

Internet Systems

6CCS3INS Coursework

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Exercise 1.

In Exercise1, I was trying to find routes to the yelp.com from KCL lab desktop. Used traceroute command with -q6 option which is increasing the numbers of probe packets per hop for making it more accurate. But I used just five results to get Average Latency. When KCL desktop is trying to go to the yelp.com, it's not a direct connection to the server, but accessed through routers. Hence, traceroute command helps to find routers of each path to determine how long access is accessed and how much speed delay is achieved at any point on the path.

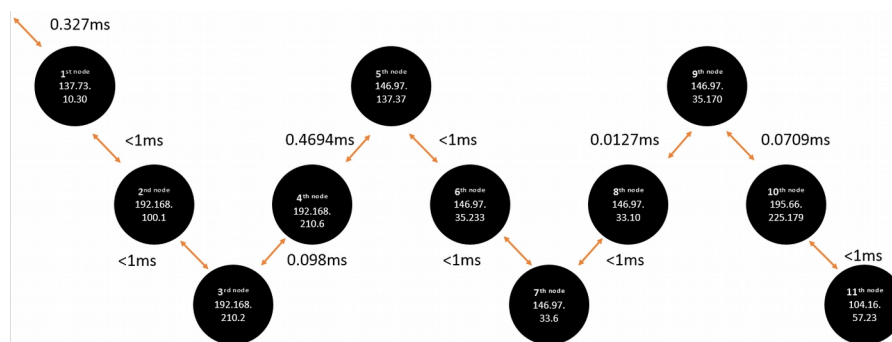
```

k1070823@nmscde000856:~$ traceroute -q6 yelp.com
traceroute to yelp.com (104.16.57.23), 30 hops max, 60 byte packets
 1 137.73.10.30 (137.73.10.30)  0.679 ms  0.738 ms  0.792 ms  0.837 ms  0.835 ms  0.881 ms
 2 192.168.100.1 (192.168.100.1)  0.348 ms  0.377 ms  0.456 ms  0.459 ms  0.455 ms  0.451 ms
 3 192.168.210.2 (192.168.210.2)  0.173 ms  0.154 ms  0.159 ms  0.156 ms  0.147 ms  0.139 ms
 4 192.168.210.6 (192.168.210.6)  0.351 ms  0.353 ms  0.329 ms  0.372 ms  0.364 ms  0.410 ms
 5 xe-5-0-0.londpg-ban1.ja.net (146.97.137.37)  1.324 ms  1.321 ms  1.314 ms  1.308 ms  1.196 ms  1.229 ms
 6 ae26.londpg-sbr2.ja.net (146.97.35.233)  0.888 ms  1.020 ms  1.006 ms  1.006 ms  0.997 ms  0.986 ms
 7 ae30.londtw-sbr2.ja.net (146.97.33.6)  1.500 ms  1.605 ms  1.539 ms  1.666 ms  1.531 ms  1.522 ms
 8 ae29.londtn-sbr1.ja.net (146.97.33.10)  1.461 ms  1.460 ms  1.458 ms  1.412 ms  1.406 ms  1.366 ms
 9 ae0.londtn-ban3.ja.net (146.97.35.170)  1.471 ms  1.464 ms  1.467 ms  1.459 ms  1.463 ms  1.451 ms
10 linux-juniper.as13335.net (195.66.225.179)  1.593 ms  1.591 ms  1.590 ms  1.631 ms  1.628 ms  1.620 ms
11 104.16.57.23 (104.16.57.23)  1.561 ms  1.503 ms  1.501 ms  1.542 ms  1.530 ms  1.532 ms
[k1070823@nmscde000856 ~]$
  
```

As a result of seeing screenshot found out that there are 11 routers to reach yelp.com from KCL lab. Also, there are routers IP information and time to arrive at each router which is called round trip time. It is time taken to return packets to host on the Internet. After getting this information, I made a summarize of the table to calculate the average latency.

	A	B	C	D	E	F	G	H	I
1		IP address	q1	q2	q3	q4	q5	Each Hop Latency	Average Hop Latency
2	1st node	137.73.10.30	0.679ms	0.738ms	0.792ms	0.837ms	0.835ms	0.327ms	0.327ms
3	2nd node	192.168.100.1	0.348ms	0.377ms	0.456ms	0.459ms	0.455ms	0.2095ms	<1ms(-0.1175)
4	3rd node	192.168.210.2	0.173ms	0.154ms	0.159ms	0.156ms	0.147ms	0.0789ms	<1ms(-0.308)
5	4th node	192.168.210.6	0.351ms	0.353ms	0.329ms	0.372ms	0.364ms	0.1769ms	0.098ms
6	5th node	146.97.137.37	1.324ms	1.321ms	1.314ms	1.308ms	1.196ms	0.6463ms	0.4694ms
7	6th node	146.97.35.233	0.888ms	1.020ms	1.006ms	1.006ms	0.997ms	0.4917ms	<1ms(-0.1546)
8	7th node	146.97.33.6	1.500ms	1.605ms	1.539ms	1.666ms	1.531ms	0.7841ms	0.2924ms
9	8th node	146.97.33.10	1.461ms	1.460ms	1.458ms	1.412ms	1.406ms	0.7197ms	<1ms(-0.0644)
10	9th node	146.97.35.170	1.471ms	1.464ms	1.467ms	1.459ms	1.463ms	0.7324ms	0.0127ms
11	10th node	195.66.225.179	1.593ms	1.591ms	1.590ms	1.631ms	1.628ms	0.8033ms	0.0709ms
12	11th node	104.16.57.23	1.561ms	1.503ms	1.501ms	1.542ms	1.530ms	0.7637ms	<1ms(-0.0396)

Based on table information, I obtained an average latency. Basically, traceroute command give information about round trip time so I need some arithmetic works to get hop latency. Hop latency is the time it takes to send a packet over a particular hop in one direction but round trip including a step which is back to the originating node. Therefore, to get hop latency, need to divide by two from the result and divide by five again(Each hop latency = $q1+q2+q3+q4+q5/2/5$). And then to get average hop latency, subtract previous latency from present latency except the first average hop latency(ex. $H3-H2 = I2$).



Exercise 2.

In exercise2, I did exactly same things in exercise1 but the different network and operating system. In exercise1, I used KCL network and Linux operating system, but in exercise2 I used Home broadband and Windows operating system.

```

C:\Program Files (x86)\Microsoft Visual Studio 14.0>tracert yelp.com

최대 30홉 이상의
yelp.com [104.16.57.23](으)로 가는 경로 추적:

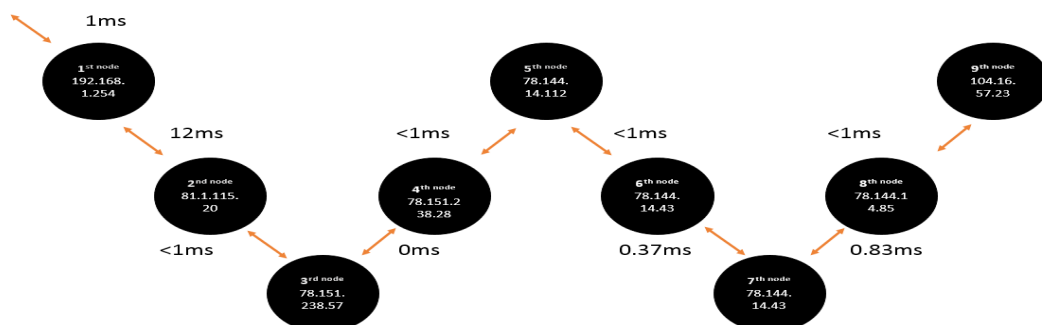
  1  1 ms    1 ms    1 ms    dsldevice.lan [192.168.1.254]
  2  28 ms   28 ms   22 ms    81.1.115.20
  3  23 ms   23 ms   25 ms    host-78-151-238-57.as13285.net [78.151.238.57]
  4  24 ms   24 ms   23 ms    host-78-151-238-28.as13285.net [78.151.238.28]
  5  24 ms   24 ms   24 ms    host-78-144-14-112.as13285.net [78.144.14.112]
  6  24 ms   23 ms   24 ms    host-78-144-14-43.as13285.net [78.144.14.43]
  7  24 ms   23 ms   26 ms    host-78-144-14-85.as13285.net [78.144.14.85]
  8  29 ms   26 ms   23 ms    host-78-144-3-117.as13285.net [78.144.3.117]
  9  23 ms   25 ms   24 ms    104.16.57.23

추적을 완료했습니다.
C:\Program Files (x86)\Microsoft Visual Studio 14.0>
  
```

Thus I used tracert command for windows which is to know paths to the destination. As a result, I knew that there are nine routers to reach yelp.com.

	B	C	D	E	F	G
1	IP address	q1	q2	q3	Each hop Latency	Average Hop Latency
2	192.168.1.254	1ms	1ms	1ms	1ms	1ms
3	81.1.115.20	28ms	28ms	22ms	13ms	12ms
4	78.151.238.57	23ms	23ms	25ms	11.8ms	<1ms(-1.17)
5	78.151.238.28	24ms	24ms	23ms	11.8ms	0ms
6	78.144.14.112	24ms	24ms	24ms	8ms	<1ms(-3.8)
7	78.144.14.43	24ms	23ms	24ms	11.8ms	3.8ms
8	78.144.14.85	24ms	23ms	26ms	12.17ms	0.37ms
9	78.144.3.177	29ms	26ms	23ms	13ms	0.83ms
10	104.16.57.23	23ms	25ms	24ms	12ms	<1ms(-1)

Thus I used tracert command for windows which is to know paths to the destination. As a result, I knew that there are nine routers to reach yelp.com. Also, I made a table to get average hope latency and did the same way when I made the previous table in exercise1. Thus divide by 2 in each round trip time and add together and divide by 3 to get each hop latency($q1+q2+q3/2/3$ =each hop latency).And then to get average hop latency subtract previous hop latency from present hop latency(ex. $F3-F2 = G2$).



Exercise 3

In exercise3, repeated exercises 1 and 2 at a different time of day. Therefore I did in Morning(10:30), afternoon(14:30), evening(17:00). In this test, I noticed that all router has different round trip time and latencies in the different time. Normally 10th node was the latest router in KCL network in 6th of November. However, traceroute can vary by many causes, such as the state of the server and number of time zone users. Also I knew that KCL network is round trip time is much less than my home network.

-Exercise3 for 6th of november morning 10:30 in KCL network-

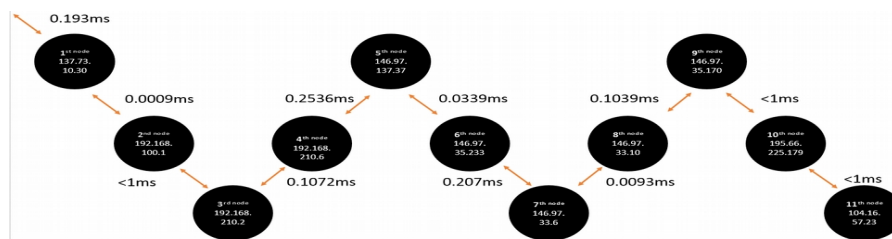
-Screenshot of traceroute command in KCL-

```
k1070823@nmscde000856:~$ traceroute -q6 yelp.com
traceroute to yelp.com (104.16.56.23), 30 hops max, 60 byte packets
 1 137.73.10.30 (137.73.10.30)  0.318 ms  0.380 ms  0.378 ms  0.428 ms  0.425 ms  0.600 ms
 2 192.168.100.1 (192.168.100.1)  0.353 ms  0.351 ms  0.397 ms  0.395 ms  0.449 ms  0.445 ms
 3 192.168.210.2 (192.168.210.2)  0.221 ms  0.213 ms  0.211 ms  0.194 ms  0.127 ms  0.121 ms
 4 192.168.210.6 (192.168.210.6)  0.471 ms  0.460 ms  0.335 ms  0.379 ms  0.393 ms  0.355 ms
 5 xe-5-0-0.londpg-ban1.ja.net (146.97.137.37)  0.925 ms  0.925 ms  0.912 ms  0.916 ms  0.909 ms  0.956 ms
 6 ae26.londpg-sbr2.ja.net (146.97.35.233)  0.953 ms  0.951 ms  1.005 ms  1.004 ms  1.000 ms  1.034 ms
 7 ae30.londtw-sbr2.ja.net (146.97.33.6)  1.423 ms  1.402 ms  1.391 ms  1.380 ms  1.387 ms  1.375 ms
 8 ae29.londtn-sbr1.ja.net (146.97.33.10)  1.418 ms  1.417 ms  1.415 ms  1.423 ms  1.403 ms  1.402 ms
 9 ae0.londtn-ban3.ja.net (146.97.35.170)  1.586 ms  1.657 ms  1.578 ms  1.649 ms  1.645 ms  1.570 ms
10 linx-juniper.as13335.net (195.66.225.179)  1.558 ms  1.554 ms  1.544 ms  1.586 ms  1.575 ms  1.565 ms
11 104.16.56.23 (104.16.56.23)  1.557 ms  1.574 ms  1.565 ms  1.544 ms  1.575 ms  1.566 ms
```

-Table of how I get the average latency-

	A	B	C	D	E	F	G	H	I
		IP address	q1	q2	q3	q4	q5	Each Hop Latency	Average Hop Latency
1	1st node	137.73.10.30	0.318ms	0.380ms	0.378ms	0.428ms	0.425ms	0.193ms	0.193ms
2	2nd node	192.168.100.1	0.353ms	0.351ms	0.397ms	0.395ms	0.449ms	0.1939ms	0.0009ms
3	3rd node	192.168.210.2	0.221ms	0.213ms	0.211ms	0.194ms	0.127ms	0.0966ms	<1ms(-0.0973)
4	4th node	192.168.210.6	0.471ms	0.460ms	0.335ms	0.379ms	0.393ms	0.2038ms	0.1072ms
5	5th node	146.97.137.37	0.925ms	0.912ms	0.916ms	0.912ms	0.909ms	0.4574ms	0.2536ms
6	6th node	146.97.35.233	0.953ms	0.951ms	1.005ms	1.004ms	1ms	0.4913ms	0.0339ms
7	7th node	146.97.33.6	1.423ms	1.402ms	1.391ms	1.380ms	1.387ms	0.6983ms	0.207ms
8	8th node	146.97.33.10	1.418ms	1.417ms	1.415ms	1.423ms	1.403ms	0.7076ms	0.0093ms
9	9th node	146.97.35.170	1.586ms	1.657ms	1.578ms	1.649ms	1.645ms	0.8115ms	0.1039ms
10	10th node	195.66.225.179	1.558ms	1.554ms	1.544ms	1.586ms	1.575ms	0.7817ms	<1ms(-0.0298)
11	11th node	104.16.57.23	1.557ms	1.574ms	1.565ms	1.544ms	1.575ms	0.7815ms	<1ms(-0.0002)

-Diagram of the route with average latency-



-Exercise3 for 6th of november morning 14:30 in KCL network-

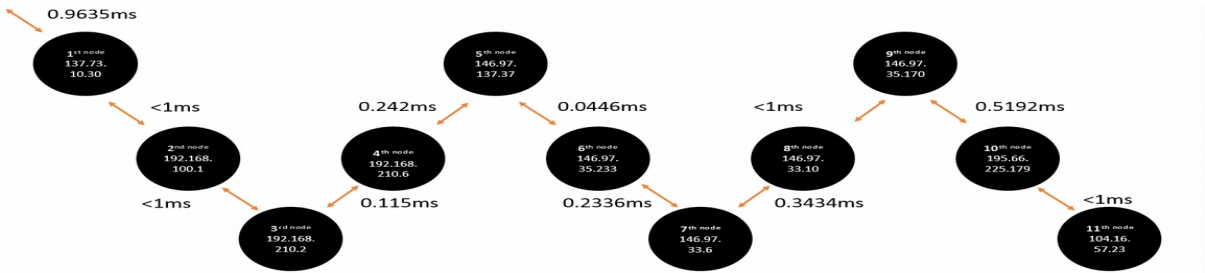
-Screenshot of traceroute command in KCL-

```
k1070823@nmscde000856:~$ traceroute -q5 yelp.com
traceroute to yelp.com (104.16.57.23), 30 hops max, 60 byte packets
 1 137.73.10.30 (137.73.10.30)  1.870 ms  1.910 ms  1.905 ms  1.955 ms  1.995 ms
 2 192.168.100.1 (192.168.100.1)  0.325 ms  0.367 ms  0.364 ms  0.416 ms  0.411 ms
 3 192.168.210.2 (192.168.210.2)  0.158 ms  0.147 ms  0.153 ms  0.145 ms  0.141 ms
 4 192.168.210.6 (192.168.210.6)  0.380 ms  0.364 ms  0.407 ms  0.348 ms  0.395 ms
 5 xe-5-0-0.londpg-ban1.ja.net (146.97.137.37)  0.873 ms  0.910 ms  0.865 ms  0.857 ms  0.809 ms
 6 ae26.londpg-sbr2.ja.net (146.97.35.233)  0.941 ms  0.933 ms  0.974 ms  0.960 ms  0.952 ms
 7 ae30.londtw-sbr2.ja.net (146.97.33.6)  1.356 ms  1.362 ms  1.512 ms  1.437 ms  1.429 ms
 8 ae29.londtn-sbr1.ja.net (146.97.33.10)  1.361 ms  1.371 ms  4.903 ms  1.416 ms  1.459 ms
 9 ae0.londtn-ban3.ja.net (146.97.35.170)  1.403 ms  1.412 ms  1.477 ms  1.471 ms  1.465 ms
10 linx-juniper.as13335.net (195.66.225.179)  6.088 ms  1.531 ms  1.589 ms  1.586 ms  1.626 ms
11 104.16.57.23 (104.16.57.23)  1.506 ms  1.561 ms  1.561 ms  1.554 ms  1.545 ms
```

-Table of how I get the average latency-

	A	B	C	D	E	F	G	H	I
1		IP address	q1	q2	q3	q4	q5	Each Hop Latency	Average Hop Latency
2	1st node	137.73.10.30	1.870ms	1.910ms	1.905ms	1.955ms	1.995ms	0.9635ms	0.9635ms
3	2nd node	192.168.100.1	0.325ms	0.367ms	0.364ms	0.416ms	0.411ms	0.1883ms	<1ms(-0.7752)
4	3rd node	192.168.210.2	0.158ms	0.147ms	0.153ms	0.145ms	0.141ms	0.0744ms	<1ms(-0.1139)
5	4th node	192.168.210.6	0.380ms	0.364ms	0.407ms	0.348ms	0.395ms	0.1894ms	0.115ms
6	5th node	146.97.137.37	0.873ms	0.910ms	0.865ms	0.857ms	0.809ms	0.4314ms	0.242ms
7	6th node	146.97.35.233	0.941ms	0.933ms	0.974ms	0.960ms	0.952ms	0.476ms	0.0446ms
8	7th node	146.97.33.6	1.356ms	1.362ms	1.512ms	1.437ms	1.429ms	0.7076ms	0.2336ms
9	8th node	146.97.33.10	1.361ms	1.371ms	4.903ms	1.416ms	1.459ms	1.051ms	0.3434ms
10	9th node	146.97.35.170	1.403ms	1.412ms	1.477ms	1.471ms	1.465ms	0.7228ms	<1ms(-0.3282)
11	10th node	195.66.225.179	6.088ms	1.531ms	1.589ms	1.586ms	1.626ms	1.242ms	0.5192ms
12	11th node	104.16.57.23	1.506ms	1.561ms	1.561ms	1.554ms	1.545ms	0.7727ms	<1ms(-0.4693)

-Diagram of the route with average latency-



-Exercise3 for 6th of november morning 17:00 in KCL network-

-Screenshot of traceroute command in KCL

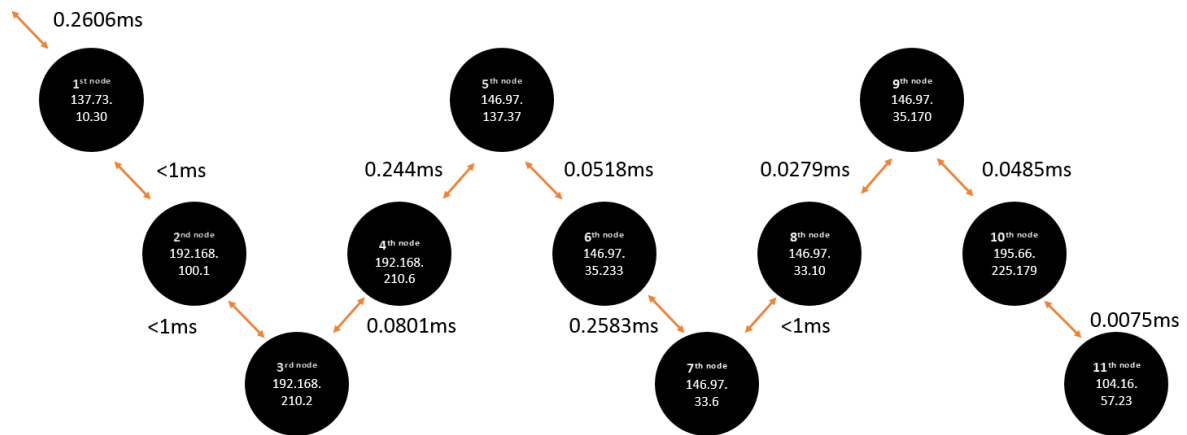
```

k1070823@nmscde000856:~
File Edit View Search Terminal Help
[k1070823@nmscde000856 ~]$ traceroute -q5 yelp.com
traceroute to yelp.com (104.16.56.23), 30 hops max, 60 byte packets
 1 137.73.10.30 (137.73.10.30) 0.448 ms 0.463 ms 0.556 ms 0.552 ms 0.587 ms
 2 192.168.100.1 (192.168.100.1) 0.374 ms 0.369 ms 0.354 ms 0.385 ms 0.432 ms
 3 192.168.210.2 (192.168.210.2) 0.240 ms 0.229 ms 0.217 ms 0.191 ms 0.198 ms
 4 192.168.210.6 (192.168.210.6) 0.276 ms 0.385 ms 0.430 ms 0.394 ms 0.391 ms
 5 xe-5-0-0.londpg-ban1.ja.net (146.97.137.37) 0.823 ms 0.883 ms 0.874 ms 0.870 ms 0.866 ms
 6 ae26.londpg-sbr2.ja.net (146.97.35.233) 1.020 ms 0.963 ms 1.007 ms 0.926 ms 0.918 ms
 7 ae30.londtw-sbr2.ja.net (146.97.33.6) 1.477 ms 1.479 ms 1.529 ms 1.468 ms 1.464 ms
 8 ae29.londtn-sbr1.ja.net (146.97.33.10) 1.453 ms 1.449 ms 1.396 ms 1.389 ms 1.381 ms
 9 ae0.londtn-ban3.ja.net (146.97.35.170) 1.495 ms 1.493 ms 1.482 ms 1.480 ms 1.397 ms
10 linx-juniper.asl3335.net (195.66.225.179) 1.547 ms 1.585 ms 1.577 ms 1.569 ms 1.554 ms
11 104.16.56.23 (104.16.56.23) 1.559 ms 1.550 ms 1.605 ms 1.600 ms 1.593 ms
[k1070823@nmscde000856 ~]$
  
```

-Table of how I get the average latency-

	A	B	C	D	E	F	G	H	I
1		IP address	q1	q2	q3	q4	q5	Each Hop Latency	Average Hop Latency
2	1st node	137.73.10.30	0.448ms	0.463ms	0.556ms	0.552ms	0.587ms	0.2606ms	0.2606ms
3	2nd node	192.168.100.1	0.374ms	0.369ms	0.354ms	0.385ms	0.432ms	0.1914ms	<1ms(-0.0692)
4	3rd node	192.168.210.2	0.240ms	0.229ms	0.217ms	0.191ms	0.198ms	0.1075ms	<1ms(-0.0839)
5	4th node	192.168.210.6	0.276ms	0.385ms	0.430ms	0.394ms	0.391ms	0.1876ms	0.0801ms
6	5th node	146.97.137.37	0.823ms	0.883ms	0.874ms	0.870ms	0.866ms	0.4316ms	0.244ms
7	6th node	146.97.35.233	1.020ms	0.963ms	1.007ms	0.926ms	0.918ms	0.4834ms	0.0518ms
8	7th node	146.97.33.6	1.477ms	1.479ms	1.529ms	1.468ms	1.464ms	0.7417ms	0.2583ms
9	8th node	146.97.33.10	1.453ms	1.449ms	1.396ms	1.389ms	1.381ms	0.7068ms	<1ms(-0.0349)
10	9th node	146.97.35.170	1.495ms	1.493ms	1.482ms	1.480ms	1.397ms	0.7347ms	0.0279ms
11	10th node	195.66.225.179	1.547ms	1.585ms	1.577ms	1.569ms	1.554ms	0.7832ms	0.0485ms
12	11th node	104.16.57.23	1.559ms	1.550ms	1.605ms	1.600ms	1.593ms	0.7907ms	0.0075ms

-Diagram of the route with average latency-



-Exercise3 for 7th of november morning 10:30 in Home network-

-Screenshot of tracert command in Home-

```

Developer Command Prompt for VS2015
C:\Program Files (x86)\Microsoft Visual Studio 14.0>tracert yelp.com

최대 30홉 이상의
yelp.com [104.16.56.23](으)로 가는 경로 추적:

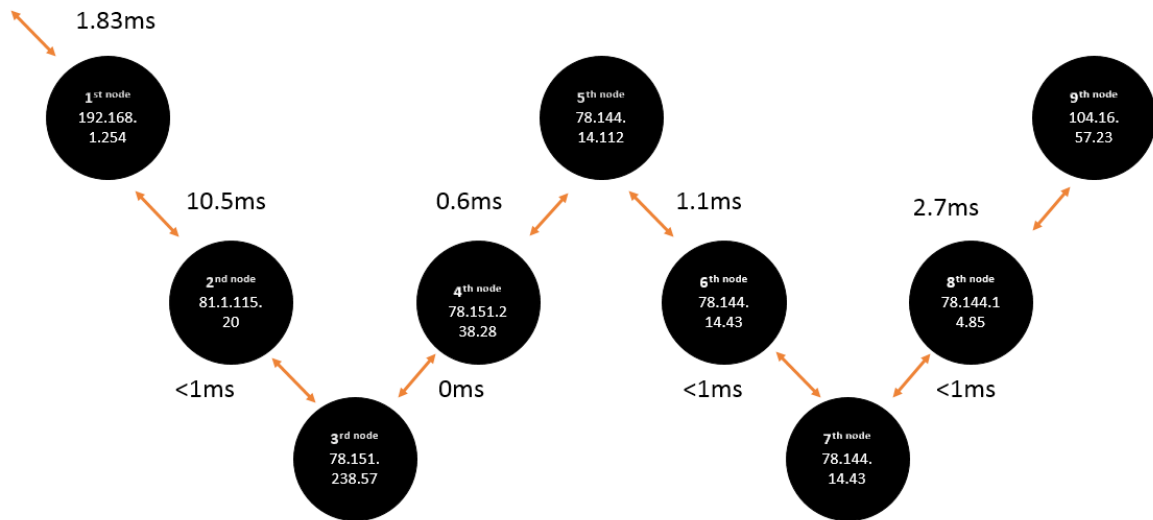
  1    8 ms    1 ms    2 ms    dsldevice.lan [192.168.1.254]
  2   49 ms   22 ms   23 ms    81.1.115.20
  3   23 ms   23 ms   23 ms    host-78-151-238-57.as13285.net [78.151.238.57]
  4   23 ms   23 ms   23 ms    host-78-151-238-44.as13285.net [78.151.238.44]
  5   27 ms   23 ms   23 ms    host-78-144-14-114.as13285.net [78.144.14.114]
  6   24 ms   27 ms   29 ms    host-78-144-14-43.as13285.net [78.144.14.43]
  7   23 ms   23 ms   23 ms    host-78-144-14-57.as13285.net [78.144.14.57]
  8   24 ms   24 ms   23 ms    host-78-144-3-117.as13285.net [78.144.3.117]
  9   34 ms   30 ms   23 ms    104.16.56.23

추적을 완료했습니다.
  
```

-Table of how I get the average latency-

	B	C	D	E	F	G
1	IP address	q1	q2	q3	Each hop Latency	Average Hop Latency
2	192.168.1.254	8ms	1ms	2ms	1.83ms	1.83ms
3	81.1.115.20	29ms	22ms	23ms	12.3ms	10.5ms
4	78.151.238.57	23ms	23ms	23ms	11.5ms	<1ms(-0.8)
5	78.151.238.28	23ms	23ms	23ms	11.5ms	0ms
6	78.144.14.112	27ms	23ms	23ms	12.2ms	0.6ms
7	78.144.14.43	24ms	27ms	29ms	13.3ms	1.1ms
8	78.144.14.85	23ms	23ms	23ms	11.5ms	<1ms(-1.8)
9	78.144.3.177	24ms	24ms	23ms	11.8ms	<1ms(0.3)
10	104.16.57.23	34ms	30ms	23ms	14.5ms	2.7ms

-Diagram of the route with average latency-



-Exercise3 for 7th of november morning 14:30 in Home network-

-Screenshot of tracert command in Home-

```

C:\Program Files (x86)\Microsoft Visual Studio 14.0>tracert yelp.com

최대 30홉 이상의
yelp.com [104.16.57.23](으)로 가는 경로 추적:

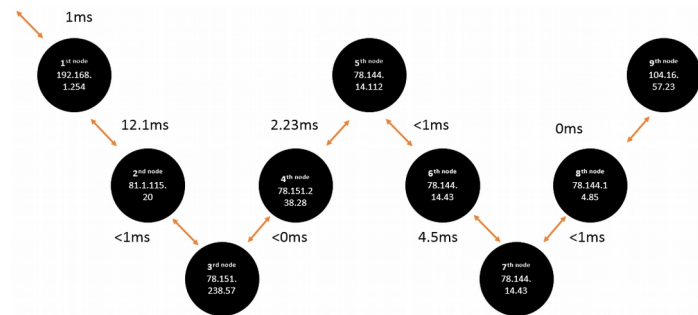
  1    1 ms    <1 ms    1 ms    dsldevice.lan [192.168.1.254]
  2   25 ms   23 ms   31 ms    81.1.115.20
  3   24 ms   23 ms   23 ms    host-78-151-238-57.as13285.net [78.151.238.57]
  4   24 ms   23 ms   23 ms    host-78-151-238-28.as13285.net [78.151.238.28]
  5   33 ms   25 ms   25 ms    host-78-144-14-112.as13285.net [78.144.14.112]
  6   23 ms   24 ms   25 ms    host-78-144-14-43.as13285.net [78.144.14.43]
  7   39 ms   24 ms   36 ms    host-78-144-14-85.as13285.net [78.144.14.85]
  8   24 ms   23 ms   23 ms    host-78-144-3-117.as13285.net [78.144.3.117]
  9   24 ms   23 ms   23 ms    104.16.57.23

추적을 완료했습니다.
  
```

-Table of how I get the average latency-

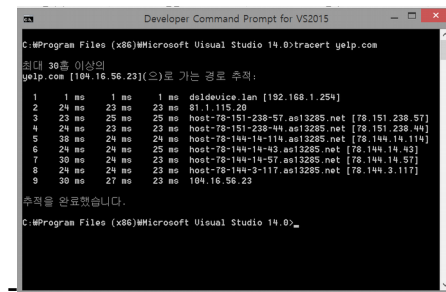
	B	C	D	E	F	G
1	IP address	q1	q2	q3	Each hop Latency	Average Hop Latency
2	192.168.1.254	1ms	1ms	1ms	1ms	1ms
3	81.1.115.20	25ms	23ms	31ms	13.1ms	12.1ms
4	78.151.238.57	24ms	23ms	23ms	11.6ms	<1ms(-1.5)
5	78.151.238.28	24ms	23ms	23ms	11.6ms	0ms
6	78.144.14.112	33ms	25ms	25ms	13.8ms	2.23ms
7	78.144.14.43	23ms	24ms	25ms	12ms	<1ms(-1.8)
8	78.144.14.85	39ms	24ms	36ms	16.5ms	4.5ms
9	78.144.3.177	24ms	23ms	23ms	11.6ms	<1ms(-4.9)
10	104.16.57.23	24ms	23ms	23ms	11.6ms	0ms

-Diagram of the route with average latency-



-Exercise3 for 7th of november morning 17:00 in Home network-

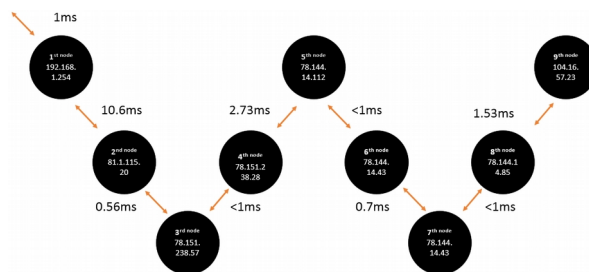
-Screenshot of tracer command in Home-



-Table of how I get the average latency-

	B	C	D	E	F	G
1	IP address	q1	q2	q3	Each hop Latency	Average Hop Latency
2	192.168.1.254	1ms	1ms	1ms	1ms	1ms
3	81.1.115.20	24ms	23ms	23ms	11.6ms	10.6ms
4	78.151.238.57	23ms	25ms	25ms	12.1ms	0.56ms
5	78.151.238.28	24ms	23ms	23ms	11.6ms	<1ms(-0.5)
6	78.144.14.112	38ms	24ms	24ms	14.3ms	2.73ms
7	78.144.14.43	24ms	24ms	25ms	12.1ms	<1ms(-2.1)
8	78.144.14.85	30ms	24ms	23ms	12.8ms	0.7ms
9	78.144.3.177	24ms	24ms	23ms	11.8ms	<1ms(-0.9ms)
10	104.16.57.23	30ms	27ms	23ms	13.3ms	1.53ms

-Diagram of the route with average latency-



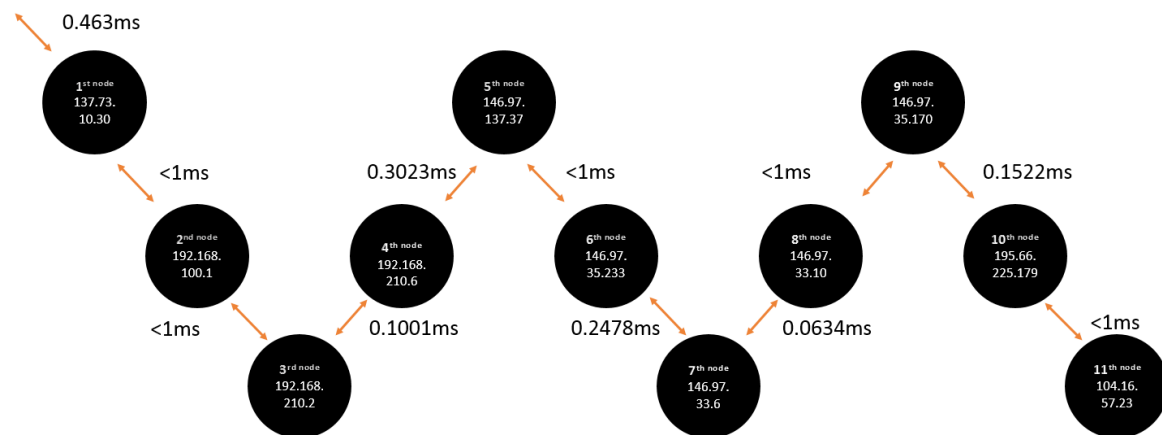
Exercise 4

To combine all diagrams, I have to calculate total latency and average latency again. Hence I add all average latencies from previous work and divide by four. The reason for divide by four is that I have four results. (Total latency(G),=section C+D+E+F, Average Latency(H) = Section (G)/4)

-table for how I combine all nodes and calculate average latency for KCL network-

	A	B	C	D	E	F	G	H
1		IP address	5/11 Sat	6/11 Sun Mor	6/11 Sun Aft	6/11 Sun Eve	total laency	Average Latency
2	1st node	137.73.10.30	0.327ms	0.193ms	0.9635ms	0.2606ms	1.7441ms	0.4360ms
3	2nd node	192.168.100.1	<1ms(-0.1175)	0.0009ms	<1ms(-0.7752)	<1ms(-0.0692)	<1ms(-0.961)	<1ms(-0.2402)
4	3rd node	192.168.210.2	<1ms(-0.308)	<1ms(-0.0973)	<1ms(-0.1139)	<1ms(-0.0839)	<1ms(-0.6031)	<1ms(-0.1508)
5	4th node	192.168.210.6	0.098ms	0.1072ms	0.115ms	0.0801ms	0.4003ms	0.1001ms
6	5th node	146.97.137.37	0.4694ms	0.2536ms	0.242ms	0.244ms	1.209ms	0.3023ms
7	6th node	146.97.35.233	<1ms(-0.1546)	0.0339ms	0.0446ms	0.0518ms	<1ms(-0.0243)	<1ms(-0.006)
8	7th node	146.97.33.6	0.2924ms	0.207ms	0.2336ms	0.2583ms	0.9913ms	0.2478ms
9	8th node	146.97.33.10	<1ms(-0.0644)	0.0093ms	0.3434ms	<1ms(-0.0349)	0.2534ms	0.0634ms
10	9th node	146.97.35.170	0.0127ms	0.1039ms	<1ms(-0.3282)	0.0279ms	<1ms(-0.1837)	<1ms(-0.0459)
11	10th node	195.66.225.179	0.0709ms	<1ms(-0.0298)	0.5192ms	0.0485ms	0.6088ms	0.1522ms
12	11th node	104.16.57.23	<1ms(-0.0396)	<1ms(-0.0002)	<1ms(0.4693)	0.0075ms	<1ms(-0.5016)	<1ms(0.1254)

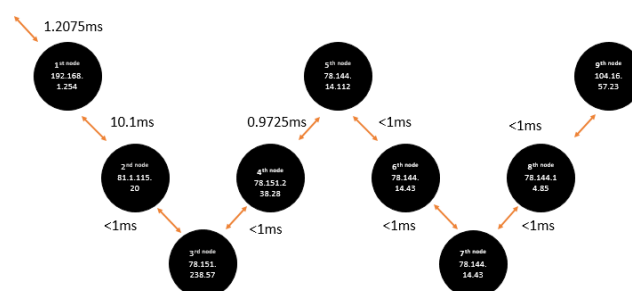
-combined diagram for kcl network-



-table for how I combine all nodes and calculate average latency for Home network-

	B	C	D	E	F	G	H
1	IP address	5/11 Sat	7/11 Mon Mor	7/11 Mon Aft	7/11 Mon Eve	Total Latency	Average Hop Latency
2	192.168.1.254	1ms	1.83ms	1ms	1ms	1.2075ms	1.2075ms
3	81.1.115.20	12ms	10.5ms	12.1ms	10.6ms	11.3ms	10.1ms
4	78.151.238.57	<1ms(-1.17)	<1ms(-0.8)	<1ms(-1.5)	0.56ms	<1ms(-2.91)	<1ms(8.39)
5	78.151.238.28	0ms	0ms	0ms	<1ms(-0.5)	<1ms(-0.125)	<1ms(-3.035)
6	78.144.14.112	<1ms(-1.17)	0.6ms	2.23ms	2.73ms	1.0975ms	0.9725ms
7	78.144.14.43	3.8ms	1.1ms	<1ms(-1.8)	<1ms(-2.1)	1ms	<1ms(-0.0975)
8	78.144.14.85	0.37ms	<1ms(-1.8)	4.5ms	0.7ms	0.9425ms	<1ms(0.0575)
9	78.144.3.177	0.83ms	<1ms(0.3)	<1ms(-4.9)	<1ms(0.9ms)	<1ms(-5.27)	<1ms(-6.2125)
10	104.16.57.23	<1ms(-1)	2.7ms	0ms	1.53ms	3.23ms	<1ms(-2.04)

-combined diagram for Home network-



Exercise 5

To find out maximum transmission unit, I used ping command with options. Ping is a command that checks the amount of time of a certain amount of data sent to the server and checking for a particular interval of time. So sending “ECHO_REQUEST” datagram to the host or gateway and receive the “ICMP ECHO RESPONSE”. Hence tried ping method and found out my default value of the maximum transmission unit is 1500 and actual maximum value is 1472. The rest 28 amounts are for 20 bytes for IP header and 8 bytes for ICMP header. So as we can see in the screenshot, the value of 1473 is not working, but an amount of 1472 can be sent to the yelp.com.

```
k1070823@nmscde000817:~$ ping -M do -s 1473 yelp.com
PING yelp.com (104.16.57.23) 1473(1501) bytes of data.
ping: local error: Message too long, mtu=1500
ping: local error: Message too long, mtu=1500
ping: local error: Message too long, mtu=1500
^C
--- yelp.com ping statistics ---
3 packets transmitted, 0 received, +3 errors, 100% packet loss, time 1999ms

k1070823@nmscde000817:~$ ping -M do -s 1472 yelp.com
PING yelp.com (104.16.56.23) 1472(1500) bytes of data.
1480 bytes from 104.16.56.23: icmp_seq=1 ttl=54 time=1.71 ms
1480 bytes from 104.16.56.23: icmp_seq=2 ttl=54 time=1.78 ms
1480 bytes from 104.16.56.23: icmp_seq=3 ttl=54 time=1.75 ms
^C
--- yelp.com ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2003ms
rtt min/avg/max/ndev = 1.715/1.750/1.780/0.055 ms
k1070823@nmscde000817:~$
```

Exercise 6.

exercise6 is about to find out command option of the maximum number of hops and value. thus I used -m option which specifies the maximum number of hops which is 255.

```
k1070823@nmscde000817:~$ traceroute -q 5 -m 255 yelp.com
traceroute to yelp.com (104.16.57.23), 255 hops max, 60 byte packets
 1 137.73.10.30 (137.73.10.30) 0.346 ms 0.338 ms 0.415 ms 0.400 ms 0.447 ms
 2 192.168.100.1 (192.168.100.1) 0.301 ms 0.378 ms 0.377 ms 0.376 ms 0.415 ms
 3 192.168.210.2 (192.168.210.2) 0.156 ms 0.160 ms 0.166 ms 0.152 ms 0.149 ms
 4 192.168.210.6 (192.168.210.6) 0.311 ms 0.345 ms 0.403 ms 0.401 ms 0.388 ms
 5 xe-5-0-0.londpg-ban1.ja.net (146.97.137.37) 0.850 ms 0.844 ms 0.902 ms 0.835 ms 0.835 ms
 6 ae26.londpg-sbr2.ja.net (146.97.35.233) 1.108 ms 1.100 ms 1.097 ms 1.085 ms 1.090 ms
 7 ae30.londtw-sbr2.ja.net (146.97.33.6) 1.578 ms 1.571 ms 1.559 ms 1.545 ms 1.546 ms
 8 ae29.londtn-sbr1.ja.net (146.97.33.10) 1.547 ms 1.549 ms 1.532 ms 1.528 ms 1.511 ms
 9 ae0.londtn-ban3.ja.net (146.97.35.170) 1.500 ms 1.605 ms 1.581 ms 1.585 ms 1.577 ms
10 linx-juniper.as13335.net (195.66.225.179) 3.691 ms 1.600 ms 2.302 ms 1.580 ms 1.576 ms
11 104.16.57.23 (104.16.57.23) 1.564 ms 1.556 ms 1.546 ms 1.548 ms 1.546 ms
k1070823@nmscde000817:~$ traceroute -q 5 -m 256 yelp.com
max hops cannot be more than 255
k1070823@nmscde000817:~$
```

The reason of this is Time to live(TTL) field is one byte in the datagram. 1 byte is equal to 8bit in decimal number, so maximum value is going to be two to the power of eight which is 256. Hence when packet hops TTL value decrease each time when moving to next hop, so maximum value of the TTL value is 255.

