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LAB 2: BASIC NETWORK UTILITIES

AIM:

Experimenting with some basic command line networking utilities.

IMPLEMENTATION:

ping

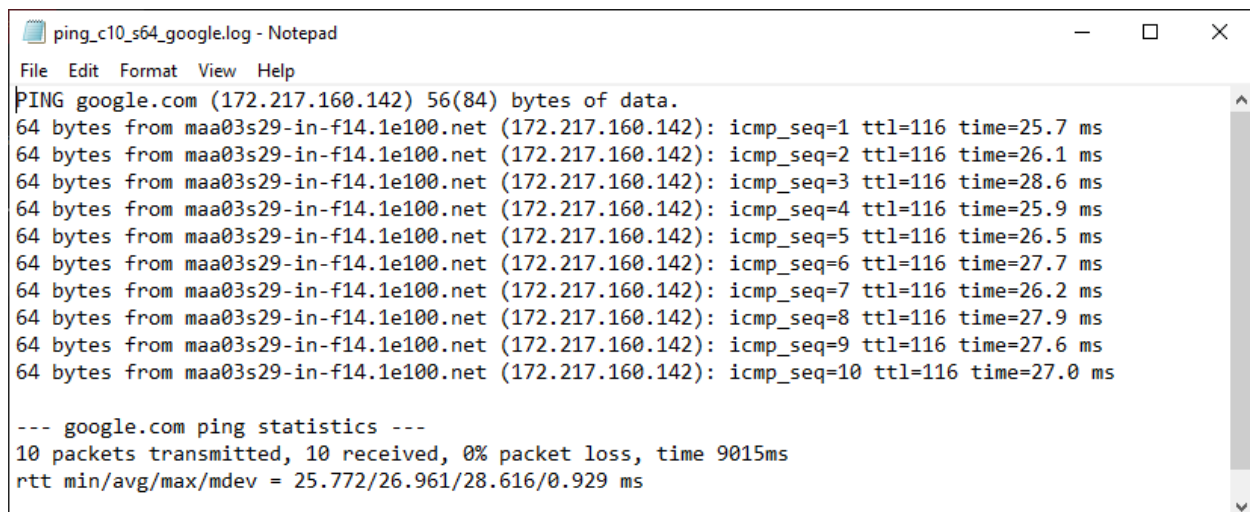
Syntax: ping [-n <count>] [-l <packetsize>] <hostname>

1. Ping the any hosts 10 times (i.e., packet count is 10) with a packet size of 64 bytes, 100 bytes, 500 bytes, 1000 bytes, 1400 bytes.

Hostname: google.com

Count: 10

a) Packet size: 64 bytes (default for Linux)



```
ping_c10_s64_google.log - Notepad
File Edit Format View Help
PING google.com (172.217.160.142) 56(84) bytes of data.
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=1 ttl=116 time=25.7 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=2 ttl=116 time=26.1 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=3 ttl=116 time=28.6 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=4 ttl=116 time=25.9 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=5 ttl=116 time=26.5 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=6 ttl=116 time=27.7 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=7 ttl=116 time=26.2 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=8 ttl=116 time=27.9 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=9 ttl=116 time=27.6 ms
64 bytes from maa03s29-in-f14.1e100.net (172.217.160.142): icmp_seq=10 ttl=116 time=27.0 ms

--- google.com ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9015ms
rtt min/avg/max/mdev = 25.772/26.961/28.616/0.929 ms
```

Observation:

- IP address 172.217.160.142 is pinged 10 times with 64 bytes packets when host google.com is pinged. The average RTT is 26.961 ms.

b) Packet Size: 100 bytes

```
ping_c10_s100_google.log - Notepad
File Edit Format View Help
PING google.com (172.217.27.206) 100(128) bytes of data.
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=1 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=2 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=3 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=4 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=5 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=6 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=7 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=8 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=9 ttl=117 (truncated)
76 bytes from bom07s15-in-f14.1e100.net (172.217.27.206): icmp_seq=10 ttl=117 (truncated)

--- google.com ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9216ms
rtt min/avg/max/mdev = 6.199/8.581/19.647/3.943 ms
```

Observation:

- When google.com is pinged with 10 packets of size 100 bytes, IP address 172.217.27.206 is pinged. This IP address is different from the previous one.
- The average RTT is 8.581 ms. This time is much less compared to the pinging with 10 byte packets. This could be because this server is faster than the previous one.

c) Packet Size: 500 bytes

```
ping_c10_s500_google.log - Notepad
File Edit Format View Help
PING google.com (216.58.200.206) 500(528) bytes of data.
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=1 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=2 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=3 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=4 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=5 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=6 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=7 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=8 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=9 ttl=117 (truncated)
76 bytes from nrt12s12-in-f206.1e100.net (216.58.200.206): icmp_seq=10 ttl=117 (truncated)

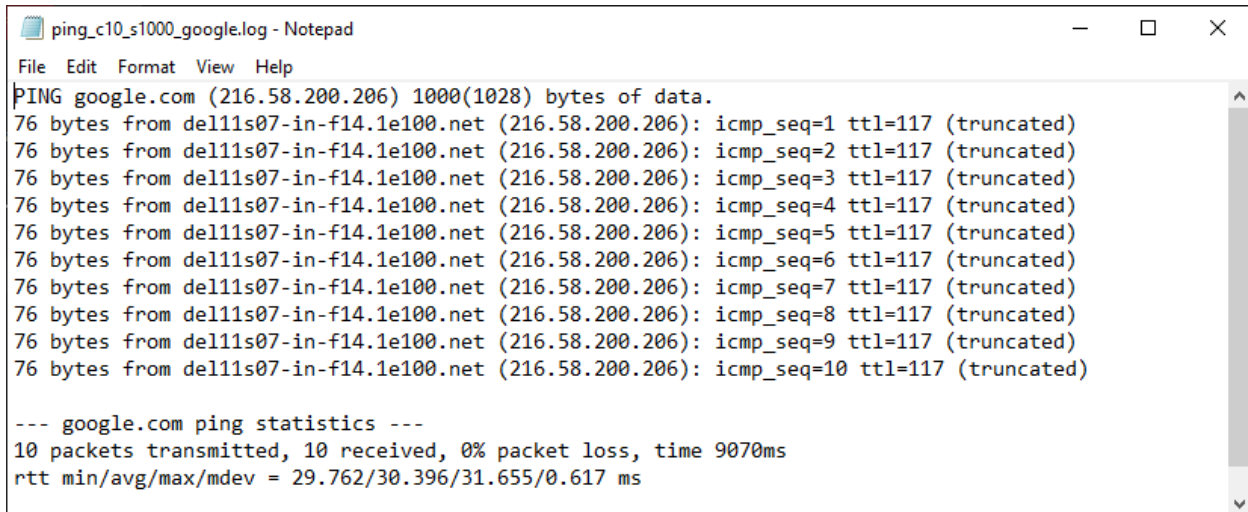
--- google.com ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9255ms
rtt min/avg/max/mdev = 29.680/30.408/31.383/0.485 ms
```

Observation:

- When google.com is pinged with 10 packets of size 500 bytes, IP address 216.58.200.206 is pinged. This IP address is again different from the previous ones.
- So, the server is different for different packet sizes.

- The average RTT is larger than the previous ping results.

d) Packet Size: 1000 bytes



```

ping_c10_s1000_google.log - Notepad
File Edit Format View Help
PING google.com (216.58.200.206) 1000(1028) bytes of data.
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=1 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=2 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=3 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=4 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=5 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=6 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=7 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=8 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=9 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=10 ttl=117 (truncated)

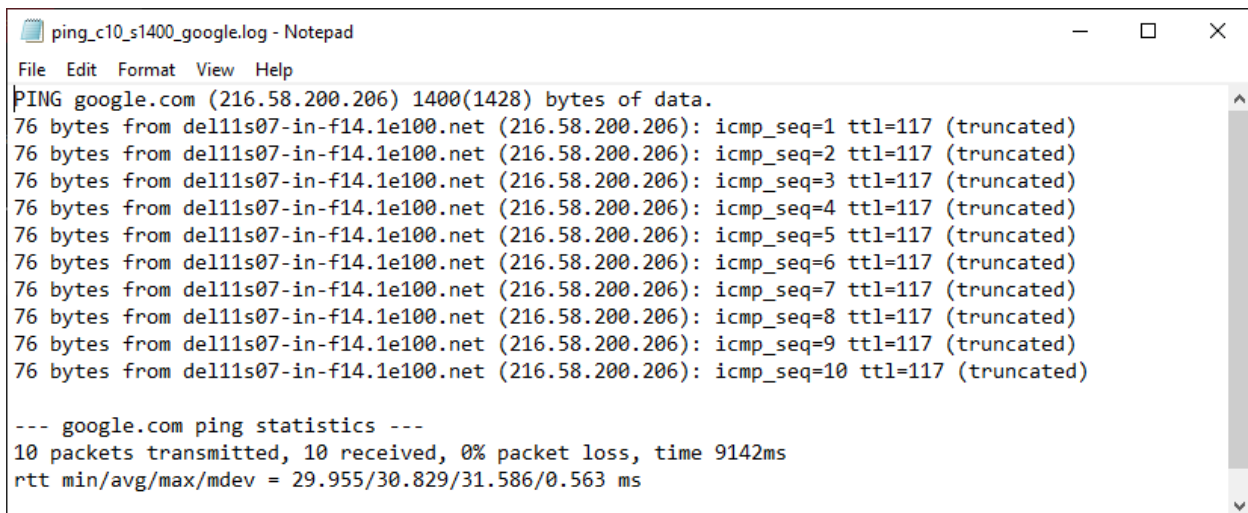
--- google.com ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9070ms
rtt min/avg/max/mdev = 29.762/30.396/31.655/0.617 ms

```

Observation:

- When google.com is pinged with 10 packets of size 1000 bytes, IP address 216.58.200.206 is pinged. This address is the same as that for ping with 500 bytes.
- The average RTT is also almost the same as when 500 bytes are transferred.

e) Packet Size: 1400 bytes



```

ping_c10_s1400_google.log - Notepad
File Edit Format View Help
PING google.com (216.58.200.206) 1400(1428) bytes of data.
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=1 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=2 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=3 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=4 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=5 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=6 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=7 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=8 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=9 ttl=117 (truncated)
76 bytes from del11s07-in-f14.1e100.net (216.58.200.206): icmp_seq=10 ttl=117 (truncated)

--- google.com ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9142ms
rtt min/avg/max/mdev = 29.955/30.829/31.586/0.563 ms

```

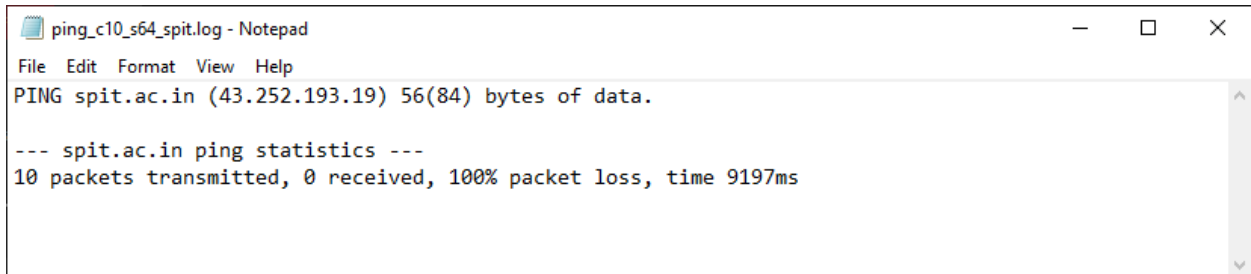
Observation:

- When google.com is pinged with 10 packets of size 1400 bytes, IP address 216.58.200.206 is pinged. This address is the same as that for ping with 500 bytes and 1000 bytes.

- The average RTT is also almost the same as when 500 bytes and 1000 bytes are transferred.

2. Pinging various hosts:

a) spit.ac.in



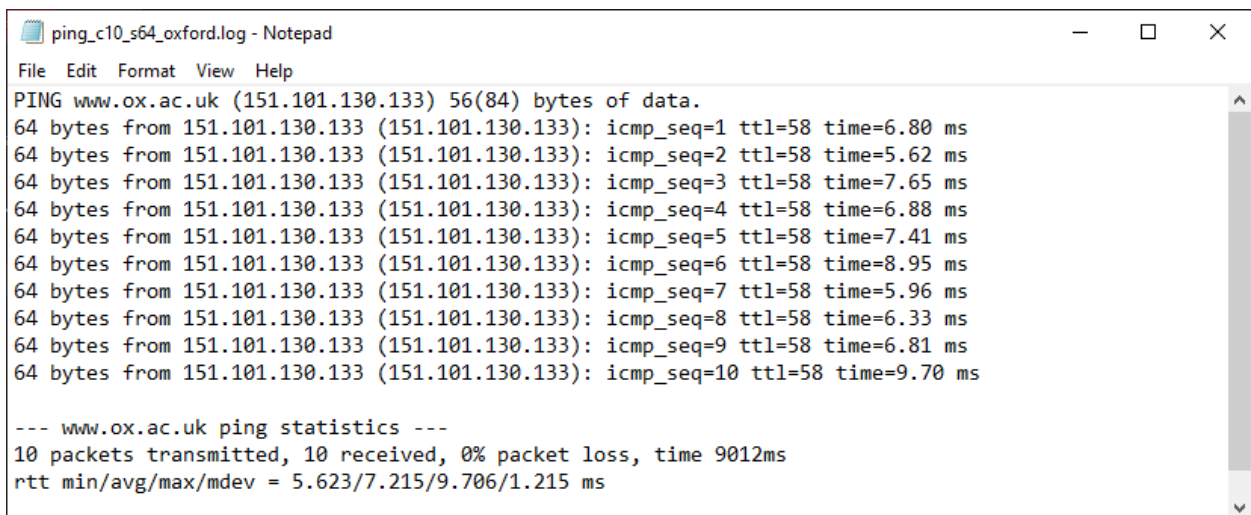
```
ping_c10_s64_spit.log - Notepad
File Edit Format View Help
PING spit.ac.in (43.252.193.19) 56(84) bytes of data.

--- spit.ac.in ping statistics ---
10 packets transmitted, 0 received, 100% packet loss, time 9197ms
```

Observation:

- When host spit.ac.in was pinged with 10 packets of size 64 bytes, there was 100% packet loss. This could be because some routers and firewalls block ping requests so no response is received on pinging.

b) www.ox.ac.uk



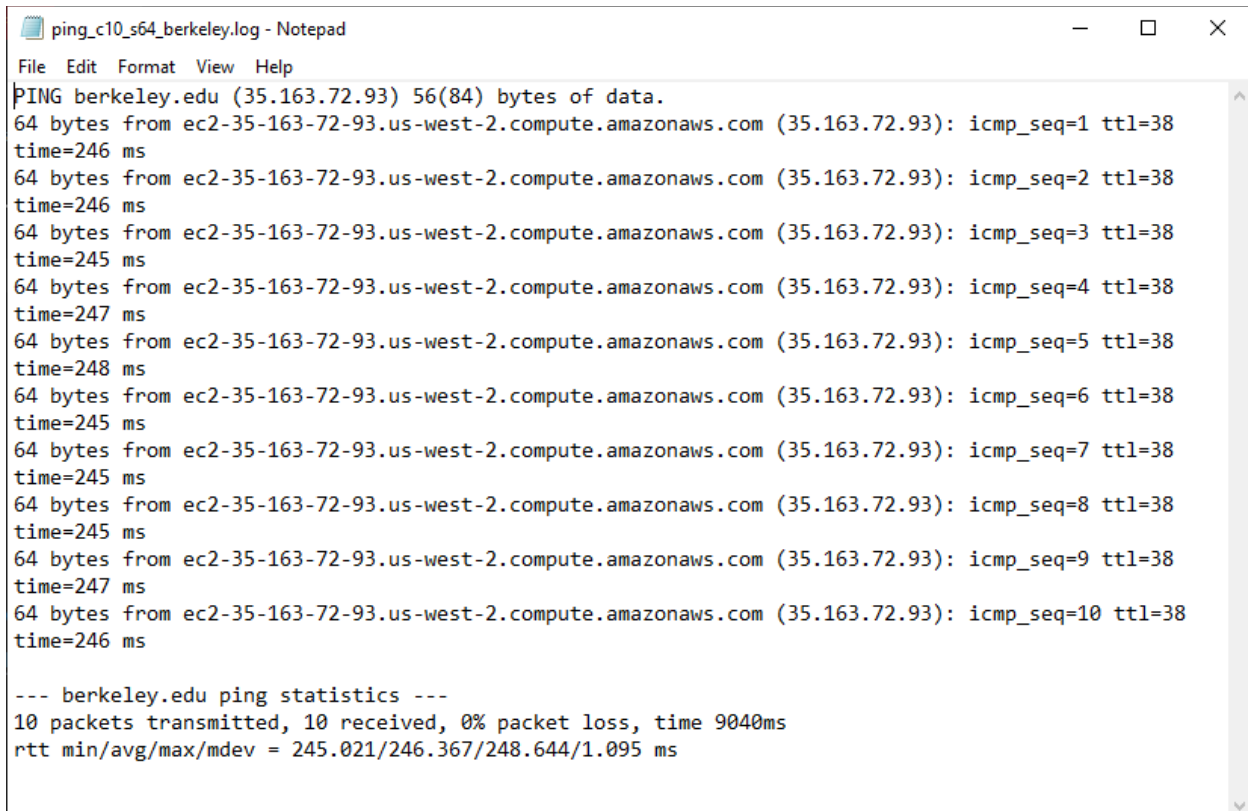
```
ping_c10_s64_oxford.log - Notepad
File Edit Format View Help
PING www.ox.ac.uk (151.101.130.133) 56(84) bytes of data.
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=1 ttl=58 time=6.80 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=2 ttl=58 time=5.62 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=3 ttl=58 time=7.65 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=4 ttl=58 time=6.88 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=5 ttl=58 time=7.41 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=6 ttl=58 time=8.95 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=7 ttl=58 time=5.96 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=8 ttl=58 time=6.33 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=9 ttl=58 time=6.81 ms
64 bytes from 151.101.130.133 (151.101.130.133): icmp_seq=10 ttl=58 time=9.70 ms

--- www.ox.ac.uk ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9012ms
rtt min/avg/max/mdev = 5.623/7.215/9.706/1.215 ms
```

Observation:

- Pinging www.ox.ac.uk resulted in a very small average RTT (only 7.215 ms).

c)berkeley.edu



```
ping_c10_s64_berkeley.log - Notepad
File Edit Format View Help
PING berkeley.edu (35.163.72.93) 56(84) bytes of data.
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=1 ttl=38
time=246 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=2 ttl=38
time=246 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=3 ttl=38
time=245 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=4 ttl=38
time=247 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=5 ttl=38
time=248 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=6 ttl=38
time=245 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=7 ttl=38
time=245 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=8 ttl=38
time=245 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=9 ttl=38
time=247 ms
64 bytes from ec2-35-163-72-93.us-west-2.compute.amazonaws.com (35.163.72.93): icmp_seq=10 ttl=38
time=246 ms

--- berkeley.edu ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9040ms
rtt min/avg/max/mdev = 245.021/246.367/248.644/1.095 ms
```

Observation:

- When host berkeley.edu is pinged, response is received from an IP address serviced by Amazon Web Services.
- The average RTT is very large, almost 0.3 seconds.

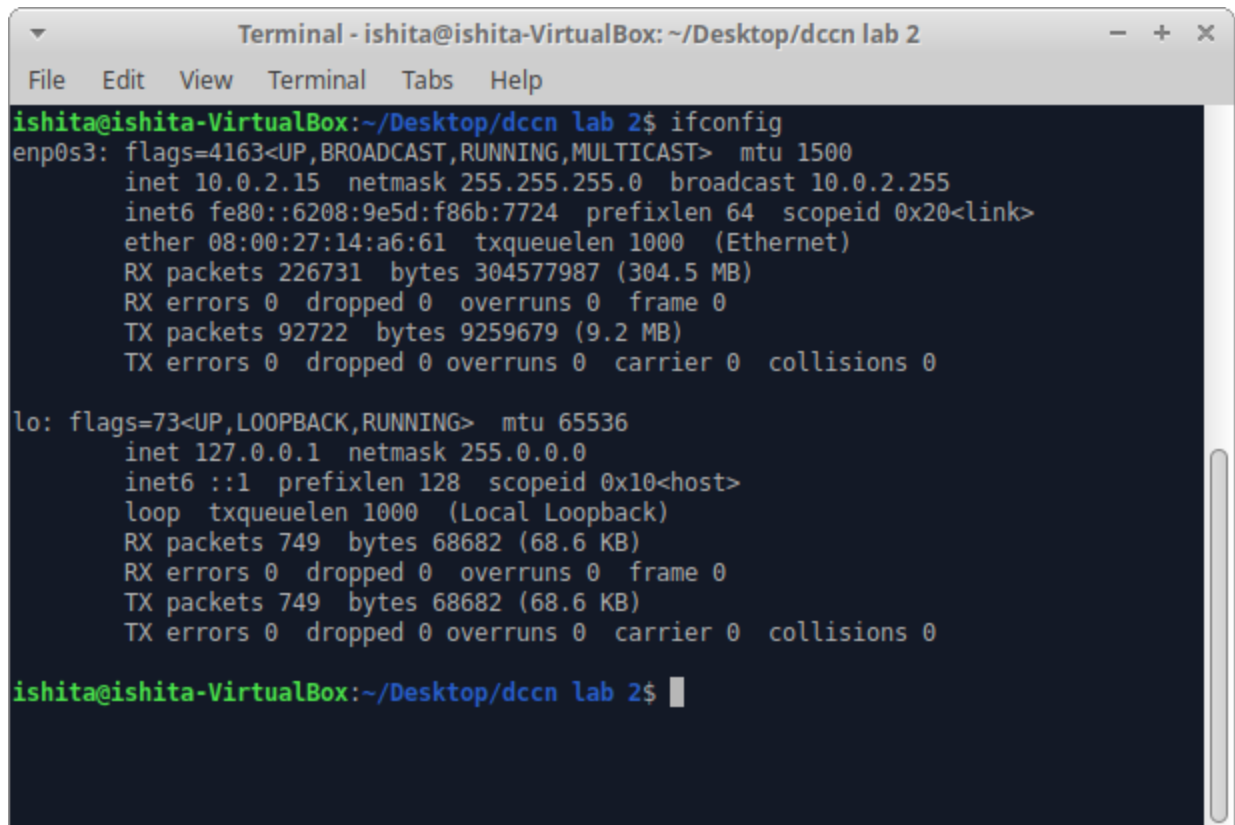
Factors Influencing RTT

Actual round trip time can be influenced by:

- Distance – The length a signal has to travel correlates with the time taken for a request to reach a server and a response to reach a browser.
- Transmission medium – The medium used to route a signal (e.g., copper wire, fiber optic cables) can impact how quickly a request is received by a server and routed back to a user.
- Number of network hops – Intermediate routers or servers take time to process a signal, increasing RTT. The more hops a signal has to travel through, the higher the RTT.
- Traffic levels – RTT typically increases when a network is congested with high levels of traffic. Conversely, low traffic times can result in decreased RTT.
- Server response time – The time taken for a target server to respond to a request depends on its processing capacity, the number of requests being

handled and the nature of the request (i.e., how much server-side work is required). A longer server response time increases RTT.

Ifconfig

A screenshot of a terminal window titled "Terminal - ishita@ishita-VirtualBox: ~/Desktop/dccn lab 2". The terminal shows the output of the 'ifconfig' command. It displays details for two network interfaces: 'enp0s3' (an Ethernet interface) and 'lo' (a local loopback interface). For 'enp0s3', it shows flags, MTU, IP address (10.0.2.15), netmask, broadcast address, MAC address, and statistics for RX and TX packets, bytes, errors, and collisions. For 'lo', it shows flags, MTU, IP address (127.0.0.1), netmask, and statistics. The prompt at the bottom is 'ishita@ishita-VirtualBox:~/Desktop/dccn lab 2\$' with a cursor.

```
Terminal - ishita@ishita-VirtualBox: ~/Desktop/dccn lab 2
File Edit View Terminal Tabs Help
ishita@ishita-VirtualBox:~/Desktop/dccn lab 2$ ifconfig
enp0s3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.2.15 netmask 255.255.255.0 broadcast 10.0.2.255
    inet6 fe80::6208:9e5d:f86b:7724 prefixlen 64 scopeid 0x20<link>
    ether 08:00:27:14:a6:61 txqueuelen 1000 (Ethernet)
    RX packets 226731 bytes 304577987 (304.5 MB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 92722 bytes 9259679 (9.2 MB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
    inet6 ::1 prefixlen 128 scopeid 0x10<host>
    loop txqueuelen 1000 (Local Loopback)
    RX packets 749 bytes 68682 (68.6 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 749 bytes 68682 (68.6 KB)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ishita@ishita-VirtualBox:~/Desktop/dccn lab 2$
```

Observation:

- The “ifconfig” command with no arguments will display all the active interfaces details.
- The ifconfig command is also used to check the assigned IP address of a server.

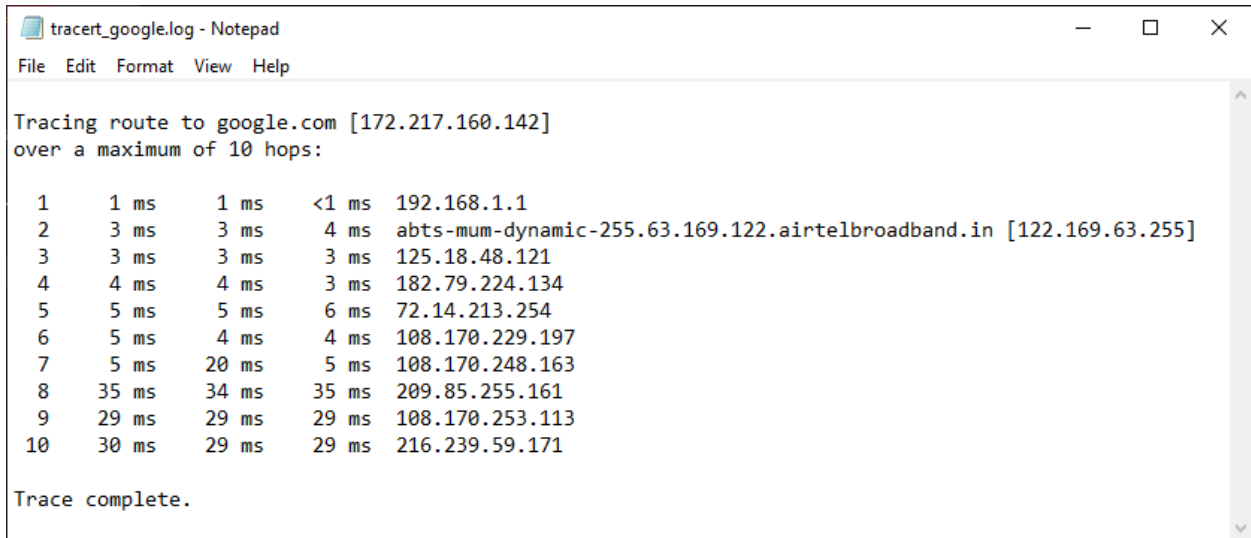
traceroute

Syntax: `tracert [-h <maximum-hops>] <hostname>`

Note: Default value for maximum hops is 30.

1. Tracing various hosts from local machine

a) google.com



```
tracert_google.log - Notepad
File Edit Format View Help

Tracing route to google.com [172.217.160.142]
over a maximum of 10 hops:

  1    1 ms    1 ms    <1 ms  192.168.1.1
  2    3 ms    3 ms    4 ms   abts-mum-dynamic-255.63.169.122.airtelbroadband.in [122.169.63.255]
  3    3 ms    3 ms    3 ms   125.18.48.121
  4    4 ms    4 ms    3 ms   182.79.224.134
  5    5 ms    5 ms    6 ms   72.14.213.254
  6    5 ms    4 ms    4 ms   108.170.229.197
  7    5 ms    20 ms   5 ms   108.170.248.163
  8   35 ms    34 ms   35 ms   209.85.255.161
  9   29 ms    29 ms   29 ms   108.170.253.113
 10   30 ms    29 ms   29 ms   216.239.59.171

Trace complete.
```

Observation:

- For each $n = 1, 2, 3, \dots$, traceroute sends a packet with "time-to-live" (ttl) equal to n ms.
- The first router is 192.168.1.1. It is an IP address which routers like Linksys and other network brands use as an access point or gateway.
- The second router is of the internet service provider(Airtel). This particular router is in Powai. So, we can see that packets are sent and received via ISP.

b) iitb.ac.in

```
tracert_iitb.log - Notepad
File Edit Format View Help

Tracing route to iitb.ac.in [103.21.127.114]
over a maximum of 10 hops:

  1    1 ms    1 ms    <1 ms  192.168.1.1
  2    4 ms    3 ms    3 ms  abts-mum-dynamic-255.63.169.122.airtelbroadband.in [122.169.63.255]
  3    4 ms    4 ms    3 ms  125.18.48.121
  4   30 ms   59 ms   23 ms  182.79.224.132
  5    5 ms    5 ms    5 ms  115.110.234.141.static.Mumbai.vsnl.net.in [115.110.234.141]
  6    5 ms    *        6 ms  115.110.234.170.static.Mumbai.vsnl.net.in [115.110.234.170]
  7    *        *        *      Request timed out.
  8    *        *        *      Request timed out.
  9    *        *        *      Request timed out.
 10    *        *        *      Request timed out.

Trace complete.
```

Observation:

- The first three routers are the same as when tracerouting google.com.
- It took a relatively large amount of time for the packets to be sent from the thirist router(Airtel) to the fourth. Traffic congestion can be one of the reasons.
- The traceroute result has the IP address of VSNL, after which the request timed out.
* indicates no response. This can be because the next routers block tracerouting.

c) berkeley.edu

```
tracert_berkeley.log - Notepad
File Edit Format View Help

Tracing route to berkeley.edu [35.163.72.93]
over a maximum of 10 hops:

  1    1 ms    <1 ms    <1 ms  192.168.1.1
  2    3 ms    4 ms    3 ms  abts-mum-dynamic-255.63.169.122.airtelbroadband.in [122.169.63.255]
  3    4 ms    3 ms    4 ms  dsl-ncr-dynamic-093.88.16.125.airtelbroadband.in [125.16.88.93]
  4   228 ms   228 ms   229 ms  116.119.55.207
  5   225 ms   225 ms   225 ms  99.83.67.88
  6    *        *        *      Request timed out.
  7    *        *        *      Request timed out.
  8   253 ms   252 ms   253 ms  52.93.135.181
  9    *        *        *      Request timed out.
 10    *        *        *      Request timed out.

Trace complete.
```

Observation:

- The traceroute shows that packets are sent from Airtel's Mumbai router to Airtel's Noida router and then transferred to California where Berkeley University is located.
- There are "request timed out" messages which mean that routers didn't respond to the packets.

- The time taken to reach an international router is large compared to reaching a router within the country.

d) www.ox.ac.uk

```
tracert_oxford.log - Notepad
File Edit Format View Help

Tracing route to www.ox.ac.uk [151.101.194.133]
over a maximum of 30 hops:

  0  1 ms  <1 ms  <1 ms  192.168.1.1
  1  3 ms   3 ms   3 ms  abts-mum-dynamic-255.63.169.122.airtelbroadband.in [122.169.63.255]
  2  4 ms   4 ms   3 ms  dsl-ncr-dynamic-093.88.16.125.airtelbroadband.in [125.16.88.93]
  3  5 ms   4 ms   4 ms  116.119.52.88
  4  41 ms  40 ms  41 ms  167.82.128.6
  5  4 ms   6 ms   4 ms  151.101.194.133

Trace complete.
```

Observation:

- The first four routers in the route are the same as when tracerouting to Berkeley University.
- This indicates that the packets are sent via Delhi when an international host is to be reached.
- Previous observation that the time taken to reach an international router is large compared to reaching a router within the country is observed again. So, we can conclude that distance plays a role in time taken to transfer packets.
- The trace completed in 6 hops. So, only a few routers are part of the route to send packets to Oxford University.
- One very interesting observation is that the routers are not physically located in the UK. The routers 5 and 6 are located in California.

RESOURCES:

<https://www.tecmint.com/ifconfig-command-examples/>

<https://www.ip2location.com/demo>

<https://www.imperva.com/learn/performance/round-trip-time-rtt/#:~:text=Server%20response%20time%20%E2%80%93%20The%20time,server%20response%20time%20increases%20RTT>

CONCLUSION:

Successfully implemented basic command line Networking utilities namely ping, ifconfig and traceroute and observed variations in the outputs for each, thereby gaining further knowledge about the sending and receiving of packets.

- Different routes are chosen for different packet sizes i.e. the route taken for 10 byte sized packets may be different than the route taken by 100 bytes packets.
- Distance plays a role in time taken to transfer packets.
- Routers may be physically located anywhere.