CS408 – Computer Networks – Spring 2024 - HW 1

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Q1)

a)

My location is Sabancı Campus. This is the screenshot of ping command between my computer and Stanford University at midnight. And the average RTT İS 234ms.

```
PS C:\Users\aycaaelifaktas> ping stanford.edu

Pinging stanford.edu [171.67.215.200] with 32 bytes of data:
Reply from 171.67.215.200: bytes=32 time=268ms TTL=240
Reply from 171.67.215.200: bytes=32 time=228ms TTL=240
Reply from 171.67.215.200: bytes=32 time=216ms TTL=240
Reply from 171.67.215.200: bytes=32 time=227ms TTL=240

Ping statistics for 171.67.215.200:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 216ms, Maximum = 268ms, Average = 234ms
PS C:\Users\aycaaelifaktas>
```

This is the screenshot of ping command between my computer and Stanford University at noon. And the average RTT is 301 ms.

```
PS C:\Users\aycaaelifaktas> ping stanford.edu

Pinging stanford.edu [171.67.215.200] with 32 bytes of data:
Reply from 171.67.215.200: bytes=32 time=286ms TTL=240
Reply from 171.67.215.200: bytes=32 time=299ms TTL=240
Reply from 171.67.215.200: bytes=32 time=305ms TTL=240
Reply from 171.67.215.200: bytes=32 time=314ms TTL=240

Ping statistics for 171.67.215.200:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 286ms, Maximum = 314ms, Average = 301ms
```

The observed difference in the average round-trip delays between midnight (234ms) and noon (301ms) of 67ms could indicate variations in network performance or conditions during these two time periods. During daytime hours, network usage tends to be higher as more people are active online. This increased usage can lead to network bottleneck and potentially longer round-trip times. Conversely, at midnight, when fewer users are typically active, the network may experience lower bottleneck, resulting in shorter round-trip times. The responsiveness of the destination server (Stanford University, in this case) can also play a role. If the server experiences varying loads or performance characteristics during different hours, it can affect the round-trip times.

b)

This is the screenshot of Traceroute command between my computer and Stanford University at midnight.

```
PS C:\Users\aycaaelifaktas> tracert stanford.edu

Tracing route to stanford.edu [171.67.215.200]
over a maximum of 30 hops:

  1    59 ms     5 ms    60 ms  10.80.100.1
  2    97 ms    49 ms    58 ms  10.201.201.9
  3    42 ms   149 ms    74 ms  10.201.8.1
  4    15 ms    29 ms     3 ms  10.201.0.254
  5     3 ms    14 ms     3 ms  ASR1.sunet [10.255.0.2]
  6     3 ms     7 ms    62 ms  host-85-29-49-13.reverse.superonline.net [85.29.49.13]
  7    34 ms     5 ms     7 ms  10.40.178.209
  8     *        *        *     Request timed out.
  9    34 ms     6 ms     7 ms  10.40.179.162
 10    75 ms    73 ms    77 ms  10.36.6.38
 11    49 ms    82 ms   103 ms  e0-5.core2.fra1.he.net [216.66.87.197]
 12    56 ms     *        *     port-channel1.core3.fra1.he.net [184.104.198.26]
 13     *        *        *     Request timed out.
 14     *        *        *     Request timed out.
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17   290 ms   204 ms   235 ms  stanford-university.e0-62.core2.pao1.he.net [184.105.177.238]
 18   253 ms   258 ms   202 ms  campus-ial-nets-b-vl1102.SUNet [171.66.255.196]
 19     *        *        *     Request timed out.
 20   324 ms   231 ms   198 ms  web.stanford.edu [171.67.215.200]

Trace complete.
PS C:\Users\aycaaelifaktas> |
```

This is the screenshot of Traceroute command between my computer and Stanford University at noon.

```
PS C:\Users\aycaaelifaktas> tracert stanford.edu

Tracing route to stanford.edu [171.67.215.200]
over a maximum of 30 hops:

  1    47 ms    38 ms    28 ms  10.80.100.1
  2    18 ms     4 ms    20 ms  10.201.201.9
  3    41 ms     4 ms     4 ms  10.201.8.1
  4     3 ms    14 ms     4 ms  10.201.0.254
  5    83 ms     4 ms     2 ms  ASR1.sunet [10.255.0.2]
  6    38 ms     7 ms     6 ms  host-85-29-49-13.reverse.superonline.net [85.29.49.13]
  7    16 ms    38 ms    21 ms  10.40.178.209
  8     *        *        *     Request timed out.
  9   506 ms     *        *     10.40.179.162
 10     *       26 ms     *     10.36.6.38
 11    92 ms    75 ms     *     e0-5.core2.fra1.he.net [216.66.87.197]
 12    80 ms     *      101 ms  port-channel1.core3.fra1.he.net [184.104.198.26]
 13     *        *        *     Request timed out.
 14     *        *        *     Request timed out.
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17   260 ms   209 ms   226 ms  stanford-university.e0-62.core2.pao1.he.net [184.105.177.238]
 18   210 ms   212 ms   270 ms  campus-nw-rtr-vl1102.SUNet [171.66.255.196]
 19     *        *        *     Request timed out.
 20   309 ms   205 ms   243 ms  web.stanford.edu [171.67.215.200]

Trace complete.
```

The provided traceroute results indicate the path taken by packets from my location to the destination (stanford.edu) and the round-trip times (in milliseconds) for each hop. In both traceroutes, there are instances of request timeouts (denoted by asterisks) at hop 8 and between hops 13 and 16. This could indicate that some routers along the path are not responding to the traceroute requests. It doesn't necessarily imply a problem, as routers may be configured not to respond to such requests for security reasons. Traceroute provides a snapshot of the network path at a specific moment, and network conditions can change throughout the day. The round-trip times vary significantly between hops, instances of high RTT/Round trip delay at specific hops can be indicative of potential bottlenecks. For example, the high latency at Hop 9 (506 ms) might be a of potential bottleneck when the Traceroute command executed at noon. This could be due to network congestion, routing changes, or other factors. The round-trip times for the same hops vary between the two traceroutes, suggesting that network conditions fluctuate throughout the day as well.

c)

Number of routers in the path at each of the time is 30 and the paths did not change at both of the times.

Q2)

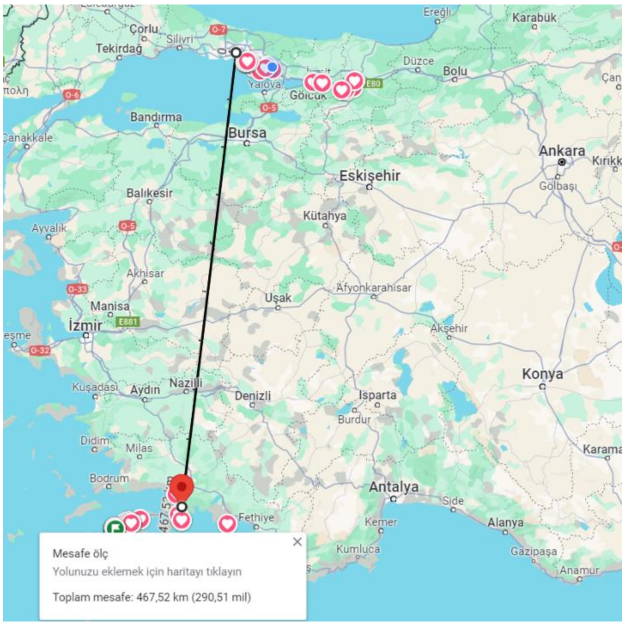
a)

The total distance from my location (Sabancı Campus) to the Stanford University is 10.838,18 km.

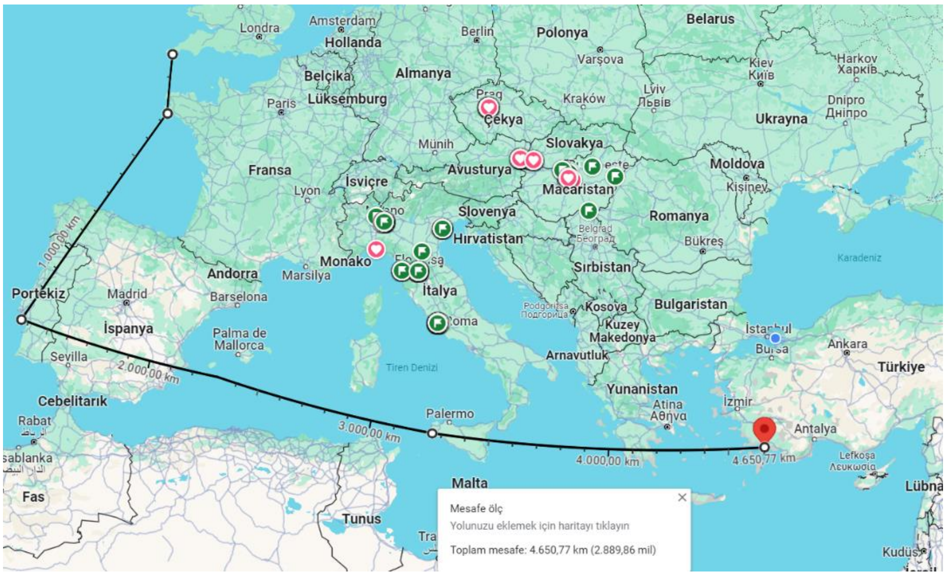
Because my propagation medium is fiber optic cables my one bit of data travels in speed of light. And that is about 200.000 km/s. To calculate the propagation delay we need to use this formula : Propagation Delay = Distance / propagation speed.

In our case : Propagation Delay= (10.838,18 km) / (200.000 km/s) ≈ 0,054190 seconds

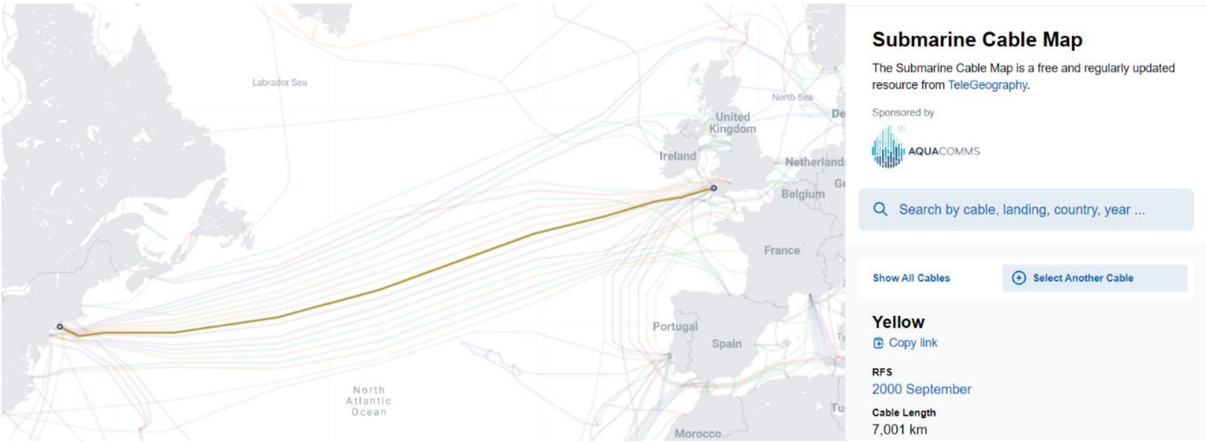
b)



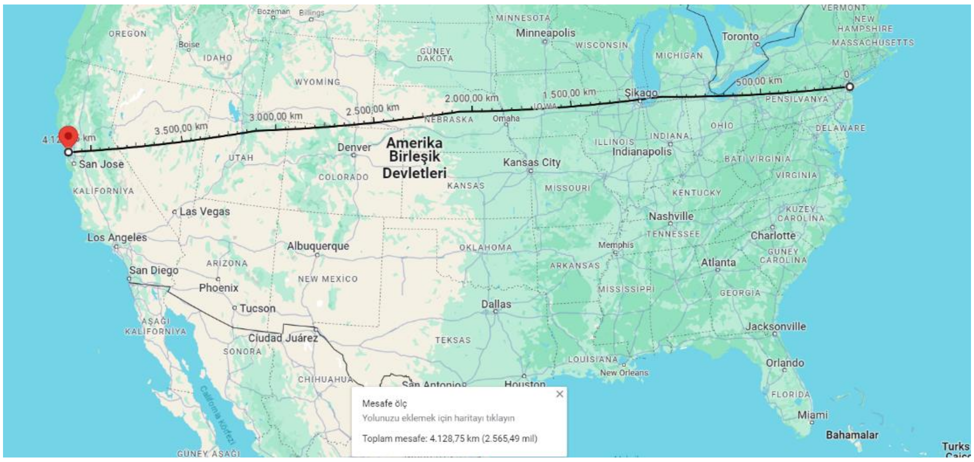
The distance from Istanbul to Marmaris is 467,52 km.



The distance from Marmaris to GoonHilly Downs, UK using SeaMeWe-3 submarine cable approximately 4.650,77 km.



The distance from UK to Bellport, NY, USA through Yellow submarine cable is 7001 km.



Finally distance from NY, USA to San Francisco is 4.128,75 km.

TOTAL distance is 16.248,04 km.

If we assume that my ping packages travel through fiber optic cables in this path then my one bit of data travels in speed of light. And that is about 200.000 km/s. To calculate the propagation delay we need to use this formula : Propagation Delay = Distance / propagation speed.

In this propagation delay is the sum of all propagation delays at each stop.

Propagation Delay from Istanbul to Marmaris= (467,52 km) / (200.000 km/s) ≈ 0,002337 s

Propagation Delay from Marmaris to Italy = (1.389,26 km) / (200.000 km/s) ≈ 0,006946 s

Propagation Delay from Italy to Portugal= (1.897,07 km) / (200.000 km/s) ≈ 0,009485 s

Propagation Delay from Portugal to France= (1.110,37 km) / (200.000 km/s) ≈ 0,005551 s

Propagation Delay from France to GoonHilly Downs,UK=(254,07 km) / (200.000 km/s) ≈ 0,001270 s

Propagation Delay from UK to NY= (7001 km) / (200.000 km/s) ≈ 0,035005 s

Propagation Delay from NY to San Fransico= is (4.128,75 km) / (200.000 km/s) ≈ 0,020643 s

TOTAL PROPAGATION DELAY ≈ 0,081237 s

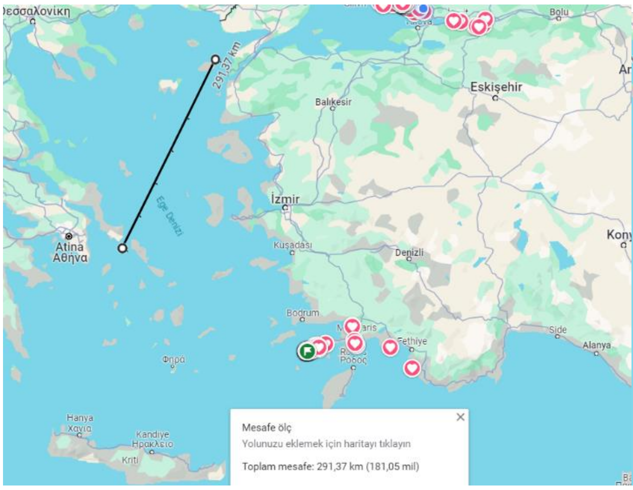
RTT= Total Delay + time needed for acknowledgment to be received by the sender.

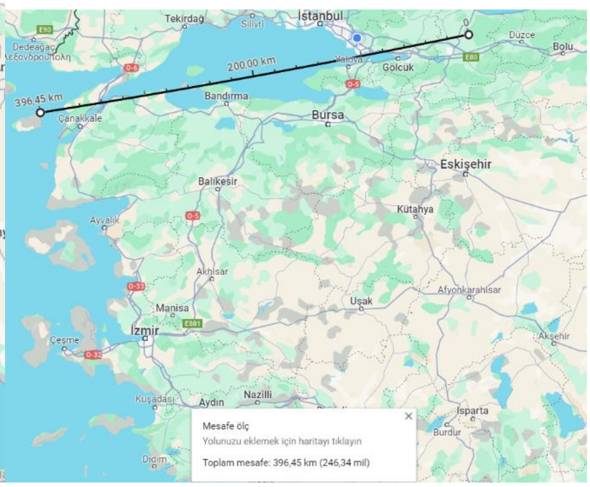
RTT = 2 x (0,081237 s) ≈ 0,162474 s = 162,474 ms (millisecond)

c)

In Q1-a I found an average RTT value of the ping command as 234 millisecond while I found RTT in Q2-b as 162,474 milisecond. The reason for that may be the actual RTT measured by ping includes the time spent in routers, switches, and other network devices, which may introduce delays. The actual network path may vary due to routing changes, affecting the measured RTT. And also the ping command measures the complete round-trip time, including the time it takes for the destination host to process the ping and process time of acknowledgment signal at the sender. These may be the reasons why I measured average RTT Q1-a higher that in Q2-b.

Q3)





Distance from my ship that is located north of Crete Island to the satellite STARLINK-5188 is 542 km. Then from this satellite to the closest satellite STARLINK-3121 there is approximately 292 km. Then from this satellite to the closest satellite STARLINK-30901 there is approximately 397 km. Then from that satellite to the Gebze ground station there is 318,8 km distance.

The total distance between source and destination is 1549,8 km.

Given the bandwidth is 50 Mbit/s we can convert this to megabytes per second (MB/s):
(50 Mbit/s) / 8= 6.25 MB/s.

Time to transfer a 1MB file: 1 MB / (6.25 MB/s) =0,16s .