NETWARS

Introduction to the ACE Editors

2005-1 Final User's Guide (OPNET 230)

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Identification

Document Identification

Document Title: Introduction to the ACE Editors
Version: Final (OPNET 230)

Software Identification

Product Name: NETWARS
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
August 31, 2005	5.1 Final	All	Changed document title from *Introduction to ACE* to *Introduction to the ACE Editors* to better reflect the relationship to NETWARS. Chap. 1: Rewritten to more directly address the 'why' & 'when' (not just the 'how') for NETWARS users utilizing the ACE Editors. Reorganized document around specific use cases rather than product workflow. Moved chapters on 'Capturing Application Traffic' and 'Importing Capture Files' to Appendices.
May 13, 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 access to an optional OPNET module called the Application Characterization Environment, or *ACE*. This user's guide, *Introduction to the ACE Editors,* describes how NETWARS users can utilize ACE and the ACE Whiteboard to perform network performance analysis and troubleshooting.

The examples provided in this guide were presented at OPNETWORK as part of various ACE-related workshops. If you do not have access to the sample files referenced in a particular example, simply view the screenshots provided in this guide.

Note—To learn more about the ACE module, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

Referenced Documents

- *ACE User Guide*, OPNET Technologies.

ACE Editors Overview

The capabilities of the NETWARS software are organized into multiple editors: the System Editor, the Scenario Builder, the IER Editor, the Icon Editor, and (if you have an ACE license) ACE and the ACE Whiteboard.

- **ACE** allows you to troubleshoot application and network performance problems by analyzing raw traffic data files obtained from a live network without months of data gathering and error prone traffic approximations (i.e, IERS).
- **ACE Whiteboard** enables you to predict application performance under varying configurations and network conditions, and simulate the behavior of an application that does not exist yet by creating a model of the application and then running analyses on it.

Thus, the ACE Editors can be used in a pre-deployment environment to assist in application rollouts on the network, or in a post-deployment environment to troubleshoot the behavior of existing applications on the network.

When Should You Use the ACE Editors?

The ACE Editors can help you to answer important questions about your network such as:

- *Why is my application slow?* (Use Case 1: Troubleshooting Problems)
  - — User's desktop running slowly?
  - — Server delays?
  - — Application not doing what it's supposed to do?
  - — Non-optimal TCP settings?
  - — Heavy congestion over WAN?
  - — Too little bandwidth?
  - — Latency too high?
- *Can this new application be deployed over our network?* (Use Case 2: Predicting Performance)
  - — Will users have to wait two seconds or two minutes?
  - — Will deploying this applicaiton impact other critical applications?
  - — Do you need to add bandwidth?

Use Case 1: Troubleshooting Applications Using the ACE Editor

The standard workflow to follow when using ACE to troubleshoot applications on your network is provided below:

- Identify application with performance issues,

- Work with users to enumerate tasks or workflows that have performance issues,
- Capture each task from production network, trying to reproduce bad performance,
- Import traces into ACE,
- Visualize, diagnose, and perform predictive analysis, and
- Create reports to share what you have learned.

Use Case 2: Predicting Application Performance Using ACE Whiteboard

The standard workflow to follow when using ACE Whiteboard to predict application performance before deployment is provided below:

- Determine key workflows and tasks:
  - — Frequent tasks, and
  - — Big tasks.
- Capture key tasks in lab environment:
  - — One capture file per task, and
  - — All tiers usually on same LAN.
- Import a task into ACE,
- Create templates of import and report options, prediction scenarios, etc.,
- Import other tasks,
- Flag tasks with application problems,
- Use QuickPredict to predict performance from different sites, and
- Optional: Use Discrete Event Simulation (DES) to predict response times or perform server capacity planning.

ACE Inputs and Outputs

The ACE Editors require ACE traffic data (atc.m) files (called “trace files” or “capture files” as input. Trace files are simply a snapshot of the application traffic in your network. This traffic is in the form of packets generated by your applications. Assuming that the trace files were captured correctly, their traffic information would be more accurate that any user approximations of real-world traffic using IERs in NETWARS.

The ACE Editors analyze your traffic data and present results in:

- Reports, graphs, and tables,
- Visualization of application behavior,
- Diagnosis of bottlenecks and performance problems,
- Predictive analysis of same traffic on different network, and
- Information NETWARS can use for capacity planning studies.

ACE Features and Tools

ACE provides several important features and tools to help you visualize, analyze, diagnose, and predict network traffic behavior.

For additional product information, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

Visualization Features

ACE includes three different windows for viewing your application; often you can troubleshoot an application just by viewing it in one of these windows. You can also use these windows to remove or delete sections of an ACE file, and thereby focus on transactions of interest:

- Treeview window—Organizes a task into tier pairs, connections and frames. This window also shows summary information and a timeline of the individual transactions that make up your application.
- Data Exchange Charts—Use a timeline to show the overall flow of data between tiers. You can view applications from both the network and the application layer, quickly determine inefficient or “chatty” applications, and pinpoint delays in both the network and the application.
- Tier Pair Circle window— View all tier-pair conversations in your ACE file. You can easily determine which tiers are conversing (and not conversing), view general information on each conversation, and zero in on conversations of interest.

Refer to Chapter 2 in this user’s guide for more information. For additional product information, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

AppDoctor Tool

The AppDoctor feature includes three different tools for performing high-level analysis. You can use AppDoctor to identify and diagnose bottlenecks, determine the relative amounts of application vs. network delay, and view detailed statistics on your network and application. ACE also allows you to decode and analyze the protocol and application data found in individual packets.

Refer to Chapter 2 in this user's guide for more information. For additional product information, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

Predictive Features

ACE includes four separate predictive features: QuickPredict, QuickRecode, discrete-event simulations, and ACE traffic flows.

- QuickPredict—This feature provides instant feedback on how network variations will affect an application's performance. This allows you to answer questions such as, "If I double the bandwidth between two tiers, will it speed up my application's response time?".
- QuickRecode—You can use this feature to predict how proposed fixes and changes to your application will affect its performance. You do this by manually editing your ACE file to create a "hypothetical application" and comparing its performance to the original. This enables you to study questions such as, "How will my application be affected if my database could transmit a record in 30 messages, instead of the current 300?"
- Discrete-event ACE simulations—You can take full advantage of OPNET's event-based simulation technology and model library to test your application in a wide variety of network scenarios. For example, you could create a "virtual deployment" of an FTP application to test the effects of multiple downloads on the application's overall response time. Using the Import from ACE operation, you can easily generate and configure network scenarios based directly on an ACE task.
- Given an existing network, you can import end-to-end traffic directly from ACE. You can also scale the ACE traffic to model the effects of multiple iterations on a single node or multiple nodes. ACE traffic flows are especially useful when you want to study the effects of massive deployments, in which a discrete-event simulation of hundreds or thousands of transactions would require too much time or memory.

Before You Begin

Before you can use the ACE Editors to perform traffic analyses, you must have ACE traffic data (atc.m) files to use as input. If you do not have these files, you can create them and import them for use in the ACE Editors. This involves two general steps:

1) Capturing application traffic—ACE uses raw traffic data, captured from your network, as the basis for modeling an application. You can use ACE's application capture utility or a third-party tool such as Sniffer to create these *capture files*.

   Refer to Appendix A in this user's guide for more information. For additional product information, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

2) Importing the capture file—The ACE Import Wizard guides you through the process of importing your capture data. This wizard might prompt you for additional information about your network, such as tier locations and the bandwidths of certain connections. ACE can import multiple capture files of the same exchange and merge the results into an accurate, realistic model of your application. Using ACE's capture and import features, you can model highly complex application exchanges that span many tiers.

   ACE can import capture files from external programs like Sniffer and TCPdump. ACE also interfaces with the conversion utility ProConvert to support a wide variety of other formats.

   Refer to Appendix B in this user's guide for more information. For additional product information, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

2 Troubleshooting Applications Using the ACE Editor

The ACE Editor provides visualization graphs, diagnosis charts, and predictive analysis features and tools to enable you to analyze 'near real' NETWARS traffic data obtained via capture agents from a real network without months of data gathering and error prone traffic approximations (i.e., IERs).

Use the ACE Editor features and tools described in this chapter to generate the most granular traffic description of NETWARS traffic available today.

Note—For instructions for capturing NETWARS traffic data using ACE's application capture utility or a third-party tool such as Sniffer, refer to Appendix A. For instructions for importing captured data into the ACE Editor for analysis, refer to Appendix B.

Overview of ACE Editor Features

The ACE Editor provides three primary windows for visualizing your application:

- Treeview window—Organizes a task into tier pairs, connections and frames. This window also shows summary information and a timeline of the individual transactions that make up your application.

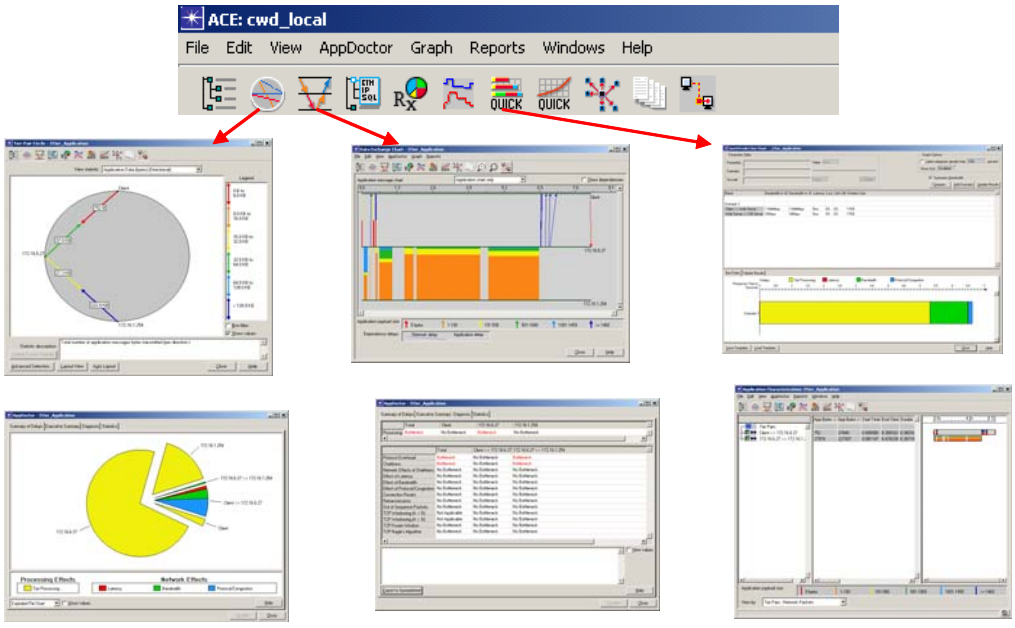


Figure 2-1 ACE Visualization Windows and Charts

- Tier Pair Circle window— View all tier-pair conversations in your ACE file. You can easily determine which tiers are conversing (and not conversing), view general information on each conversation, and zero in on conversations of interest.
- Data Exchange Charts—Use a timeline to show the overall flow of data between tiers. You can view applications from both the network and the application layer, quickly determine inefficient or “chatty” applications, and pinpoint delays in both the network and the application.

For additional information about using ACE visualization windows and charts, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

Treeview Window

You can access the Treeview window by clicking the Treeview window toolbar icon. The Treeview window provides a breakdown of conversation pairs, organized in three views:

- Tier Pairs – Application Messages,
- Tier Pairs – Network Packets, and
- Application Messages.

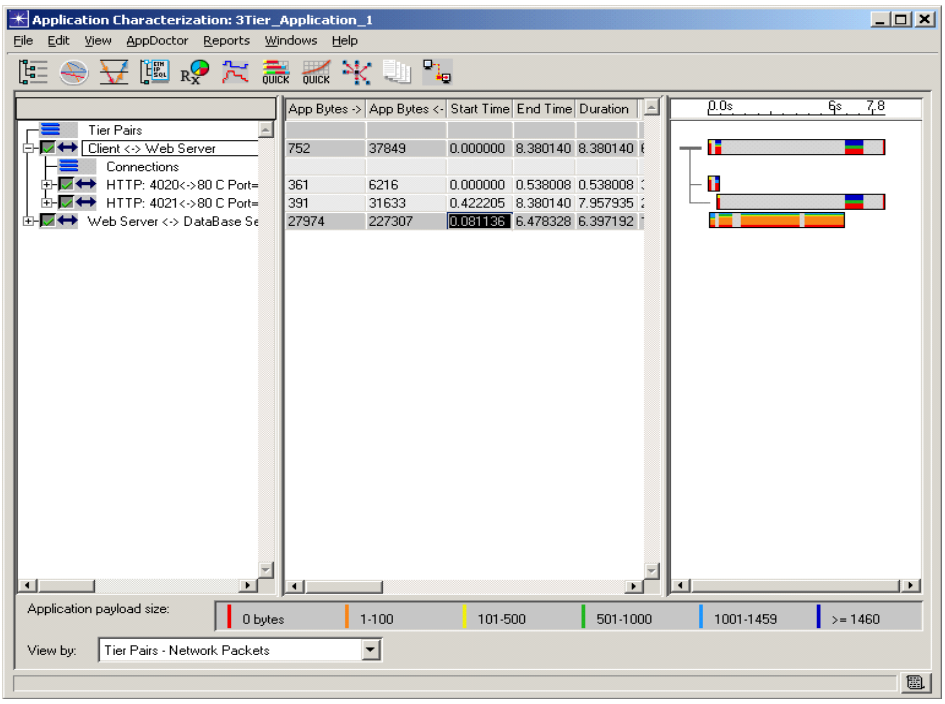


Figure 2-2 Sample Treeview window

Each view has three panes:

- Tree pane (on the left-hand side) showing tier pairs, connections, and frames,
- Table pane (center) shows detailed statistics by tier pairs, connections, and frames, and
- Timeline pane (on the right-hand side) shows an overview of messages (color coded by size) over the time of the task.

Tier Pair Circle Window

The Tier Pair Circle window shows the flow of data between different tiers for a transaction. Each arrow (in a one-way conversation) or arrow pair (in a two-way conversation) represents a conversation between tiers.

The Tier Pair Circle can also be used to visualize other statistics, such as:

- Response times,
- Application turns,
- Application information (Messages, Data, Average size),
- Network information (packets, data, average size),
- Latency,
- Bandwidth,
- Effects of Protocol/Congestion,
- Max Application Bytes Per Turn (directional),
- Max Unacknowledged Data (directional),

- Retransmissions, and
- Connections Resets.

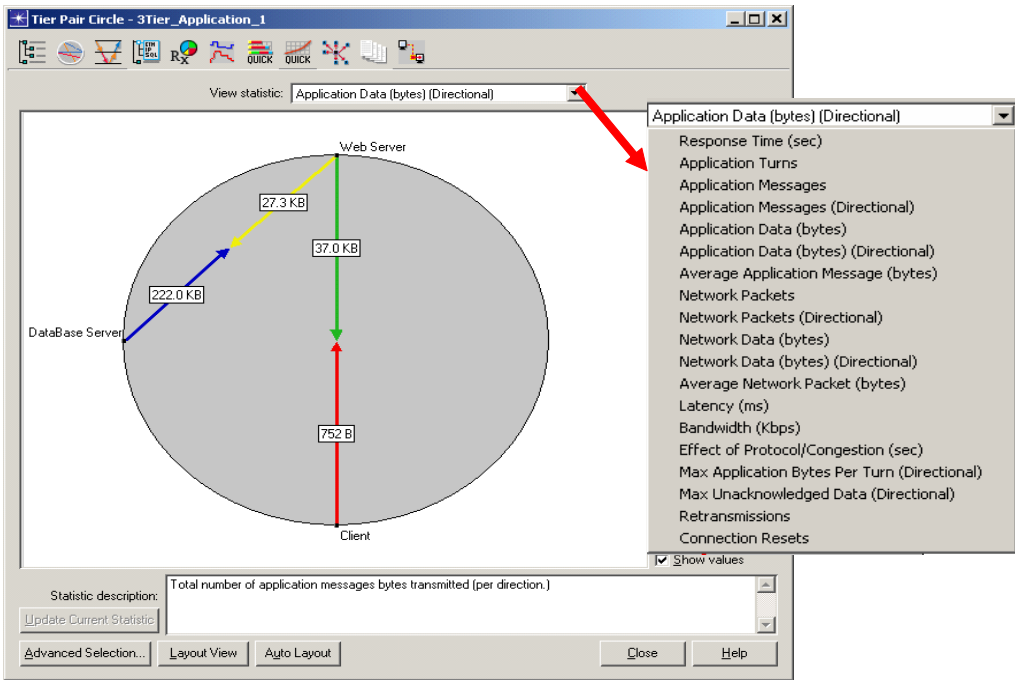


Figure 2-3 Sample Tier Pair Circle Window and Menu

Data Exchange Chart

The Data Exchange Chart shows the data transferred between tiers on a time line. As with the Tier Pair Circle window, the colors of the application messages indicate the size of the messages. Each group's color represents a histogram of message sizes.

Data provided on the Data Exchange Chart includes:

- Application messages (exchange between tiers),
- Application tiers,
- Network messages,
- Time line of task,

- Messages dependencies (application and network), and
- Application payload sizes.

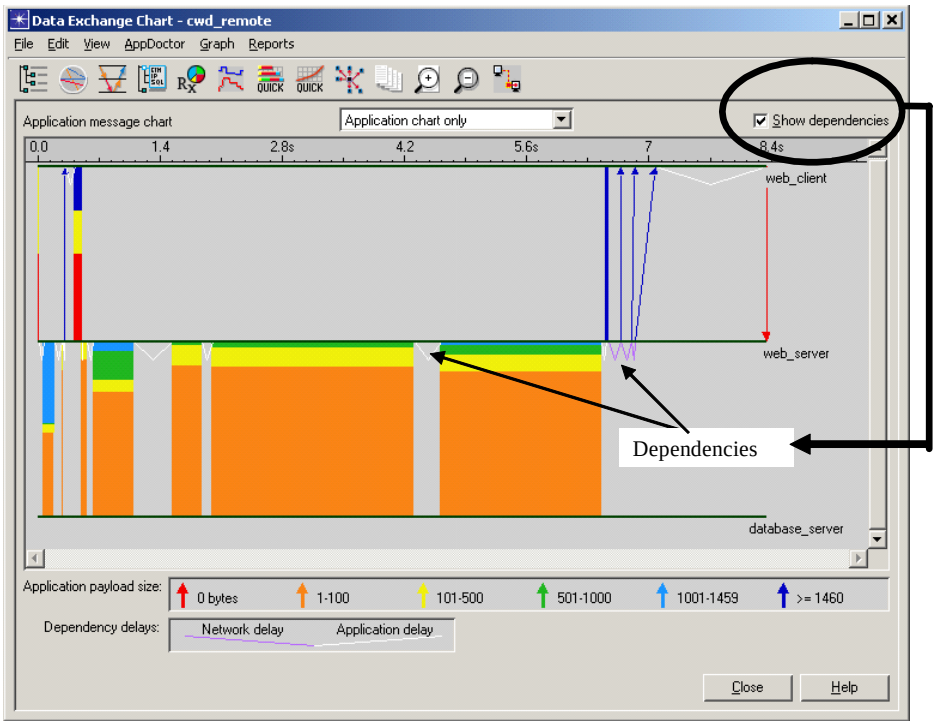


Figure 2-4 Sample Data Exchange Chart with Application Chart Only

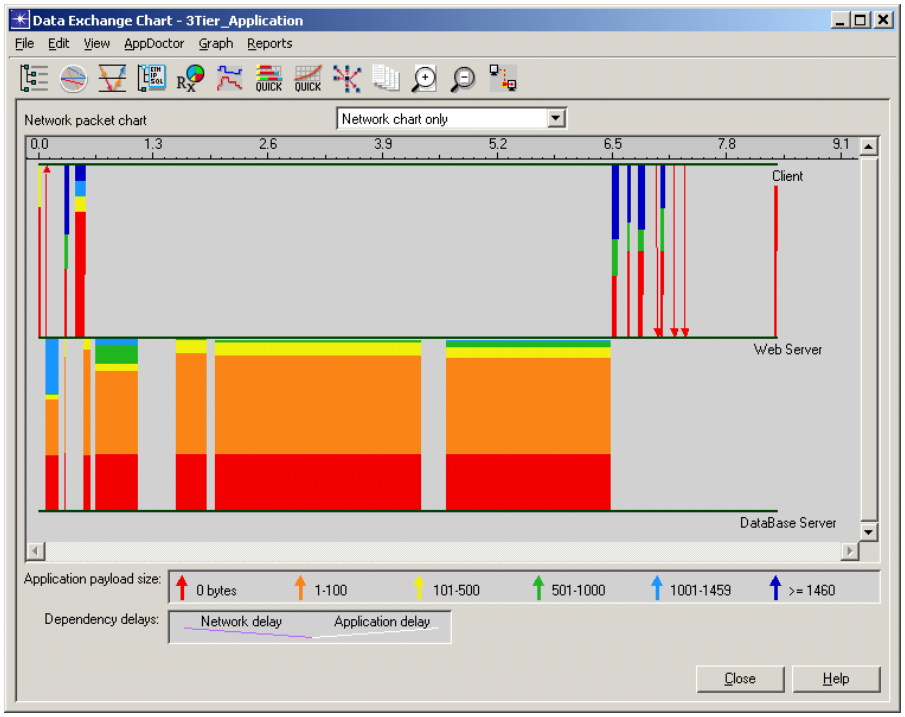


Figure 2-5 Sample Data Exchange Chart with Network Chart Only

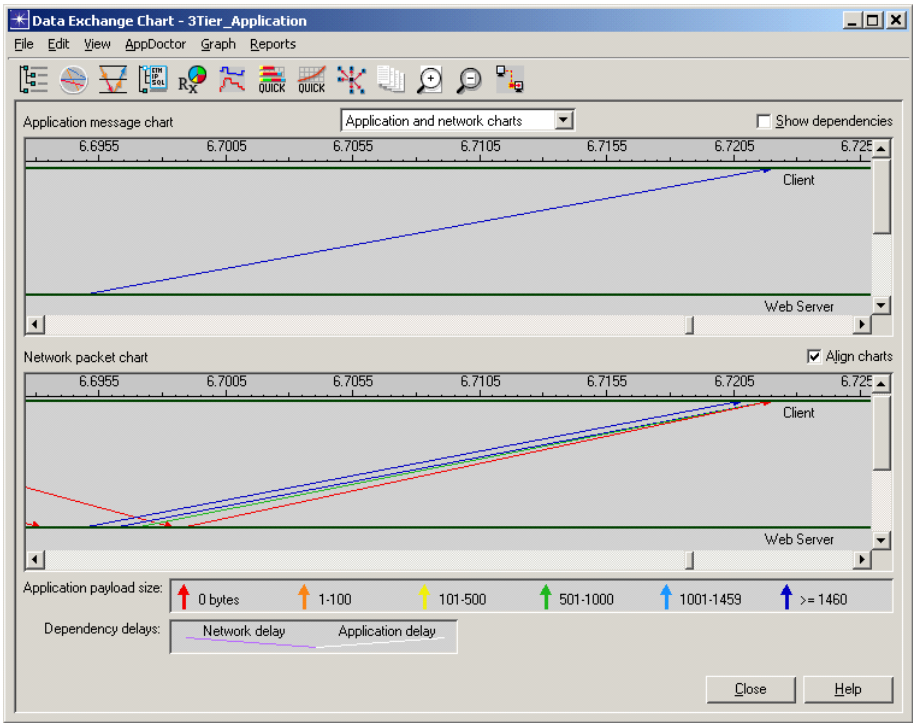


Figure 2-6 Sample Data Exchange Chart with Application and Network Charts

Overview of the ACE AppDoctor Tool

ACE's AppDoctor tool automates the process of application troubleshooting. AppDoctor finds the major components of delay and determines the root cause of application performance problems.

AppDoctor presents four (4) main tabbed windows, and if applicable, special tabs for specific statistical information:

- Summary of Delays window,
- Executive Summary window,
- Diagnosis window,
- Statistics window, and
- Special windows of statistical information (optional) for HTTP, Citrix ICA, Corba, and SOAP.

For additional information about AppDoctor, access the *ACE User Guide* by selecting **Help > ACE Product Documentation** from within ACE.

Summary of Delays Window

The AppDoctor Summary of Delays window divides the total application response time into separate components of network and application delay:

- Tier-Processing delay is the total time it takes to process the application at each tier, including user "think time".
- Latency delay is the component of delay due to latency in the network. (Latency is the time required for 1 bit to be transmitted across the network. Using ping is one way to measure latency.)
- Bandwidth delay is the component of delay caused by the limited bandwidth of the network.
- Protocol/Congestion delay is a metric of network restriction to packet flow. This restriction may be caused by packet queuing in the network (congestion), or by flow control mechanisms imposed by network protocols. TCP, for example, has several built-in flow control mechanisms.

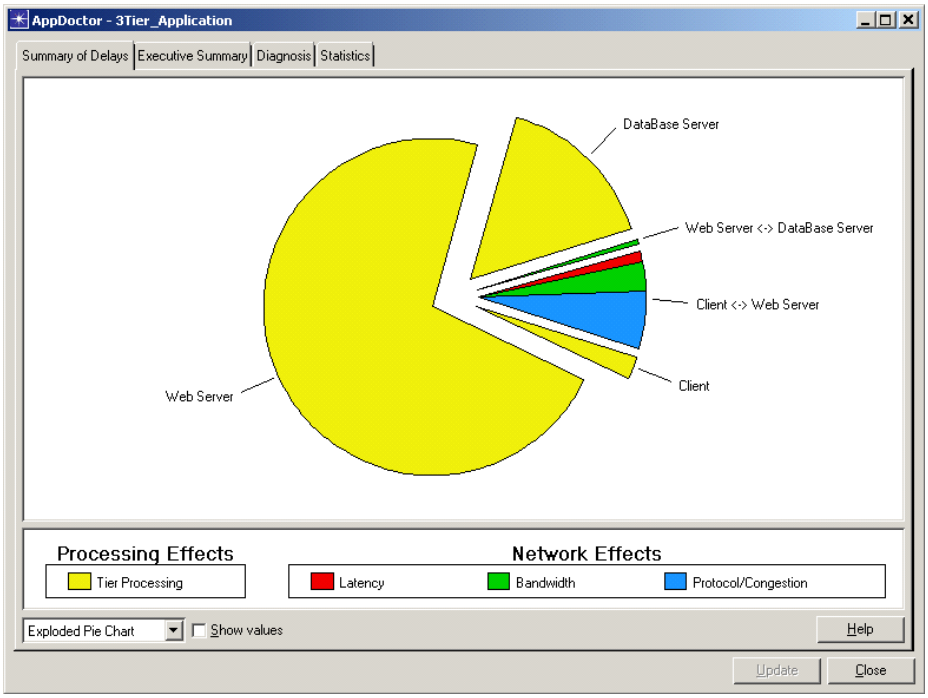


Figure 2-7 Sample AppDoctor Summary of Delays window

Executive Summary Window

The AppDoctor Executive Summary window provides the following information:

- Total Transaction time,
- Total Application data transferred,
- Single greatest cause of delay,
- Tiers in application, and
- Bandwidth and latency at each tier.

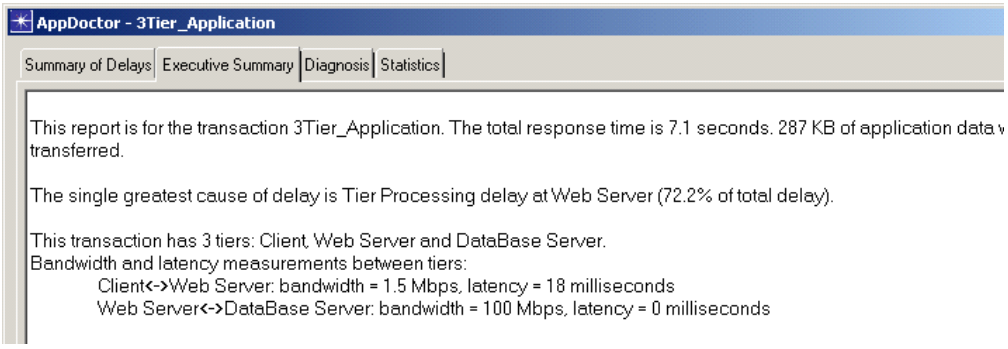


Figure 2-8 Sample AppDoctor Executive Summary window

Diagnosis Window

The AppDoctor Diagnosis window provides a detailed analysis of probable bottlenecks for the application. Bottleneck categories exist for both network and application issues and are identified by machine or by network segment.

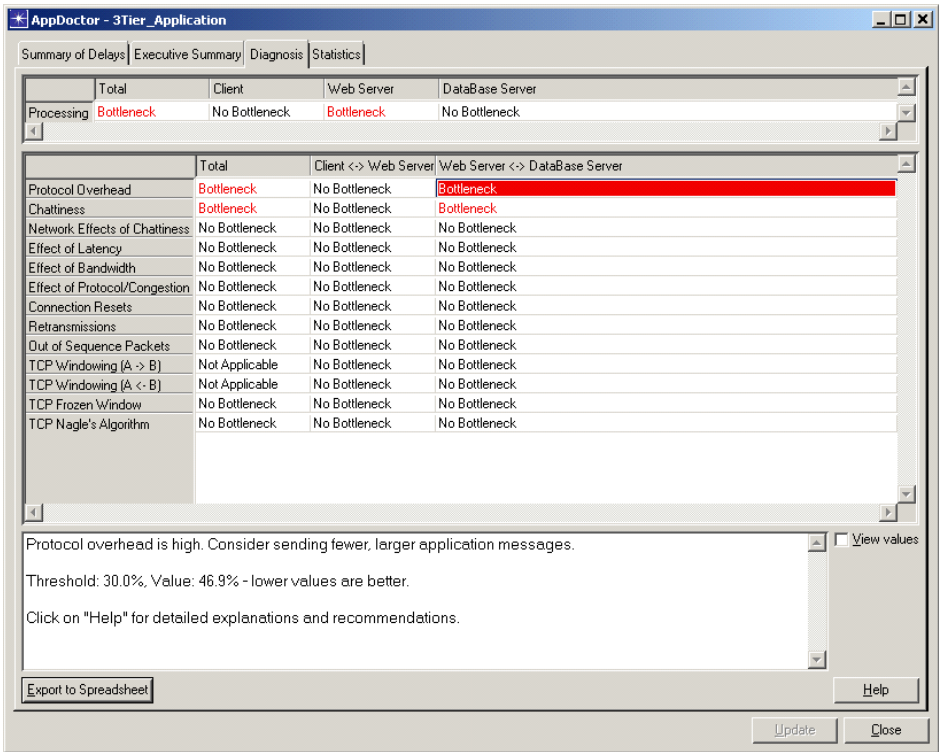
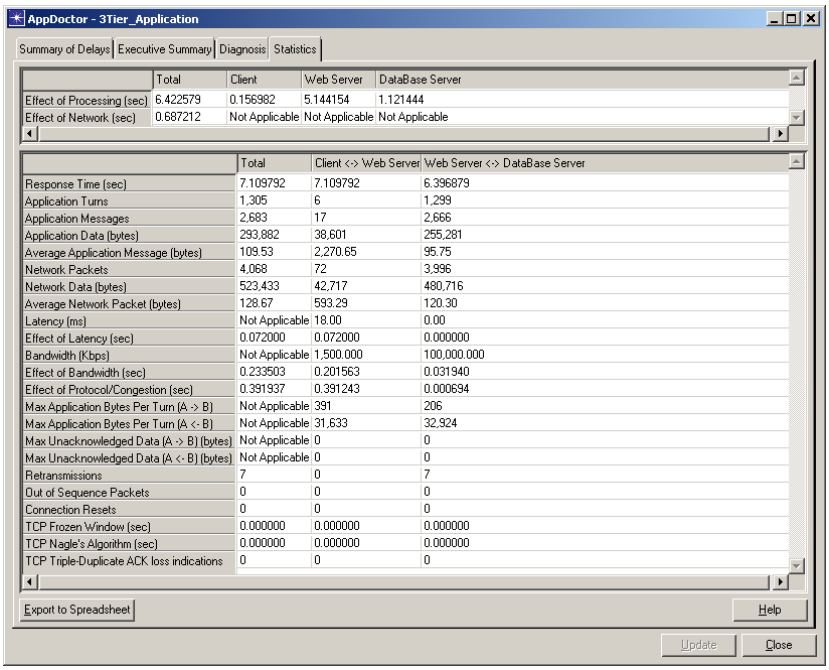


Figure 2-9 Sample AppDoctor Diagnosis window

Statistics Window

The AppDoctor Statistics window provides detailed task statistics by tier on various measures of network and application performance.



	Total	Client	Web Server	DataBase Server
Effect of Processing (sec)	6.422579	0.156982	5.144154	1.121444
Effect of Network (sec)	0.687212	Not Applicable	Not Applicable	Not Applicable

	Total	Client <-> Web Server	Web Server <-> DataBase Server
Response Time (sec)	7.109792	7.109792	6.396879
Application Turns	1,305	6	1,299
Application Messages	2,683	17	2,666
Application Data (bytes)	293,882	38,601	255,281
Average Application Message (bytes)	109.53	2,270.65	95.75
Network Packets	4,068	72	3,996
Network Data (bytes)	523,433	42,717	480,716
Average Network Packet (bytes)	128.67	593.29	120.30
Latency (ms)	Not Applicable	18.00	0.00
Effect of Latency (sec)	0.072000	0.072000	0.000000
Bandwidth (Kbps)	Not Applicable	1,500.000	100,000.000
Effect of Bandwidth (sec)	0.233503	0.201563	0.031940
Effect of Protocol/Congestion (sec)	0.391937	0.391243	0.000694
Max Application Bytes Per Turn (A -> B)	Not Applicable	391	206
Max Application Bytes Per Turn (A <- B)	Not Applicable	31,633	32,924
Max Unacknowledged Data (A -> B) (bytes)	Not Applicable	0	0
Max Unacknowledged Data (A <- B) (bytes)	Not Applicable	0	0
Retransmissions	7	0	7
Out of Sequence Packets	0	0	0
Connection Resets	0	0	0
TCP Frozen Window (sec)	0.000000	0.000000	0.000000
TCP Nagle's Algorithm (sec)	0.000000	0.000000	0.000000
TCP Triple-Duplicate ACK loss indications	0	0	0

Figure 2-10 Sample AppDoctor Statistics window

Troubleshooting Applications Using the ACE Editor

The following sample use cases illustrate three common application problems: bandwidth constraints, “chatty” applications, and TCP window constraints. Follow the procedures in this section to import three example application packet traces that show these different application and network issues or problems. Read each trace file, one at a time, and then use ACE diagnosis, visualization, and statistics features to study each of the problem traces and evaluate the results and findings in ACE.

Note—The following examples were presented at OPNETWORK 2004 in Session 1209, Introduction to Using ACE, as Lab 2. 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.

Use Case 1: Troubleshooting Bandwidth Constraints

Procedure 2-1 Diagnose an Application with Bandwidth Constaints

1 Launch NETWARS.

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

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

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

5 In the Select Capture File for Import dialog box, select the file named `1209_LAB_2_Problem1`, 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 Proceed through the ACE Import Wizard screens without modifying any data. The Treeview window displays the following information.

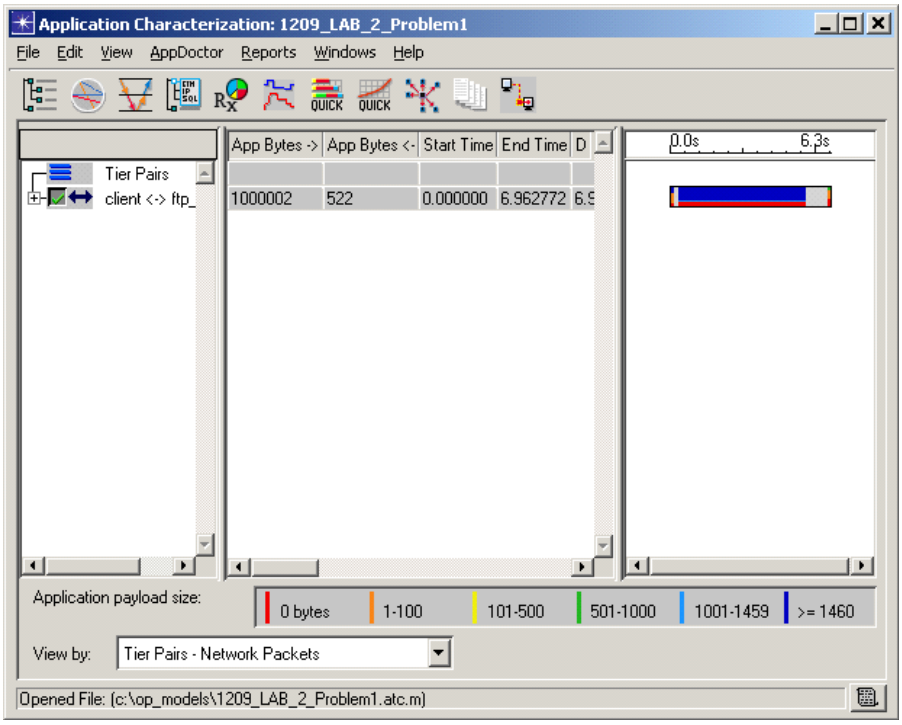


Figure 2-11 Treeview window

7 Click the Data Exchange Chart toolbar icon to switch to the Data Exchange Chart.

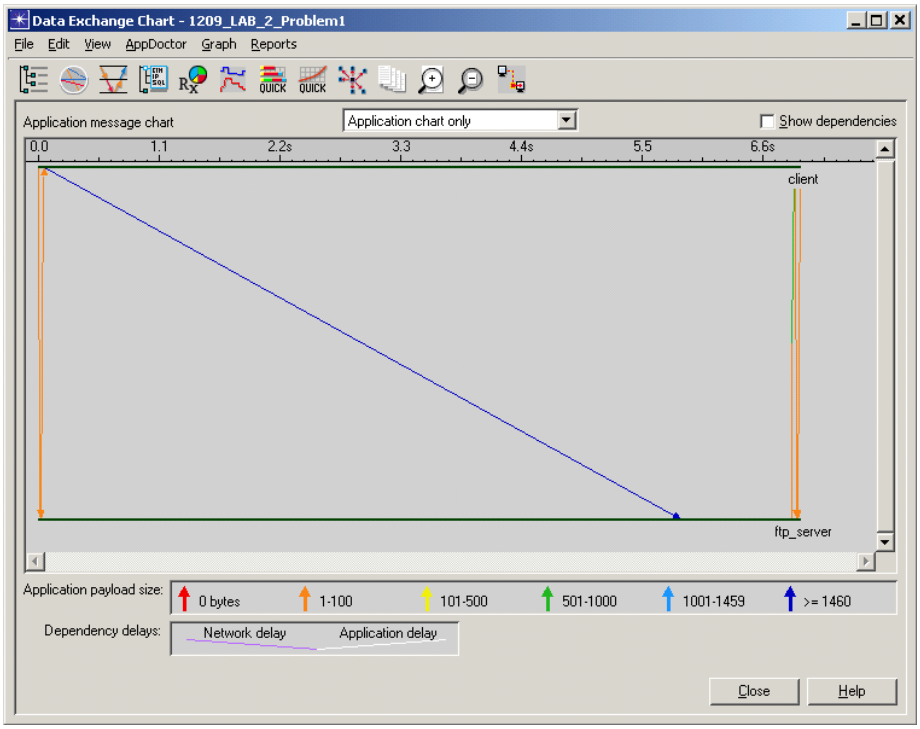


Figure 2-12 Data Exchange Chart

8 Click the AppDoctor toolbar icon, and then use AppDoctor to diagnose the trace.

This trace shows an application that is being constrained by bandwidth. Increasing the bandwidth would help this application with improved response time.

9 Click the QuickPredict toolbar icon, and then use QuickPredict to test the bottlenecks you find, and determine what changes would improve the response time (i.e., ranges, how much?)

The decision to be made involves weighing the cost of upgrading links vs. the gain in response time. A possible option would be to upgrade links in smaller increments to different user locations, based on urgency and user priorities.

10 Close all currently opened windows, except for NETWARS.

End of Procedure 2-1

Use Case 2: Troubleshooting Chatty Applications

Procedure 2-2 Diagnose a Chatty Application

1 Launch NETWARS.

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

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

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

5 In the Select Capture File for Import dialog box, select the file named `1209_LAB_2_Problem2`, 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 Proceed through the ACE Import Wizard screens without modifying any data. The Treeview window displays the following information.

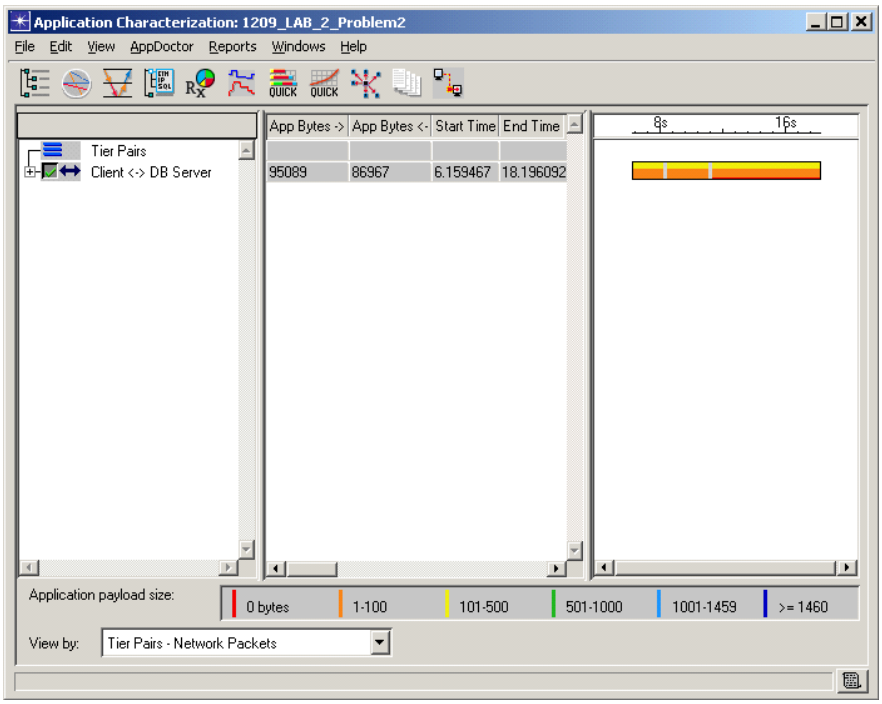


Figure 2-13 Treeview window

7 Click the Data Exchange Chart toolbar icon to switch to the Data Exchange Chart.

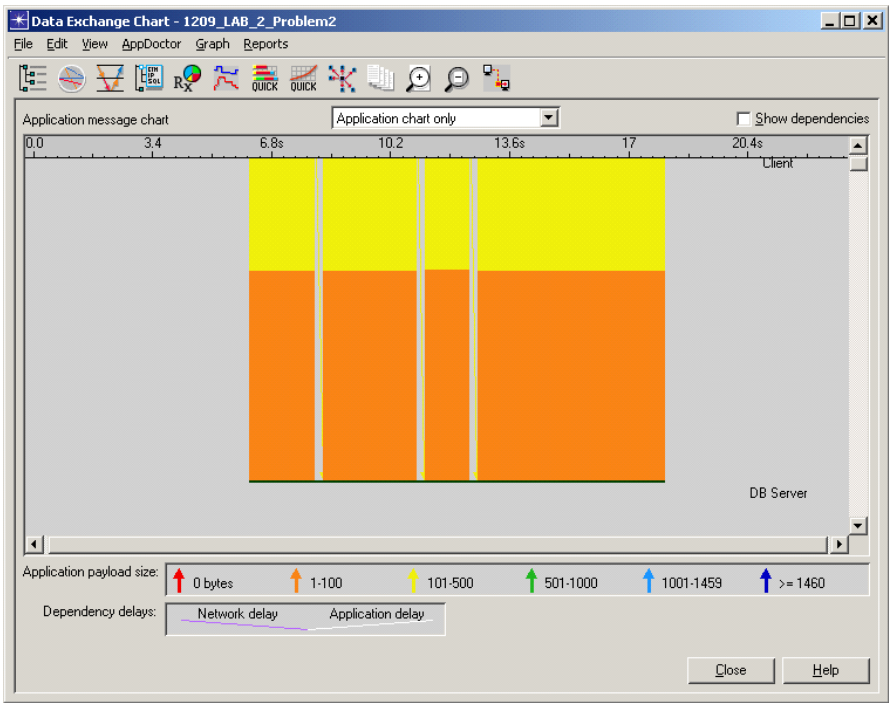


Figure 2-14 Data Exchange Chart

8 Click the AppDoctor toolbar icon, and then use AppDoctor to diagnose the trace.

This trace shows that the number of application “turns” (applications that are very “chatty”) could cause a considerable amount of delay, even for applications over a high-speed connection with low latency. A large number of turns through the connection will build up latency.

9 Click the QuickPredict toolbar icon, and then use QuickPredict to test the bottlenecks you find, and determine what changes would improve the response time (i.e., ranges, how much?)

The application would have to be modified to reduce its interaction/activity. This can be validated with “QuickRecode”.

10 Close all currently opened windows, except for NETWARS.

End of Procedure 2-2

Use Case 3: Troubleshooting TCP Window Constraints

Procedure 2-3 Diagnose an Application with TCP Window Contraints

1 Launch NETWARS.

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

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

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

5 In the Select Capture File for Import dialog box, select the file named `1209_LAB_2_Problem3`, 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 Proceed through the ACE Import Wizard screens without modifying any data. The Treeview window displays the following information.

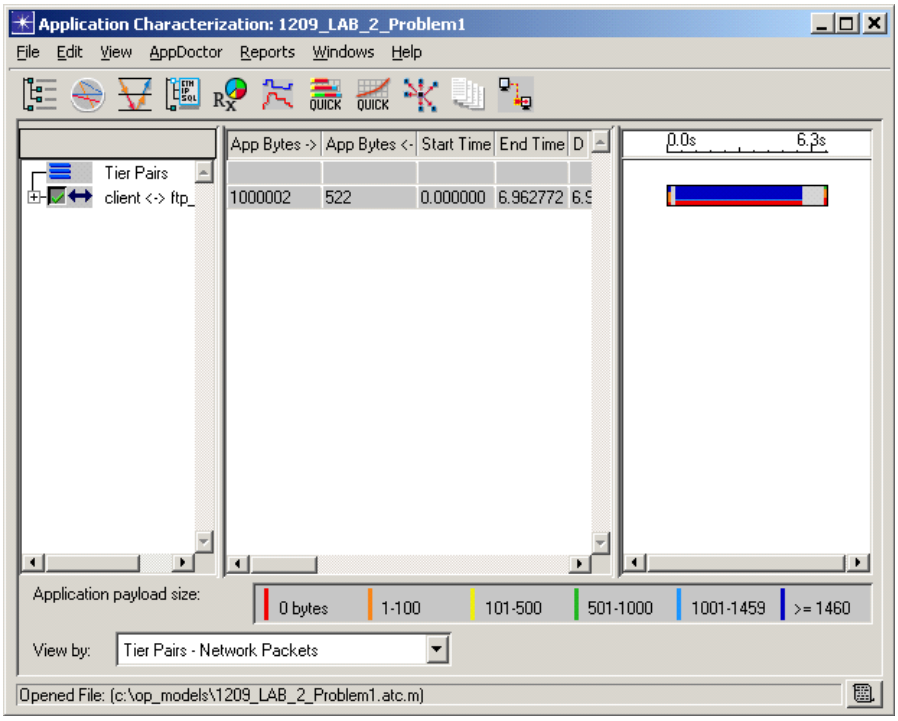


Figure 2-15 Treeview window

7 Click the Data Exchange Chart toolbar icon to switch to the Data Exchange Chart.

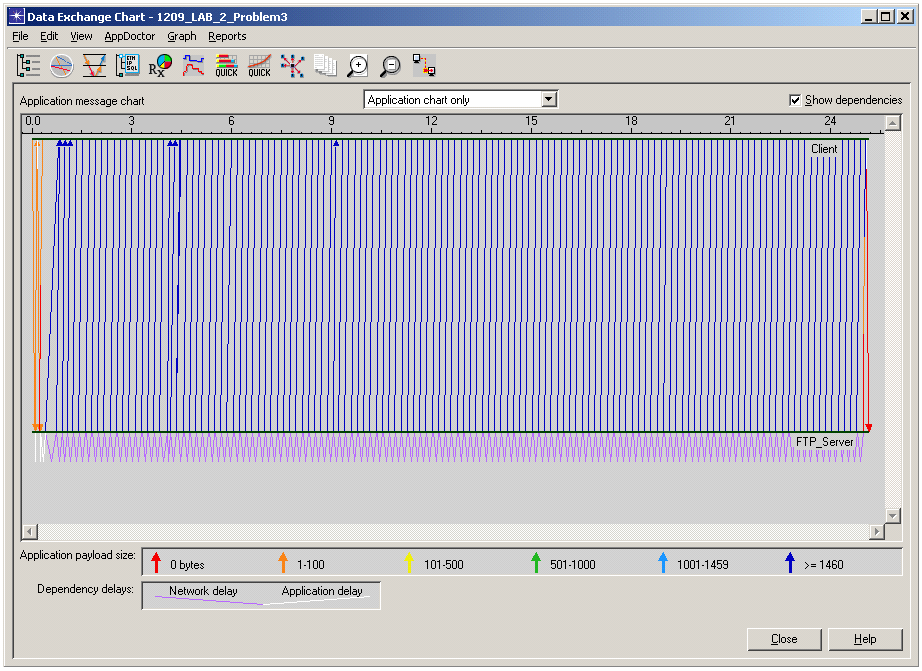


Figure 2-16 Data Exchange Chart

8 Click the AppDoctor toolbar icon, and then use AppDoctor to diagnose the trace.

This trace shows the application is constrained by the TCP window. The application could complete faster, but the TCP window size between the Client and Server was not set for optimum use by this application. This can be validated with QuickPredict.

9 Click the QuickPredict toolbar icon, and then use QuickPredict to test the bottlenecks you find, and determine what changes would improve the response time (i.e., ranges, how much?)

Operating systems have standard defaults for the TCP Window size (i.e., Windows NT = 8K, Windows 2K = 17K). Some applications programmatically set the TCP window size.

10 Close all currently opened windows, except for NETWARS.

End of Procedure 2-3

Analyzing an FTP Download

In the following example, the client is executing a large FTP download over a T1, but is only observing approximately 400 Kbps of throughput. The network has high and variable latencies. There are traces already captured at Client and FTP Server.

We will merge the client trace with the FTP server trace within ACE to generate an accurate model of the transaction. This production environment, with high/variable latency, lends itself to diagnosing the problem using the ACE trace merge feature. Then we will use the ACE diagnostic and visualization capabilities to identify the bottleneck, and contrast trace merge to single trace import in this production environment.

Note—The following example was presented at OPNETWORK 2004 in Session 1415, Application Capture and Import Strategies with ACE, as Lab 2. 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.

Procedure 2-4 Analyze an FTP Download

1. Launch NETWARS.
2. From the System Editor's **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, select **ACE**, and then click **OK**. The ACE Import: Choose Capture File(s) dialog box displays.
4. Click **Add Capture File**. The Select Capture File for Import dialog box displays.
5. In the Select Capture File for Import dialog box, select the file named `1415_lab_2_FTP_download_client.enc`, 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.
6. Click **Add Capture File**. The Select Capture File for Import dialog box displays.

7 In the Select Capture File for Import dialog box, select the second file named `1415_lab_2_FTP_download_server.enc`, and then click **Open**. The selected file name displays in the **Capture File** column of the ACE Import: Choose Capture File(s) dialog box.

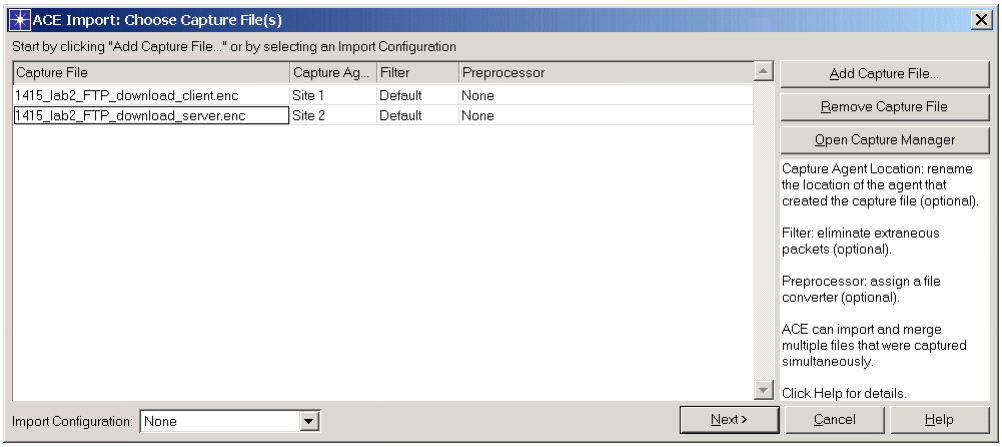


Figure 2-17 ACE Import: Choose Capture File(s) dialog box

8 After you have specified the two (2) capture file(s) to import in the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

9 Assign a **Tier Name** to each **Hostname** as indicated below.

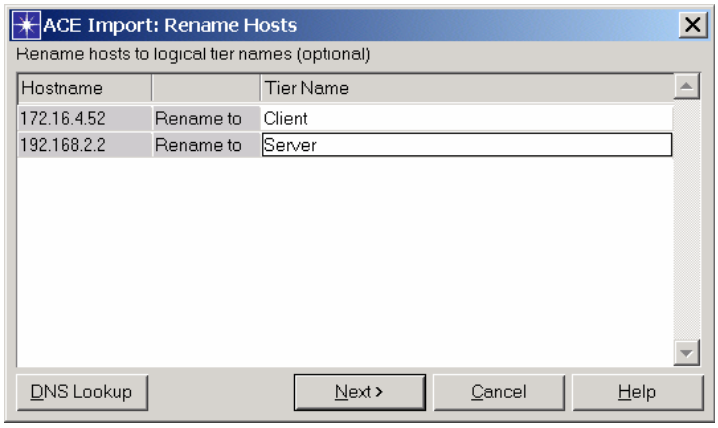


Figure 2-18 ACE Import: Rename Hosts dialog box

10 Click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

Notice that both Tiers' locations were **Auto-detected** by ACE. When the traces being merged contain shared traffic, ACE will auto-detect tier locations.

11 Click **Next**. The ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

12 Specify the bandwidth and latency between the capture locations. Specifying this information is *very important* for accurate AppDoctor results.

12.1 Specify 1,544 (Kbps) as the **Bandwidth**.

12.2 Note that the **One-way Latency** was **Auto-Detected** by ACE.

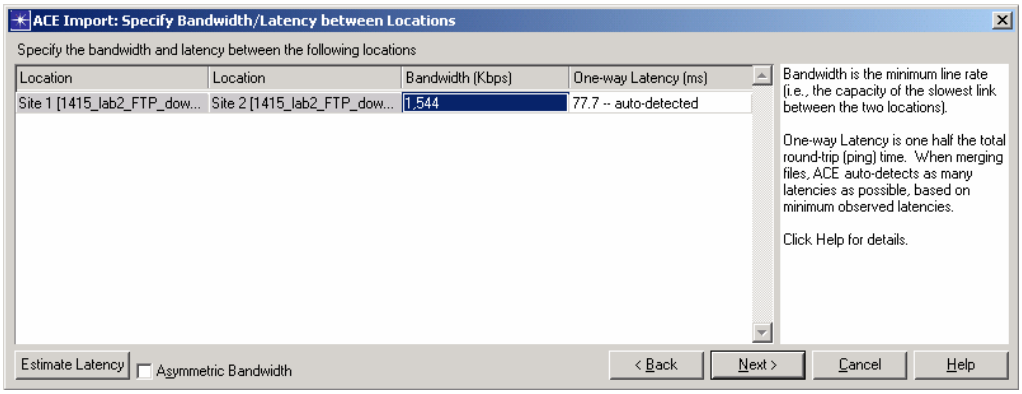


Figure 2-19 ACE Import: Specify Bandwidth/Latency between Locations dialog box

13 Click **Next**. The Save Import Configuration dialog box displays.

To finish the import, you can save an import configuration to avoid typing in all of the information again if you were to import another set of traces that were captured at the same locations. You can also select the view that will be launched when the import completes.

14 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

15 View the merged result using the Data Exchange chart (shown below).

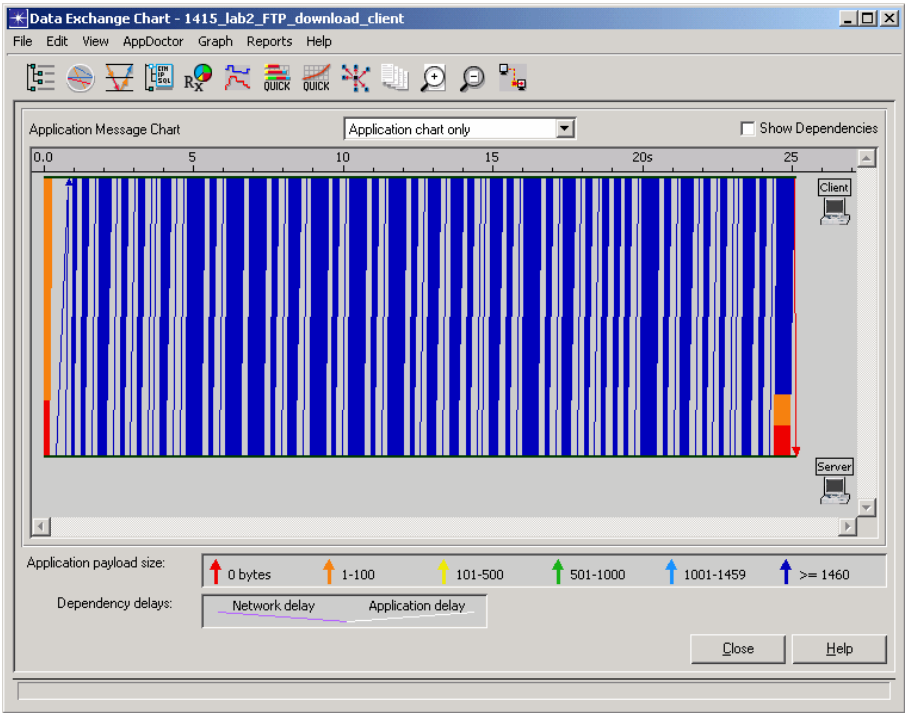


Figure 2-20 Data Exchange Chart

16 For diagnosis, select **AppDoctor > AppDoctor Analysis** or click the **AppDoctor** toolbar icon, and display AppDoctor's Summary of Delays window.

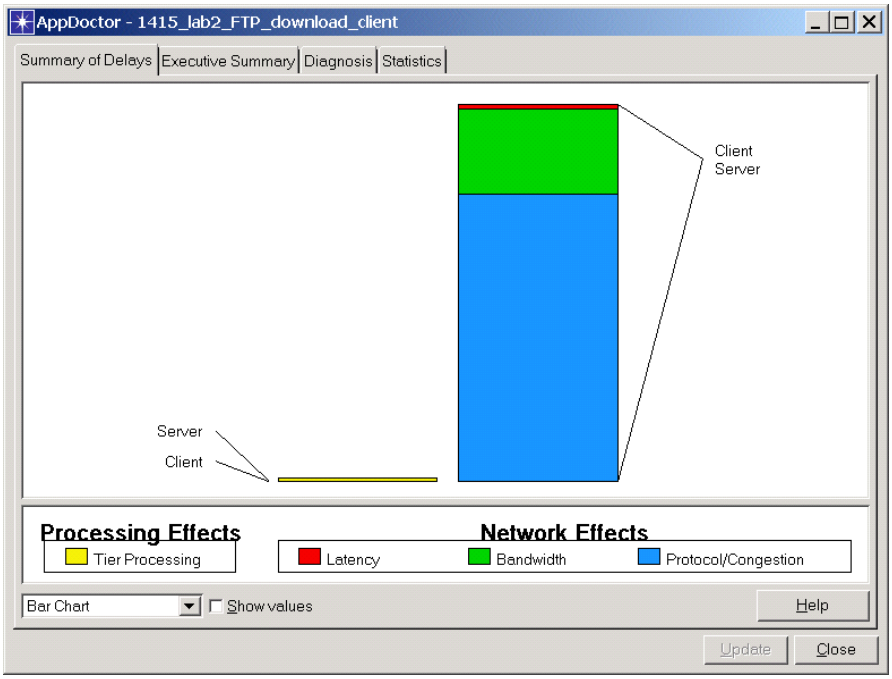


Figure 2-21 Summary of Delays window

17 Use the drop-down menu to view the various options (bar chart, pie chart, exploded pie chart).

The big portion of delay seems to be Protocol/Congestion.

18 Click the **Executive Summary** tab to display the Executive Summary window.

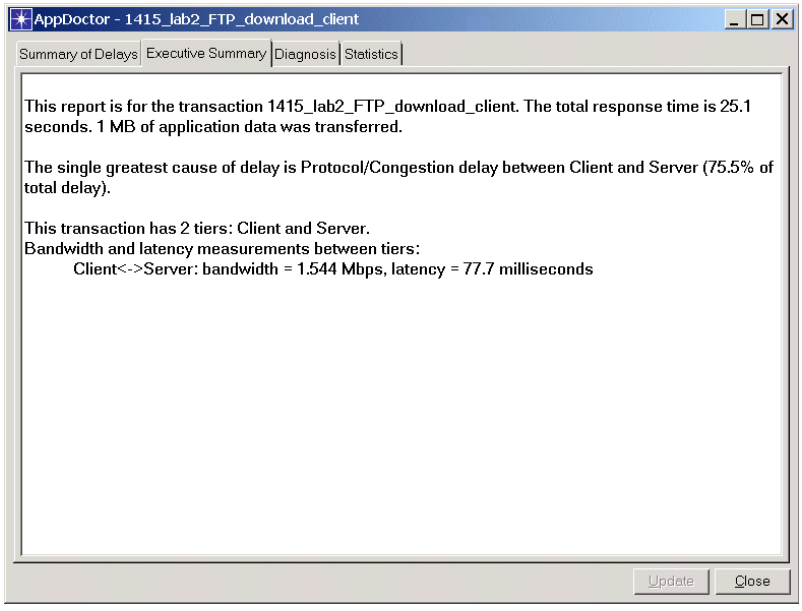


Figure 2-22 Executive Summary window

19 Click the **Diagnosis** tab to display the Diagnosis window.

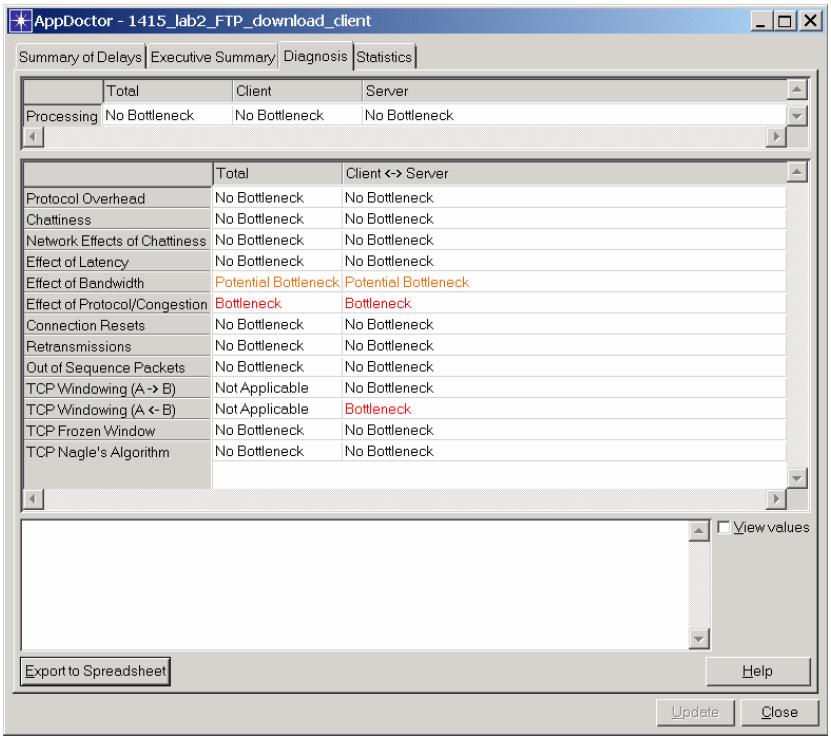


Figure 2-23 Diagnosis window

TCP Windowing (Server to Client) seems to be the bottleneck.

20 Click **Close** to close AppDoctor.

21 Zoom in on the network on the Data Exchange Chart by selecting **Network chart only** from the drop-down list.

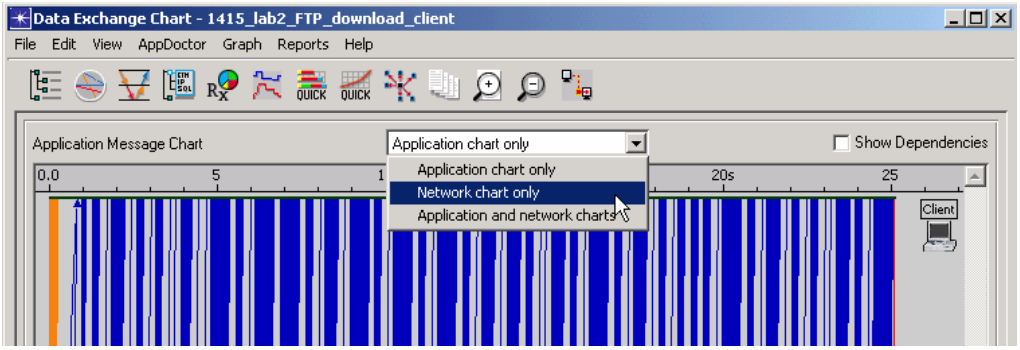


Figure 2-24 Data Exchange Chart drop-down list

22 Select **View > Set Visible Time Range** from the Data Exchange Chart's menu bar. Set the time range to "10.83 – 11.06".

23 Check the accuracy of the trace merge.

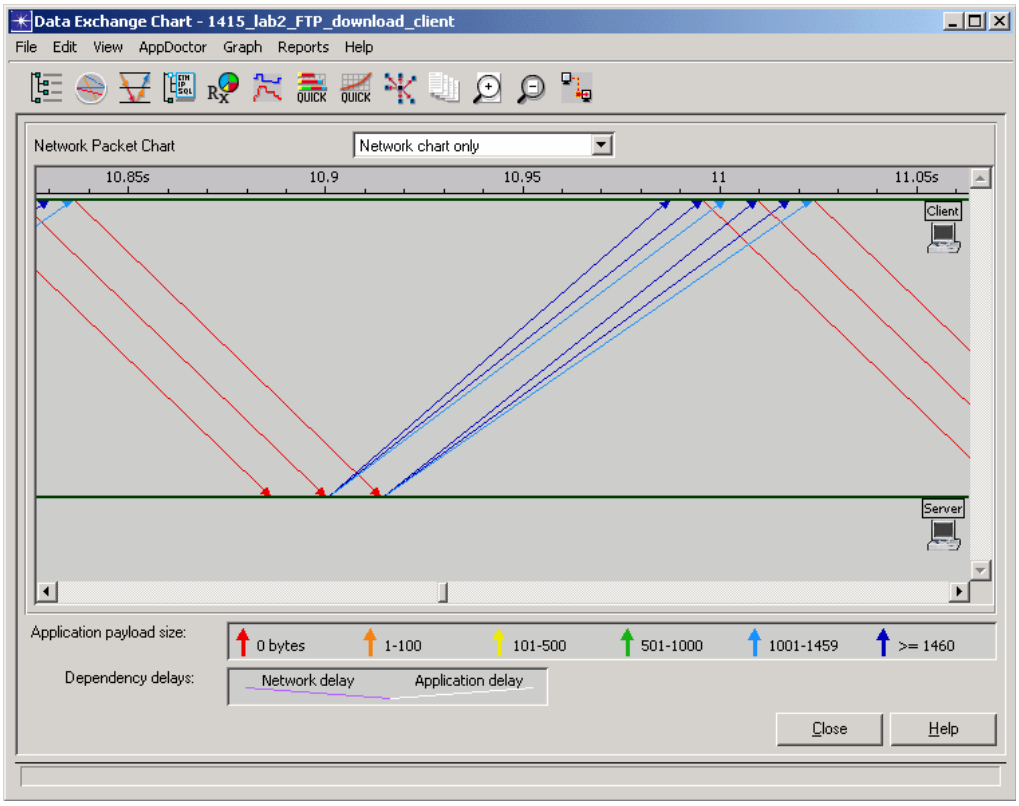


Figure 2-25 Data Exchange Chart with Network chart only

The Server is very clearly waiting for TCP ACKs before sending additional data. Note that large (blue) data packets are sent out simultaneously, but arrive fanned-out, which is caused by queuing in the network. The accurate, fanning-out visualization only exists with trace merge.

24 Compare the two-trace approach with the approach of only capturing traffic on the client side.

24.1 Do not close the existing trace; instead select **File > New > ACE**, and then click **OK**. The ACE Import: Choose Capture File(s) dialog box displays.

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

24.3 In the Select Capture File for Import dialog box, select the file named `1415_lab_2_FTP_download_client.enc`, and then click **Open**. The selected file name displays in the **Capture File** column of the ACE Import: Choose Capture File(s) dialog box.

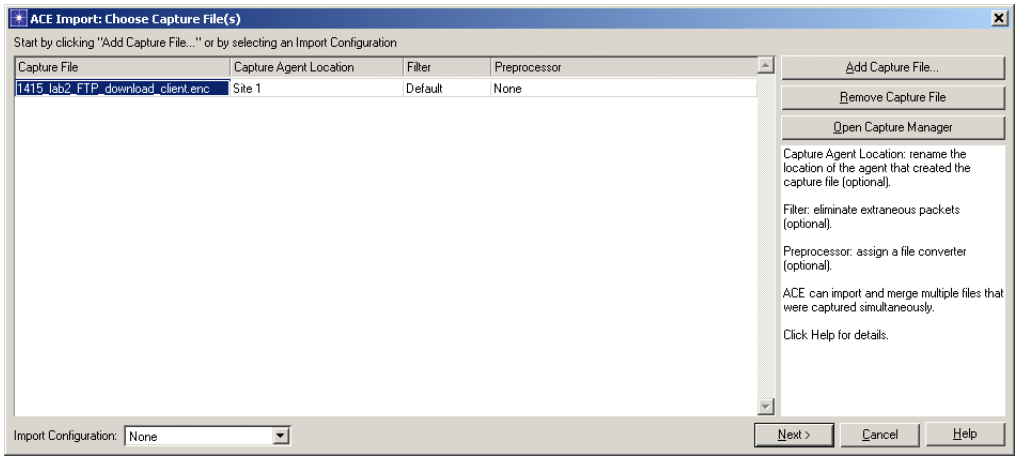


Figure 2-26 ACE Import: Choose Capture File(s) dialog box

24.4 Click **Next**. The ACE Import: Rename Hosts dialog box displays.

24.5 Assign a **Tier Name** to each **Hostname** as indicated below.

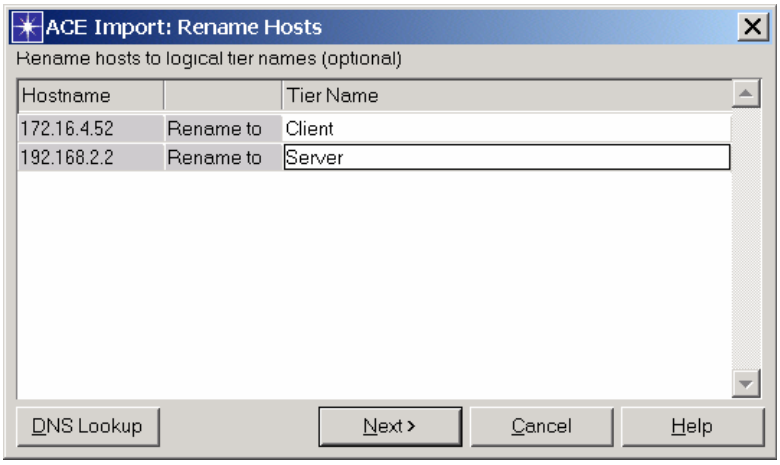


Figure 2-27 ACE Import: Rename Hosts dialog box

24.6 Click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

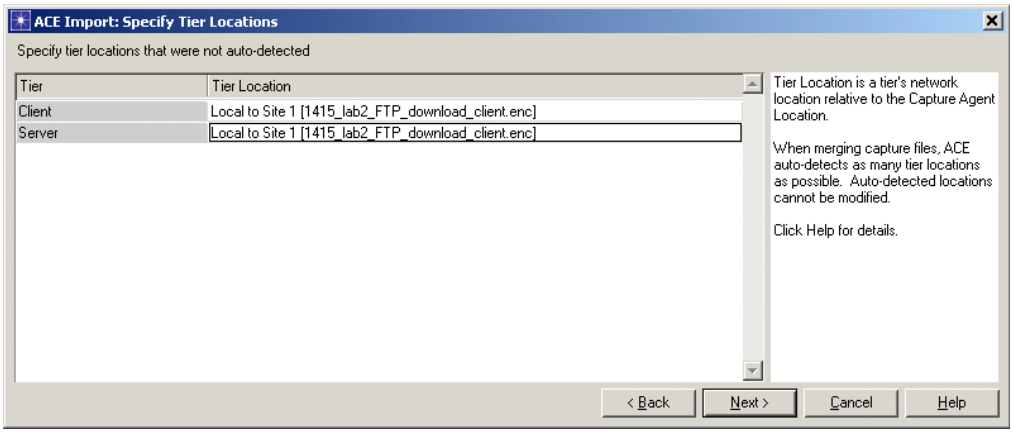


Figure 2-28 ACE Import: Specify Tier Locations dialog box

Notice that both Tiers have the same location. In a single trace import you need to input tier location.

This trace was captured near the Client; you need to change the Server Tier from Local to Site 1 to **Remote**.

24.7 Left-click the Tier Location for the Server and select **Remote**.

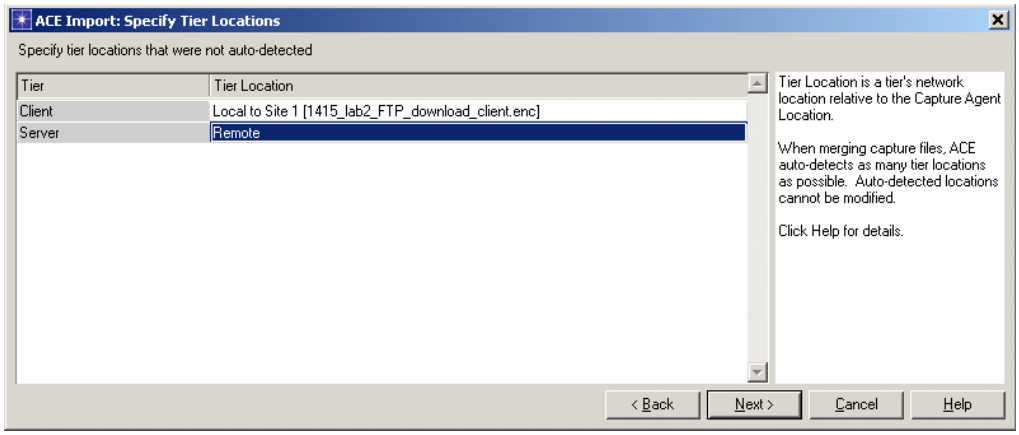


Figure 2-29 ACE Import: Specify Tier Locations dialog box

24.8 Click **Next**. The ACE Import: Specify Bandwidth for Segment dialog box displays. As the following screen is the Client side, leave it as is.

24.9 Click **Next**. The ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

24.10 Input the bandwidth and latency for the Server Bandwidth “1,544” (Kbps) and One-Way Latency “77.7” (ms) (this latency value was previously determined during trace merge.)

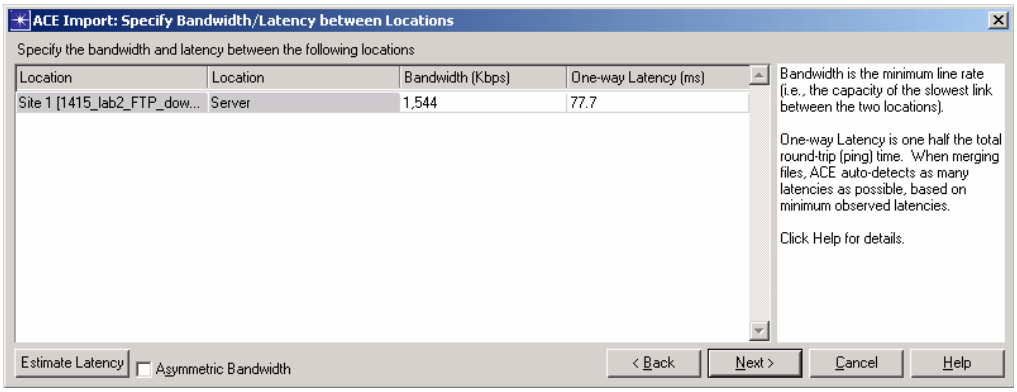


Figure 2-30 ACE Import: Specify Bandwidth/Latency between Locations dialog box

24.11 Click **Next**. The Save Import Configuration dialog box displays.

24.12 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

24.13 Zoom in on the network on the Data Exchange Chart by selecting **Network chart only** from the drop-down list.

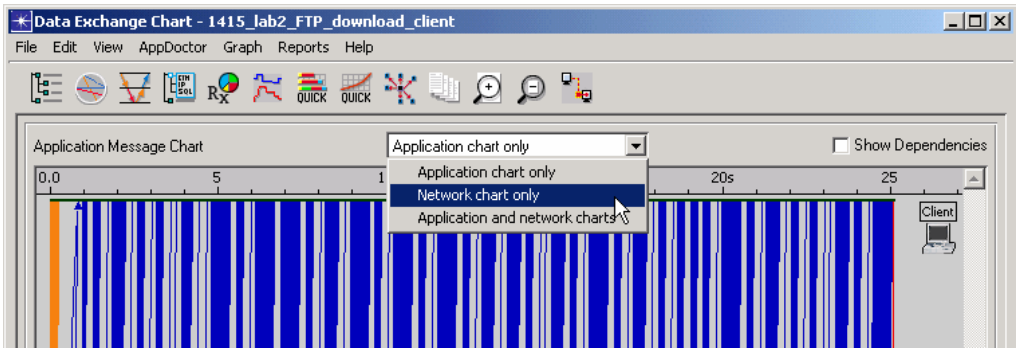


Figure 2-31 Data Exchange Chart drop-down list

24.14 Select **View > Set Visible Time Range** from the Data Exchange Chart's menu bar. Set the time range to "10.83 – 11.06".

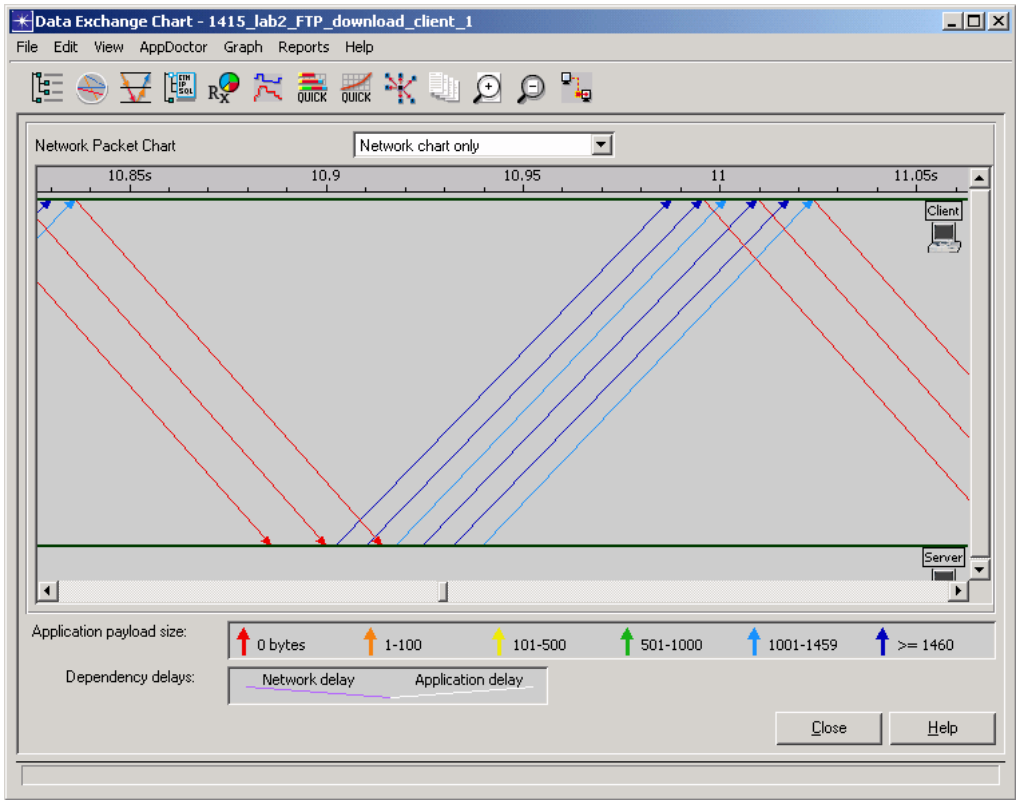


Figure 2-32 Data Exchange Chart with Network chart only

It is not as obvious that the Server was waiting for the TCP ACKs before sending additional data. Since only the Client trace was imported, the fact that all the large (blue) data packets were actually sent out simultaneously is not visible.

From this example, we can conclude that a trace merge paints a more accurate picture in high-latency, low-bandwidth environments.

End of Procedure 2-4

3 Predicting Application Performance Using ACE Whiteboard

Introduction

The ACE Whiteboard is an easy-to-use graphical environment for defining the behavior of an application. It is licensed as part of the ACE Module. You can use the ACE Whiteboard to create models of applications that do not yet exist. Also, you can substantially edit the behavior of applications captured with ACE in a lab or production environment. The application models created in the ACE Whiteboard can then be used in planning and prediction studies using QuickPredict or discrete event simulation.

Sample Use Cases

The ACE Whiteboard allows you to graphically create and modify application definitions, ranging from small changes to existing applications captured with ACE to creating new application models entirely from scratch.

Sample use cases for the ACE Whiteboard include the following:

- Use Case 1: You have captured an ACE trace of an application that currently exists in your network. This application always downloads an image of a fixed size. You are interested in studying how the application will perform if a different image size is used. You can use the ACE Whiteboard to:
  - — Import the existing ACE file of the transaction,
  - — Change the image size, and
  - — Use QuickPredict or Discrete Event Simulation to predict performance.

  An alternative approach is to parameterize the image size. This technique is shown in the section “Modify an Existing ACE File”, provided later in this chapter.

- Use Case 2: You have captured an ACE trace of a database application that currently exists on your network. This application has a variable number of SELECT statements, and the amount of data returned per statement is also variable. You can use the ACE Whiteboard to:
  - — Import the existing ACE file of the transaction,
  - — Use distributions for the number of requests and sizes of the responses, and
  - — Use Discrete Event Simulation to study the variability of the application’s response time.

- Use Case 3: You have captured an ACE trace of an application that includes a significant amount of user think time. You wish to study the response time of this application without user think time. You can use the ACE Whiteboard to:
  - — Import the existing ACE file of the transaction,
  - — Change the dependencies on the client to only reflect tier processing time, and
  - — Use QuickPredict or Discrete Event Simulation to predict performance.

- Use Case 4: You are planning to add more robust authentication to an existing login transaction. You have an ACE capture of the existing login and a separate ACE capture of the authentication transaction. You can use the ACE Whiteboard to:
  - — Import the two existing transactions into two separate ACE Whiteboard models, and
  - — Copy the first transaction and paste it into the second ACE Whiteboard model.

  A more advanced and flexible alternative is to use the ACE Whiteboard Scripting API to dynamically invoke or call one transaction from the other. This technique is shown in the tutorial “Advanced: Modeling an Application Using Logic Scripts” available by selecting **Help > ACE Tutorials** in ACE Whiteboard.

- Use Case 5: You are interested in predicting the response times for an application that either does not currently exist or cannot be captured in ACE. Based your knowledge of how the application behaves, you can graphically draw the application layer data exchange in the ACE Whiteboard. More advanced users can take advantage of Python scripting and the ACE Whiteboard Scripting APIs to introduce sophisticated logic into the application definition.

This last use case is the subject of the next section, “Create a New Application Model.”

Create a New Application Model

In this section, you will use the ACE Whiteboard to model the behavior of the OPNET Capture Agent when finishing a capture. (Note that this tutorial is also available by choosing **Launch the ACE Whiteboard Tutorial** from the ACE Whiteboard Startup Wizard Welcome dialog box, or selecting **Help > ACE Tutorials** in ACE Whiteboard.)

The OPNET Capture Agent is a utility for performing packet captures. When a user finishes a capture, the capture file is automatically transferred to the Capture Manager. However, if the capture is performed over a low-bandwidth link or on a heavily congested network, it may not be desirable to immediately transfer the capture file from the agent back to the Capture Manager.

Objectives

1) Create a new ACE Whiteboard model.

2) Use QuickPredict to determine the expected response time to four remote locations.

Understanding the Application's Behavior

The following is a description of the application's behavior:

- The Capture Manager sends a 50-byte message to the capture agent and receives a 100-byte response.
- The Capture Manager sends a 600-byte request for the file; the Capture Agent then responds by sending the capture file.

Creating a New ACE Whiteboard Model

Procedure 3-1 Create a New ACE Whiteboard Model

1 Launch NETWARS.

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

3 From the Open Editor drop-down menu, select **ACE Whiteboard**, and then click **OK**. The ACE Whiteboard Startup Wizard launches and displays the Welcome dialog box.

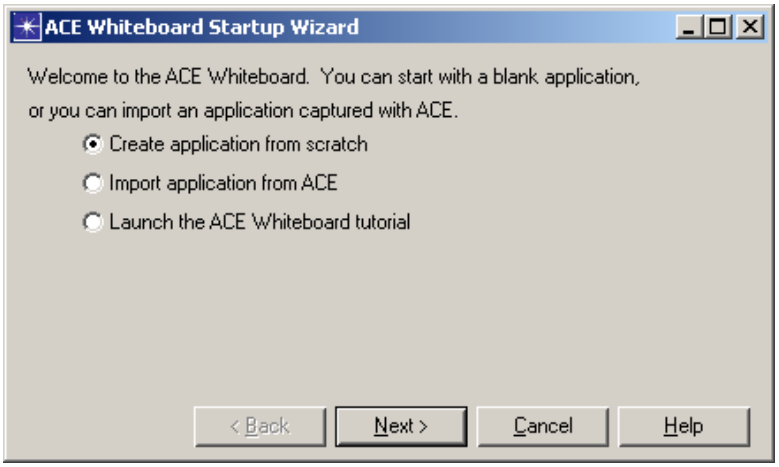


Figure 3-1 ACE Whiteboard Startup Wizard Welcome dialog box

4 In the Welcome dialog box, select **Create application from scratch**, and then click **Next**. The ACE Whiteboard Startup Wizard displays the Specify Tiers dialog box.

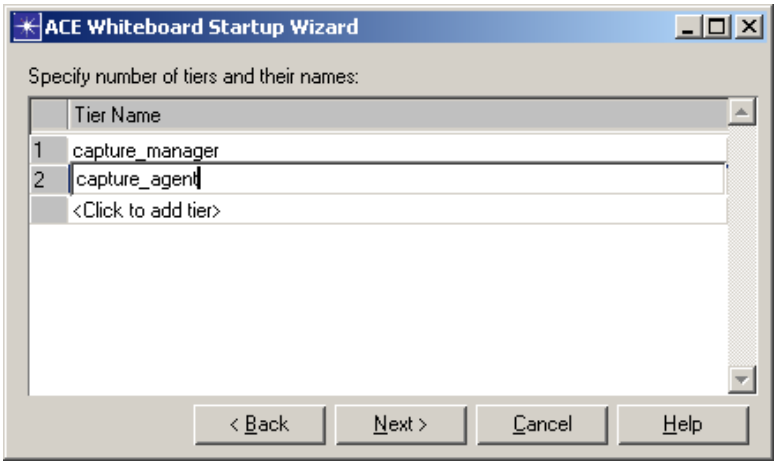


Figure 3-2 ACE Whiteboard Startup Wizard Specify Tiers dialog box

5 In the Specify Tiers dialog box, specify the names of the tiers; type **capture_manager** in the first row, and **capture_agent** in the second row, as shown in the figure above.

6 Click **Next** to advance to the next wizard dialog box, and then click **Finish** to close the startup wizard. Your ACE Whiteboard model now contains the two tiers specified in the wizard, capture_manager and capture_agent. Now you are ready to add messages to the model.

7 From the **Insert** menu, choose **Message**. The cursor in the Data Exchange Chart changes color from blue to green when you enter message creation mode.

8 Create the first message from the capture_manager to the capture_agent:

8.1 Click the **capture_manager** line to specify the source tier and start time of the message.

8.2 Click the **capture_agent** line to specify the destination tier. A green arrow displays between capture_manager and capture_agent.

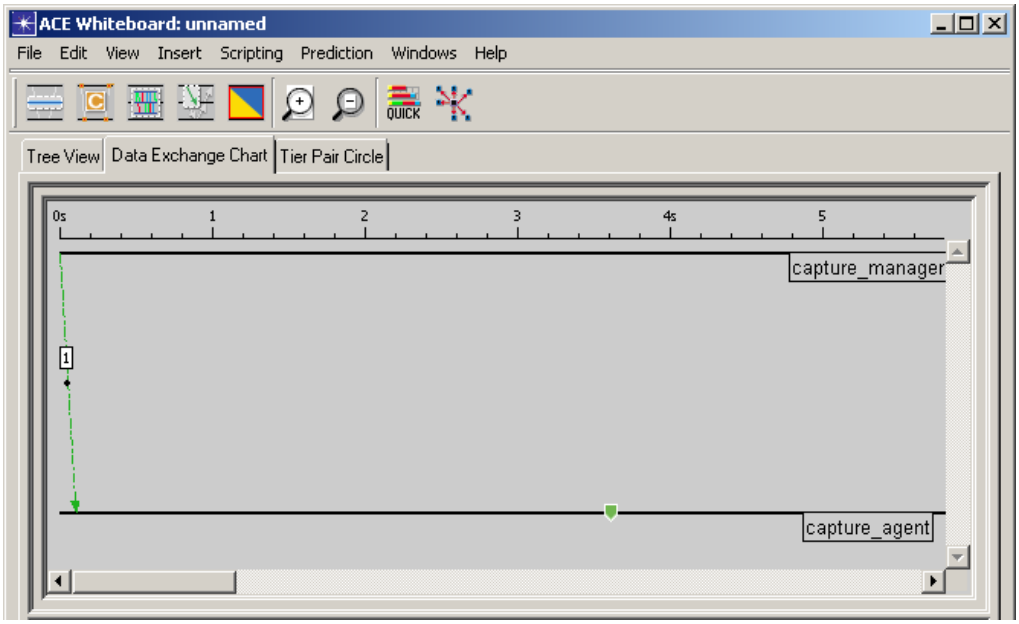


Figure 3-3 First Message from capture_manager to capture_agent

Note—Since this is the only message in the trace, the start time of the message is automatically shifted to 0.0 seconds.

9 Create the response from the capture_agent to the capture_manager:

9.1 Click the **capture_agent** line just to the right of the reception of the first message.

9.2 Click anywhere on the **capture_manager** line to complete the second message. (The reception time for the newly drawn message is determined by the **Simple Network Estimation** settings in the lower-left hand corner of the ACE Whiteboard window). Also note that each newly created message is automatically added to the Message Editor.

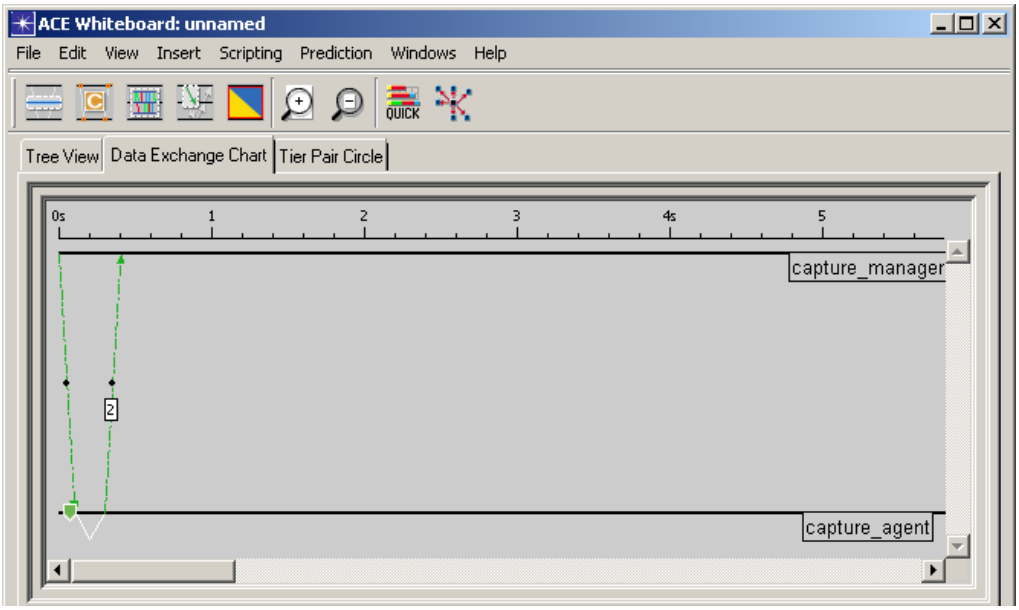


Figure 3-4 First Response from capture_agent to capture_manager

9.3 Right-click on a blank section of the Data Exchange Chart to exit message creation mode. The cursor changes from green back to blue.

10 Edit the sizes and the dependency between the first two messages:

10.1 Make sure the two messages are displayed in the Message Editor. If the Message Editor is empty, select the two messages in the Data Exchange Chart.

10.2 Click in the **Bytes** cell for the first message (ID: 1). From the drop-down menu, choose **Edit...**, and then type **50** as the new size. The color of the arrow will change to orange.

10.3 For the second message (ID: 2), change the **Bytes** value to **100**.

10.4 By looking at the value in the **Depends On** column for the second message, you can see that message 2 depends on message 1. Double-click on the **Processing Time** cell for the second message, and change the value to **0.005**.

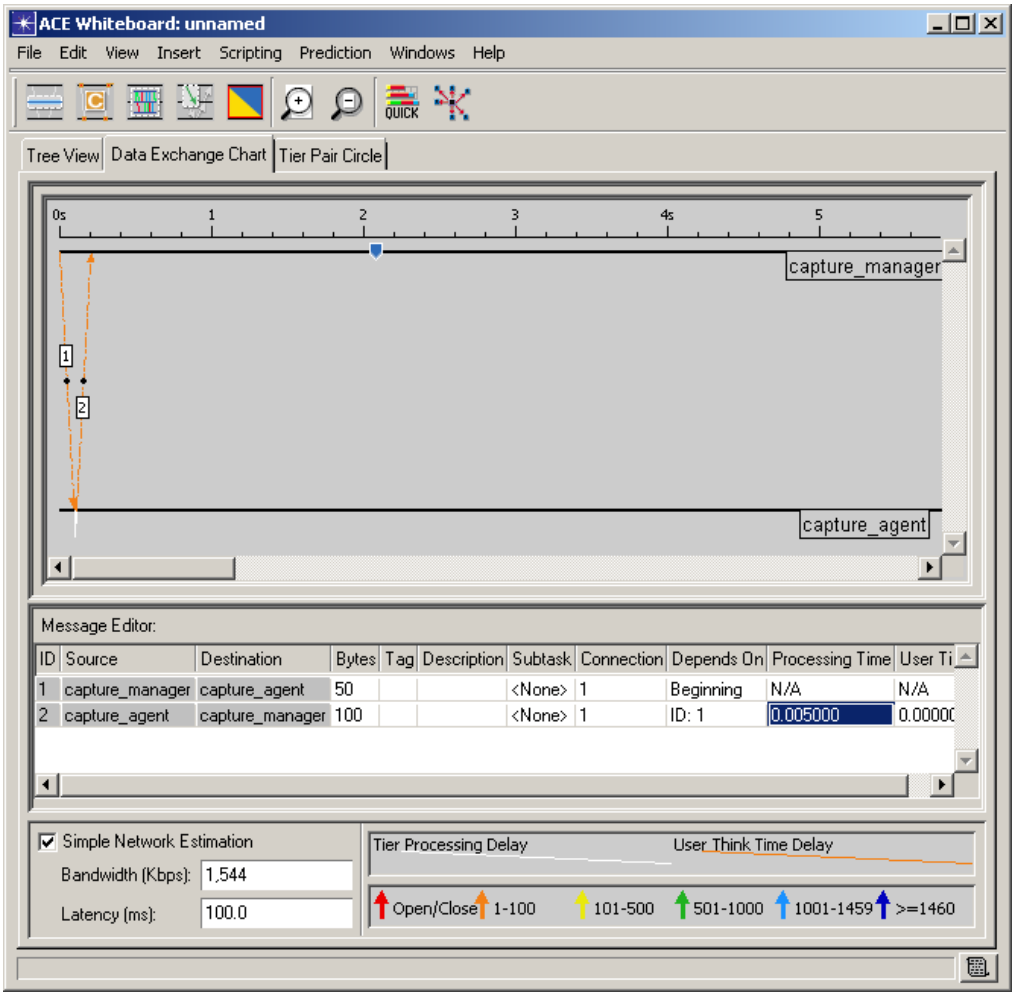


Figure 3-5 Edit Size/Dependency between First Two Messages

11 Create the next request/response pattern between capture_manager and capture_agent:

11.1 From the **Insert** menu, choose **Message**.

11.2 Create another request message from capture_manager to capture_agent, following the procedure outlined in step 8.

11.3 Create the response message from capture_agent to capture_manager, following the procedure outlined in step 9.

11.4 Right-click on a blank section of the Data Exchange Chart to exit message creation mode.

11.5 Change the size of message 3 to **600**.

11.6 Change the size of message 4 to **100,000**.

11.7 Change the **Processing Time** delay of message 3 to **0.01**.

11.8 Change the **Processing Time** delay of message 4 to **0.2**, as shown in the figure below.

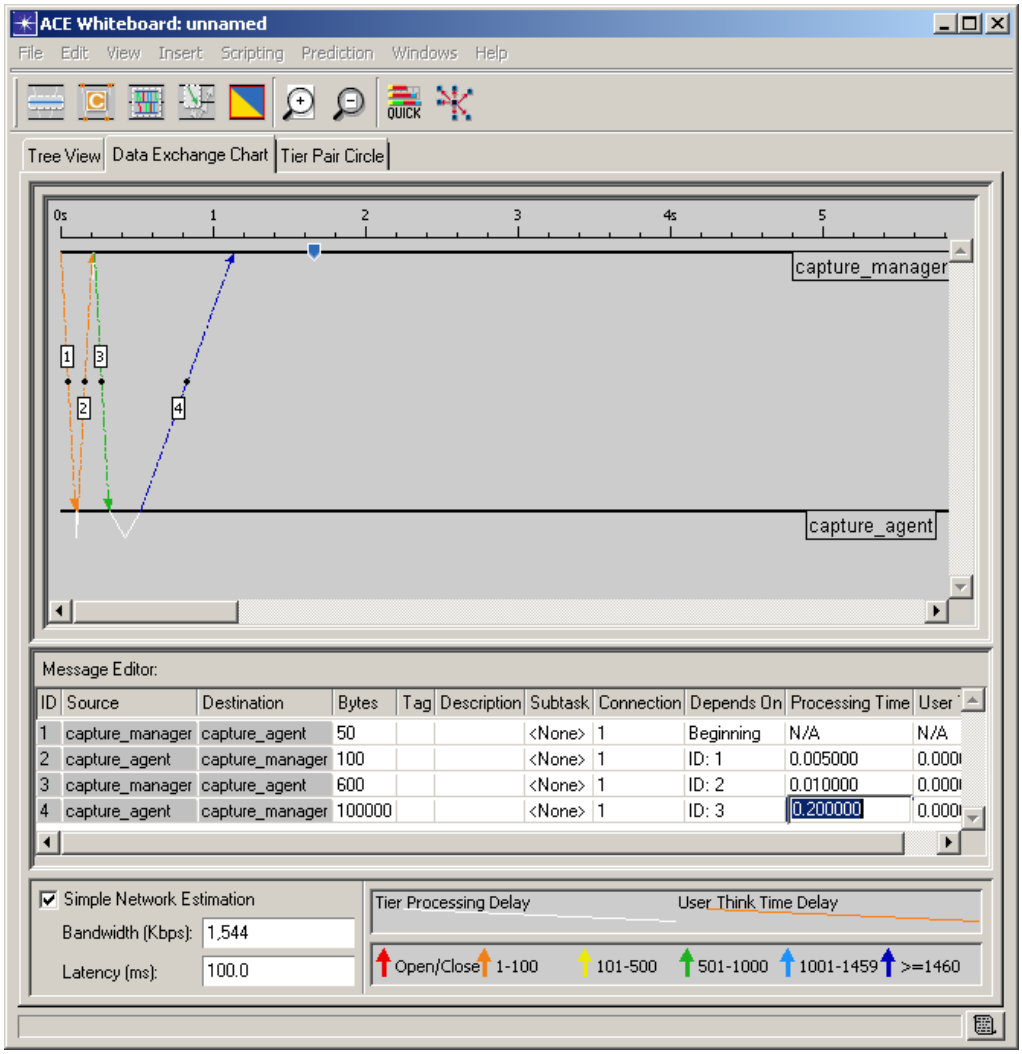


Figure 3-6 Edit Size/Dependency between Next Two Messages

12 Change the zoom level to Full Zoom by right-clicking on a blank portion of the Data Exchange Chart, and then choosing **Full Zoom** from the short-cut menu.

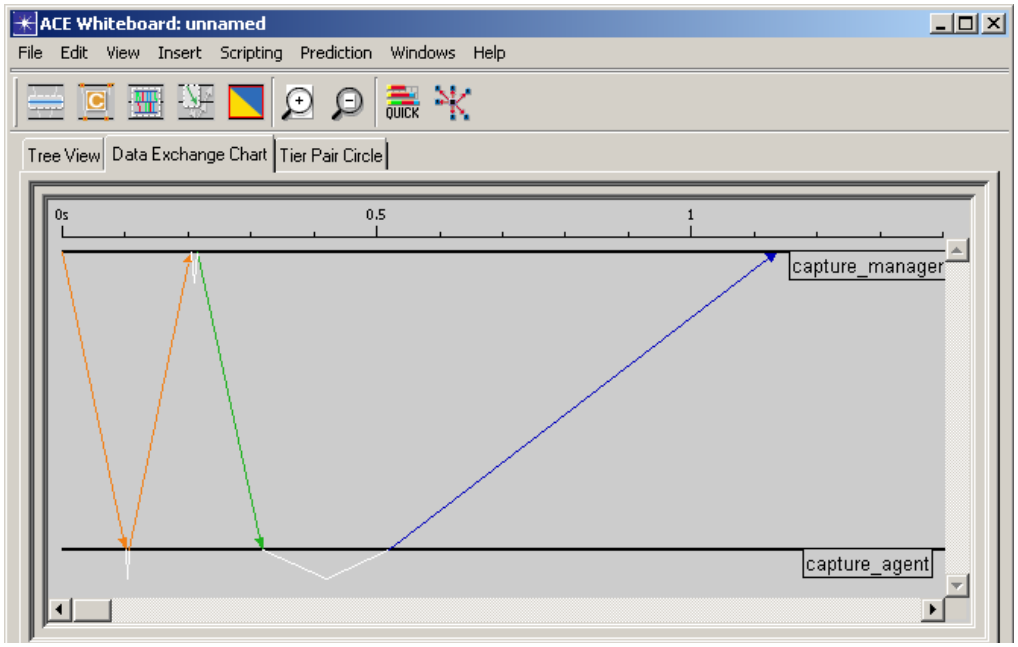


Figure 3-7 View with Full Zoom Selected

Notice that the large message from capture_agent to capture_manager takes longer to arrive than the three smaller messages. To make it easier to draw and edit messages, the ACE Whiteboard determines the reception time of each message based on a single bandwidth and latency value. This is known as Simple Network Estimation.

13 In the lower-left corner of the ACE Whiteboard window, uncheck the **Simple Network Estimation** checkbox. With Simple Network Estimation turned off, each message displays straight up-and-down.

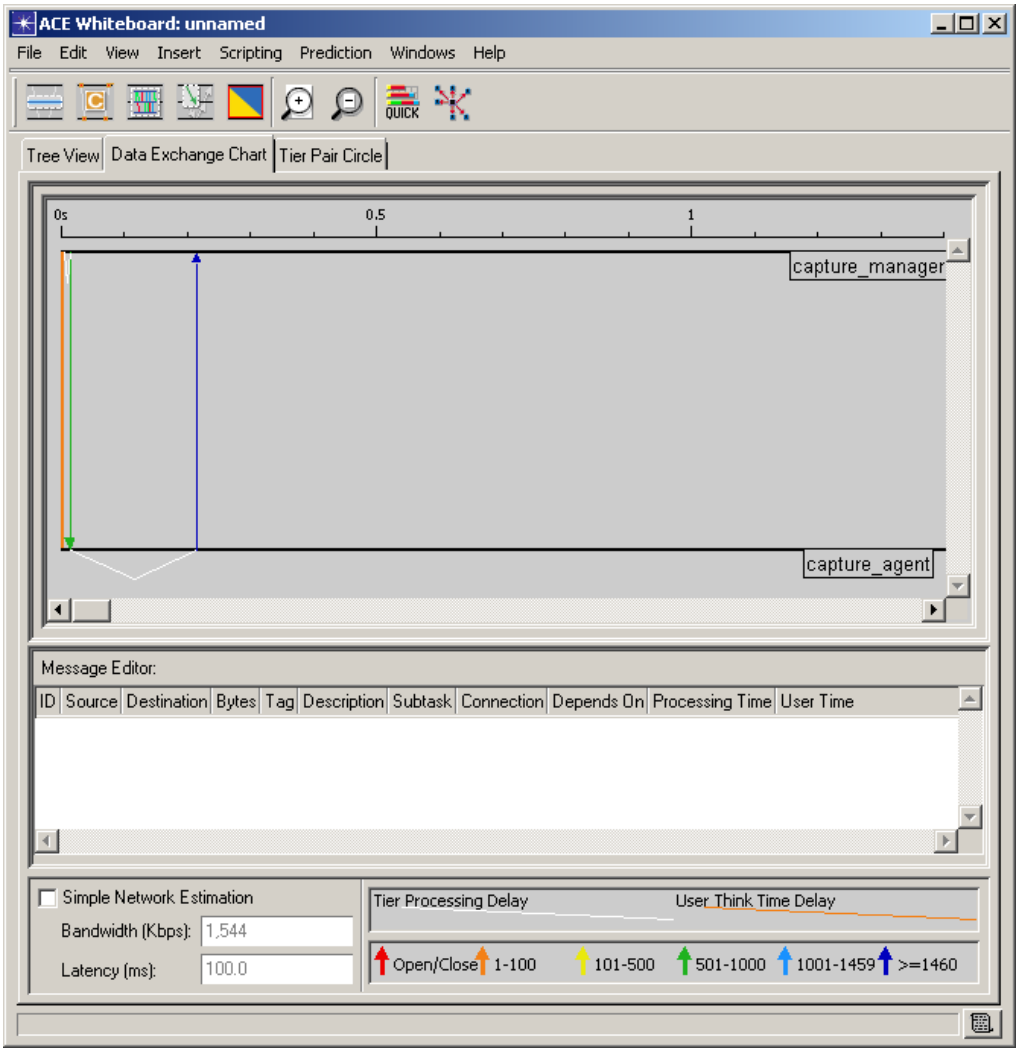


Figure 3-8 View with Simple Network Estimation Unchecked

Note—The **Simple Network Estimation** settings can be used to make an application's behavior easier to visualize. The settings do not impact any simulation results.

13.1 Recheck the **Simple Network Estimation** checkbox.

14 Select **File > Save As...**, and save your ACE Whiteboard model as `<your_initials>_ tutorial_create_new_model`.

End of Procedure 3-1

Using QuickPredict to Determine Expected Response Time

Using the ACE Whiteboard, you created an application model that defined the communication between the Capture Manager and Capture Agent when downloading a file. Next, you will use QuickPredict to evaluate how this application will perform on a variety of network conditions.

Procedure 3-2 Use QuickPredict to Determine the Expected Response Time

1. From the **Prediction** menu in ACE Whiteboard, choose **QuickPredict**. The QuickPredict dialog box displays.
2. Click **Load Template...**.
3. Select the file `tutorial_new_model.ace.qpb` in `C:\Netwars\Scenario_Builder\11.0.A\models\std\tutorial_req\module`.
4. Click the **Open** button. The specified template is applied to the QuickPredict results and the following bar chart displays.

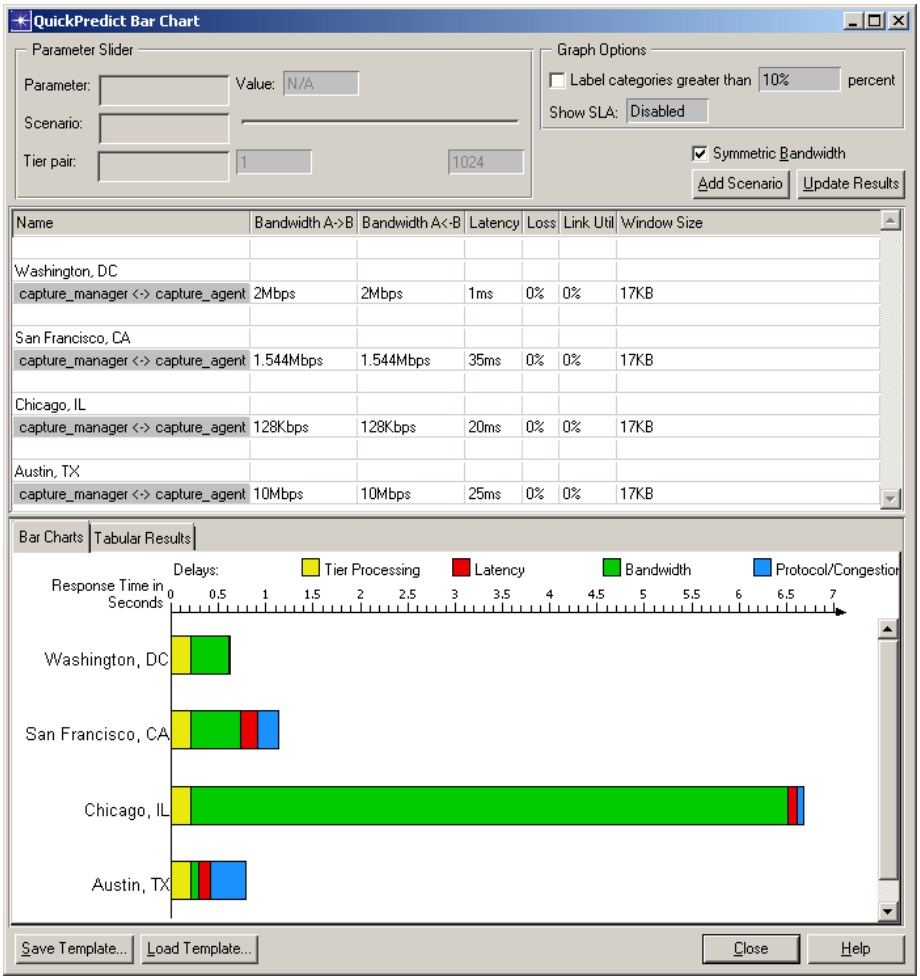


Figure 3-9 QuickPredict Bar Chart

This chart shows the results of running this application from the four locations with the specified bandwidth and latency values. Notice that it takes significantly longer to retrieve the capture file when running across a low-bandwidth link.

Using QuickPredict Bar Charts

You can use elements provided in the QuickPredict Bar Chart window as follows:

- **Parameter Slider:** When you put a parameter on the slider, you can see instant result updates by moving the slider bar. To put a parameter on the slider, click in the parameter cell in the table and choose **Put on Slider**.
  - **Parameter/Scenario/Tier pair**—Indicates which item is on the slider bar. These fields are empty if nothing is on the slider.
  - **Value**—Current value of the slider. To set the slider to an exact value, click in this field.
  - **Min** and **Max** fields—Below the slider to the left and right, these specify the range of the slider.
- **Graph Options:** Control some display options for the graphical results.
  - **Label categories**—Show labels for tiers and tier pairs. To specify a threshold, click in the percent field. A low threshold might cause labels to overlap.
  - **Show SLA**—When this option is enabled, a vertical dashed line indicates the SLA time. Click in the field to enter an SLA (in seconds) or choose "Don't Show SLA" to make the SLA line disappear.
- **Update Results button**—Updates all results. You must click this button after making any change to the table.
- **Add Scenario button**—Adds a new scenario. To remove a scenario, right-click in an open part of the "Bar Charts" domain.
- **Save Template button**—Saves your current set of scenarios to a text file, which you can either edit or load for this or a different ACE task.
- **Load Template button**—Loads scenarios from a template file and overwrites any existing scenarios. If the tier names do not match exactly, ACE might prompt you for the correct mapping.
- **Close button**—Closes the QuickPredict Bar Chart window. If you reopen this window without closing ACE, your current results will reappear.
- **Scenario Input Table:** Controls the values for the different network scenarios.
  - **Name**—To edit a scenario name, click in the table cell. The new name appears in the results panel after you click **Update Results**.
  - Other columns—You can change the value of any parameter for any tier pair for any of your scenarios. To put a value on the slider, click on the cell and choose **Put On Slider**. To remove an item from the slider, click on the cell again and choose another value for the parameter. You must click **Update Results** after making any changes in this table.
- **Bar Charts Page:** Shows a graphical representation of the results. ACE creates one bar for every (scenario/task) combination.

- Right-click options—Right-clicking in an open part of this pane will allow you to remove traces and scenarios.
- Tooltips—If you hold your tooltip over a result bar, the exact time for that component will be displayed.

- **Tabular Results Page:** Shows the exact numbers for the components of response time for the (scenario, trace) pairs. Not all categories (such as app delay for a tier pair) will have values; these will be denoted with an "N/A".
  - Right-click options—If you right-click in the table, you can copy the entire table to the system clipboard.

5 Click the **Close** button to close QuickPredict.

6 Select **File > Save** to save your model.

7 Select **File > Close** to close the ACE Whiteboard.

End of Procedure 3-2

Conclusion

In this section, you learned how to use the ACE Whiteboard to model the behavior of the OPNET Capture Agent when finishing a capture. You also learned how to use QuickPredict to determine the expected response time to four remote locations.

Additional Details

- To add more flexibility to your ACE Whiteboard model, you could have parameterized the size of the capture file that the Capture Agent sends back to the Capture Manager. You will see an example of this in the next section, "Modifying an Existing ACE File".
- Instead of creating messages 3 and 4 using the **Insert > Message** operation, you could have copied and pasted messages 1 and 2, and then edited the message sizes and dependency values. This technique is useful when copying a large block of messages, especially when moving them from one file to another.
- You can also create messages using keyboard shortcuts using Rapid Message Creation. For example, to create a message that starts at tier 1 and ends at tier 2, press **Ctrl + 1** then **Ctrl + 2**. To create a message from tier 3 to tier 2, press **Ctrl + 3** then **Ctrl + 2**. See the documentation (**Help > ACE Product Documentation**) for more details.
- If you want to create a repeating pattern of messages (such as a 120 byte SELECT statement and a 400 byte response, repeated 1,000 times), you can use a Message Group (**Insert > Message Group**). For more information, look at the "Message Group Operations" section of the "ACE Whiteboard – User Interfaces and Procedures" chapter of the *ACE User Guide*.

- If you want to change the same value on many messages in the Message Editor, you can use multi-message editing. This can be used, for example, to move 30 messages from one connection to another connection. For more information, see the topic “Multi-Message Editing,” which is in the “Message Operations” section of the “ACE Whiteboard – User Interfaces and Procedures” chapter of the *ACE User Guide*.

Modifying an Existing ACE File

In the following section, assume that you have been asked to determine the expected response time for a portion of a new “Staff Listing” application that will be rolled out in a few months. You have used ACE to capture a beta version of this application, and you will now use the ACE Whiteboard to create an application model that accurately represents the anticipated final application version. (Note that this tutorial is also available by choosing **Launch the ACE Whiteboard Tutorial** from the ACE Whiteboard Startup Wizard Welcome dialog box, or selecting **Help > ACE Tutorials** in ACE Whiteboard.)

Objectives

1) Import an existing ACE file into the ACE Whiteboard.

2) Modify the application model so that it matches the final version of the application.

3) Parameterize the size of a message so that you can change the size of the message in the project editor, and have different applications that use the same Whiteboard model, but have different message sizes.

Importing an ACE Whiteboard Model

Procedure 3-3 Import an ACE Whiteboard Model

1 Launch NETWARS.

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

3 From the Open Editor drop-down menu, select **ACE Whiteboard**, and then click **OK**. The ACE Whiteboard Startup Wizard launches and displays the Welcome dialog box.

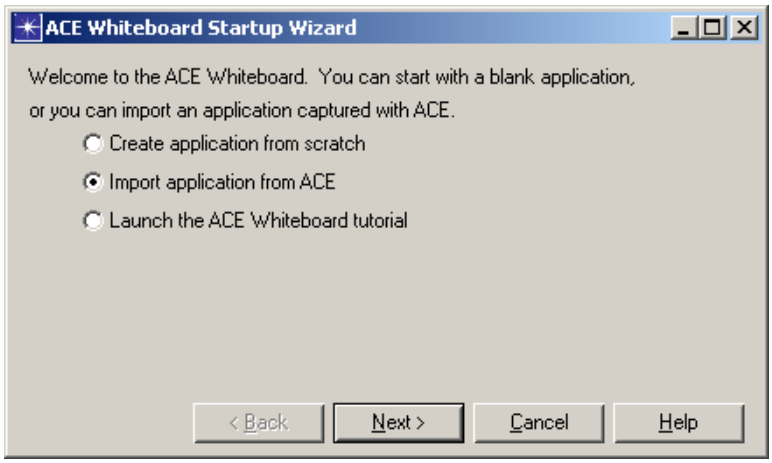


Figure 3-10 ACE Whiteboard Startup Wizard Welcome dialog box

4 In the Welcome dialog box, select **Import application from ACE**, and then click **Next**.

5 In the subsequent dialog box, choose the ACE file `tutorial_staff_listing_beta` under `C:\Netwars\Scenario_Builder\11.0.A\models\std\tutorial_req\module` and then click **Import**. The existing ACE file imports into the ACE Whiteboard.

6 In the **Data Exchange Chart**, notice that the task contains three tiers and some messages.

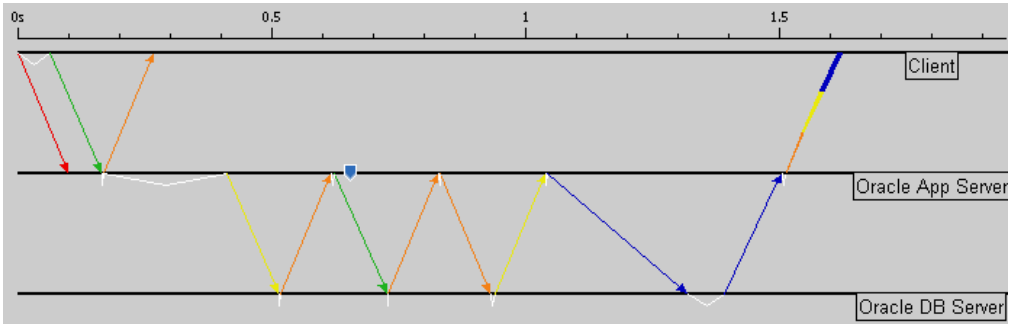


Figure 3-11 Task containing three tiers and multiple messages

7 Select **File > Save**, and then save the file as `<your_initials>_tutorial_auth`. Leave the file open.

The file imported from ACE contains the messages sent as a result of the client selecting the division of interest from a Web page. The first message from Client to Oracle App Server is the HTTP POST message. The Oracle App Server processes this message and requests the appropriate data from the Oracle DB Server. The Oracle App Server then sends a Web page containing the requested data back to the Client.

End of Procedure 3-3

Modifying the Application Model in the ACE Whiteboard

Prior to sending a message to the Oracle DB Server, the Oracle App Server needs to authenticate with the Authentication Server.

Procedure 3-4 Modify the Application Model in the ACE Whiteboard

1 Insert a new tier for the Authentication Server.

1.1 Select **Insert > Tier** from the main menu.

1.2 In the Insert Tier dialog box, enter **Authentication Server** as the tier name.

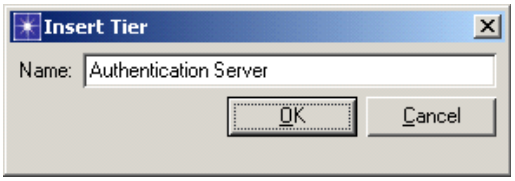


Figure 3-12 Insert Tier dialog box

1.3 Click **OK**.

2 Create a single request/response pattern between Oracle App Server and Authentication Server.

2.1 Select **Insert > Message** from the main menu.

2.2 Click on the **Oracle App Server** tier just after the orange message.

2.3 Click on the **Authentication Server** tier to complete the message.

2.4 Click on the **Authentication Server** tier just after the arrival of the newly created message.

2.5 Click on the **Oracle App Server** tier to complete the message.

2.6 Right-click in the workspace to exit message creation mode.

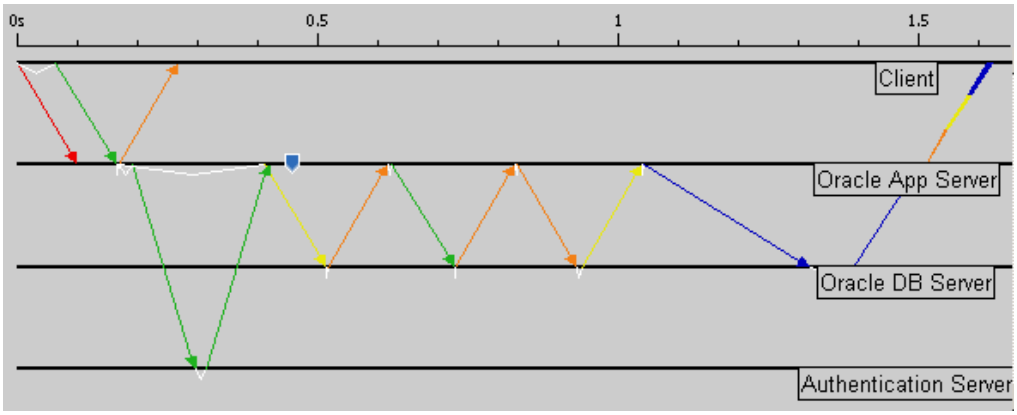


Figure 3-13 Single request/response pattern between two tiers

3 Modify the first message between Oracle App Server and Oracle DB Server so that it is dependent on the last message you just created. Notice that this message is currently dependent on the orange message from the Oracle App Server to the Client.

3.1 In the **Data Exchange Chart**, right-click on the dependency just before the first message from Oracle App Server to Oracle DB Server (the yellow message).

3.2 Select **Change Parent Dependency**.

3.3 Click on the **Oracle App Server** tier near where the green message from Authentication Server to Oracle App Server was received. Notice that this causes the yellow message to shift to the right.

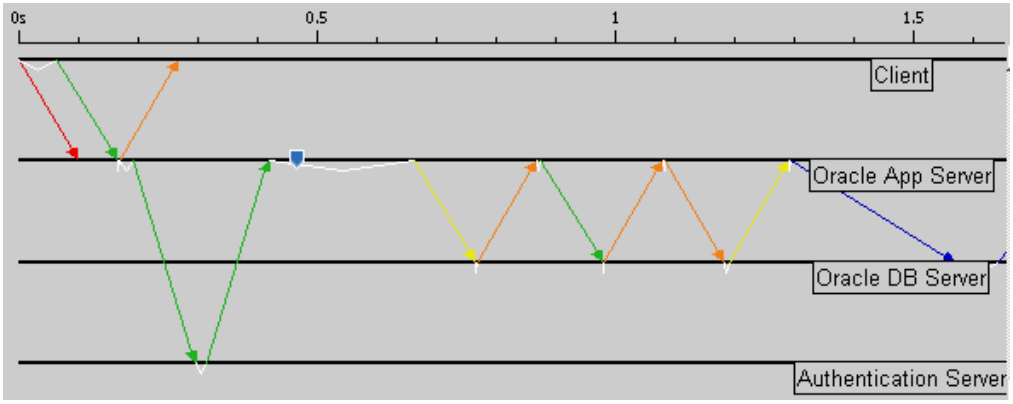


Figure 3-14 Edit Parent Dependency

4 Edit the two green messages you created in Step 2.

4.1 Select the two messages in the **Data Exchange Chart**. You can select the two messages by clicking in the background, holding the mouse button down, and drawing a rectangle around the two messages. Alternatively, you can shift-click to select the messages individually.

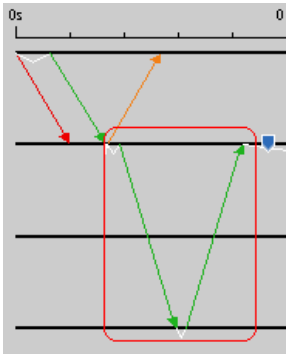


Figure 3-15 Select Messages with a Rectangle

4.2 In the **Message Editor**, change the size of the first green message (ID: 15) to **50**.

4.3 Change the size of the second green message (ID: 16) to **100**.

4.4 Change the **Processing Time** value of the first green message (ID: 15) to **0.05**.

4.5 In the **Message Editor**, change the **Processing Time** value for the second green message (ID: 16) to a **Uniform** distribution from **0.2** to **0.3**:

- Click in the **Processing Time** field for the response message (ID: 16).
- Select **Edit As Distribution...**, and then change the distribution to **Uniform** in the Specify Distribution dialog box.
- Change the **Minimum Outcome** to **0.2**.
- Change the **Maximum Outcome** to **0.3**.

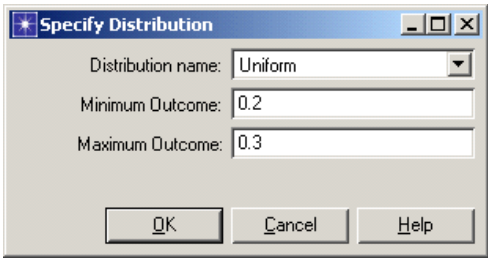


Figure 3-16 Specify Distribution dialog box

- Click **OK**. The Message Editor should now look like the following figure.

Message Editor:

ID	Source	Destination	Bytes	Tag	Description	Subtask	Connection	Depends On	Processing Time	User Time
15	Oracle App S...	Authentication...	50			<None>	3	ID: 3	0.050000	0.000000
16	Authenticatio...	Oracle App Se...	100			<None>	3	ID: 15	Uniform (0.20000...	0.000000

Figure 3-17 Edit Size/Processing Time between Two Messages

5 Change the zoom level to Full Zoom by right-clicking on a blank portion of the **Data Exchange Chart,** and then choosing **Full Zoom** from the short-cut menu. At this point, the **Data Exchange Chart** should look similar to the following figure.

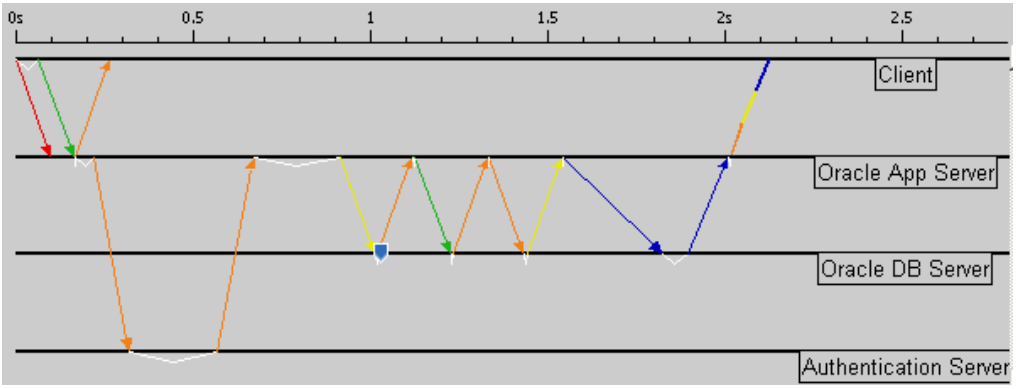


Figure 3-18 View with Full Zoom Selected

6 Select **File > Save** to save the file. Leave the file open.

At this point, you have imported an ACE file into the ACE Whiteboard, created a new tier, added two messages, used a distribution to specify a processing time dependency, and reassigned a message's parent dependency.

End of Procedure 3-4

Adding a Parameter to the ACE Whiteboard Model

Assume that based on your knowledge of the application, you know the size of the last response message from the Oracle DB Server to the Oracle App Server depends on the number of employees in the division (specified by the user in the initial request). Since you want to be able to change this value in the Project Editor prior to running a simulation, you should parameterize the response size.

Procedure 3-5 Add a Parameter to the ACE Whiteboard Model

1 Add a parameter to the task:

1.1 Select **Scripting > Declare Parameters...**.The Declare Parameters dialog box displays.

1.2 Click **Add** to add a new row to the table.

1.3 Specify the **Parameter**, **Type**, **Default Value**, and **Description** values as shown in the figure below.

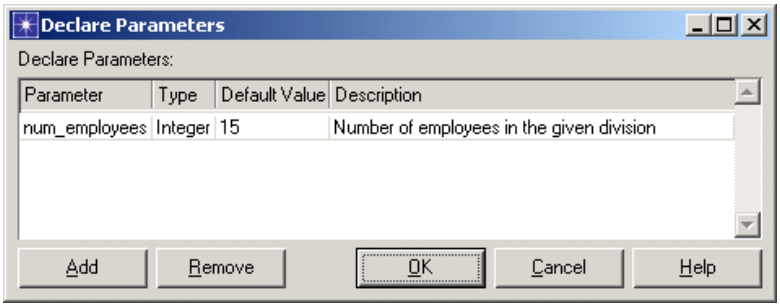


Figure 3-19 Declare Parameters dialog box

1.4 Click **OK**.

2 Identify the last message from Oracle DB Server to Oracle App Server by giving it a unique tag. This will allow you to access this message from within a logic script.

2.1 In the **Data Exchange Chart**, select the last message from Oracle DB Server to Oracle App Server.

2.2 In the **Message Editor**, click the **Tag** field for message 11, and then change the value to **db_response**.

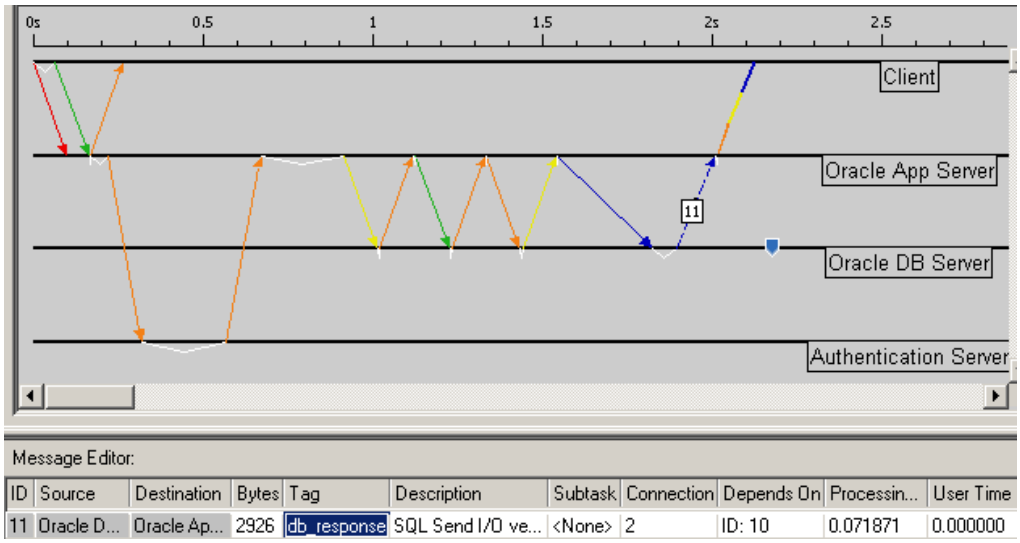


Figure 3-20 Edit Message Tag

3 Logic scripts can be used to dynamically modify the behavior of an application model. You will write a logic script that changes the size of the **db_response** message based on the value of the parameter **num_employees**.

3.1 Add a logic script before the message you just tagged as **db_response**. Right-click on the dependency before the message and choose **Add Logic Script at End**.

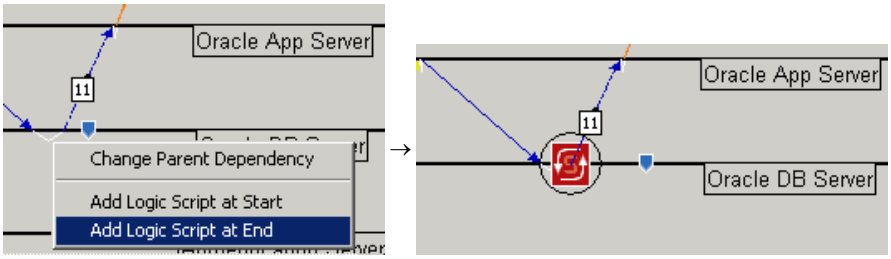


Figure 3-21 Add Logic Script at End

3.2 The Edit function window displays. Add the following lines of code to the logic:

```
num_employees = self.get_parameter ('num_employees')
response_msg = self.get_message ('db_response')
response_msg.size = num_employees * 2000
```

3.3 Select **File > Save** to save the logic script.

End of Procedure 3-5

Using QuickPredict to Determine the Expected Response Time

Procedure 3-6 Use QuickPredict to Determine the Expected Response Time

1 From the **Prediction** menu, choose **QuickPredict**. The QuickPredict dialog box displays.

2 Click **Load Template...**.

3 Select the file `tutorial_staff_listing_modified.ace.qpb` in `C:\Netwars\Scenario_Builder\11.0.A\models\std\tutorial_req\module`.

4 Click the **Open** button. The specified template is applied to the QuickPredict results and the following bar chart displays.

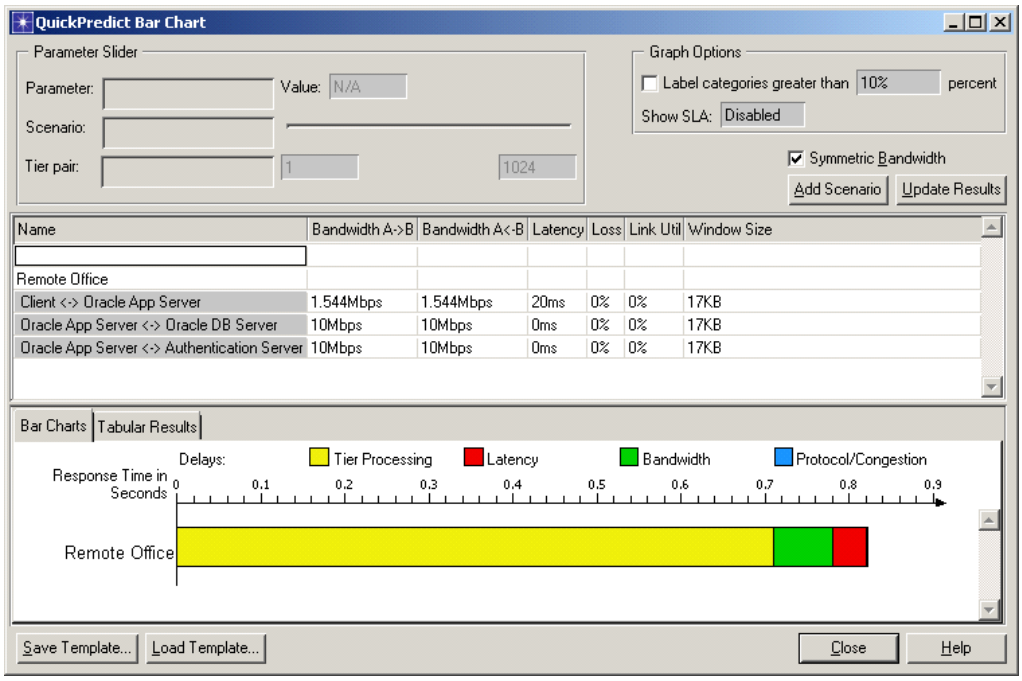


Figure 3-22 QuickPredict Bar Chart with num_employees parameter set to 15

Notice that the revised application takes less than 1 second to complete when there are 15 employees. (Note: We gave the parameter num_employees a default value of 15 earlier in this procedure.)

5 In the main ACE Whiteboard window, select **Scripting > Declare Parameters**. Change the default value of **num_employees** to **200**, and then click **OK**.

6 In QuickPredict, click the **Update Results** button.

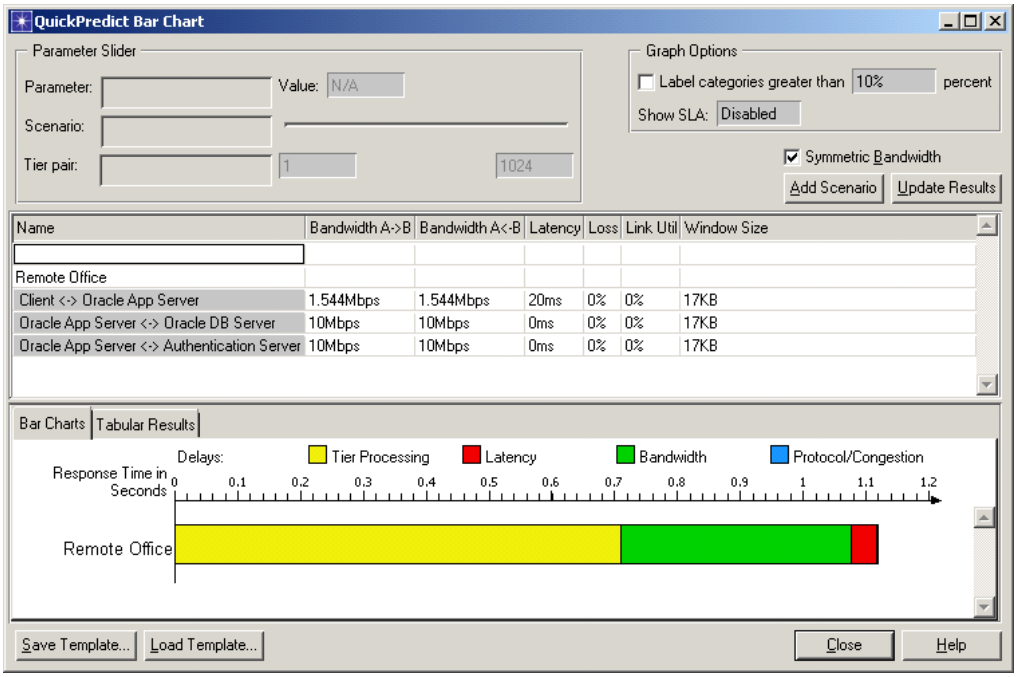


Figure 3-23 QuickPredict Bar Chart with num_employees parameter set to 200

Notice that increasing the default value for the num_employees parameter caused an increase in the response time of the application.

7 Click the **Close** button to close QuickPredict.

8 Select **File > Save** to save your model.

9 Select **File > Close** to close the ACE Whiteboard.

End of Procedure 3-6

Conclusion

Starting with an ACE file of a beta version of your application, you used the ACE Whiteboard to modify the behavior of the application. These modifications included adding a request/response pattern to a new Authentication Server tier, changing the parent dependency of a message, adding variability to the application using a distribution, and specifying the size of a message based on a parameter. You also learned how to use QuickPredict to determine the response time of the application for two different values of the parameter.

Additional Details

- In this section, you wrote a logic script to dynamically change the size of a message based on a parameter. If you had deployed this application on a network in the Project Editor to run a Discrete Event Simulation, you would be able to specify the message size in the **ACE Parameters** field of the task specification.
- Instead of manually adding a request/response pattern to an authentication server, you could have created a separate ACE Whiteboard file to handle the authentication. Then, you could have invoked your authentication Whiteboard file. You can see an example of this in the tutorial “Advanced: Modeling an Application Using Logic Scripts” available by selecting **Help > ACE Tutorials** in ACE Whiteboard.
- When making a large number of changes to an ACE Whiteboard file, it is often useful to turn on Multi-Message Editing Mode via the **Edit** menu. See the documentation (**Help > ACE Product Documentation**) for more details.

App A Capturing Application Traffic

Introduction

The first step to creating a model of your application using ACE is recording application transactions in one or more capture files. ACE uses raw traffic data, captured from your network, as the basis for modeling an application. You can use ACE's application capture utility to create these *capture files* (also known as "packet trace files"), or you can use files that were captured using other third-party tools and/or probes (then converted by third party utilities.) ACE accepts capture file formats including:

- OPNET .appcapture
- Network Associates' Sniffer
  - — Industry-standard Binary Ethernet format (.enc, .cap). Other analyzers (such as NetScout) can also generate .enc files.
  - — Binary Token Ring format (.trc)
  - — Binary FDDI format (.fdc)
- Free utilities, such as TCPdump and Windump
- Comma Separated Value file (.csv)

Documentation on specific analyzers is beyond the scope of this user's guide, as individual equipment can vary. However, you should follow these general guidelines when you capture traffic to import into ACE:

- Configure your analyzer's filtering capabilities to focus on hosts of interest. Filtering keeps your trace file shorter and enables your analyzer to accommodate a longer duration for your capture, given limited memory and disk resources.
- Aim for as "clean" a trace as possible. You might want to run and record your application at a time when network traffic is minimal–such as late in the evening or during the weekend–to keep as many irrelevant packets out of the capture file as possible.
- If using network probe and you are limited in the number of probes available, place your analyzer as close as possible to the application instance(s) relevant to your studies. For example, if you want to study performance on a file server, you should capture on the same LAN as the server so that network delays across a WAN link or the Internet do not affect the analyzer's view of the relevant information (application performance on the file server).
- Capture one application exchange in its entirety. For example, if want to study an FTP application, you should capture the exchange from the initial request from the client host to the conclusion of the download. The application exchange should not include user "think time." This is especially important if you want valid results and diagnoses from AppDoctor. ACE does

not distinguish between processing delay at a tier and user think time (that is, the delay when an application simply waits for input from a user). If the captured exchange does include user think time, you might want to divide the resulting ACE task into multiple tasks, then analyze each task individually. To do this, you would:

— Open the original task,

— Exclude or delete packets so only a specific phase is included, and

— Save the task under a different name (for example, *FTP_download_phase_1*).

Repeat this process for each part of the original task, so you have a group of individual tasks that record the entire transaction, minus think time.

Using ACE Capture Agents

You can use the ACE application capture utility to record traffic throughout your network and import the data into ACE. This utility uses capture processes (called *capture agents*) that enable you to capture traffic from multiple locations simultaneously. ACE includes an Application Capture Manager so you can manage all capture agents and operations from your NETWARS computer.

Before you can capture traffic using this utility, you must:

- Install a capture agent on every computer where you want to capture traffic, and
- Create a capture agent list, which specifies the agents you want to use for a capture operation and the configuration settings for each agent.

Install/Uninstall and Troubleshoot Capture Agents

Before you can capture traffic, you must first install capture agents on the computers where you want to capture traffic. A capture agent resides on a local or remote computer. It records packet-by-packet traffic in response to commands from the Application Capture Manager (**Start Capture**, **Finish Capture**, etc.)

Install Capture Agents

ACE includes agent installers for several platforms, including Windows, Solaris, Linux, HP/UX, and AIX. You can download installers and instructions for all available platforms from the Support Center section of the OPNET website (*http://www.opnet.com/support*).

Place Capture Agents

Place agents on or near tier(s) involved in an application conversation. For a single trace import, place the agent on or near the most active tier, or near the tier of most interest. If it is not possible to place agents on a tier, consider port mirroring, hubs, passive taps, etc.

Troubleshoot Capture Agents

The OPNET Support Center maintains a set of Frequently Asked Questions (FAQs) that address common questions and issues involving ACE capture agents. To search the FAQ database for the latest troubleshooting information on capture agents, go to *http://www.opnet.com/support* and follow the “FAQ” link. To obtain a list of useful FAQs, search for the string “ACE capture agents”; you also might want to search based on a specific error message you receive.

Uninstall Capture Agents

The FAQ database includes several entries that describe how to uninstall ACE capture agents. Go to *http://www.opnet.com/support* and follow the “FAQ” link. To obtain a list of relevant FAQs, search for the string “uninstall.”

Creating a Capture Agent List

After you install your capture agents at the desired locations, the next step is to create a capture agent list. An agent list specifies the agents to use during a capture and the configuration settings to use with each agent.

Procedure A-1 Create a Capture Agent List

1. Launch NETWARS.
2. From the System Editor’s **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, select **ACE**, and then click **OK**. The ACE Import: Choose Capture Files dialog box displays.
4. Click **Open Capture Manager**.The Application Capture Manager window displays.

   Note—You can also open the Application Capture Manager by selecting **File > Application Capture Manager** in the ACE Treeview window, Data Exchange Chart, or Tier Pair Circle.

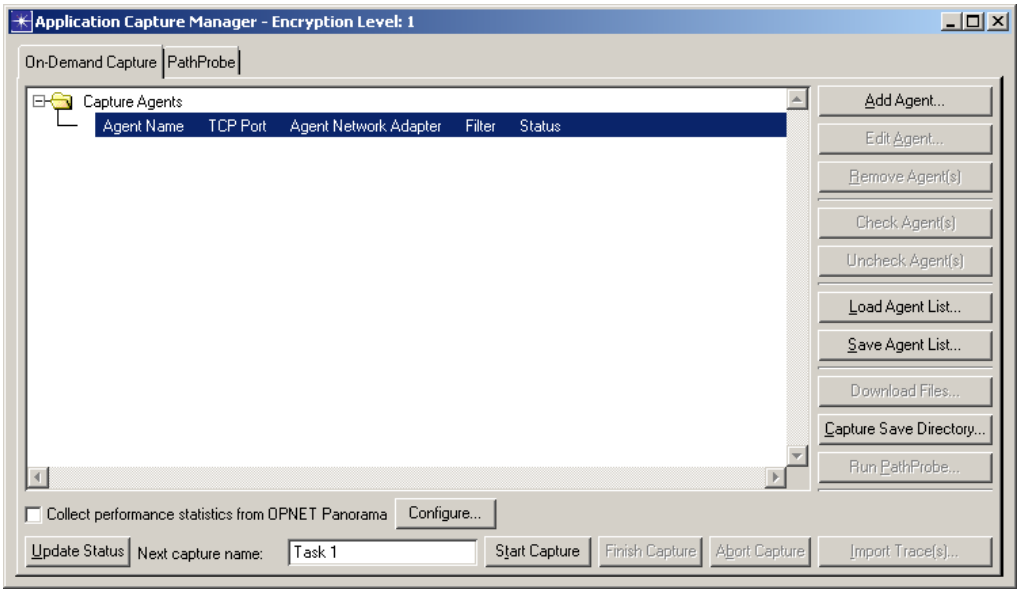


Figure A-1 Application Capture Manager

5 For each agent you want to add to the list, perform the following steps:

5.1 Click **Add Agent**.The Remote Application Capture Agent Editor window displays.

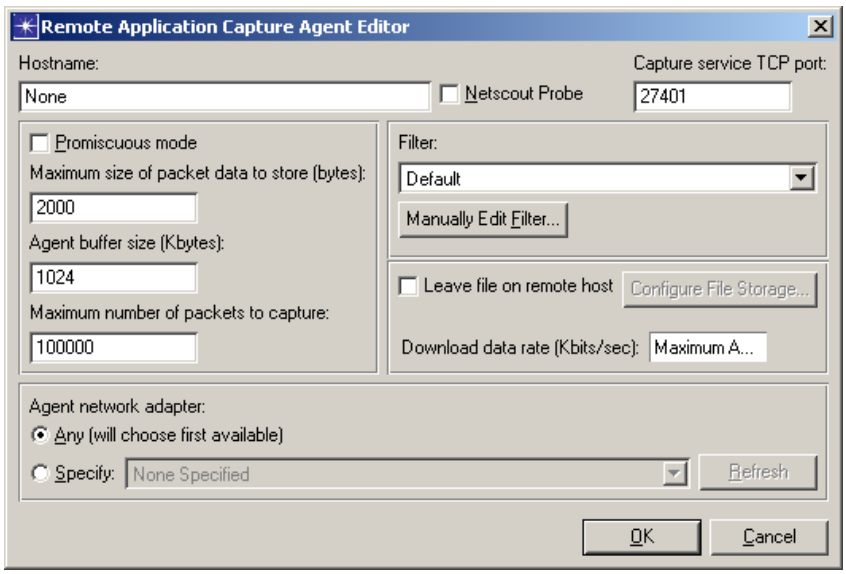


Figure A-2 Remote Application Capture Agent

5.2 Specify the computer where the agent resides in the Hostname field. You can use either a computer name or an IP address.

5.3 An agent can capture traffic on one network interface only. If the host computer has multiple network adapter cards, set the **Agent network adapter** radio buttons to enter a specific interface.

5.4 If a host computer has multiple interfaces, you can create separate agents (one per interface) for that computer. This is essentially equivalent to creating agents on separate computers. When you create multiple agents for the same computer, you must specify the interface for each agent under **Agent network adapter**; do not use the default setting of “Any”.

5.5 Configure other settings for your agent as needed:

- Capture Service TCP Port field—Port on which the Capture Manager and capture agent communicate. This port is set when installing the capture agent. The default is 27401.
- **Promiscuous Mode** checkbox—When enabled, the agent captures all traffic seen by the host on that LAN segment.
- Maximum Size of Packet Data To Store (Bytes) field—Specifies the maximum number of bytes from each packet that the agent should include in a capture file.
- Agent Buffer Size (Kbytes) field—Specifies the buffer size used by the capture agent to store packet-trace data before it gets saved to disk.
- Maximum Number of Packets to Capture field—Configurable safety measure in case you forget to stop a capture. The default setting is 100,000. You can enter -1 to specify “all packets”.
- **Manually Edit Filter** button—Use to specify a capture file filter so the agent captures certain packets.
- **Leave file on remote host** checkbox—Controls whether data is automatically downloaded from remote agent when capture completes. Provides better control and security of remote capture files.
- Download data rate (Kbits/sec) field—Controls amount of bandwidth consumed when remote capture file is downloaded.

5.6 Click **OK** to return to the Capture Manager. A new agent entry displays in the Capture Agents treeview.

6 (*Optional*) After you add and configure all agent entries in the list, you can save your list by clicking **Save Agent List** and then entering a file name and directory. ACE saves the agent list file with an “.agents” extension in your capture save directory. You can reuse a previously saved agent list by clicking **Load Agent List**.

Note—You can return to this Editor to edit a capture agent at any time.

End of Procedure A-1

Advice for Using Capture Agents

Keep in mind the following advice when using ACE Capture Agents:

- Capturing in **Promiscuous Mode**—Enabling this option means the agent will capture all traffic seen by the host on that LAN segment, which is typically more data than is required for analysis.

- Make sure that you specify the correct NIC on the host in Capture Manager. You need to know which NIC card is connected to the appropriate link that is being monitored.
- The filter named **Default** is UDP/TCP. It is defined to capture only UDP/TCP protocol information. Use the filter named **None** if you want to capture "all" protocols, or create a custom filter and specify which protocols to capture.
- Make sure that you know where your ACE files reside—New (raw) capture files have suffixes of ".enc" and ".appcapture". When you save a new file, it will be stored in the first directory specified in the "mod_dirs" preference with an "atc.m" suffix. Existing ACE capture files are ".atc.m" files. ACE will search all directories specified in the "mod dirs" preference and present all files with an ".atc.m" suffix.
- Use filtering to keep out extraneous traffic—Diagnosis, graphs, and statistics will present inaccurate information on a task if extraneous, irrelevant traffic is left in the trace. Filter out traffic during the capture and the import process (with filters), and after the import (delete tier-pairs, connections, or individual packets and messages within the ACE editor.)
- Analyzing human "think time"—Take into account that the processing time credited to "Client" hosts, that are being driven by people, will have think time (pauses by individual, and the speed at which the individual can enter data) as part of the total tier process time.

Capturing Traffic Using the Application Capture Manager

To capture traffic using the ACE Application Capture Manager, launch the Capture Manager, then configure a capture agent, and finally, perform a capture.

Procedure A-2 Capture Traffic using the Application Capture Manager

1. Launch NETWARS.
2. From the System Editor's **File** menu, choose **Open Editor**.
3. From the Open Editor drop-down menu, select **ACE**, and then click **OK**. The ACE Import: Choose Capture Files dialog box displays.
4. Click **Open Capture Manager**.The Application Capture Manager window displays.

   Note—You can also open the Application Capture Manager by selecting **File > Application Capture Manager** in the ACE Treeview window, Data Exchange Chart, or Tier Pair Circle.
5. If necessary, click **Load Agent List** and select the agent list you want to use for the capture.

6 Enable the agent(s) that you want to capture data. To enable an agent, select the agent in the Capture Agents tree, then click the **Enable Agent** button. You can also right-click on an agent and choose **Enable Agent** from the pull-down menu.

7 Click **Capture Save Directory** and select the local directory where you want to store the capture files.

8 Click **Start Capture** to start the capture operation. Each enabled agent begins to capture data, and the **Start Capture** button changes to **Finish Capture**.

9 Start the transaction you want to capture.

  9.1 To stop the capture, click **Abort Capture**.

  9.2 To view the statistics about the capture, click the **Update Status** button.

10 When the transaction ends, click **Finish Capture**. The message “Capture complete” should display in the Status field next to each enabled agent. The file name for the resulting capture displays in a line beneath each enabled agent.

11 Proceed with the ACE import. You can import a capture file directly into ACE by selecting the file in the agent tree and clicking the **Import Trace** button at the bottom of the Application Capture Manager window. Then proceed with the import as described in Appendix B of this user’s guide.

End of Procedure A-2

App B Importing Capture Files

Introduction

After you have captured application traffic data from your network using ACE's application capture utility or a third-party tool (as described in Appendix A of this user's guide), you can import the capture file(s) into the ACE Editor to create a model of your application. The ACE Editor parses the data and creates a single representation of the exchange. This representation is called an *application task characterization* or simply application task.

Using the ACE Import WIzard

The ACE Import Wizard guides you through the process of importing your capture data. This wizard might prompt you for additional information about your network, such as tier locations and the bandwidths of certain connections. ACE can import multiple capture files of the same exchange and merge the results into an accurate, realistic model of your application. Using ACE's capture and import features, you can model highly complex application exchanges that span many tiers.

To import capture files into the ACE Editor, use the ACE Import WIzard to perform the following steps:

1) Specify capture file(s) to import,

2) Filter traffic,

3) Rename hosts,

4) Specify tier locations,

5) Specify bandwidth and latency, and

6) Save import configuration.

Specifying Capture File(s)

The first step in creating an application task is to specify the capture files you want to import. The ACE Editor can create a task based on a single capture file, or on multiple files that were captured simultaneously.

Procedure B-1 Specify Capture File(s)

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.

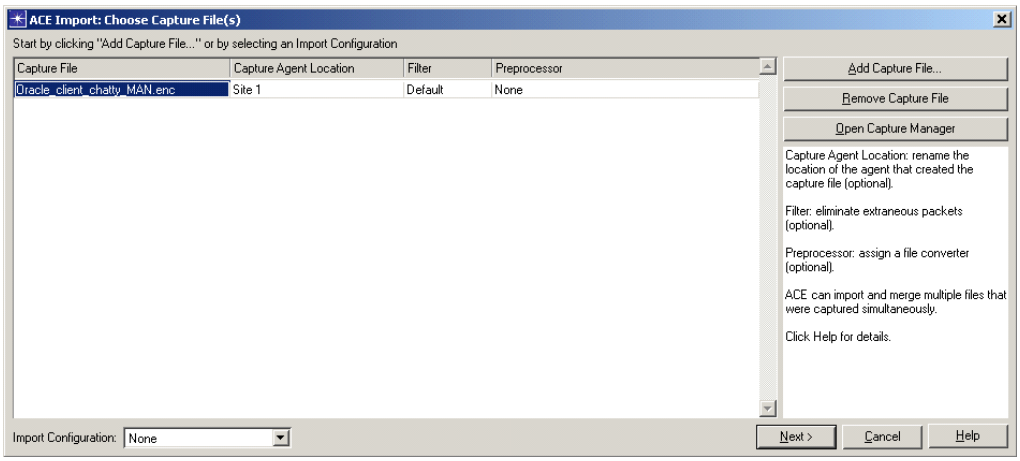


Figure B-1 ACE Import: Choose Capture File(s) dialog box

The ACE Import: Choose Capture File(s) dialog box contains four columns of information, a drop-down list of selectable Import Configurations, and several buttons as described below:

- **Capture File** column: You can create a list of capture files to import using the **Add Capture File** and **Remove Capture File** buttons.
- **Capture Agent Location** column (optional): For each capture file, you can enter a logical name for the capture agent location—for example, “Chicago office” or “My PC”. **Capture Agent Location** refers to the network segment where the capture agent/protocol analyzer was located. Subsequent dialog boxes in the ACE Import Wizard will refer to these capture agent locations when requesting additional information.
- **Filter** column (optional): Use this column to filter out extraneous packets unrelated to the application transaction of interest.
- **Preprocessor** column (optional): If you want to import a capture file that uses a non-standard format, and have a script or program to convert the file, you can specify this in the **Preprocessor** column.
- **Import Configuration** drop-down list (optional): You can save and reuse your ACE import settings. Choosing a saved or previous configuration from this menu fills the editable fields in all the ACE Import Wizard dialog boxes.
- **Open Capture Manager** button: Launches the Application Capture Manager that you can use to create a capure agent list (as described in Appendix A of this user’s guide.)

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

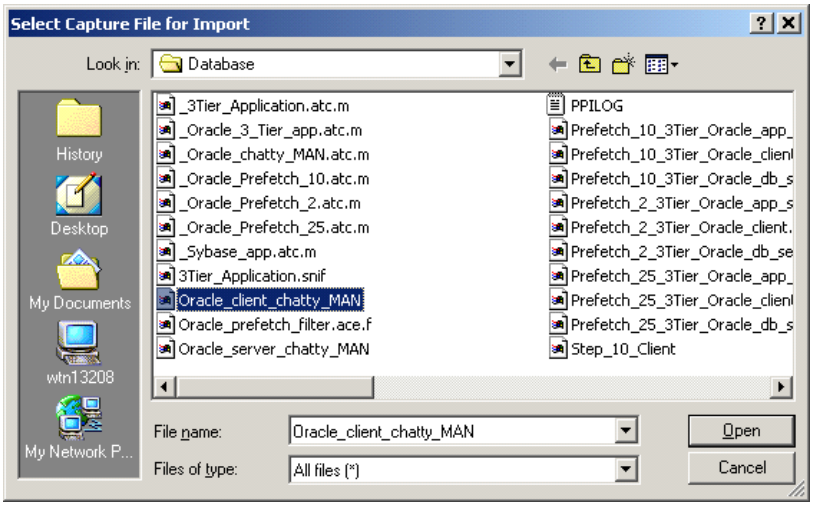


Figure B-2 Select Capture File for Import dialog box

5 In the Select Capture File for Import dialog box, select the file that you want to import, and then click **Open**. The selected file name displays in the **Capture File** column of the ACE Import: Choose Capture File(s) dialog box.

6 (Optional) To enter a logical name for the capture agent location, click in the **Capture Agent Location** column to the right of the Capture File name and type a name.

7 (Optional) To specify a filter to prevent extraneous frames from being imported, click in the **Filter** column to the right of the Capture File name. Choose a predefined filter from the pull-down menu, or select **Edit** to define your own filter. To edit an existing filter, choose it and then select **Edit**.

Note—Default filters include **None**, which accepts all frames, and **Default**, which accepts all frames that contain TCP or UDP. Capture agents use the **None** filter by default, and the import process uses the **Default** filter.

8 (Optional) To specify a script or program to convert a capture file that uses a non-standard format, click in the **Preprocessor** column to the right of the Capture File name and enter the information.

9 (Optional) To automatically fill the editable fields in all the ACE Import Wizard dialog boxes with settings that were saved from a previous import (such as tier names, tier locations, bandwidth, latency), select the saved configuration from the **Import Configuration** drop-down list.

10 After you have specified your data manually (capture files, capture locations, packet filters and preprocessors) or automatically (by choosing an import configuration file), click **Next** and continue to follow the ACE Import WIzard screens as they are presented to you.

End of Procedure B-1

Filtering Traffic

By default, the ACE Editor imports nearly all packets captured in a file. The Capture File Filter dialog box enables you to filter out unwanted packets when you import your capture data. You can filter packets based on host, ports or protocols. You can also save a defined filter to disk and reuse it when creating other ACE files.

Procedure B-2 Edit Filters

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.
4. Click **Add Capture File**. The Select Capture File for Import dialog box displays.
5. Select the file that you want to import, and then click **Open**. The selected file name displays in the **Capture File** column.
6. In the **Filter** column to the right of the Capture File name, select **Edit** to define your own filter. To edit an existing filter, choose it and then select **Edit**. The Capture File Filter dialog box displays.

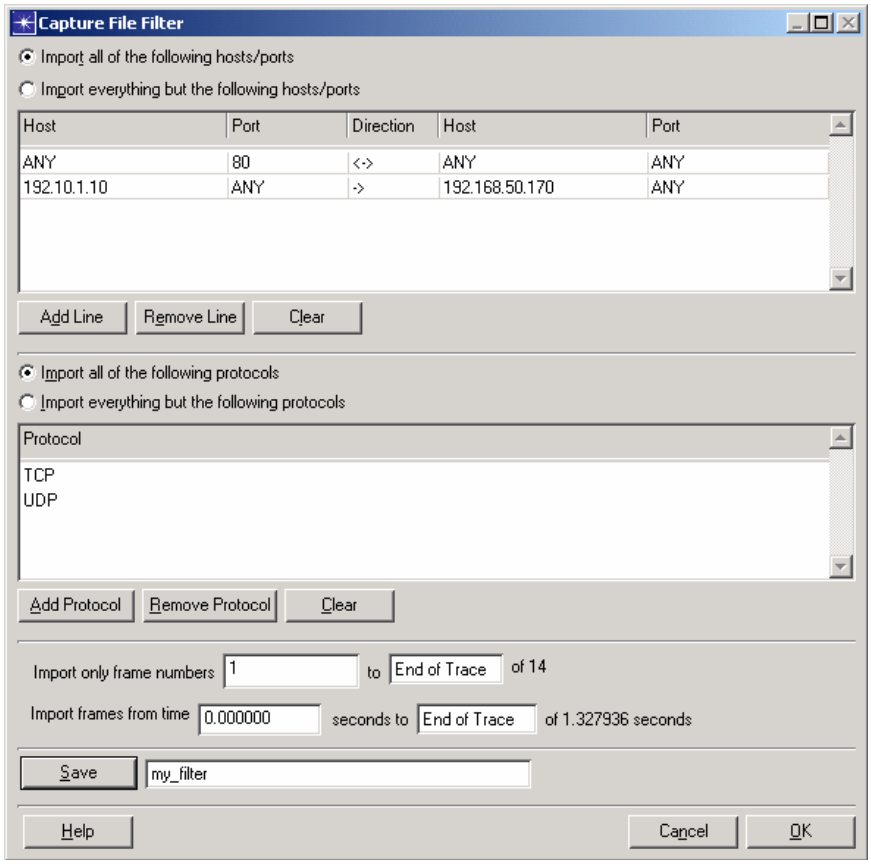


Figure B-3 Capture File Filter dialog box

7 Click the **Import all of the following hosts/ports** radio button(s) if you want ACE to import only those packets that meet the host/port or protocol criteria defined in the Host/Port and/or Protocol filters panes.

8 Click the **Import everything but the following hosts/ports** radio button(s) if you want ACE to import only those packets that do NOT meet the host/port or protocol criteria defined in the Host/Port and/or Protocol filters panes.

9 Use the Host/Port and/or Protocol filters panes to define the filter:

- Host/Port filters pane: A capture file filter is composed of one or more criteria, each residing on a separate line in the Host/Port or Protocol filters panes. You can define host, port, and direction for a line by clicking in each column and selecting an item from the pull-down menu. ACE performs a logical AND on the criteria in both panes to create a compound filter. For example, if the Host/Port filters pane were configured to import all packets originating from host A, and the Protocol filters pane were configured to import only those packets that do not have UDP data, ACE would then import only those packets originating from host A that do not have UDP data (these might be TCP, DLC, and others).
- Protocol filters pane: This pane works in the same general way as the Host/Port filters pane. Each line contains one protocol (or All Protocols) found in the capture file.
- Click the **Add Line/Add Protocol** and **Remove Line/Remove Protocol** buttons to add or remove a line, or **Clear** to clear all filtering criteria, from either the Hosts/Ports or the Protocols filters panes.

  Clicking **Clear** with the **Import everything but the following hosts/ports** radio button in either pane will result in a filter that excludes all packets from the capture file.

10 Type criteria into the **Import only frame numbers** and **Import frames from time** fields if you want to filter out packets based on frame number and time stamp.

11 If you want to reuse your filter in other tasks, you can save your filter to disk. Type a name for the filter in the field next to the **Save** button, and then click **Save**.

12 Click **OK** to close the Capture File Filter dialog box.

End of Procedure B-2

Renaming Hosts

The ACE Editor enables you to assign friendly names, or “tier names”, to replace host names (IP addresses.) Tier names display on all reports.

Sometimes you might want to represent multiple hosts as one tier in your ACE task. For example, you might have multiple web servers handling traffic between a client and a database server. You can combine hosts into one tier by assigning them both the same logical tier name.

Procedure B-3 Rename Hosts

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.

4 After you have specified the capture file(s) to import in the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

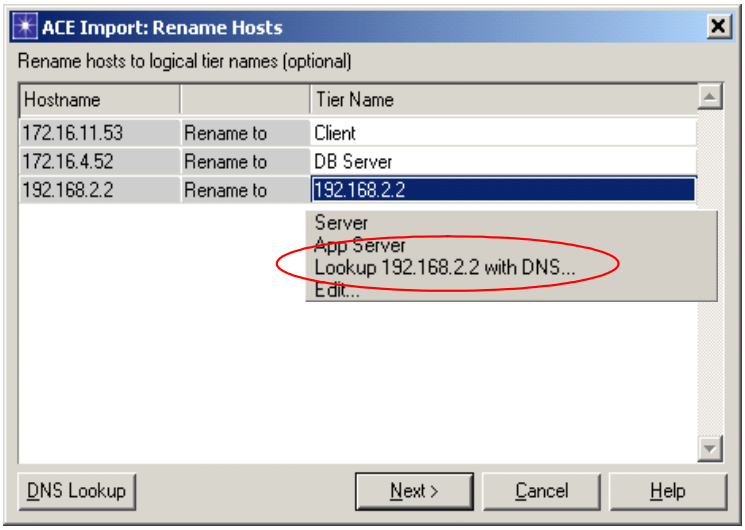


Figure B-4 ACE Import: Rename Hosts dialog box

5 Change a Hostname (IP address) by clicking on the address in the **Tier Name** column. Either select another name from the drop-down list, or select **Lookup** to perform a DNS lookup on the specified tier, or select **Edit** to modify a tier name.

Note—ACE retains a database of previously assigned tier names in the tier_name_db.txt file located in the ace_import_configs directory. This database is automatically used when importing new files. You can modify the database by selecting **Edit**.

6 Click the **DNS Lookup** button if you want to perform a DNS lookup on all tiers.

7 After you have renamed your hosts, click **Next** and continue to follow the ACE Import WIzard screens as they are presented to you.

End of Procedure B-3

Specifying Tier Locations

"Tier location" is the location of each application tier relative to where the capture was done (probe, capture-agent, etc.) By default, the ACE Editor places each tier in the same network segment as the agent that captured its traffic. However, you might need to change the location of particular tiers if your actual network is different—for example, if a tier is in a remote segment from an agent.

ACE will automatically detect locations when you import multiple capture files.

Procedure B-4 Change Tier Locations

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.
4. Follow the Import Wizard screens as they are presented to you, specifying your capture file(s) and tier names, until the ACE Import: Specify Tier Locations dialog box displays.

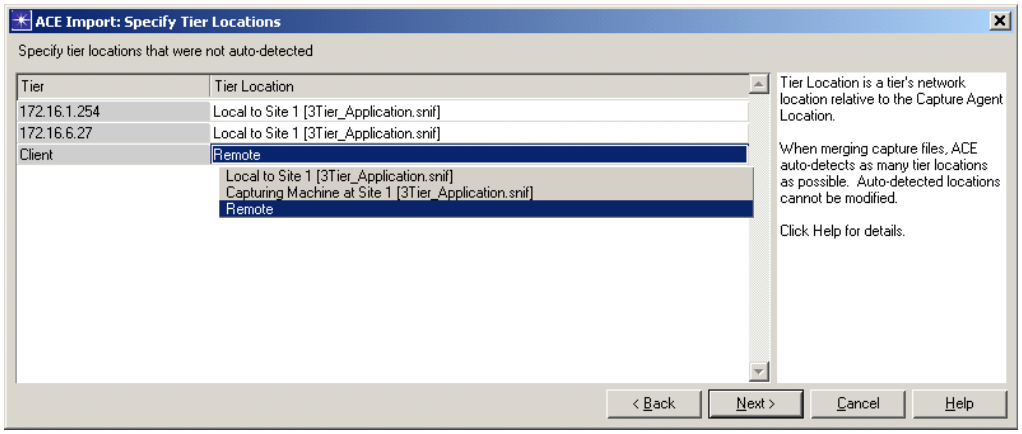


Figure B-5 ACE Import: Specify Tier Locations dialog box

5. Click on a tier's location in the **Tier Location** column and select a different location from the drop-down list. Repeat for each tier as needed.

   Note—In a capture file that contains tiers that are not local (on the same LAN segment), you MUST specify which tiers are remote, relative to the capture location, by selecting **Remote** as their tier location from the drop-down list.

6. After you have changed your tier locations, click **Next** and continue to follow the ACE Import WIzard screens as they are presented to you.

End of Procedure B-4

Specifying Bandwidth for Segment

Sometimes (this option does not always display) you might need to specify the bandwidth (Kbps) observed between hosts at a capture site location.

Procedure B-5 Specify Bandwidth for Segment

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.
4. Follow the Import Wizard screens as they are presented to you, specifying your capture file(s) and tier names and locations, until the ACE Import: Specify Bandwidth for Segment dialog box displays.

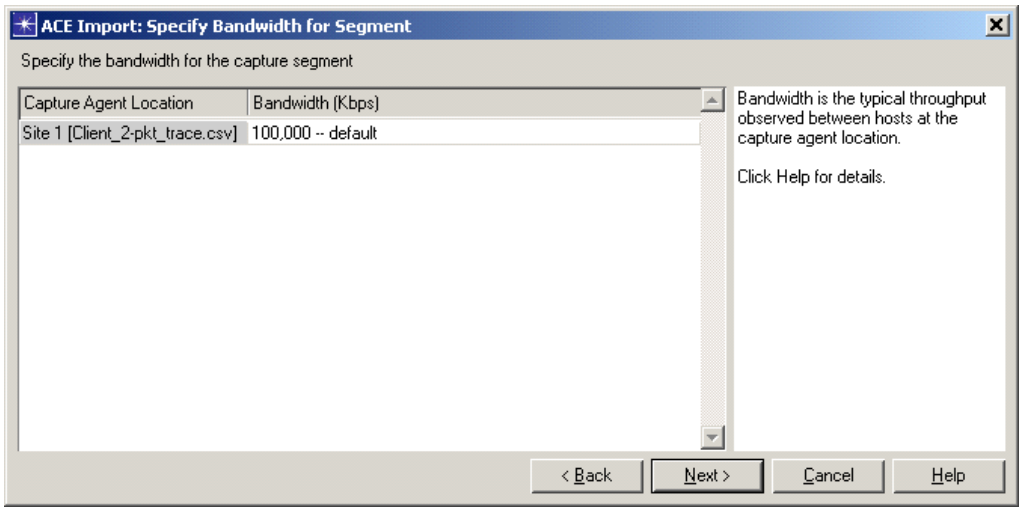


Figure B-6 ACE Import: Specify Bandwidth for Segment dialog box

5. Click on a capture agent's bandwidth in the **Bandwidth** column and enter a new bandwidth value (in Kbps).
6. After you have changed your bandwidth value, click **Next** and continue to follow the ACE Import WIzard screens as they are presented to you.

End of Procedure B-5

Specifying Bandwidth/Latency between Locations

Sometimes (this option does not always display) you might need to specify the bandwidth (Kbps) and one-way latency (ms) measurements between each capture site location.

Bandwidth should be a known factor about your network. If you have different bandwidth's due to multiple segments, then use the "minimum bandwidth" (the capacity of the slowest link.)

Procedure B-6 Specify Bandwidth/Latency between Locations

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.
4. Follow the Import Wizard screens as they are presented to you, specifying your capture file(s) and tier names and locations, etc., until the ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

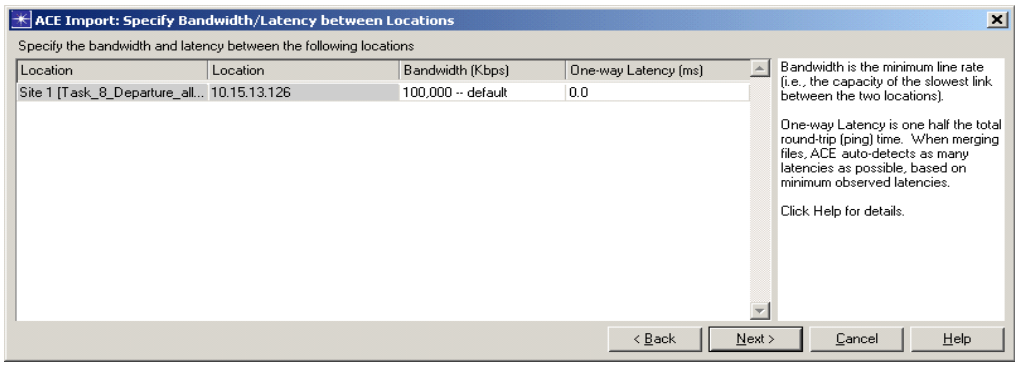


Figure B-7 ACE Import: Specify Bandwidth/Latency between Locations dialog box

5. Click on a location's bandwidth in the **Bandwidth** column and enter a new bandwidth value (in Kbps).
6. Click on a location's one-way (NOT round-trip) latency in the **One-way Latency** column and enter a new latency value (in ms).

   Note—If you use PathProbe to provide latency estimates, the data will be reflected as one-way already. However, if you use Ping, then you must divide the latency in half.
7. After you have changed your bandwidth and latency values, click **Next**. The Save Import Configuration dialog box displays.
8. Click **Finish** if you want to complete the import process.

End of Procedure B-6

Using PathProbe to Estimate Bandwidth and Latency

You can use PathProbe, an OPNET utility, to measure and provide bandwidth and latency estimates.

Procedure B-7 Run PathProbe

1 Launch NETWARS.

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

3 From the Open Editor drop-down menu, select **ACE**, and then click **OK**. The ACE Import: Choose Capture Files dialog box displays.

4 Click **Open Capture Manager**.The Application Capture Manager window displays.

Note—You can also open the Application Capture Manager by selecting **File > Application Capture Manager** in the ACE Treeview window, Data Exchange Chart, or Tier Pair Circle.

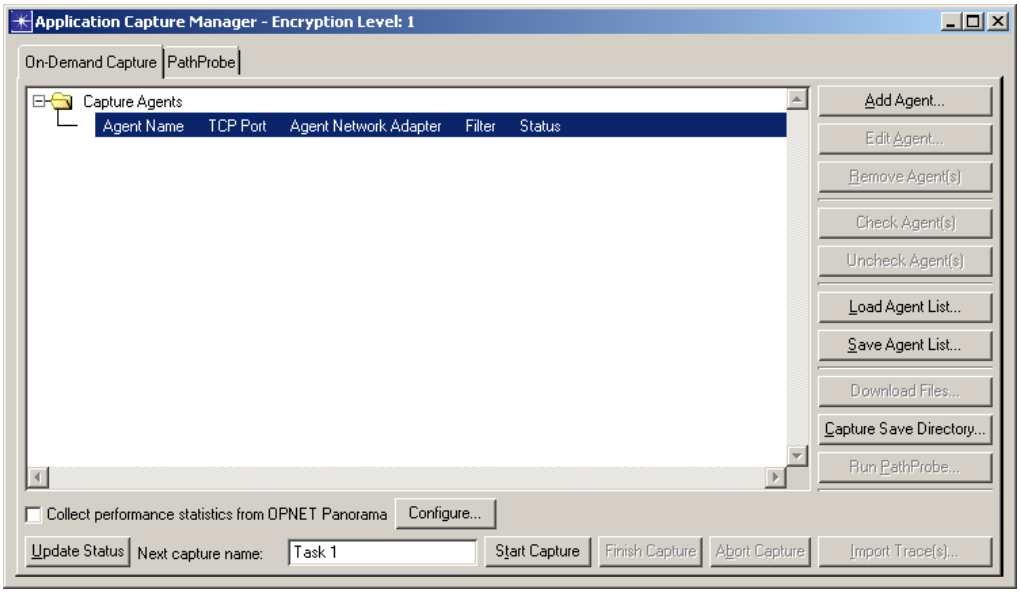


Figure B-8 Application Capture Manager

5 Click **Run PathProbe...**. The PathProbe dialog box displays.

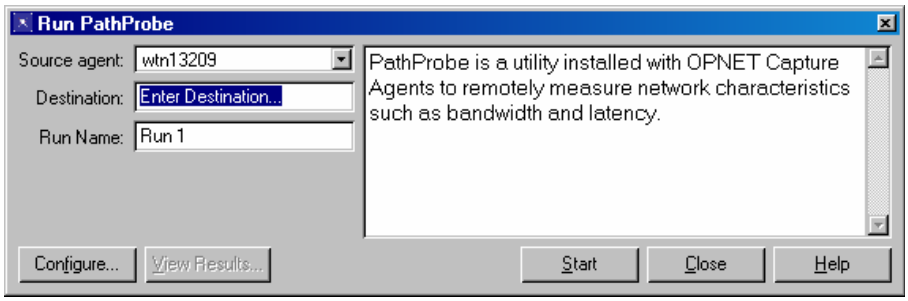


Figure B-9 PathProbe dialog box

6 Specify the Source agent and Destination, and name the run in the appropriate fields.

7 Click **Configure** to configure different experiments.

8 Click **Start** to start the run, and then view the results displayed in the PathProbe Results Dialog Box.

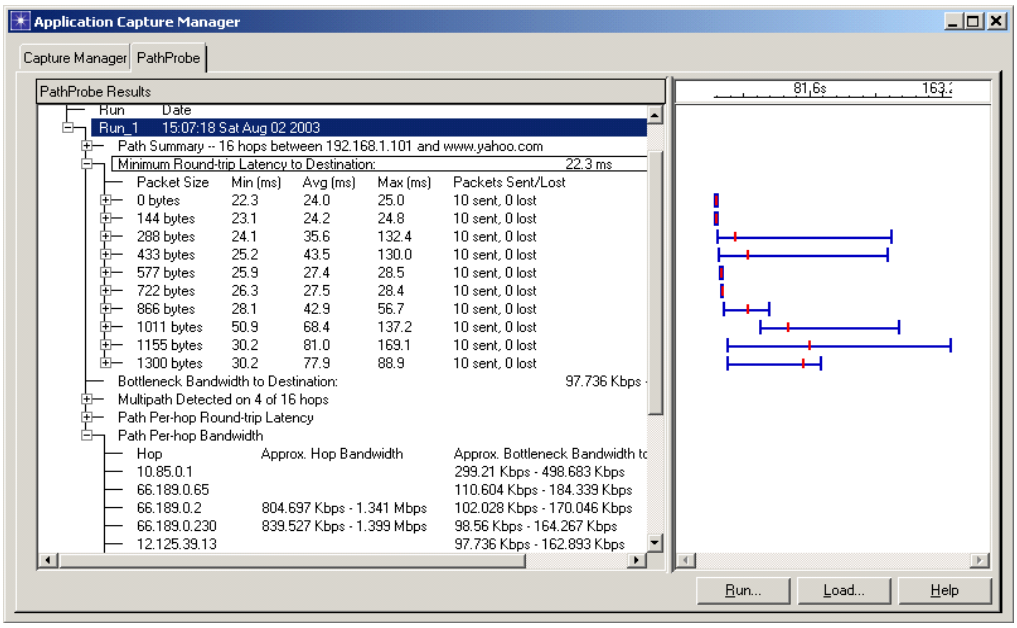


Figure B-10 Sample PathProbe Results

End of Procedure B-7

Saving an Import Configuration

You can create and use Import Configuration files that contain the filters, tier names, tier locations, and bandwidth/latency settings that you've designated previously in the ACE Import: Choose Capture File(s) dialog box. The import information is saved for use with future imports that involve the same tiers and the same capture locations. The ACE Editor automatically saves the settings you designated most recently under the name "Previous Configuration."

Procedure B-8 Save Import Configuration

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, select **ACE**, and then click **OK**. The ACE Import WIzard displays the ACE Import: Choose Capture File(s) dialog box.

4 Follow the Import Wizard screens as they are presented to you, specifying your data (capture files, capture locations, packet filters and preprocessors) until the Save Import Configuration dialog box displays.

5 In the Save Import Configuration dialog box, type a name for the import configuration file in the field next to the **Save** button, and then click **Save**.

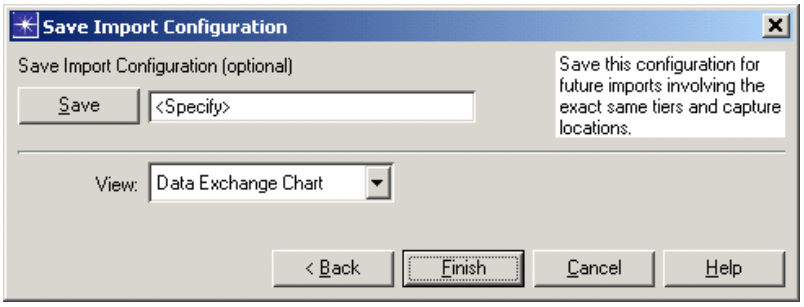


Figure B-11 Save Import Configuration dialog box

6 Click **Finish** if you want to complete the import process.

End of Procedure B-8

Import Strategies

There are three strategies for importing capture file(s) that can handle any network configuration:

- Import a single capture file,
- Auto-merge and import multiple capture files, and
- Manually merge and import multiple capture files.

Single Capture File

A single capture file is easy to set up, but tiers must be co-located to see all traffic, and high/variable latencies aren't captured well. This strategy is ideal for a lab environment where all tiers' locations are "Local to…" and bandwidth/latency often matches default values of 100,000 Kbps, 0 ms.

Refer to the "Importing a Single Capture File" section provided later in this chapter for a sample scenario that walks you through the import process for a single capture file.

Multiple Capture Files

You can "merge" multiple capture files, which is when two or more traces of an application transaction are combined to create a unified view of an application. This strategy allows analysis of multi-tier transactions where all traffic does not go through one location, and improves analysis in a production environment with large and/or variable latencies.

The benefits to merging multiple capture files over using a single capture file include:

- Packets' send/receive times are accurate,
- Time spent at each tier is accurate, and
- The result is a better visualization of delays and better diagnosis.

ACE can merge traces that come from opposite sides of a simple packet filtering firewall, but cannot automatically merge traces that come from opposite sides of an application proxy firewall.

Auto-Merge Import

To auto-merge multiple capture files, you need capture files containing common traffic, and you need to specify the bandwidth between the capture locations (i.e., between tiers where the captures occurred.) ACE auto-detects locations and one-way latency between the capture locations.

Refer to the "Merging Multiple Capture Files" section provided later in this chapter for a sample scenario that walks you through the import process for an auto-merged import of multiple capture files.

Manual Merge Import

Manual merging of capture files is an advanced feature that is rarely needed for most users. It allows merging of non-shared traffic, including traces from dual-homed hosts, traces from non-contiguous hosts (missing tiers in conversation path, and captures separated by capture time and collection method.

To merge capture files manually, you must select the traces that you want to merge, and specify a synchronization value:

- Two traces from a dual-homed machine
  - — Accept synchronization value proposed by ACE
- Two traces from two machines with synchronized clocks
  - — Accept synchronization value proposed by ACE (you may have to re-import and tweak the synchronization value)
- Two traces from two machines with unsynchronized clocks
  - — Specify 0.0 as the synchronization value
  - — Estimate the offset, then re-import using the estimated offset
  - — Repeat until you get the desired result

Importing a Single Capture File

When importing application traffic into ACE, it is important that you set the parameters appropriately. In the following procedure, we will import a single capture file without specifying the appropriate relationship (locations) between the application tiers and the capture site. You will see the steps involved in the import process and understand the importance of providing the correct information to the import process. After we import this capture file, we will re-import the same file (this time with appropriate parameters) and compare the differences.

Note—The following example was presented at OPNETWORK 2004 in Session 1209, Introduction to Using ACE, 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:

- An application capture trace was taken at the Washington, DC, data center (Site 1), where the Web and Database Server are located, on a 100MB LAN. The Network Probe was placed on the local switch. The Application request is initiated by a remote Client, located in Dallas. The network connection between the Client and the Servers is a 512Kb link, with an average of 80Ms latency.

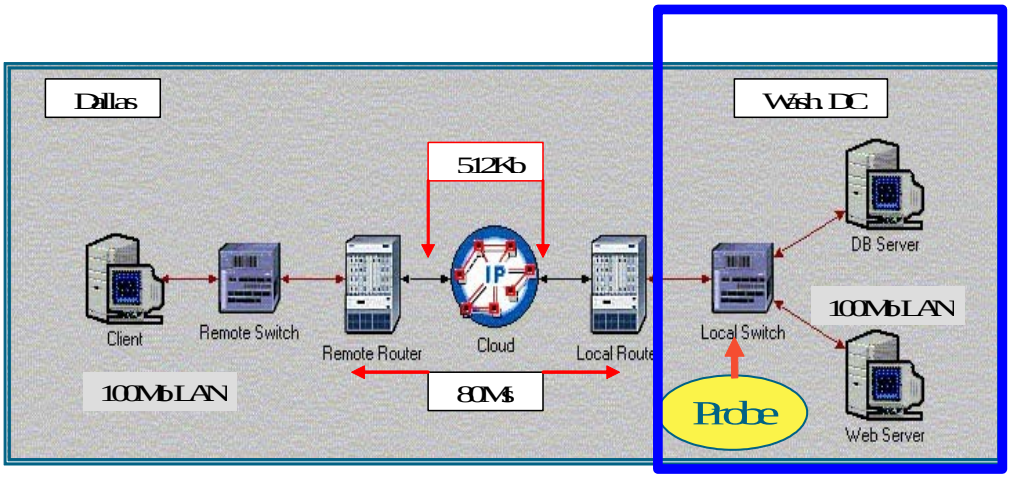


Figure B-12 Example Scenario for Importing a Single Trace FIle

---

Procedure B-9 Import a Single Capture File

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, select **ACE**, and then click **OK**. The ACE Import: Choose Capture File(s) dialog box displays.

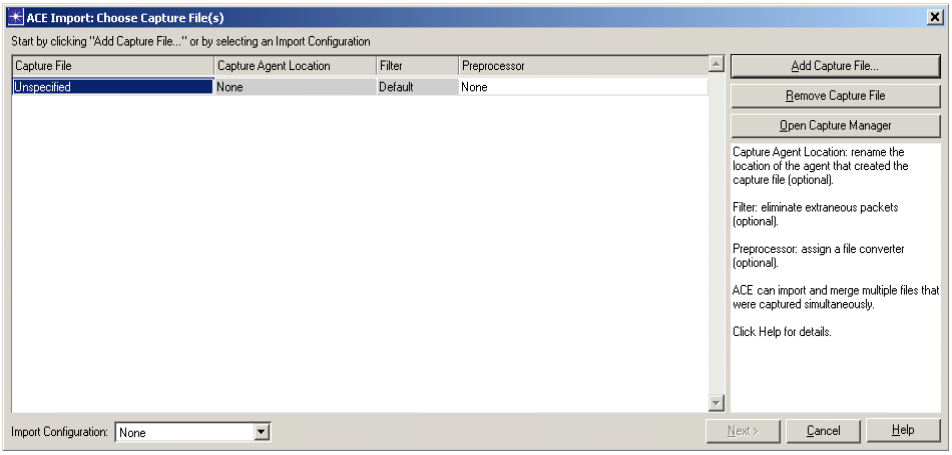


Figure B-13 ACE Import: Choose Capture File(s) dialog box

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

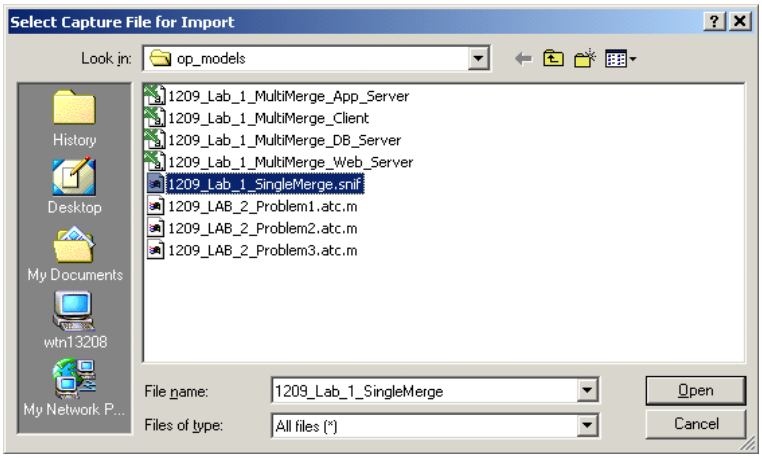


Figure B-14 Select Capture File for Import dialog box

5 In the Select Capture File for Import dialog box, select the file named `1209_Lab_1_SingleMerge.sniff`, 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.

The ACE Import: Choose Capture File(s) dialog box shows the capture file in the Capture File column.

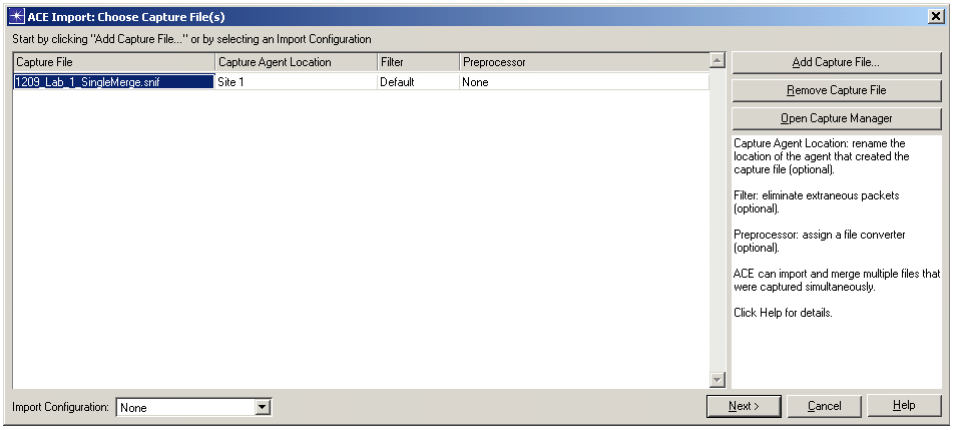


Figure B-15 ACE Import: Choose Capture File(s) dialog box with Selected Capture File

6 In the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

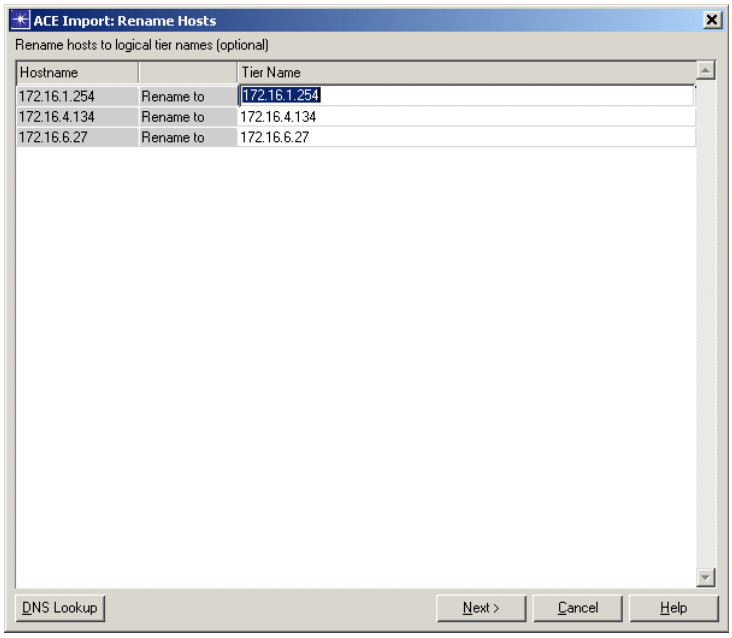


Figure B-16 ACE Import: Rename Hosts dialog box

7 In the ACE Import: Rename Hosts dialog box, change the IP addresses by clicking on the address in the Tier Name column and selecting **Edit**.

7.1 Change 172.161.1.254 to “DataBase Server”.

7.2 Change 172.164.4.134 to “Client”.

7.3 Change 172.16.6.27 to “Web Server”.

8 In the ACE Import: Rename Hosts dialog box, click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

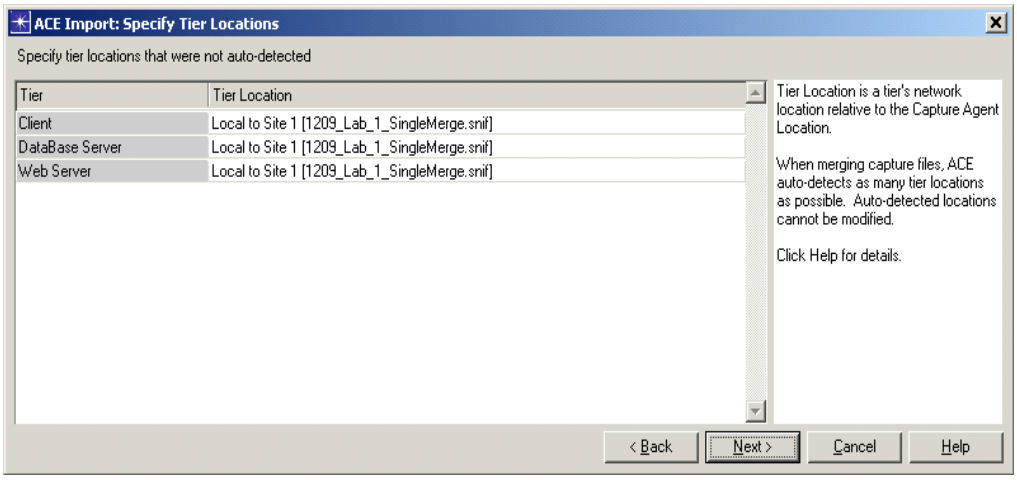


Figure B-17 ACE Import: Specify Tier Locations dialog box

9 In the ACE Import: Specify Tier Locations dialog box, click **Next**. The ACE Import: Specify Bandwidth for Segment dialog box displays.

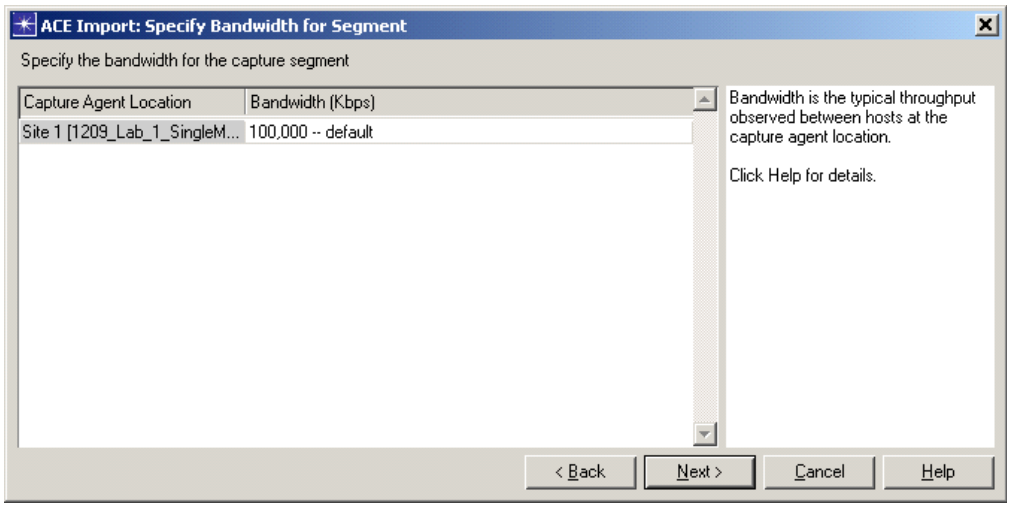


Figure B-18 ACE Import: Specify Bandwidth for Segment

10 In the ACE Import: Specify Bandwidth for Segment dialog box, click **Next**. The Save Import Configuration dialog box displays.

11 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

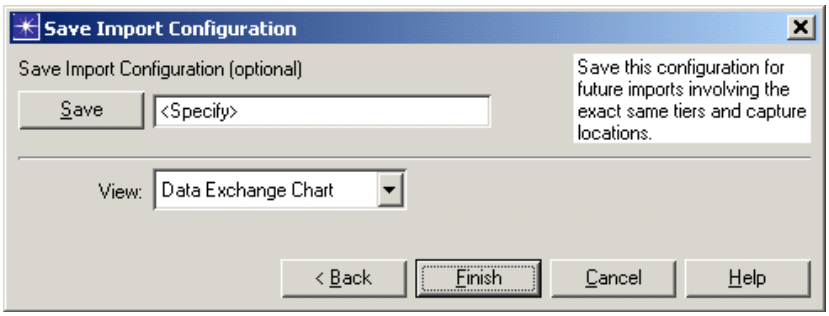


Figure B-19 Save Import Configuration dialog box

12 Analyze the application packet trace. Using the Data Exchange chart (shown below), you can view the number of messages between each tier and the messages sizes between the Web and Database Servers.

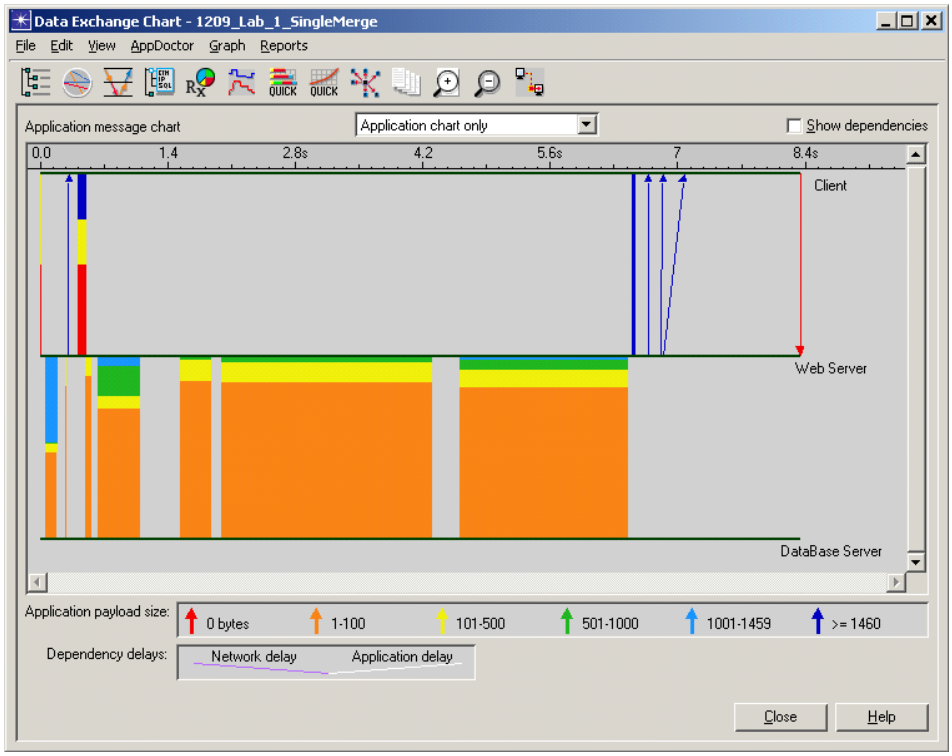


Figure B-20 Data Exchange Chart with no Parameters Set

13 Select **AppDoctor > AppDoctor Analysis** or click the **AppDoctor** toolbar icon, and display AppDoctor's Summary of Delays chart.

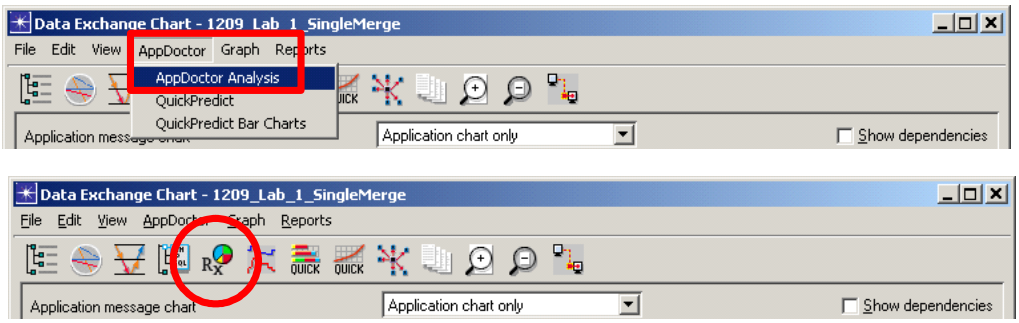


Figure B-21 AppDoctor Menu Commands and Toolbar Button

14 Check the **Show values** checkbox (located in the lower left corner), and study the exploded pie chart statistics.

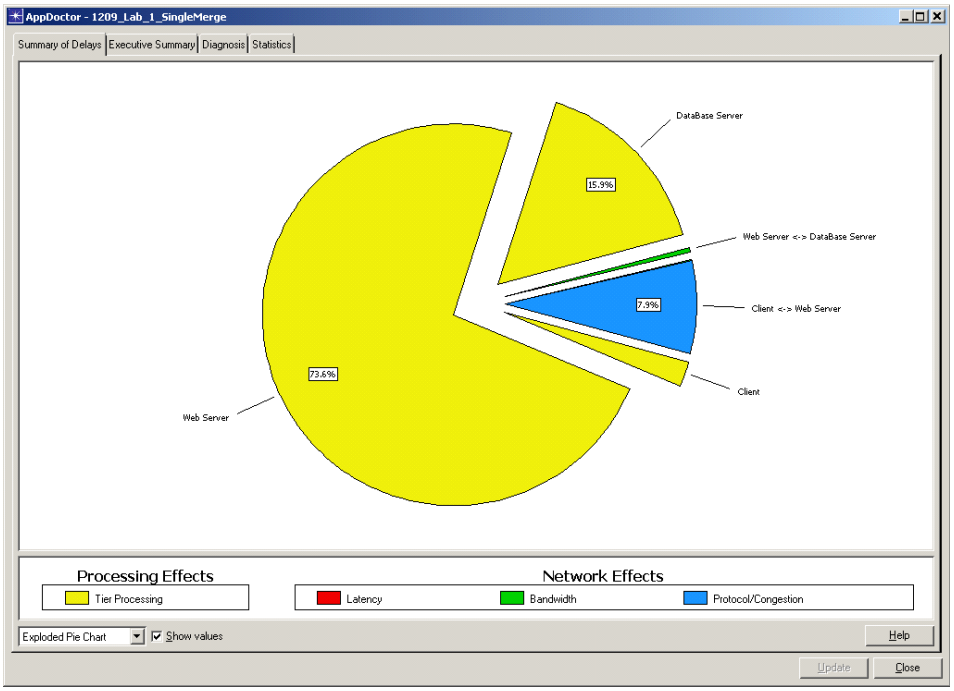


Figure B-22 Exploded Pie Chart Statistics

15 Select **Bar Chart** from the drop-down menu (located in the lower left corner), and study the bar chart statistics.

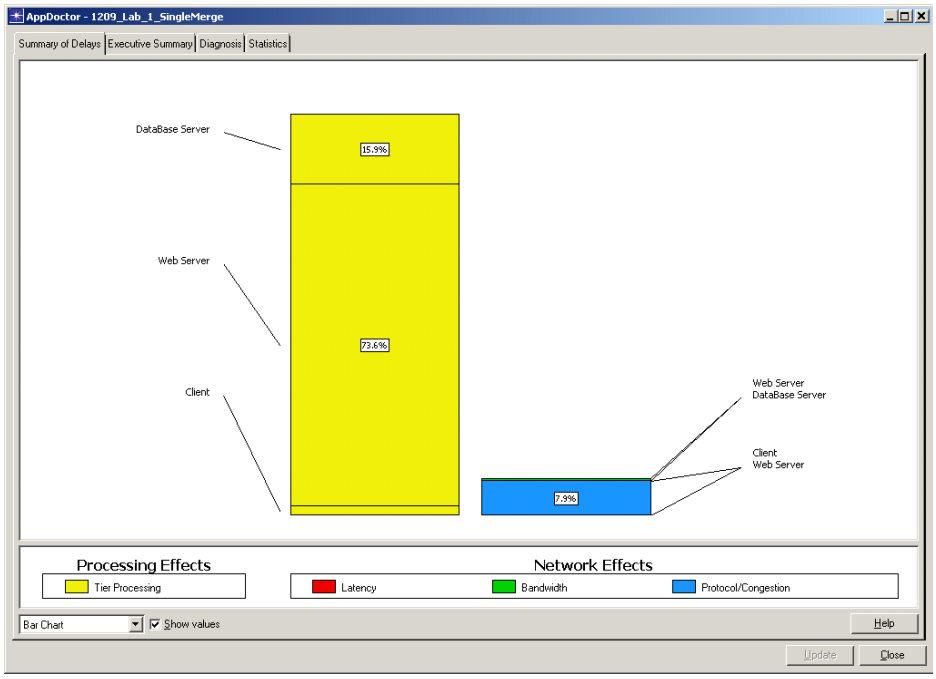


Figure B-23 Bar Chart Statistics

16 Select **Pie Chart** from the drop-down menu (located in the lower left corner), and study the regular pie chart statistics.

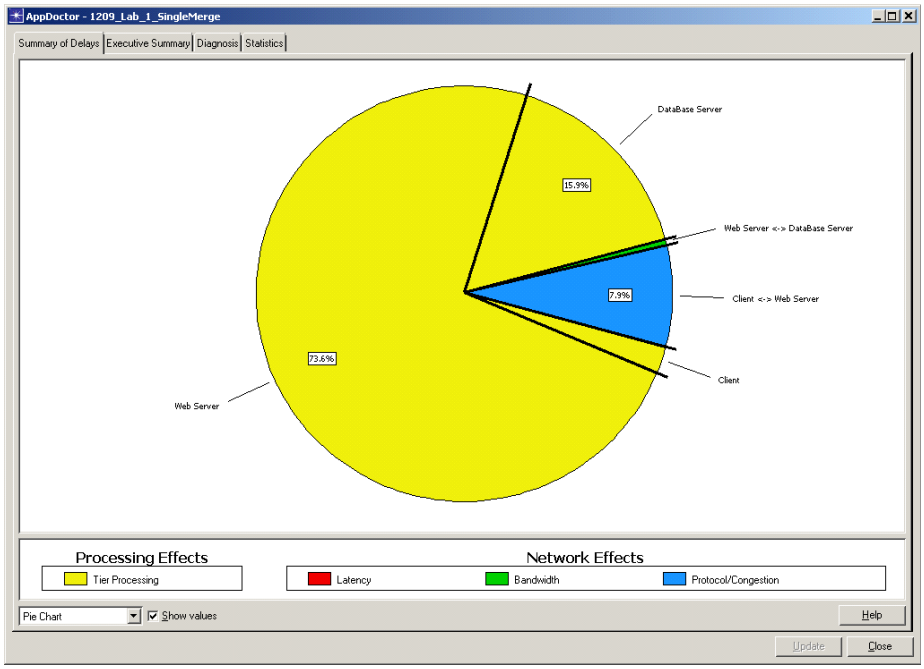


Figure B-24 Pie Chart Statistics

17 Close all currently opened windows, except for NETWARS.

18 Re-import the same application packet trace file, this time specifying appropriate tier locations, bandwidth, and latency.

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

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

18.3 Click **Add Capture File**.

18.4 In the Select Capture File for Import dialog box, select the first capture file named `1209_Lab_1_SingleMerge.sniff`, and then click **Open**.

The ACE Import: Choose Capture File(s) dialog box shows the capture file in the Capture File column.

18.5 In the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

Note—The Tier Names have already been selected. ACE remembers IP addresses from previous packet trace imports. ACE builds and maintains a database of IP addresses so you will not have to keep renaming the same hosts.

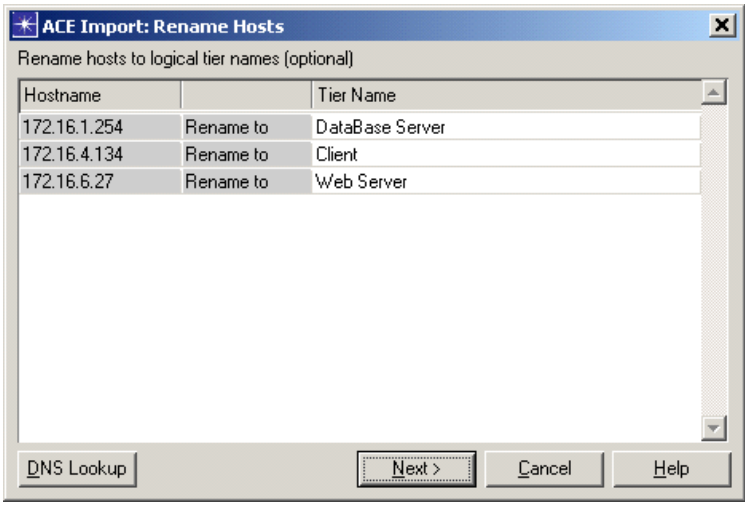


Figure B-25 ACE Import: Rename Hosts dialog box

18.6 In the ACE Import: Rename Hosts dialog box, click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

18.7 In the ACE Import: Specify Tier Locations dialog box, click on the Client's tier location in the Tier Location column and select "Remote". Leave the other tiers as "Local to Site 1".

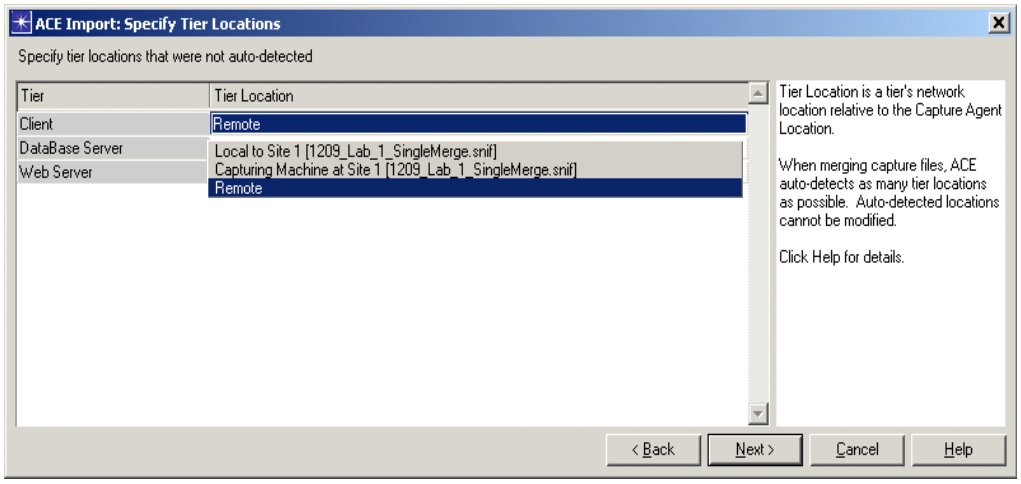


Figure B-26 Changing the Client's Tier Location

18.8 In the ACE Import: Specify Tier Locations dialog box, click **Next**. The ACE Import: Specify Bandwidth for Segment dialog box displays.

18.9 In the ACE Import: Specify Bandwidth for Segment dialog box, click **Next**. The ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

18.10 In the ACE Import: Specify Bandwidth/Latency between Locations dialog box,edit the following values:

- Edit the **Bandwidth** column and specify "512" (Kbps).
- Edit the **One-way Latency** column and specify "40" (ms).

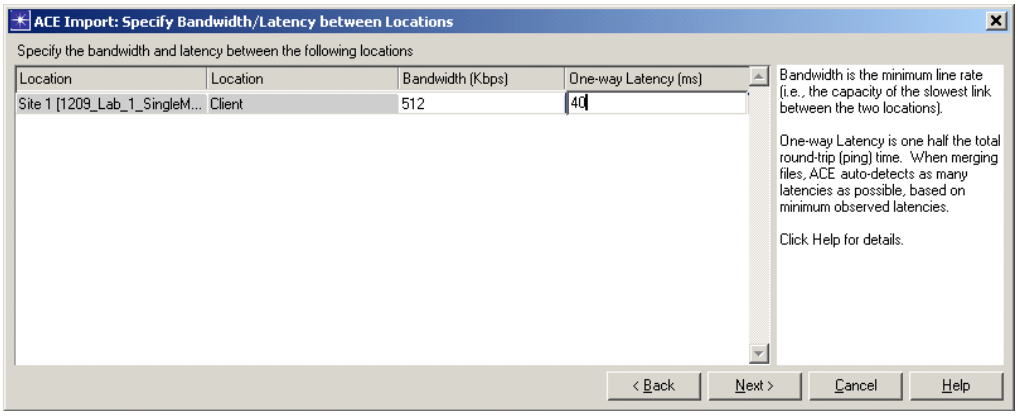


Figure B-27 ACE Import: Specify Bandwidth/Latency between Locations dialog box

18.11 In the ACE Import: Specify Bandwidth/Latency between Locations dialog box, click **Next**. The Save Import Configuration dialog box displays.

18.12 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

18.13 Analyze the application packet trace. Using the Data Exchange chart (shown below), note the number and size of messages and which tier pair has the most activity.

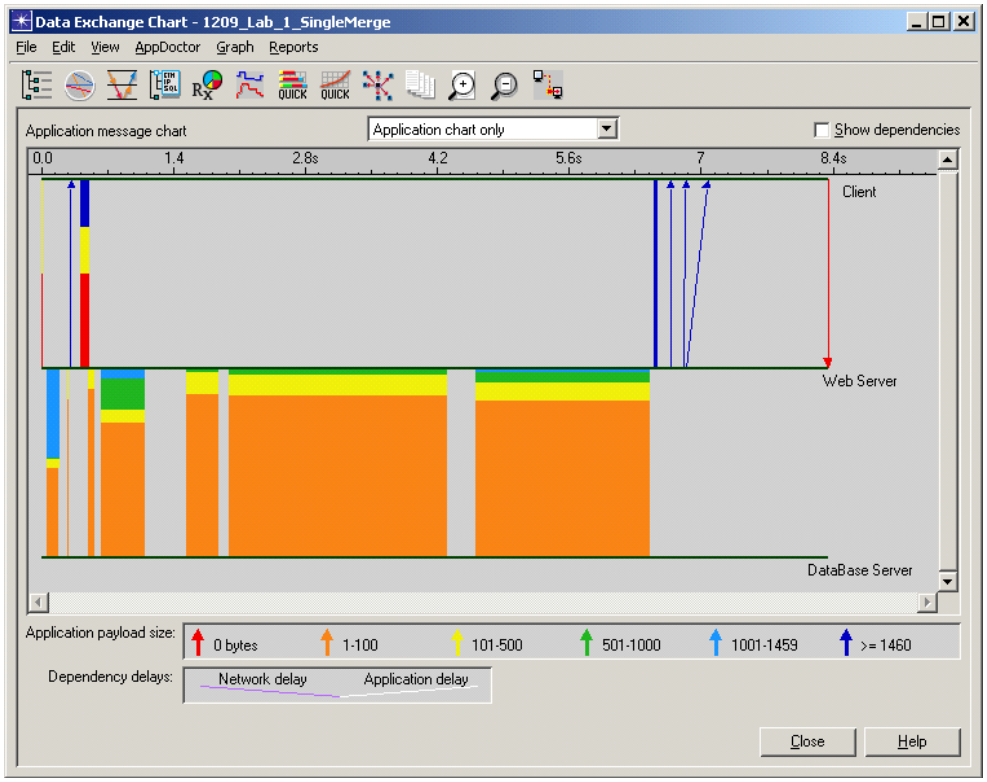


Figure B-28 Data Exchange Chart with Parameters Set

18.14 Select **AppDoctor > AppDoctor Analysis** or click the **AppDoctor** toolbar icon, and display AppDoctor's Summary of Delays chart.

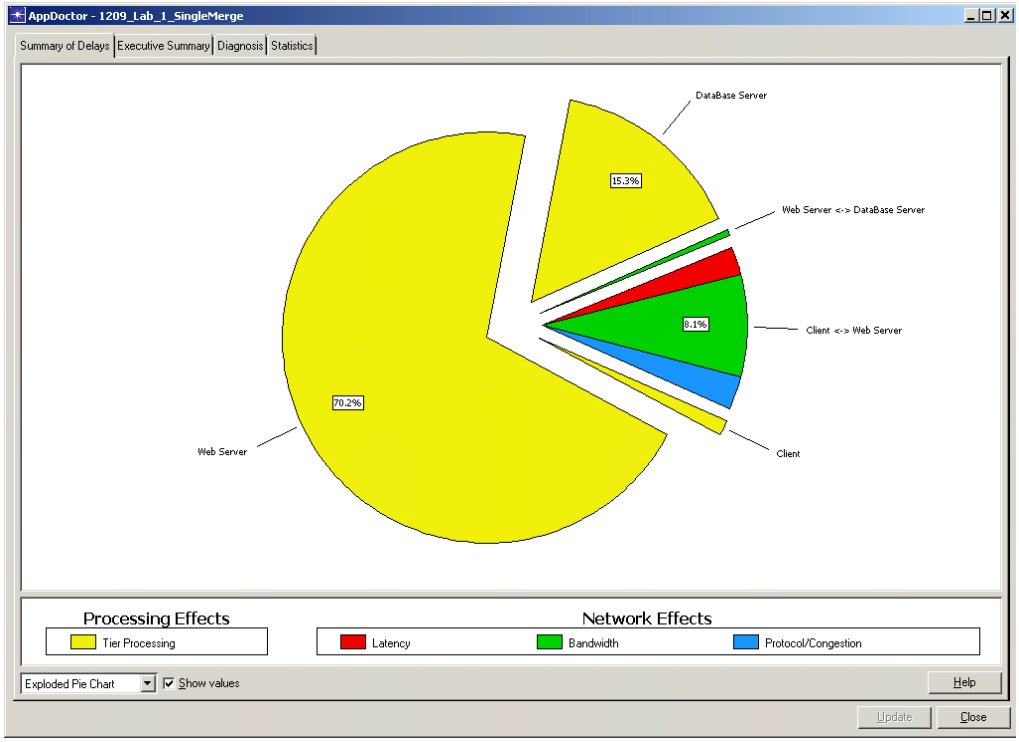


Figure B-29 AppDoctor's Summary of Delays Chart

18.15 Check the **Show values** checkbox (located in the lower left corner), and study the exploded pie chart statistics.

End of Procedure B-9

Conclusion

In the first import, all three tiers were specified to be on the same segment as the capture location (Site 1). The Client was actually "remote" to the capture location on a WAN link of 512Kb. The fact that the Client was not correctly identified as remote caused the calculations of the network effects to be incorrect.

In the second import, the Client was specified as remote to the capture location, and shows the correct evaluation of network effects.

Using QuickPredict to Analyze Bandwidth

In the previous section, we showed you how to import a single capture file. Next, we will show you how to use QuickPredict to validate the effect of bandwidth on the transaction and explore other different bandwidth "what-ifs".

Procedure B-10 Use QuickPredict to Analyze Bandwidth

1 Click the **QuickPredict** toolbar button.

Figure B-30 QuickPredict Toolbar Button

The QuickPredict Control dialog box displays along with an Impact of Bandwidth on Response Time graph showing bandwidth sweep.

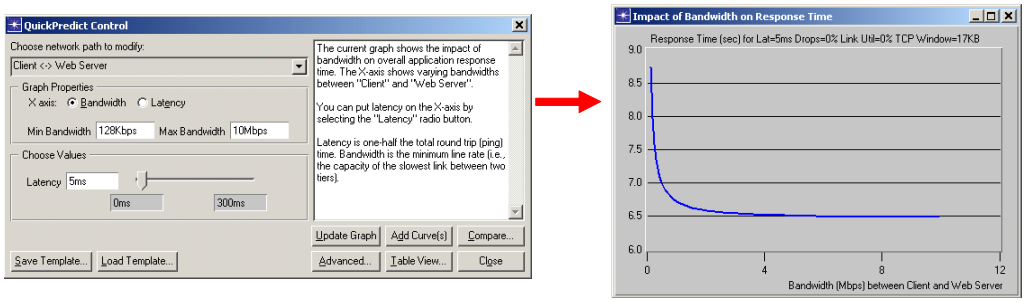


Figure B-31 QuickPredict Control dialog box and graph

2 In the QuickPredict Control dialog box, change the **Min Bandwidth** and **Max Bandwidth** fields both to “512Kbps”, and then click **Update Graph**.

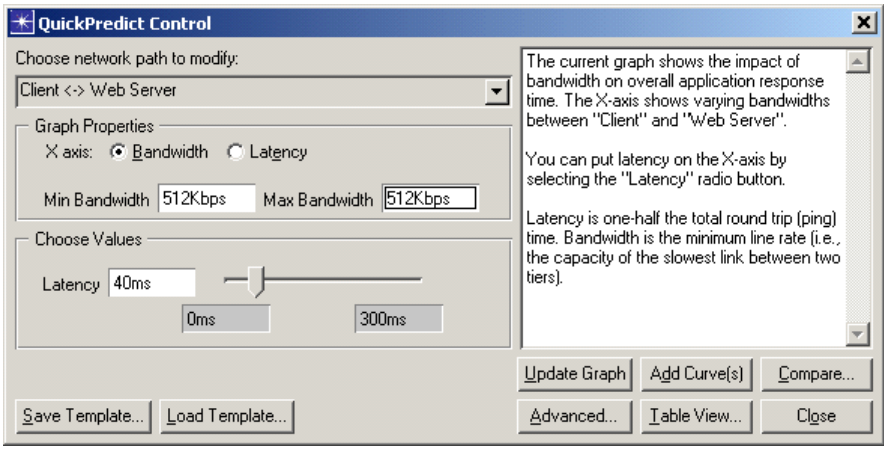


Figure B-32 Editing the QuickPredict Control dialog box

The updated QuickPredict graph displays. The “Y” axis is response time, and the “X” axis is bandwidth.

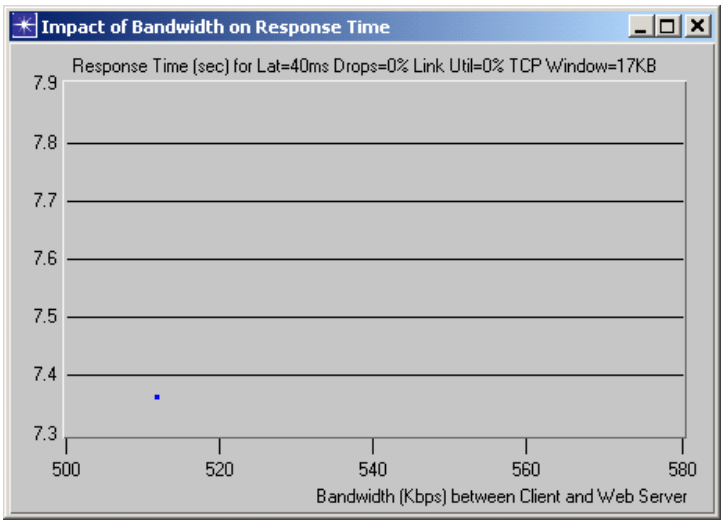


Figure B-33 Impact of Bandwidth on Response Time graph

Note that at 512Kbps bandwidth, the response time is around 7.3 secs.

3 Increase the bandwidth, at different Intervals, and study its effect on the response time.

3.1 In the QuickPredict Control dialog box, change the **Max Bandwidth** field to “756Kbps”, and then click **Add Curve(s)**.

3.2 In the QuickPredict Control dialog box, change the **Max Bandwidth** field to “1Mbps”, and then click **Add Curve(s)**.

3.3 In the QuickPredict Control dialog box, change the **Max Bandwidth** field to “1.544Mbps”, and then click **Add Curve(s)**.

The updated QuickPredict graph should look like the one provided below.

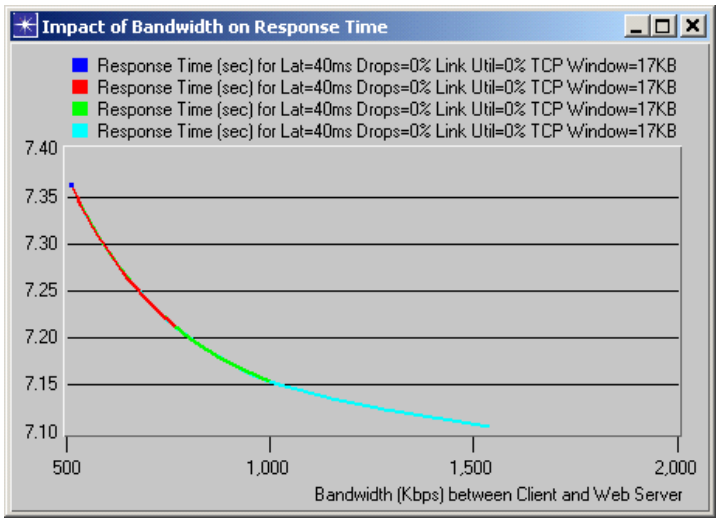


Figure B-34 Updated Impact of Bandwidth on Response Time graph

4 Note the impact (gain) of increasing bandwidth on response time when upgrading from 512Kbps to 756Kbps, from 756Kbps to 1Mbps, from 756Kbps to 1.544Mbps (T1), and the total potential gain from 512Kbps to 1.544Mbps.

5 Increase the bandwidth from 1.544Mbps (T1) to 100Mbps, and study its effect on the response time.

5.1 In the QuickPredict Control dialog box, change the **Min Bandwidth** field to "1.544Mbps" and the **Max Bandwidth** field to "100Mbps", and then click **Add Curve(s)**.

The updated QuickPredict graph should look like the one provided below.

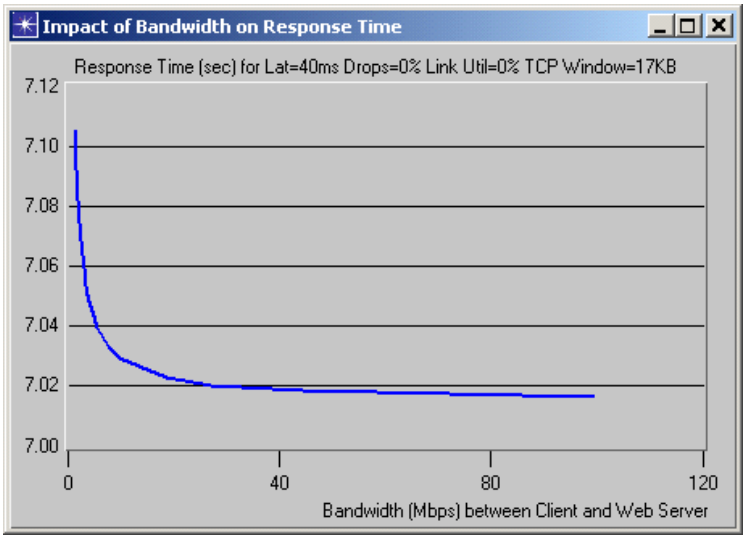


Figure B-35 Updated Impact of Bandwidth on Response Time graph

6 Close all currently opened windows, except for NETWARS.

End of Procedure B-10

Conclusion

With QuickPredict, you can see the network effect of bandwidth on response time. You can evaluate how upgrading bandwidth may help the total response time, and even determine at what point (bandwidth) the response time may level off (point at which more bandwidth will not decrease or impact response time any more).

You can use the information provided by QuickPredict to evaluate the cost of increasing bandwidth against the return in increased response time. In our example, bandwidth was such a small percentage of the total process and network effects, that the percentage gained is probably not worth the cost.

Merging Multiple Capture Files

Note—The following example was presented at OPNETWORK 2004 in Session 1209, Introduction to Using ACE, 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:

- An application packet trace was taken over the Far East Network. The Client is located in Beijing (Site 1), the Web and Application Servers are located in Seoul (Site 2), and the Database Server is located in Tokyo (Site 3). The network connection between Beijing and Seoul is a 1.544Mbps (T1) link, with a 23.754ms one-way latency. The network connection between Seoul and Tokyo is a 3.0Mbps link, with a 39.311 one-way latency. The LAN configurations at each site are 100Mbps. ACE capture agents were installed on each of the four hosts and used to capture the packet traces.

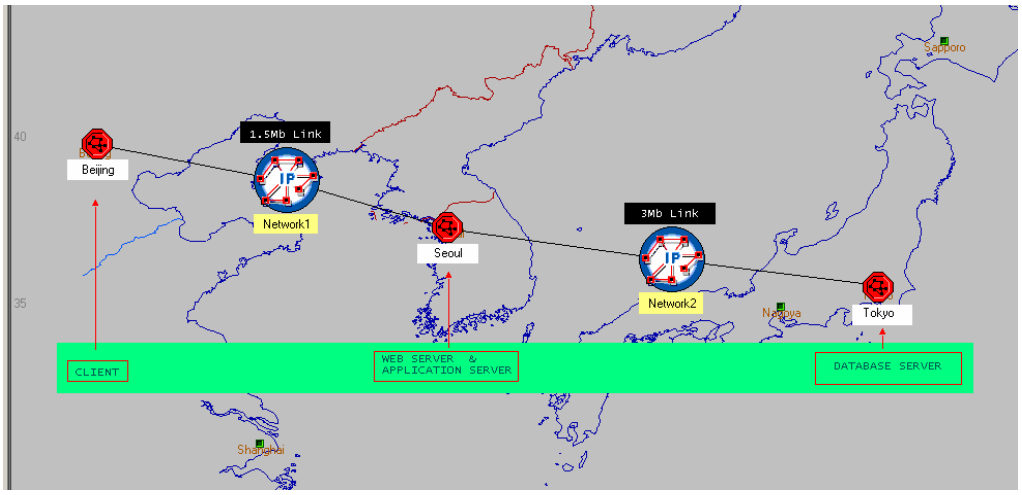


Figure B-36 Example Scenario for Merging Multiple Capture Files

In the following procedure, we will merge the capture files from Site 1 and Site 2 and analyze the results. Then we will merge the capture files from Site 1, Site 2, and Site 3, and analyze and compare the different results. This exercise will help you to understand the difference and importance of location of the capture.

Procedure B-11 Merge Multiple Capture Files

1 Launch NETWARS, if not already opened.

2 Merge multiple trace files:

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

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

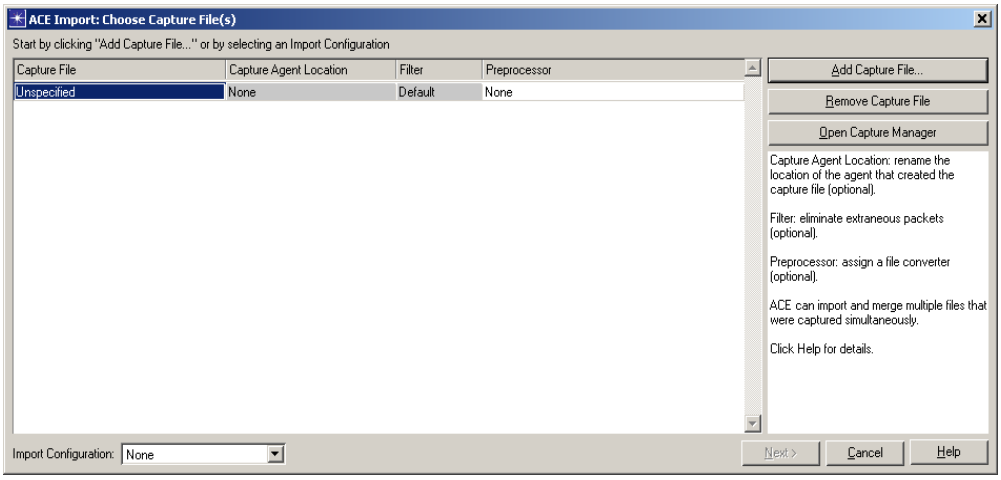


Figure B-37 ACE Import: Choose Capture File(s) dialog box

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

2.4 In the Select Capture File for Import dialog box, select the first capture file named `1209_Lab_1_MultiMerge_Client`, and then click **Open**.

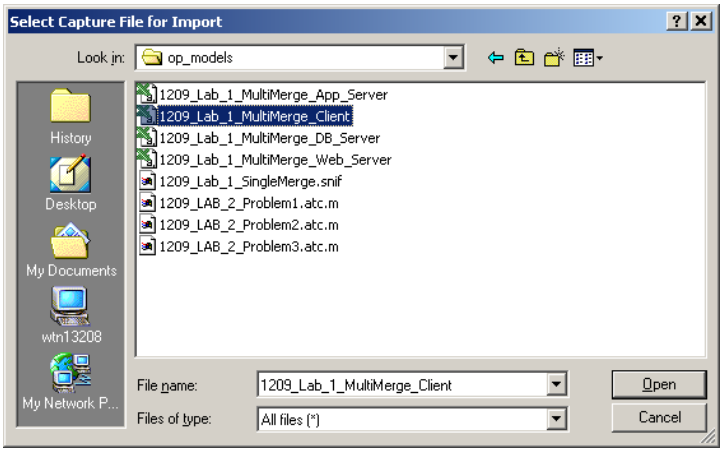


Figure B-38 Select Capture File for Import dialog box

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.

The ACE Import: Choose Capture File(s) dialog box shows the first capture file in the Capture File column.

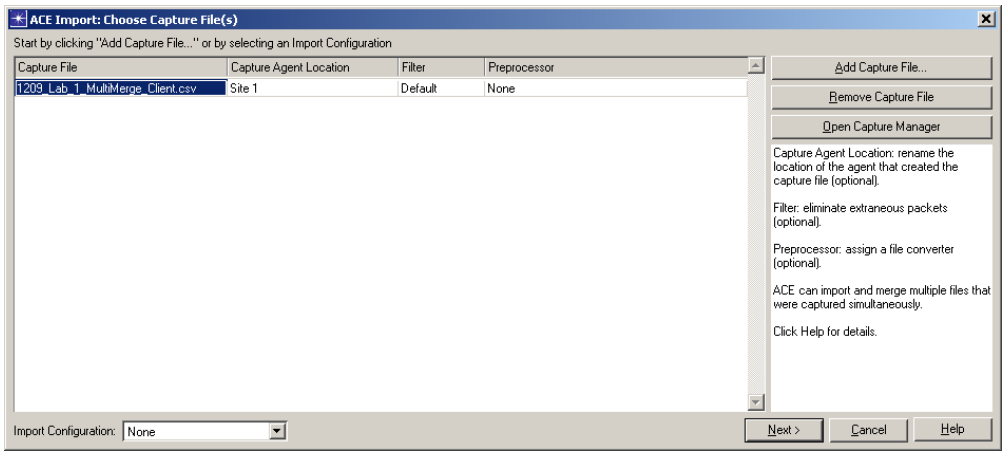


Figure B-39 The ACE Import: Choose Capture File(s) dialog box with Selected Capture File

2.5 In the ACE Import: Choose Capture File(s) dialog box, click **Add Capture File**. The Select Capture File for Import dialog box displays.

2.6 In the Select Capture File for Import dialog box, select the second capture file named `1209_Lab_1_MultiMerge_Web_Server`, and then click **Open**.

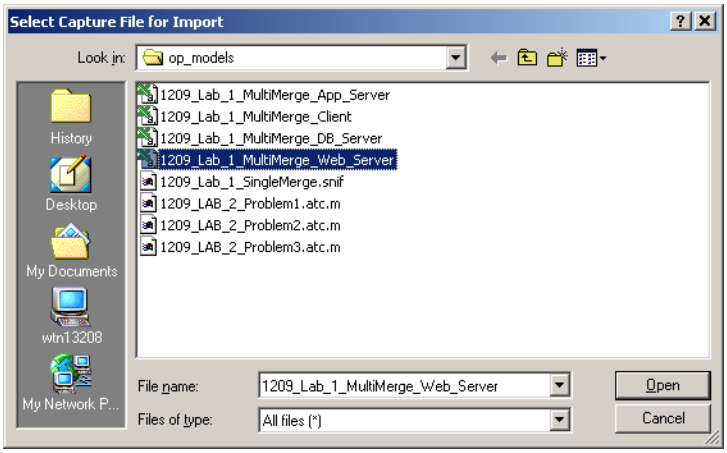


Figure B-40 Select Capture File for Import dialog box

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.

The ACE Import: Choose Capture File(s) dialog box shows the second capture file in the Capture File column.

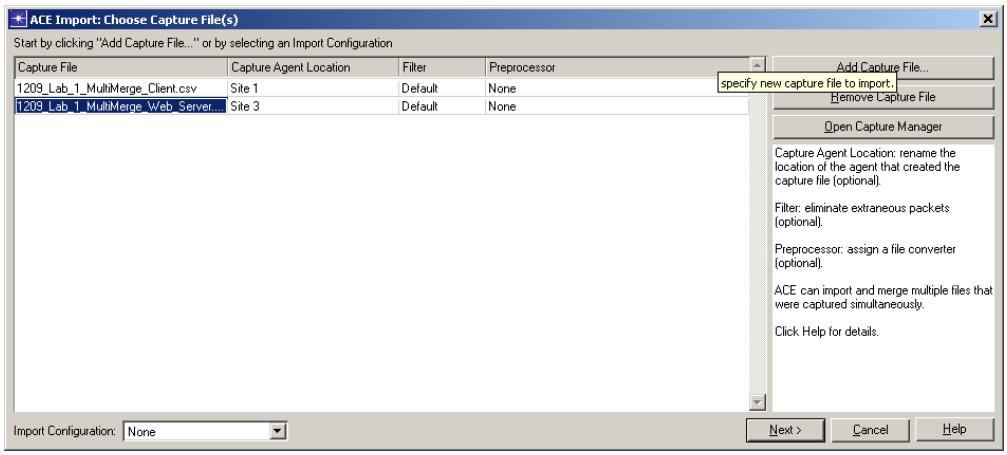


Figure B-41 The ACE Import: Choose Capture File(s) dialog box with Two Selected Capture Files

2.7 In the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

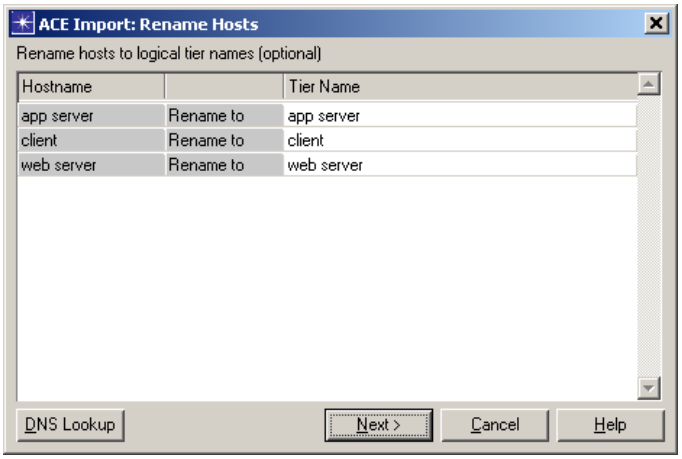


Figure B-42 ACE Import: Rename Hosts dialog box

2.8 In the ACE Import: Rename Hosts dialog box, click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

Notice that both tiers' locations were **Auto-detected** by ACE. When the traces being merged contain shared traffic, ACE will auto-detect tier locations.

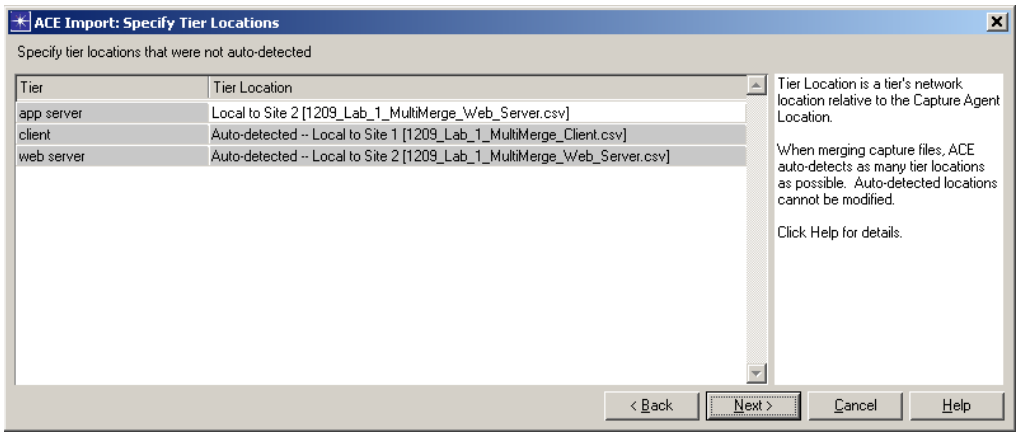


Figure B-43 ACE Import: Specify Tier Locations dialog box

Note that the tier location for the Client and WebServer have been auto-detected as Site 1 and Site 2. The App Server shows it was found on capture location Site 2 (which is correct).

2.9 In the ACE Import: Specify Tier Locations dialog box, click **Next**. The ACE Import: Specify Bandwidth/Latency for Segment dialog box displays.

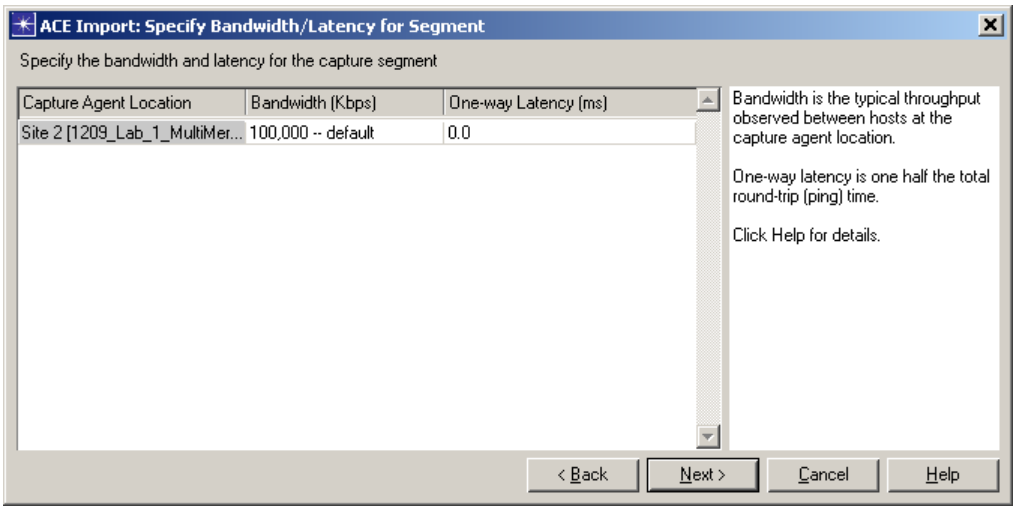


Figure B-44 ACE Import: Specify Bandwidth/Latency for Segment dialog box

2.10 In the ACE Import: Specify Bandwidth/Latency for Segment dialog box, click **Next**. The ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

Now specify the bandwidth and latency. The following dialog box prompts you for the bandwidth and latency between the capture locations. Specifying this information is *very important* for accurate AppDoctor results.

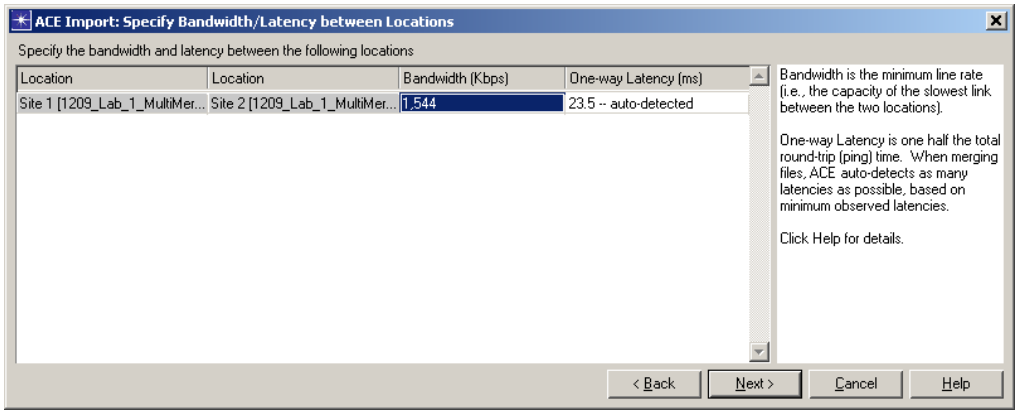


Figure B-45 ACE Import: Specify Bandwidth/Latency between Locations dialog box

- Edit the **Bandwidth** column and specify “1544” (Kbps).
- Note that the **One-way Latency** was **Auto-Detected** by ACE.

2.11 In the ACE Import: Specify Bandwidth/Latency between Locations dialog box, click **Next**.

To finish the import, you can save an import configuration to avoid typing in all of the information again if you were to import another set of traces that were captured at the same locations. You can also select the view that will be launched when the import completes.

2.12 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

3 Analyze the merged trace. Note that the Data Exchange chart shows three (3) application tiers:

- Captured at Site 1, where the Client host was located.
- Captured at Site 2, where the Web Server and App Server hosts were located. Note that no traffic beyond the App Server was detected.

- The 4th tier, the (Database Server), was not detected, therefore any processing and network effects are attributed to the App Server.

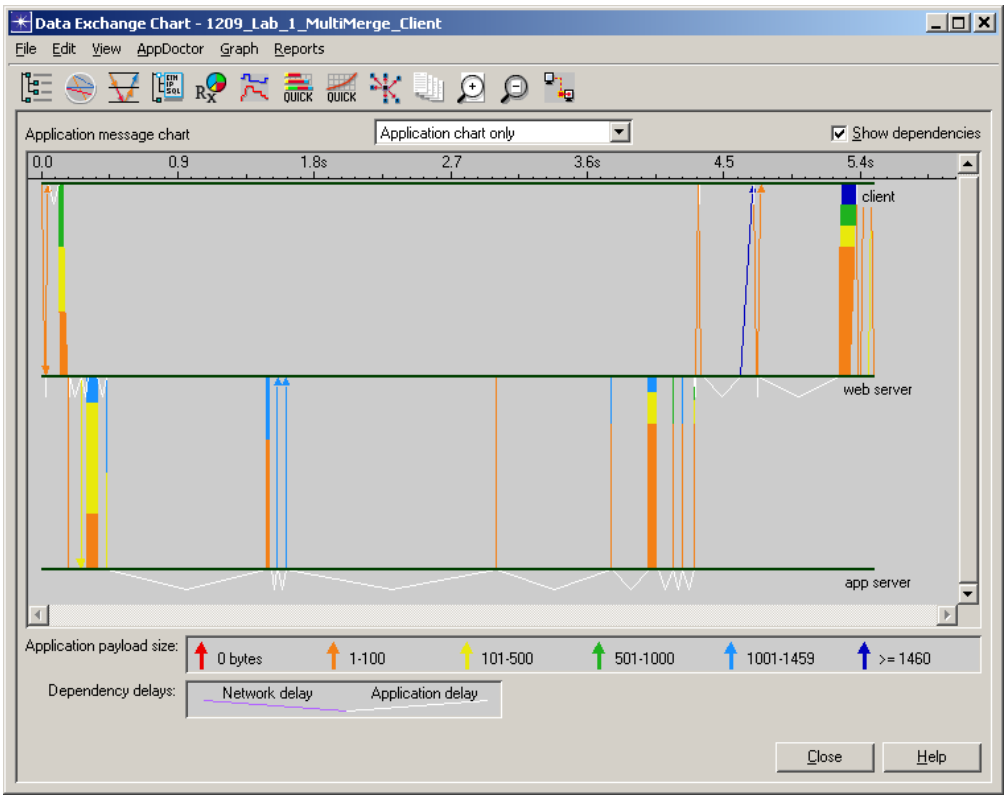


Figure B-46 Sample Data Exchange Chart

4 Select **AppDoctor > AppDoctor Analysis** or click the **AppDoctor** toolbar icon to use AppDoctor's Summary of Delays, Diagnosis, and Statistics tabs.

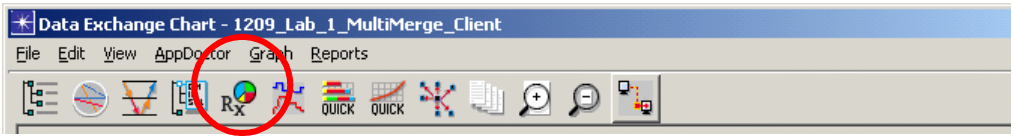


Figure B-47 AppDoctor Toolbar button

5 Note which tier has the largest "processing effect" (and what the percentage of processing effect is for that tier.) Note the largest component of the "network effect" (and what the percentage of network effect is.) Note the existence of any other bottlenecks.

6 Close all currently opened windows, except for NETWARS.

7 Re-import packet traces, this time using packet traces captured at all hosts**.**

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

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

7.3 Click **Add Capture File**.

7.4 In the Select Capture File for Import dialog box, select the first capture file named `1209_Lab_1_MultiMerge_Client`, and then click **Open**.

The ACE Import: Choose Capture File(s) dialog box shows the first capture file in the Capture File column.

7.5 In the ACE Import: Choose Capture File(s) dialog box, click **Add Capture File**. The Select Capture File for Import dialog box displays.

7.6 In the Select Capture File for Import dialog box, select the second capture file named `1209_Lab_1_MultiMerge_Web_Server`, and then click **Open**.

The ACE Import: Choose Capture File(s) dialog box shows the second capture file in the Capture File column.

7.7 In the ACE Import: Choose Capture File(s) dialog box, click **Add Capture File**. The Select Capture File for Import dialog box displays.

7.8 In the Select Capture File for Import dialog box, select the third capture file named `1209_Lab_1_MultiMerge_App_Server`, and then click **Open**.

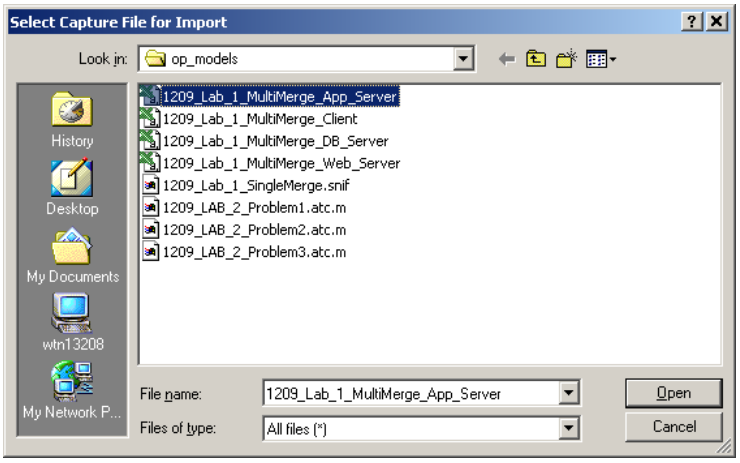


Figure B-48 Select Capture File for Import dialog box

The ACE Import: Choose Capture File(s) dialog box shows the third capture file in the Capture File column.

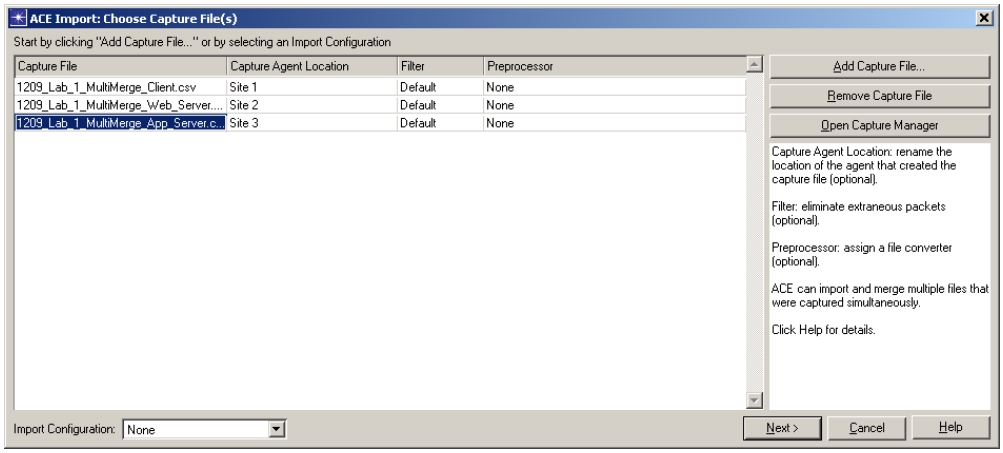


Figure B-49 ACE Import: Choose Capture File(s) dialog box with Three Selected Capture Files

7.9 In the Select Capture File for Import dialog box, select the fourth capture file named `1209_Lab_1_MultiMerge_DB_Server`, and then click **Open**.

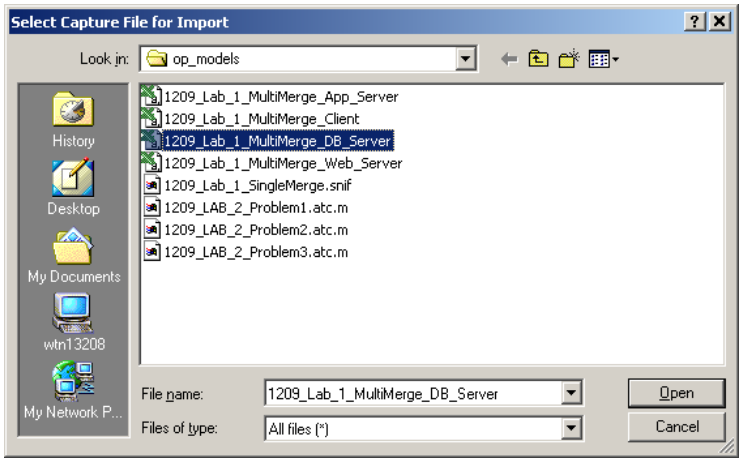


Figure B-50 Select Capture File for Import dialog box

The ACE Import: Choose Capture File(s) dialog box shows the fourth capture in the Capture File column.

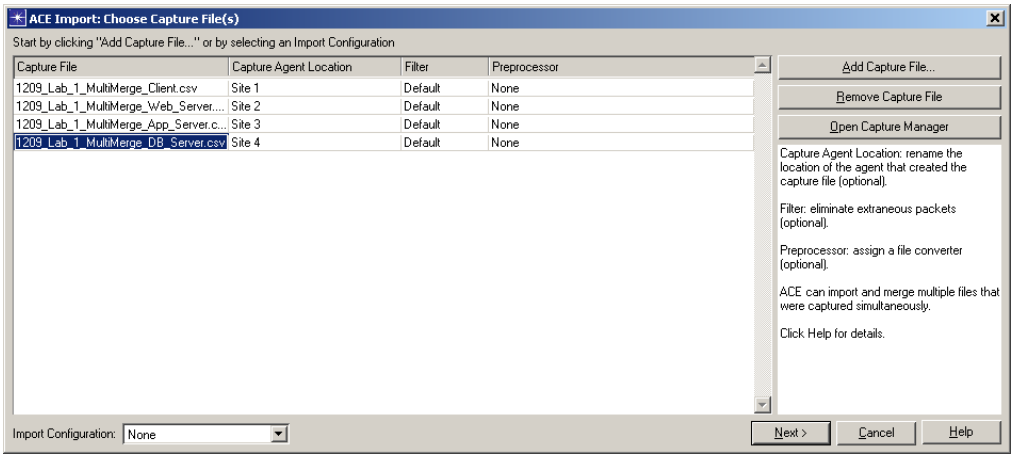


Figure B-51 ACE Import: Choose Capture File(s) dialog box with Four Selected Capture Files

7.10 In the ACE Import: Choose Capture File(s) dialog box, click **Next**. The ACE Import: Rename Hosts dialog box displays.

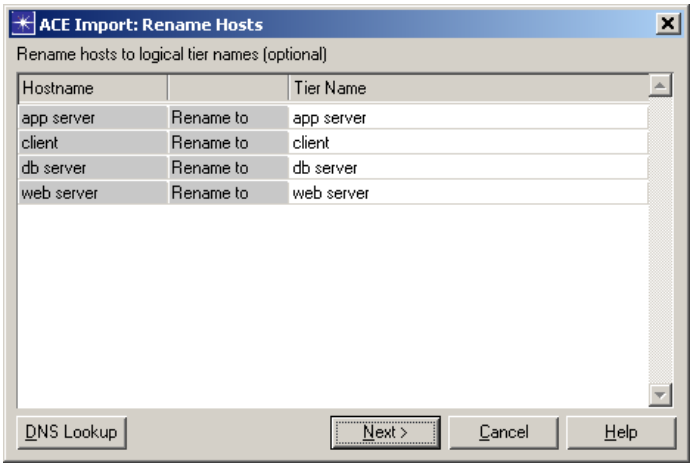


Figure B-52 ACE Import: Rename Hosts dialog box

7.11 In the ACE Import: Rename Hosts dialog box, click **Next**. The ACE Import: Specify Tier Locations dialog box displays.

Notice that all tier locations were **Auto-detected** by ACE as Sites 1, 2, 3, and 4.

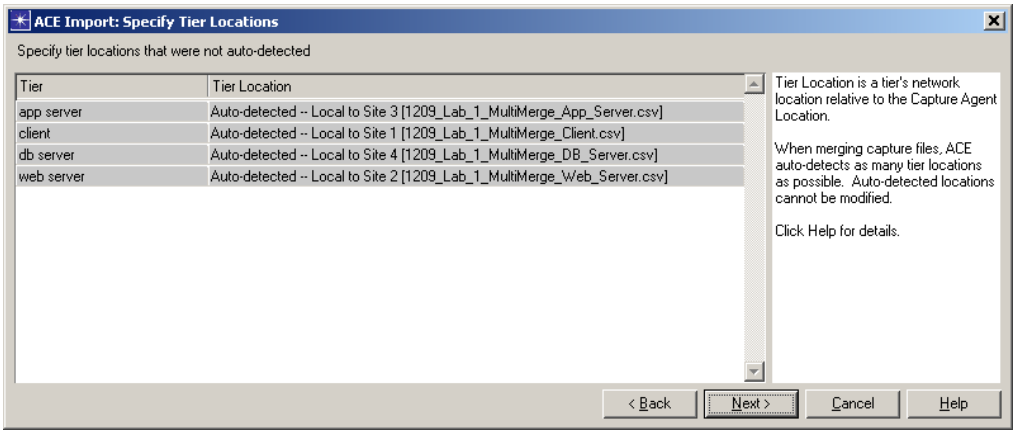


Figure B-53 ACE Import: Specify Tier Locations dialog box

7.12 In the ACE Import: Specify Tier Locations dialog box, click **Next**. The ACE Import: Specify Bandwidth/Latency between Locations dialog box displays.

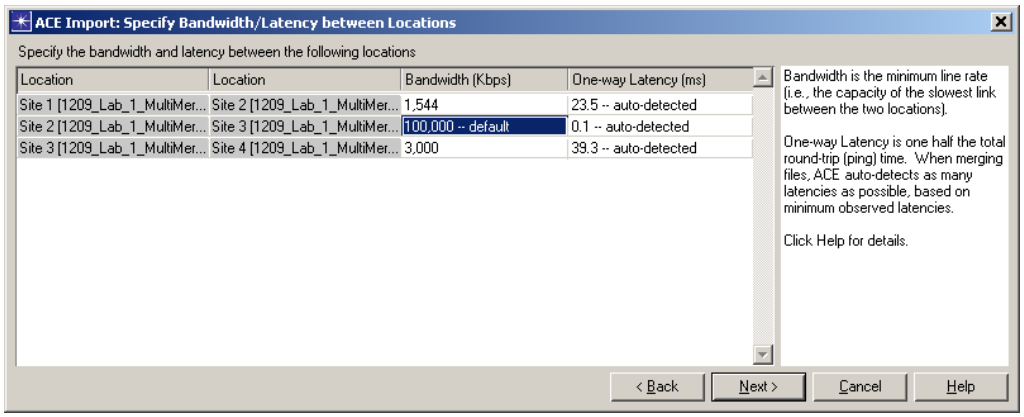


Figure B-54 ACE Import: Specify Bandwidth/Latency between Locations dialog box

- Specify “1544” (Kbps) as the **Bandwidth** between Site 1 and Site 2.
- Specify “3000” (Kbps) as the **Bandwidth** between Site 3 and Site 4.
- Leave the default between Site 2 and Site 3.
- Note that the **One-way Latency** was **Auto-Detected** by ACE.

7.13 In the ACE Import: Specify Bandwidth/Latency between Locations dialog box, click **Next**.

To finish the import, you can save an import configuration to avoid typing in all of the information again if you were to import another set of traces that were captured at the same locations. You can also select the view that will be launched when the import completes.

7.14 In the Save Import Configuration dialog box, click **Finish** to complete the import process.

8 Analyze the merged trace. Note that the Data Exchange chart now shows all four application tiers.

- Captured at Site 4, where the DB Server host was located, now shows the activity between the App Server and DB Server.

- The process and network effects between the App and DB Servers are now attributed to the correct tiers and are correctly calculated.

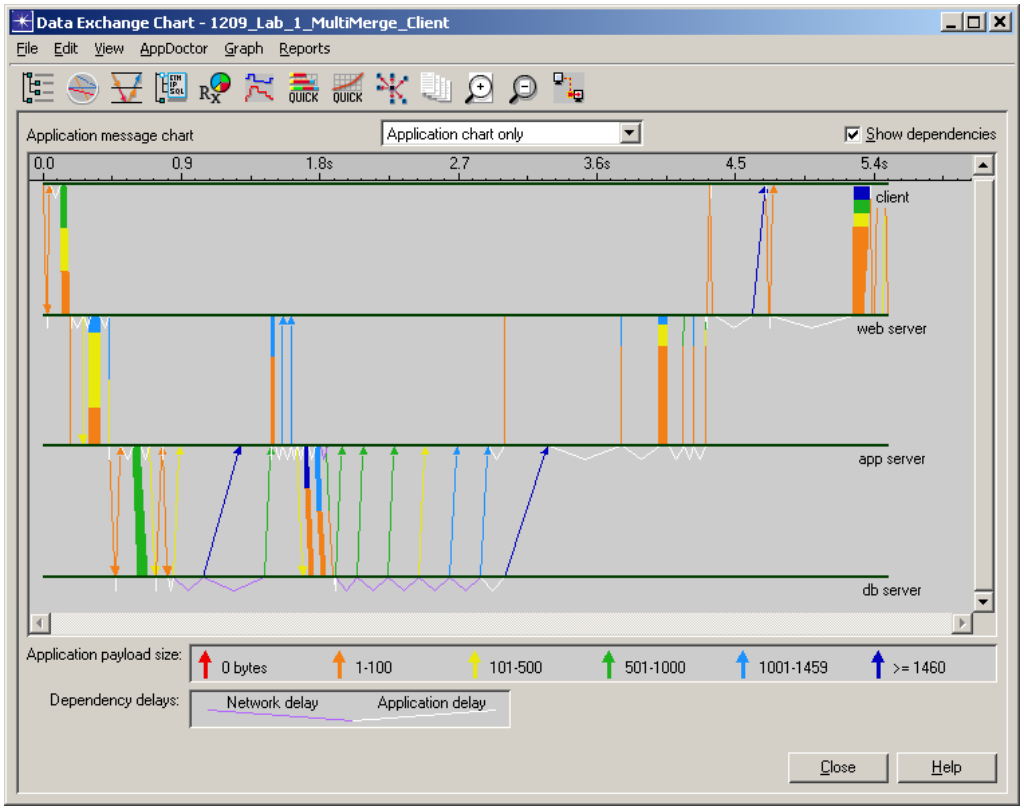


Figure B-55 Sample Data Exchange Chart

9 Select **AppDoctor > AppDoctor Analysis** or click the **AppDoctor** toolbar icon to use AppDoctor's Summary of Delays, Diagnosis, and Statistics tabs.

10 Note what has the largest "effect" (and the percentage of effect) on the application. Note which tier has the largest "processing effect" (and what the percentage of processing effect is.) Note the existence of any bottlenecks between each tier.

11 Close all currently opened windows, except for NETWARS.

End of Procedure B-11

Conclusion

In the first import, two capture files were merged. One capture file was taken at the Client location (Site 1), and the second capture file was taken where the Web Server and Application Server resided (Site 2). In this merge you could see three of the four tiers of the application. In this analysis, the Application Server was "charged" with all the process effect and network effects that should have been attributed to the Database Server.

In the second import, four capture files were merged, one at each application tier. This gave a complete/proper analysis of all processing and network effects. You will note that this analysis also highlighted that the “Nagle” algorithm was a factor between the Application Server and Database Server. This could not have been detected in the first capture merge.

When importing capture files into ACE, understand that processing and network effects may be charged/allocated/attributed to those tiers that are present in the capture.

When importing multiple capture files into ACE, be aware of the bandwidth between locations.