Predicting the Impact of TCP Window Size on Application Performance

Objective

This lab teaches the use of a very important TCP parameter, the TCP window size value, which is contained in the window size field of the TCP segment. Suppose that Host A is transmitting a segment to Host B. The window size field value tells Host B how many more bytes of data the Host B may transmit before getting another TCP segment with a window size field value to extend the number of bytes that Host B may send. If the window size field value is made too small, Host B will often have to wait to transmit because it has reached its transmission limit. In the extreme case, Host A will have to wait after each transmitted TCP segment to get a response before sending the next segment. Having to wait will slow throughput considerably. On the other hand, if the window size field is made too large, the Host B may transmit so many segments that Host A will be overloaded. The window size field provides flow control, regulating the rate at which the transport processes on the two hosts may transmit. In this lab, we'll investigate the performance of an account transfer application with different TCP window sizes.

Overview

Standard Chartered Bank has one of its branches located in Sydney, Australia from where it transfers daily account and transaction information of 25 MB to its backup center (data center) in Washington DC.

The branch and the backup station are connected through a frame relay network with a latency of 5 ms. The time to transfer a 25 MB file over a T1 link is estimated by the IT team to be approximately 130 sec. We will first observe the actual transfer time for this transfer over a T1 link.

After observing very high transfer times for the file transfer, the IT team decides to upgrade the link to the frame relay cloud to a T3 link, assuming that the delay is caused due to low bandwidth.

Even the upgrade in bandwidth does not give the desired results. The company decides to go back to a T1 link and increase the TCP window size from the initial 8K to 65K. While upgrading a WAN link is expensive, optimizing configuration parameters such as window sizes is free.

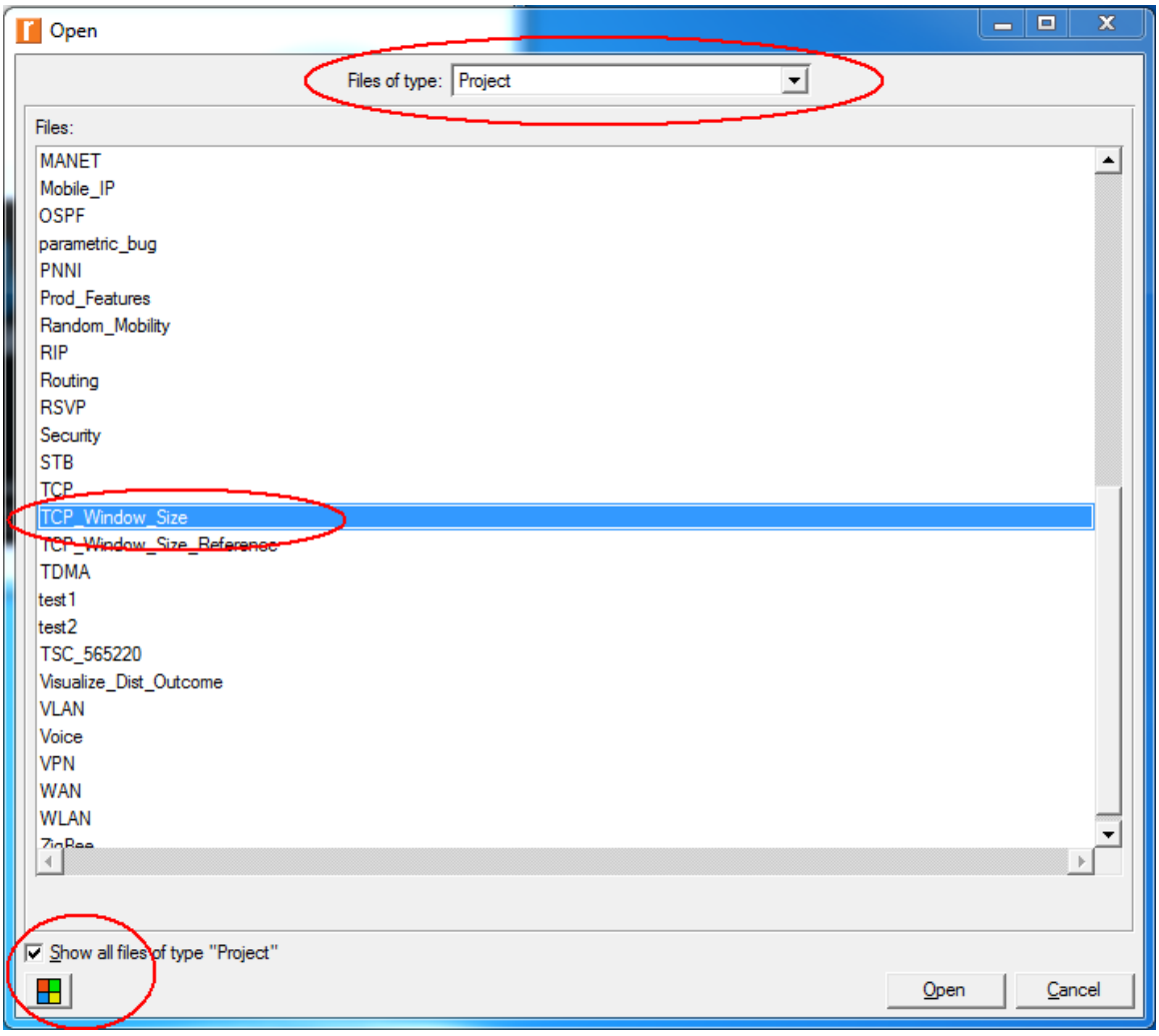
Lab Instructions

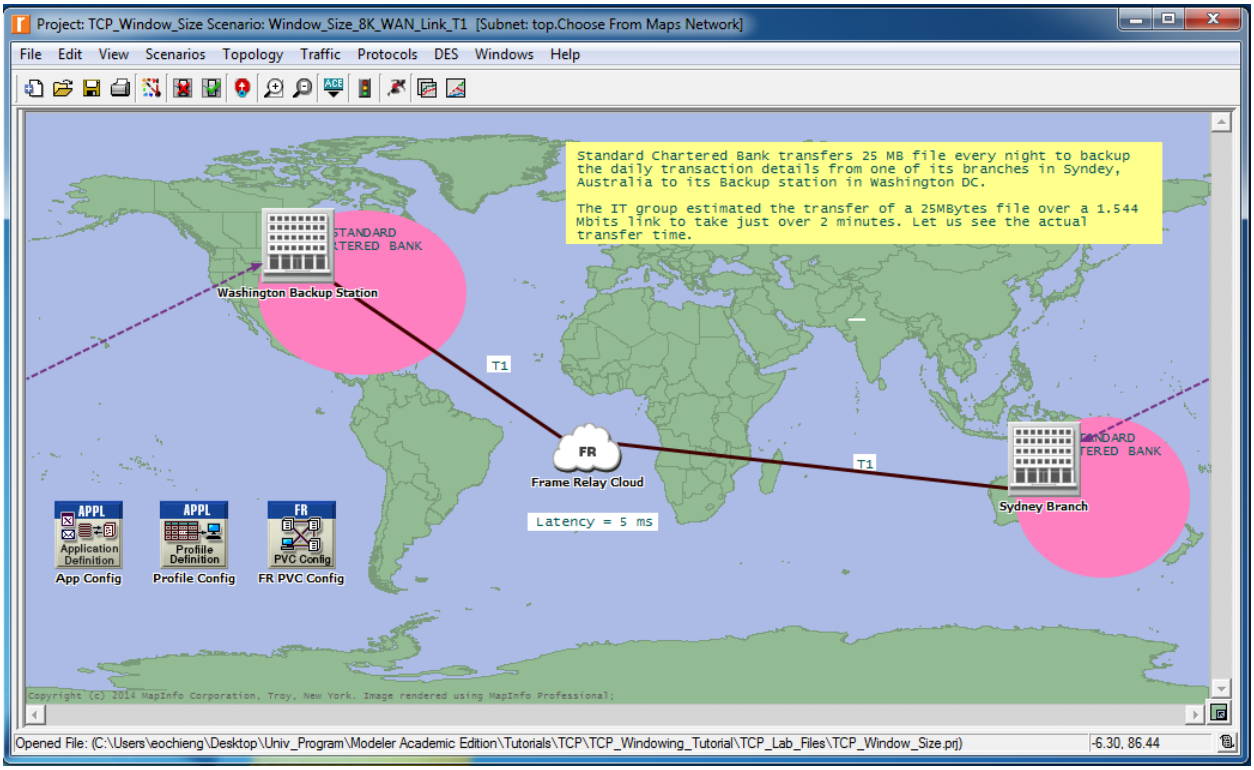
Step 1: Open Lab 1

1. Start *Riverbed Modeler Academic Edition*.

2. Select **File/Open…**

3. Scroll down to the project named **TCP_Window_Size**, select it and click **OK**.





Here we have one of Standard Chartered Bank's backup stations in Washington DC connected to one of its branches in Sydney, Australia via a frame relay network. The Sydney branch daily performs file transfer of 25 MB to back up account and transaction information.

Step 2: Configure and Run the Simulation

Transferring a 25 MB file over a T1 link should not take more than 130 sec. Run the simulation for an hour and see how long it takes to transfer this file.

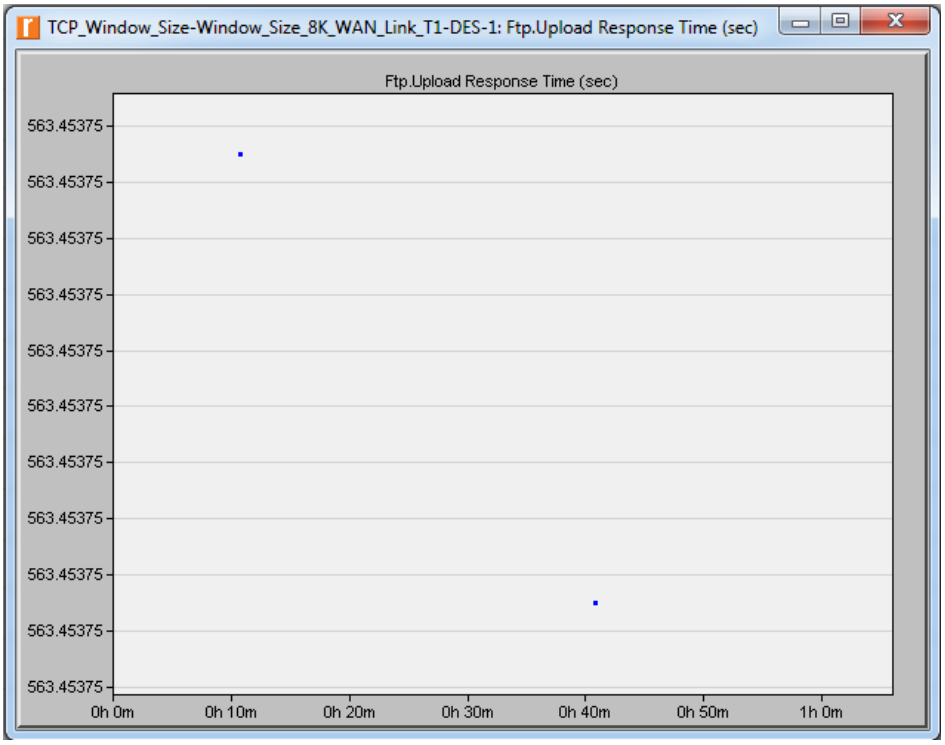
1. Click on the **Configure/Run Discrete Event Simulation (DES)** button  .
2. Make sure the simulation **Duration** is set to **1** hour.
3. Click **Run.** Monitor the progress bar as the simulation proceeds.
4. When the simulation completes, Click **Close**.

Step 3: View Results

View the actual response time for transferring the file.

1. Select **DES/Results/View Results…**

2. Choose **Global Statistics /Ftp/Upload Response Time (sec)** and click **Show**.
   - The actual response time is close to 560 sec.
   - This is much higher than the company's estimated value.
   - The IT team immediately presumes that T1 line is insufficient to send such a large file.
   - Therefore, they plan to upgrade the links between the routers and the frame relay cloud from T1 to T3.
   - Click on the **hide or show all graphs** button to hide the graph  .
   - Close the View Results window.



Step 4: Duplicate Scenario

1. Select **Scenarios/Duplicate Scenario…**

2. Name the scenario as **Window_Size_8K_WAN_Link_T3**.

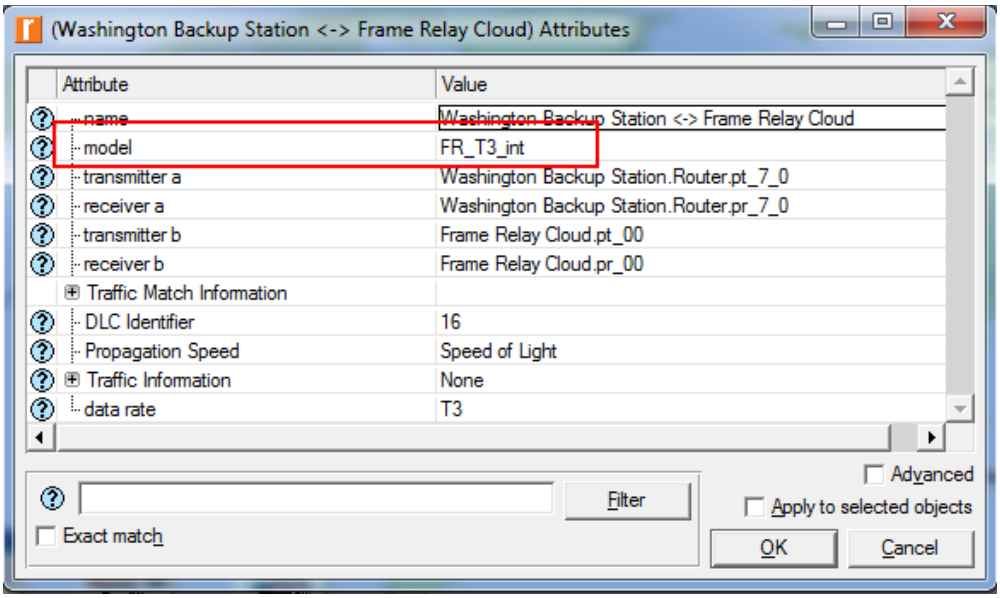
Step 5: Configure the WAN links to T3

Upgrade the links connecting the routers to the frame relay cloud to T3.

1. Right-click on the link connecting the Washington DC Backup Station and the Frame Relay Cloud and choose **Select Similar Links**.

2. Right-click on the same link again and select **Edit Attributes**.

3. Click in the **Value** column for **model** and choose **FR_T3_int**.



Note: Make sure to check the option below which reads as **Apply Changes to Selected Objects**. This will change both the links connecting the routers to the frame relay cloud to T3 link.

Step 6: Configure and Run the Simulation

Rerun the simulation for an hour to see if the bandwidth upgrade leads to better response times.

- Refer to previous steps for setting the duration and running the simulation.

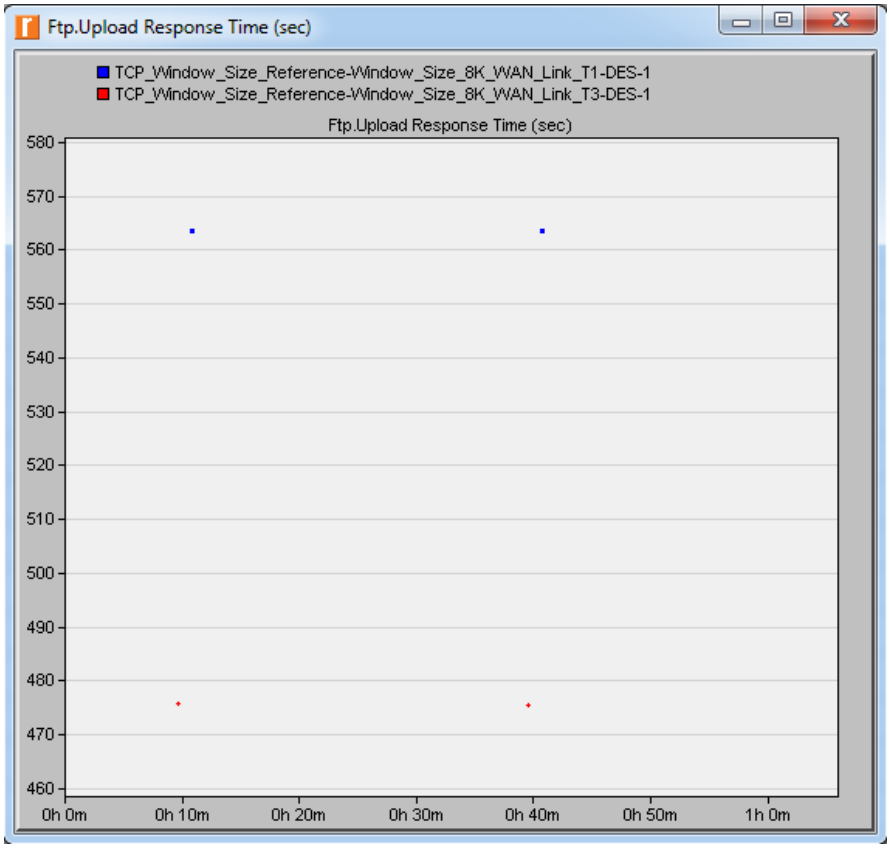
Step 7: Compare Results

We'll compare the Ftp Response Times. The company expects the link upgrade to reduce the application response times.

1. Select **DES/Results/View Results…**

2. Choose **Global Statistics /Ftp /Upload Response Time (sec)**.

3. Click **Show** and select **Close** in the View Results window.



- The response time reduced from approximately 560 sec to 475 sec.
- The IT team calculated that transferring a 25MBytes file over a T3 link should take approximately 5 sec.
- The results show that bandwidth is not the bottleneck.
- The company then decided to go back to T1 links and instead increase the TCP window size from the default of 8K to 65K assuming there could be some protocol issues.

We'll implement these changes and compare the application response time.

Step 8: Switch to Previous Scenario

Select **Scenarios /Switch To Scenario/Window_Size_8K_WAN_Link_T1**.

Step 9: Duplicate Scenario

1. Select **Scenarios /Duplicate Scenario…**
2. Name the scenario as **Window_Size_65K_WAN_Link_T1**.

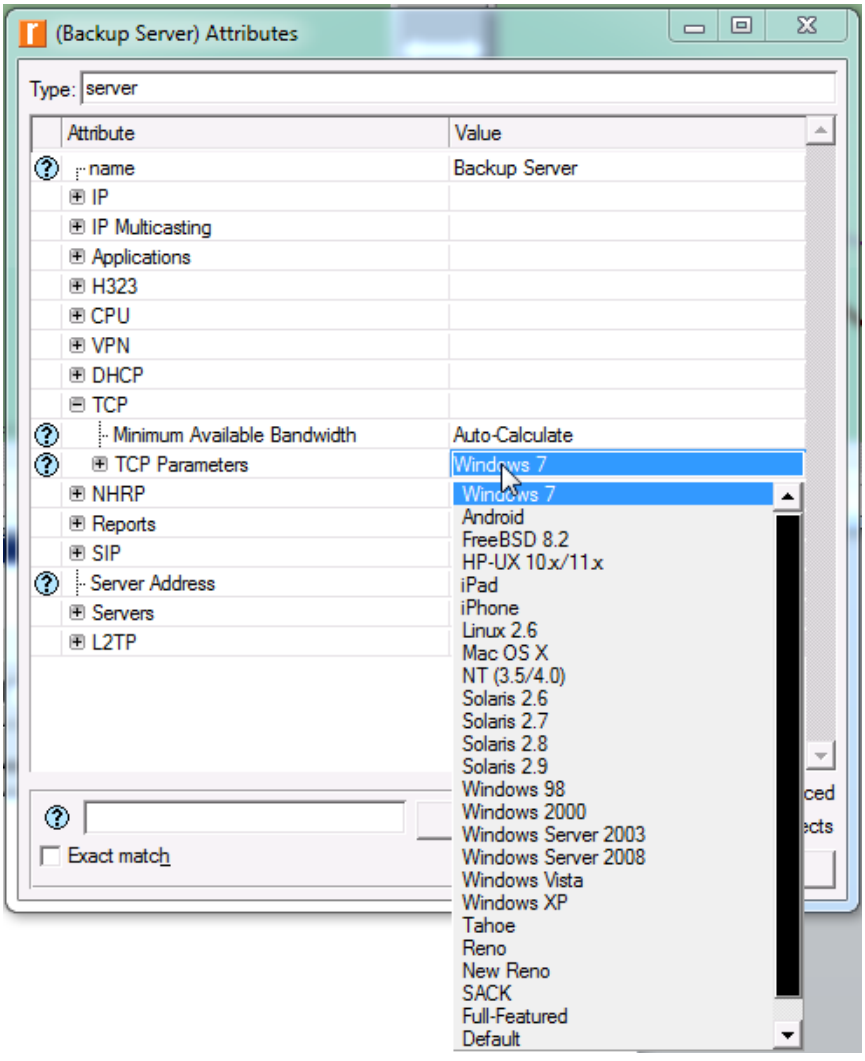
Step 10: Configure the server's TCP Window Size

We'll configure the backup station server for TCP Window Size of 65K.

1. Double-click on the subnet labeled **Washington Backup Station**.

2. Right-click on the **Backup Server** and select **Edit Attributes**.

3. Click in the **Value** column for **TCP Parameters** and select **Edit…** Different TCP parameters can be manipulated here.



4. To set the window size, change the **Value** for **Receive Buffer (bytes)** to **65535**.

5. Select **OK** twice to close all windows.

Step 11: Configure the Client's TCP Window Size

Now configure the TCP Window Size for the branch in Sydney.

1. Right-click in the workspace and select **Go To Parent Subnet**.
2. Double-click on the subnet labeled **Sydney Branch**.
3. Right-click on the **Sydney Branch** workstation and select **Edit Attributes**.
4. Configure the TCP Window Size to 65k in the same way as we did for the server.

Step 12: Configure the WAN links to T1

Refer to step 5 to reconfigure the WAN links back to T1.

Step 13: Configure and Run the Simulation

Now that the TCP window size has been increased, rerun the simulation for an hour to evaluate the network performance.

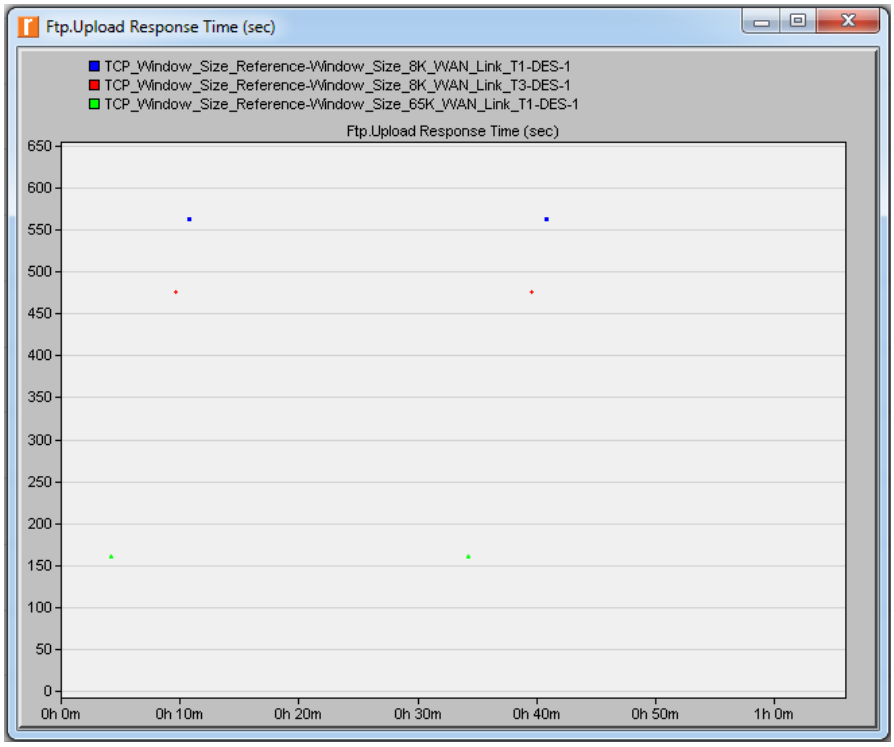
- Refer to previous steps for setting the duration and running the simulation.

Step 14: Compare Results

Compare the results of response times for all 3 scenarios. This will give a clear picture of the effect of increasing the TCP window size.

1. Select **DES/Results/View Results…**
2. Choose **Global Statistics/ Ftp /Upload Response Time (sec)**.
3. Click **Show** and then close the View Results window.

Conclusion



- These results show that bandwidth was not the cause for the high response times.

- By increasing the TCP window size from 8K to 65K and keeping the bandwidth to T1, we were able to achieve almost the estimated results. In other ways, intelligence in optimizing TCP parameters costs little or nothing but does a better job than an expensive WAN upgrade.

Advanced Scenarios

- **Advanced Scenario 1.** Duplicate the last scenario. Keeping the window size to 65K, try upgrading the bandwidth for links connecting the routers and the frame relay cloud to T3 and see its effect on the Ftp Response Time.

- **Advanced Scenario 2.** Duplicate scenario 3 and increase the TCP window size to 200K. Also, enable the TCP window scaling attribute listed in the TCP parameters for both the server and the client and how it affects the Ftp Response Time.