ECE 506:
Introduction to Wide Area Networks

Class Project

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For our class project, we were tasked with using networking utilities PING and TRACERT to analyze the paths that ping requests took to reach international servers. We were then asked to analyze this data to look for weaknesses in the paths taken, as well as deduce what could be the cause, or solution.

1 - Servers

The list of international servers I used is as follows:

1. Target Name: www.iuj.ac.jp [JAPAN]
    a. IP: 202.223.160.72
2. Target Name: www.whiterabbitcollection.org [AUSTRALIA]
    a. IP: 35.201.25.177
3. Target Name: www.tablemountain.net [SOUTH AFRICA]
    a. IP: 195.201.98.191
4. Target Name: www.nationalmuseum.gov.ph [PHILIPPINES]
    a. IP: 184.107.55.92
5. Target Name: zoocity.kz [KAZAKHSTAN]
    a. IP: 2a00:5da0:1000::112
6. Target Name: www.ozarena.com [SOUTH KOREA]
    a. IP: 183.111.138.159
7. Target Name: buudienhospital.vn [VIETNAM]
    a. IP: 171.244.17.13
8. Target Name: www.taironainn.com [COSTA RICA]
    a. IP: 98.129.229.84
9. Target Name: www.goodthai.fr [FRANCE]
    a. IP: 164.132.235.17

10. Target Name: www.dodo-sushi.com [CANADA]
    a. IP: 35.185.81.122

Since all of these servers were in completely different locations on earth, measuring their times separately would require me to be awake at time like the middle of the night to measure certain server's 'heavy usage times. Servers like the ones in South Korea, Vietnam, and Kazakhstan has times zones Over 12 hours ahead of the East Coast. This would mean their heavy usage times would be the opposite to Worcester. Because of this, I choose to take every server's pings together, in sessions, at different times throughout the day for East Coast time. Taking times in the morning would measure more heavy times during the evening for the servers listed earlier. Taking ping data in from later in the day for the east coast would equate to morning times for the same servers.

2 - Data Collecting Sessions

	Session	Time	~ # of Pings
	6-28	10:00	100
	7-8	09:20	100
	7-10	14:50	100
	7-14	12:48	100
	7-17	12:43	300

TOTAL	5 Sessions		700

Table A: Session Descriptions

Regarding the data. I sent an email to the professor explaining how ping plotter corrupted a fair portion of the data I had collected. Because of this, I lost a fair amount of data, and also lost the ability to extract full raw data from the ping plotter as the trail had run out. This was a bummer because I had previous sessions that were in later times during the east coast time zone, which would measure less heavy usage times across the globe. Because of this unfortunate event, the session after 7-8 has summary data, as in the averages, and the hop averages. The session on 6-28 only contains a minimal amount of the servers from the list.

NOTE: ALL DATA CAN BE FOUND IN MY CLASS PROJECT GITHUB REPOSITORY, FOUND HERE: https://github.com/nnova831/ECE506

3 - Histogram Results

Below are the histogram results from the 10 different international servers listed in section 1. The histograms were created by take the RTT times from the available raw data collected (earliest 2 sessions) as well as the minimum, maximum, and average times of the RTT's from the summary data that was available after my unfortunate set of events occurred with corrupt data and end of ping plotter trial.

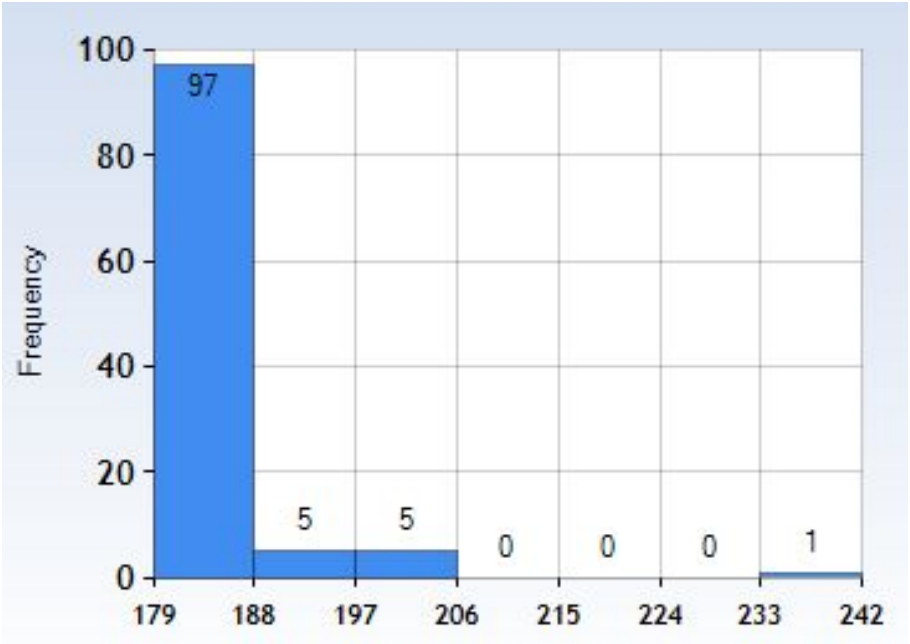

Figure 1: iuj.ac.jp histogram

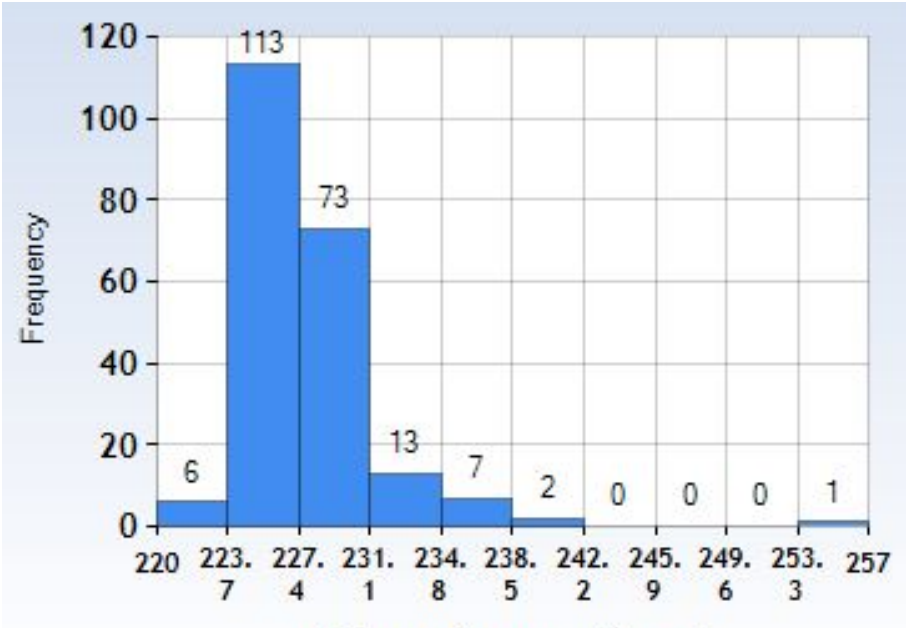

Figure 2: whiterabbitcollection.org histogram

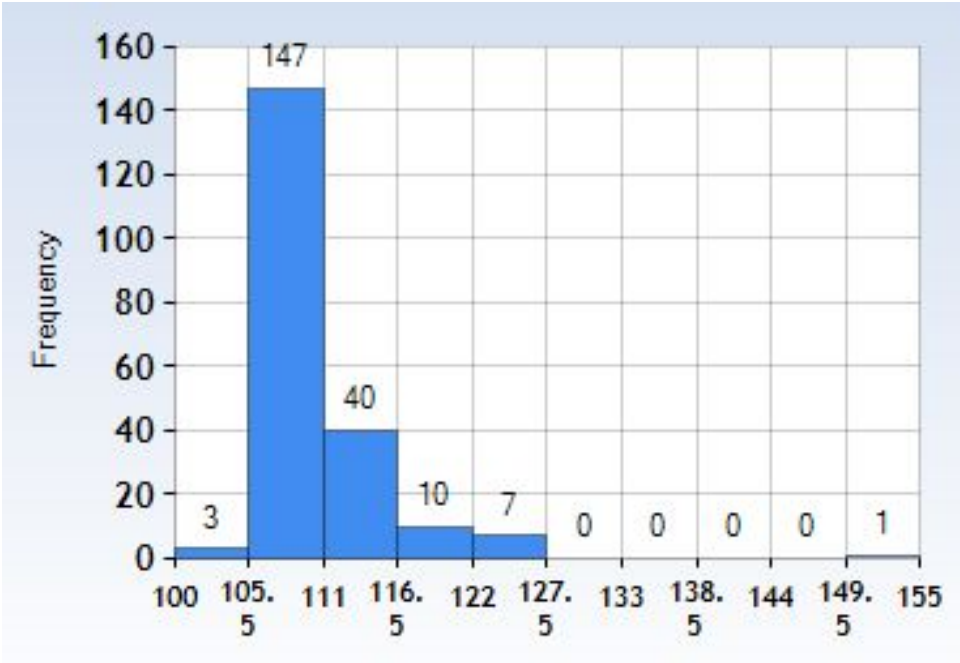

Figure 3: tablemountain.net histogram

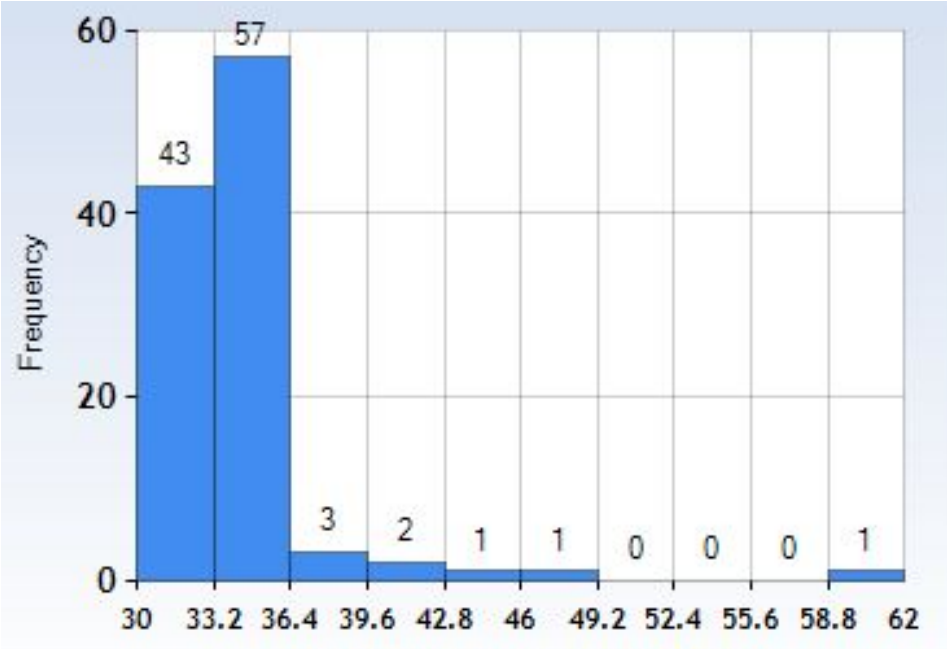

Figure 4: nationalmuseum.gov.ph histogram

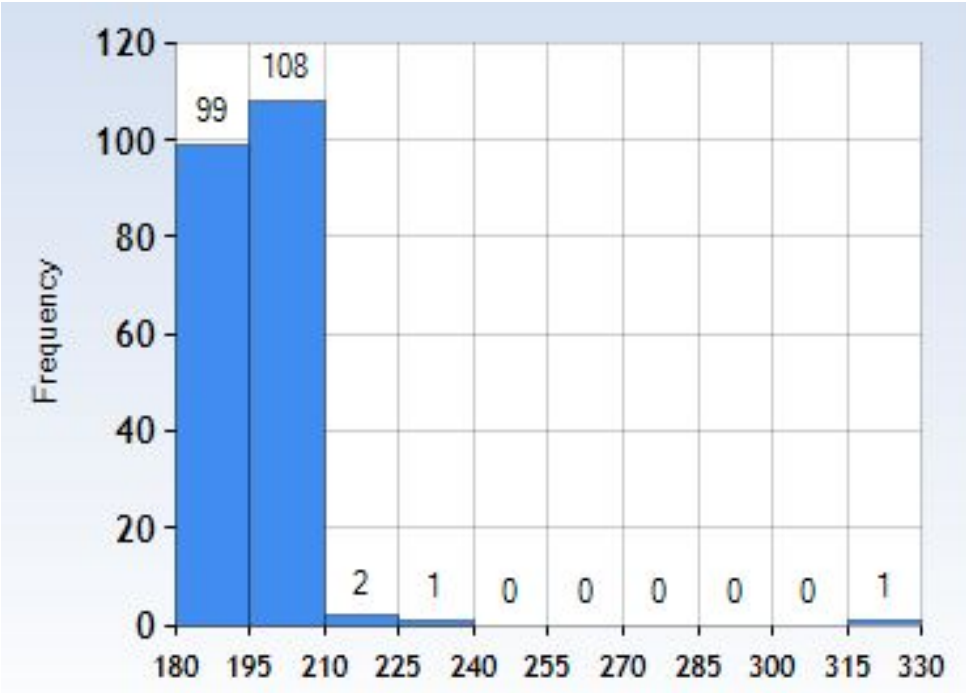

Figure 5: zoocity.kz histogram

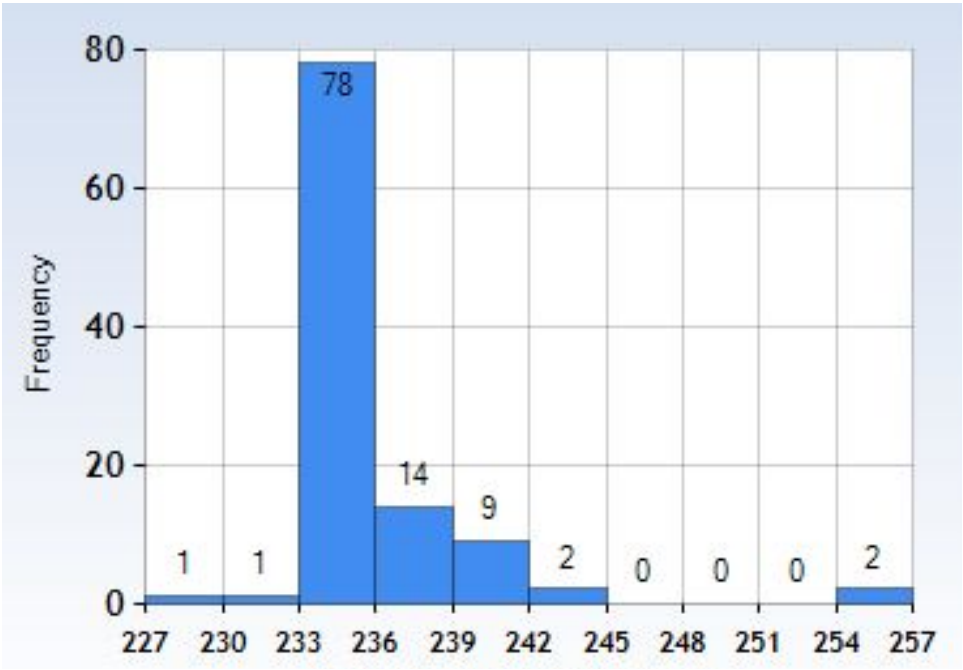

Figure 6: ozarena.com histogram

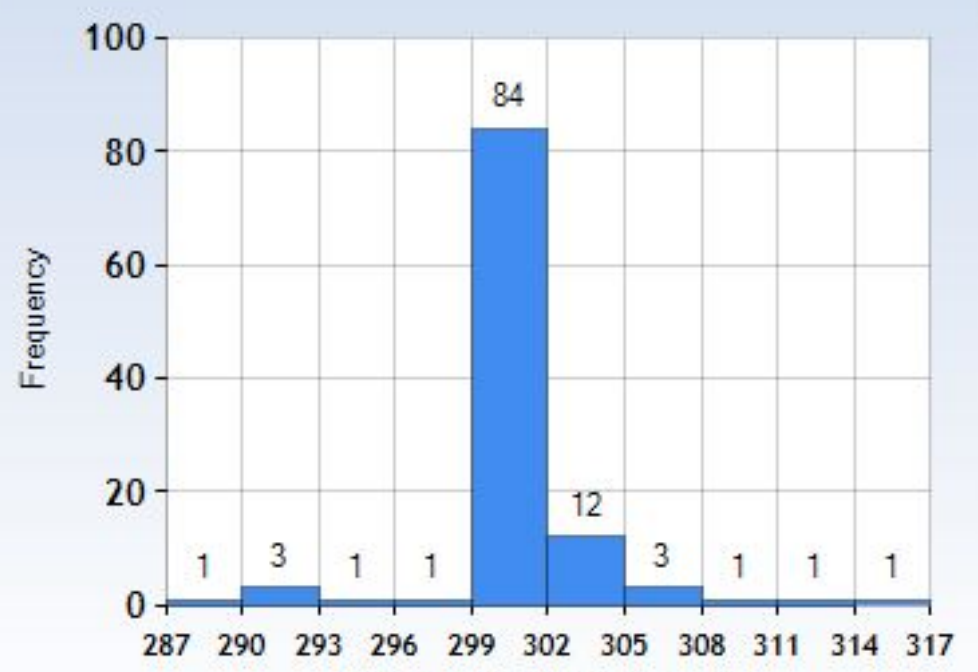

Figure 7: buudienhospital.vn histogram

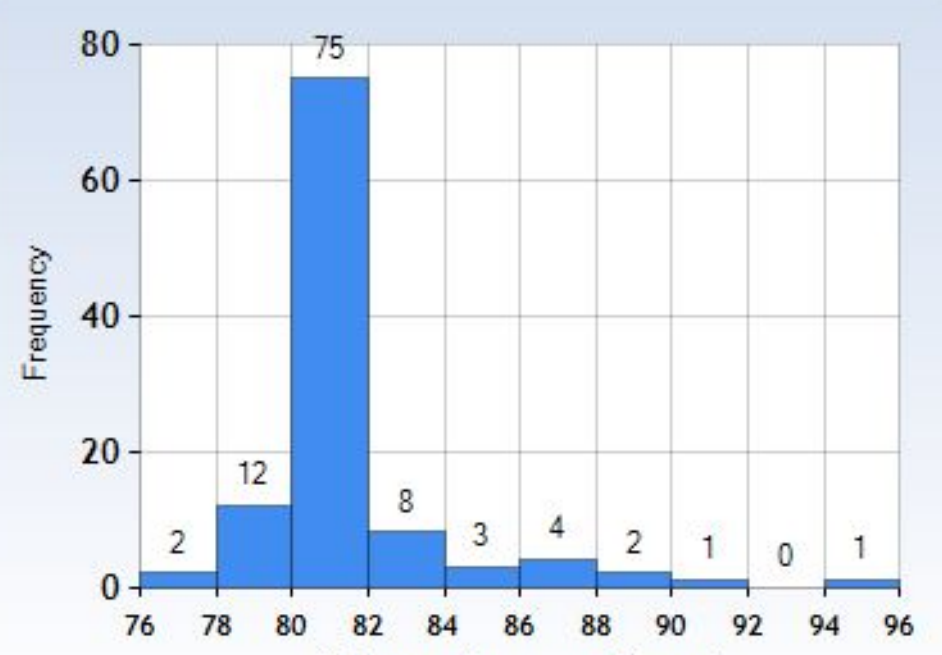

Figure 8: taironainn.com histogram

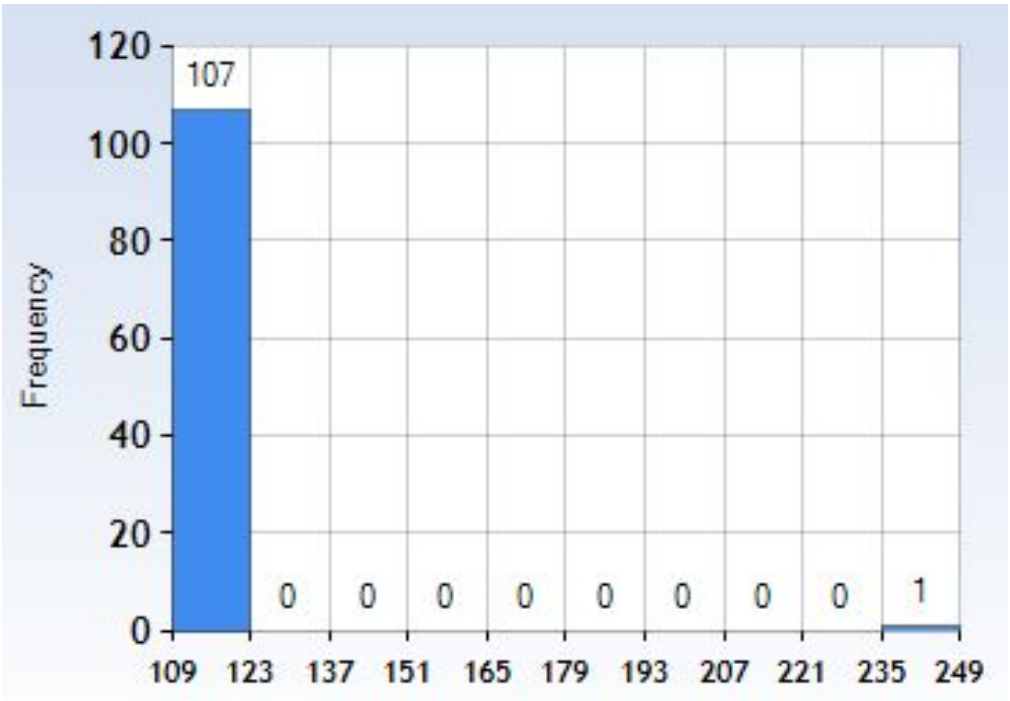

Figure 9: goodthai.fr histogram

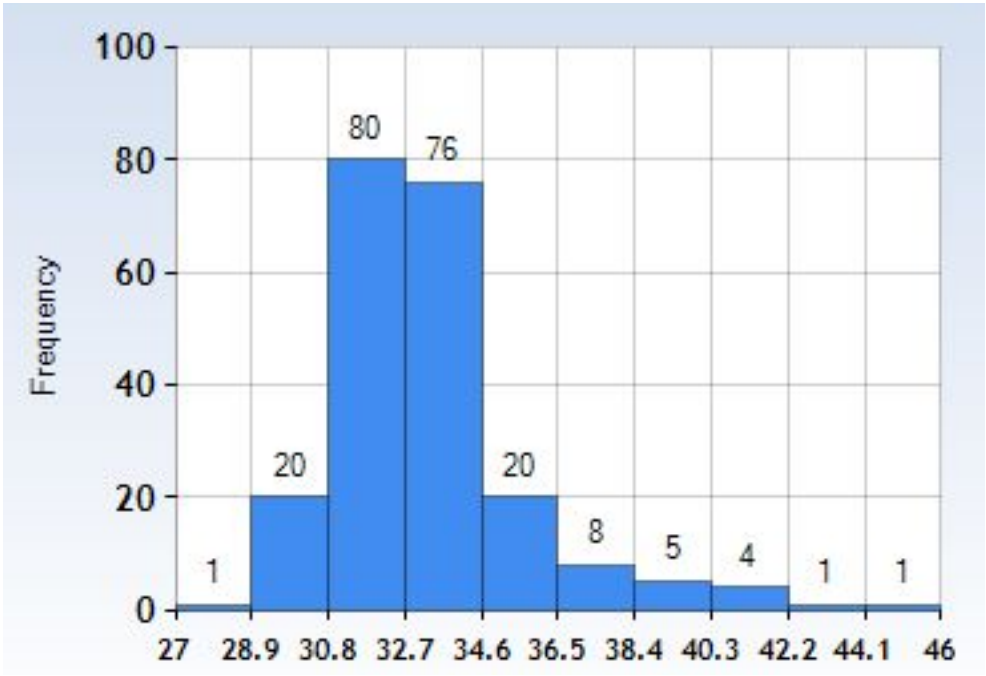

Figure 10: dodo-sushi.com histogram

Histogram Result Discussion

The above results come from many different times of the day, and based on the times laid out in the session description table (Table A), we know the ranges of times for collecting data were from around 10am to 3pm EST. These times are considered higher in traffic times. Usually peak usage times in most countries are between 7am and 11pm local time. This is the time when most humans are awake and actively on the internet. In the case of Dodo Sushi (Figure 10) the majority of the RTT are between 30 and 34 ms. The fact that the time difference between EST and PST is only 3 hours would suggest the fairly normalized distribution of RTT. Usage times are about the same for the times in which the data was collected. Many of the histograms can be described not by the RTTs, but from the stability of their connections. Because Dodo sushi was the closest in time zone to that of mine, the connection might have been more well distributed because of the heavy usage the server was under.

Upon further observation of the hops of the servers, I found very few of the servers in this experiment that were pinged using different hops. After comparing some of the earlier sessions with the new ones, I was only able to find at most, a two server difference within data for a specific international server. Servers such as tablemountain.net, and zoocity.kz, coming from Cape Town, and Kazakhstan, are hoping through different hop paths usually during the last, or first few hops. This can be explained by the international countries lower tier internet infrastructure, and stability.

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4 - Hop Visualizations

During and after my trail of pingplotter, they were kind enough to include the feature to generate a chain and link visualization of the hops took from each session, Because of the unfortunate data corruption as I previously emailed you about, the following visualizations are from the last 4 of the 5 session total.

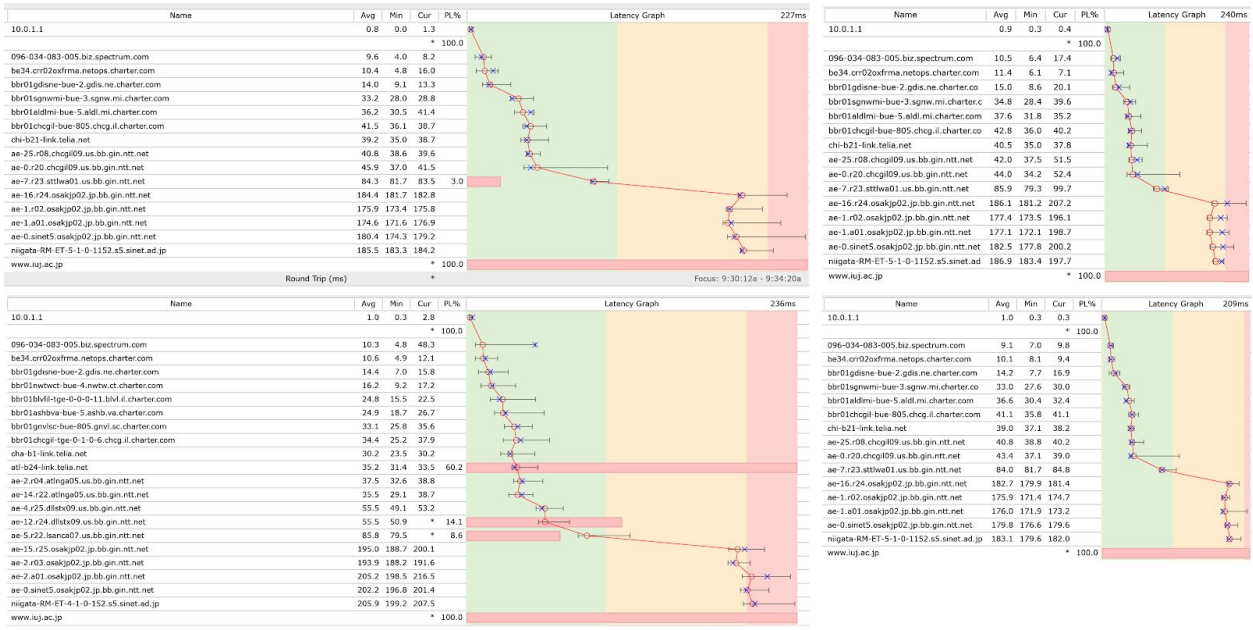

Figure 11: Visualization of iuj.ac.jp

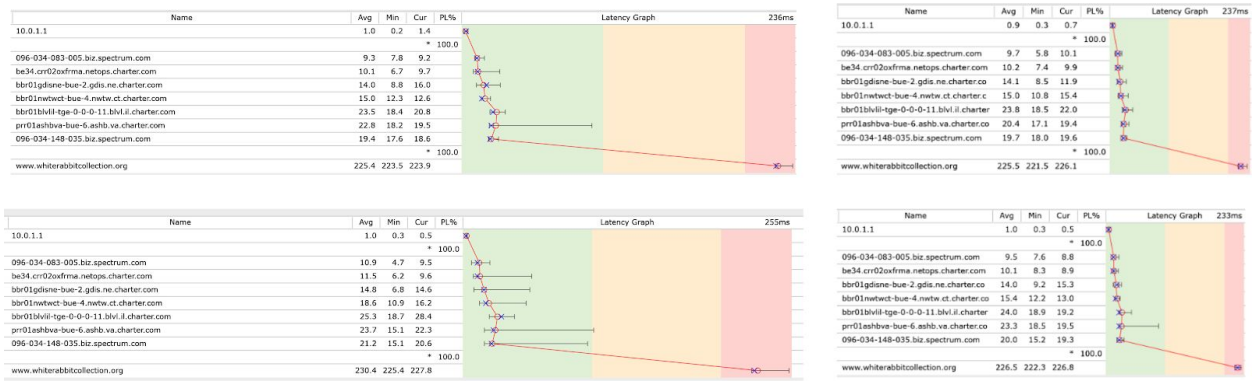

Figure 12: Visualization of whiterabbitcollection.org

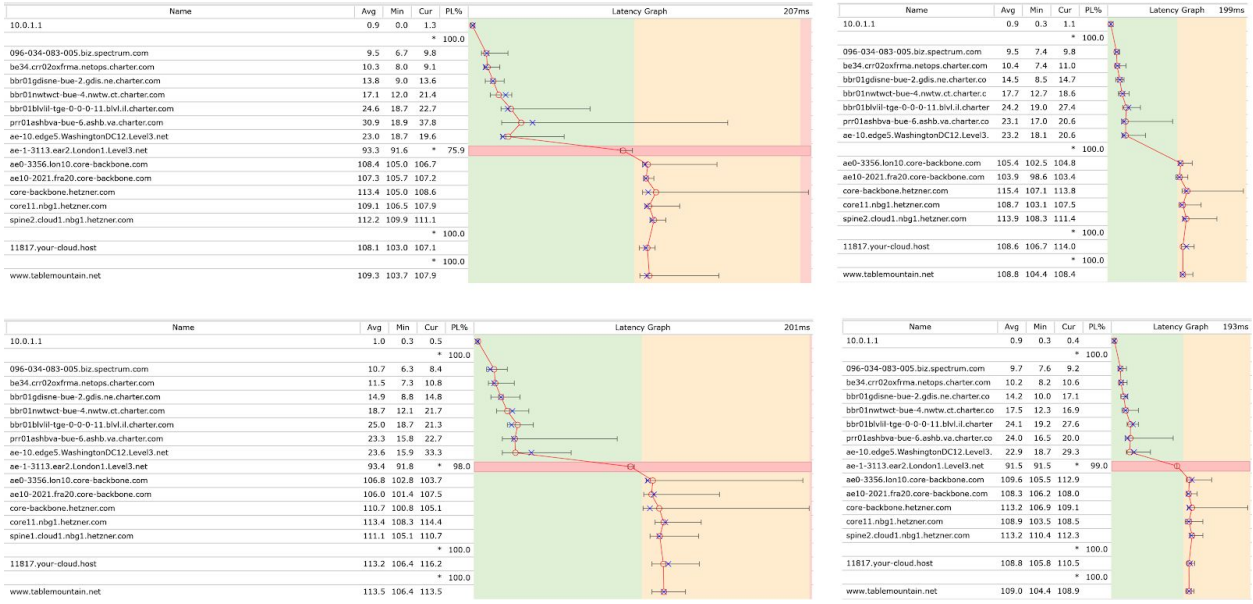

Figure 13: Visualization of tablemountain.net

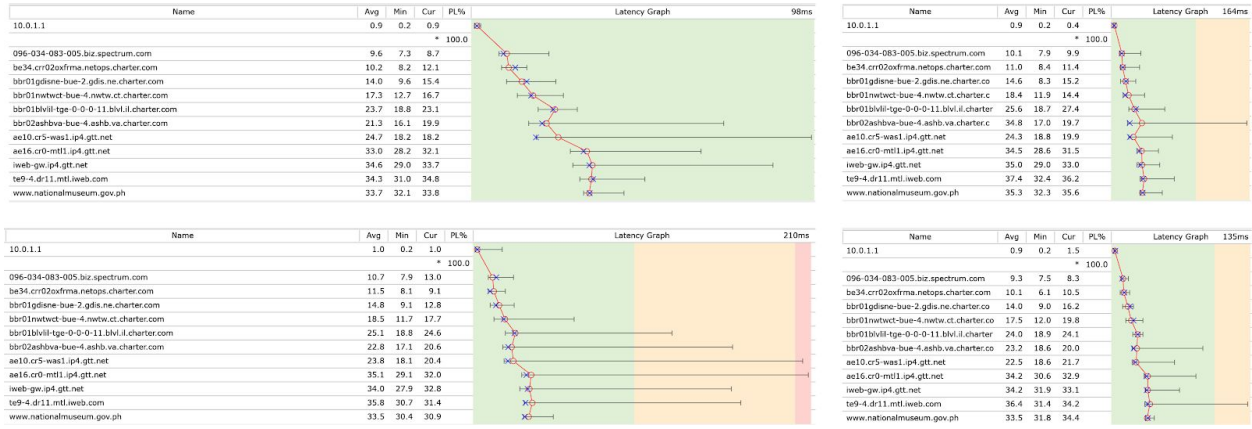

Figure 14: Visualization of nationalmuseum.gov.ph

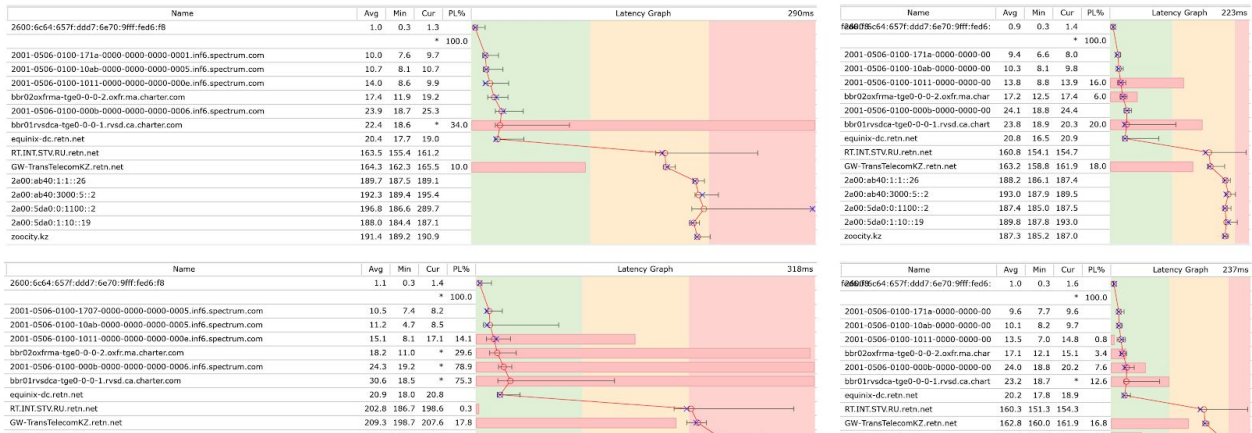

Figure 15: Visualization of zoocity.kz

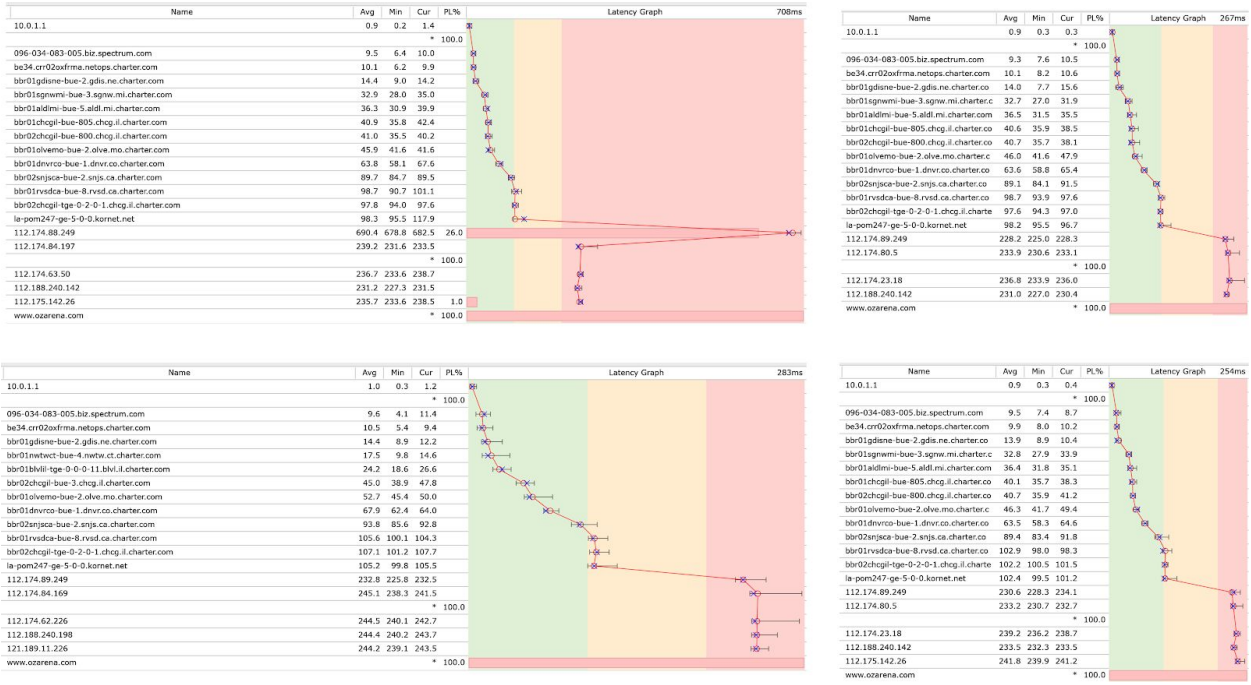

Figure 16: Visualization of ozarena.com

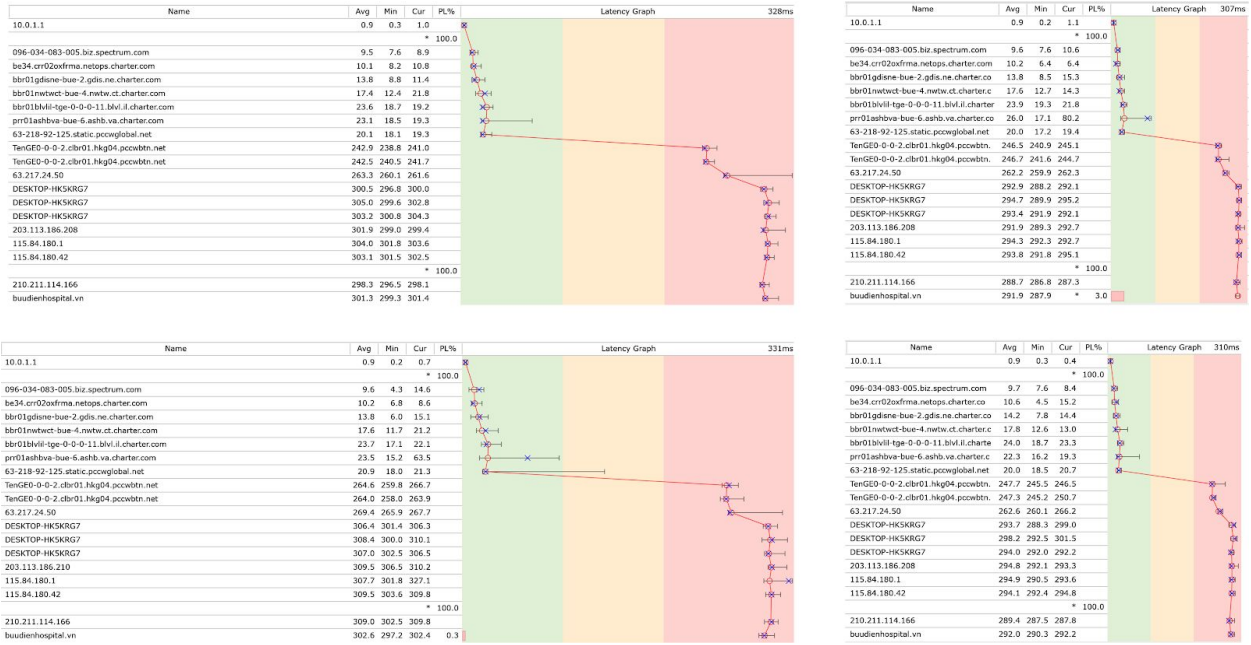

Figure 17: Visualization of buudienhospital.vn

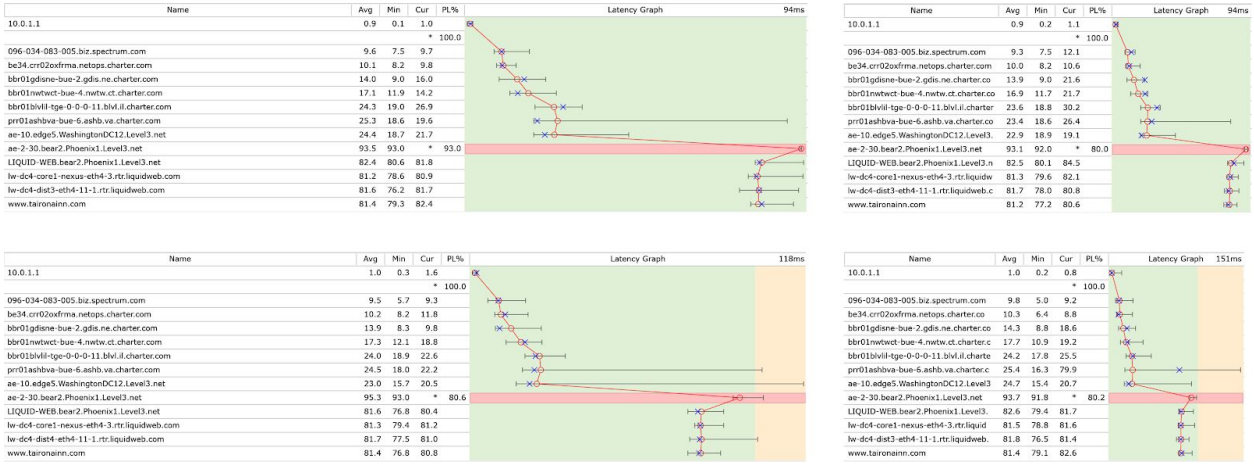

Figure 18: Visualization of taironainn.com

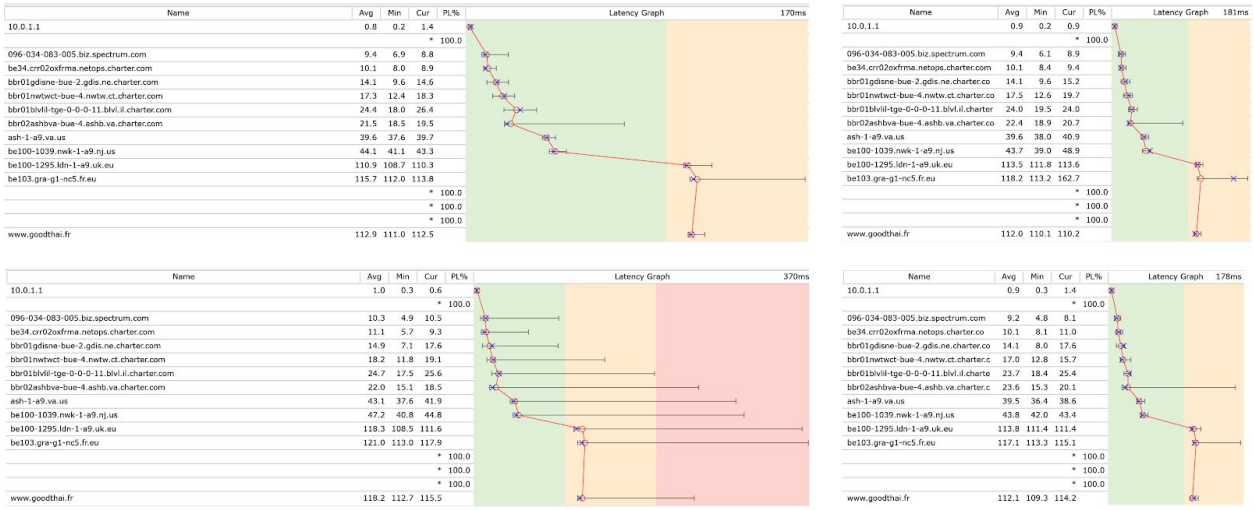

Figure 19: Visualization of goodthai.fr

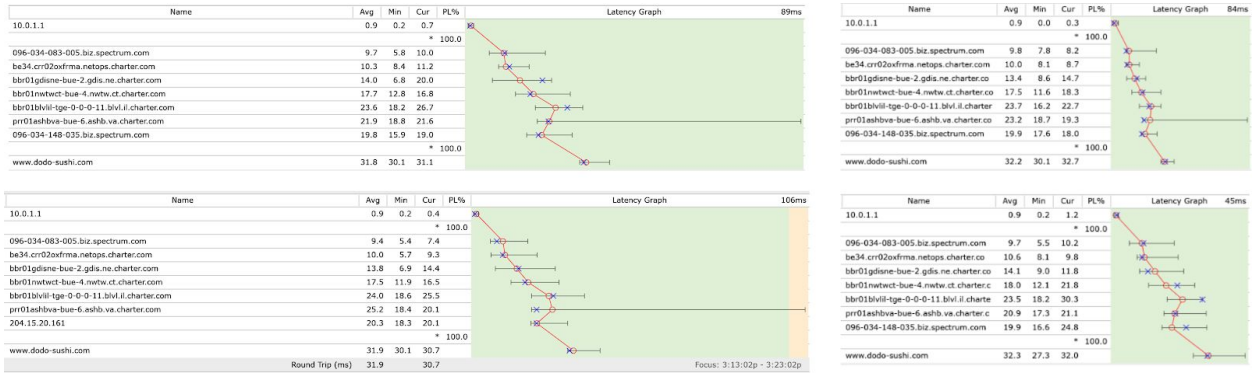

Figure 20: Visualization of dodo-sushi.com

Visualization Result Discussion

Obviously the graphics above didn't come out as well as i'd like them to be, but with the time I had and the data I collected I feel like this is suitable. The graphics show 4 separate chain and link visualizations for each of the 10 servers listed in Section 1. In many of these visualizations (Figures 11, 15, 16, etc.) there are red rectangles on certain hops. I believe this indicates packet loss or connection problems. There appears to be more packet loss for servers found in 2nd or 3rd world countries, and the hops in which the packet loss appears are usually on the second half of its total journey. Using an IP locator such as https://tools.keycdn.com/geo, I was able to analyze the jumps in these visualizations that caused the most delay, or change in delay. For these servers, the biggest change in delay time came from the hop from within the U.S, to that outside of the U.S. For example, in Figure 15, all 4 of the graphs have a major change in RTT delay around halfway through the hops. Using the IP address before and after that jump, the jumps delay came from exiting the United States.

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5 - Conclusion

As a summary, Using the suggesting ping plotter networking utility, Data collection was made on 10 international servers, across the globe. This data was then visualized and analyzed of its destination hops, its average times, and its frequency in RTT delays. Looking at servers from across the globe, as well as across a nation, it was easy to see that many of the servers had stability, regardless of time and

usage hour. It was also clear that many of the countries with less internet infrastructure had a less stable connection. The very same countries were pinged over different hop destinations, and sometimes exhibited packet loss. From the visualizations and an online IP locator, we were able to deduce that some of the biggest change in RTT delay between hops in a ping request come from the hop out of the United States.

Prior to this course I was unaware of TRACERT and its potential. The ability to locate and analyze each hop of a request on its way to its final destination server is very helpful in the analysis and examination of internet protocols. In the future it would be interesting to create some kind of script that could automate the process of pinging and tracert of different servers. It would be interesting to further analyze the results of data such as this one.