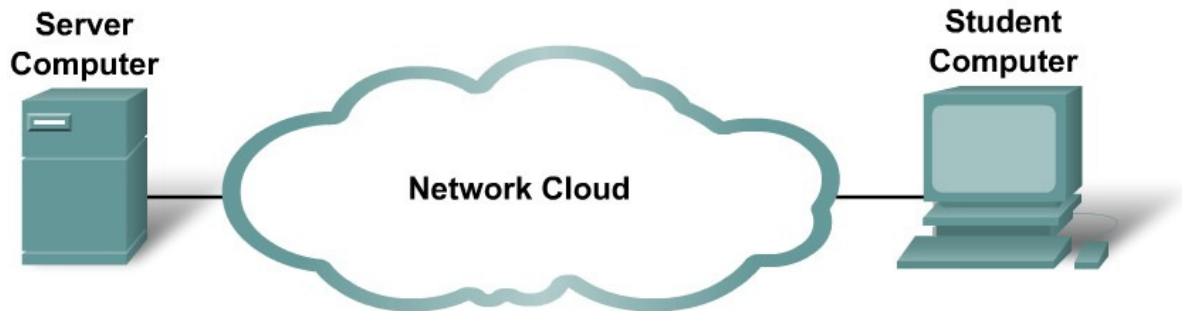


11.4.3.3: Network Latency Documentation with Ping

Topology Diagram



Learning Objectives

- Use the **ping** command to document network latency.
- Compute various statistics on the output of a **ping** capture.
- Measure delay effects from larger datagrams.

Background

To obtain realistic network latency statistics, this activity must be performed on a live network. Be sure to check with your instructor for any local security restrictions against using the **ping** command on the network.

The destination Server Computer must return ECHO replies, otherwise delay cannot be computed. Some computers have this feature disabled through a firewall, and some private networks block transit ECHO datagrams. For this experiment to be interesting, a sufficiently distant destination should be chosen. For example, destinations on the same LAN or within a few hops may return an unrepresentative low latency. With patience, a suitable destination will be found.

The purpose of this lab is to measure and evaluate network latency over time, and during different periods of the day to capture a representative sample of typical network activity. This will be accomplished by analyzing the return delay from a distant computer with the **ping** command.

Statistical analysis of throughput delay will be performed with the assistance of a spreadsheet application such as Microsoft Excel. Return delay times, measured in milliseconds, will be summarized with through computation of the average latency (mean), noting the latency value at the center of the ordered range of latency points (median), and identification of the most frequently occurring delay (mode). The Appendix contains a chart that can be submitted to the instructor when finished.

Delay will also be measured when the ICMP datagram size is increased.

Scenario

In the topology graphic above, the network cloud represents all of the network devices and cabling between the student computer and the destination Server Computer. It is normally these devices that introduce network latency. Network engineers routinely rely on networks outside of local administration for connectivity to external networks. Monitoring path latency does provide some measure of administrative diligence, which may be used in decision-making when evaluating suitable applications for wide area network (WAN) deployment.

This activity will require five days of testing. On each day, three tests will be performed. Preferably, one test will be made in the early morning, one around mid-day, and one in the evening. The idea is to note and document latency differences that occur during the different periods of the day. When finished there will be a total of 15 sets of this data.

To understand the delay effects from larger datagrams, ICMP datagrams will be sent with increasingly larger datagrams and analyzed.

Task 1: Use the `ping` Command to Document Network Latency.

Step 1: Verify connectivity between Student Computer and destination Server Computer.

To verify connectivity between the Student Computer and destination Server Computer, open a terminal window by clicking on start | run. Enter `cmd`, and then select `OK`. Attempt to ping a suitably distant destination, such as `www.yahoo.com`:

```
C:\> ping -n 1 www.yahoo.com
Pinging www.yahoo-ht3.akadns.net [209.191.93.52] with 32 bytes of data:
Reply from 209.191.93.52: bytes=32 time=304ms TTL=52
Ping statistics for 209.191.93.5:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss)
    Approximate round trip times in milli-seconds:
        Minimum = 304ms, Maximum = 304ms , Average = 304 ms
```

Use the `ping /?` command to answer the following questions:

What is the purpose of the `-n` option and argument 1?

What option and argument would change the default size to 100 bytes? _____

Decide on a destination Server Computer, and write down the name: _____

Use the `ping` command to verify connectivity with the destination, and write down the results:

Packets sent	Packets Received	Packets Lost
--------------	------------------	--------------

If there are lost packets, use another destination and retest.

Step 2: Perform a delay test.

Write down the command that will send 100 ECHO requests to the destination:

Use the ping command to send 100 ECHO requests to your destination. When finished, copy the replies into Notepad. Notepad can be opened by clicking on Start | Programs | Accessories, and select Notepad. Save the file using the name format *day-sample#.txt*, where: *day* = the day the test was performed (1-5), and *sample#* = the sample period (1-3).

Alternately, output can be redirected to a file by appending `> day-sample#.txt` to the end of the **ping** command. NOTE: the terminal will remain blank until the command has finished.

Task 2: Compute Various Statistics on the Output of a ping Capture.

Step 1: Bring the text file into the Excel Spreadsheet Application.

If not already opened, start Microsoft Excel. Select menu options File | Open. Use Browse to move to the directory that holds the text file. Highlight the filename and select Open. To format a text file for use within Excel, insure all numeric values are separated from text characters. In the Text Import Wizard, Step 1, select Fixed Width. In Step 2, follow instructions in the window to separate numeric values from text values. Refer to Figure 1.

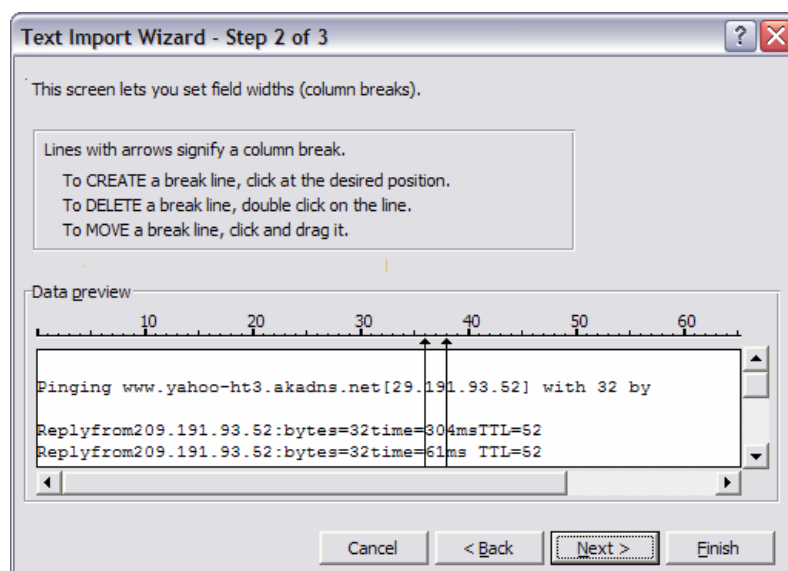


Figure 1. Excel Text Import Wizard.

Step 2. Compute mean, median and mode delay values.

When input formatting is satisfactory, select **Finish**. If the spreadsheet has numbers in different fields, manually fix the numbers. After the spreadsheet has been opened, format the columns so they are more readable. When complete, you should have a spreadsheet that looks similar to Figure 2.

	A	B	C	E	G	I
1				Bytes	Delay (ms)	TTL
2	Reply from	209.191.93.52:		32	304	52
3	Reply from	209.191.93.52:		32	61	52
4	Reply from	209.191.93.52:		32	56	52
5	Reply from	209.191.93.52:		32	54	52
6	Reply from	209.191.93.52:		32	65	52
7	Reply from	209.191.93.52:		32	55	52
8	Reply from	209.191.93.52:		32	57	52

Figure 2. Partial spreadsheet correctly formatted.

Record the number of dropped packets in your chart, column Dropped Packets. Dropped packets will have a consistently large delay value.

Finally, the delay values must be ordered (sorted) when computing the median and mode values. This is accomplished with the Data | Sort menu options. Highlight all of the data fields. Figure 3 shows a partial spreadsheet highlighted and the Data | Sort menu opened. If a header row was highlighted, click on the Header row radio button. Select the column that contains the Delay values, in Figure 3 it is Column G. When finished click OK.

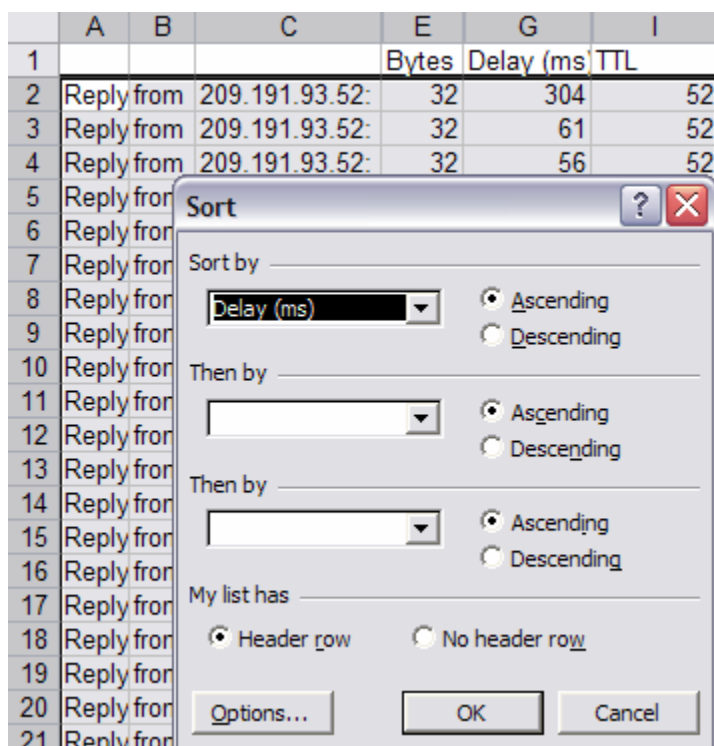


Figure 3. Ordering on the Delay column.

The formula used to compute the mean, or average, delay is the sum of the delays, divided by number of measurements. Using the example above, this would equate to the formula in cell G102:

=average(G2:G101). Perform a visual 'sanity check' to verify your mean value is approximately the value shown. Record this number in your chart, under column Mean.

The formula used to compute the median delay, or the delay value in the center of the ordered range, is similar to the average formula, above. For the median value, the formula in cell G103 would be

`=median(G2:G101)`. Perform a visual 'sanity check' to verify your median value is similar to what is shown midway in the data range. Record this number in your chart, under column Median.

The formula used to compute the modal delay, or the delay value that is the most frequently occurring, is also similar. For the mode value, the formula in cell G104 would be `=mode(G2:G101)`. Perform a visual 'sanity check' to verify your mode value is the most frequently occurring value in the data range. Record this number in your chart, under column Mode.

The new spreadsheet file may be saved or discarded as desired, but the data text file should be retained.

Task 3: Measure Delay Effects from Larger Datagrams.

To determine if larger datagrams affect delay, increasingly larger ECHO requests will be sent to the destination. In this analysis, 20 datagrams will be incremented by 100 bytes per **ping** request. A spreadsheet will be created with the reply results, and a chart that plots size vs. delay will be produced.

Step 1: Perform a variable sized delay test.

The easiest way to accomplish this task is to use the Windows built-in FOR loop command. The syntax is:

```
FOR /L %variable IN (start,step,end) DO command [command-parameters]
```

The set is a sequence of numbers from start to end, by step amount. So (1,1,5) would generate the sequence 1 2 3 4 5 and (5,-1,1) would generate the sequence (5 4 3 2 1)

In the following command, *destination* is the destination. Issue the command:

```
FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i destination
```

Copy the output into Notepad, and save the file using the name `variablesizedelay.txt`.

To redirect output to a file, use the redirect append operator, `>>`, as shown below. The normal redirect operator, `>`, will clobber the file each time the ping command is executed and only the last reply will be saved. NOTE: the terminal will remain blank until the command has finished:

```
FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i destination >>  
variablesizedelay.txt
```

The output of one line is shown below. All 20 replies are arranged similarly:

```
C:\> FOR /L %i IN (100,100,2000) DO ping -n 1 -l %i www.yahoo.com

C:\> ping -n 1 -l 100 www.yahoo.com

Pinging www.yahoo-ht3.akadns.net [209.191.93.52] with 100 bytes of data:
Reply from 209.191.93.52: bytes=100 time=383ms TTL=52

Ping statistics for 209.191.93.52:
    Packets: Sent = 1, Received = 1, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 383ms, Maximum = 383ms, Average = 383ms
```

Step 2: Bring the text file into the Excel Spreadsheet Application.

Open the new text file in Excel. Refer to Figure 4.

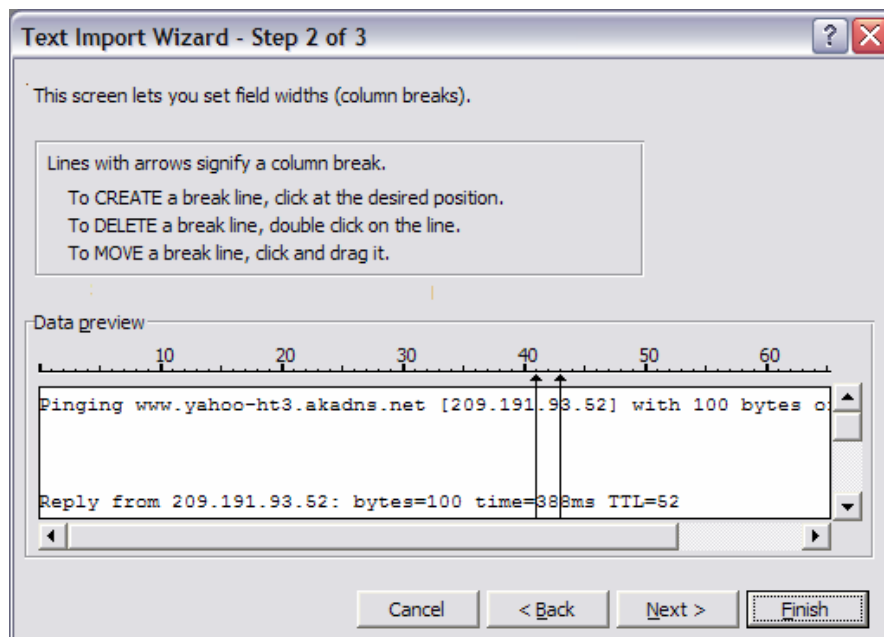


Figure 4. Excel Text Import Wizard.

The difference between this file and the previous file is that the variable size file has much more information than is really needed.

Step 3: Format the spreadsheet.

Clean and organize the spreadsheet data into two columns, Bytes and Delay. When finished, the spreadsheet should look similar to Figure 5.

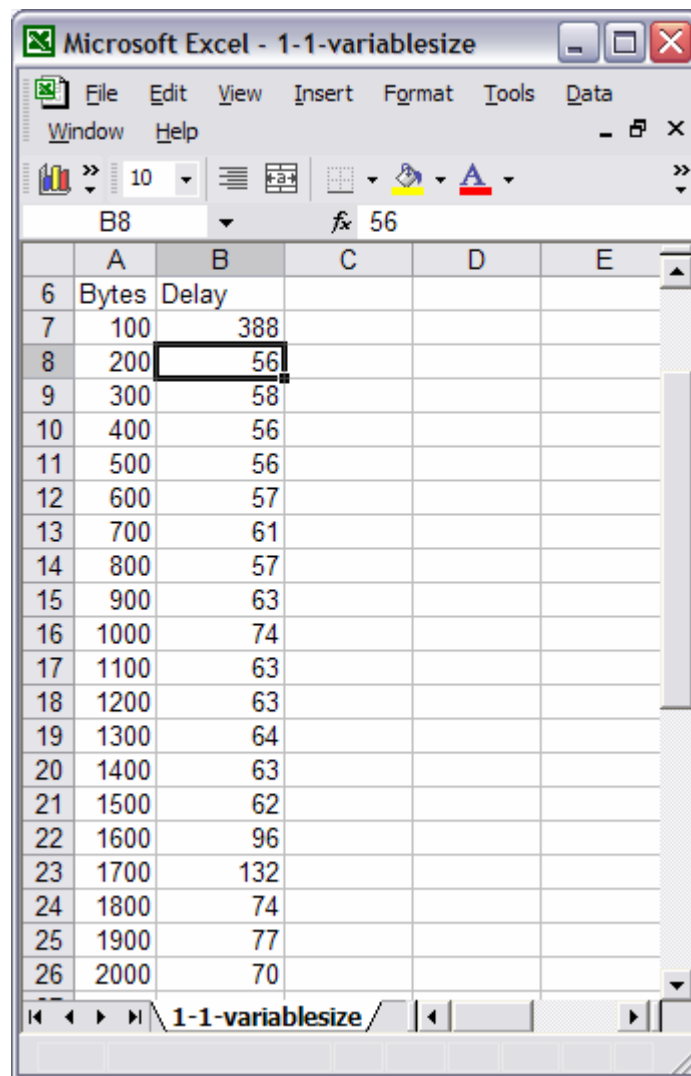


Figure 5. Formatted Spreadsheet.

Step 3: Create a chart of the data.

Highlight the Delay column data. Select menu options Insert | Chart. There are a number of charts that can be used to display delay data, some better than others. While a chart should be clear, there is room for individual creativity. The chart in Figure 6 is a Stacked Line chart.

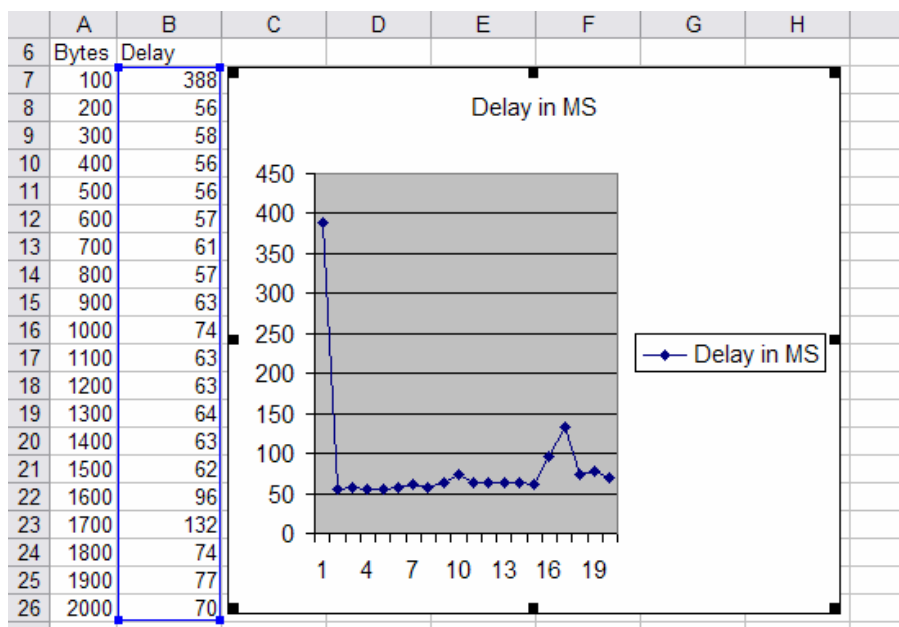


Figure 6. Plot of Delay vs. datagram size.

When finished, save your spreadsheet and chart and submit it to your instructor with the final delay analysis.

Are there any assumptions that can be made regarding delay when larger datagrams are sent across a network?

Task 4: Reflection

The **ping** command can provide important network latency information. Careful delay analysis over successive days and during different periods of the day can alert the network engineer to changes in network performance. For example, network devices may become overwhelmed during certain periods of the day, and network delay will spike. In this case, routine data transfers should be scheduled during off-peak times when delay is less. Also, many users subscribe to peer-to-peer applications such as KaZaA and Napster. When these file-sharing applications are active, valuable bandwidth will be diverted from critical business applications. If delays are caused by events within the organization, network analysis tools can be used to determine the source and corrective action taken. When the source originates from external networks, not under the control of the organization, subscribing with a different or additional Internet service provider (ISP) may prove beneficial.

Task 5: Challenge

If permitted, download a large file and perform a separate delay test while the file is downloading. Write a one or two paragraph analysis that compares these delay results against a measurement made without the download.

Appendix

NAME: _____			Network Delay Documentation			
Source IP Address: _____			Destination IP Address: _____		TTL: _____	
Statistical Analysis of Network Latency with 32 byte datagrams						
Day (1-5)	Date (mm/dd/yyyy)	Time (hh:mm)	MEAN	MEDIAN	MODE	Dropped Packets
1						
2						
3						
4						
5						