PROJECT B

Internet Technologies

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SECTION 2.1

Sol2.1.

We used tracert –dw1 <servername> for windows to trace the route of packets in a network to the server. The following parameters were used to speed up the process:

-n or –d(windows) : This option stands for do not resolve and is to disable the mapping of addresses to a host name thus speeding up the traceroute process removing the overhead of host name mapping

-w : This option is used to configure the response time i.e the utility waits for the time specified next to w for a response to ICMP packets, by default it is 3 sec. When we set it to 1 sec the utility waits for a lower time for response thus speeding up the process.

[1]

Sol2.2.

Server Name	Server Location	IP Address	Total Hop Count	Geographical Distance
ping.online.net	France	62.210.18.40	22	15,180.27
iperf.ips.versatel.de	Germany	212.93.6.52	20	14,779.98
iperf.comneonext.de	Germany	85.25.140.156	25	14,670.54
iperf-verne.okhysing.is	Iceland	122.150.5.20	8	15,339.76
st2.nn.ertelecom.ru	Russia	91.144.184.232	19	13,224.04
iperf.lan.kth.se	Sweden	130.237.0.218	26	14,101.04
iperf.xmission.com	USA	198.60.22.20	16	13,997.22
iperf.securityinspection.com	USA	205.251.184.27	25	16,342.42
iperf.nersc.gov	USA	128.55.80.8	21	13,051.07
iperf.he.net	USA	216.218.227.10	17	13,030.73
iperf.scottlinux.com	USA	173.230.156.66	15	17,142.79
iperf.volia.net	France	82.144.193.18	26	15,180.27
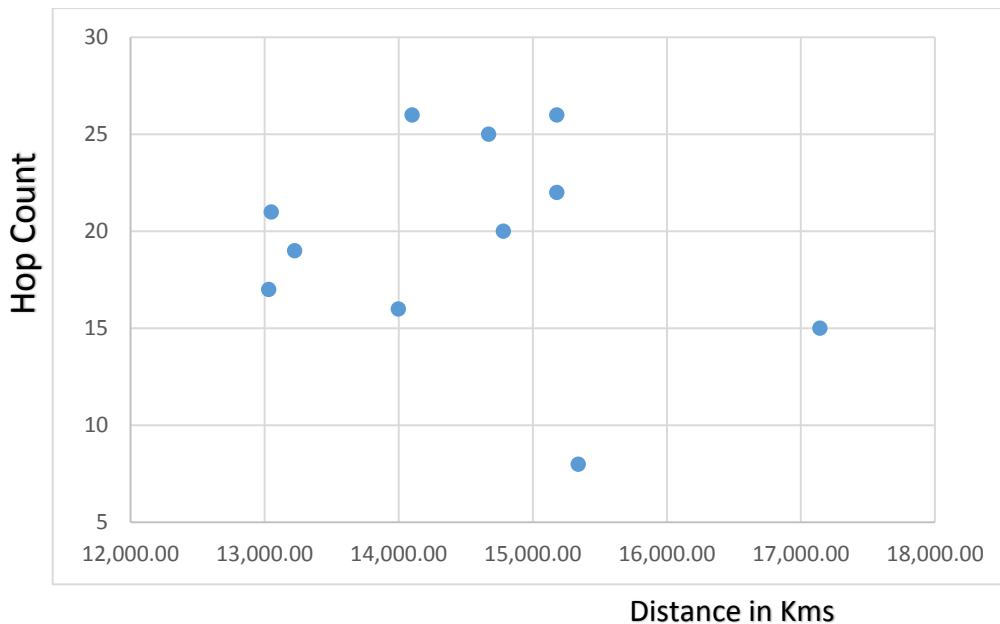
There is no direct correlation between hop count and geographical distance or maybe a weak one because there can be different hop count for a similar physical distance. This is mainly because routes may go over ATM tunnels which achieve transmission over large distance in a single hop or the packet could be bounced around in an ADSL network among quite a few hosts before it reaches its destination.

I have decided to include request time outs also as hop count. These packets might have been dropped by a particular host since ICMP packets take a low priority in a lot of networks as they networks want to provide bandwidth to actual users and network traffic, also sometimes these are blocked by firewalls to prevent DDOS attempts and hence re-routed through a different host.

[2]

SECTION 3.1

Sol3.1. User facing implications of high jitter and high delay:

1. Voice over IP: While sending voice over the internet – audio is digitized and converted to packets and transmitted over the network. A large amount of delay can cause synchronization issues. Also, jitter (variation of packets received) are controlled by jitter buffers but variation over 100ms causes drop in packets and replaced by a tone which can cause irritation and communication disruptions.[3]
2. Video Conferencing: Delay in video conferencing over 150 ms can cause an effect which seems that people are speaking over each other rendering communication unintelligible. Jitter renders packets being dropped in video conferencing and might cause the image to be stuck for some millisecond.[4]
3. Real Time Gaming – Games like Dota and CounterStrike which rely on player reflexes to anticipate other players moves and game environment changes , even a little delay and jitter renders the game unplayable and is often termed as "LAG".

Sol.3.2.

Server Name	Server Location	Delay 1 (ms)	Delay 2 (ms)	Delay 3 (ms)	Average Delay (ms)	Jitter (Standard Dev)(ms)	Geographical Distance (km)
ping.online.net	France	337	336	336	336.33	0.47	15,180.27
iperf.ips.versatel.de	Germany	338	341	340	339.67	1.25	14,779.98
iperf.comneonext.de	Germany	333	332	334	333.00	0.82	14,670.54
st2.nn.ertelecom.ru	Russia	389	390	381	386.67	4.03	13,224.04
iperf.lan.kth.se	Sweden	352	348	348	349.33	1.89	14,101.04
iperf.xmission.com	USA	198	198	196	197.33	0.94	13,997.22
iperf.securityinspection.com	USA	293	293	296	294.00	1.41	16,342.42
iperf.nersc.gov	USA	193	193	196	194.00	1.41	13,051.07
iperf.he.net	USA	246	250	247	247.67	1.70	13,030.73
iperf.scottlinux.com	USA	179	180	179	179.33	0.47	17,142.79
iperf.volia.net	France	366	367	364	365.67	1.25	15,180.27

3
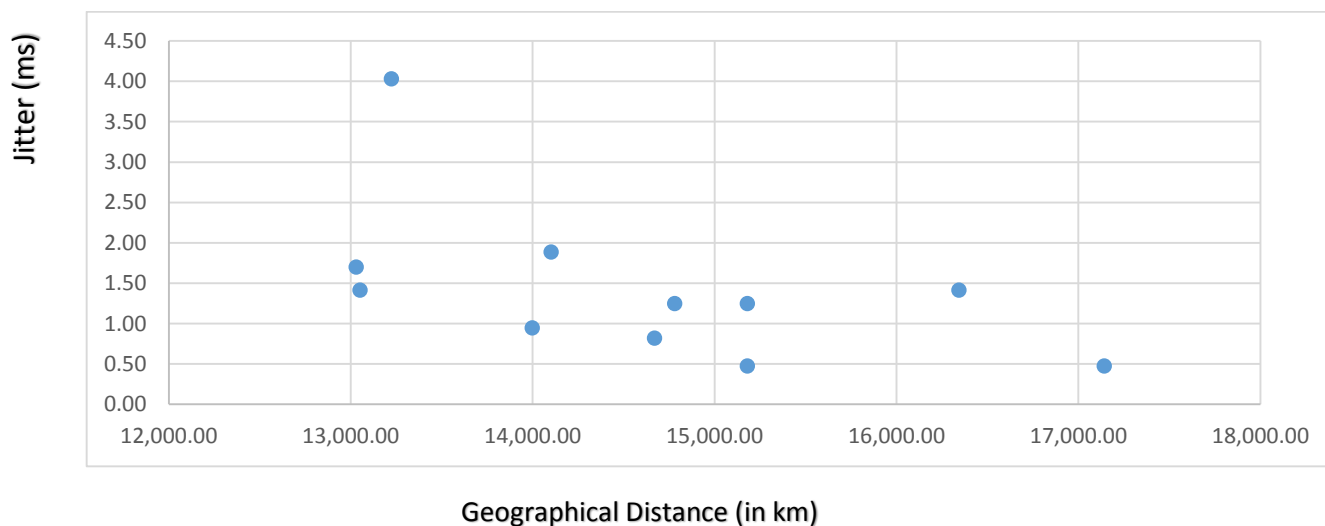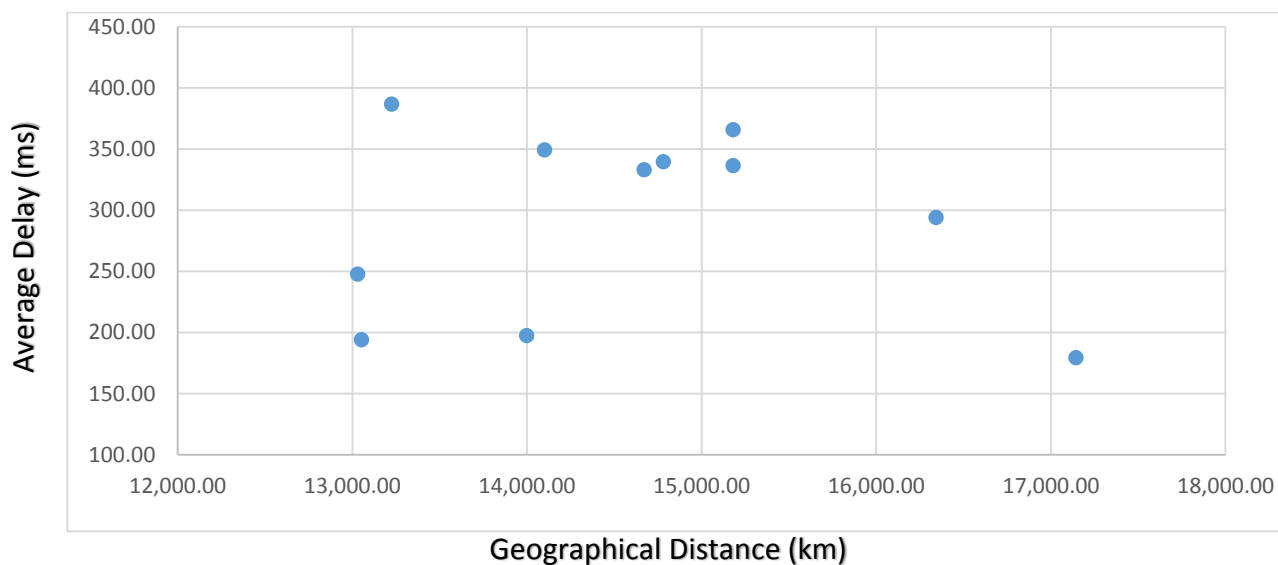
In addition to this I performed an independent test on 9 servers through pingtest.net to correlate delay and jitter with distance, this time taking closer servers in Australia in comparison to servers all around the world

SERVER_NAME	Delay (ms)	JITTER (ms)	DISTANCE_MILES
Adelaide	37	9	400
Perth	60	3	1700
Brisbane	50	3	850
Nairobi	508	36	7150
New York, NY	328	97	10350
Ho Chi Minh City	173	4	4150
Almaty	526	70	7050
Budapest	343	2	9700
Sevilla	353	17	10850

Delay (in ms) vs Distance (miles)

Jitter (ms) vs Distance (in miles)
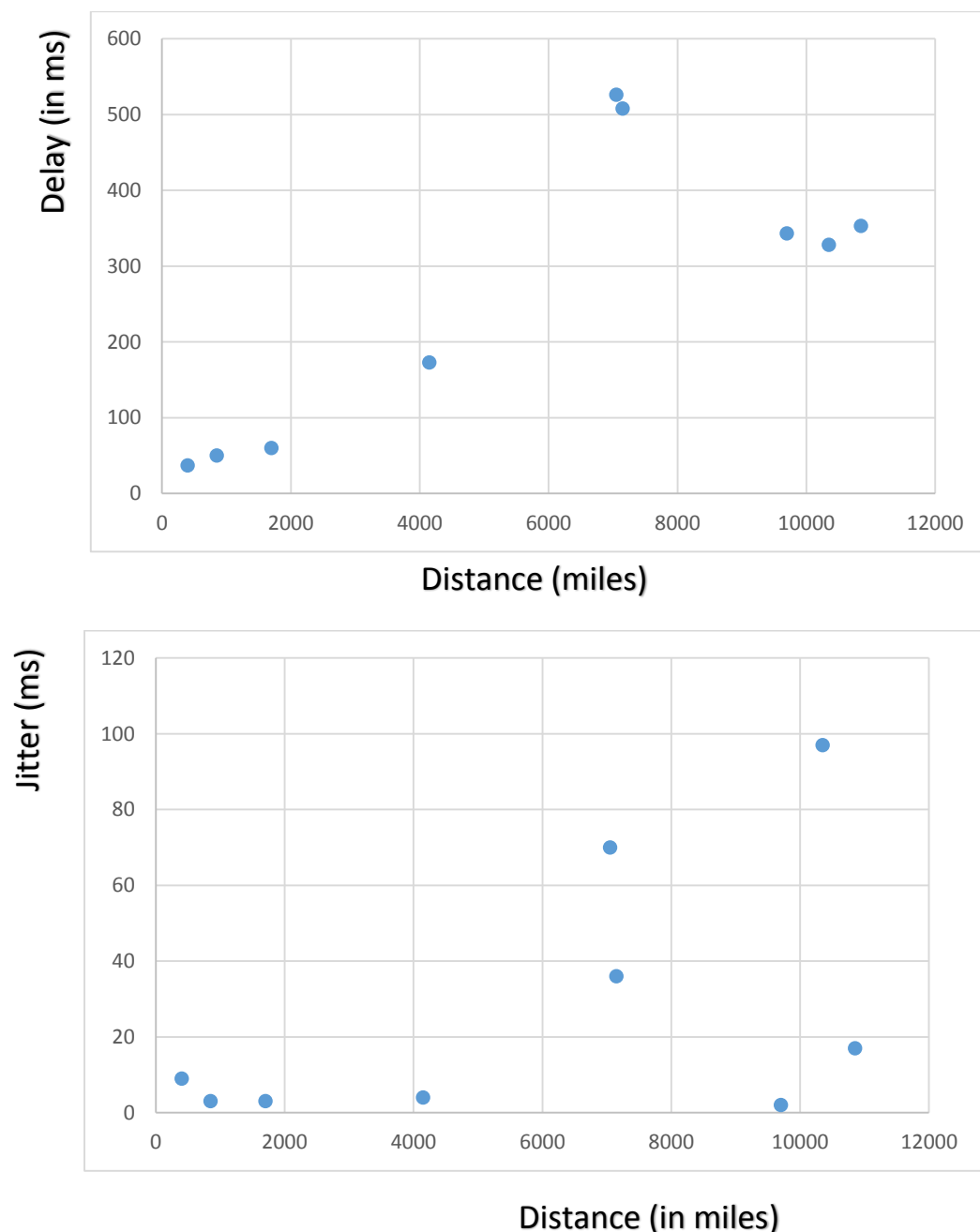
Sol.3.3. Correlation Analysis with respect networking environment:

It is very hard to correlate Jitter and Delay with the results from experimenting with ping and traceroute to the mentioned hosts because of the networking environment. Plausible reasons for this are:

- High congestion in the ISP network since the tests were executed at peak time (around 2pm Melbourne time).
- This could have resulted in longer delay to even closer servers due to network congestion resulting in rerouting or dropping of packets (dropped packets will require retransmission.)

In reality, Delay and Jitter are correlated to the physical distance of the server and this is evident in my pingtest.net experiment as well. On trying to ping closer servers (Adelaide, Perth and Brisbane) the delay was much lower than the delay to New York which is much farther, the same can be said about Jitter as well.

The reasons for this are because:

1. More Distance to be covered thus increasing propagation delay and hence resulting in higher latency to farther servers
2. Since each packet has to take a longer path to reach farther servers and some packets may take different paths to reach the same destination – it is highly likely that there is a variation in time of the received packets inducing increasing jitter with distance which is evident above.

SECTION 4.1

Sol.4.1:

Bandwidth delay product is the measure of how much data can a network hold at a particular time in transit. This is the maximum amount of data in bits/bytes in a network link at a particular time which hasn't been acknowledged.

Examples of high bandwidth delay products are:

1. Geo Satellite Communication – The high distance between sender and receiver means a large amount of propagation delay which results in high Round trip time, this makes stop and wait protocols difficult to use and we need to send more data per acknowledgement to ensure proper throughput and hence these connections have high bandwidth delay product.
2. High speed LAN networks – FastEthernet LAN interface and Gigbit LAN interfaces with 1ms round trip time send huge chunks of data and receive an acknowledgement within 1 ms.
   BDP = 100000000 bits* 0.001 sec = 100000 bits for FastEthernet
   BDP = 1000000000 bits * 0.001 sec = 1000000 bits for Gigabit Ethernet
3. ADSL2+ with 20 Mbits/s with 50 ms RTT
   BDP = 20000000 * 0.05 = 1000000 bits

BDP and Throughput: With a large BDP we ensure that we fill the entire network with data without wasting capacity of the network. If we send 1Mb of data in a 6 Mbit mobile broadband connection link, we are basically sending an acknowledgement for every 1 Mb of data received and hence utilizing the network poorly as we can send an acknowledgement for every 6 Mb of data received in the same Round trip time.

Hence a higher BDP allows better utilization of bandwidth to transmit data giving better throughput (more data with respect to time) and BDP can be used effectively for performance tuning for TCP networks.

[5]

Sol.4.2.

Server Name	Server Location	Bandwidth Reading 1(Kbps)	Bandwidth Reading 2 (Kbps)	Bandwidth Reading 3(Kbps)	Mean Bandwidth(Kbps)
ping.online.net	France	1020	1000	941	987
iperf.comneonext.de	Germany	1010	1000	1010	1006.666667
st2.nn.ertelecom.ru	Russia	894	916	907	905.6666667
iperf.lan.kth.se	Sweden	980	969	964	971
iperf.nersc.gov	USA	772	713	1040	841.6666667
iperf.he.net	USA	707	989	488	728
iperf.volia.net	France	31.4	31.7	31.1	31.4

Sol.4.3.

Server Name	Server Location	Mean Bandwidth(Kbps)	Delay(ms)	Bandwidth Delay product (kilobits)
ping.online.net	France	987	336.33	331.95771
iperf.comneonext.de	Germany	1006.666667	333.00	335.22
st2.nn.ertelecom.ru	Russia	905.6666667	386.67	350.19413
iperf.lan.kth.se	Sweden	971	349.33	339.19943
iperf.nersc.gov	USA	841.6666667	194	163.2833333
iperf.he.net	USA	728	247.66	180.29648
iperf.volia.net	France	31.4	365.66	11.481724

Bandwidth Delay Product (Kilobits)
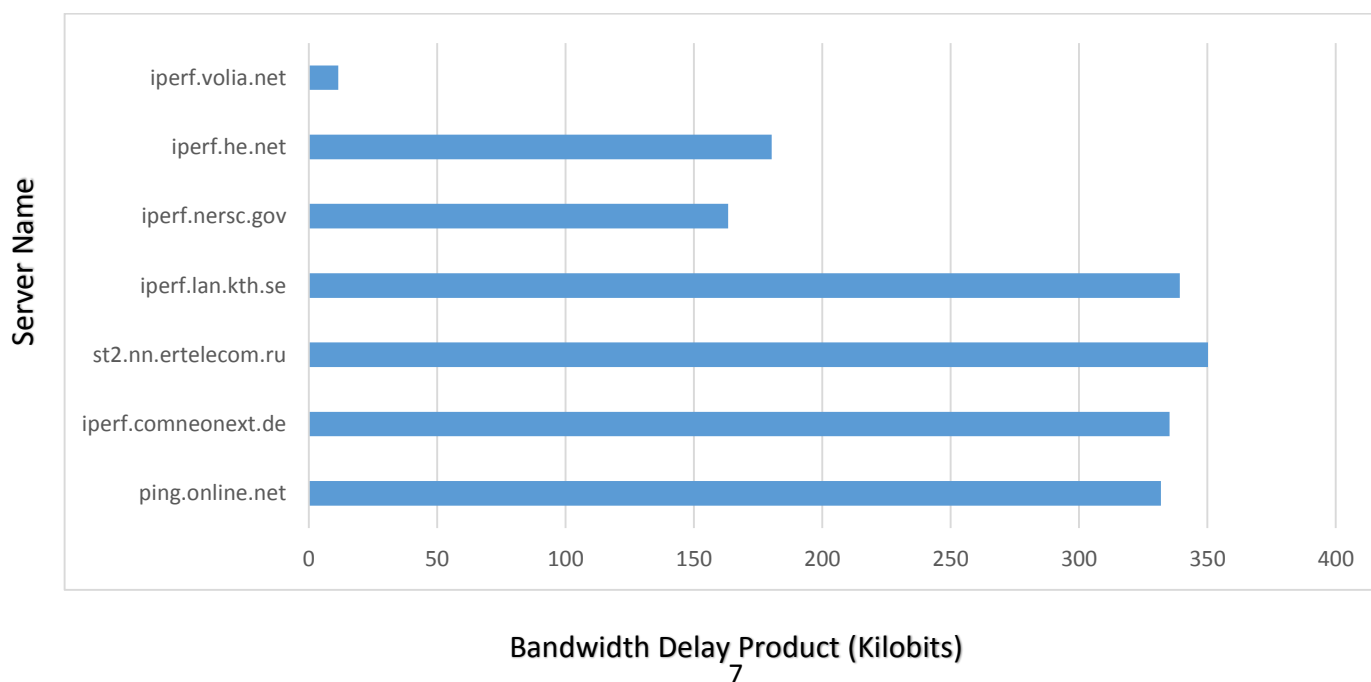
The networking environment is a DODO ADSL2+ Broadband.

The IPERF experiments were quite consistent except for with iperf.volia.net – a server situated in France which gave bandwidth readings of 31.4, 31.7 and 31.1 Kbps in 3 attempts taking more than 65 seconds each time to transfer just 256Kbytes.

Now since I am attempting to send data to different hosts in different countries through different networks, each of these networks might have different bottle necks. My network can download data at the speed of 14Mbps and upload data with 0.97 Mbps whereas when a connection is established for example ping.online.net. (Healthiest network in my opinion)
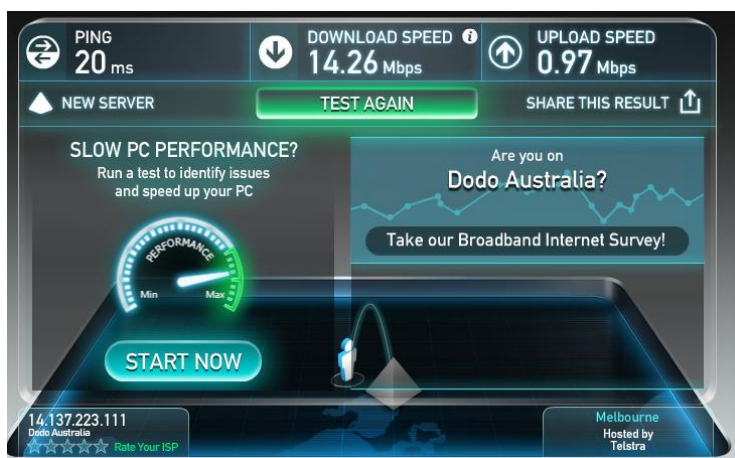
Can send 1.25 Mbytes of data in 10.3 seconds which is 0.9708 Mbits per second (verified through IPERF)

If I do a calculation for another host such as iperf.he.net I can send 896 Kbytes of data in 10.4 seconds – which will result in a speed of less than 0.97Mbps – this might be because the TCP network is experiencing congestion in a transit network.

Sol.4.4

Theoretically speaking there is no correlation between bandwidth delay product and hop count because hop count was calculated using tracert tool which uses UDP datagrams whereas BDP is a parameter over TCP connections which was calculated using the IPERF tool which establishes a TCP connection instead of sending UDP datagrams in the default mode which we are using it in.

Moreover hop count indicates the kind of routing followed by a packet or the path a packet follows whereas BDP indicates how much unacknowledged data can reside in the network in transit and have no correlation with each other.

Hop Count
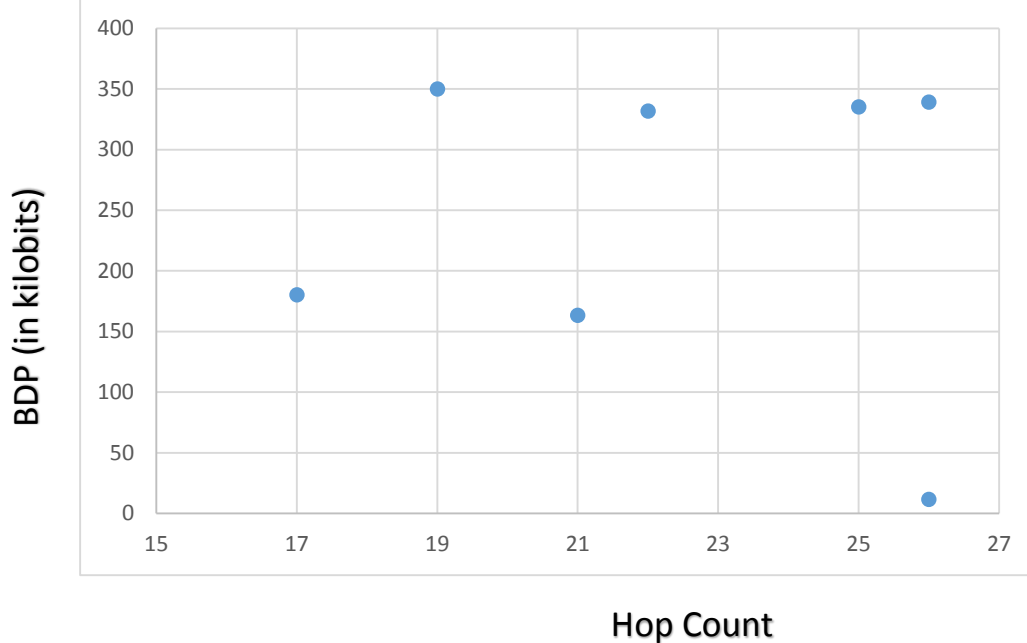
Sol.4.5.

Operating system – Windows 8.1

Commands invoked:

tracert –d –w 1 <servername> : Issues ICMP packets encapsulated in UDP datagram probes to explore the path (route) to the given server name. The –d speeds up the process by not mapping these intermediate hops to domain names

ping <servername> : Uses the ICMP protocol coupled with IP to find the latency to a particular server i.e the amount of time taken to receive a response(acknowledgement) to an outbound request.

iperf –c <servername> : This command invokes iperf in its default mode that is TCP. It can be used to calculate the bandwidth and the amount of time taken to transfer some test data. It sets the default tcp window to be 208Kbyte and uses the 5001 port by default. – c stands for running in client mode and packets will be sent and received to the nominated server name.

Networking Environment – I used a windows laptop connected to an ADSL2+ Wi-Fi using the 802.11n protocol which in turn is connected to a modem which might be connected through optical fibre using the SONET protocol to the internet.

All results were collected in a consistent networking environment at a stretch.

IPERF was able to connect with 7 servers (5/9 initial servers and 2/3 additional servers)

PING was able to connect to all servers except iperf-verne.okhysing.is (Iceland)

In addition to these 9 additional servers were tested by me through pingtest.net for section 3 to correlate delay and jitter with physical distance.

Microsoft Excel was used to compare, record and calculate standard deviation for jitter and mean for bandwidth.

Plotting Software – Microsoft excel.

The variables effecting accuracy of results are:

1. Network Congestion – The experiments were conducted during peak times at around 2pm on a weekday which could be a reason of a lot of congestion in the network resulting in increased delay as well as dropping of packets in the network.
2. Wireless Interference – Many households nearby using WIFI might cause interference in WIRELESS network which is inevitable unless we coat walls with tin foils. When the experiments were conducted my NIC was in range of 15 such wireless networks.
3. Packet Loss – Plausible packet loss due to signal strength, noise and interference. Packet loss is inevitable in wireless protocols and can be caused due to network congestion as well.

It is very difficult to collect information accurately in such long links because as the length of the link increases – more variables come in to play. For instance if I test a server at US at 4 AM in Melbourne Time thinking that network congestion will be low as most people might be sleeping - The upload might be fast, but a new bottle neck is introduced because 4 AM is Melbourne is 2 PM peak time in US (Washington) and the packet might experience congestion in the US network before it reaches is destination.

Moreover some networks have firewalls configured to block diagnostic packets (ICMP) thus introducing a lot of request time outs in section 2. A combination of all these factors as well as possible wireless interference issues hinder the process of accurate collection of network data.

Some of these factors can be improved upon by

1. Using wired connectivity (Ethernet) instead of wireless 802.11n protocol – Might make results more consistent
2. Testing for closer servers in a similar time zone (+-4 hours) and contrasting them with farther servers which will result in easier contrast of Delay and Jitter with physical distance (with a few outliers of course).

Appendix

Traceroute Snippets

```
C:\Users\Aman Lal>tracert -dw1 ping.online.net

Tracing route to ping.online.net [62.210.18.40]
over a maximum of 30 hops:

  1     2 ms     1 ms     1 ms  192.168.2.1
  2    20 ms    19 ms    19 ms  123.2.2.253
  3    22 ms    20 ms    23 ms  123.2.1.65
  4    20 ms    20 ms    20 ms  161.43.75.9
  5     *        *        *     Request timed out.
  6     *        *        *     Request timed out.
  7     *        *        *     Request timed out.
  8     *        *        *     Request timed out.
  9     *        *        *     Request timed out.
 10   263 ms   260 ms   259 ms  59.154.18.18
 11   258 ms   258 ms   259 ms  203.208.192.201
 12   193 ms   192 ms   194 ms  66.198.144.41
 13   333 ms   333 ms   334 ms  64.86.21.1
 14   331 ms   328 ms   329 ms  63.243.205.1
 15   339 ms   340 ms     *     63.243.128.28
 16     *      337 ms   336 ms  63.243.128.38
 17   338 ms   339 ms   337 ms  80.231.131.2
 18   337 ms   330 ms   332 ms  80.231.130.86
 19   339 ms   337 ms   337 ms  5.23.25.5
 20   336 ms   337 ms   336 ms  5.23.25.18
 21   340 ms   341 ms   339 ms  195.154.1.107
 22   337 ms   336 ms   337 ms  62.210.18.40

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.ips.versatel.de

Tracing route to iperf.ips.versatel.de [212.93.6.52]
over a maximum of 30 hops:

   1      6 ms      1 ms      1 ms  192.168.2.1
   2     22 ms     23 ms     19 ms  123.2.2.253
   3     20 ms     20 ms     21 ms  123.2.1.65
   4     21 ms     20 ms     20 ms  139.130.198.249
   5     21 ms     22 ms     23 ms  203.50.11.113
   6     36 ms     37 ms     37 ms  203.50.11.124
   7     36 ms     36 ms     35 ms  203.50.6.93
   8     39 ms     37 ms     43 ms  203.50.13.98
   9    194 ms    195 ms    196 ms  202.84.136.198
  10    192 ms    192 ms    190 ms  202.84.251.38
  11    192 ms    192 ms    193 ms  80.157.128.205
  12    341 ms    341 ms    342 ms  217.239.42.174
  13      *       339 ms    331 ms  87.128.232.54
  14    348 ms    346 ms    346 ms  62.214.105.122
  15    345 ms    340 ms    339 ms  62.214.111.26
  16    346 ms    347 ms    347 ms  62.214.104.170
  17    349 ms    346 ms    338 ms  62.214.110.133
  18    337 ms    336 ms    362 ms  62.214.104.206
  19    340 ms    341 ms    338 ms  62.214.89.46
  20    344 ms    341 ms    339 ms  212.93.6.52

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.comneonext.de

Tracing route to iperf.comneonext.de [85.25.140.156]
over a maximum of 30 hops:

   1      2 ms      1 ms      1 ms  192.168.2.1
   2     19 ms     20 ms     19 ms  123.2.2.253
   3     20 ms     20 ms     21 ms  123.2.1.65
   4     20 ms     21 ms     20 ms  139.130.198.249
   5     26 ms     24 ms     21 ms  203.50.11.113
   6     36 ms     35 ms     36 ms  203.50.11.124
   7     37 ms     36 ms     35 ms  203.50.6.93
   8     37 ms     36 ms     35 ms  203.50.13.98
   9     40 ms     48 ms     37 ms  202.84.222.54
  10    173 ms      *       173 ms  202.84.144.82
  11    268 ms    240 ms    213 ms  202.40.149.234
  12    195 ms    183 ms    203 ms  154.54.10.133
  13    184 ms    188 ms    177 ms  154.54.41.57
  14    183 ms    183 ms    183 ms  154.54.44.85
  15    193 ms    194 ms    194 ms  154.54.42.66
  16    207 ms    212 ms    207 ms  154.54.30.161
  17    221 ms    221 ms    225 ms  154.54.28.129
  18    266 ms    281 ms    241 ms  154.54.24.221
  19    247 ms    244 ms    238 ms  154.54.40.109
  20    325 ms    326 ms    325 ms  154.54.31.190
  21    335 ms    334 ms    332 ms  130.117.49.117
  22    334 ms    334 ms    334 ms  154.25.1.242
  23    331 ms    331 ms    340 ms  149.11.26.10
  24    373 ms    337 ms    338 ms  217.118.23.131
  25    343 ms    334 ms    335 ms  85.25.140.156

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 st2.nn.ertelecom.ru

Tracing route to st2.nn.ertelecom.ru [91.144.184.232]
over a maximum of 30 hops:

  1     2 ms     3 ms     1 ms  192.168.2.1
  2    21 ms    19 ms    26 ms  123.2.2.253
  3    21 ms    19 ms    21 ms  123.2.1.65
  4    20 ms    20 ms    22 ms  139.130.198.249
  5    24 ms    22 ms    22 ms  203.50.11.113
  6    36 ms    37 ms    36 ms  203.50.11.124
  7    37 ms    38 ms    36 ms  203.50.6.93
  8    40 ms    36 ms    36 ms  203.50.13.98
  9    36 ms    38 ms    37 ms  202.84.222.58
 10   191 ms   193 ms   192 ms  202.84.144.185
 11   264 ms   262 ms   265 ms  202.40.149.197
 12   325 ms   320 ms   326 ms  202.84.143.58
 13   328 ms   328 ms   337 ms  202.84.178.150
 14     *        *        *     Request timed out.
 15   409 ms   381 ms   401 ms  87.245.232.181
 16   565 ms   663 ms   389 ms  87.245.229.178
 17   401 ms   390 ms   427 ms  91.144.185.82
 18     *        *        *     Request timed out.
 19   388 ms   391 ms   389 ms  91.144.184.232

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.lan.kth.se

Tracing route to s11.lan.kth.se [130.237.0.218]
over a maximum of 30 hops:

  1     2 ms     3 ms     1 ms  192.168.2.1
  2    19 ms    21 ms    19 ms  123.2.2.253
  3    20 ms    20 ms    20 ms  123.2.1.65
  4    22 ms    19 ms    23 ms  139.130.198.249
  5    21 ms    23 ms    22 ms  203.50.11.113
  6    36 ms    35 ms    35 ms  203.50.11.124
  7    35 ms    35 ms    36 ms  203.50.6.93
  8    36 ms    35 ms    35 ms  203.50.13.98
  9    36 ms    37 ms    38 ms  202.84.222.66
 10   176 ms   172 ms   173 ms  202.84.144.82
 11   185 ms   187 ms   187 ms  202.40.149.138
 12   183 ms   179 ms   175 ms  206.223.123.199
 13   253 ms   254 ms   251 ms  64.57.20.246
 14   237 ms   238 ms   239 ms  64.57.21.54
 15   249 ms   275 ms   248 ms  109.105.97.142
 16   327 ms   326 ms   325 ms  109.105.97.138
 17   334 ms   336 ms   338 ms  109.105.97.136
 18   331 ms   342 ms   342 ms  109.105.97.133
 19   349 ms   349 ms   350 ms  109.105.102.17
 20   349 ms   352 ms   350 ms  109.105.102.18
 21   345 ms   345 ms   347 ms  130.242.83.50
 22   356 ms   350 ms   352 ms  193.11.0.194
 23   351 ms   354 ms   353 ms  130.237.0.2
 24   351 ms   351 ms   351 ms  130.237.211.117
 25   375 ms   349 ms   349 ms  130.237.211.122
 26   352 ms   348 ms   350 ms  130.237.0.218

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.xmission.com

Tracing route to iperf.xmission.com [198.60.22.20]
over a maximum of 30 hops:

   1      4 ms      1 ms      2 ms  192.168.2.1
   2     19 ms     19 ms     19 ms  123.2.2.253
   3     22 ms     20 ms     20 ms  123.2.1.65
   4     22 ms     20 ms     20 ms  139.130.198.249
   5     22 ms     21 ms     22 ms  203.50.11.113
   6     36 ms     36 ms     35 ms  203.50.11.124
   7     37 ms     36 ms     40 ms  203.50.6.93
   8     37 ms     36 ms     42 ms  203.50.13.98
   9     35 ms     38 ms     37 ms  202.84.222.54
  10    174 ms    172 ms    176 ms  202.84.144.82
  11    174 ms    176 ms    184 ms  202.40.149.194
  12    173 ms    172 ms    172 ms  4.68.62.9
  13    200 ms    245 ms    219 ms  4.69.202.162
  14    198 ms    203 ms    199 ms  4.53.42.62
  15    201 ms    207 ms    202 ms  166.70.1.5
  16    197 ms    197 ms    198 ms  198.60.22.20

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.securityinspection.com

Tracing route to iperf.securityinspection.com [205.251.184.27]
over a maximum of 30 hops:

   1      1 ms      1 ms      4 ms  192.168.2.1
   2     19 ms     22 ms     19 ms  123.2.2.253
   3     20 ms     20 ms     20 ms  123.2.1.65
   4     23 ms     20 ms     21 ms  139.130.198.249
   5     22 ms     21 ms     26 ms  203.50.11.113
   6     36 ms     36 ms     35 ms  203.50.11.124
   7     39 ms     38 ms     36 ms  203.50.6.93
   8     36 ms     38 ms     35 ms  203.50.13.98
   9     38 ms     39 ms     36 ms  202.84.222.58
  10    172 ms    173 ms    177 ms  202.84.144.82
  11    172 ms    172 ms    172 ms  202.84.251.154
  12    197 ms    173 ms    174 ms  154.54.10.133
  13    174 ms    175 ms    175 ms  154.54.41.57
  14    188 ms    185 ms    191 ms  154.54.44.85
  15    193 ms    191 ms    194 ms  154.54.42.66
  16    208 ms    208 ms    207 ms  154.54.30.161
  17    212 ms    217 ms    212 ms  154.54.44.230
  18    227 ms    231 ms    226 ms  154.54.3.214
  19    242 ms    238 ms    239 ms  154.54.44.170
  20    247 ms    245 ms    246 ms  154.54.6.94
  21    291 ms    295 ms    293 ms  38.122.60.46
  22    296 ms    292 ms    292 ms  205.251.184.27
  23      *         *         *     Request timed out.
  24      *         *         *     Request timed out.
  25      *         *         *     Request timed out.
  26      *         *         *     Request timed out.
  27      *         *         *     Request timed out.
  28      *         *         *     Request timed out.
  29    299 ms    293 ms    295 ms  205.251.184.27

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.nersc.gov

Tracing route to iperf.nersc.gov [128.55.80.8]
over a maximum of 30 hops:

  1     2 ms    26 ms     6 ms  192.168.2.1
  2    19 ms    19 ms    19 ms  123.2.2.253
  3    20 ms    19 ms    22 ms  123.2.1.65
  4    22 ms    22 ms    20 ms  161.43.75.9
  5     *        *         *    Request timed out.
  6     *        *         *    Request timed out.
  7     *        *         *    Request timed out.
  8   255 ms   255 ms   257 ms  59.154.18.26
  9   301 ms   261 ms   263 ms  203.208.190.17
 10   247 ms   247 ms   247 ms  203.208.173.138
 11     *        *         *    Request timed out.
 12     *        *         *    Request timed out.
 13   203 ms   193 ms   195 ms  198.129.78.34
 14   193 ms   205 ms   196 ms  128.55.192.65
 15   196 ms   196 ms   197 ms  128.55.192.29
 16   193 ms   197 ms   195 ms  128.55.15.250
 17   209 ms   197 ms   199 ms  128.55.15.145
 18   193 ms   193 ms   206 ms  128.55.80.8

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.he.net

Tracing route to 9000.mtu.he.net [216.218.227.10]
over a maximum of 30 hops:

  1     2 ms     1 ms     1 ms  192.168.2.1
  2    19 ms    19 ms    19 ms  123.2.2.245
  3    21 ms    21 ms    21 ms  123.2.4.65
  4    20 ms    20 ms    21 ms  139.130.199.65
  5    24 ms    22 ms    22 ms  203.50.11.111
  6    36 ms    30 ms    32 ms  203.50.11.90
  7    61 ms    58 ms    59 ms  203.50.11.19
  8    61 ms    62 ms    63 ms  203.50.6.198
  9    59 ms    59 ms    58 ms  203.50.13.250
 10   110 ms   111 ms   111 ms  202.84.143.2
 11   143 ms   143 ms   143 ms  202.84.244.46
 12   235 ms   237 ms   236 ms  216.218.221.141
 13   242 ms   231 ms   235 ms  184.105.223.189
 14   239 ms   240 ms   255 ms  184.105.223.169
 15   246 ms   247 ms   248 ms  184.105.81.237
 16   256 ms   247 ms   246 ms  184.105.213.65
 17   247 ms   257 ms   247 ms  216.218.227.10

Trace complete.
```

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```
C:\Users\Aman Lal>tracert -dw1 iperf.scottlinux.com

Tracing route to iperf.scottlinux.com [173.230.156.66]
over a maximum of 30 hops:

   1     1 ms     3 ms     5 ms   192.168.2.1
   2    28 ms    28 ms    30 ms   123.2.2.245
   3    31 ms    30 ms    30 ms   123.2.4.65
   4    22 ms    20 ms    21 ms   139.130.199.65
   5    23 ms    22 ms    23 ms   203.50.11.111
   6    43 ms    49 ms    33 ms   203.50.11.122
   7    50 ms    38 ms    35 ms   203.50.6.61
   8    38 ms    34 ms    36 ms   203.50.13.90
   9   182 ms   184 ms   181 ms   202.84.136.194
  10   189 ms   192 ms   191 ms   202.40.149.122
  11   193 ms   179 ms   178 ms   134.159.61.22
  12   192 ms   199 ms   193 ms   184.105.222.89
  13     *        *        *      Request timed out.
  14   183 ms   173 ms   172 ms   173.230.159.7
  15   180 ms   191 ms   185 ms   173.230.156.66

Trace complete.
```

```
C:\Users\Aman Lal>tracert -dw1 iperf.volia.net

Tracing route to speedtest.volia.net [82.144.193.18]
over a maximum of 30 hops:

   1     2 ms     1 ms     1 ms   192.168.2.1
   2    19 ms    19 ms    19 ms   123.2.2.245
   3    20 ms    19 ms    20 ms   123.2.4.65
   4    20 ms    20 ms    20 ms   139.130.199.65
   5    21 ms    22 ms    20 ms   203.50.11.111
   6    32 ms    33 ms    33 ms   203.50.11.122
   7    39 ms    33 ms    35 ms   203.50.6.61
   8    35 ms    35 ms    35 ms   203.50.13.90
   9   191 ms   182 ms   181 ms   202.84.136.194
  10   179 ms   186 ms   179 ms   202.40.149.54
  11   180 ms   180 ms   181 ms   154.54.11.157
  12   182 ms   180 ms   182 ms   154.54.0.177
  13   219 ms   218 ms   217 ms   154.54.30.66
  14   231 ms   230 ms   232 ms   154.54.44.170
  15   236 ms   236 ms   236 ms   154.54.7.130
  16   239 ms   238 ms   239 ms   154.54.31.90
  17   253 ms   253 ms   252 ms   154.54.44.106
  18   322 ms   332 ms   322 ms   154.54.44.142
  19   328 ms   328 ms   328 ms   154.54.58.70
  20   344 ms   336 ms   346 ms   154.54.38.210
  21   343 ms   344 ms   343 ms   130.117.0.166
  22   354 ms   354 ms   354 ms   130.117.0.177
  23   378 ms   368 ms   370 ms   130.117.48.94
  24   373 ms   374 ms   373 ms   149.6.191.50
  25   366 ms   366 ms   365 ms   77.120.1.34
  26   364 ms   364 ms   365 ms   82.144.193.18

Trace complete.
```

PING Snippets

```
C:\Users\Aman Lal>ping ping.online.net

Pinging ping.online.net [62.210.18.40] with 32 bytes of data:
Reply from 62.210.18.40: bytes=32 time=337ms TTL=42
Reply from 62.210.18.40: bytes=32 time=336ms TTL=42
Reply from 62.210.18.40: bytes=32 time=336ms TTL=42
Reply from 62.210.18.40: bytes=32 time=337ms TTL=42

Ping statistics for 62.210.18.40:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 336ms, Maximum = 337ms, Average = 336ms
```

```
C:\Users\Aman Lal>ping iperf.ips.versatel.de

Pinging iperf.ips.versatel.de [212.93.6.52] with 32 bytes of data:
Reply from 212.93.6.52: bytes=32 time=338ms TTL=45
Reply from 212.93.6.52: bytes=32 time=341ms TTL=45
Reply from 212.93.6.52: bytes=32 time=340ms TTL=45
Reply from 212.93.6.52: bytes=32 time=342ms TTL=45

Ping statistics for 212.93.6.52:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 338ms, Maximum = 342ms, Average = 340ms

C:\Users\Aman Lal>ping iperf.comneonext.de
```

```
C:\Users\Aman Lal>ping iperf.comneonext.de

Pinging iperf.comneonext.de [85.25.140.156] with 32 bytes of data:
Reply from 85.25.140.156: bytes=32 time=333ms TTL=44
Reply from 85.25.140.156: bytes=32 time=332ms TTL=44
Reply from 85.25.140.156: bytes=32 time=334ms TTL=44
Reply from 85.25.140.156: bytes=32 time=333ms TTL=44

Ping statistics for 85.25.140.156:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 332ms, Maximum = 334ms, Average = 333ms
```

```
C:\Users\Aman Lal>ping st2.nn.ertelecom.ru

Pinging st2.nn.ertelecom.ru [91.144.184.232] with 32 bytes of data:
Reply from 91.144.184.232: bytes=32 time=389ms TTL=44
Reply from 91.144.184.232: bytes=32 time=390ms TTL=44
Reply from 91.144.184.232: bytes=32 time=381ms TTL=44
Reply from 91.144.184.232: bytes=32 time=391ms TTL=44

Ping statistics for 91.144.184.232:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 381ms, Maximum = 391ms, Average = 387ms
```

```
C:\Users\Aman Lal>ping iperf.lan.kth.se

Pinging s11.lan.kth.se [130.237.0.218] with 32 bytes of data:
Reply from 130.237.0.218: bytes=32 time=352ms TTL=41
Reply from 130.237.0.218: bytes=32 time=348ms TTL=41
Reply from 130.237.0.218: bytes=32 time=348ms TTL=41
Reply from 130.237.0.218: bytes=32 time=348ms TTL=41

Ping statistics for 130.237.0.218:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 348ms, Maximum = 352ms, Average = 349ms
```

```
C:\Users\Aman Lal>ping iperf.xmission.com

Pinging iperf.xmission.com [198.60.22.20] with 32 bytes of data:
Reply from 198.60.22.20: bytes=32 time=198ms TTL=49
Reply from 198.60.22.20: bytes=32 time=198ms TTL=49
Reply from 198.60.22.20: bytes=32 time=196ms TTL=49
Reply from 198.60.22.20: bytes=32 time=196ms TTL=49

Ping statistics for 198.60.22.20:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 196ms, Maximum = 198ms, Average = 197ms
```

```
C:\Users\Aman Lal>ping iperf.securityinspection.com

Pinging iperf.securityinspection.com [205.251.184.27] with 32 bytes of data:
Reply from 205.251.184.27: bytes=32 time=293ms TTL=48
Reply from 205.251.184.27: bytes=32 time=293ms TTL=48
Reply from 205.251.184.27: bytes=32 time=296ms TTL=48
Reply from 205.251.184.27: bytes=32 time=294ms TTL=48

Ping statistics for 205.251.184.27:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 293ms, Maximum = 296ms, Average = 294ms
```

```
C:\Users\Aman Lal>ping iperf.nersc.gov

Pinging iperf.nersc.gov [128.55.80.8] with 32 bytes of data:
Reply from 128.55.80.8: bytes=32 time=193ms TTL=45
Reply from 128.55.80.8: bytes=32 time=193ms TTL=45
Reply from 128.55.80.8: bytes=32 time=196ms TTL=45
Reply from 128.55.80.8: bytes=32 time=193ms TTL=45

Ping statistics for 128.55.80.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 193ms, Maximum = 196ms, Average = 193ms
```

```
C:\Users\Aman Lal>ping iperf.he.net

Pinging 9000.mtu.he.net [216.218.227.10] with 32 bytes of data:
Reply from 216.218.227.10: bytes=32 time=246ms TTL=52
Reply from 216.218.227.10: bytes=32 time=250ms TTL=52
Reply from 216.218.227.10: bytes=32 time=247ms TTL=52
Reply from 216.218.227.10: bytes=32 time=248ms TTL=52

Ping statistics for 216.218.227.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 246ms, Maximum = 250ms, Average = 247ms
```

```
C:\Users\Aman Lal>ping iperf.scottlinux.com

Pinging iperf.scottlinux.com [173.230.156.66] with 32 bytes of data:
Reply from 173.230.156.66: bytes=32 time=179ms TTL=49
Reply from 173.230.156.66: bytes=32 time=180ms TTL=49
Reply from 173.230.156.66: bytes=32 time=179ms TTL=49
Reply from 173.230.156.66: bytes=32 time=181ms TTL=49

Ping statistics for 173.230.156.66:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 179ms, Maximum = 181ms, Average = 179ms
```

```
C:\Users\Aman Lal>ping iperf.volia.net

Pinging speedtest.volia.net [82.144.193.18] with 32 bytes of data:
Reply from 82.144.193.18: bytes=32 time=366ms TTL=46
Reply from 82.144.193.18: bytes=32 time=367ms TTL=46
Reply from 82.144.193.18: bytes=32 time=364ms TTL=46
Reply from 82.144.193.18: bytes=32 time=365ms TTL=46

Ping statistics for 82.144.193.18:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 364ms, Maximum = 367ms, Average = 365ms
```

IPERF SNIPPETS

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c ping.online.net
------------------------------------------------------------
Client connecting to ping.online.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60525 connected with 62.210.18.40 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-10.3 sec  1.25 MBytes  1.02 Mbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c ping.online.net
------------------------------------------------------------
Client connecting to ping.online.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60526 connected with 62.210.18.40 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-10.4 sec  1.25 MBytes  1.00 Mbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c ping.online.net
------------------------------------------------------------
Client connecting to ping.online.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60527 connected with 62.210.18.40 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-11.1 sec  1.25 MBytes   941 Kbits/sec
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.comneonext.de
------------------------------------------------------------
Client connecting to iperf.comneonext.de, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60533 connected with 85.25.140.156 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-10.4 sec  1.25 MBytes  1.01 Mbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.comneonext.de
------------------------------------------------------------
Client connecting to iperf.comneonext.de, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60534 connected with 85.25.140.156 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-10.5 sec  1.25 MBytes  1000 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.comneonext.de
------------------------------------------------------------
Client connecting to iperf.comneonext.de, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60537 connected with 85.25.140.156 port 5001
[ ID] Interval        Transfer     Bandwidth
[  3]  0.0-10.4 sec  1.25 MBytes  1.01 Mbits/sec
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c st2.nn.ertelecom.ru
------------------------------------------------------------
Client connecting to st2.nn.ertelecom.ru, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60540 connected with 91.144.184.232 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.6 sec  1.12 MBytes   894 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c st2.nn.ertelecom.ru
------------------------------------------------------------
Client connecting to st2.nn.ertelecom.ru, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60541 connected with 91.144.184.232 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.3 sec  1.12 MBytes   916 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c st2.nn.ertelecom.ru
------------------------------------------------------------
Client connecting to st2.nn.ertelecom.ru, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60542 connected with 91.144.184.232 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.4 sec  1.12 MBytes   907 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.lan.kth.se
------------------------------------------------------------
Client connecting to iperf.lan.kth.se, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60547 connected with 130.237.0.218 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.7 sec  1.25 MBytes   980 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.lan.kth.se
------------------------------------------------------------
Client connecting to iperf.lan.kth.se, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60548 connected with 130.237.0.218 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.8 sec  1.25 MBytes   969 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.lan.kth.se
------------------------------------------------------------
Client connecting to iperf.lan.kth.se, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60549 connected with 130.237.0.218 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.9 sec  1.25 MBytes   964 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.nersc.gov
------------------------------------------------------------
Client connecting to iperf.nersc.gov, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60557 connected with 128.55.80.8 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.9 sec  1.00 MBytes   772 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.nersc.gov
------------------------------------------------------------
Client connecting to iperf.nersc.gov, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60560 connected with 128.55.80.8 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-11.8 sec  1.00 MBytes   713 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.nersc.gov
------------------------------------------------------------
Client connecting to iperf.nersc.gov, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 60586 connected with 128.55.80.8 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-11.1 sec  1.38 MBytes  1.04 Mbits/sec
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.he.net
------------------------------------------------------------
Client connecting to iperf.he.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63788 connected with 216.218.227.10 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.4 sec   896 KBytes   707 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.he.net
------------------------------------------------------------
Client connecting to iperf.he.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63789 connected with 216.218.227.10 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-10.6 sec  1.25 MBytes   989 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.he.net
------------------------------------------------------------
Client connecting to iperf.he.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63792 connected with 216.218.227.10 port 5001
[ ID] Interval       Transfer     Bandwidth
[  3]  0.0-12.9 sec   768 KBytes   488 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>
```

```
C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.volia.net
------------------------------------------------------------
Client connecting to iperf.volia.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63845 connected with 82.144.193.18 port 5001
write failed: Connection reset by peer
[ ID] Interval        Transfer      Bandwidth
[  3]  0.0-66.8 sec   256 KBytes  31.4 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.volia.net
------------------------------------------------------------
Client connecting to iperf.volia.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63858 connected with 82.144.193.18 port 5001
write failed: Connection reset by peer
[ ID] Interval        Transfer      Bandwidth
[  3]  0.0-66.2 sec   256 KBytes  31.7 Kbits/sec

C:\Users\Aman Lal\Desktop\Project utilities>iperf -c iperf.volia.net
------------------------------------------------------------
Client connecting to iperf.volia.net, TCP port 5001
TCP window size:  208 KByte (default)
------------------------------------------------------------
[  3] local 192.168.2.24 port 63863 connected with 82.144.193.18 port 5001
write failed: Connection reset by peer
[ ID] Interval        Transfer      Bandwidth
[  3]  0.0-67.5 sec   256 KBytes  31.1 Kbits/sec
```

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