Chris Tsuei

Professor Rabinovich

EECS 325

21 April 2016

Lab Report: RTT vs hops to destination

For this lab, I was supposed to run a python program and give it a website in order to get a round trip time (RTT) and a number of hops to the destination website. This was accomplished by sending a UDP datagram to a port that is used for ping (33434) on the website. The return ICMP packet from the website would then be unpacked, and read in order to get the count of the number of hops. The ICMP packet contains the ICMP error message, which I ignored, and the first few bytes of the original datagram (20 bytes minimum). By recording the time I received the ICMP error message and unpacking the original datagram that was received by the sender and reading the time to live field, I was able to compute the number of hops taken in order to reach the destination and the round trip time of the packet.

Time to live (TTL) is a field set in the original IP header before the packet was sent to the website specified. As per the instructions, the TTL was set as 32. The TTL field in the IP header is decremented on every router it hits. If the field is equal to 0 when received by a router, the packet would be dropped, and therefore lost. In order to resend a packet, the select method of the select API was used. This would enable me to loop back to the beginning in the event that the packet took too long to return.

In order to tell the packets received by my machine apart, I manually set the packet ID number in the IP header to a value (5036). On receipt of the packet on my machine, I read the ICMP error packet’s datagram and compared the packet ID numbers. If the packet numbers matched, I would compute the number of hops. However, if the ID number did not match, I ignored the packet and tried again.

Overall, there was a correlation between the Time to Live and the Round trip time. I took samples of the RTT and number of hops of 17 different websites. Originally, I was told to do 10 different websites of the top 500 most visited sites. However, of those 10 original sites, four sites were dropped, probably due to the fact that they were a far distance away from the original send point (Cleveland Ohio). Those four sites were foreign sites that probably not based in the United States, so therefore it would take greater than 32 hops in order to reach them.

There was a positive slope for the relationship between the RTT and the number of hops taken by the packet. On average, each hop took an additional 17.5 milliseconds. This is likely due to a combination of propagation, queuing, processing and transmission delay. Propogation delay and transmission delay happen when the packet is being sent. Processing delay is when the router is looking at the IP header and computing the UDP checksum in order to determine if the packet should be dropped. Finally, queuing delay happens when the packets have to wait in order to be processed by the router.

The correlation between RTT and the number of hops in the 10 sites that I recorded data of had an R-squared value of 0.3684 (Figure 1). There was one data set that looked like an outlier. However, removing that outlier decreased the R-squared value to 0.147. There is a definite correlation between the RTT and the number of hops to a site. However, it is a really weak correlation. The number of hops is likely not correlated to the RTT of a packet.

This is due to the fact that your request is routed from your local CDN and then to the global ISP and can go between many short or long links before reaching your destination. The difference in results for similar number of hops with vastly different RTT’s was probably due to propagation delay. Propagation delay is the delay between the sending of one bit from the sender to the receiver. It is dependent on the distance of the link between sender and the receiver. If there were a lot of hops along shorter links, it stands to reason that the propagation delay (an integral part of RTT) was small. However, if the packet was sent over longer distances each hop, the propagation delay would be larger, so it would lead to a larger RTT.

Figure 1: Hops vs RTT

Figure 2: Hops vs RTT (without the outlier)