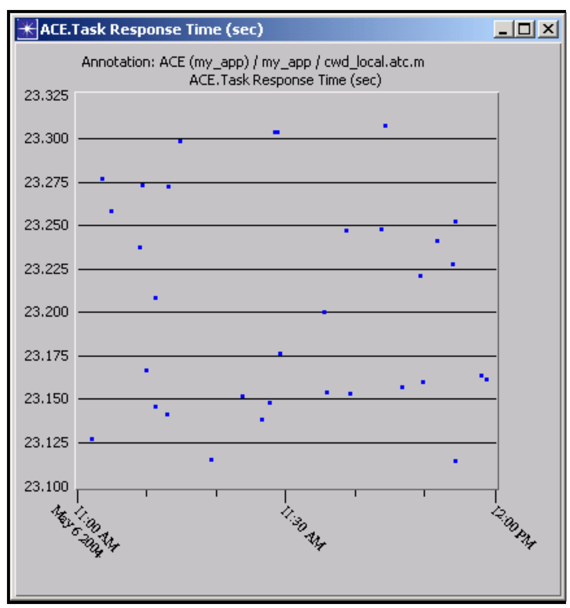


Figure 2-32 Task Response Time Statistics

3.7 In the View Results dialog box, change the display filter from “As Is” to “average”.

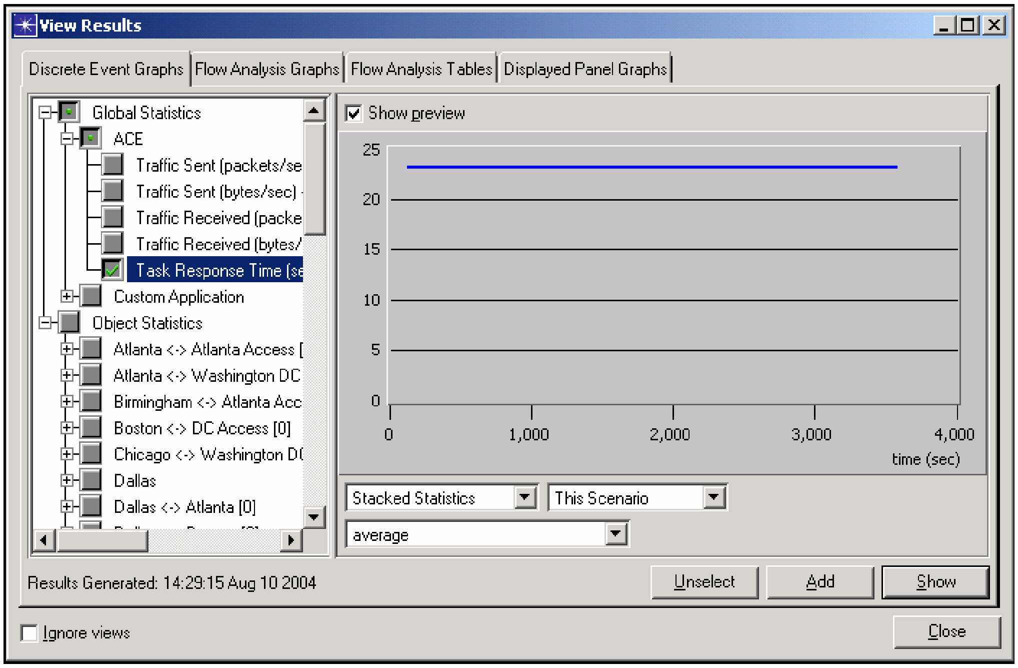


Figure 2-33 View Results dialog box

3.8 Click **Show**.

The graph shows the average response time for the new application.

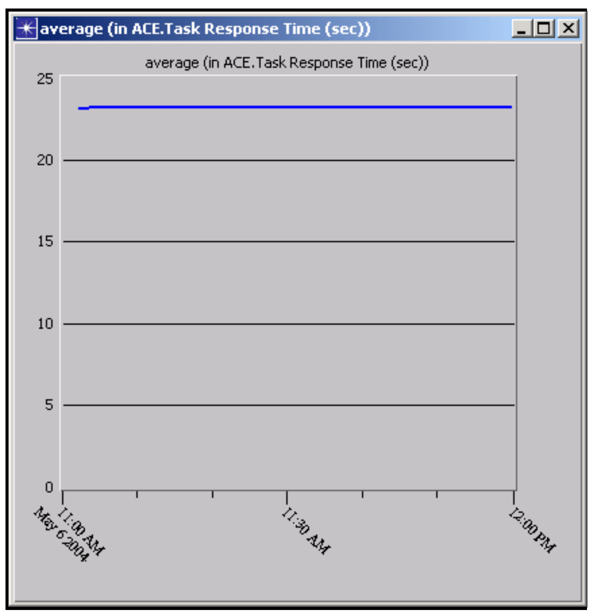


Figure 2-34 Average Task Response Time Statistics

Note—Remember that the duration of the application in the ACE editor was about 8.1 seconds. However, the application response time statistics now show that it takes about 23.2 seconds to complete the applications. Why the difference? The application trace was captured on a local network and all the tiers were part of the same LAN. In this scenario the application is deployed in a WAN and the application tiers are placed in different geographical locations (San Diego, Los Angeles, Houston). This causes addition latency in the communication between the tiers, and as a result of this the application response time increases.

4 Include pre-existing baseline traffic.

In the next scenario, we add the baseline traffic (modeled as link loads) and observe its impact on the new application.

4.1 Switch to the “app_user_and_linkloads” scenario (select **Scenario > Switch to Scenario > app_user_and_linkloads**).

This scenario already includes the application traffic we configured in the previous scenario. In addition there are background loads configured on the links that represent the pre-exiting baseline traffic (link loads can be configured manually or imported from a variety of traffic management tools).

4.2 To view an example traffic load profile, right-click on the Salt Lake City ↔ Dallas link and select **Edit Attributes**.

4.3 Click the “Background Load” attribute and select **Edit...**.

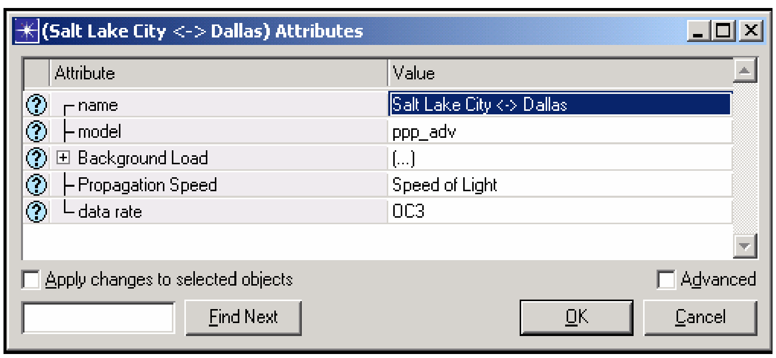


Figure 2-35 Link Attributes dialog box

4.4 Click the “Intensity (bps) [Salt Lake City → Dallas]” attribute and select **Edit...**.

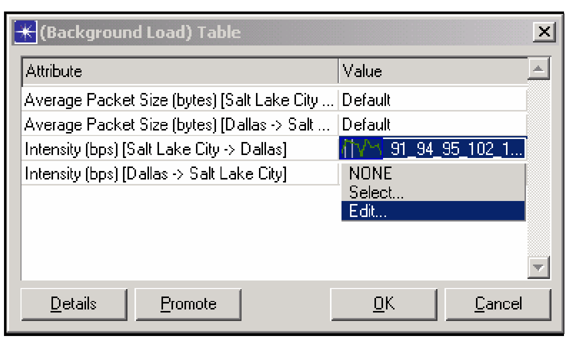


Figure 2-36 Background Load Attributes dialog box

The profile captures the WAN link traffic during business hours on May 6 (from 8am to 6pm). Note the green vertical line in the profile whose position indicates the current network time. The current network time can be configured in the Time Controller tool (invoked by **Ctrl+Alt+T**). In this scenario the current network time has been pre-configured to 11 am, so that the 1-hour simulation that we will run includes the busiest period of the workday (from 11 am to 12 pm).

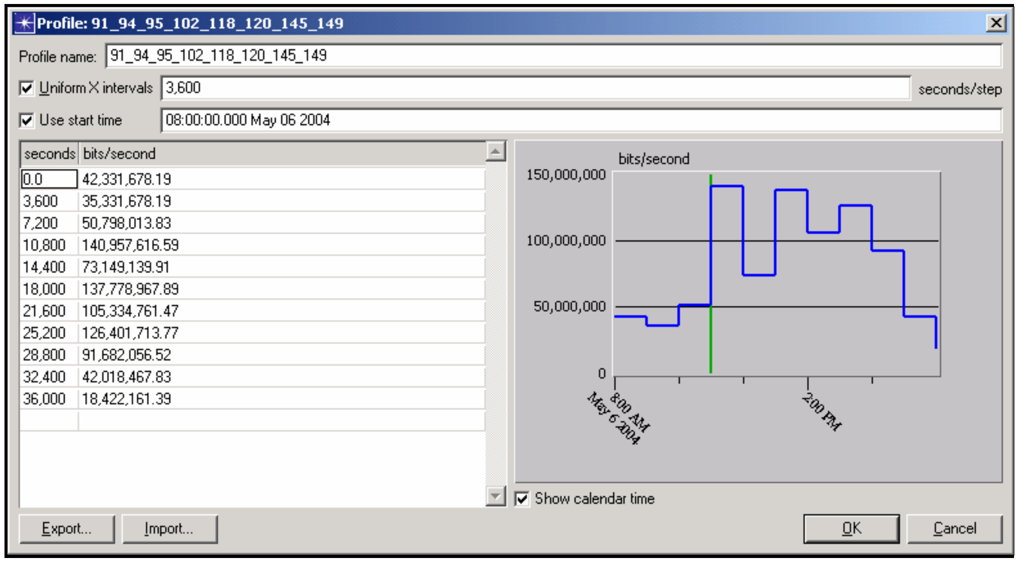


Figure 2-37 Profile dialog box

4.5 Click **Cancel** until you have closed all the Attribute dialog boxes.

5 Run the simulation and view the results.

5.1 Click the **Configure/Run Simulation** toolbar button.

5.2 Click **Run** to start the simulation.

5.3 Close the Simulation Sequence dialog box after the simulation runs.

5.4 Click **DES > Results > View Statistics**.

5.5 Expand "Global Statistics / ACE" and select the "Task Response Time (sec)" statistics.

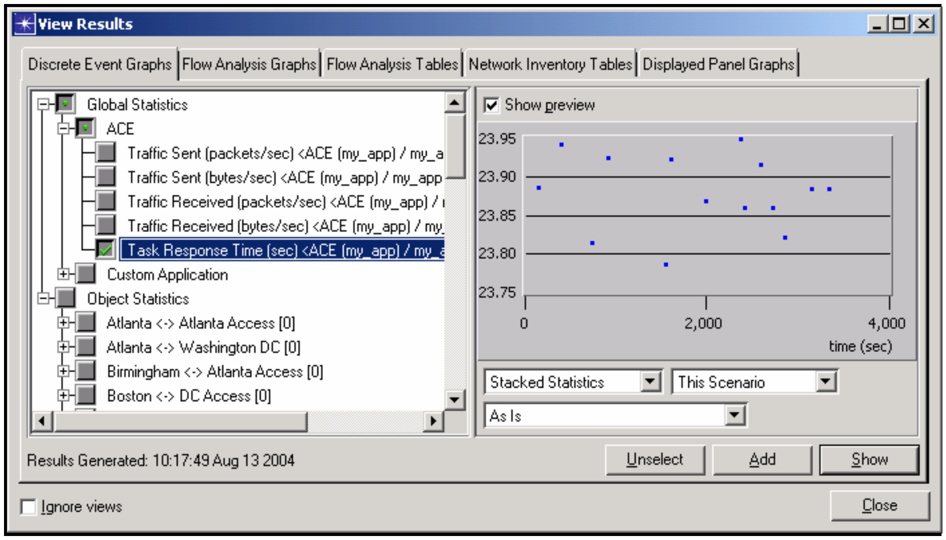


Figure 2-38 View Results dialog box

5.6 Click **Show**.

Compared to the previous scenario, as a result of including the baseline traffic load, the application response time increased by about 0.7 seconds to 23.9 seconds. The response time is still, however, well below the SLA limit (30 seconds).

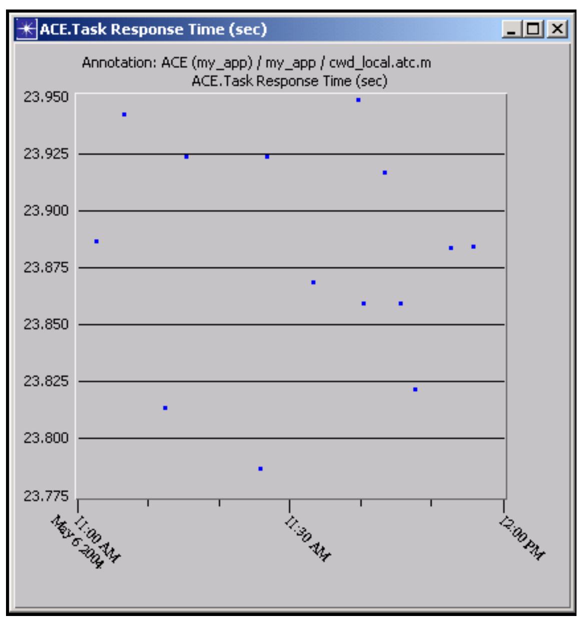


Figure 2-39 Task Response Time Statistics

Note—The above result indicates that under current traffic conditions the network has sufficient spare capacity to support one new application within the SLA limits. Will the network capacity be enough to support thousands of new users? Continue on to the next scenario.

6 Deploy additional application users modeled as traffic flows.

In the following scenario, we configure an additional 1,690 application users in the network. This time, however, the users will not be modeled using discrete traffic, but rather as background traffic flows. We could model all the new users as explicit traffic, but that might result in a long simulation time. To get a quick answer, we use mixed traffic and hybrid simulation.

6.1 Select **Scenario > Duplicate Scenario**.

6.2 Name the new scenario “add_app_users_as_flows”.

6.3 Select **Protocols > Applications > Deploy ACE Application on Existing Network > as Traffic Flows**.

6.4 In the ACE Traffic Import: Specify Tasks dialog box under “Tasks”, click on “Click here to add new task”, select the “cwd_local” trace file, and then click **Next**.

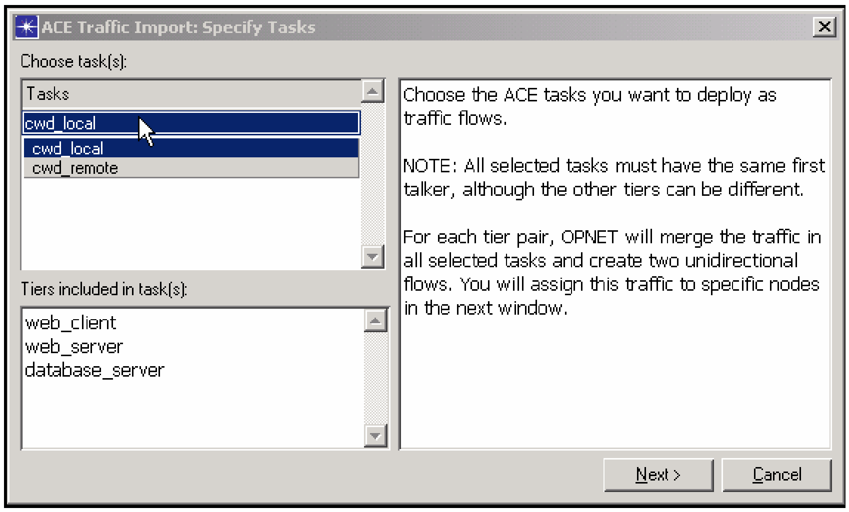


Figure 2-40 ACE Traffic Import: Specify Tasks dialog box

6.5 Assign nodes for each of the application tiers. Click on “ACE Tier web_client <initiating_tier>” to select it.

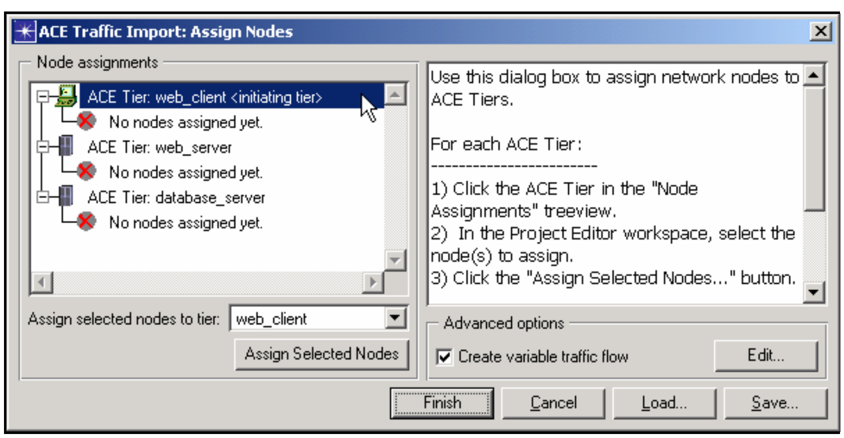


Figure 2-41 ACE Traffic Import: Assign Nodes dialog box

Next, assign all thirteen end-nodes in the network to support one hundred and thirty web_clients each (1,690 users total).

6.6 Go to the project editor, right-click on Seattle, and choose **Select Similar Nodes**.

6.7 Return to the ACE Traffic Import: Assign Nodes dialog box, and click **Assign Selected Nodes**.

6.8 In the ACE Traffic Import: Configure Initiating Node dialog box:

- Set the "Number of users" to "130".
- Set "Repetitions per user per hour" to "20".
- Check the **Apply to remaining nodes (12)** checkbox.

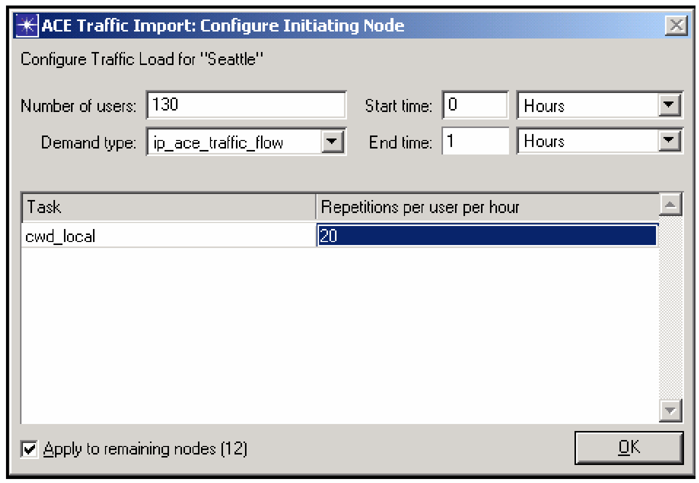


Figure 2-42 ACE Traffic Import: Configure Initiating Node dialog box

6.9 Click **OK**.

Note that the 13 selected nodes were added to the web_client list.

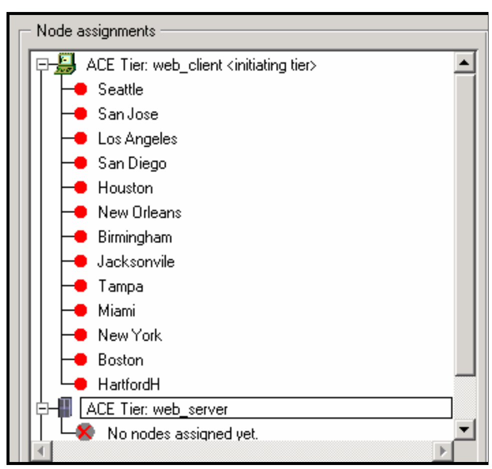


Figure 2-43 Node Assignments (web_client) List

6.10 Next we will assign five nodes to support the web_server functionality. Click on “ACE Tier web_server” to select it.

6.11 Go to the project editor. Click in the workspace to unselect the previously selected nodes. While holding the **Shift** key, click on the following five nodes to select them: Seattle, Los Angeles, Houston, Miami, New York.

6.12 Return to the ACE Traffic Import: Assign Nodes dialog box, and click **Assign Selected Nodes**.

The five nodes should now appear listed under the web_server.

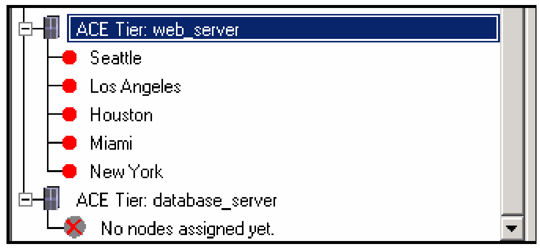


Figure 2-44 Node Assignments (web_server) List

6.13 Finally, click on the “ACE Tier database_server” to select it. Select Houston in the project editor, and click **Assign Selected Nodes**. Houston will be added to the list.

Figure 2-45 Node Assignments (database_server) List

6.14 Click **Finish**. Observe the purple traffic demands added to the network to represent the traffic generated by the new application users.

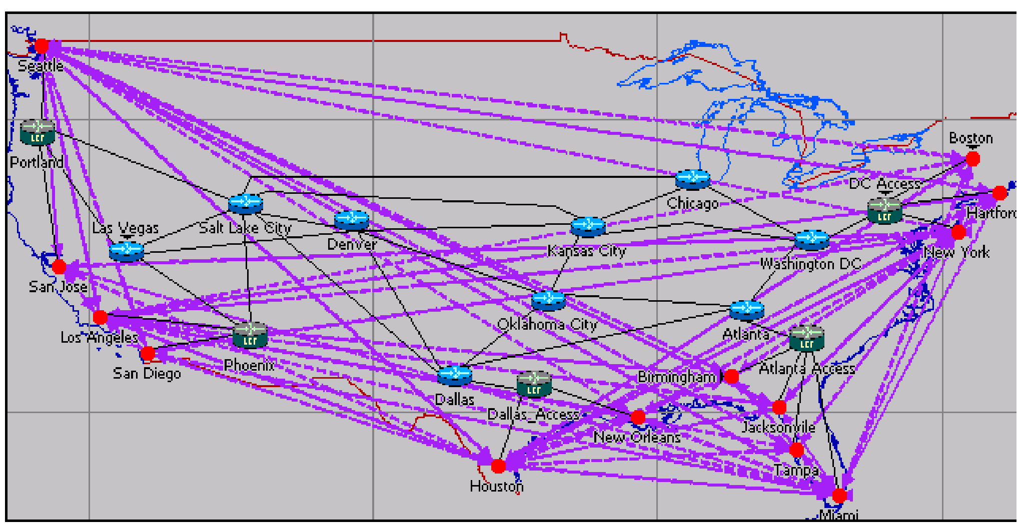


Figure 2-46 Network Traffic Demands

7 Run the simulation and view the results.

7.1 Click the **Configure/Run Simulation** toolbar button.

7.2 Click **Run** to start the simulation.

7.3 Close the Simulation Sequence dialog box after the simulation runs.

7.4 Click **DES > Results > View Statistics**.

7.5 Expand "Global Statistics / ACE" and select the "Task Response Time (sec)" statistics. Click **Show**.

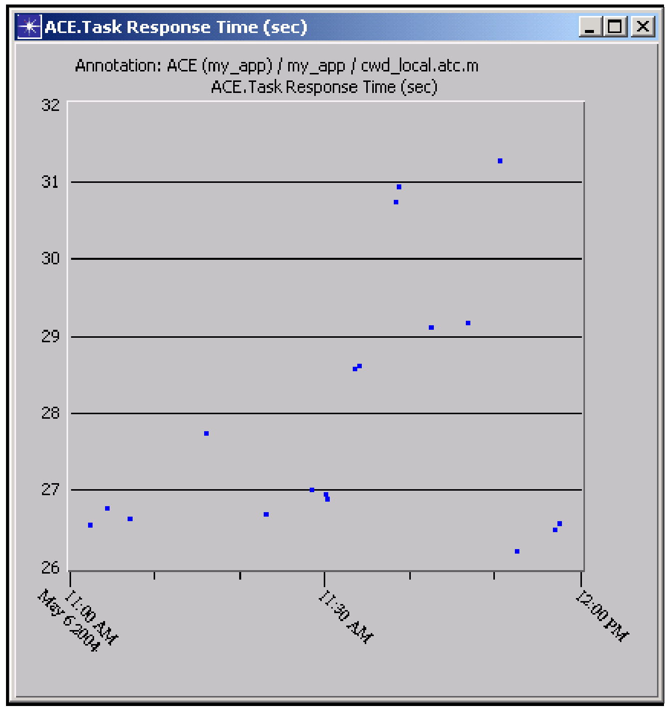


Figure 2-47 Task Response Time Statistics

Note that the application response time increased dramatically and some of the values are above the 30-second Service Level Agreement limit.

7.6 To find the reason for this increase, select **DES > Results > Find Top Statistics**. Expand the “Link Statistics / point-to-point” group and select “utilization”. Click **Find Top Statistics**.

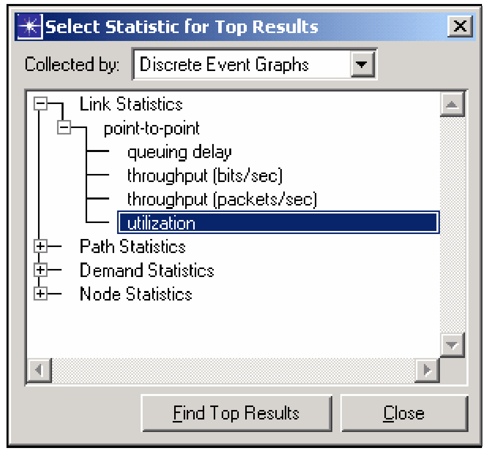


Figure 2-48 Select Statistic for Top Results dialog box

7.7 Observe that as a result of adding new ACE application users, several links in the network become over 97% utilized. The link utilization for the “Dallas Access ↔ Dallas” link reaches 99.4%.

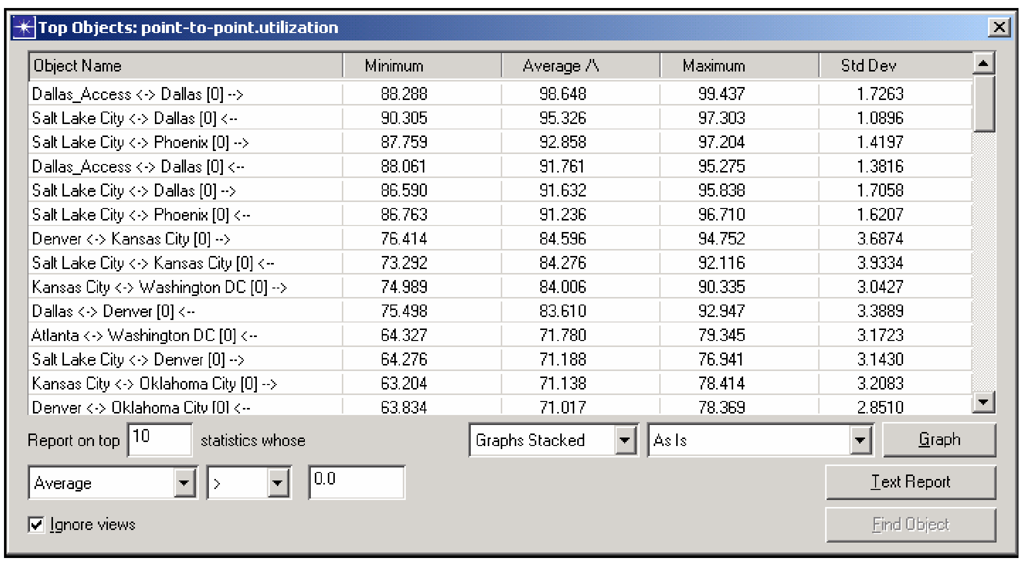


Figure 2-49 Top Objects Point-to-Point Utilization dialog box

7.8 Close the above window showing link utilizations.

7.9 Close the Select Statistic for Top Results dialog box.

The above results indicate that the current network bandwidth will not be enough to support the new application on top of the pre-existing traffic. This problem can be solved either by increasing the network capacity or applying some QoS techniques to prioritize the critical traffic. We will try out the latter approach and apply Quality of Service in the next scenario.

End of Procedure 2-4

Implementing QoS in the Network and Prioritizing Application Traffic

In the following scenario, we apply Weighted Fair Queuing (WFQ) to all the routers in the network. We will configure a high-priority Type of Service on the ACE application traffic (both discrete and flow based) and thus give it preferential treatment over the pre-existing traffic (link loads).

Procedure 2-5 Implement QoS in the Network and Prioritize Traffic

1 Choose **Scenario > Duplicate Scenario**.

2 Name the new scenario “with_qos”.

3 Apply WFQ on all the interfaces in the network.

3.1 Select **Protocols > IP > QoS > Configure QoS**.

3.2 In the QoS Configuration dialog box:

- Set the “QoS Scheme” to “WFQ (Class Based)”.
- Set the “Qos Profile” to “ToS Based”.
- Uncheck the **Visualize QoS configuration** checkbox.

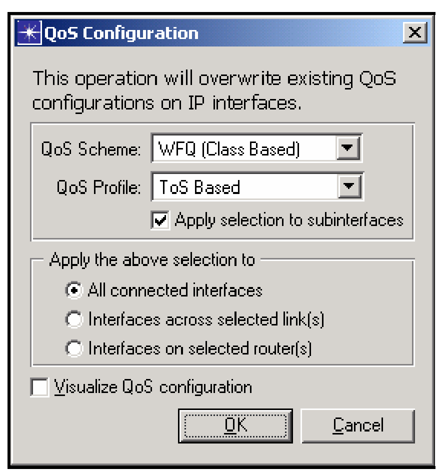


Figure 2-50 QoS Configuration dialog box

- Click **OK**.

4 Set the Type of Service on all the traffic representing the new application (i.e. both the discrete traffic and the flows) to give it a preferential treatment over the baseline traffic.

4.1 To set the Type of Service on the traffic flows, right-click on any demand in the network and choose **Select Similar Demands**.

4.2 Right-click on the same demand and select **Edit Attributes**.

4.3 Expand the “Traffic Characteristics” attribute group by clicking on the (+) sign next to it. Set the “Type of Service” attribute to “Interactive Multimedia (5)”.

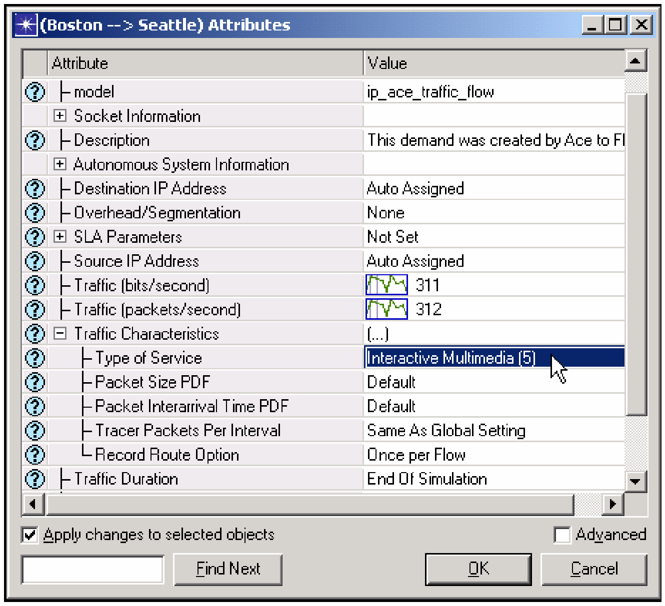


Figure 2-51 Attributes dialog box

4.4 Check the **Apply changes to selected objects** check box, and click **OK**.

5 Change the Type of Service on the discrete application traffic.

5.1 Right-click on the “Applic Config” utility node and select **Edit Attributes**.

5.2 Click on the “Application Definitions” value and select **Edit**.

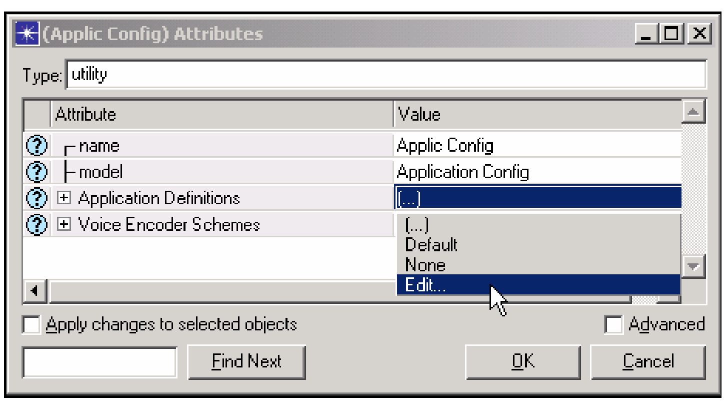


Figure 2-52 Applic Config Attributes dialog box

5.3 Edit the Description for “my_app”.

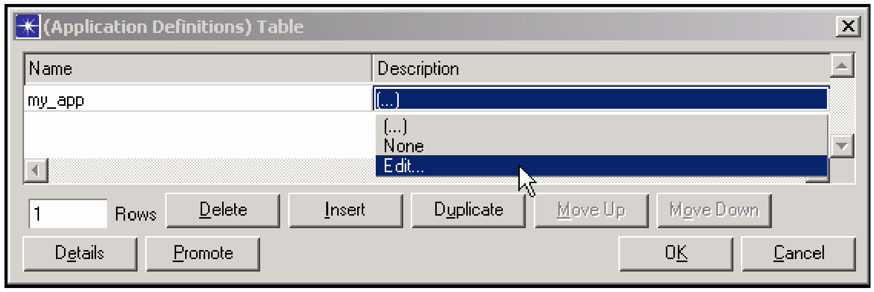


Figure 2-53 Application Definitions Table

5.4 Edit the Value for “Custom”.

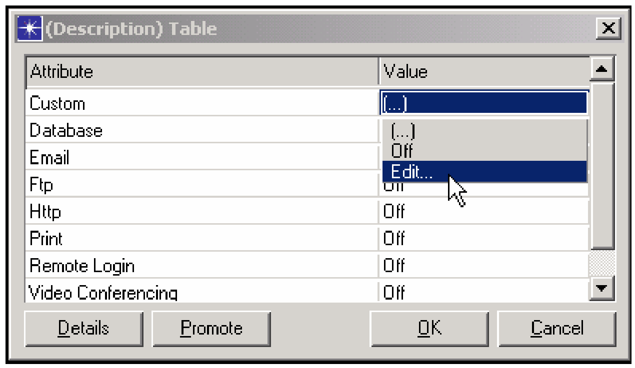


Figure 2-54 Descriptions Table

6 Change the “Type of Service” attribute to “Interactive Multimedia (5)”.

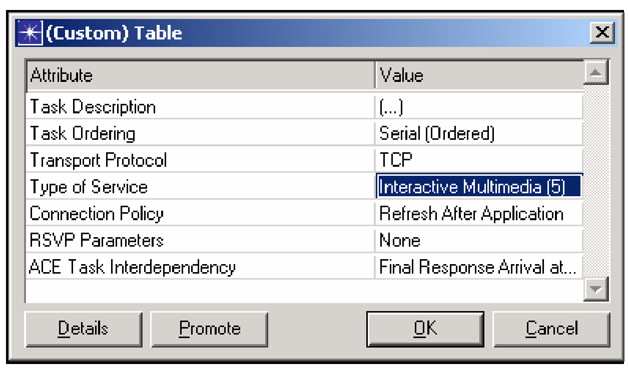


Figure 2-55 Custom Table

6.1 Click **OK** as often as needed to close all the open dialog boxes.

7 Run the simulation and view the results.

7.1 Click the **Configure/Run Simulation** toolbar button.

7.2 Click **Run** to start the simulation.

7.3 Close the Simulation Sequence dialog box after the simulation runs.

7.4 Click **DES > Results > View Statistics**.

7.5 Expand “Global Statistics / ACE” and select the “Task Response Time (sec)” statistics. Click **Show**.

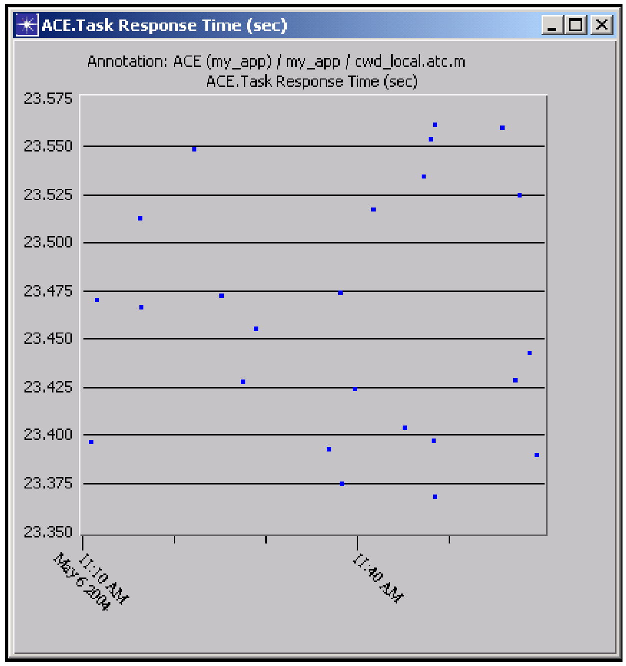


Figure 2-56 Task Response Time Statistic

We can see that applying QoS and prioritizing the new application helped achieve the goal. The application response time is about 23.5 seconds, which is below the 30-second SLA limit.

End of Procedure 2-5

3 Importing IP and Layer 2 Networks with MVI

Introduction

The Multi-Vendor Import (MVI) module gives you a practical way to import topology and traffic data from the production network environment. The Device Configuration Import (DCI) feature of the MVI module lets you automatically create high-fidelity network models by importing router and switch configuration data.

This chapter shows you how to use the DCI features to import from switch, router, and security appliance configuration files. DCI's current platform support includes Cisco IOS, Cisco CatOS, Cisco PIX, and Juniper JunOS devices.

Note—The following examples were presented at OPNETWORK 2004 in Session 1617, Importing IP and Layer 2 Networks with MVI. If you do not have access to the files that these procedures use, you can still follow along using the sample screens provided in this user's guide.

Import an Example Network

A set of router configuration files is provided for an enterprise scale network. In this example, we will import the device configuration files to create a network model and explore it using available visualization features.

Procedure 3-1 Import Device Configuration Files

1 Launch NETWARS, if not already opened.

2 From the System Editor's **File** menu, choose **Open Editor**.

3 From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.

4 Create a new project.

4.1 Choose **File > New Project**, and click **OK**.

4.2 Name the project *Session_1617.*

4.3 Name the phase *Lab_1,* and click **OK**.

4.4 Choose **Topology > Import> Device Configuration Files...** The Import Device Configurations dialog box opens.

5 Specify folders for device configuration files [we will look into in detail on vendor types later in the procedure].

5.1 Select the checkbox for **Cisco (IOS, CatOS, PIX)**.

5.2 Click the **Browse** button for Cisco (IOS, CatOS, PIX), and select the folder:

```
C:\Netwars\User_Data\Projects\Session_1617\Lab_1\Cisco
```

5.3 Select the checkbox for **Juniper (JunOS)**.

5.4 Click the **Browse** button for Juniper (JunOS) and select the folder:

```
C:\Netwars\User_Data\Projects\Session_1617\Lab_1\Juniper
```

5.5 Specify import options [we will look into in detail on import options later in the procedure].

5.6 Select the checkbox for **Generate import log**.

5.7 Select the checkbox for **Create PVCs**.

5.8 Leave other options unchecked.

6 Import.

6.1 Make sure your settings are as shown below:

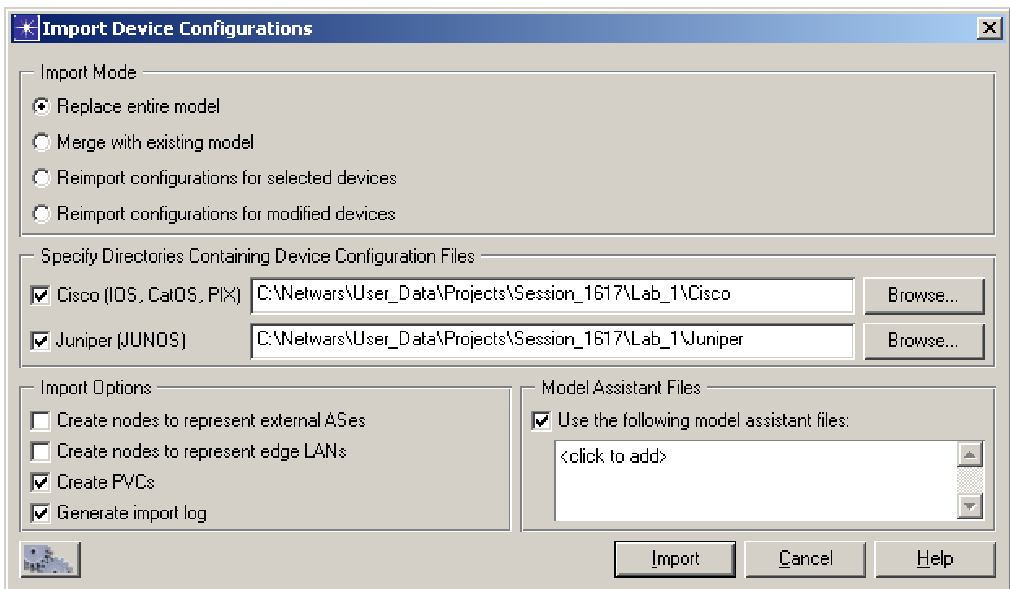


Figure 3-1 Import Device Configurations dialog box

6.2 Click **Import**.

7 The Open Import Assistant dialog box displays. It reports that the network has unnumbered interfaces and connected interfaces with data rates unspecified. For now, click **Cancel** to close the dialog box; you will come back to this in a later procedure.

8 Save the project.

8.1 Choose **File > Save Project**.

The imported network should look as follows:

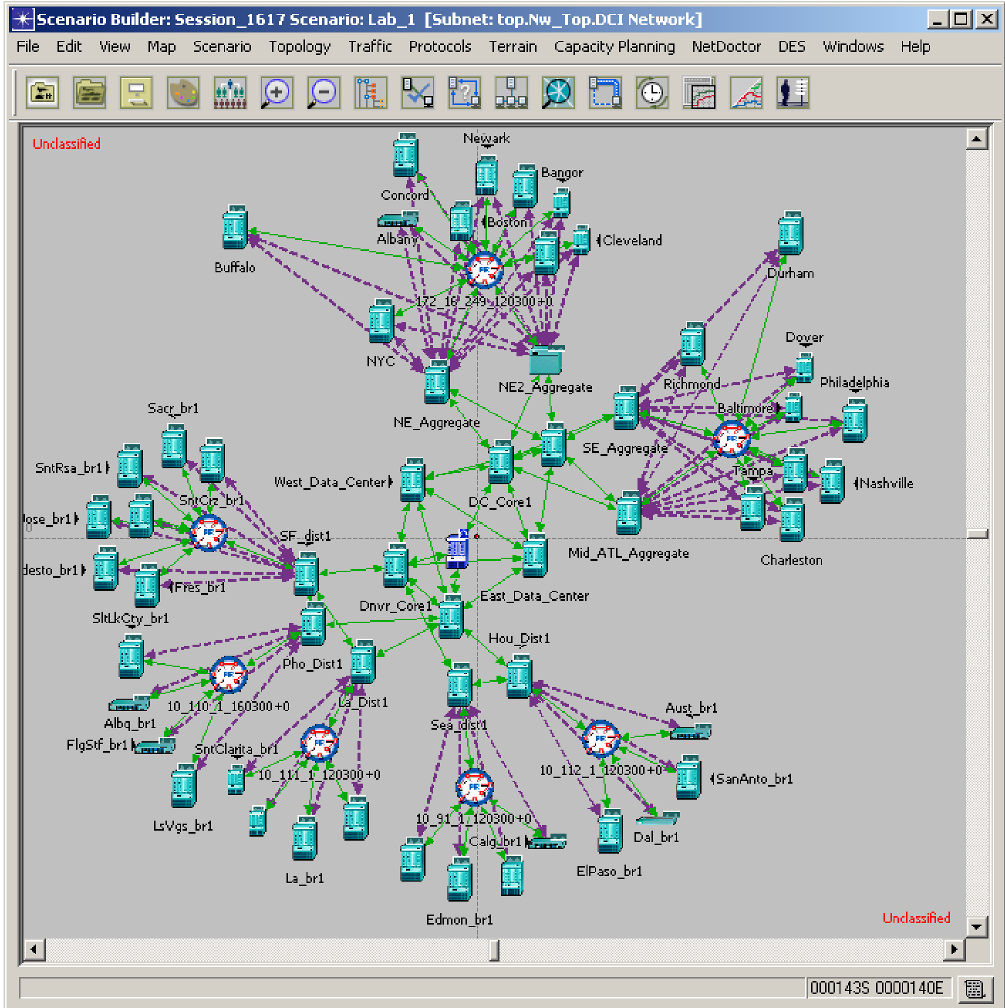


Figure 3-2 Sample Network

The import process is now complete.

End of Procedure 3-1

Exploring the OPNET Network Model

In this section you will explore different parts of the imported network model using built-in visualization tools.

Procedure 3-2 Explore the OPNET Network Model

1 Zoom to the core of the network in the network editor by:

1.1 Clicking the **Zoom In** toolbar button.

1.2 Drag the cursor to create a box around the area of interest.

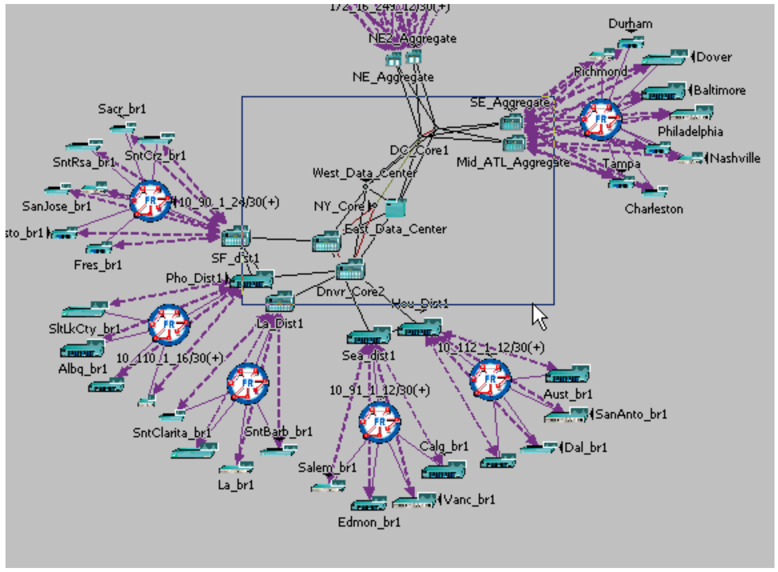


Figure 3-3 Zoom In

Note—If you want to zoom to another area, you can come back to the original view by clicking the **Zoom Out** toolbar button.

2 Observe that the different types of links are shown in different colors.

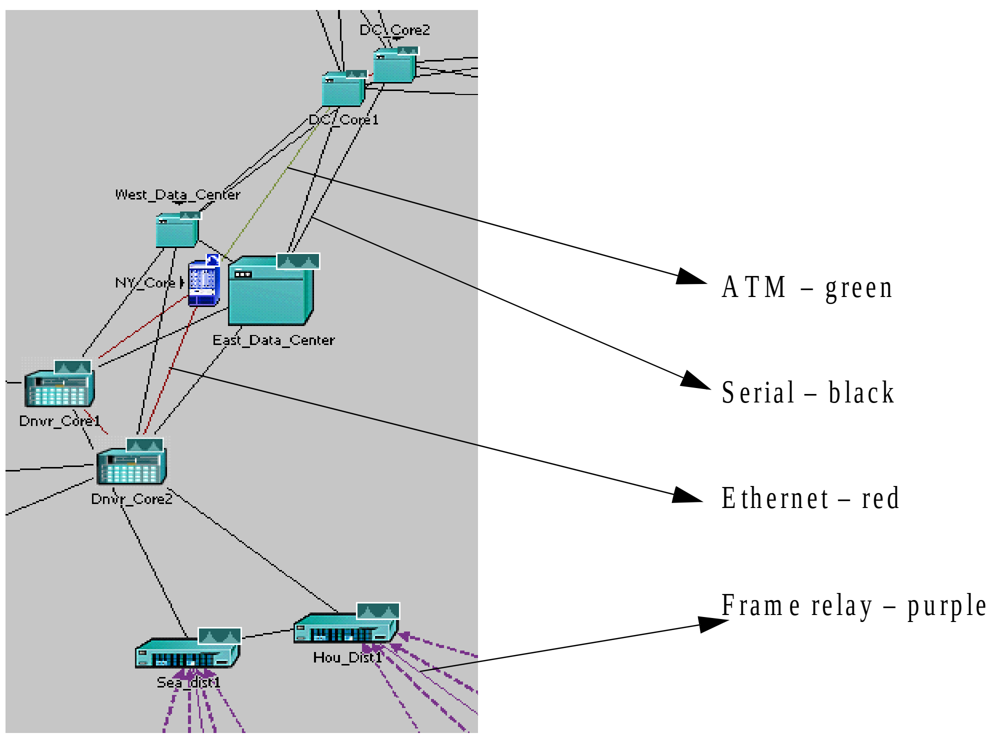


Figure 3-4 Link Types in Color

PVCs are shown using dashed lines in the same color as the corresponding link types.

3 Hide all logical connections. Right-click on a demand object, and select **Hide Similar Demands**.

4 Click the **Zoom Out** button to go back to the top-level view, and choose **View > Show Network Browser** (**Ctrl + B**).

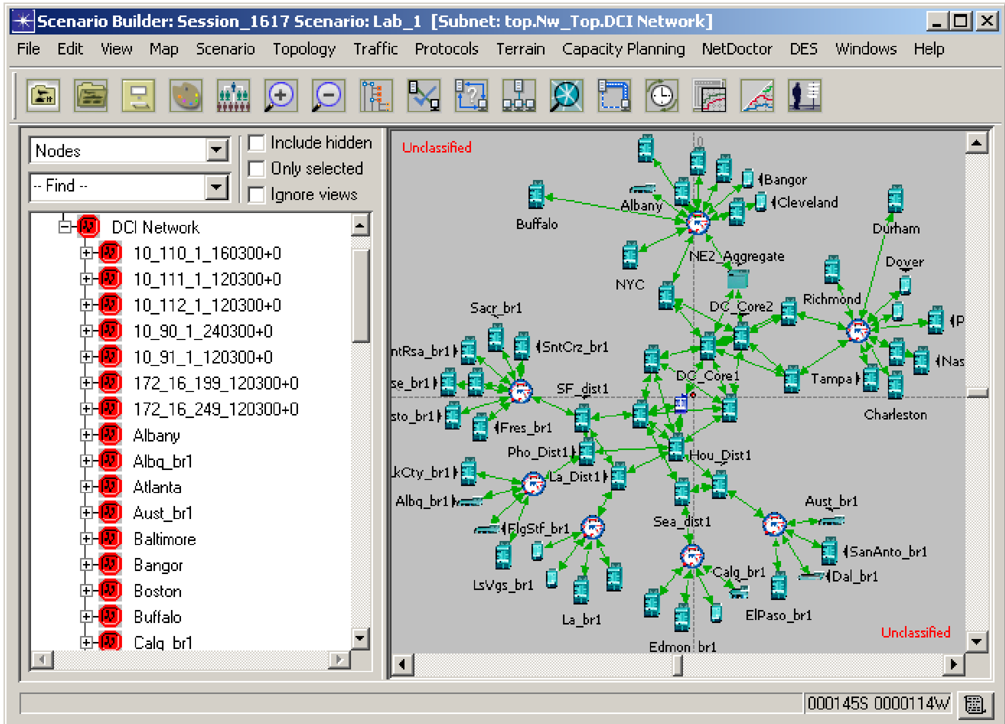


Figure 3-5 Network Browser

5 View link tool tip:

5.1 In the network browser, choose **Links** from the top drop-down list. The network browser shows the list of links in the network ordered alphabetically.

5.2 In the browser, choose the link *Albany / Serial0/0 <-> 172_16_249_12/30(+)* .

5.3 The link between *Albany* and the FR cloud gets selected in the project editor. Point your mouse at this link for a few seconds.

5.4 If you can't find the link in the network, double-click on it for the editor to auto-zoom to that part of the network.

Link tool tip displays link type; node, interface, and IP address; and data rate.

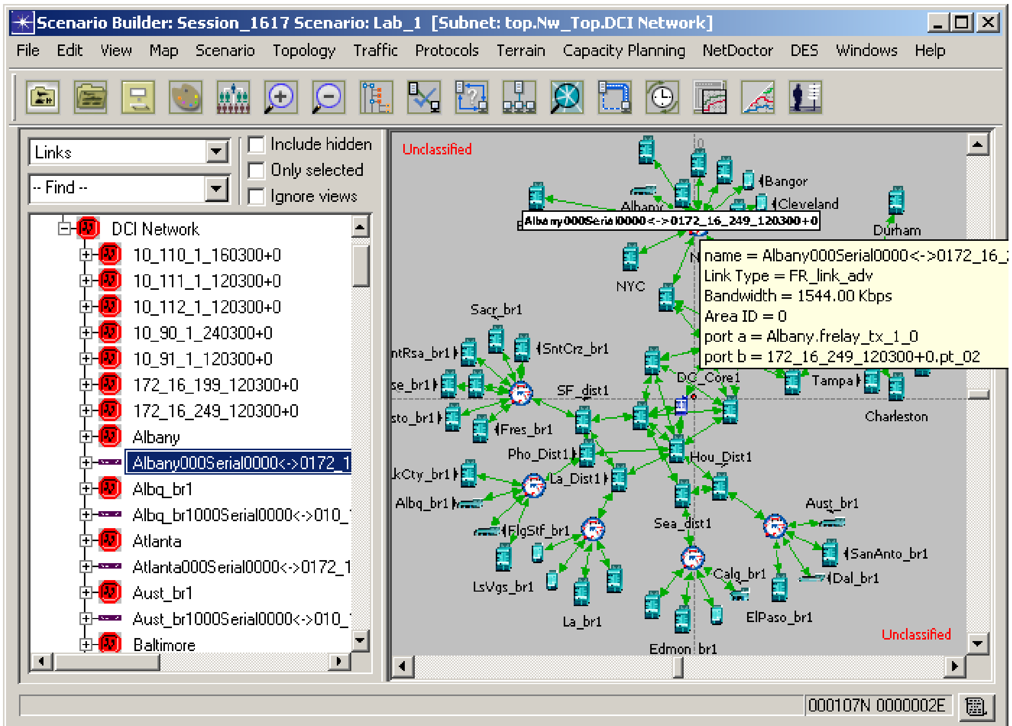


Figure 3-6 Link Tool Tip

6 In the network browser, change back to **Nodes** from the top drop-down list; Select the router *Albany,* observe that the node is selected on the network browser at the top left corner of the network.

7 Choose **View > Show Network Browser** again to close the network browser.

8 View command mappings for interface *FastEthernet0/0.*

9 Right-click on router *Albany,* and select **Edit Attributes**.

10 Expand the attribute group **IP.**

11 Go to the **Interface Information** attribute under **IP Routing Parameters**. Each physical interface of the router is mapped to a single row under this attribute.

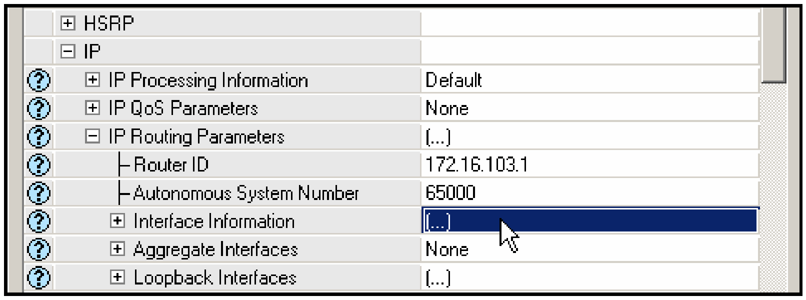


Figure 3-7 Attributes dialog box

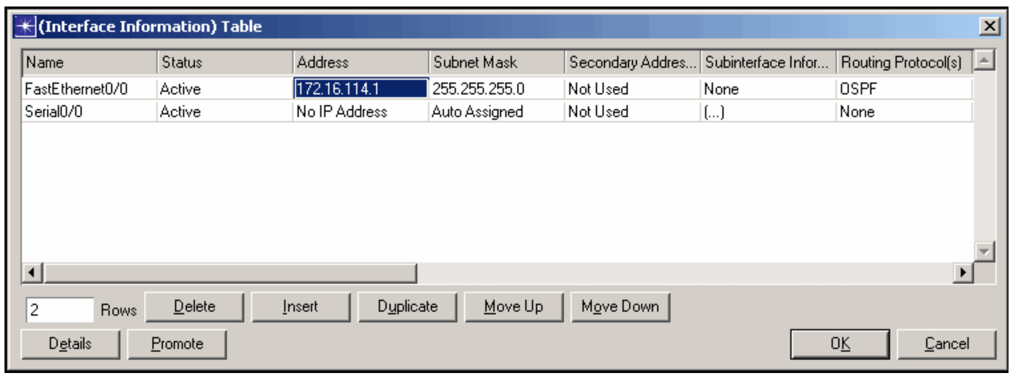


Figure 3-8 Interface Information Attribute

12 Observe the values set on the attributes **IP Address** and **Subnet Mask** for interface *FastEthernet0/0*. They are 172.16.114.1 and 255.255.255.0 respectively. These are the same values as you noticed before in the configuration file.

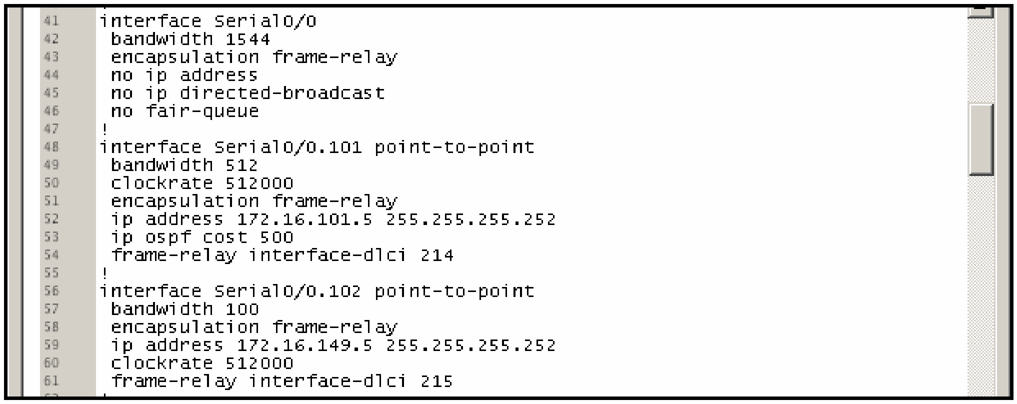
13 Click **Cancel** to close the dialog box that shows interface information.

14 Click **Cancel** to close the dialog box that shows attributes for node *Albany.*

15 View subinterface information.

16 Right-click on router *Albany* again, and select **View Device Configuration Source Data**.

17 Scroll down to see the subinterfaces configured for the device.



```
41 interface Serial0/0
42  bandwidth 1544
43  encapsulation frame-relay
44  no ip address
45  no ip directed-broadcast
46  no fair-queue
47 !
48 interface Serial0/0.101 point-to-point
49  bandwidth 512
50  clockrate 512000
51  encapsulation frame-relay
52  ip address 172.16.101.5 255.255.255.252
53  ip ospf cost 500
54  frame-relay interface-dlci 214
55 !
56 interface Serial0/0.102 point-to-point
57  bandwidth 100
58  encapsulation frame-relay
59  ip address 172.16.149.5 255.255.255.252
60  clockrate 512000
61  frame-relay interface-dlci 215
```

Figure 3-9 Device Subinterfaces

18 Interface *Serial0/0* has subinterfaces *Serial0/0.101, Serial0/0.102.* Notice on line 53 that *Serial0/0.101* has an OSPF cost set to 500.

19 Close the window that shows the configuration file.

20 Right-click on router *Albany* and select **Edit Attributes**.

21 Expand the attribute group **IP Routing Protocols.**

22 Go to the **Interface Information** attribute under **OSPF Parameters**.

23 Choose **Subinterface Information** for interface *Serial0/0*. Each subinterface of the physical interface is mapped to a single row under **OSPF Parameters > Interface Information > Subinterface Information.**

24 You can notice subinterfaces *Serial0/0.101, Serial0/0.102*, etc., configured here. Note that the *Cost* field of interface *Serial0/0.101* is set to 500, as noted in the configuration file.

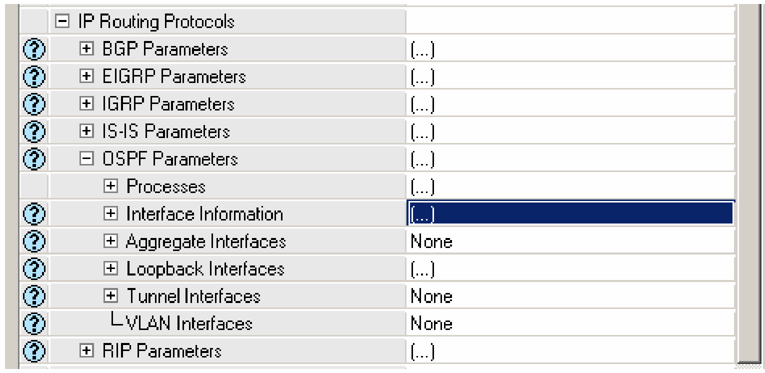


Figure 3-10 Attributes dialog box

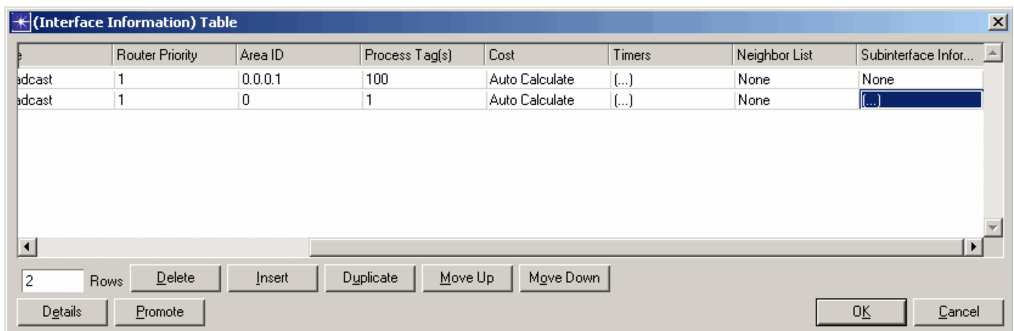


Figure 3-11 Interface Information Attribute

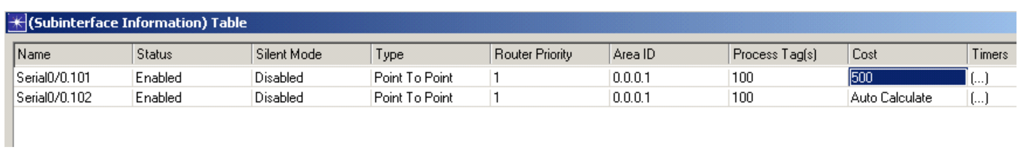


Figure 3-12 Subinterface Information Attribute

25 Click **Cancel** to close the dialog box that shows subinterface information.

26 Click **Cancel** to close the dialog box that shows interface information.

27 Click **Cancel** to close the dialog box that shows attributes for node *Albany.*

End of Procedure 3-2

Procedure 3-3 View Skipped Commands

1 View log messages:

1.1 Right-click on router *Albany* and select **View Detailed Import Log**. The following dialog box displays.

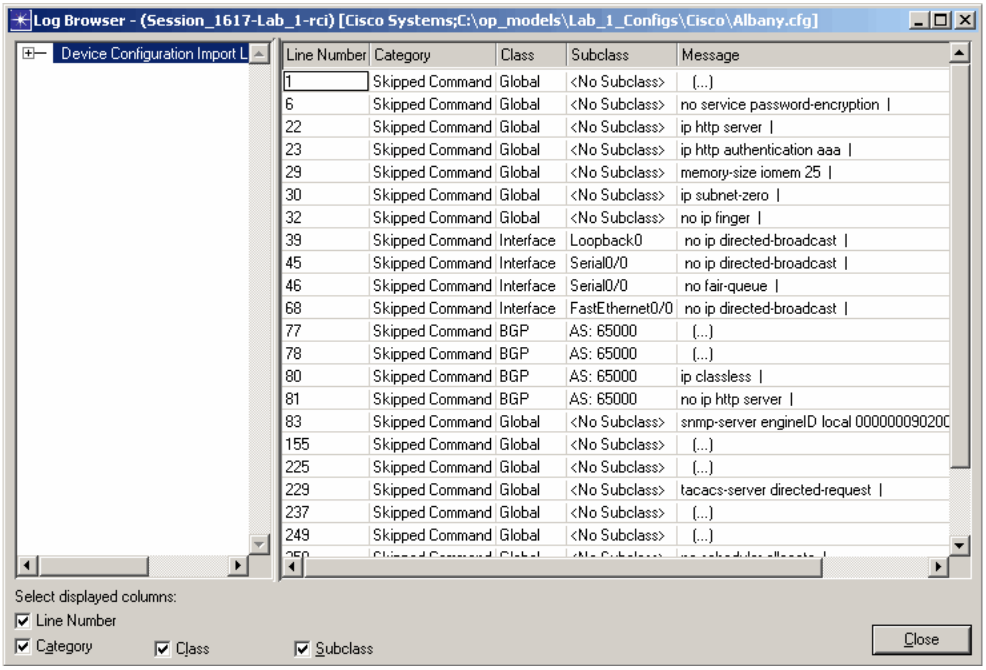


Figure 3-13 Log Browser Showing Skipped Commands for Albany

Skipped commands are shown according to their class and subclass.

1.2 Expand the tree-view in the left to see the various categories of skipped commands.

1.3 Choose subclass *FastEthernet0/0,* under *Interface* class in the tree-view to view the skipped commands for this particular interface. These are commands that are currently not supported by DCI.

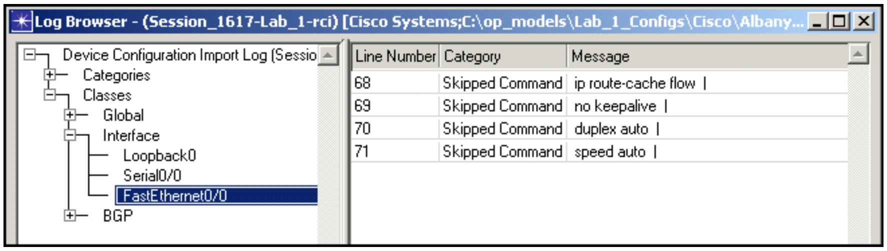


Figure 3-14 Log Browser Showing Skipped Commands for FastEthernet0/0

1.4 Click **Close** to close the dialog box that shows log messages.

End of Procedure 3-3

Procedure 3-4 Visualize the Network Model

1 Choose **View > Visualize Protocol Configuration > IP Routing Domains** (**Ctrl+Shift+V**) to visualize the routing domains in the network. The network's routing domains display as follows.

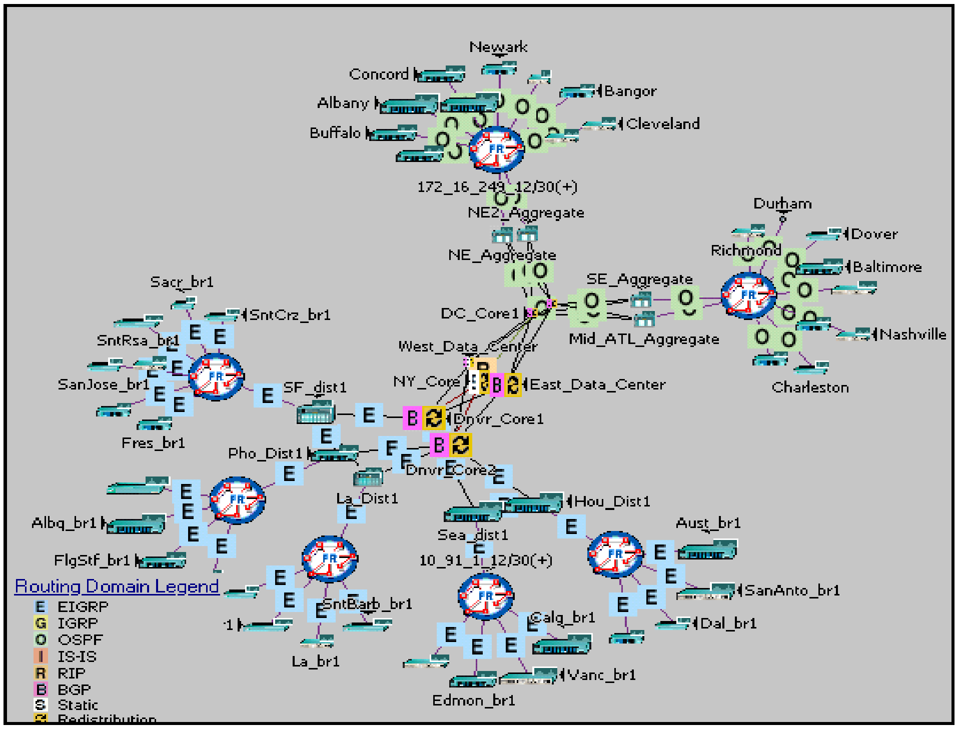


Figure 3-15 Sample Network's Routing Domains

2 Scale the icons in the network.

2.1 Choose **View > Visualize Protocol Configuration > Clear Visualization** to clear routing domain visualization.

2.2 Left-click in an empty space in the project editor to deselect all objects.

2.3 Choose **View > Layout > Scale Selected Icons**.

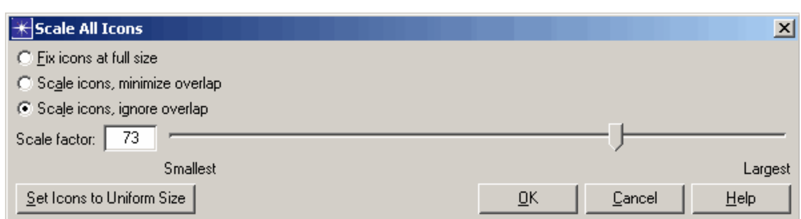


Figure 3-16 Scale All Icons dialog box

2.4 Set **Scale factor** value to 25.

Notice, the icons become smaller; in many cases where you have a very large topology, scaling can help to get a better view of the network and its topology.

2.5 Click **Cancel** to close the Scale All Icons dialog box.

3 Choose **File > Save Project** to save the project.

End of Procedure 3-4

Conclusions

The Multi Vendor Import module (MVI) allows you to import network topology using device configuration files. Using the “Import Logging” feature, you can view the commands that the Device Configuration Import (DCI) does not use during the import.

The network browser is useful for navigating through the network. NETWARS provides several visualization features that make it easy to understand the network topology and configuration.

Importing from device configuration files provides the ability to build a network model, however all the relevant info is not contained in the configuration files. In the following procedure, you will learn how to provide supplemental information to deal with these inadequacies.

Using the Model Assistant

The device configuration files obtained from a network may not always contain all of the necessary information to model the network accurately. In this section, we will import a new set of configuration files with missing information and see how we can provide additional information during and after the import process using the Model Assistant.

Procedure 3-5 Import the Configuration Files

1 Launch NETWARS, if not already opened.

2 From the System Editor’s **File** menu, choose **Open Editor**.

3 From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.

4 Select **File > Open Project**. The Open Project dialog box displays.

5 In the Open Project dialog box, select the project file named `Session_1617`, and then click **Open**.

Note—If you do not have access to this file, simply view the screens provided in this user’s guide to follow along with the procedure.

6 Create a new scenario: Choose **Scenario > New Scenario**, name the scenario *Lab_2*, and click **OK**.

7 Choose **Topology > Import> Device Configuration Files...** The Import Device Configurations dialog box opens.

8 Specify import settings:

Note—The Import Device Configurations dialog box retains its settings from the previous import; the following steps will direct you based on the retained settings in the dialog box from the previous procedures in this chapter.

8.1 Keep the checkbox for **Cisco (IOS, CatOS, PIX)** checked.

8.2 Click the **Browse** button for Cisco Router IOS and select the folder:

C:\Netwars\User_Data\Projects\Session_1617\Lab_2\Cisco_Routers

8.3 Keep the checkbox for **Juniper (JunOS)** checked.

8.4 Click the **Browse** button for Juniper JunOS and select the folder:

C:\Netwars\User_Data\Projects\Session_1617\Lab_2\Juniper_Routers

8.5 Toggle off the import option **Generate Import Log**.

8.6 Keep the **Create PVCs** option checked.

8.7 Check that the dialog box appears as follows:

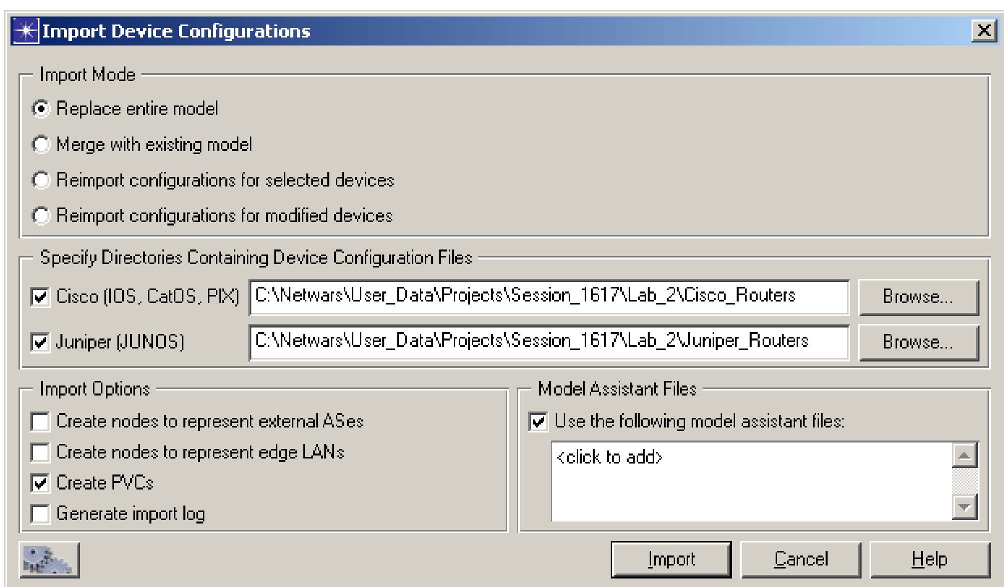


Figure 3-17 Import Device Configurations dialog box

9 Import:

9.1 Click the **Import** button.

9.2 After import of the network model, the following dialog box displays:

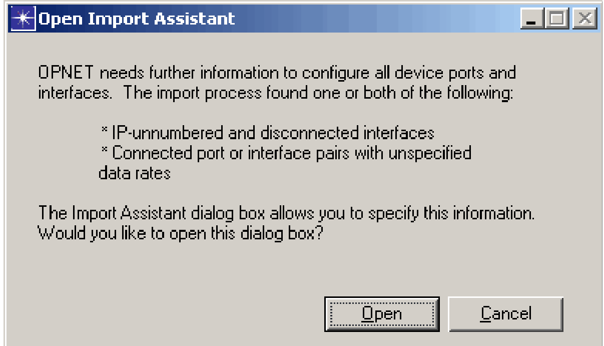


Figure 3-18 Open Import Assistant

The Open Import Assistant dialog box displays automatically when the import process detects that all of the necessary information cannot be found within the device configuration files. The Import Assistant requests, but does not require, that you provide supplemental information.

9.3 Click **Open**. The following dialog box displays:

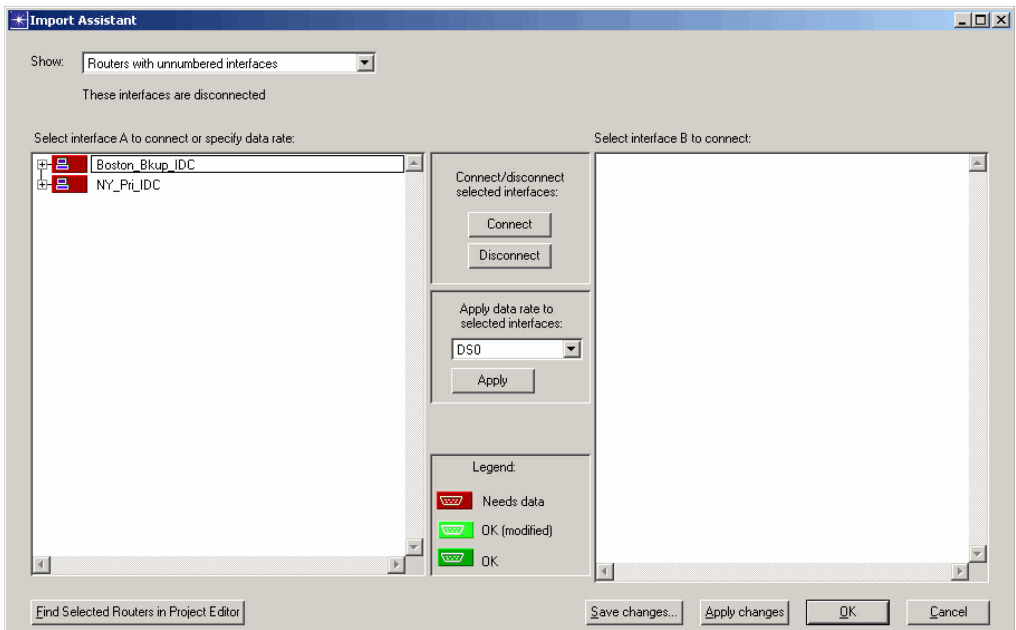


Figure 3-19 Import Assistant dialog box

End of Procedure 3-5

Procedure 3-6 Use Import Assistant to Connect Interfaces and Specify Data Rates

1 Connect unnumbered interfaces.

1.1 Make sure that the **Show** pull-down menu is set to **Routers with unnumbered interfaces.**

1.2 In the interface A pane, click on the (+) sign next to the router icon for **Boston_Bkup_IDC** to expand the view of the router to include its name and interfaces.

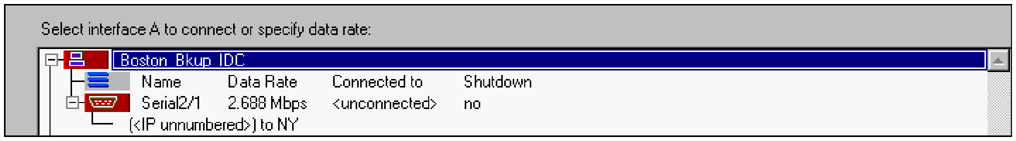


Figure 3-20 Unnumbered Interfaces

Note that the interface description appears and reads “to NY”. The interface description is populated in the table to provide extra information useful in connecting unnumbered interfaces.

1.3 In the interface A pane, select the unnumbered interface, **Serial2/1** of **Boston_Bkup_IDC**; in the interface B pane, an entry appears for **NY_Pri_IDC.**

1.4 In the interface B pane, expand the view of router **NY_Pri_IDC** and select interface **Serial2/2**.

1.5 Click **Connect**.

The two interfaces are connected as the interface disappears from the right pane; the icons in the interface A pane change from red (Needs data) to light green (OK, modified).

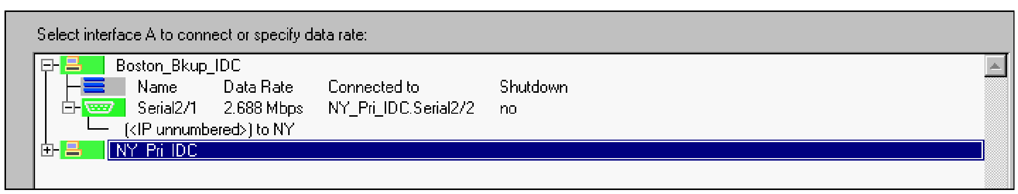


Figure 3-21 Modified Interfaces

2 Specify unknown data rates.

2.1 Set the **Show** pull-down menu to **All devices.** The following dialog box appears showing all devices in the network model:

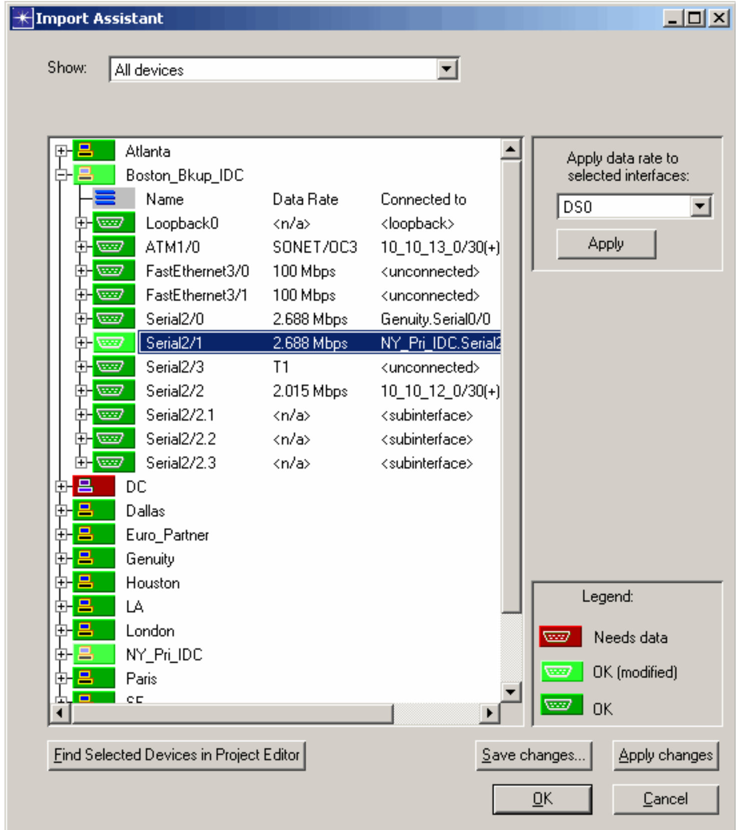


Figure 3-22 Import Assistant Showing All Devices

Notice that most devices are green (OK), the connected unnumbered interfaces are light green (OK, modified), and only the device named **DC** is red (Needs data).

2.2 Set the **Show** pull-down menu to **Devices with unspecified interface data rates.**

2.3 In the window, click on the (+) sign next to the router icon for DC to expand the view of the router to include its name and interfaces.

2.4 Select interface *at-0/1/0* .

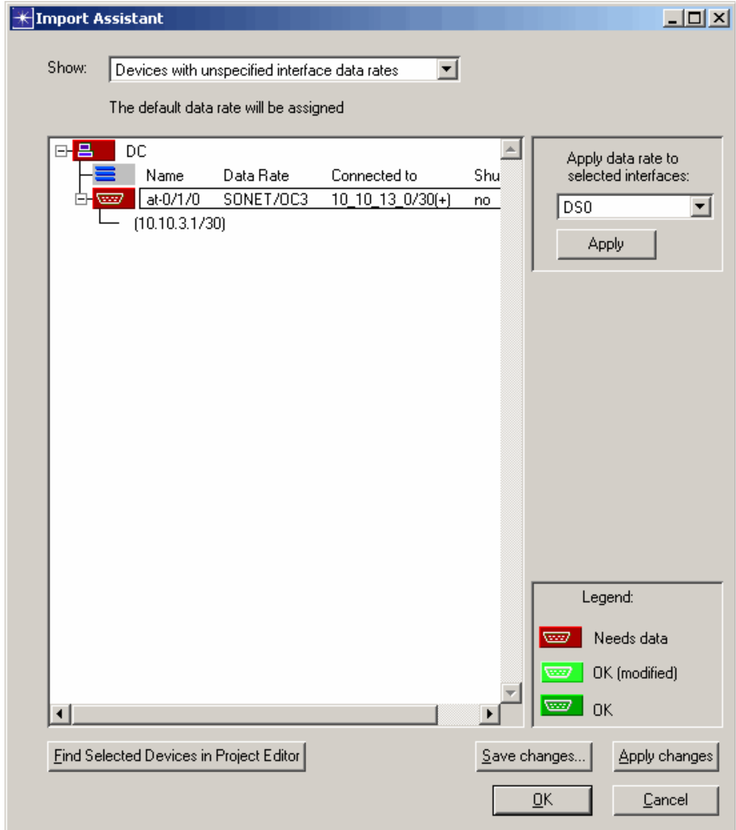


Figure 3-23 Import Assistant with *at-0/1/0* Selected

Note that the default data rate for the ATM interface is specified as SONET/OC3. If no supplemental information is provided, ATM interfaces default to SONET/OC3 data rates.

2.5 Choose the data rate **SONET/OC1** from the **Data Rate** pull-down menu, and click **Apply**; the icons change from red (Needs data) to green (OK, modified).

3 Save changes to Model Assistant file.

3.1 Click **Save changes...**

3.2 Specify the filename to be *session1617_links_and_data_rates*, and click **OK**.

3.3 Click **OK** in the Import Assistant dialog box to apply the changes to the network model.

4 **Import Summary (Concise)** displays. Click **Close**. We will come back to this in a later procedure.

5 Choose **File > Save Project** to save project.

End of Procedure 3-6

Procedure 3-7 Apply Model Assistant File to Move Nodes from Logical to Geographic Positions

The network model created has nodes placed in logical locations (non-geographic) – i.e., nodes “London”, “LA” etc., appear next to each other instead of being placed in correct geographic location (as indicated by their names).

1 Duplicate the scenario:

1.1 Choose **Scenario > Duplicate Scenario**.

1.2 Name the new scenario *Lab_2b*, and click **OK**.

2 To position them geographically:

2.1 Choose **Topology > Model Assistant > Apply File…**

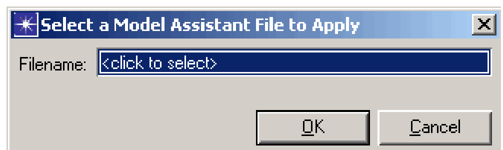


Figure 3-24 Select a Model Assistant File to Apply dialog box

2.2 Click **<click to select>** and choose ***session1617_geographic_locations*** from the popup list.

2.3 Click **OK**.

3 View the network model.

4 Choose **File > Save Project** to save project.

End of Procedure 3-7

Procedure 3-8 Export Site Locations and Hierarchy for Re-use in Future Imports

1 Export hierarchy and location information to Model Assistant file:

1.1 Choose **Topology > Model Assistant > Save Current Topology to File**.

1.2 Choose to export **Locations (X/Y coordinates)**, **Threshold (displayed icon size)**, and **Subnet hierarchy**.

1.3 Verify that the dialog box reads as below, and click **Save**.

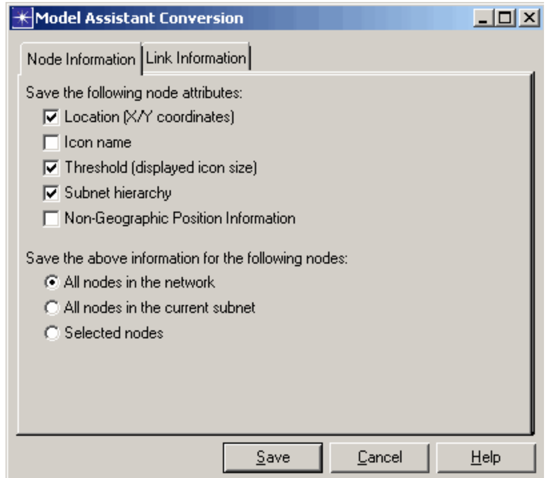


Figure 3-25 Model Assistant Conversion dialog box

1.4 Leave the name of the MA file to *Session_1617-Lab2b-ma_export,* and click **Save**.

2 Re-import using Model Assistant file.

2.1 Choose **Topology > Import > Device Configuration files...**

- Under **Model Assistant Files**, click on **<click to add>** and choose *session1617_links_and_data_rates.*
- Again click on **<click to add>** and choose *Session_1617-Lab_2b-ma_export.*

2.2 Check that the dialog box appears as follows:

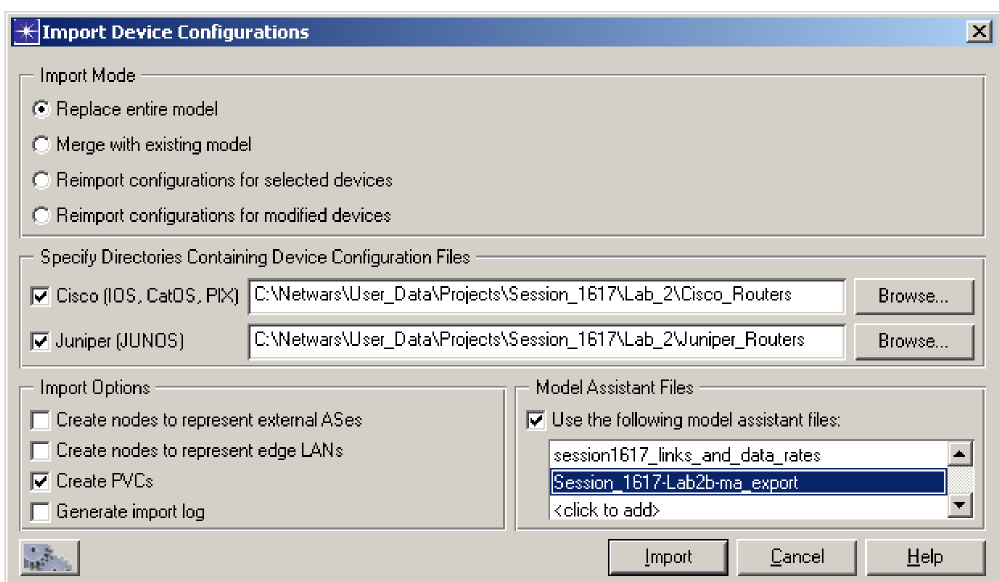


Figure 3-26 Import Device Configuration dialog box

2.3 Click **Import**, and notice that no additional information was requested.

2.4 Click **Close** in the Import Summary (Concise) dialog box.

2.5 Choose **File > Save Project** to save the project.

End of Procedure 3-8

Apply the Model Assistant File after the Import

The geographical layout is only one method of viewing the network model. The network can also be viewed in a logical layout.

Procedure 3-9 Apply the Model Assistant File after the Import

1 Choose **Scenario > Switch to Scenario**, and choose scenario *Lab_2*.

2 Choose **Topology > Model Assistant > Apply File ...**

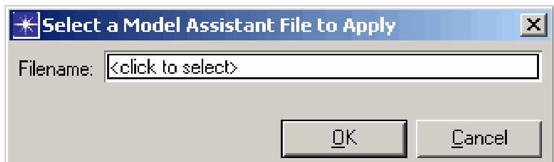


Figure 3-27 Select a Model Assistant File to Apply dialog box

3 Click **<click to select>** and choose *session1617_logical_locations* from the popup list.

4 Click **OK**.

5 Choose **File > Save Project**.

The network now looks as follows:

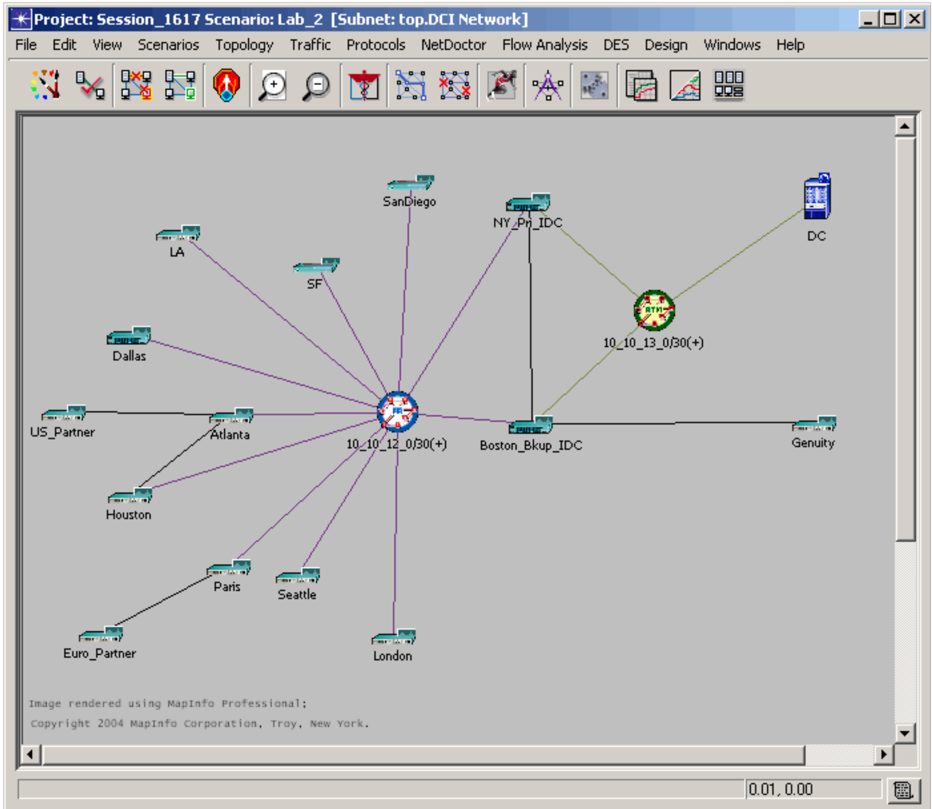


Figure 3-28 Sample Network

Conclusions

The import process sometimes requires supplemental information such as interface data rates and device locations that do not exist in the device configuration files. You used the Import Assistant to provide connectivity for unnumbered interfaces and to provide data rates for interfaces. You used the Model Assistant to introduce subnet hierarchy into the network model, and your task required using the Model Assistant to place devices both logically and geographically. Finally, you learned how to switch quickly and easily between two views of the network by using the Model Assistant in a manner independent of the import process.

Incremental Import: Selected Devices Re-import

A network model is given which might have some configuration errors. Your job is to detect such errors in the network and clear them by modifying the device configuration files or by using the virtual command line interface (Virtual CLI). The modified files are to be reimported to create a network model that has no configuration errors.

Find Configuration Errors

Procedure 3-10 Find Configuration Errors

1 Launch NETWARS, if not already opened.

2 From the System Editor's **File** menu, choose **Open Editor**.

3 From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.

4 Do one of the following:

4.1 If you haven't completed all the steps in the previous section of this chapter:

- Select **File > Open Project**. The Open Project dialog box displays.
- In the Open Project dialog box, select the project file named `Session_1617_ref`, and then click **Open**.

4.2 If you have completed all the steps in the previous section of this chapter:

- Select **File > Open Project**. The Open Project dialog box displays.
- In the Open Project dialog box, select the project file named `Session_1617`, and then click **Open**.

Note—If you do not have access to this file, simply view the screens provided in this user's guide to follow along with the procedure.

5 Choose **Scenario > Switch to Scenario** and select scenario *Lab_2.*

6 Duplicate the scenario:

6.1 Choose **Scenario > Duplicate Scenario**.

6.2 Name the new scenario *Lab_3* and click **OK**.

7 Detect configuration errors:

7.1 Choose **NetDoctor > Configure/Run NetDoctor**.

7.2 Select all the rules in the **Rule Suites > IP Addressing.**

7.3 Expand the rule suite **IP Routing,** and select **Inconsistent Metric Components rule.**

7.4 Click **Run**.

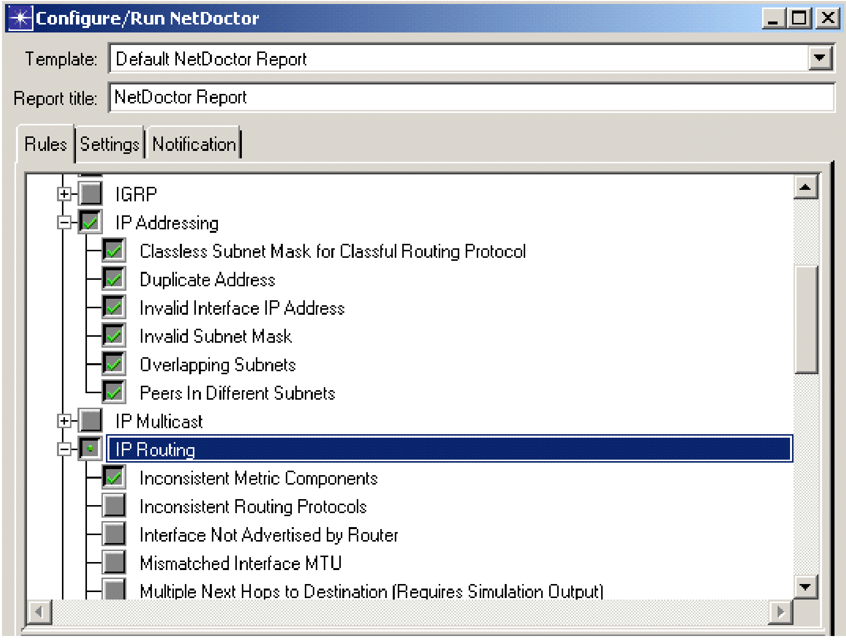


Figure 3-29 Configure/Run NetDoctor

NetDoctor shows one configuration error and one warning.

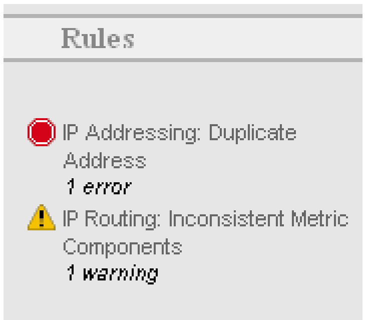


Figure 3-30 NetDoctor Report's Rules Section

7.5 Click on each of them to see more details about the error/warning.

7.6 **Error: IP Addressing: Duplicate Address:** - two interfaces in the network are using the same IP address 10.2.1.3.

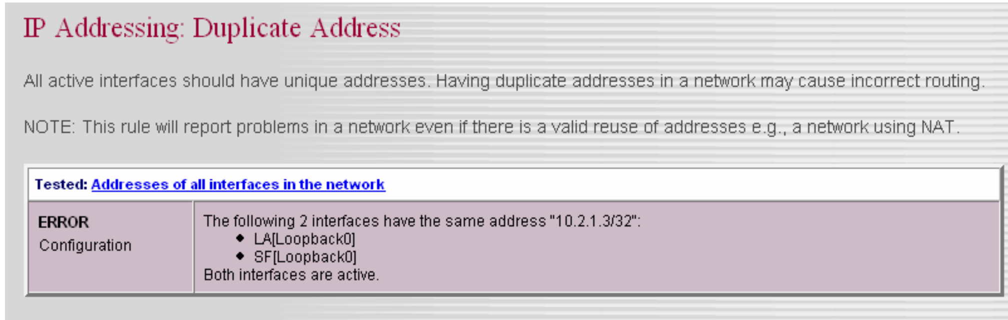


Figure 3-31 IP Addressing Error

7.7 h. **Warning: IP Routing: Inconsistent Metric Components: -** two peer interfaces are having inconsistent bandwidth or delay metrics.

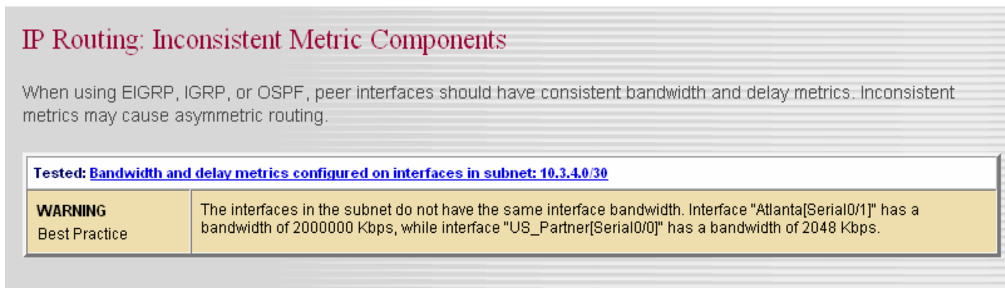


Figure 3-32 IP Routing Error

7.8 Close the browser window that shows the NetDoctor report.

We will first fix the Duplicate Address error by modifying the configuration file and then work on the inconsistent metric warning using the Virtual Command Line Interface (Virtual CLI).

End of Procedure 3-10

Procedure 3-11 Clear Configuration Errors

1 Locate problem devices:

1.1 Choose **Protocols > IP > Addressing > Select Node with a Specified IP Address**.

1.2 Enter **10.2.1.3**, and click **Find**.

Two nodes *LA* and *SF* are shown to have duplicate IP addresses on their loopback interfaces.

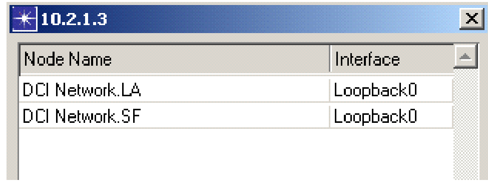


Figure 3-33 Nodes with Duplicate IP Addresses

Click **OK** to close the dialog box that shows the nodes having duplicate IP addresses.

1.3 Click **Cancel** to close the IP Address-based Node Selection dialog box.

2 Right-click on router SF and select **View Device Configuration Source Data**.

3 Scroll down to line number 48 in the file.

4 Change the IP address of interface **Loopback0** from 10.2.1.3 to 10.2.1.1.

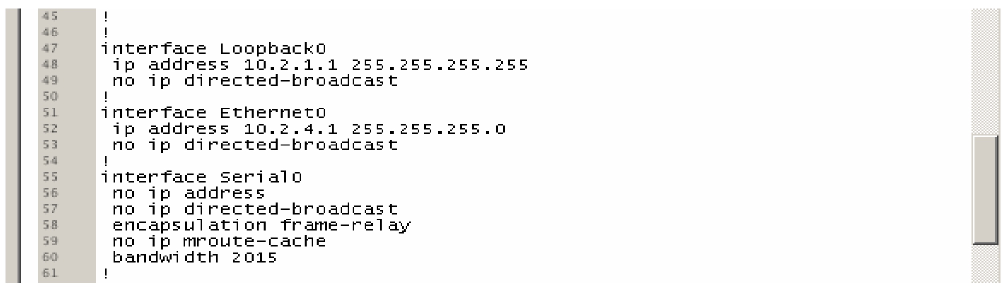


Figure 3-34 Device Configuration Source Data

5 Choose **File > Save Project**, and close Edit Pad.

End of Procedure 3-11

Procedure 3-12 Re-import Modified Configuration Files

1 Select **Topology > Import > Device Configuration files...**

2 Select the **Reimport configurations for modified devices** import mode.

3 Deselect model assistant files, if any are selected, by unchecking the checkbox **Use the following model assistant files**.

4 Make sure your settings display as shown below:

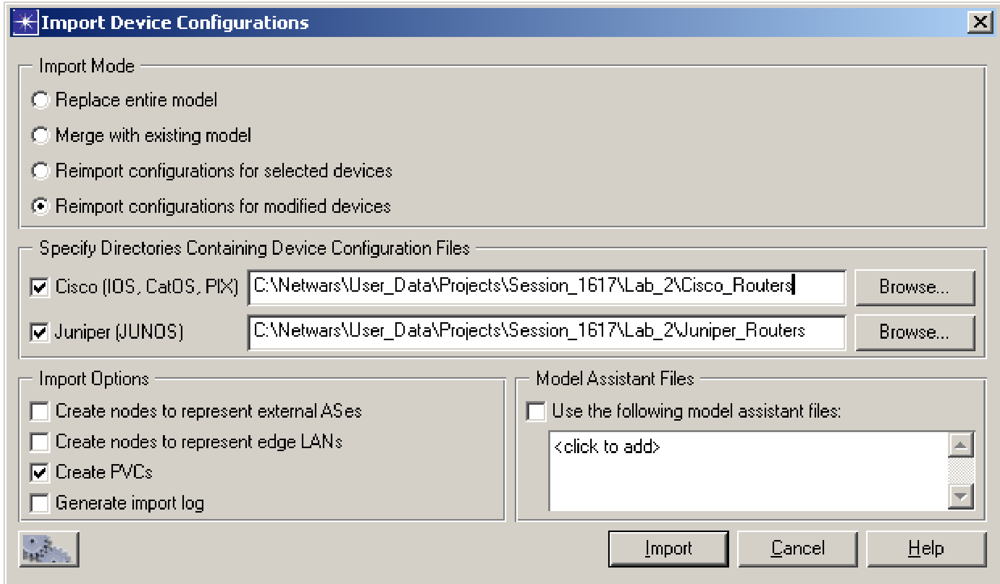


Figure 3-35 Import Device Configuration dialog box

5 Click **Import**.

6 The **Import Summary (Concise)** displays. Click **Close**.

Procedure 3-13 Verify that Configuration Errors are Cleared

1 Run NetDoctor:

1.1 Choose **NetDoctor > Configure/Run NetDoctor**.

1.2 Make sure all the rules in the **Rule Suites > IP Addressing** are selected.

1.3 Make sure the **Inconsistent Metric Components rule** under rule suite **IP Routing** is also selected.

1.4 Click **Run**.

2 Verify that NetDoctor reports zero errors and one warning message in the web report. We will fix this warning using the Virtual Command Line Interface (Virtual CLI).

3 Close the browser window that shows the NetDoctor report.

End of Procedure 3-13

Virtual Command Line Interface

Virtual CLI emulates Cisco's CLI so that Cisco configuration commands can be entered for NETWARS models. This interface is only available for NETWARS node models created from Cisco IOS and CatOS configurations.

Procedure 3-14 Use Virtual CLI

1 Verify the correctness of the NetDoctor warning message, by observing the following attribute at the nodes **Atlanta,** interface **Serial0/1** and **US_Partner,** interface **Serial0/0.**

1.1 Go under the **IP** attributes group: IP Routing Parameters > Interface Information > Metric Information > Bandwidth.

To fix this warning message, the bandwidth metric of one of the peer interfaces has to be changed. We will fix the problem at the interface S*erial0/1 at Atlanta.*

2 The command that you enter on a router to change the bandwidth is "*bandwidth values*" in the interface configuration mode.

3 Right-click on the router **Atlanta** and select **Open Virtual CLI…**

The dialog box that appears is the virtual command line interface and Cisco commands can be entered as you enter them on the real Cisco device.

4 At any point you can also make use of the auto-fill and list supported commands feature by pressing **Tab** or typing a **?**.

5 Press **Enter**, and type **en** to enter the enable mode.

6 Type **show running-config,** and press **Enter**.

7 Press **Enter** or <space bar> to scroll down to the interface configuration for ***Serial0/1**.*

8 Note that the bandwidth command has a value of 200000 which is not same as its peer's value (2048).

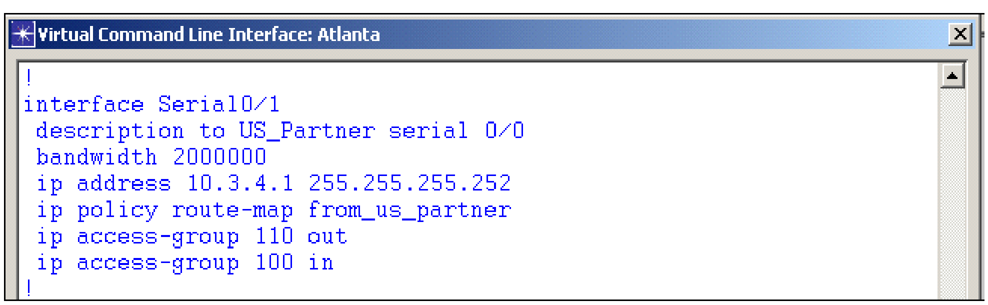


Figure 3-36 Virtual Command Line interface

9 Enter **q** or any character to exit the **show running config** output.

10 Type **config t** and press **Enter** to enter configuration commands from the terminal.

11 The interface of interest to us is *Serial 0/1*, so type in ***interface Serial0/1*** and press **Enter** to enter the interface configuration mode.

12 Type ***bandwidth 2048***, and press **Enter**.

13 Type **Exit** to leave the interface configuration mode.

14 Type **Exit** to leave of the configuration mode and save the changes.

15 Click **Close** to leave the Virtual Command line interface.

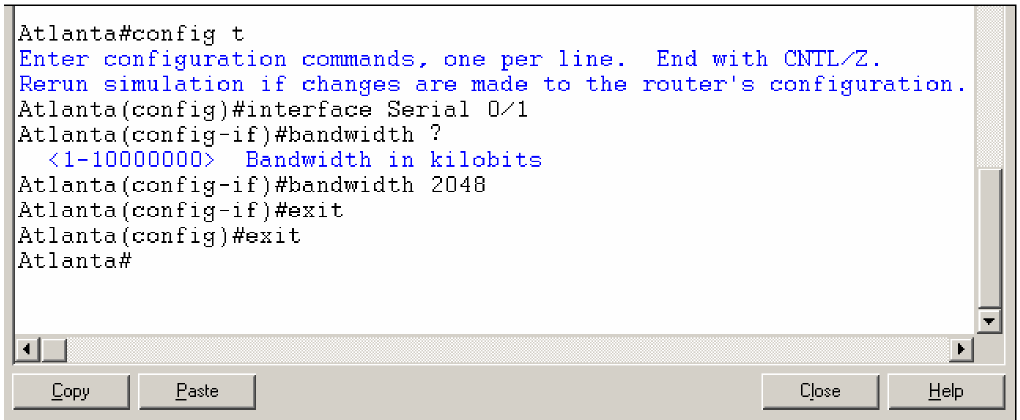


Figure 3-37 Virtual Command Line interface

16 Verify that the bandwidth attribute was indeed changed by observing the attribute **"IP.IP Routing Parameters. Interface Information. Metric Information. Bandwidth"** at the router **Atlanta** for the interface **Serial0/1.**

End of Procedure 3-14

Procedure 3-15 Verify that Warnings are Cleared

1 Run NetDoctor:

1.1 Choose **NetDoctor > Configure/Run NetDoctor**.

1.2 Make sure all the rules in the **Rule Suites > IP Addressing** are selected.

1.3 Make sure the **Inconsistent Metric Components rule** under rule suite **IP Routing** is selected.

1.4 Click **Run**.

2 Verify that NetDoctor reports zero errors and zero warning messages in the web report.

End of Procedure 3-15

Conclusions

The NetDoctor module can be used to detect configuration errors in a network model. You cleared configuration errors reported by NetDoctor by editing a device configuration file and using virtual command line interface

DCI's import mode **Reimport configurations for modified devices** is useful when configurations change for some select devices in the network. You used this mode to reimport the modified configuration for a single node that had a configuration error. This mode results in considerable savings in time when only a small part of a large network is changed.

Troubleshooting the Imported Network

A configuration file set is given which might have some missing information that is leading to unconnected islands in your network. Your job is to detect such issues and fix them.

Find Configuration Errors

Procedure 3-16 Find Configuration Errors

1. Launch NETWARS, if not already opened.
2. From the System Editor's **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.
4. Select **File > Open Project**. The Open Project dialog box displays.
5. In the Open Project dialog box, select the project file named `Session_1617`, and then click **Open**.

   Note—If you do not have access to this file, simply view the screens provided in this user's guide to follow along with the procedure.
6. Choose **Scenario > New Scenario**, name the scenario *Lab_4*, and click **OK**.
7. Choose **Topology > Import> Device Configuration Files...** The Import Device Configurations dialog box opens.
8. Specify import settings:

   8.1 Keep the checkbox for **Cisco (IOS, CatOS, PIX)** checked.

   8.2 Click the **Browse** button for Cisco Router IOS and select the folder:

   C:\Netwars\User_Data\Projects\Session_1617\Lab_4\Origina l_Configs

   8.3 Uncheck the **Juniper (JunOS)** checkbox.

8.4 Make sure the import option **Create PVCs** is checked.

8.5 Toggle off the import option **Generate Import Log**.

9 Import:

9.1 Click the **Import** button.

Import Summary (Concise) displays. The summary says there are 2 devices with missing CDP Information and 1 device with missing the show version information.

Also, observe in the background that there are 3 unconnected islands in the network.

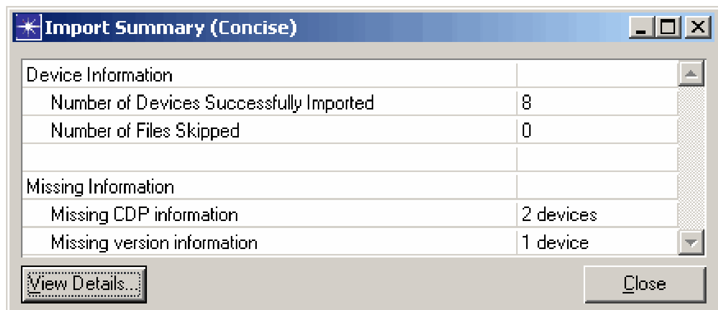


Figure 3-38 Import Summary (Concise) dialog box

9.2 Click **View Details…**

Detailed summary shows us a number of useful information in determining the status of the import and, for troubleshooting.

9.3 Notice that the log says, devices ***c5500_DC_switch1*** and ***c5500_DC_switch3*** have no CDP information and device ***c6500_DC_gw1*** does not have version info.

9.4 Close the summary log.

The imported network looks like.

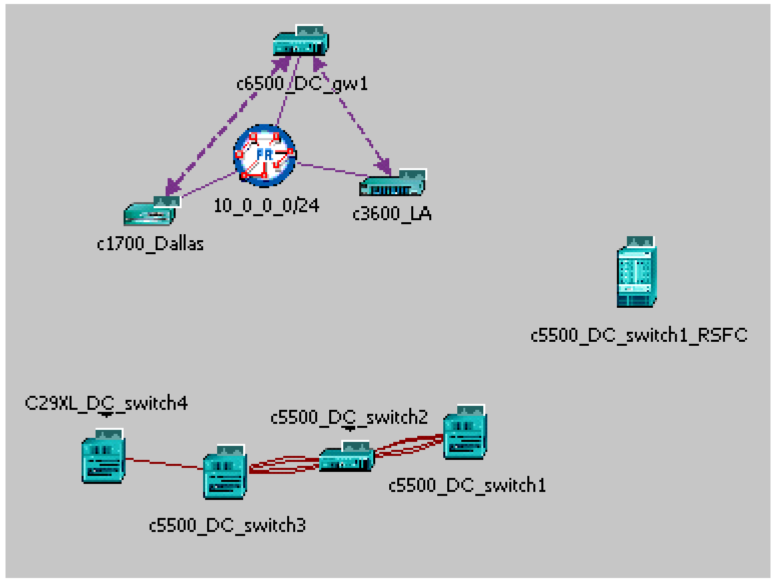


Figure 3-39 Sample Network

9.5 Right-click on the device ***c6500_DC_gw1*** and select **Edit Attributes**. Notice the make of the device.

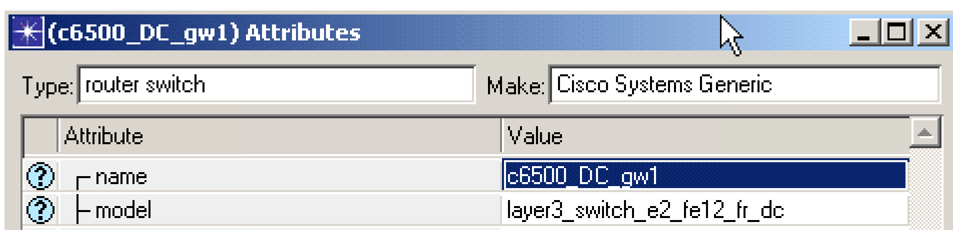


Figure 3-40 Attributes dialog box

9.6 Close the dialog box.

10 Examine the topology diagram below, provided to us by the network admin for the above network.

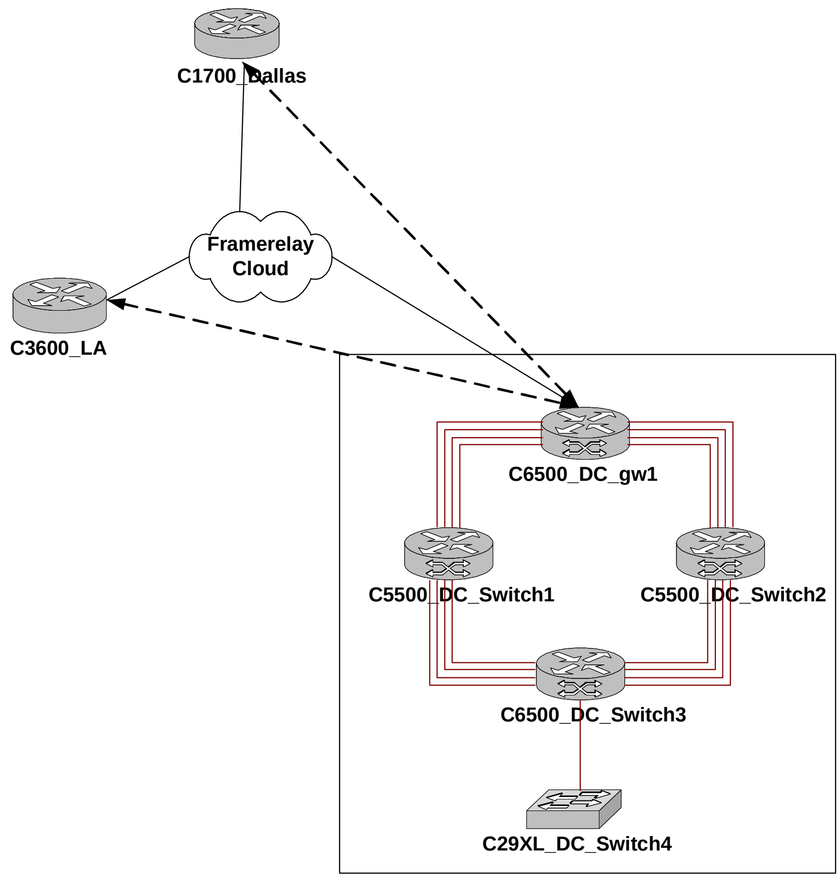


Figure 3-41 Sample Network Topology Diagram

Comparing it with our imported network, we see that there are 3 discrepancies in our import.

- The device ***c5500_DC_switch1_RSFC*** is the routing module for the ***c5500_DC_switch1*** and should appear in the network as one device.
- Device ***c5500_DC_switch3*** and ***c5500_DC_switch1*** should have been connected to ***c6500_DC_gw1.***
- Device ***c6500_DC_gw1*** should have been brought in as Cisco 6500 model.

11 Identify the cause for the problems above.

- *Why is the routing module not connected to its switch?*

  DCI identifies the router (MSFC) and switch coupling based on the CDP neighbor information available on the switch or the MSFC card.

  CAUSE: From the import summary, we know that device ***c5500_DC_switch1*** is missing the output from “show cdp” command.

  Right click on the device ***c5500_DC_switch1*** and choose **View Device Configuration Source Data** and note that there is no “show cdp” information .

- *Why is the layer two connectivity between three devices missing? Or how can DCI infer layer 2 connectivity?*

  DCI can infer layer 2 connectivity only based on the CDP neighbor information.

  CAUSE: From the import summary, we know that device ***c5500_DC_switch3*** is also missing the "show cdp neigh" information.

  Right-click on the device ***c5500_DC_switch3*** and choose **View Device Configuration Source Data**, and note that there is no "show cdp" information.

- *How can DCI identify the device type and make? Or what information is needed for DCI to identify the device type and make?*

  DCI identifies the device type based on the "show version" information.

  CAUSE: Again, from the import summary, we know that the device ***c6500_DC_gw1*** is missing "show version" information.

  Right click on the device ***c6500_DC_gw1*** and choose **View Device Configuration Source Data** and note that there is no "show version" information.

End of Procedure 3-16

Procedure 3-17 Providing the Missing Information

1 To fix the problems, we must include the missing information in the config files:

1.1 Add "show cdp neighbors" output to both ***c5500_DC_switch1*** and ***c5500_DC_switch2.***

1.2 Add "show version" output to ***c6500_DC_gw1.***

Note—For this example, we have added the outputs of these commands to the configuration files and have provided the modified config files.

2 Import the modified configurations:

2.1 Choose **Scenario > New Scenario**, name the scenario *Lab_4b*, and click **OK**.

2.2 Choose **Topology > Import> Device Configuration Files...** The Import Device Configurations dialog box opens.

2.3 Specify import settings:

- Keep the checkbox for **Cisco (IOS, CatOS, PIX)** checked.
- Click the **Browse** button for Cisco Router IOS and select the folder:

  C:\Netwars\User_Data\Projects\Session_1617\Lab_4\Modified_Configs

2.4 Click **Import**.

3 **Import Summary (Concise)** displays. Note that there is no missing information.

Also, observe that we now have a completely connected network.

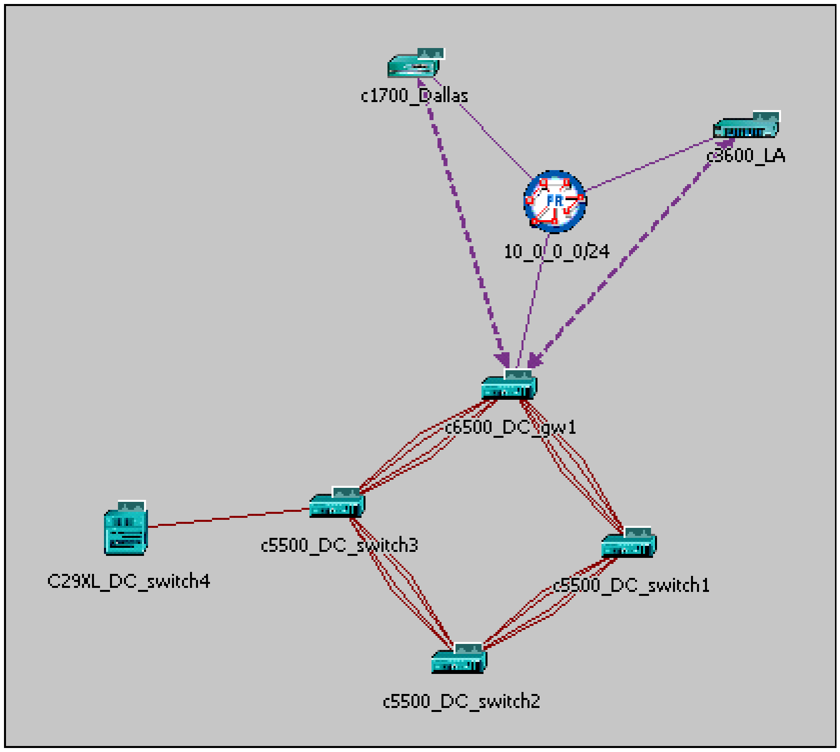


Figure 3-42 Sample Network

End of Procedure 3-17

Conclusions

The concise import summary provides us a brief summary and lets us evaluate the status of the configuration import. The detailed summary provides more specifics about the devices with missing information. You used this information to troubleshoot an unconnected network, by providing the missing information.

4 Importing Network Traffic Data with MVI

Introduction

The Multi-Vendor Import (MVI) module enables users to leverage real-world traffic data and build accurate and efficient models by importing time-varying link and PVC load data as well as end-to-end flow data from various data sources.

This chapter covers the different types of traffic data that can be imported using MVI: link and pvc baseline loads and end-to-end traffic flow data. Users will perform traffic flow and link/pvc baseline load imports and learn about the workflow options available when performing network analyses using data from various sources, such as:

- Concord eHealth (link/pvc loads)
- HP Openview Performance Insight (link/pvc loads)
- MRTG (link/pvc loads)
- InfoVista (link/pvc loads)
- Cisco Netflow (traffic flows)
- NetScout Manager/nGenius (traffic flows)
- Cflowd (traffic flows)
- Distributed Sniffer (traffic flows)
- Fluke Networks OptiView
- ASCII Text Files (link/pvc loads or traffic flows)

Note—The following examples were presented at OPNETWORK 2004 in Session 1619, Importing Network Traffic Data with MVI. If you do not have access to the files that these procedures use, you can still follow along using the sample screens provided in this user's guide.

Examining Loads and Flows

The following procedure shows you how to examine background load and flow data in an existing network. Specifically, you will examine background load on a link and a PVC, visualize link loads gain, and examine a traffic flow using the Flows Browser.

Procedure 4-1 Examine Loads and Flows

1 Launch NETWARS, if not already opened.

2 From the System Editor's **File** menu, choose **Open Editor**.

3 From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.

4 Select **File > Open Project**. The Open Project dialog box displays.

5 In the Open Project dialog box, select the project file named `1619`, and then click **Open**.

Note—If you do not have access to this file, simply view the screens provided in this user's guide to follow along with the procedure.

5.1 If the scenario is not set to Lab1, choose **Scenario > Switch to Scenario** and select **Lab1.**

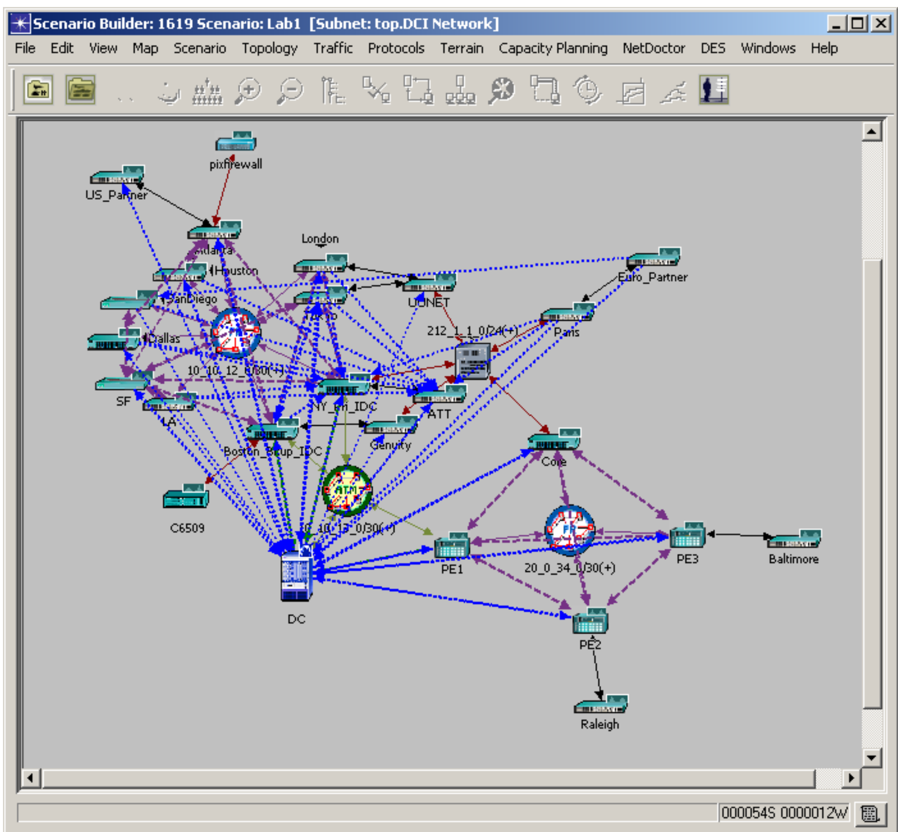
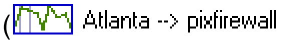


Figure 4-1 Sample Network

6 Right-click on the link going to the **pixfirewall** node.

7 Select **Edit Attributes**.

8 Double click on the **Background Load** attribute value (…).

9 Double click on **Atlanta-pixfirewall** (

). Note the following profile editor:

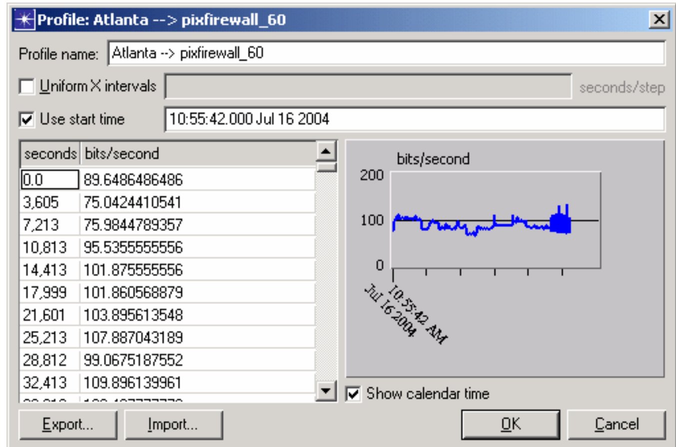


Figure 4-2 Profile Editor for Atlanta-pixfirewall

10 Click **Cancel** (three times) to close all the object editor dialog boxes.

11 Select **View > Visualize Link Loads > Color by Link Load...** The Color Links by Load dialog box displays.

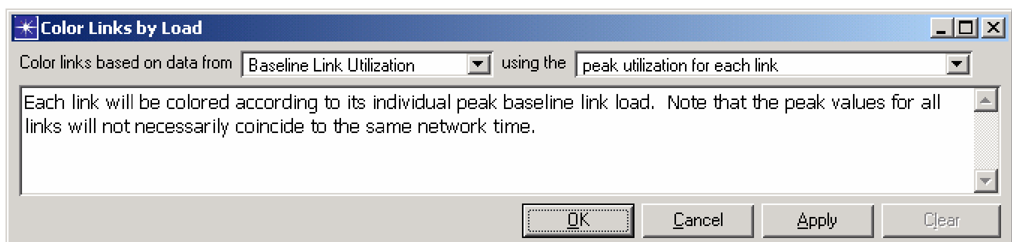


Figure 4-3 Color Links by Load dialog box

12 Set the drop-down list boxes to **Baseline Link Utilization** and **peak utilization for each link,** and then click **OK**.

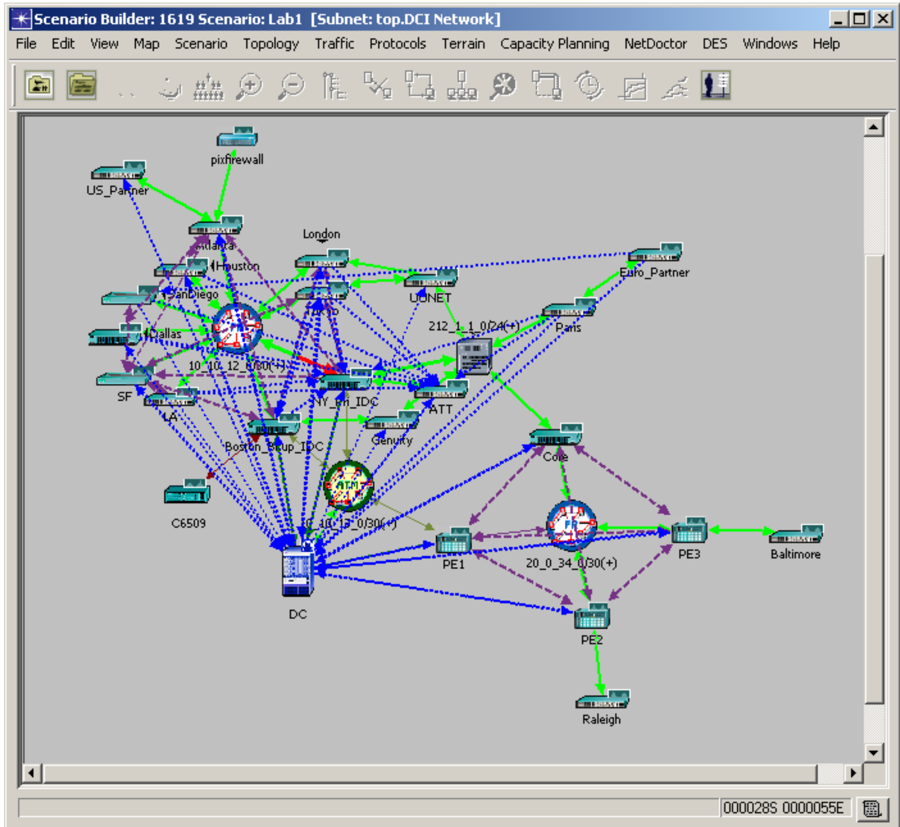


Figure 4-4 Sample Network with Colored Links

Links are colored based on static background utilization.

13 Place the mouse cursor over the red link.

13.1 Note the utilization in the 10_10_12_0/30(+) --> NY_Pri_IDC is at 87.39%

14 Select **View > Visualize Link Loads > Clear Visualization**.

15 Right-click on any flow going from DC to PE2 and choose **Hide Similar Demands**. This hides the flows, so we can more easily see the PVC demands.

You should now see the following network:

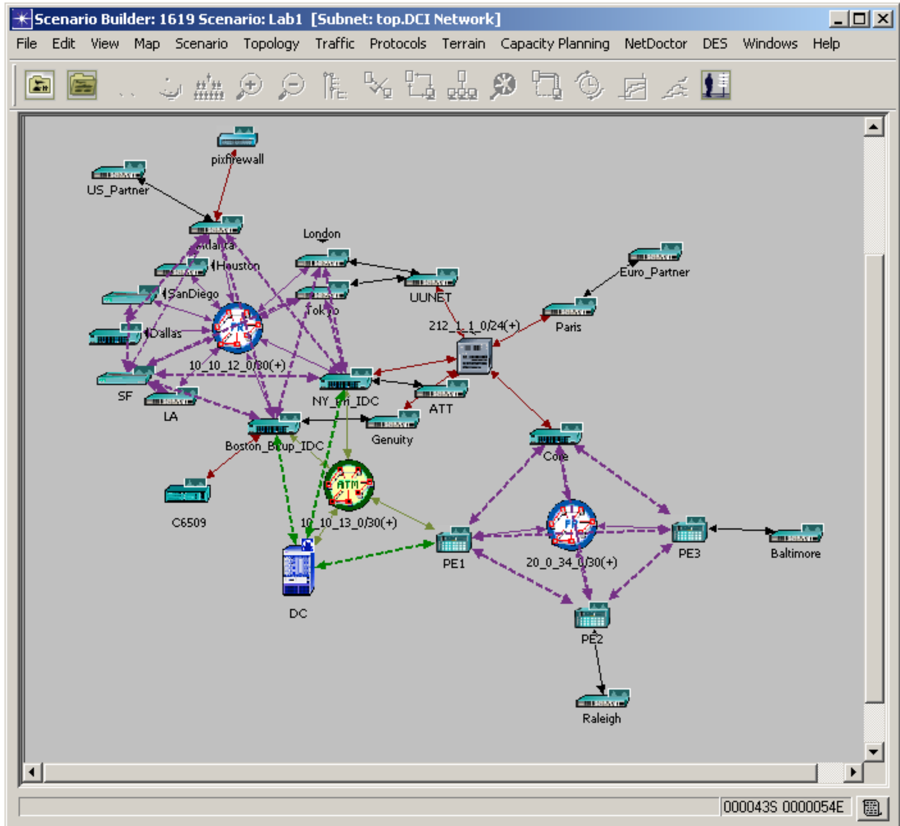


Figure 4-5 Sample Network with Hidden Flows

16 Right-click on **Boston_Bkup_IDC/ATM1/0 <-> DC/at-0/1/0** and choose **Edit Attribute**.

17 Double click on **Traffic Information (…).**

18 Double click on **Boston_Bkup_IDC --> DC** (
).

19 Observe the PVC background load profile:

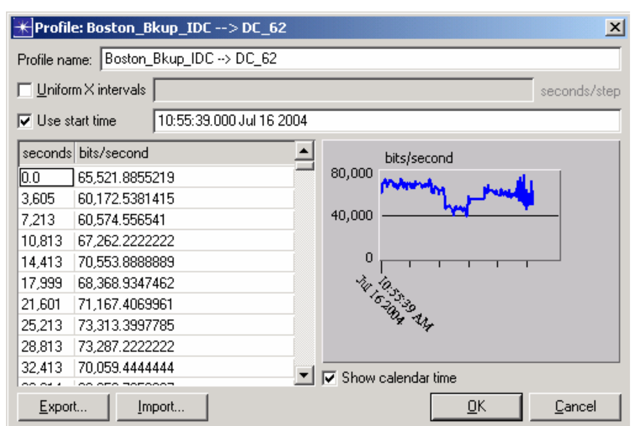


Figure 4-6 Profile Editor for Boston_Bkup_IDC-DC

20 Click **Cancel** to close the profile editor and attribute editor dialog boxes.

21 Press **Ctrl+M** to show all demands and flows. You should see the following network:

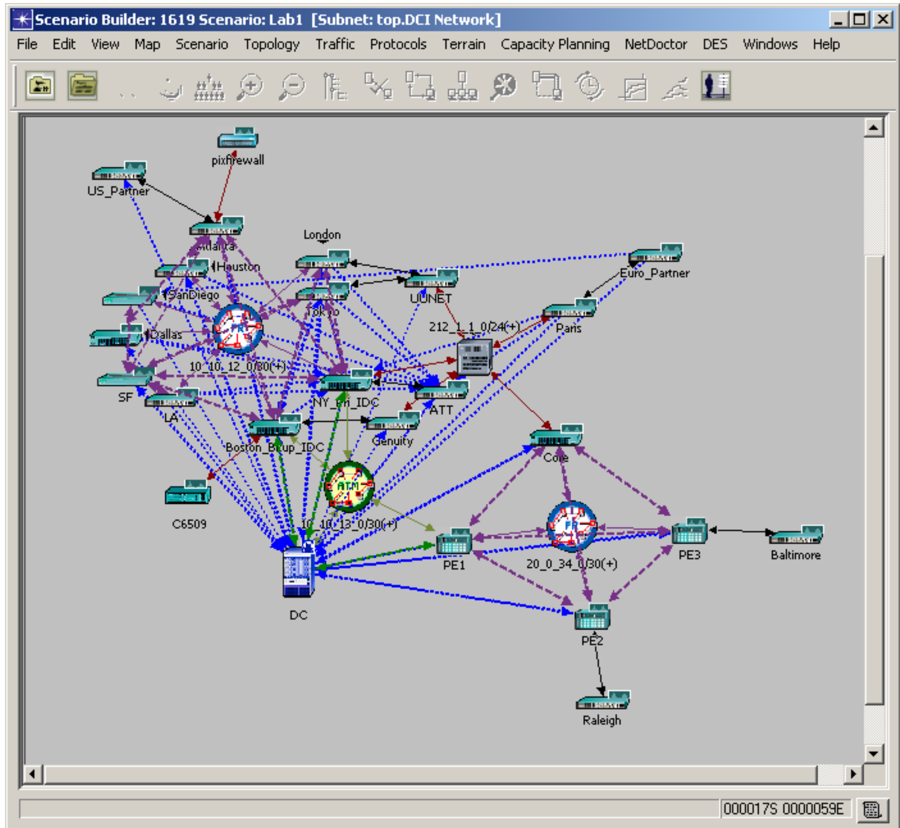


Figure 4-7 Sample Network Showing All Demands and Flows

22 Right-click on **Core (172_20_1_5)-->DC (192_168_50_10)**, and choose **Edit Attributes** from the first flow on the popup list.

23 Double-click on **Traffic (bits/second)**, and observe the following profile:

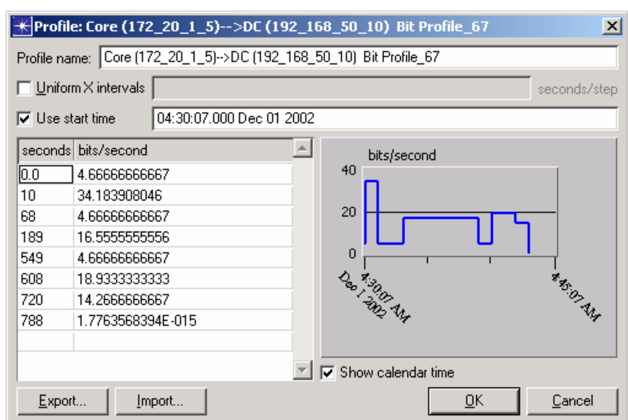


Figure 4-8 Profile Editor for Core (172_20_1_5)-->DC (192_168_50_10)

24 Click **Cancel**.

25 Double-click on **Traffic (packets/second)**, and observe the following profile:

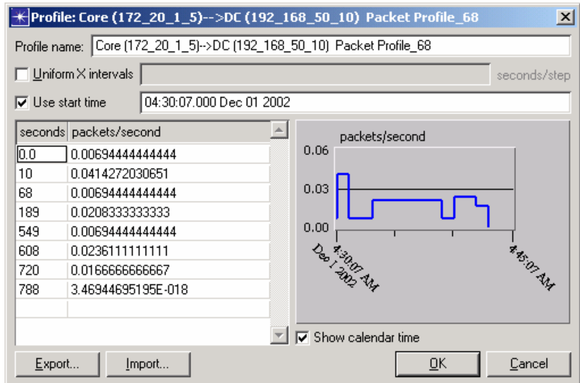


Figure 4-9 Profile Editor for Core (172_20_1_5)-->DC (192_168_50_10)

26 Click **Cancel** twice.

27 Select **Traffic > Visualize > Open Flows Browser**. The Flows Browser dialog box displays.

28 Select **Flows** in the **Arrange by** drop-down list box.

29 Click on **Atlanta (10_10_6_1)-->DC (192_168_50_10).**

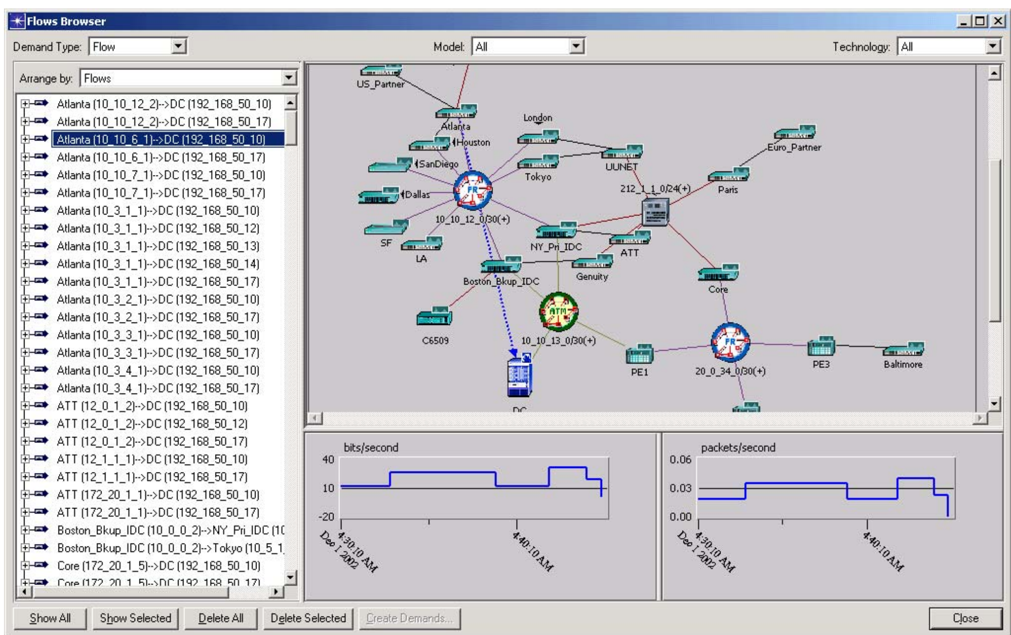


Figure 4-10 Sample Network in Flows Browser

The flow is rendered in the network window and the profiles are displayed.

30 Select **Connections** in the **Demand Type** drop-down list box.

31 Click on **DC/at-0/1/0_2 <-> PE1/ATM1/0_1**.

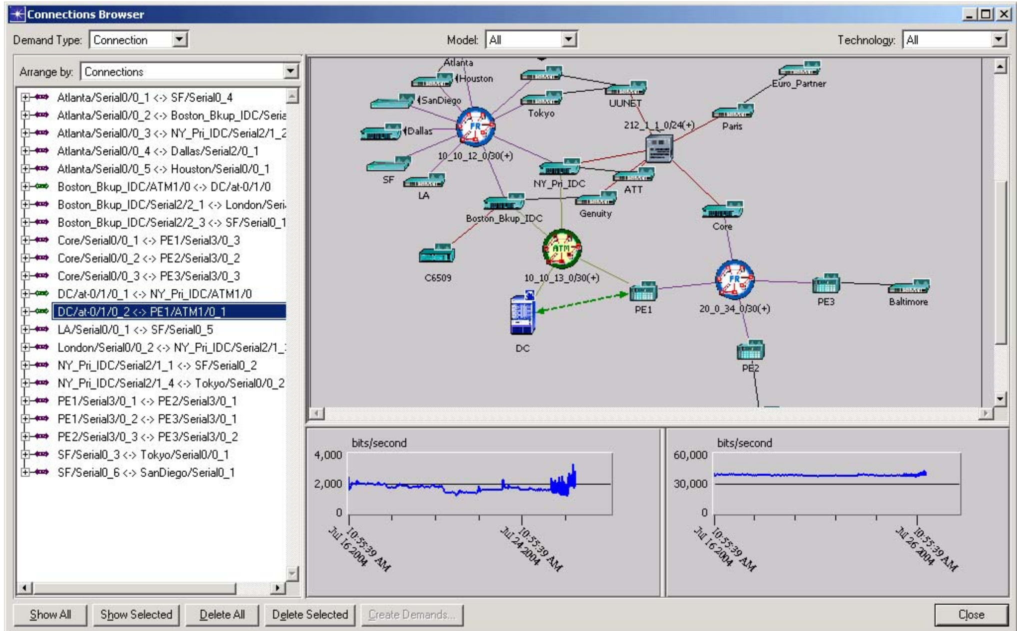


Figure 4-11 Sample Network in Flows Browser

The PVC is rendered in the network window and the profiles are displayed.

End of Procedure 4-1

Importing Link Loads

In the following procedure, imagine that you work for a small ISP and want to present a graphical representation of your network traffic to your supervisor. You have collected link load data during a period of heavy traffic using InfoVista. The following procedure shows you how to import link load data and visualize link loads.

Procedure 4-2 Import Link Loads

1. Launch NETWARS, if not already opened.
2. From the System Editor's **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.
4. Select **File > Open Project**. The Open Project dialog box displays.

5 In the Open Project dialog box, select the project file named `1619`, and then click **Open**.

Note—If you do not have access to this file, simply view the screens provided in this user's guide to follow along with the procedure.

5.1 If the scenario is not set to Lab2, choose **Scenario > Switch to Scenario** and select **Lab2.**

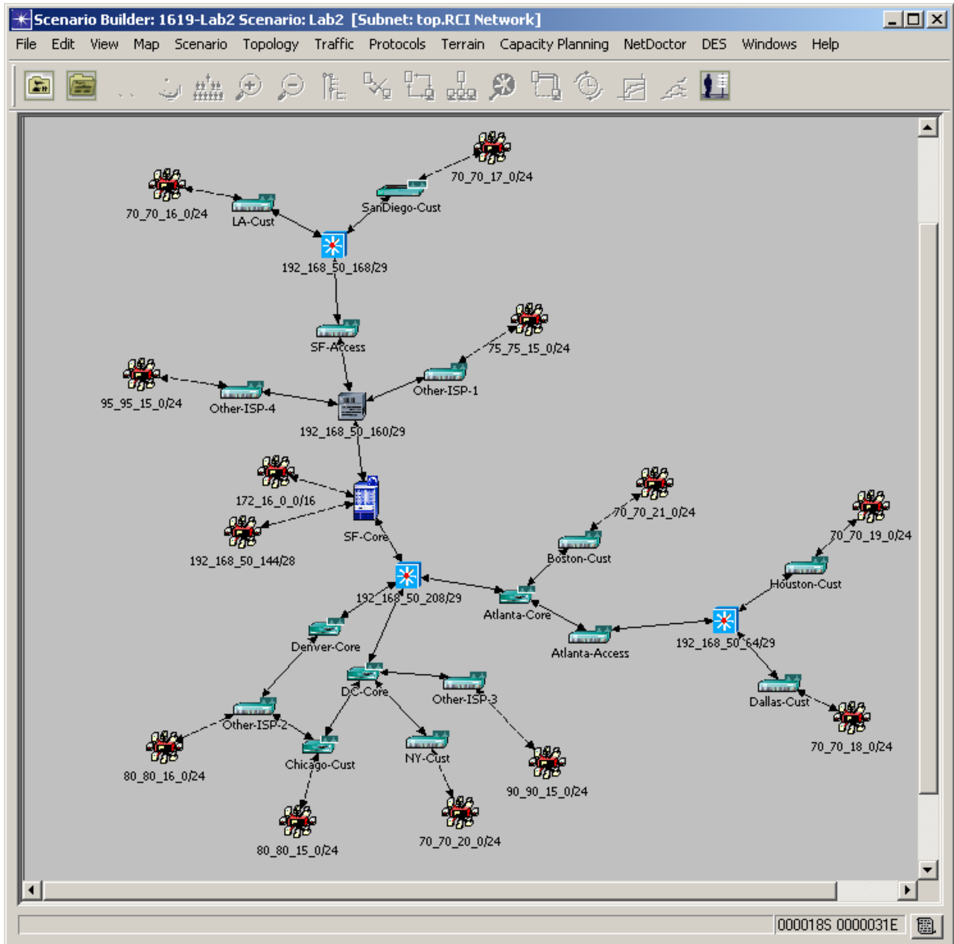


Figure 4-12 Sample Network

6 Verify that links are not currently loaded.

6.1 Hold cursor over link between **Atlanta-Access** and **192_168_50_64/29**.

6.2 Note that tooltip shows no utilization.

7 Import loads.

7.1 Select **Traffic > Import > Device/Link Baseline Loads > From InfoVista...**

7.2 Import the file.

- If ***C:\Netwars\User_Data\Traffic_Data*** is not expanded, do so.
- Choose the file ***infovista 20-jul-2002.txt.***

- Click **Import**.

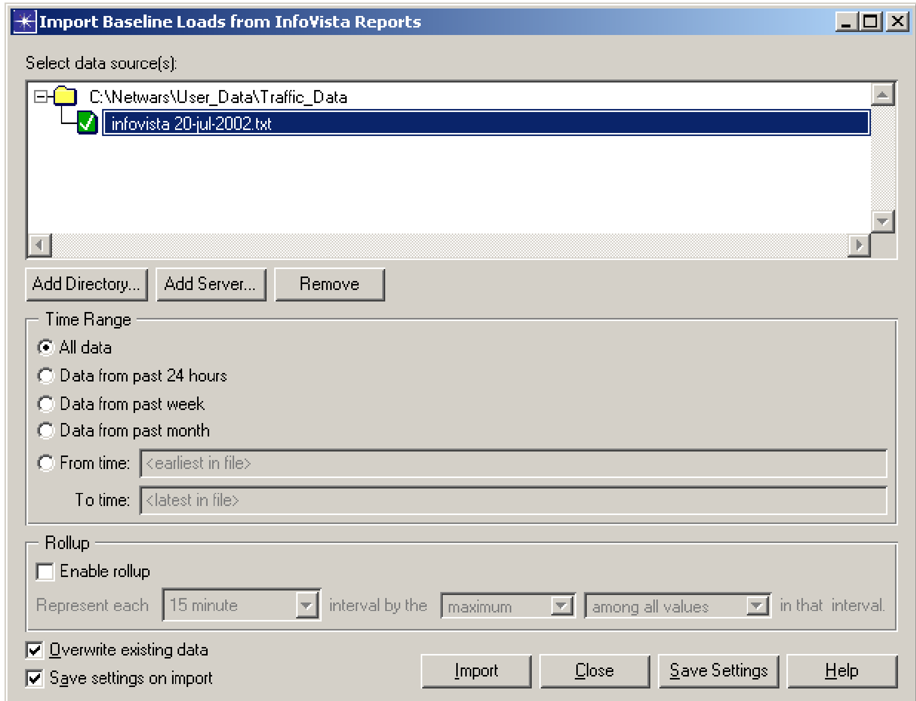


Figure 4-13 Import Link Baseline Loads from InfoVista Reports dialog box

8 Visualize Link Utilizations and Loads.

8.1 Examine the import log.

- When import statistics appear, click **View Log**.

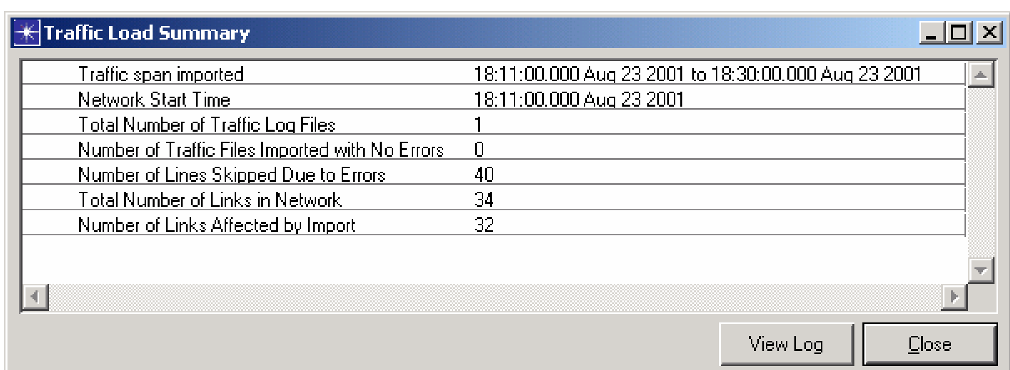


Figure 4-14 Traffic Load Summary dialog box

The only skipped lines are Loopback interfaces.

- Close the log and statistics windows.

8.2 Use visualization to inspect the network.

- Select **View > Visualize Link Loads > Color by Link Load...** The Color Links by Load dialog box displays.

- Set the drop-down list boxes to **Baseline Link Utilization** and **peak utilization for each link,** and then click **OK**.

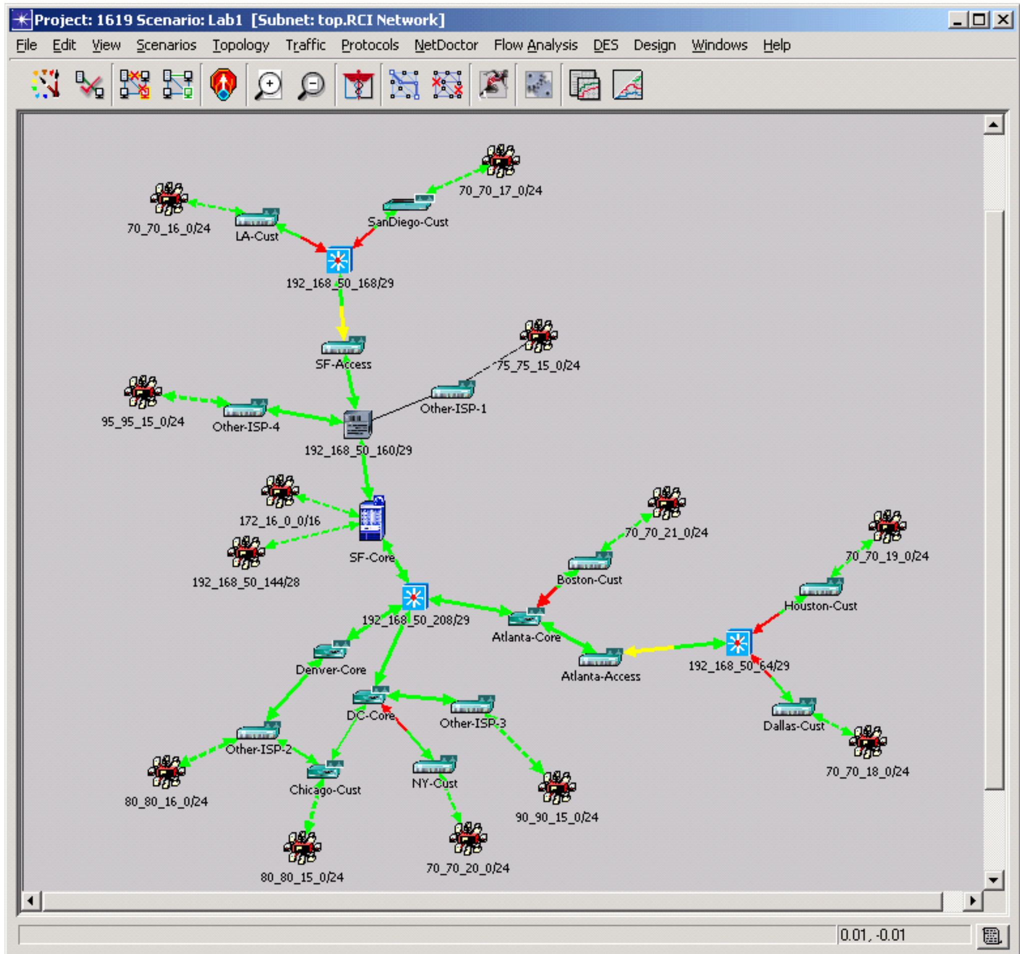


Figure 4-15 Sample Network with Colored Links

9 Examine Load Attributes.

9.1 Hold the cursor over the link between Atlanta-Access and 192_168_50_64/29. Note that the link has utilization.

9.2 Right-click on this link, and choose **Edit Attributes**.

9.3 Expand the **Background Load** attribute.

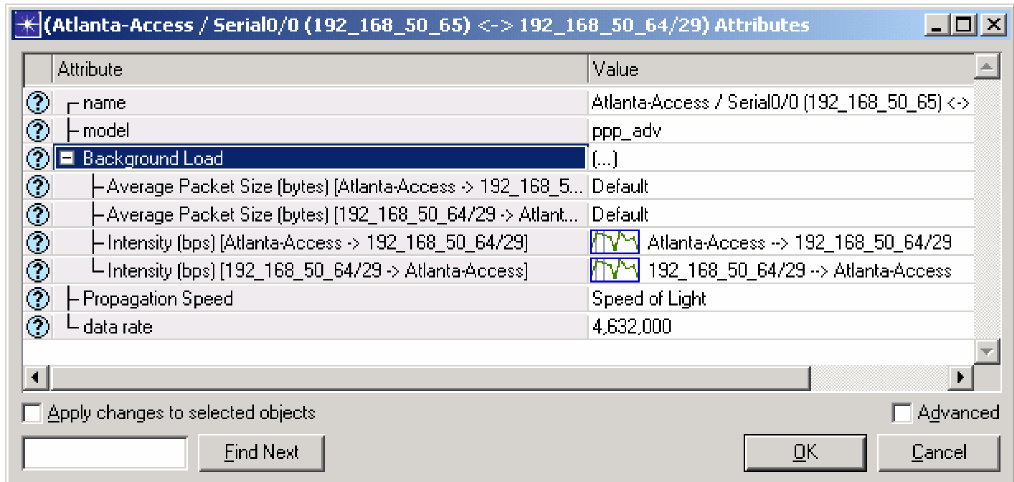


Figure 4-16 Background Load Attribute

9.4 View the profile of throughput vs. time.

- Click on the **Value** column for the **Intensity (bps) [Atlanta-Access 192_168_50_64/29]** attribute and choose **Edit...**

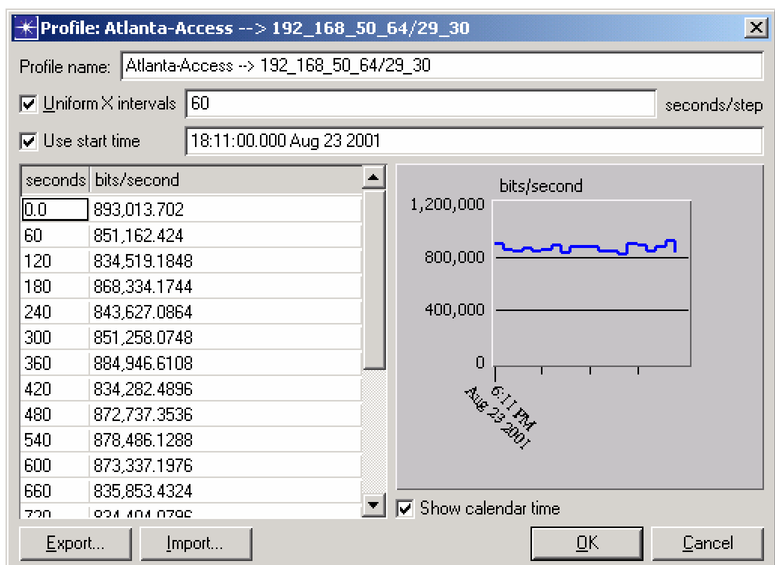


Figure 4-17 Profile Editor for Atlanta-Access-192_168_50_64/29

- Also examine the throughput in the opposite direction. Notice that the load out of Atlanta-Access is about 850Kbps, but the load into Atlanta-Access is about 2.7Mbps.

9.5 Close the load profiles when you have finished examining them.

10 Examine Node Interface Aliases.

10.1 Make sure the Edit Attributes dialog box is still open for the link between **Denver-Core** and **Other-ISP-2**.

10.2 Click the **Advanced** checkbox.

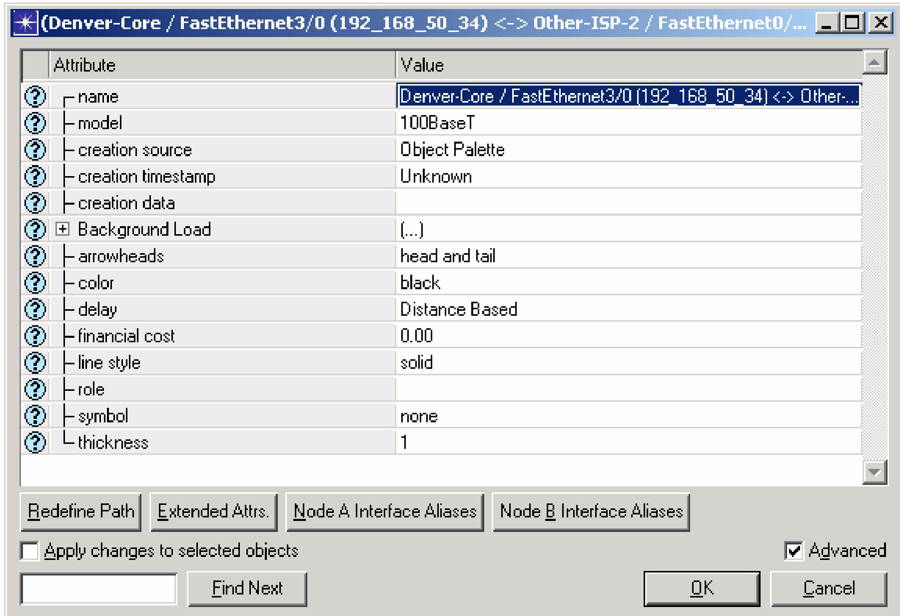


Figure 4-18 Edit Attributes dialog box

10.3 Click on **Node A Interface Aliases.**

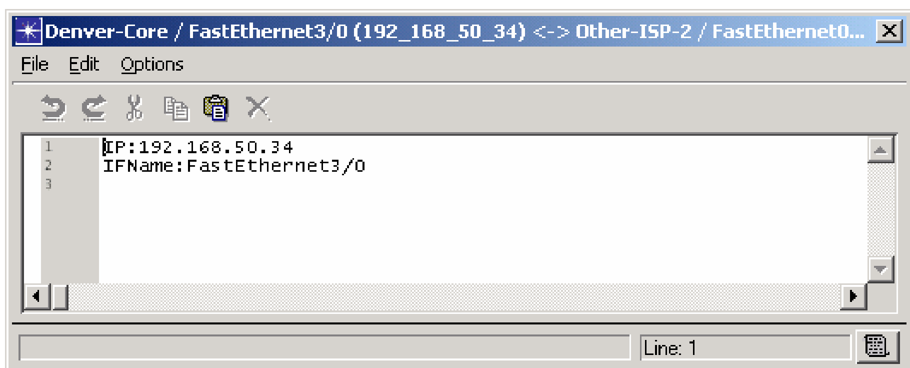


Figure 4-19 Node A Interface Aliases

Notice aliases for IP address and interface name (SNMP ifDescr).

10.4 Close these dialog boxes when you are done.

End of Procedure 4-2

Summary

You have now imported and visualized link loads. You can report on certain links of interest, or visually show how heavily loaded the network is currently.

You could go on to convert these loads to flows to perform further studies. Alternatively, you could add explicit traffic or traffic flow data to perform studies.

Importing Traffic Flows and Running Flow Analysis

Using the following procedure, imagine that you work for SuperBroadCom, a service provider. Your company is looking to add AllFirstTrust National Bank of Iowa as a client. You have existing load data for your network, and AllFirstTrust has Netflow data representing their existing traffic during a busy hour. Your company wants to determine the total load on their network due to adding AllFirstTrust's traffic. Thus, you need to overlay AllFirstTrust's Netflow traffic on top of your already-loaded network and run Flow Analysis to determine the impact of this new traffic.

Procedure 4-3 Visualize and Inspect Link Loads

Before importing the traffic flows, you will want to examine the current load on the network to anticipate where problems might occur.

1. Launch NETWARS, if not already opened.
2. From the System Editor’s **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, choose **Scenario Builder**, and then click **OK**.
4. Select **File > Open Project**. The Open Project dialog box displays.
5. In the Open Project dialog box, select the project file named `1619`, and then click **Open**.

   Note—If you do not have access to this file, simply view the screens provided in this user’s guide to follow along with the procedure.

5.1 If the scenario is not set to Lab3, choose **Scenario > Switch to Scenario** and select **Lab3**.

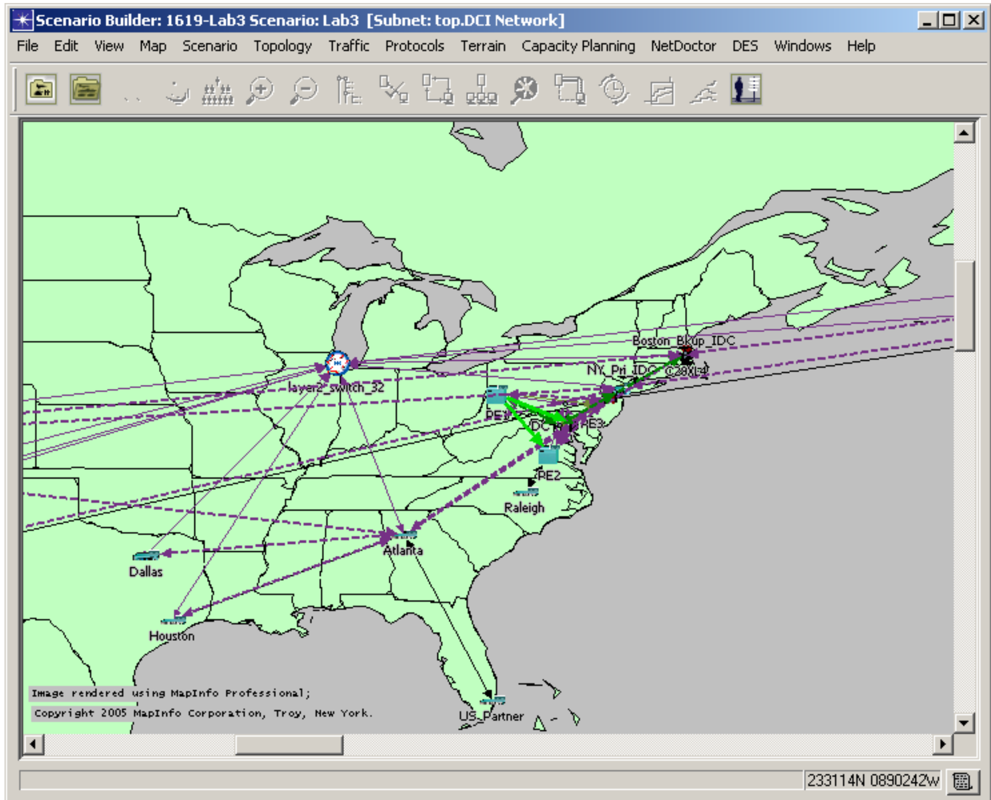


Figure 4-20 Sample Network

Note the PVC demands (purple dashed lines for Frame Relay, dark green dashed lines for ATM) created by the topology import, in addition to the links.

6 Select **View > Visualize Link Loads > Color by Link Load...** The Color Links by Load dialog box displays.

6.1 Set the drop-down list boxes to **Baseline Link Utilization** and **peak utilization for each link,** and then click **OK**.

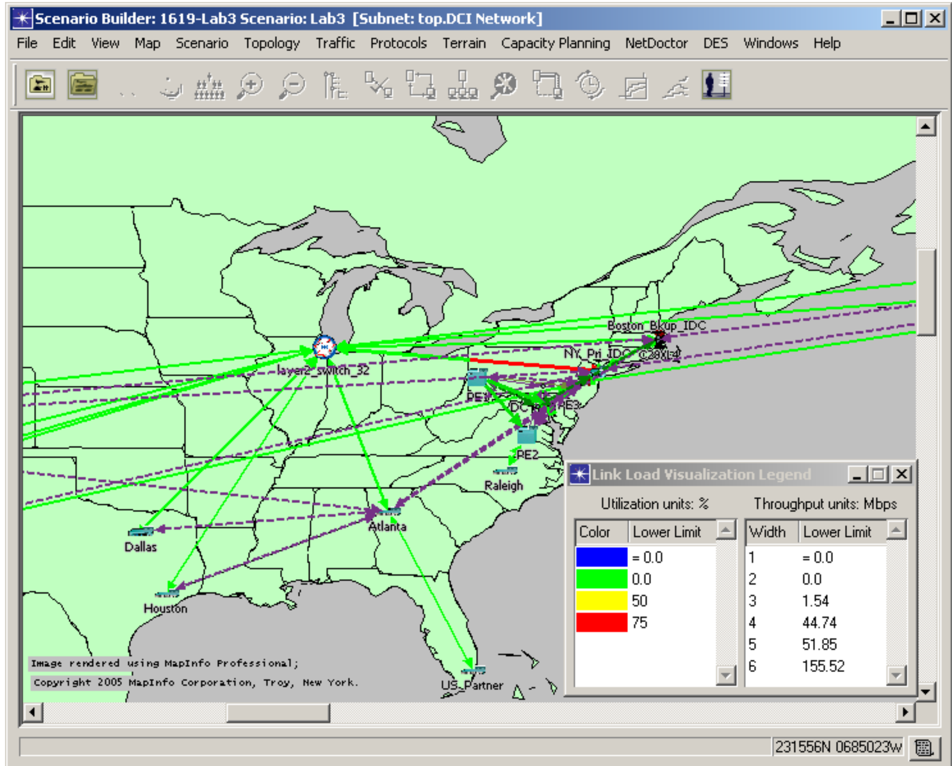


Figure 4-21 Sample Network with Colored Links

Note that the link between **NY_Pri_IDC** and **layer2_switch_32** is heavily loaded going toward **NY_Pri_IDC**.

7 Right-click on this link and choose **Edit Attributes**.

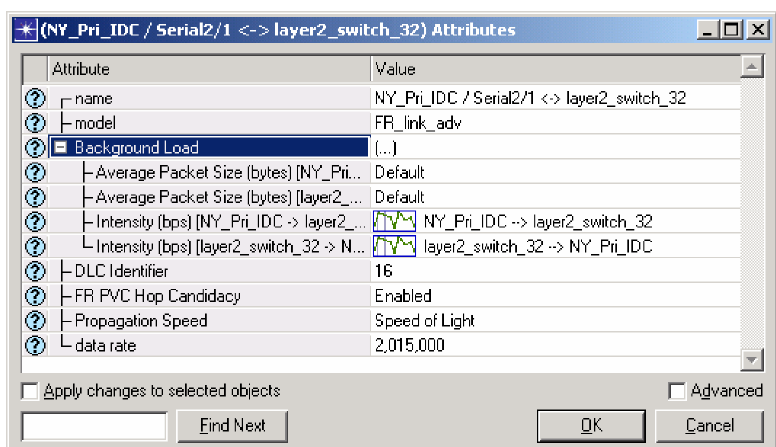


Figure 4-22 Edit Attributes dialog box

Note the data rate of 2,015,000.

8 View the traffic profile from **layer2_switch_32 NY_Pri_IDC**.

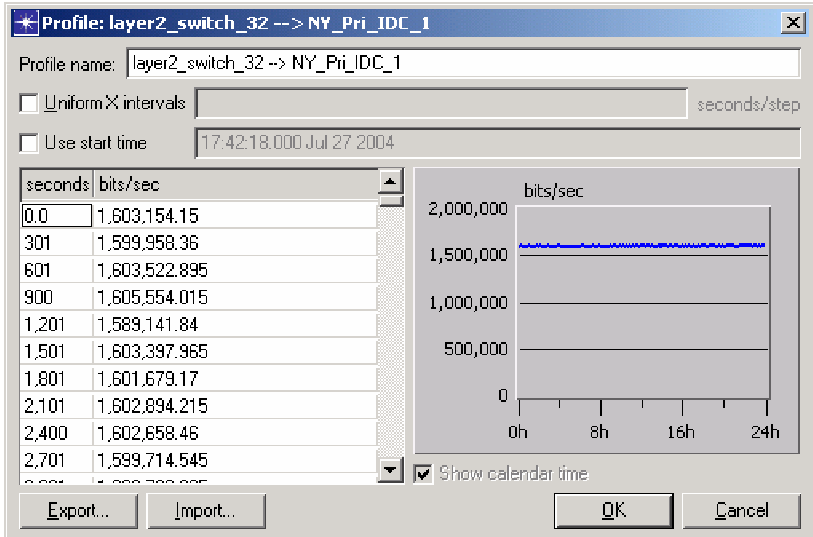


Figure 4-23 Profile Editor for layer2_switch_32-NY_Pri_IDC

Note that the traffic is about 1,600,000 bps: about 80% utilization.

9 Close these dialogs and choose **View > Visualize Link Loads > Clear Visualization**.

End of Procedure 4-3

Procedure 4-4 Import Traffic Flows

1 Choose **Traffic > Import Flows > From Cisco Netflow Traffic Data...**

2 Expand the directory in the tree view to see all available files.

3 Double-click on the directory to choose all files.

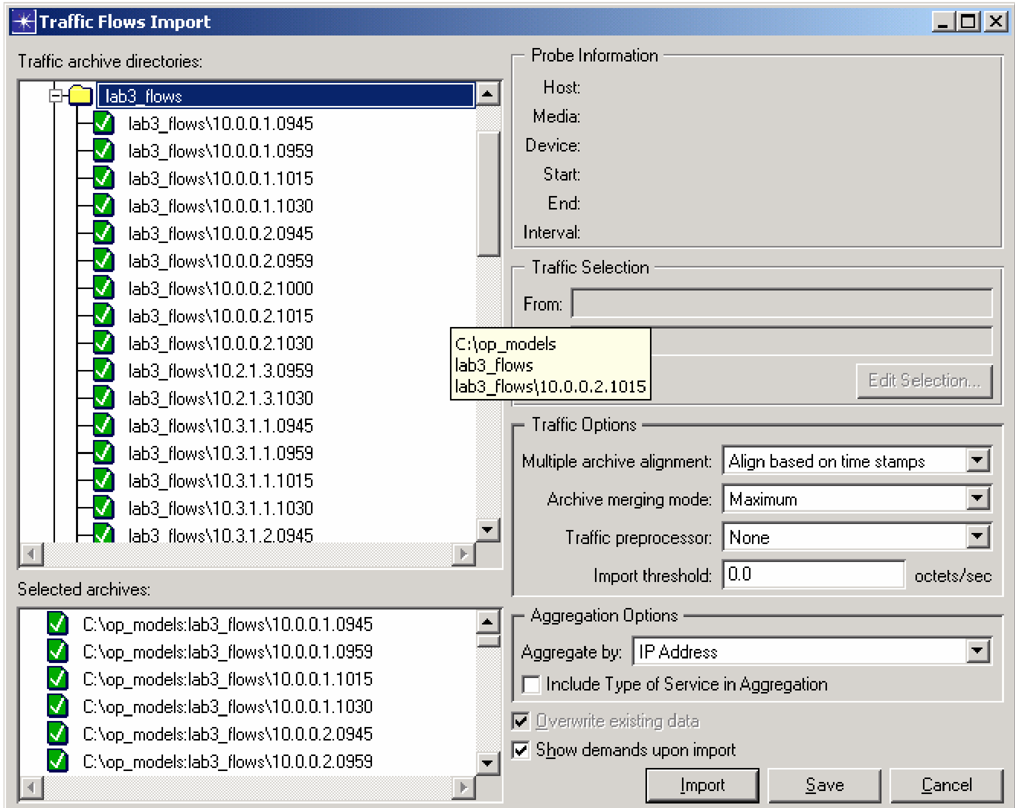


Figure 4-24 Traffic Flows Import

4 Click **Import**.

5 Once the import completes, you should see the following import statistics.

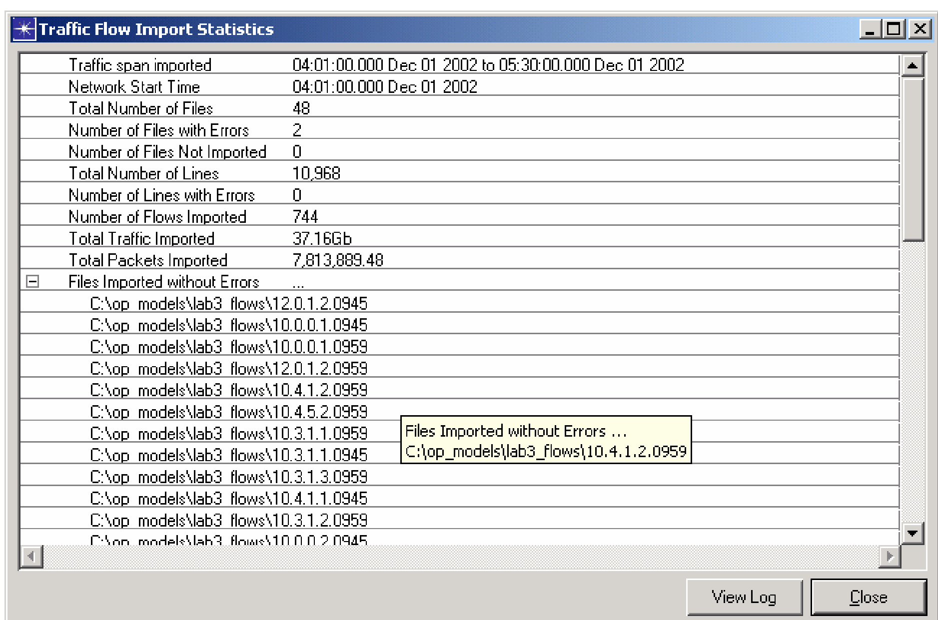


Figure 4-25 Traffic Flow Import Statistics

6 Click **Close**.

The traffic flow demands are visible in the network topology.

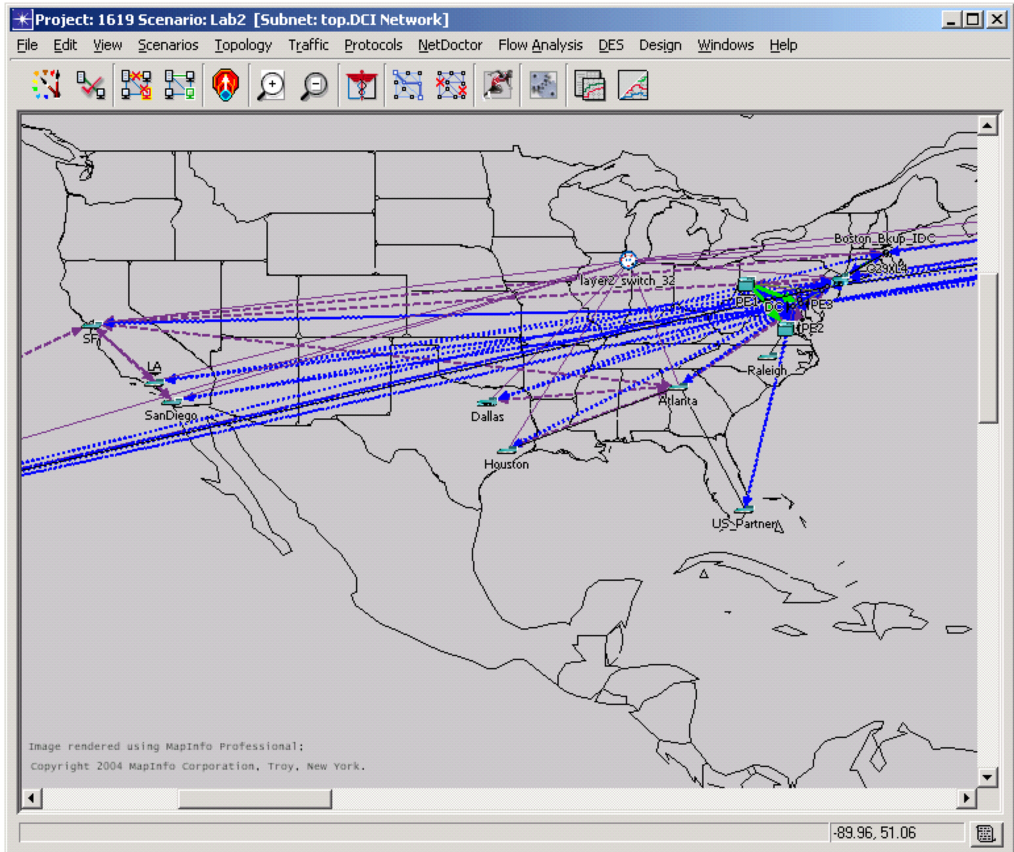


Figure 4-26 Sample Network with Traffic Flow Demands

End of Procedure 4-4

Procedure 4-5 View Flows Using the Flows Browser

The Flows Browser is a convenient way to view flows or connections in the network at a high level.

1 Choose **Traffic > Visualize > Open Flows Browser**.

By default, the Flows Browser opens showing nodes that are the source of at least one flow in the pane on the left.

2 Expand **DC** to see the flows originating at this node.

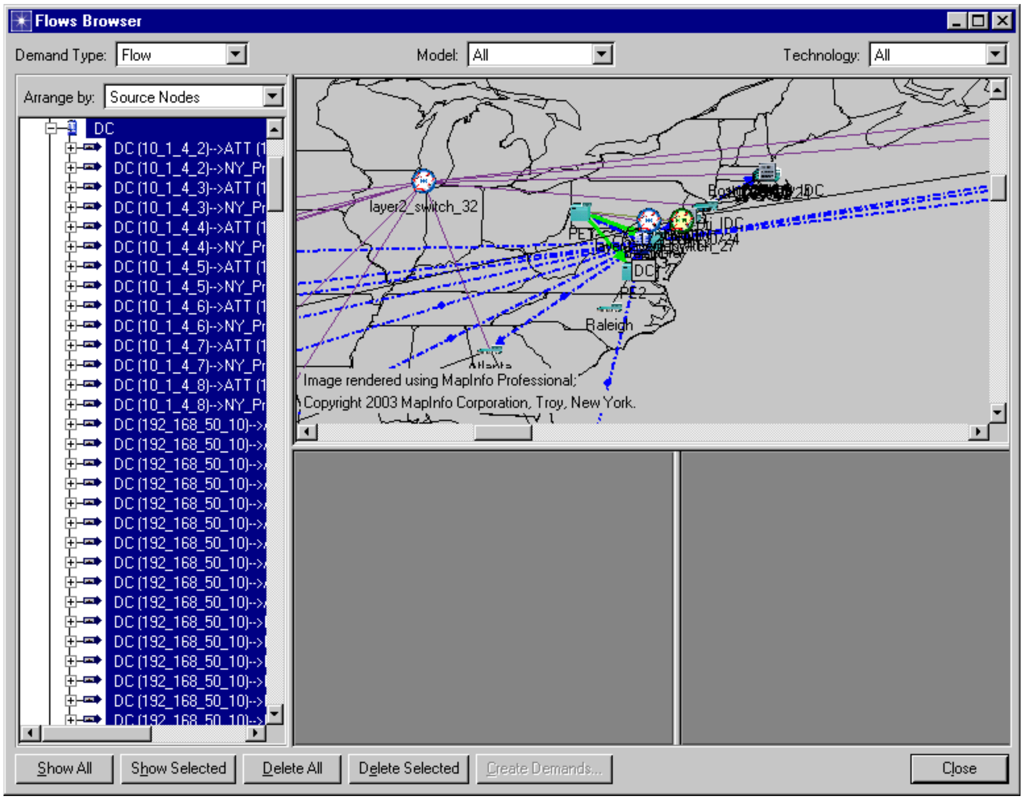


Figure 4-27 Sample Network in Flows Browser

3 Click on the flow ***DC (10_1_4_4) ATT (12_1_1_2)***. This is the fifth flow listed under DC. This shows the bits/second and packets/second profiles for this flow. Note that there is a constant level of traffic in this flow from about 1,500 seconds to about 5,000 seconds.

3.1 You can click on other flows to see that the traffic is not always constant, and sometimes the traffic-monitoring tool leaves small gaps in the measured traffic.

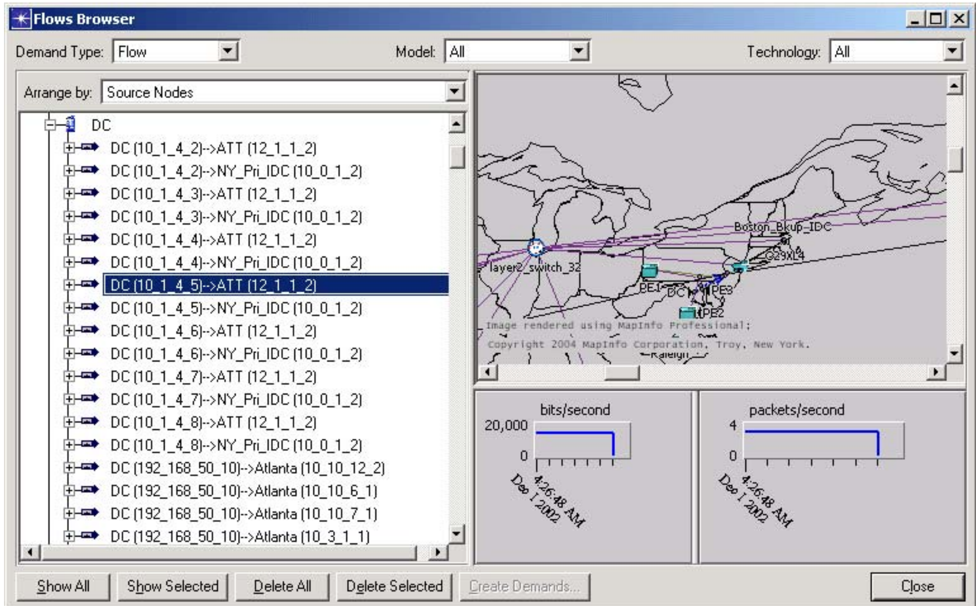


Figure 4-28 Sample Network in Flows Browser

4 You can also change how the network objects are displayed. Change the **Arrange by:** pull down menu so that the objects are arranged by flows.

5 Click on the first flow: ***Atlanta (10_10_12_2) DC (192_168_50_10)***. Expand its item in the tree view to see its source and destination nodes.

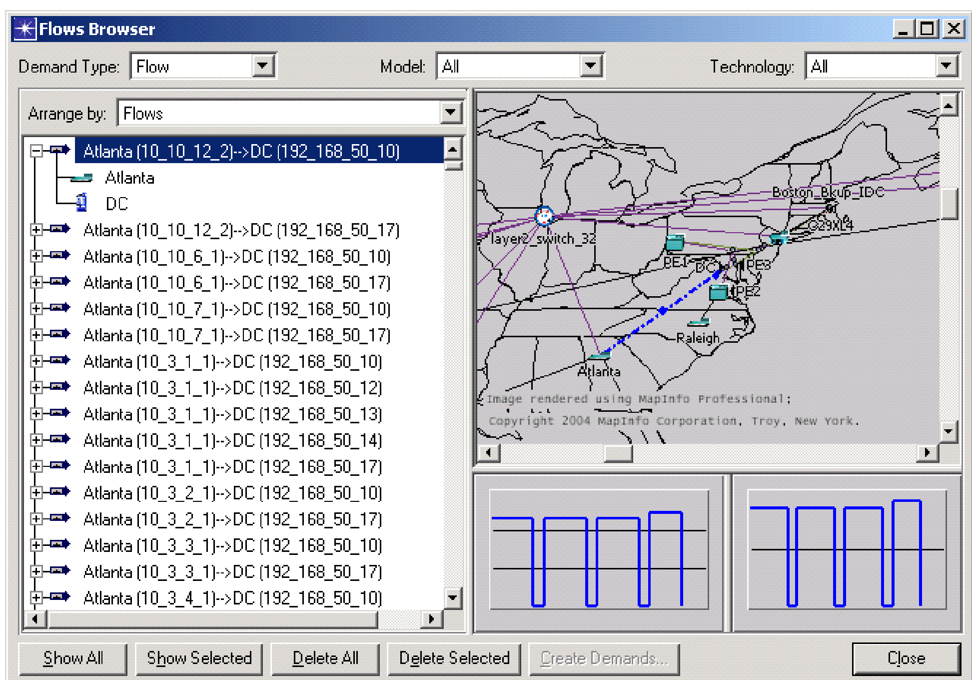


Figure 4-29 Sample Network in Flows Browser

6 Click **Close** to close the flows browser.

End of Procedure 4-5

Procedure 4-6 Run DES

Now that the network has both the existing load data and the new flow data, you are ready to analyze the total traffic on your network to determine if it can handle the combined loads.

1 Choose **DES > Configure/Run Discrete Event Simulation**.

2 Change the **Duration** to **3600 seconds**.

3 Click **Run** to start DES.

3.1 When prompted about unassigned IP addresses, you can click **Yes** or **No**. You will get the same results with either. This only changes whether IP addresses automatically assigned during flow analysis are set back on the nodes as attributes.

4 When viewing results, notice that there is now an over-utilized link with a maximum utilization of 147%.

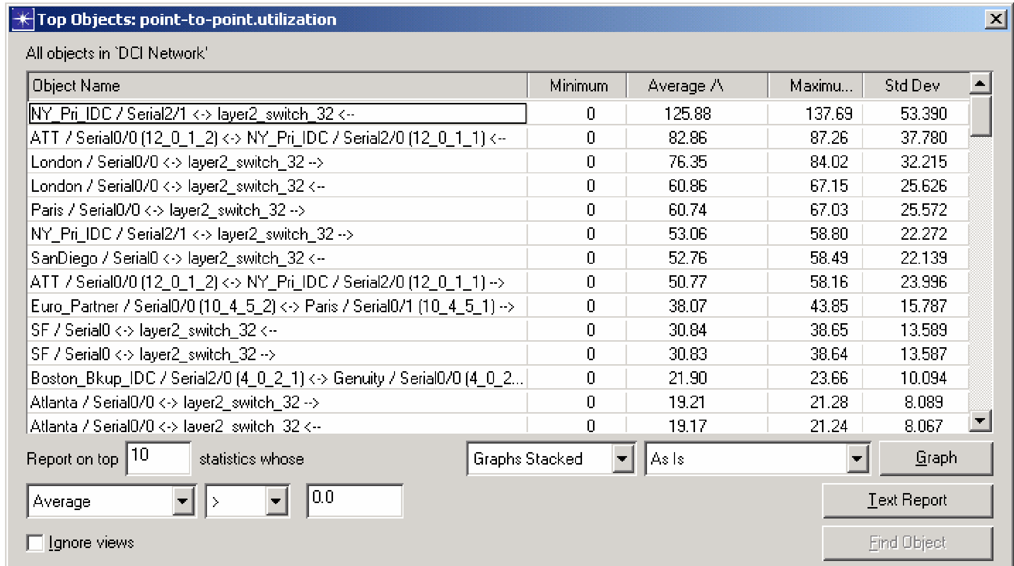
End of Procedure 4-6

Procedure 4-7 Find the Over-Utilized Link

1 Choose **DES > Results > Find Top Statistics...**

2 Expand Link Statistics, then point-to-point, and select Utilization.

3 Click **Find Top Statistics**.



Object Name	Minimum	Average /\	Maximu...	Std Dev
NY_Pri_IDC / Serial2/1 <-> layer2_switch_32 <--	0	125.88	137.69	53.390
ATT / Serial0/0 (12_0_1_2) <-> NY_Pri_IDC / Serial2/0 (12_0_1_1) <--	0	82.86	87.26	37.780
London / Serial0/0 <-> layer2_switch_32 -->	0	76.35	84.02	32.215
London / Serial0/0 <-> layer2_switch_32 <--	0	60.86	67.15	25.626
Paris / Serial0/0 <-> layer2_switch_32 -->	0	60.74	67.03	25.572
NY_Pri_IDC / Serial2/1 <-> layer2_switch_32 -->	0	53.06	58.80	22.272
SanDiego / Serial0 <-> layer2_switch_32 <--	0	52.76	58.49	22.139
ATT / Serial0/0 (12_0_1_2) <-> NY_Pri_IDC / Serial2/0 (12_0_1_1) -->	0	50.77	58.16	23.996
Euro_Partner / Serial0/0 (10_4_5_2) <-> Paris / Serial0/1 (10_4_5_1) -->	0	38.07	43.85	15.787
SF / Serial0 <-> layer2_switch_32 <--	0	30.84	38.65	13.589
SF / Serial0 <-> layer2_switch_32 -->	0	30.83	38.64	13.587
Boston_Bkup_IDC / Serial2/0 (4_0_2_1) <-> Genuity / Serial0/0 (4_0_2...	0	21.90	23.66	10.094
Atlanta / Serial0/0 <-> layer2_switch_32 -->	0	19.21	21.28	8.089
Atlanta / Serial0/0 <-> layer2_switch_32 <--	0	19.17	21.24	8.067

Figure 4-30 Find Top Statistics

As you can see, the **NY_Pri_IDC / Serial2/1 layer2_switch_32** link is overloaded. Also, **ATT / Serial0/0 (12_0_1_2) NY_Pri_IDC / Serial2/0 (12_0_1_1)** is nearly overloaded.

End of Procedure 4-7

Summary

You have found that your network will not be able to handle the additional traffic generated by AllFirstTrust. You have several possible solutions, assuming you still want to add this client. You can upgrade the links that will be at or near overloading. You could also attempt to change the routing on your network to redistribute some of the additional traffic to avoid overloads.