Indian Institute of Technology Delhi

COL334 Computer Networks: Assignment 1

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Networking Tools

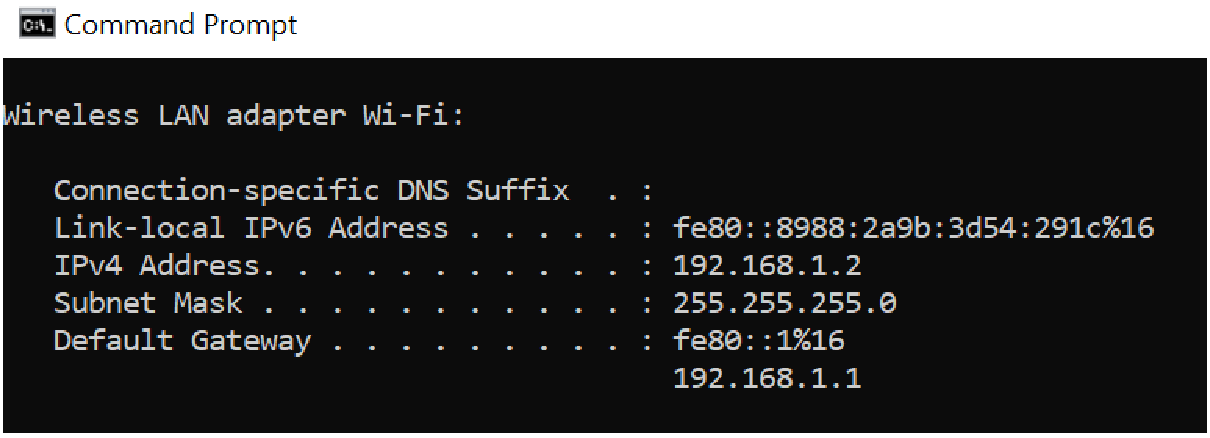
This section will mainly focus on the use of basic networking tools like *ipconfig*, *ping*, *tracert* and *nslookup*.

1.1 Finding IP Address Of My Machine

To find the local IP Address associated with a machine, run **ipconfig** on Command Line Terminal (Windows).

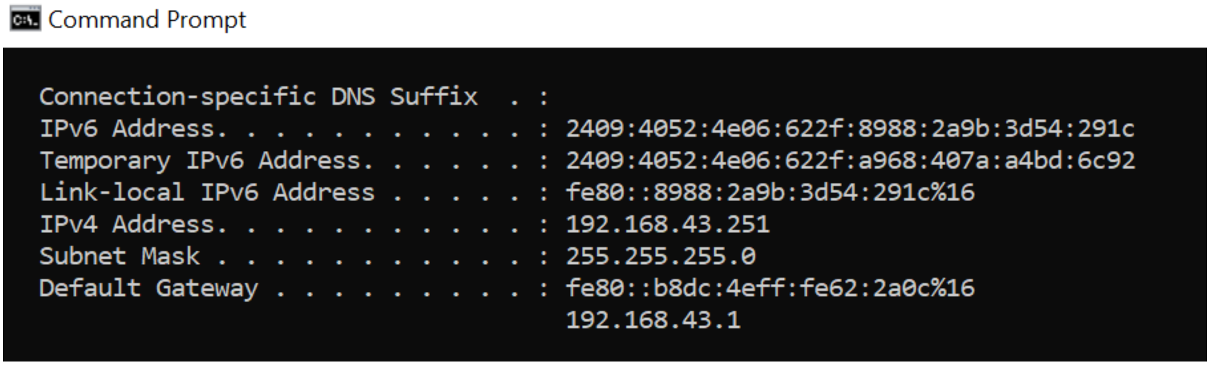
The IP for my machine is **”192.168.1.2”** when connected to Excitel (Service Provider) and **”192.168.43.251”** when connected to Jio (HotSpot from my mobile device).

This is because the Internet Service Provider dynamically assigns the IP Address to its connected devices. It may also change if we reboot the modem or reconnecting a device to the same network.



```
Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::8988:2a9b:3d54:291c%16
   IPv4 Address. . . . . . . . . . . : 192.168.1.2
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : fe80::1%16
                                       192.168.1.1
```

Figure 1: *Local IP Address when connected to Wi-Fi*



```
   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2409:4052:4e06:622f:8988:2a9b:3d54:291c
   Temporary IPv6 Address. . . . . . : 2409:4052:4e06:622f:a968:407a:a4bd:6c92
   Link-local IPv6 Address . . . . . : fe80::8988:2a9b:3d54:291c%16
   IPv4 Address. . . . . . . . . . . : 192.168.43.251
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : fe80::b8dc:4eff:fe62:2a0c%16
                                       192.168.43.1
```

Figure 2: *Local IP Address when connected to Mobile HotSpot*

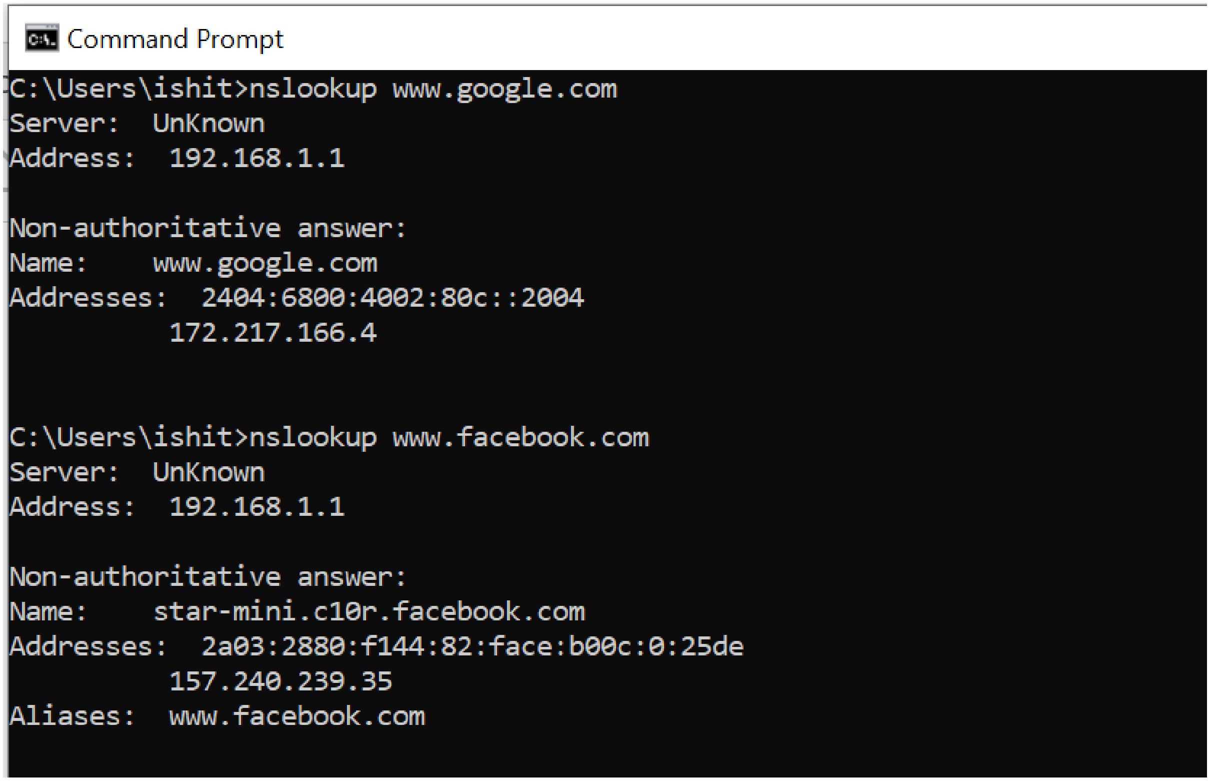
1.2 Finding IP Address Using *nslookup*

To find the IP Address associated with a domain name for default DNS Server, run **nslookup domain-name** on Command Line Terminal (Windows). In case of changing the DNS Server, run **nslookup domain-name IP-Address-of-the-Server**.

When default DNS Server is used, the non-authoritative IP Addresses comes out to be:

www.google.com: 172.217.166.4

www.facebook.com: 157.240.239.35



Command Prompt

```
C:\Users\ishit>nslookup www.google.com
Server:  UnKnown
Address:  192.168.1.1

Non-authoritative answer:
Name:    www.google.com
Addresses:  2404:6800:4002:80c::2004
          172.217.166.4


C:\Users\ishit>nslookup www.facebook.com
Server:  UnKnown
Address:  192.168.1.1

Non-authoritative answer:
Name:    star-mini.c10r.facebook.com
Addresses:  2a03:2880:f144:82:face:b00c:0:25de
          157.240.239.35
Aliases:  www.facebook.com
```

Figure 3: *IP Addresses when default DNS Server is used*

When Cisco OpenDNS Server (208.67.222.222) is used, the non-authoritative IP Addresses comes out to be:

www.google.com: 142.250.194.132

www.facebook.com: 157.240.239.35

When Quad9 DNS Server (9.9.9.9) is used, the non-authoritative IP Addresses comes out to be:

www.google.com: 142.250.207.68

www.facebook.com: 157.240.235.35

This happens because on changing the DNS Server, the requests are sent to different lookups, resulting in different IP addresses.

1.3 Finding Maximum *ping* Packet Size

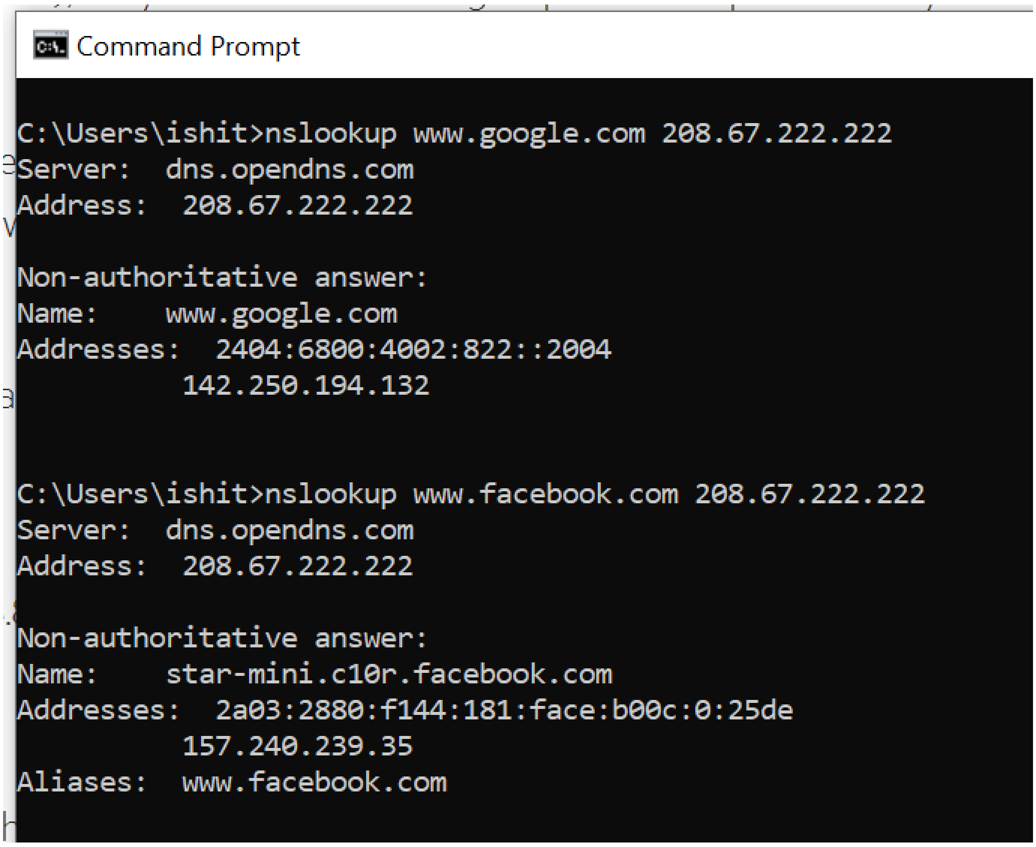
To ping the IP Address of a website, run **ping domain-name -f -l packet-size**. The packet size is in bytes. Similarly, use **-i** flag to vary TTL (Time To Live) of a packet.

The maximum packet size (for 0% loss) for the following are:

www.iitd.ac.in: 1472 bytes

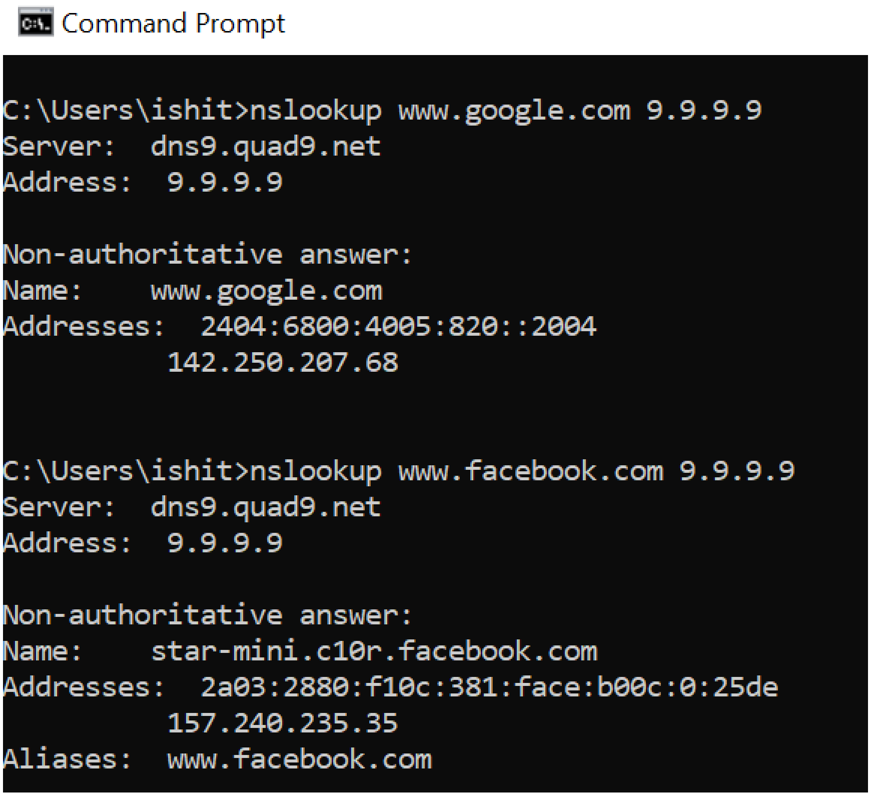
www.google.com: 1464 bytes

www.facebook.com: 1464 bytes



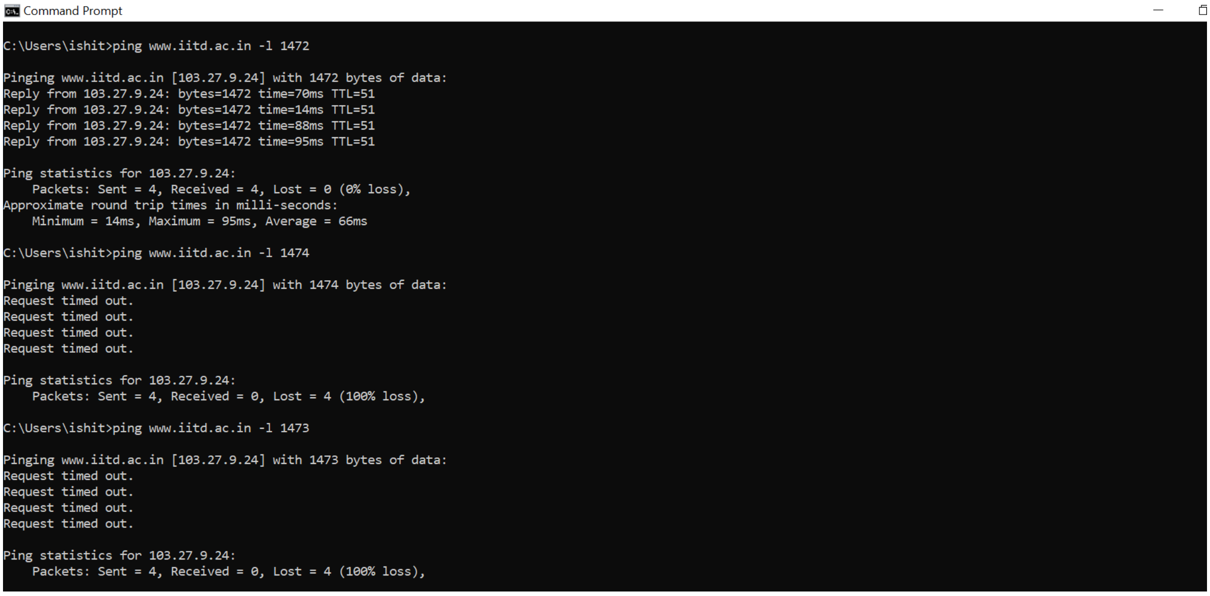
```
C:\Users\ishit>nslookup www.google.com 208.67.222.222
Server:  dns.opendns.com
Address:  208.67.222.222

Non-authoritative answer:
Name:    www.google.com
Addresses:  2404:6800:4002:822::2004
          142.250.194.132


C:\Users\ishit>nslookup www.facebook.com 208.67.222.222
Server:  dns.opendns.com
Address:  208.67.222.222

Non-authoritative answer:
Name:    star-mini.c10r.facebook.com
Addresses:  2a03:2880:f144:181:face:b00c:0:25de
          157.240.239.35
Aliases:  www.facebook.com
```

Figure 4: *IP Addresses when Cisco OpenDNS Server is used*



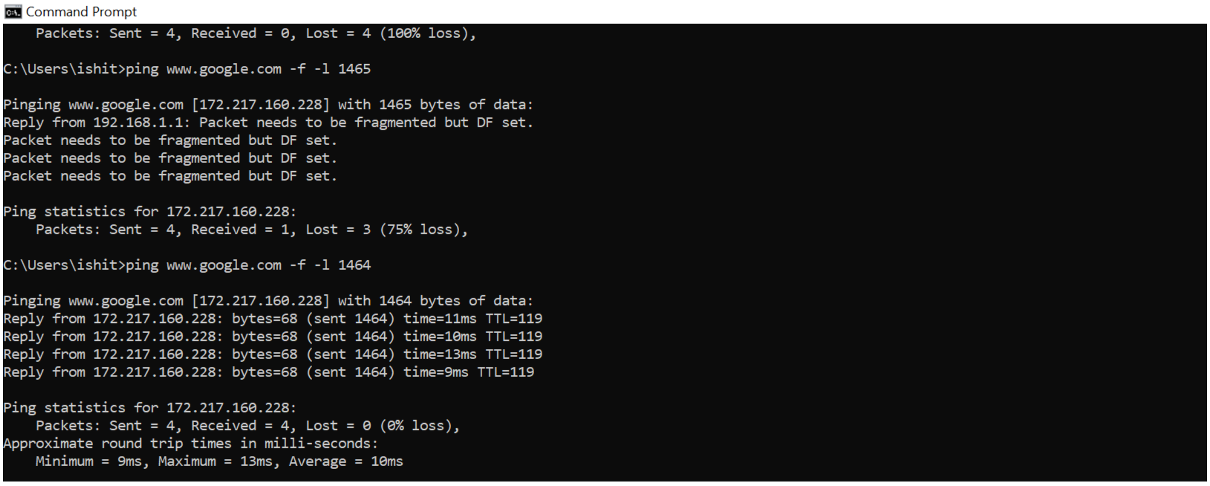
```
C:\Users\ishit>nslookup www.google.com 9.9.9.9
Server:  dns9.quad9.net
Address:  9.9.9.9

Non-authoritative answer:
Name:    www.google.com
Addresses:  2404:6800:4005:820::2004
          142.250.207.68


C:\Users\ishit>nslookup www.facebook.com 9.9.9.9
Server:  dns9.quad9.net
Address:  9.9.9.9

Non-authoritative answer:
Name:    star-mini.c10r.facebook.com
Addresses:  2a03:2880:f10c:381:face:b00c:0:25de
          157.240.235.35
Aliases:  www.facebook.com
```

Figure 5: *IP Addresses when Quad9 DNS Server is used*



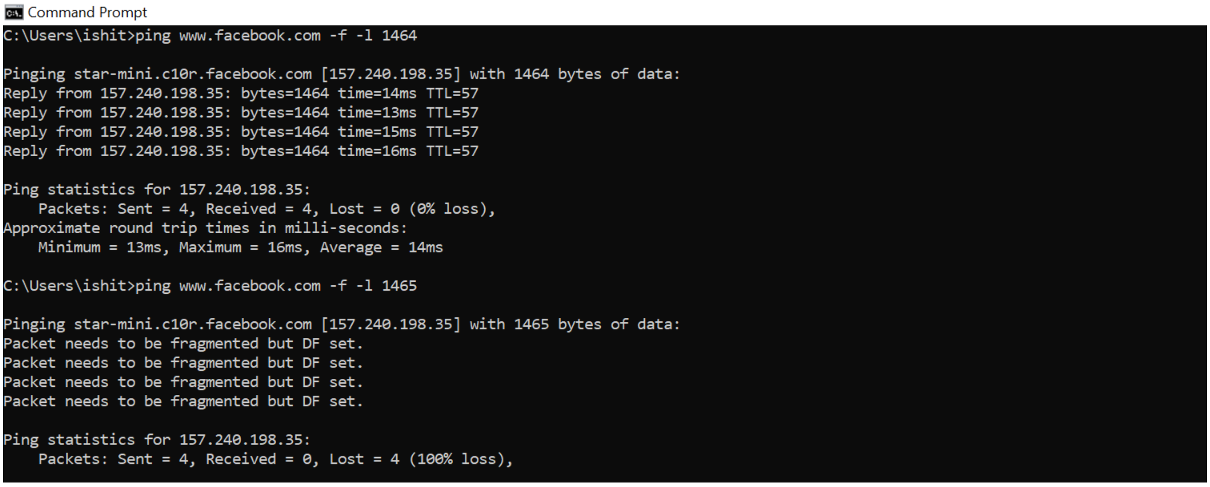
```
C:\Users\ishit>ping www.iitd.ac.in -l 1472

Pinging www.iitd.ac.in [103.27.9.24] with 1472 bytes of data:
Reply from 103.27.9.24: bytes=1472 time=70ms TTL=51
Reply from 103.27.9.24: bytes=1472 time=14ms TTL=51
Reply from 103.27.9.24: bytes=1472 time=88ms TTL=51
Reply from 103.27.9.24: bytes=1472 time=95ms TTL=51

Ping statistics for 103.27.9.24:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 14ms, Maximum = 95ms, Average = 66ms

C:\Users\ishit>ping www.iitd.ac.in -l 1474

Pinging www.iitd.ac.in [103.27.9.24] with 1474 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 103.27.9.24:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\ishit>ping www.iitd.ac.in -l 1473

Pinging www.iitd.ac.in [103.27.9.24] with 1473 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 103.27.9.24:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 6: *Maximum Packet Size for www.iitd.ac.in*



```
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\ishit>ping www.google.com -f -l 1465

Pinging www.google.com [172.217.160.228] with 1465 bytes of data:
Reply from 192.168.1.1: Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.

Ping statistics for 172.217.160.228:
    Packets: Sent = 4, Received = 1, Lost = 3 (75% loss),

C:\Users\ishit>ping www.google.com -f -l 1464

Pinging www.google.com [172.217.160.228] with 1464 bytes of data:
Reply from 172.217.160.228: bytes=68 (sent 1464) time=11ms TTL=119
Reply from 172.217.160.228: bytes=68 (sent 1464) time=10ms TTL=119
Reply from 172.217.160.228: bytes=68 (sent 1464) time=13ms TTL=119
Reply from 172.217.160.228: bytes=68 (sent 1464) time=9ms TTL=119

Ping statistics for 172.217.160.228:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 9ms, Maximum = 13ms, Average = 10ms
```

Figure 7: *Maximum Packet Size for www.google.com*

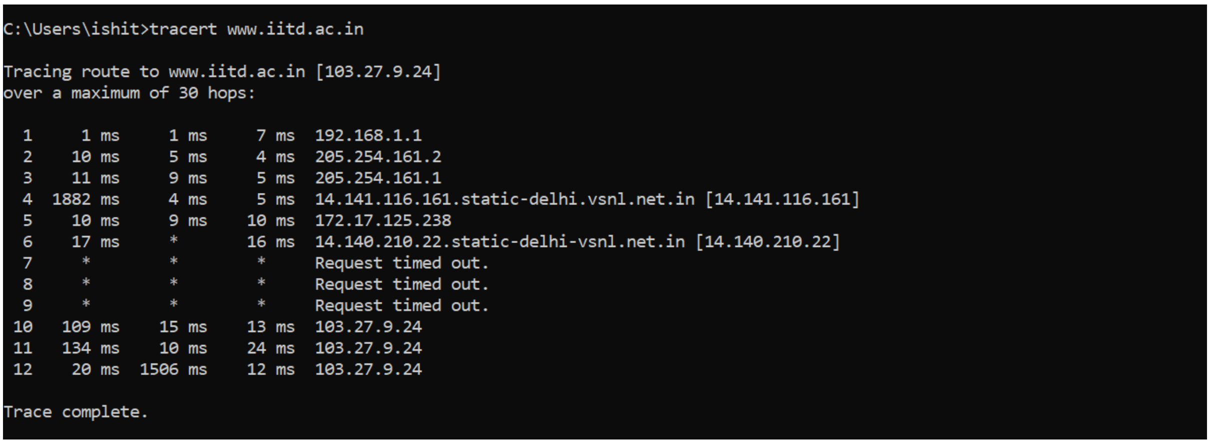


```
C:\Users\ishit>ping www.facebook.com -f -l 1464

Pinging star-mini.c10r.facebook.com [157.240.198.35] with 1464 bytes of data:
Reply from 157.240.198.35: bytes=1464 time=14ms TTL=57
Reply from 157.240.198.35: bytes=1464 time=13ms TTL=57
Reply from 157.240.198.35: bytes=1464 time=15ms TTL=57
Reply from 157.240.198.35: bytes=1464 time=16ms TTL=57

Ping statistics for 157.240.198.35:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 13ms, Maximum = 16ms, Average = 14ms

C:\Users\ishit>ping www.facebook.com -f -l 1465

Pinging star-mini.c10r.facebook.com [157.240.198.35] with 1465 bytes of data:
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.
Packet needs to be fragmented but DF set.

Ping statistics for 157.240.198.35:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Figure 8: *Maximum Packet Size for www.facebook.com*

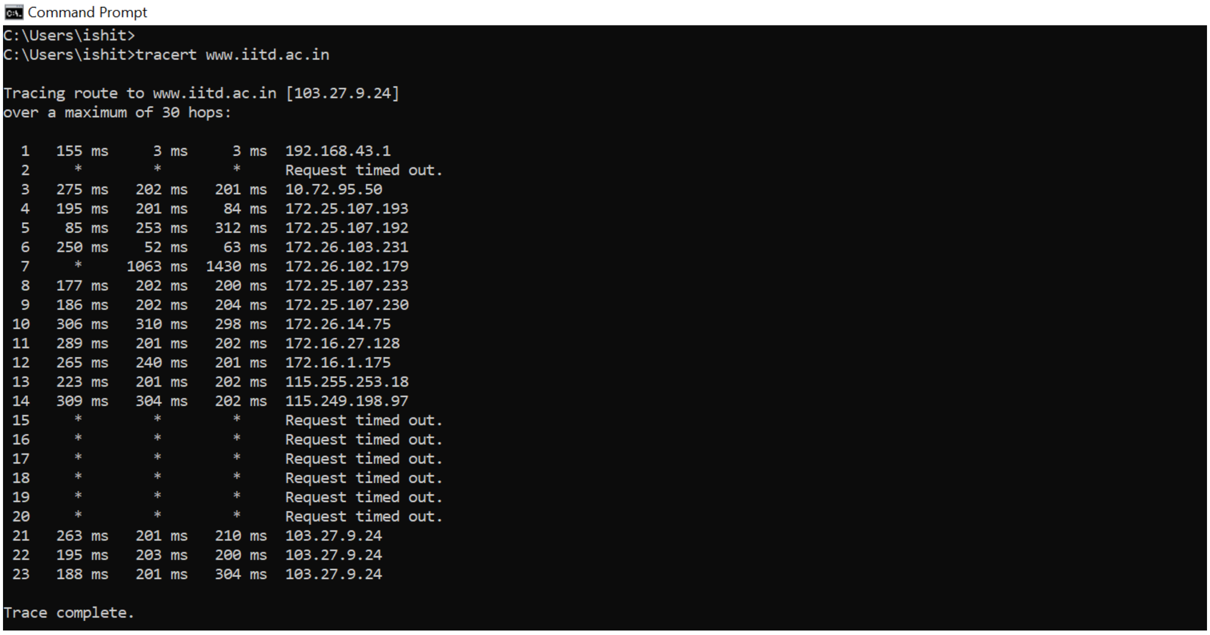
1.4 Using *traceroute*

To trace the route of a packet hop by hop, run **tracert domain-name** on Command Line Prompt (on Windows). This will give the following output when connected to Wi-fi and Mobile Hotspot.



```
C:\Users\ishit>tracert www.iitd.ac.in

Tracing route to www.iitd.ac.in [103.27.9.24]
over a maximum of 30 hops:

  1     1 ms     1 ms     7 ms  192.168.1.1
  2    10 ms     5 ms     4 ms  205.254.161.2
  3    11 ms     9 ms     5 ms  205.254.161.1
  4  1882 ms     4 ms     5 ms  14.141.116.161.static-delhi.vsnl.net.in [14.141.116.161]
  5    10 ms     9 ms    10 ms  172.17.125.238
  6    17 ms     *       16 ms  14.140.210.22.static-delhi-vsnl.net.in [14.140.210.22]
  7     *        *        *     Request timed out.
  8     *        *        *     Request timed out.
  9     *        *        *     Request timed out.
 10   109 ms    15 ms    13 ms  103.27.9.24
 11   134 ms    10 ms    24 ms  103.27.9.24
 12    20 ms  1506 ms    12 ms  103.27.9.24

Trace complete.
```

Figure 9: *Trace Route with Excitel Wi-fi Network*



```
C:\Users\ishit>
C:\Users\ishit>tracert www.iitd.ac.in

Tracing route to www.iitd.ac.in [103.27.9.24]
over a maximum of 30 hops:

  1   155 ms     3 ms     3 ms  192.168.43.1
  2     *        *        *     Request timed out.
  3   275 ms   202 ms   201 ms  10.72.95.50
  4   195 ms   201 ms    84 ms  172.25.107.193
  5    85 ms   253 ms   312 ms  172.25.107.192
  6   250 ms    52 ms    63 ms  172.26.103.231
  7     *     1063 ms  1430 ms  172.26.102.179
  8   177 ms   202 ms   200 ms  172.25.107.233
  9   186 ms   202 ms   204 ms  172.25.107.230
 10   306 ms   310 ms   298 ms  172.26.14.75
 11   289 ms   201 ms   202 ms  172.16.27.128
 12   265 ms   240 ms   201 ms  172.16.1.175
 13   223 ms   201 ms   202 ms  115.255.253.18
 14   309 ms   304 ms   202 ms  115.249.198.97
 15     *        *        *     Request timed out.
 16     *        *        *     Request timed out.
 17     *        *        *     Request timed out.
 18     *        *        *     Request timed out.
 19     *        *        *     Request timed out.
 20     *        *        *     Request timed out.
 21   263 ms   201 ms   210 ms  103.27.9.24
 22   195 ms   203 ms   200 ms  103.27.9.24
 23   188 ms   201 ms   304 ms  103.27.9.24

Trace complete.
```

Figure 10: *Trace Route with Jio Mobile Hotspot*

Some routers do not reply due to ICMP Blocking.

The traceroute command by default uses IPv4 path, to get an IPv6 path to a specified domain, we can use flag **"-6"** to fix IPv6 and similarly **"-4"** for IPv4.

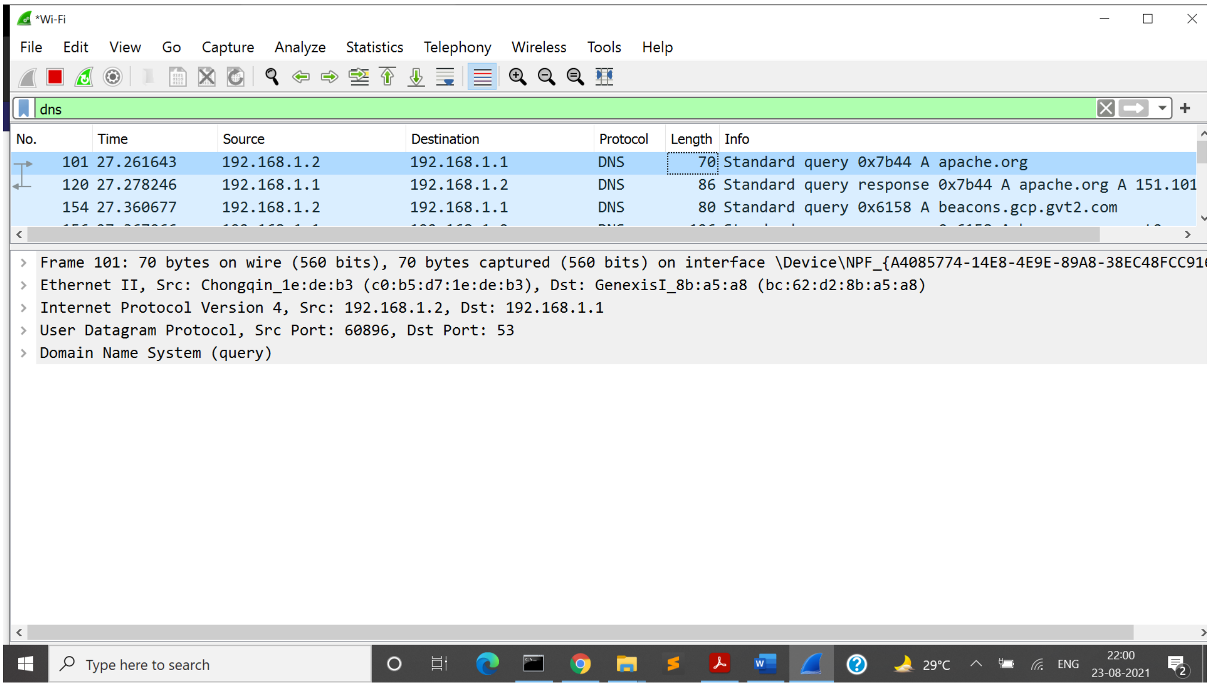
Packet Analysis

In this section, we will use Wireshark to sniff packets on the wire. Before capturing the packets, we must flush the DNS Cache by executing the following command on prompt: **ipconfig/flushdns**

Followed by clearing the browser cache.

2.1 Applying a *dns* Filter on Packet Trace

I can find one query and one response from all the grabbed packets of website. It took 16.6ms (27.278246s-27.261643s) to carry out the DNS query. This is the time between request and response DNS query.



dns

No.	Time	Source	Destination	Protocol	Length	Info
101	27.261643	192.168.1.2	192.168.1.1	DNS	70	Standard query 0x7b44 A apache.org
120	27.278246	192.168.1.1	192.168.1.2	DNS	86	Standard query response 0x7b44 A apache.org A 151.101
154	27.360677	192.168.1.2	192.168.1.1	DNS	80	Standard query 0x6158 A beacons.gcp.gvt2.com

```
> Frame 101: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface \Device\NPF_{A4085774-14E8-4E9E-89A8-38EC48FCC91
> Ethernet II, Src: Chongqin_1e:de:b3 (c0:b5:d7:1e:de:b3), Dst: GenexisI_8b:a5:a8 (bc:62:d2:8b:a5:a8)
> Internet Protocol Version 4, Src: 192.168.1.2, Dst: 192.168.1.1
> User Datagram Protocol, Src Port: 60896, Dst Port: 53
> Domain Name System (query)
```

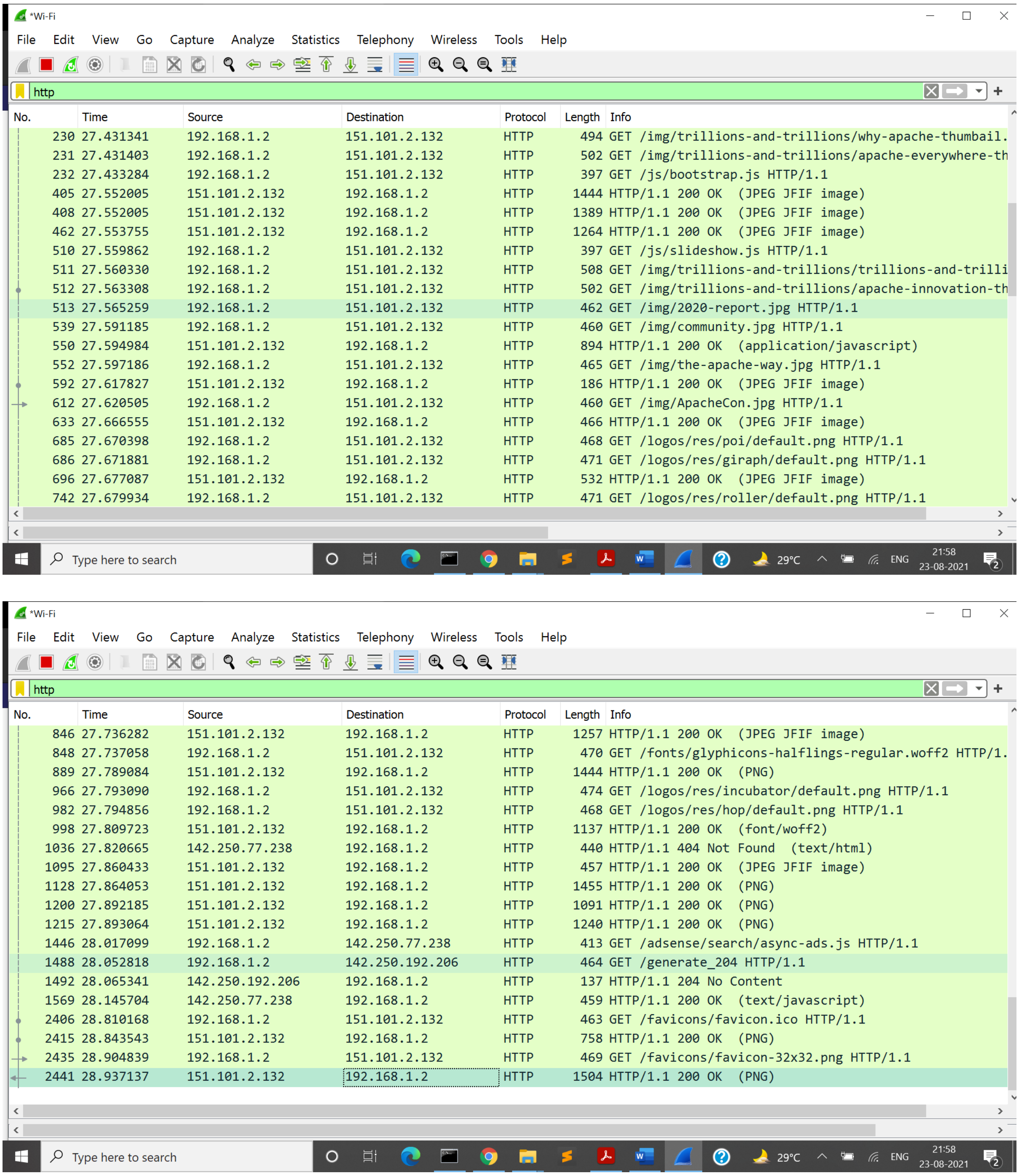
Figure 11: *DNS Filter for apache.org*

2.2 Applying an *http* Filter on Packet Trace

There were 49 HTTP packets in total, with 27 requests from my IP (192.168.1.2) to the IP of the web-server (151.101.2.132) and 22 packets sent in the other direction. From the number of packets, we get to know that web-pages are split into multiple components like html content, css content, js scripts, images, and other media. From the packets received, we can see that webpages are in the form of HTML and CSS files, with embedded JS. From here it seems that the browser starts processing the main HTML file, and then for each piece of content (multimedia or script), it sends out an HTML request to procure that file from the web server and so on (while recursively parsing the webpage and also sending out HTML requests when certain actions get triggered in the scripts).

2.3 Finding the Time Taken to Download the Webpage

The total time taken for the download of the entire webpage is 1.675494 s, which is the time when the last content object was received (the first DNS request was sent at 27.261643 s to the



```
No.   Time       Source         Destination    Protocol  Length Info
  230 27.431341  192.168.1.2    151.101.2.132  HTTP       494 GET /img/trillions-and-trillions/why-apache-thumbail.
  231 27.431403  192.168.1.2    151.101.2.132  HTTP       502 GET /img/trillions-and-trillions/apache-everywhere-th
  232 27.433284  192.168.1.2    151.101.2.132  HTTP       397 GET /js/bootstrap.js HTTP/1.1
  405 27.552005  151.101.2.132  192.168.1.2    HTTP      1444 HTTP/1.1 200 OK  (JPEG JFIF image)
  408 27.552005  151.101.2.132  192.168.1.2    HTTP      1389 HTTP/1.1 200 OK  (JPEG JFIF image)
  462 27.553755  151.101.2.132  192.168.1.2    HTTP      1264 HTTP/1.1 200 OK  (JPEG JFIF image)
  510 27.559862  192.168.1.2    151.101.2.132  HTTP       397 GET /js/slideshow.js HTTP/1.1
  511 27.560330  192.168.1.2    151.101.2.132  HTTP       508 GET /img/trillions-and-trillions/trillions-and-trilli
  512 27.563308  192.168.1.2    151.101.2.132  HTTP       502 GET /img/trillions-and-trillions/apache-innovation-th
  513 27.565259  192.168.1.2    151.101.2.132  HTTP       462 GET /img/2020-report.jpg HTTP/1.1
  539 27.591185  192.168.1.2    151.101.2.132  HTTP       460 GET /img/community.jpg HTTP/1.1
  550 27.594984  151.101.2.132  192.168.1.2    HTTP       894 HTTP/1.1 200 OK  (application/javascript)
  552 27.597186  192.168.1.2    151.101.2.132  HTTP       465 GET /img/the-apache-way.jpg HTTP/1.1
  592 27.617827  151.101.2.132  192.168.1.2    HTTP       186 HTTP/1.1 200 OK  (JPEG JFIF image)
  612 27.620505  192.168.1.2    151.101.2.132  HTTP       460 GET /img/ApacheCon.jpg HTTP/1.1
  633 27.666555  151.101.2.132  192.168.1.2    HTTP       466 HTTP/1.1 200 OK  (JPEG JFIF image)
  685 27.670398  192.168.1.2    151.101.2.132  HTTP       468 GET /logos/res/poi/default.png HTTP/1.1
  686 27.671881  192.168.1.2    151.101.2.132  HTTP       471 GET /logos/res/giraph/default.png HTTP/1.1
  696 27.677087  151.101.2.132  192.168.1.2    HTTP       532 HTTP/1.1 200 OK  (JPEG JFIF image)
  742 27.679934  192.168.1.2    151.101.2.132  HTTP       471 GET /logos/res/roller/default.png HTTP/1.1
```

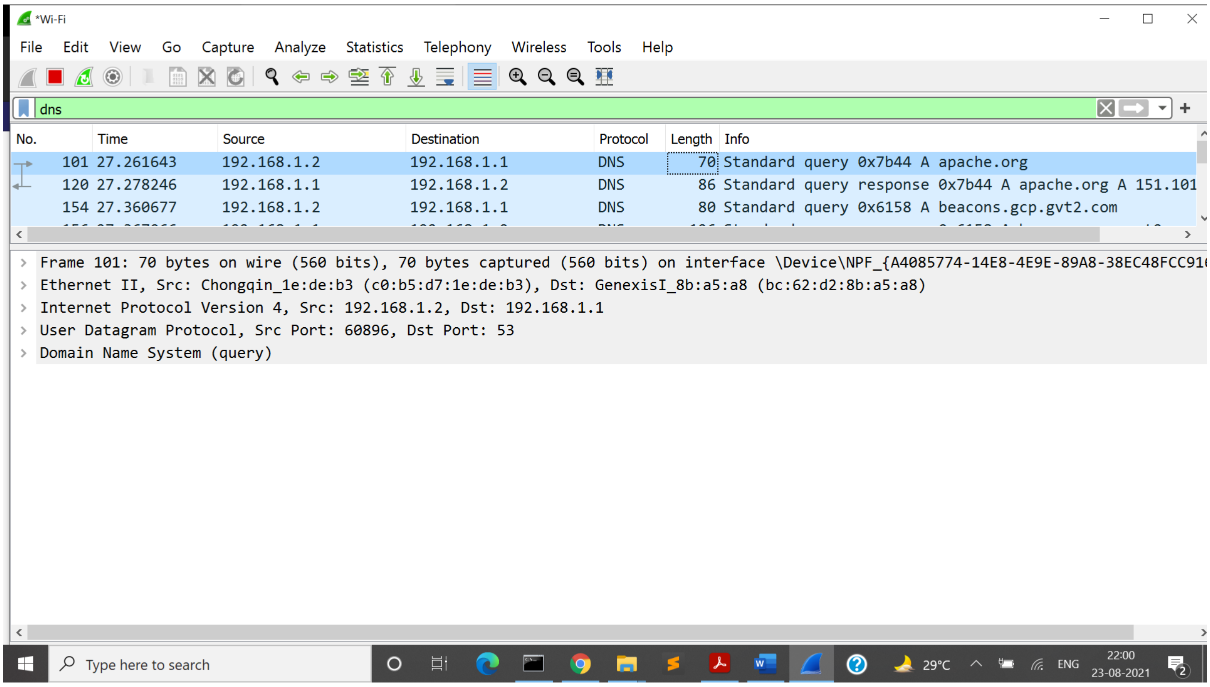
```
No.   Time       Source           Destination      Protocol  Length Info
  846 27.736282  151.101.2.132    192.168.1.2      HTTP      1257 HTTP/1.1 200 OK  (JPEG JFIF image)
  848 27.737058  192.168.1.2      151.101.2.132    HTTP       470 GET /fonts/glyphicons-halflings-regular.woff2 HTTP/1.
  889 27.789084  151.101.2.132    192.168.1.2      HTTP      1444 HTTP/1.1 200 OK  (PNG)
  966 27.793090  192.168.1.2      151.101.2.132    HTTP       474 GET /logos/res/incubator/default.png HTTP/1.1
  982 27.794856  192.168.1.2      151.101.2.132    HTTP       468 GET /logos/res/hop/default.png HTTP/1.1
  998 27.809723  151.101.2.132    192.168.1.2      HTTP      1137 HTTP/1.1 200 OK  (font/woff2)
 1036 27.820665  142.250.77.238   192.168.1.2      HTTP       440 HTTP/1.1 404 Not Found  (text/html)
 1095 27.860433  151.101.2.132    192.168.1.2      HTTP       457 HTTP/1.1 200 OK  (JPEG JFIF image)
 1128 27.864053  151.101.2.132    192.168.1.2      HTTP      1455 HTTP/1.1 200 OK  (PNG)
 1200 27.892185  151.101.2.132    192.168.1.2      HTTP      1091 HTTP/1.1 200 OK  (PNG)
 1215 27.893064  151.101.2.132    192.168.1.2      HTTP      1240 HTTP/1.1 200 OK  (PNG)
 1446 28.017099  192.168.1.2      142.250.77.238   HTTP       413 GET /adsense/search/async-ads.js HTTP/1.1
 1488 28.052818  192.168.1.2      142.250.192.206  HTTP       464 GET /generate_204 HTTP/1.1
 1492 28.065341  142.250.192.206  192.168.1.2      HTTP       137 HTTP/1.1 204 No Content
 1569 28.145704  142.250.77.238   192.168.1.2      HTTP       459 HTTP/1.1 200 OK  (text/javascript)
 2406 28.810168  192.168.1.2      151.101.2.132    HTTP       463 GET /favicons/favicon.ico HTTP/1.1
 2415 28.843543  151.101.2.132    192.168.1.2      HTTP       758 HTTP/1.1 200 OK  (PNG)
 2435 28.904839  192.168.1.2      151.101.2.132    HTTP       469 GET /favicons/favicon-32x32.png HTTP/1.1
 2441 28.937137  151.101.2.132    192.168.1.2      HTTP      1504 HTTP/1.1 200 OK  (PNG)
```

Figure 12: *http Filter for apache.org*

time when the last content was received at 28.937137 s).

2.4 Comparing the *http* Traffic

I can find only 2 http logs for the webpage http://www.cse.iitd.ac.in. There was an attempt to connect via HTTP, but there was a returned code 301, which says Moved Permanently. On searching for this error code, I found that this is considered to be a best practice for upgrading users from HTTP to HTTPS, and the lack of subsequent HTTP packets even though the whole website loaded properly indicates that this is indeed the case. HTTP uses TLS(SSL) for a secure encrypted transfer of data. On the other hand, apache.org does not use https and therefore is

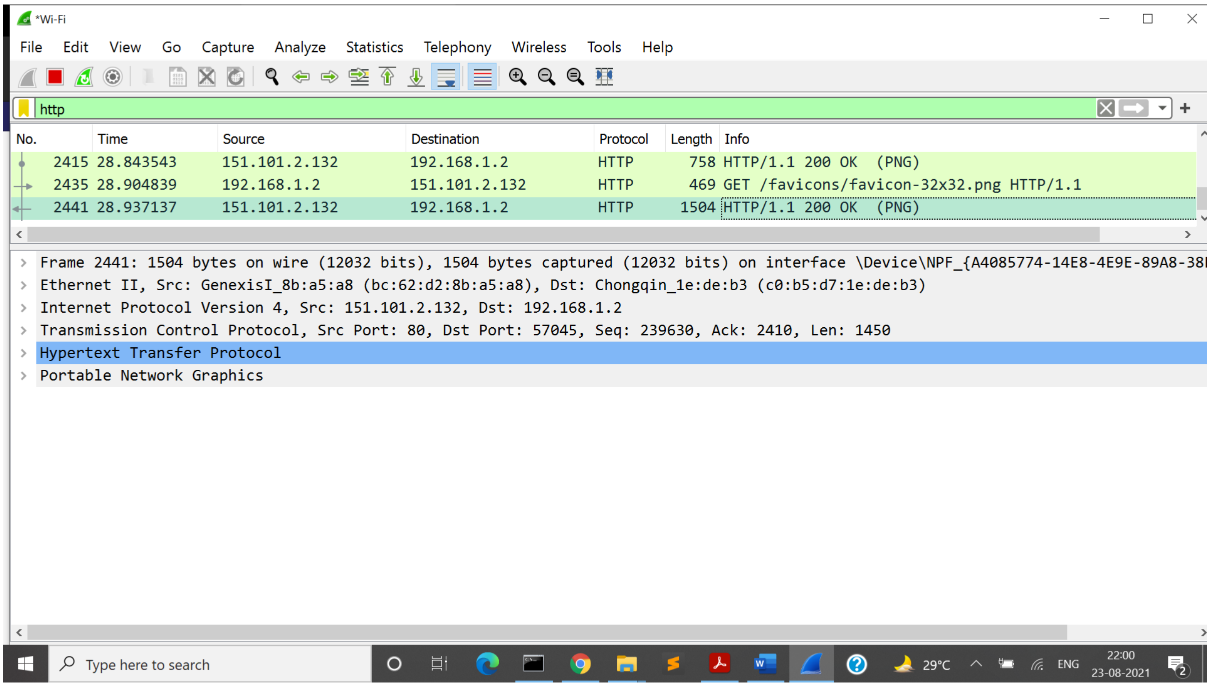

*Wi-Fi
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Type here to search
29°C
ENG
22:00
23-08-2021

dns

```
No.   Time       Source         Destination    Protocol  Length  Info
  101 27.261643  192.168.1.2    192.168.1.1    DNS           70  Standard query 0x7b44 A apache.org
  120 27.278246  192.168.1.1    192.168.1.2    DNS           86  Standard query response 0x7b44 A apache.org A 151.101
  154 27.360677  192.168.1.2    192.168.1.1    DNS           80  Standard query 0x6158 A beacons.gcp.gvt2.com
```

```
> Frame 101: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface \Device\NPF_{A4085774-14E8-4E9E-89A8-38EC48FCC91
> Ethernet II, Src: Chongqin_1e:de:b3 (c0:b5:d7:1e:de:b3), Dst: GenexisI_8b:a5:a8 (bc:62:d2:8b:a5:a8)
> Internet Protocol Version 4, Src: 192.168.1.2, Dst: 192.168.1.1
> User Datagram Protocol, Src Port: 60896, Dst Port: 53
> Domain Name System (query)
```

Figure 13: *First DNS Request being sent*


*Wi-Fi
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Type here to search
29°C
ENG
22:00
23-08-2021

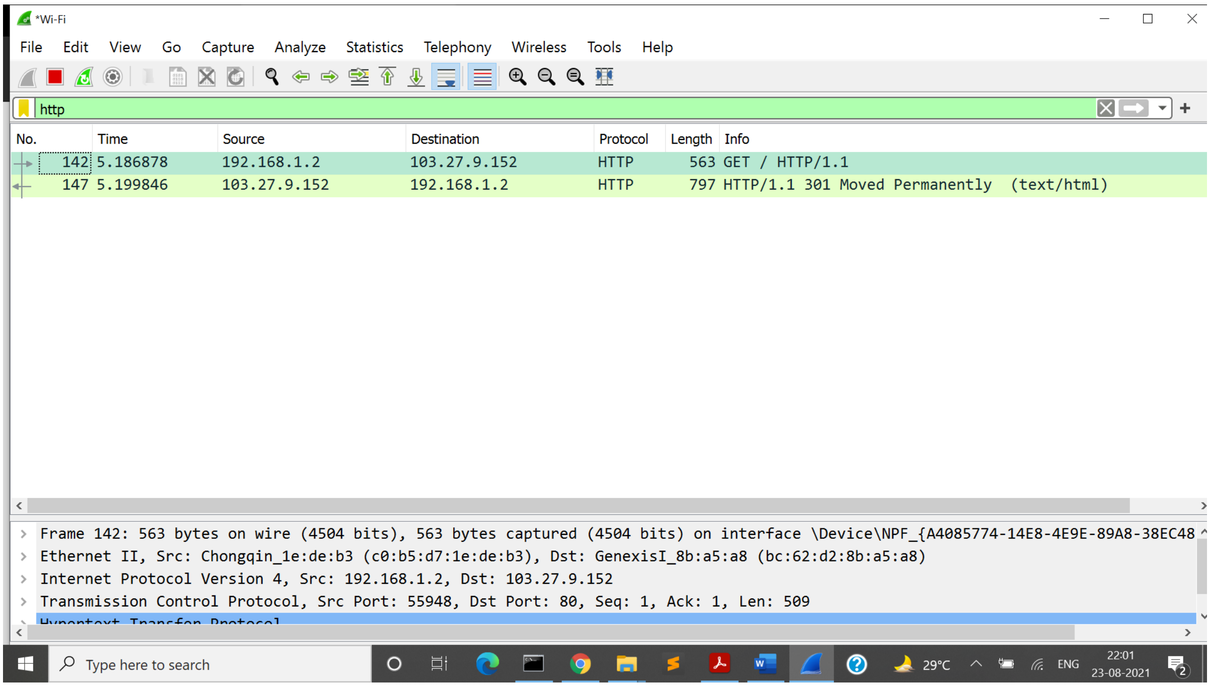
http

```
No.   Time       Source         Destination    Protocol  Length  Info
 2415 28.843543  151.101.2.132  192.168.1.2    HTTP         758  HTTP/1.1 200 OK  (PNG)
 2435 28.904839  192.168.1.2    151.101.2.132  HTTP         469  GET /favicons/favicon-32x32.png HTTP/1.1
 2441 28.937137  151.101.2.132  192.168.1.2    HTTP        1504  HTTP/1.1 200 OK  (PNG)
```

```
> Frame 2441: 1504 bytes on wire (12032 bits), 1504 bytes captured (12032 bits) on interface \Device\NPF_{A4085774-14E8-4E9E-89A8-38
> Ethernet II, Src: GenexisI_8b:a5:a8 (bc:62:d2:8b:a5:a8), Dst: Chongqin_1e:de:b3 (c0:b5:d7:1e:de:b3)
> Internet Protocol Version 4, Src: 151.101.2.132, Dst: 192.168.1.2
> Transmission Control Protocol, Src Port: 80, Dst Port: 57045, Seq: 239630, Ack: 2410, Len: 1450
> Hypertext Transfer Protocol
> Portable Network Graphics
```

Figure 14: *Last content request being recieved*

easily readable when sniffed by Wireshark.


*Wi-Fi
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Type here to search
29°C
ENG
22:01
23-08-2021

http

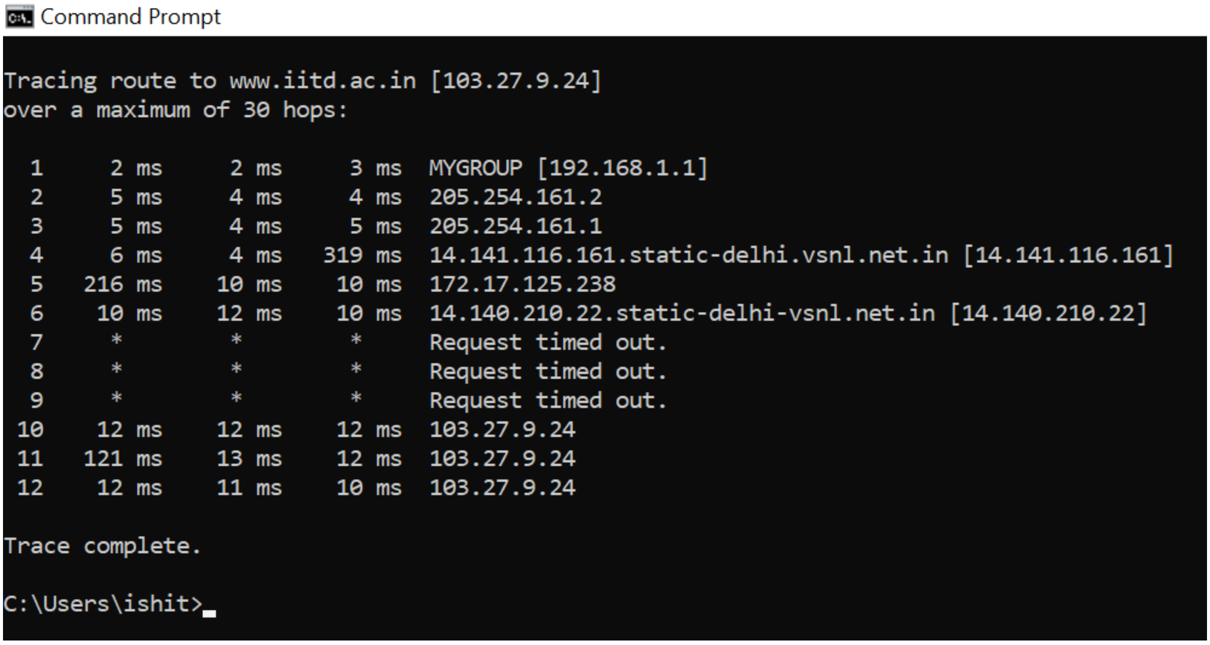
No.	Time	Source	Destination	Protocol	Length	Info
142	5.186878	192.168.1.2	103.27.9.152	HTTP	563	GET / HTTP/1.1
147	5.199846	103.27.9.152	192.168.1.2	HTTP	797	HTTP/1.1 301 Moved Permanently (text/html)

```
> Frame 142: 563 bytes on wire (4504 bits), 563 bytes captured (4504 bits) on interface \Device\NPF_{A4085774-14E8-4E9E-89A8-38EC48
> Ethernet II, Src: Chongqin_1e:de:b3 (c0:b5:d7:1e:de:b3), Dst: GenexisI_8b:a5:a8 (bc:62:d2:8b:a5:a8)
> Internet Protocol Version 4, Src: 192.168.1.2, Dst: 103.27.9.152
> Transmission Control Protocol, Src Port: 55948, Dst Port: 80, Seq: 1, Ack: 1, Len: 509
  Hypertext Transfer Protocol
```

Figure 15: *http filter for http://www.cse.iitd.ac.in*

Analysis of Traceroute

Run the tracert command for www.iitd.ac.in. We will get the results for it as follows. the first column depicts the hop number followed by three columns which depicts the RTT (Round Trip Time) as the router is being pinged with 3 packets at each hop.



```
Tracing route to www.iitd.ac.in [103.27.9.24]
over a maximum of 30 hops:

  1     2 ms     2 ms     3 ms  MYGROUP [192.168.1.1]
  2     5 ms     4 ms     4 ms  205.254.161.2
  3     5 ms     4 ms     5 ms  205.254.161.1
  4     6 ms     4 ms   319 ms  14.141.116.161.static-delhi.vsnl.net.in [14.141.116.161]
  5   216 ms    10 ms    10 ms  172.17.125.238
  6    10 ms    12 ms    10 ms  14.140.210.22.static-delhi-vsnl.net.in [14.140.210.22]
  7     *        *        *     Request timed out.
  8     *        *        *     Request timed out.
  9     *        *        *     Request timed out.
 10    12 ms    12 ms    12 ms  103.27.9.24
 11   121 ms    13 ms    12 ms  103.27.9.24
 12    12 ms    11 ms    10 ms  103.27.9.24

Trace complete.

C:\Users\ishit>
```

Figure 16: *Traceroute result for www.iitd.ac.in*

3.1 RTT vs Hop Number Analysis

Calculate the average RTT and plot it against the Hop Number to obtain the graph below.

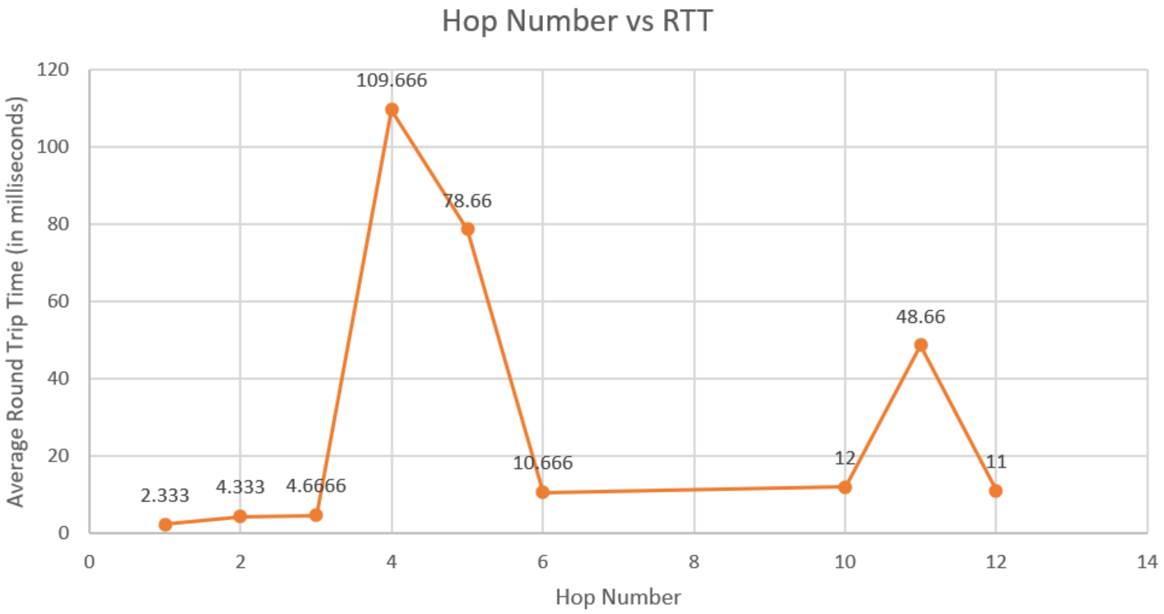


Figure 17: *RTT vs Hop Number for www.iitd.ac.in*