COMP90007

Network Analysis Assignment

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1 Measuring the hop count

1. As the document with command *man traceroute*:
   -n means printing hop addresses in numerical order.
   -w means setting the time with a variable (seconds) to wait for a response to a probe.
   1 is the variable for -w which means 1 second.

2. All results are archieved in section 1 of appendix. Get the address with https://db-ip.com and distance from Melbourne with https://www.freemaptools.com/how-far-is-it-between.htm. Following Table 1 and the chart are the hop count versus the approximate geographical distance for each hosts. As the graph, there is no correlation between them. A reason may be that the distance is between the destination and Melbourne, however, the trace of routes do not arrive at the destination directly. For example, when trying to connect to the host iperf.biznetnetworks.net, which is located in Rw 01, Indonesia, it hops to routes in US first and then HongKong. This seems to complain why it hops 10 times for just over five thousands km. Also, it may hop several times in the same city or country, like from Melbourne to Sydeny. This may also be a reason.
   For the host iperf.it-north.net and speedtest.serverius.net, it can not hop to the destination IP of the server with the normal *traceroute*, but it can hop to the server with an option -P ICMP. A hop that outputs * * * means that the router at that hop doesn't respond to the type of packet. And this option can use ICMP packets instead of UDP.

Hosts	Hop count	Distance (km)
iperf.biznetnetworks.net	10	5210.529
iperf.it-north.net	23	11741.582
iperf.he.net	7	12675.739
st2.nn.ertelecom.ru	20	14071.250
iperf.volia.net	19	14797.091
speedtest.serverius.net	19	16506.976
bouygues.testdebit.info	16	16618.952
ping.online.net	18	16807.792

Table 1: Distance vs Hop count

2_2.png

2 Measuring delay and jitter

1. Andrew and David (2011, p.405) have argued when using a network with both high delay and high jitter, users will face the situation that all packets or every frame will be delayed and arrive in random interval time. For example, real-time applications, like video calling and VoIP, are sensitive to both high delay and high jitter. Because it will become connectless when every word and every frame is delayed a long time and varies a random time.

2. All results are archieved in section 2 of appendix. Following Table 2 is mean round-trip delay and jitter for each host.

Hosts	Delay(ms)	Jitter(ms)	Distance (km)
iperf.biznetnetworks.net	211.942	0.977	5210.529
iperf.it-north.net	422.862	42.385	11741.582
iperf.he.net	163.072	0.381	12675.739
st2.nn.ertelecom.ru	357.801	1.238	14071.250
iperf.volia.net	337.406	0.501	14797.091
speedtest.serverius.net	302.091	1.396	16506.976
bouygues.testdebit.info	312.587	24.354	16618.952
ping.online.net	301.522	0.629	16807.792

Table 2: round-trip delay and jitter

3_2.png

3_2_2.png

3. No correlation. Actually, *Wikipedia* (2017) describes that the network delay can be divided to several parts: processing delay, queuing delay, transmission delay and propagation delay. Only propagation delay in these parts is related to physical geographical and others may be related to the network enviroment and QoS of the routes. And the jitter should depend on the quality of the route and the link most. Distance should be just an element.
   The experiment network evironment is a public Wi-Fi system in the apartment. The download/upload speeds are 56.51Mbps and 56.66Mbps (test with ookla speedtest). The users sharing the network may be plenty. There is no other applications like browers or mail which is active. For example, if too many users are using the network at the same time, the local route will be busy. This may influence the results.

3 Measuring the bandwidth-delay product

1. *Wikipedia* (2018) describes that the bandwidth-delay product is the max value of data on the network circuit at a given time. For example, geostationary satellite and ultra-high speed LAN are networks with high bandwidth-delay products. Throughput efficiency will be at maximum when RTT is poorest which is also known as long fat networks.

2. All results are archieved in section 3 of appendix. Following Table 3 is the mean bandwidth and bandwidth-delay product for each host.

Hosts	mean bandwidth (Mbps)	bandwidth-delay (kb)
iperf.he.net	43.70	7126.25
iperf.biznetnetworks.net	30.57	6465.31
bouygues.testdebit.info	20.40	6376.77
ping.online.net	19.13	5768.12
iperf.volia.net	17.87	6029.45
speedtest.serverius.net	15.07	4552.51
st2.nn.ertelecom.ru	14.97	5356.28
iperf.it-north.net	0.27	115.44

Table 3: mean bandwidth and bandwidth-delay product

3. When plotting the bar chart, each bandwidth-delay product times 10^{-2} for compare. The network evironment used is still the public Wi-Fi system. Due to the fact that the bandwidth of the Wi-Fi is up to around 50 Mbps. The result of bandwidth can not be more than 50. So that the result is not the actual bandwidth of the server. Moreover, if other users are occupying the bandwidth with streaming video or downloading, the result will also be influenced. It seems that the bandwidth is continually decreasing as the product is not. The results of iperf.volia.net and st2.nn.ertelecom.ru may be influenced by some elements and they may be two outliners.

   4_3.png

   Bar chart: bandwidth and bandwidth-delay product

4. Plotting bandwidth-delay vs hop count as follows. As the plot without 2 outliners, it seems there is a correlation which the bandwidth-delay product decreases when hop count grows. Due to the fact from *Wikipedia* (2018) that the bandwidth-delay product is the maximum amount of data on the network circuit at any given time, there will be more elements which influence the results while the hop count grows. For example, the bandwidth of each route on the trace and the firewall policy of each route will all influence the result.

   4_4.png

5. All of the experiment is made on macOS with a public Wi-Fi system (many sharing users and up to around 50 Mbps) and ploted with Microsoft Excel.

   (a) For experiment 1, using *traceroute* command with the option -n, -w and -P ICMP to change the packets from UDP for two hosts of them.

   (b) For experiment 2, using *ping* command with the option -c to set time. Use the stddev formula to calculate the jitter.

   (c) For experiment 3, using $iperf3$ command with the option -c for client mode and -p to change the port.

Reference

1. ANDREW S. TANENBAUM, DAVID J. WETHERALL, R 2011, fifth edition, computer networks, United States of America.

2. *man traceroute* command in macOS terminal

3. viewed 14th Sep 2018, <https://db-ip.com>

4. viewed 14th Sep 2018, <https://www.freemaptools.com/how-far-is-it-between.h-tm>

5. Wikipedia, 2017, Network delay, viewed 15th Sep 2018, <https://en.wikipedia.or-g/wiki/Network_delay>

6. Wikipedia, 2018, Bandwidth-delay product, viewed 15th Sep 2018, <https://en.wikipedia.org/wiki/Bandwidth-delay_product>

Appendix

1. Screenshots for experiment 1:

   tr1.png

   tr2.png

   tr3.png

   tr4.png

   tr5.png

   tr6.png

   tr7.png

   tr8.png

2. Screenshots for experiment 2 (using the formula for stddev in the spec):

   p1.png

   p2.png

   p3.png

   p4.png

   p5.png

   p6.png

   p7.png

   p8.png

3. Screenshots for experiment 3 (the bandwidth of sender is used):

i11.png

i12.png

i13.png

i21.png

i22.png

i23.png

i31.png

i32.png

i33.png

i41.png

i42.png

i43.png

i51.png

i52.png

i53.png

i61.png

i62.png

i63.png

i71.png

i72.png

i73.png

i81.png

i82.png

i83.png