**ECE 506 Class Project**

**Using PING for RTT Distribution and TRACERT for Route Discovery**

In this project, you will measure and compare the statistics of round-trip times (RTTs) to different destinations. In addition, you will discover hop-by-hop routes to various destinations.

Visit the Wikipedia page to learn about the [Ping (networking utility)](http://en.wikipedia.org/wiki/Ping_%28networking_utility%29)  and  [Tracert](http://en.wikipedia.org/wiki/Tracert).

For your convenience, the usage information for both programs is printed below in the Related Information section.

**Project Description**

Select at least 10 different hosts around the US and on different continents. An example host in Asia is www.ust.hk for the Web server at [Hong Kong University of Science and Technology](http://www.ust.hk/).

**Note:** If the traced route looks suspiciously short (only few hops), it may be that your chosen website uses a [content delivery network](http://en.wikipedia.org/wiki/Content_delivery_network), such as [akamai.com](http://en.wikipedia.org/wiki/Akamai_Technologies), in which case the endpoint server will be located within the US. To avoid such scenario and reach a truly intercontinental destination, you should avoid commercial websites and select a governmental or educational website.

Send the **PING** requests for at least 100 times (preferably 1,000 times). Use the option -n to specify the number of echo requests to send.

**Note:** Some hosts refuse to answer the **PING** requests for security reasons, so you might not be able to **PING** them and will get a “Request time out” message.

Try with different size request packets. Use the option -l to set the send buffer sizes.

Immediately after (or before) running **PING**, run **TRACERT** for the *same destination host*, and record all measurement results.

For each destination, repeat the **PING** / **TRACERT** measurement at least 10 times. Try this on different days and during different times of the day, when you suspect that the network will be lightly used versus heavily used. Note that for worldwide locations you will need to decide whether the network is heavily used in your region, versus in the destination host region, versus globally.

**Captured Data Analysis**

Within the **TRACERT** measurements, determine if there is a link for which the delay is significantly longer than for others. On the basis of the router names, can you guess the geographic location (country) of the two routers at the endpoints of this link?

Draw a [histogram](http://en.wikipedia.org/wiki/Histogram) of round-trip-times (RTTs). Your histogram should be shown so that RTT values are along the horizontal axis and the frequency of measurement is along the vertical axis. The scale of the horizontal axis should be from the smallest RTT value to the greatest RTT value. Indicate the time units (such as milliseconds) on the horizontal axis. The scale of the vertical axis should be from zero to the greatest frequency value.

Here “frequency” means how many times you observed a certain RTT value. Consider this example reported by **PING**:

* Approximate round trip times in milli-seconds:
* Minimum = 21ms, Maximum = 24ms, Average = 22ms

Then your horizontal axis should show four values for RTTs:

* 21, 22, 23, and 24 ms

The vertical axis should show how many times the RTT of 21 ms was observed, how many times 22 ms was observed, etc.

Recall that the [IP protocol](http://en.wikipedia.org/wiki/IP_protocol) may deliver packets from the same session along different routes. Analyze the routes observed for the same destination, but during different observation instances. Determine if different routes were recorded during different experiments.

**Report Preparation and Submission**

At a minimum, include the following information in your report:

1. Name of the pinged destination host, number of **PING** requests, and the date and time for each measurement. Describe your criteria for choosing “light” versus “heavy” usage periods.
2. All the statistics (histograms) reported by the **PING** utility, as well as all the routes reported by **TRACERT**.
3. Drawings of the chain of nodes and links for each traced route, where the nodes are represented as circles and links as lines that connect the nodes.
4. Discussion of the frequency distributions (histograms) observed for different hosts and different observation periods.
5. Discussion of **TRACERT** links, if any, with a significantly longer delay.
6. Discussion of differences, if any, in the routes reported for the same destination during different observation instances.
7. The list of references used during the data analysis and report preparation, such as websites, blogs, books, etc.

Label the charts so that it is clear which chart represents which observation.

When presenting a figure in your report, do not just say “see Figure 5”. Tell me where to look in Figure 5 and what should I see. If you don’t tell me where to look and what to see, I may not see interesting or important features that you wanted to highlight, and as a result you will not receive credit for your analysis.

You may find useful a shareware version of a Windows program called [pingplotter](http://www.pingplotter.com/) for graphing the **PING** and **TRACERT** results.

The cover page of your report should include:

* Course title and number
* Project title
* Student name and ID
* Submission date

To receive credit, it is *not* enough just to attach the raw data to your report. Instead, you must analyze and discuss the data, and include diagrams and charts. It is critical that your report summarizes the captured data in diagrams, and the narrative provides discussion and explanation of the observations.

The submission deadline given on the course schedule in the syllabus section of our class website, and your project report must be uploaded to our class website **no later than Midnight EDT/EST on that date.**

All project sources and reports will be checked for plagiarism, including being checked against solutions from online sources. If you are found guilty there will be serious consequences, including receiving a mark of zero for the project. Please review the WPI policies on Academic Honesty and Avoiding Plagiarism at <http://www.wpi.edu/Images/CMS/Bio/academic.pdf>

**Project Grade Allocation**

The items listed above form just a *minimum requirement* for the report and can be satisfied to a different degree. Only the students who have performed *greatest number of experiments* and provided *most extensive analysis and discussion* of their results shall receive the top score (100%). The reports that have satisfied all the required items, but only to a bare minimum, shall receive 70% out of 100% of the maximum score.

**Related Information**

**TRACERT usage information**

C:\Users\tgannon>tracert

Usage: tracert [-d] [-h maximum\_hops] [-j host-list] [-w timeout]

[-R] [-S srcaddr] [-4] [-6] target\_name

Options:

-d Do not resolve addresses to hostnames.

-h maximum\_hops Maximum number of hops to search for target.

-j host-list Loose source route along host-list (IPv4-only).

-w timeout Wait timeout milliseconds for each reply.

-R Trace round-trip path (IPv6-only).

-S srcaddr Source address to use (IPv6-only).

-4 Force using IPv4.

-6 Force using IPv6.

**PING usage information**

C:\Users\tgannon>ping

Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]

[-r count] [-s count] [[-j host-list] | [-k host-list]]

[-w timeout] [-R] [-S srcaddr] [-4] [-6] target\_name

Options:

-t Ping the specified host until stopped.

To see statistics and continue - type Control-Break;

To stop - type Control-C.

-a Resolve addresses to hostnames.

-n count Number of echo requests to send.

-l size Send buffer size.

-f Set Don't Fragment flag in packet (IPv4-only).

-i TTL Time To Live.

-v TOS Type Of Service (IPv4-only. This setting has been deprecated

and has no effect on the type of service field in the IP

Header).

-r count Record route for count hops (IPv4-only).

-s count Timestamp for count hops (IPv4-only).

-j host-list Loose source route along host-list (IPv4-only).

-k host-list Strict source route along host-list (IPv4-only).

-w timeout Timeout in milliseconds to wait for each reply.

-R Use routing header to test reverse route also (IPv6-only).

-S srcaddr Source address to use.

-4 Force using IPv4.

-6 Force using IPv6.

**Acknowledgments**

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