CS 558: Computer Systems Lab

Assignment – 1: Network Diagnostic Commands

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Answer 1 :

(a) **ping -c count** : option is required to specify the number of echo requests to send with ping
Example : ping -c 5 www.google.com will send 5 ICMP ECHO_REQUESTS to the specified address

(b) **-i interval** : option is required to set me interval (in seconds), rather than the default one second interval, between two successive ping ECHO_REQUESTs.
Example: ping www.google.com -i 5 will send ICMP ECHO_REQUESTS to the specified address every 5 seconds

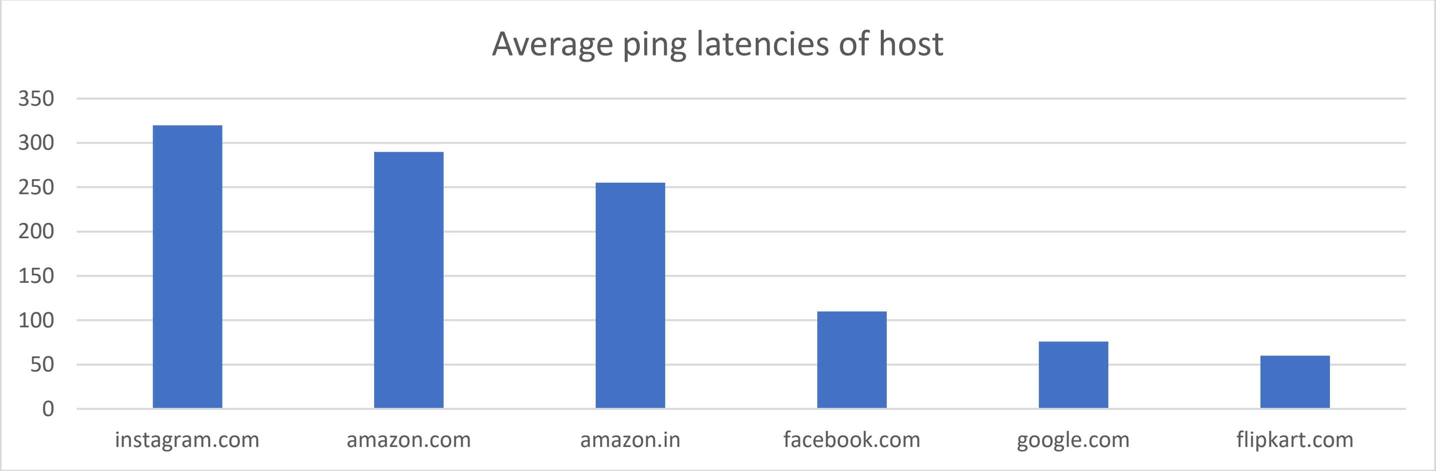
(c) **ping -f destination** command is used to send ECHO_REQUEST packets to the destination one after another without waiting for a reply.
Example: sudo ping www.google.com –f will flood the target with ICMP ECHO_REQUESTS without waiting for reply.
Such ECHO_REQUEST packets can be sent by normal users (not super user) only when **'minimal interval between each request is 0.2s'.**

(d) **ping -s size** : is the command to set the ECHO_REQUEST packet size (in bytes). If the Packet Size is set to 32 bytes, the total packet size will be 60Bytes.

Answer 2 :

Hosts Chosen are :

1.Instagram.com 2. Facebook.com 3.Google.com 4.Flipkart.com 5. Amazon.in 6.Amazon.com



Impact of geographical distance : Ping latencies are weakly correlated to Geographical distance. As seen from above graph, ping latency for amazon.com is more compared to amazon.in. Since amazon.in server is likely to be in India compared to amazon.com which would be in USA. Note that RTTs for above hosts are weakly correlated with geographic distance of host as packet travels with speed of light between two hops. It Is strongly correlated with number of hops to the host because main latency comes by waiting in queue of hop.

Packet loss greater than 0% : Packet lost in above experiments were not observed except for one case where 1 packets was lost out of 20.

Reason for packet loss greater than 0% :

- ➢ Packets were blocked by some firewall deployed on server.
- ➢ There may be packet loss due to high traffic or congestion in network.
- ➢ There are many hosts which don't respond to ping request

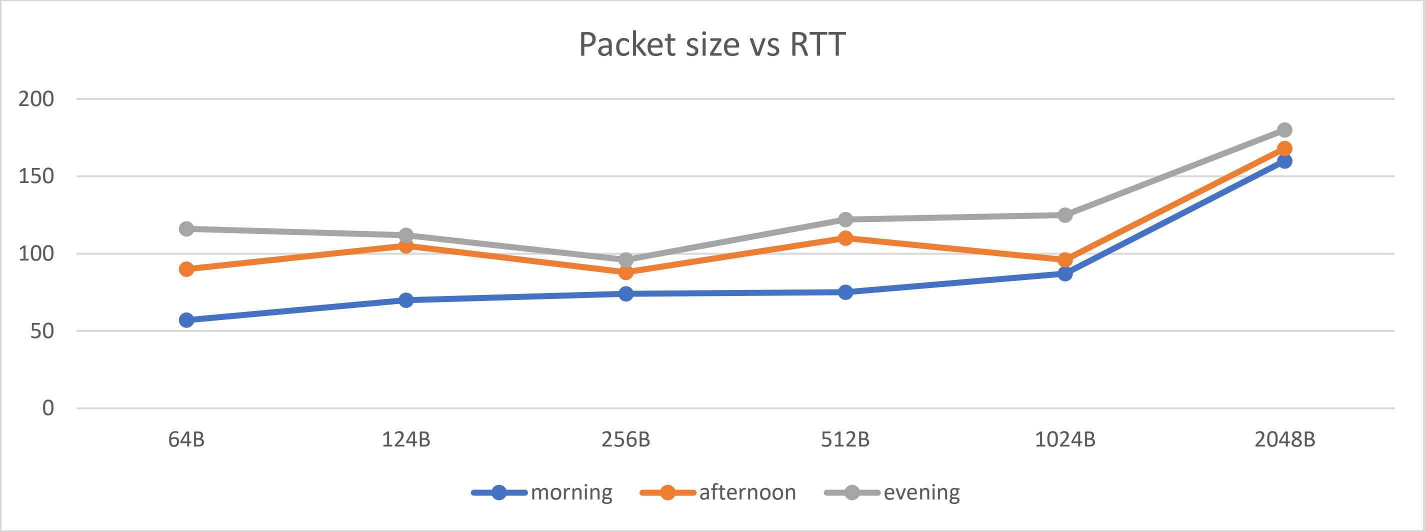
Hosts Chosen for pinging with different data size packets :

I chose www.google.com to repeat the experiment with different packet sizes from 64 bytes – 2048 bytes. I observed a change of nearly 10% in change of measured RTTs in a particular time period(diff. sizes) and we also observed that measured RTTs were different at different time of day. The probable reason for the first one could be due to larger packet size, it takes more time for transmission but the major part of RTTs is composed of connection establishment time and transmission time, it depends very less on the packet size though we can see a slight positive correlation.

Impact of ping packet size on latencies : When packet size is more than 1500(default MTU) then request is sent in multiple frame which may lead to more ping latency.

Effect of packet size on RTT: o Every router and switch along the path has to receive the entire packet/frame before it can forward it. The latency introduced at each point thus equals the speed of the inbound link in bps divided by the frame size in bits.
Larger frames = increased latency.

Effect of time of day on RTT: Internet service provider gateway can handle constant number of request per second. So in some hours of day it is seen that ping time increased, this is because of in that time there are more internet users from this ISP that sending request to gateway, therefore this high number of requests exceed the number of requests that ISP gateway can handle. so some of the request included your ping request should be remains in gateway queue and this may cause some delay in answering these request and finally it can increase the ping time

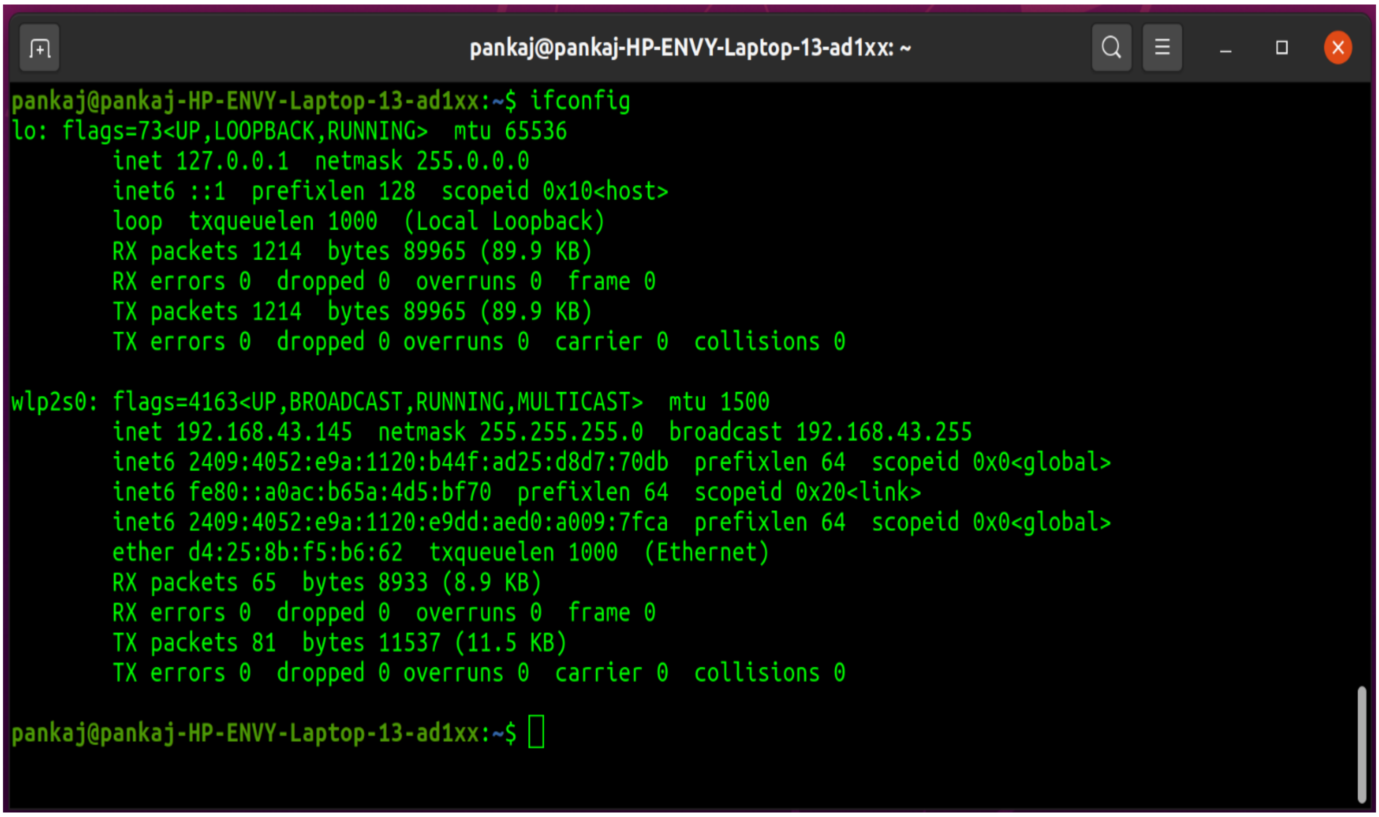


Answer 3 :

(a) **ifconfig**: A utility used to configure the kernel-resident network interfaces. It is used at boot time to set up interface as necessary. If no arguments are given. Ifconfig displays the status of the currently active interfaces.

Generally, there are 3 active network interfaces on a system: Interfaces:

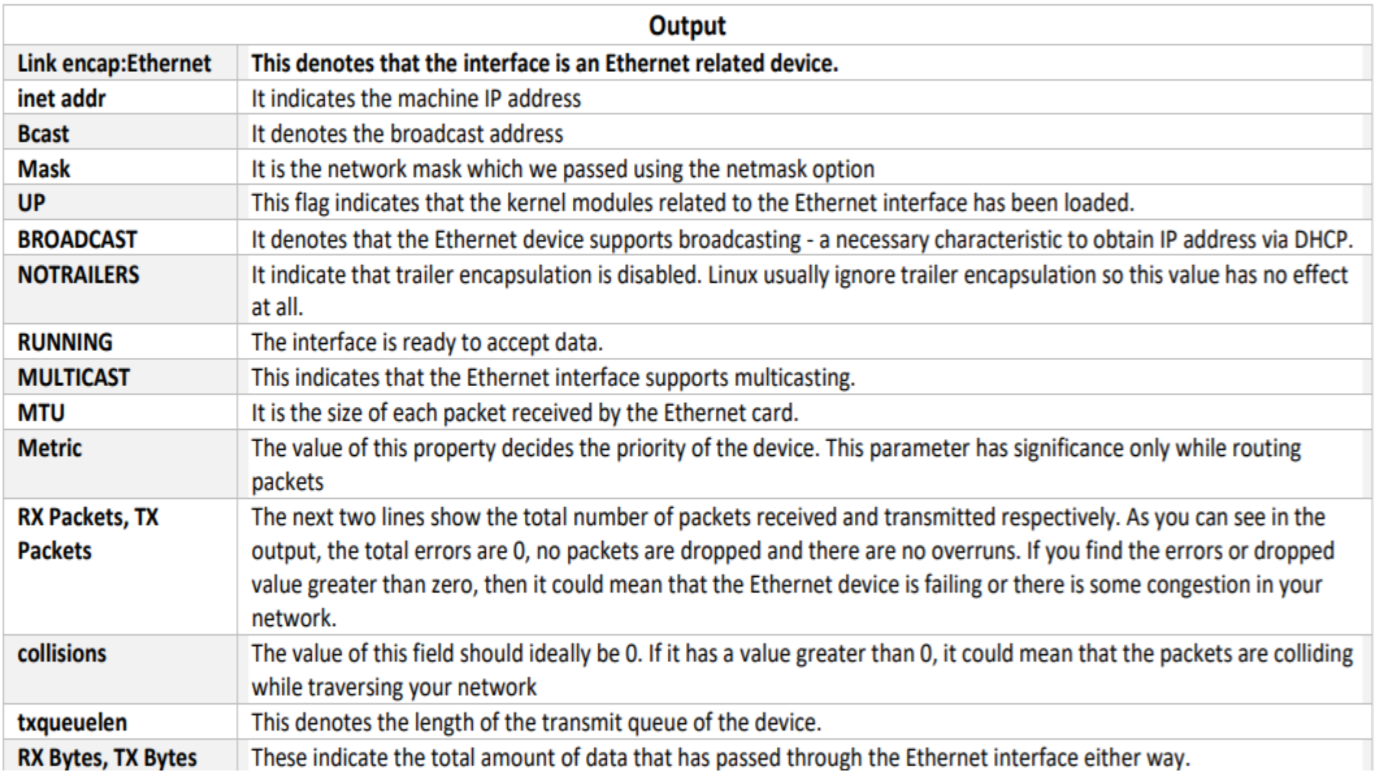
- **eno1** : This is the first ethernet interface. These types of interfaces are generally the NIC connected to the network.
- **lo :** This is the loopback interface. This is a special type of network interface which the system uses to communicate with itself.
- **wlo1**: This is the name of the first wireless network interface which the system uses for wireless communication with other devices.



```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ifconfig
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 1214  bytes 89965 (89.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 1214  bytes 89965 (89.9 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp2s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.43.145  netmask 255.255.255.0  broadcast 192.168.43.255
        inet6 2409:4052:e9a:1120:b44f:ad25:d8d7:70db  prefixlen 64  scopeid 0x0<global>
        inet6 fe80::a0ac:b65a:4d5:bf70  prefixlen 64  scopeid 0x20<link>
        inet6 2409:4052:e9a:1120:e9dd:aed0:a009:7fca  prefixlen 64  scopeid 0x0<global>
        ether d4:25:8b:f5:b6:62  txqueuelen 1000  (Ethernet)
        RX packets 65  bytes 8933 (8.9 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 81  bytes 11537 (11.5 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

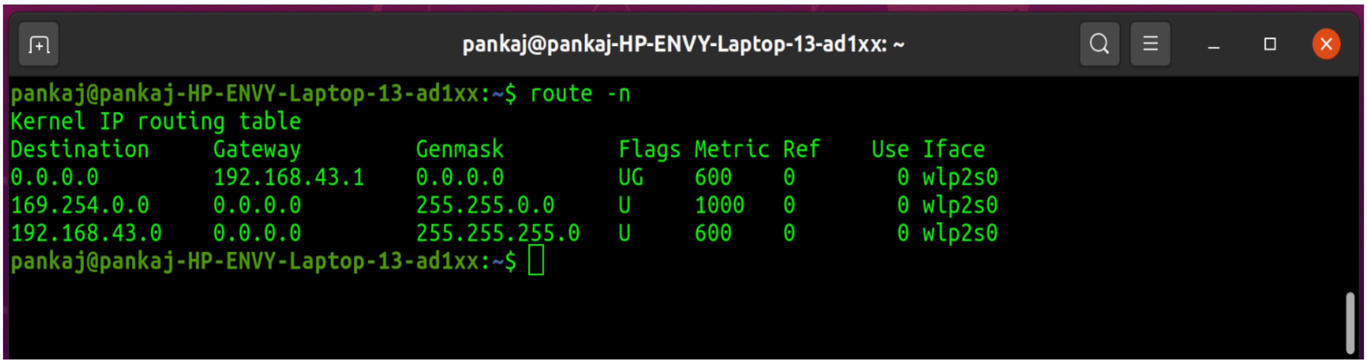


Output	
Link encap:Ethernet	**This denotes that the interface is an Ethernet related device.**
inet addr	It indicates the machine IP address
Bcast	It denotes the broadcast address
Mask	It is the network mask which we passed using the netmask option
UP	This flag indicates that the kernel modules related to the Ethernet interface has been loaded.
BROADCAST	It denotes that the Ethernet device supports broadcasting - a necessary characteristic to obtain IP address via DHCP.
NOTRAILERS	It indicate that trailer encapsulation is disabled. Linux usually ignore trailer encapsulation so this value has no effect at all.
RUNNING	The interface is ready to accept data.
MULTICAST	This indicates that the Ethernet interface supports multicasting.
MTU	It is the size of each packet received by the Ethernet card.
Metric	The value of this property decides the priority of the device. This parameter has significance only while routing packets
RX Packets, TX Packets	The next two lines show the total number of packets received and transmitted respectively. As you can see in the output, the total errors are 0, no packets are dropped and there are no overruns. If you find the errors or dropped value greater than zero, then it could mean that the Ethernet device is failing or there is some congestion in your network.
collisions	The value of this field should ideally be 0. If it has a value greater than 0, it could mean that the packets are colliding while traversing your network
txqueuelen	This denotes the length of the transmit queue of the device.
RX Bytes, TX Bytes	These indicate the total amount of data that has passed through the Ethernet interface either way.

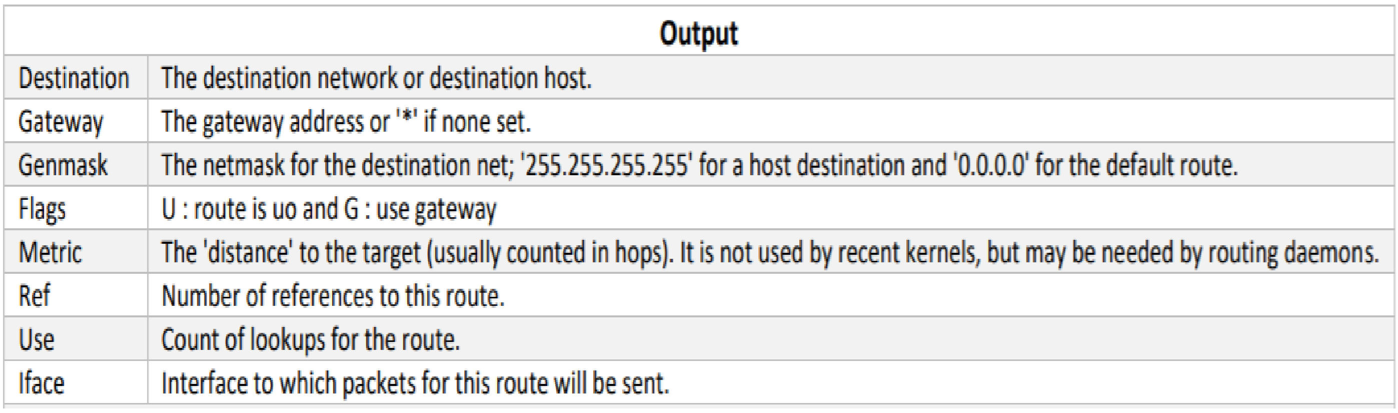
(b) Describing ifconfig command with various options :

- **ifconfig –a:** display all interfaces which are currently available, even if down
- **ifconfig lo:** If a single interface argument is given, it displays the status of the given interface only. Example here it will show status of lo (loopback) adapter.
- **Ifconfig wlo1 up :** 'wlo1' interface is activated.
- **Ifconfig wlo1 down:** 'wlo1' interface is deactivated.
- **Ifconfig wlo1 mtu 9000** : set the MTU (maximum transmission unit) for 'wlo1' interface to be 9000 bytes. This setting doesn't survive after reboot.

(c) Route explanation :

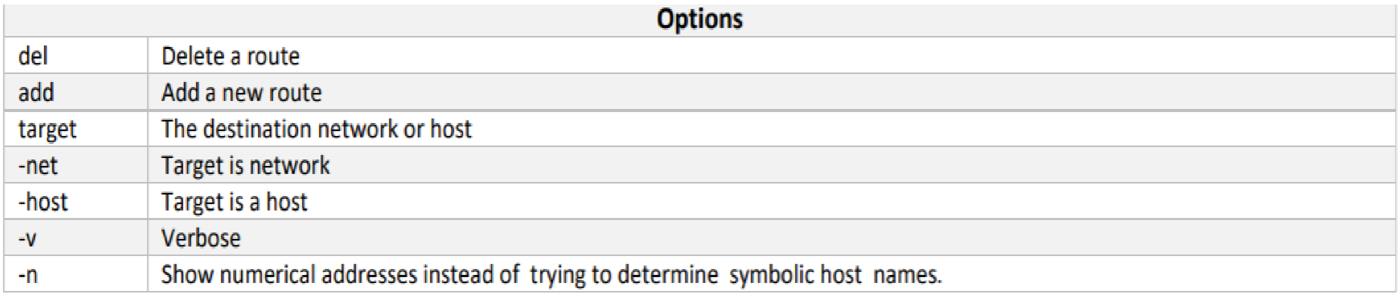


```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.43.1    0.0.0.0         UG    600    0        0 wlp2s0
169.254.0.0     0.0.0.0         255.255.0.0     U     1000   0        0 wlp2s0
192.168.43.0    0.0.0.0         255.255.255.0   U     600    0        0 wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

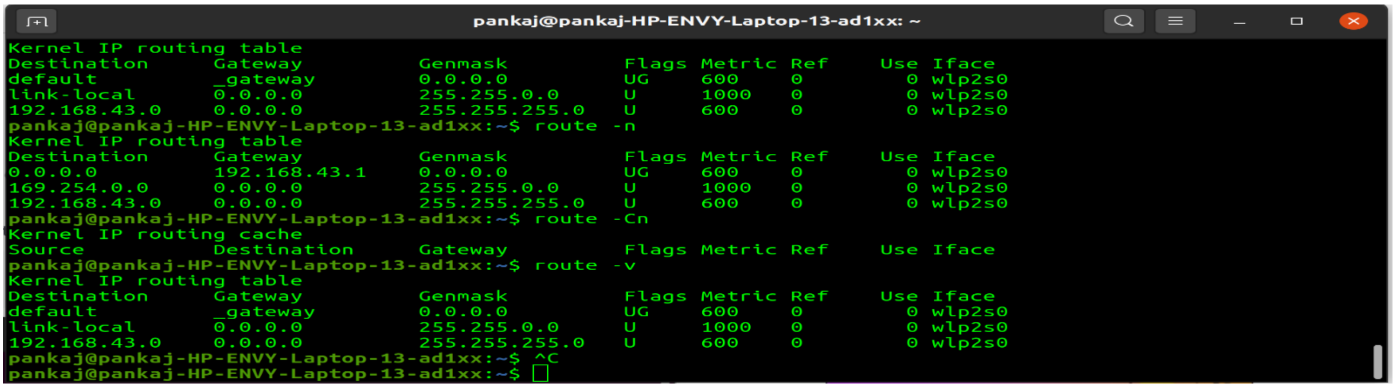


Output	
Destination	The destination network or destination host.
Gateway	The gateway address or '*' if none set.
Genmask	The netmask for the destination net; '255.255.255.255' for a host destination and '0.0.0.0' for the default route.
Flags	U : route is uo and G : use gateway
Metric	The 'distance' to the target (usually counted in hops). It is not used by recent kernels, but may be needed by routing daemons.
Ref	Number of references to this route.
Use	Count of lookups for the route.
Iface	Interface to which packets for this route will be sent.

(d)



Options	
del	Delete a route
add	Add a new route
target	The destination network or host
-net	Target is network
-host	Target is a host
-v	Verbose
-n	Show numerical addresses instead of trying to determine symbolic host names.



```
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
default         _gateway        0.0.0.0         UG    600    0        0 wlp2s0
link-local      0.0.0.0         255.255.0.0     U     1000   0        0 wlp2s0
192.168.43.0    0.0.0.0         255.255.255.0   U     600    0        0 wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.43.1    0.0.0.0         UG    600    0        0 wlp2s0
169.254.0.0     0.0.0.0         255.255.0.0     U     1000   0        0 wlp2s0
192.168.43.0    0.0.0.0         255.255.255.0   U     600    0        0 wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ route -Cn
Kernel IP routing cache
Source          Destination     Gateway         Flags Metric Ref    Use Iface
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ route -v
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
default         _gateway        0.0.0.0         UG    600    0        0 wlp2s0
link-local      0.0.0.0         255.255.0.0     U     1000   0        0 wlp2s0
192.168.43.0    0.0.0.0         255.255.255.0   U     600    0        0 wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ^C
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

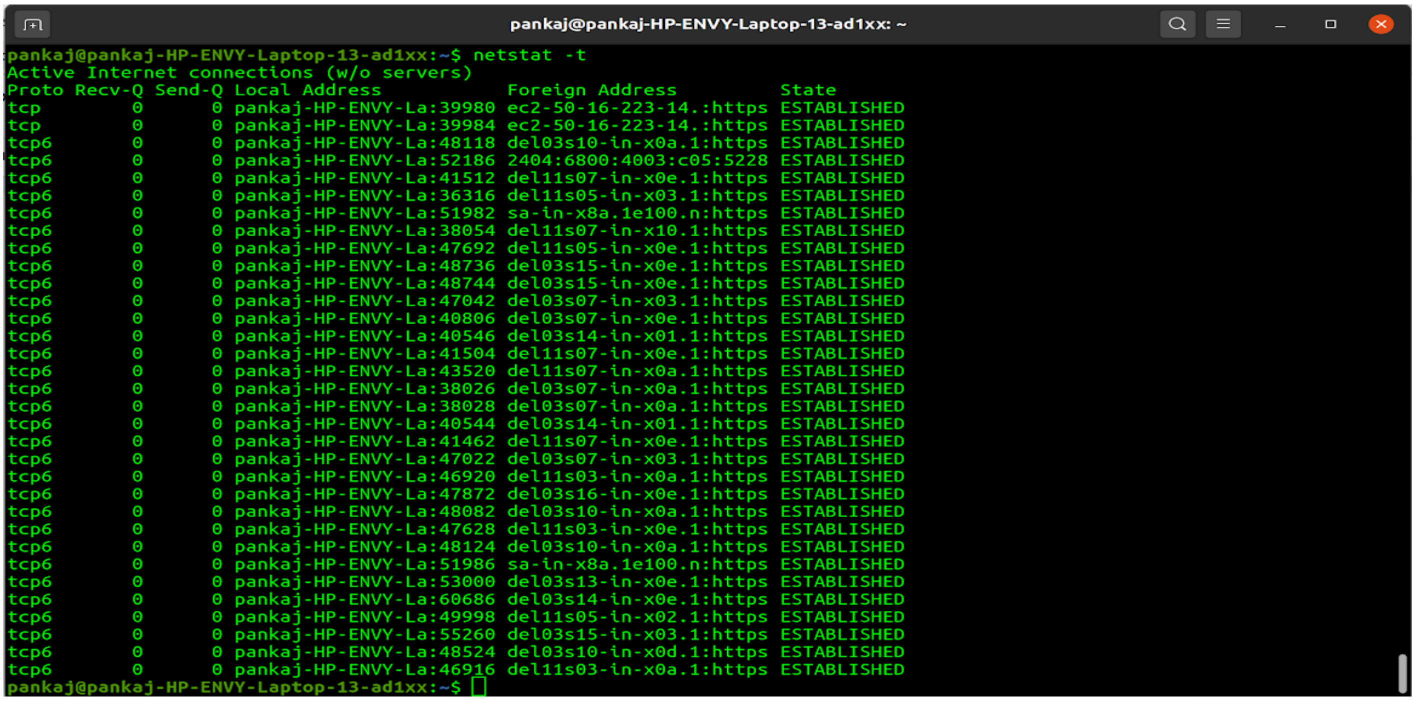
Answer 4 :

(a) Netstat: This command is capable of producing information related to network connections, routing tables, interface statistics etc. netstat is multi-platform (available on windows also). It list the network connections that currently exist between your machine and other machines, as well as sockets ‘listening’ for connections from other machines.

Use of Netstat :

- It helps the network administrators to keep an eye on the invalid or suspicious network connections.
- It can show you which programs are active on your network right now.
- It is used for finding problems in the network and to determine the amount of traffic on the network as a performance measurement.

(b) Parameters to show all the TCP connections: Netstat –t

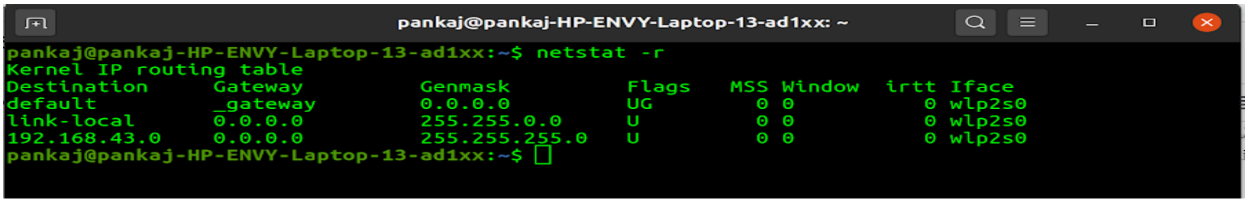


```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ netstat -t
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 pankaj-HP-ENVY-La:39980 ec2-50-16-223-14.:https ESTABLISHED
tcp        0      0 pankaj-HP-ENVY-La:39984 ec2-50-16-223-14.:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48118 del03s10-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:52186 2404:6800:4003:c05:5228 ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:41512 del11s07-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:36316 del11s05-in-x03.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:51982 sa-in-x8a.1e100.n:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:38054 del11s07-in-x10.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:47692 del11s05-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48736 del03s15-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48744 del03s15-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:47042 del03s07-in-x03.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:40806 del03s07-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:40546 del03s14-in-x01.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:41504 del11s07-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:43520 del11s07-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:38026 del03s07-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:38028 del03s07-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:40544 del03s14-in-x01.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:41462 del11s07-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:47022 del03s07-in-x03.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:46920 del11s03-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:47872 del03s16-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48082 del03s10-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:47628 del11s03-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48124 del03s10-in-x0a.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:51986 sa-in-x8a.1e100.n:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:53000 del03s13-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:60686 del03s14-in-x0e.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:49998 del11s05-in-x02.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:55260 del03s15-in-x03.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:48524 del03s10-in-x0d.1:https ESTABLISHED
tcp6       0      0 pankaj-HP-ENVY-La:46916 del11s03-in-x0a.1:https ESTABLISHED
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

Explanation :

Proto	Tells socket is TCP or UDP
Local Address	IP and port of clocal computer
Recv-Q Send-Q	Count of bytes not copied by user prog connected to socket, tells us how much data is in queue for that socket waiting to be read or sent
Foreign Address	IP and port of foreign device (other end socket)
State	Tells about state of listed sockets, LISTEN : wait for external computer to contact us, ESTABLISH : ready to communicate, TIME_WAIT : waiting to be closed

(c) Output of 'netsh –r' : It shows kernel routing table, i.e. it shows same output as route command does



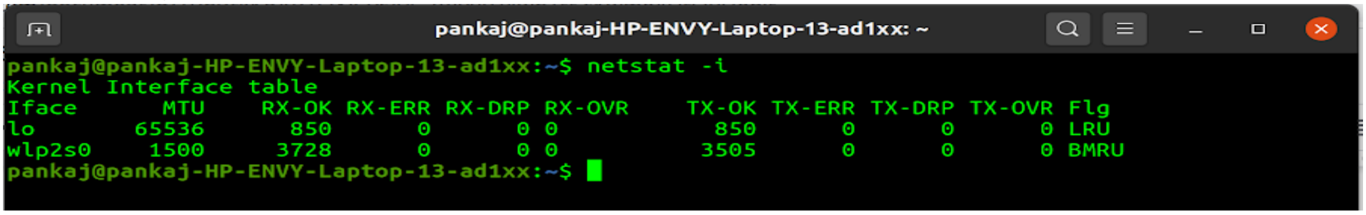
```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ netstat -r
Kernel IP routing table
Destination     Gateway         Genmask         Flags   MSS Window  irtt Iface
default         _gateway        0.0.0.0         UG        0 0          0 wlp2s0
link-local      0.0.0.0         255.255.0.0     U         0 0          0 wlp2s0
192.168.43.0    0.0.0.0         255.255.255.0   U         0 0          0 wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

Explainaiton :

- The **"Destination"** column indicates the pattern that the destination of a packet is compared to
- The **"Gateway"** column tells the computer where to send a packet that matches the destination of the same line. An asterisk (*) here means "send locally", because the destination is supposed to be on the same network.
- The **"Genmask"** column is the subnet mask that is used for the connection.
- The **"Flags"** column shows which flags apply to the current line. "U" means Up (acve line),"G" means line uses a Gateway.
- The **"MSS"** column lists the value of the Maximum Segment Size for this line. Nowadays, most computers have no problems with the most commonly used maximum packet sizes, so this column usually has the value of 0, meaning "no changes".
- The **"Window"** column is like the MSS column in that it gives the opon of altering a TCP parameter. In this case that parameter is the default window size, which indicates how many TCP packets can be sent before at least one of them has to be Acknowledged. Like the MSS, this field is usually 0, meaning "no changes".
- The **"irtt"** column stands for Initial Round Trip Time and may be used by the kernel to guess about the best TCP parameters without waiting for slow replies. In practice, it's not used much, so 0 here.
- The **"Iface"** column tells which network interface should be used for sending packets that match the destination. If your computer is connected to multiple subnets on multiple network cards.

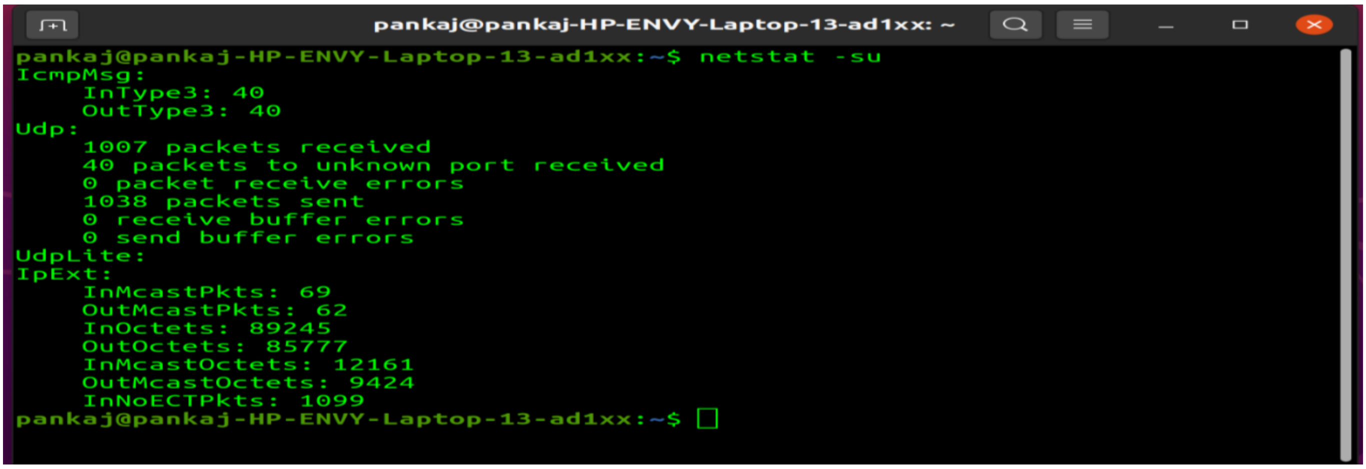
(d) To display network interface status:

'netstat –i' , as you can see it is wlp2s0 and lo (loopback interface)



```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ netstat -i
Kernel Interface table
Iface      MTU    RX-OK RX-ERR RX-DRP RX-OVR    TX-OK TX-ERR TX-DRP TX-OVR Flg
lo       65536      850      0      0 0           850      0      0      0 LRU
wlp2s0    1500     3728      0      0 0          3505      0      0      0 BMRU
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

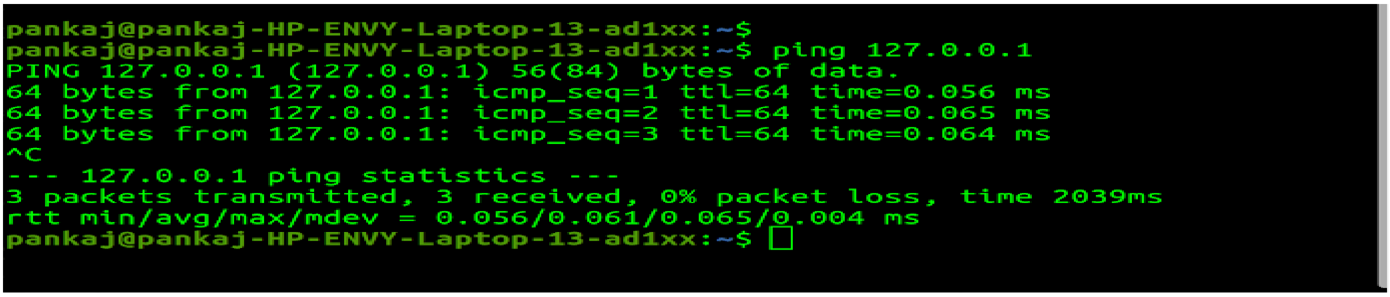
(e) The option of the netstat command to show the statistics of all UDP connections is -su.



```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ netstat -su
IcmpMsg:
    InType3: 40
    OutType3: 40
Udp:
    1007 packets received
    40 packets to unknown port received
    0 packet receive errors
    1038 packets sent
    0 receive buffer errors
    0 send buffer errors
UdpLite:
IpExt:
    InMcastPkts: 69
    OutMcastPkts: 62
    InOctets: 89245
    OutOctets: 85777
    InMcastOctets: 12161
    OutMcastOctets: 9424
    InNoECTPkts: 1099
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

(f) Loopback interface:

- The loopback interface is a virtual interface. The only purpose of the loopback interface is to return the packets sent to it, i.e. whatever you send to it is received on the interface.
- It makes little sense to put a default route on the loopback interface, because the only place it can send packets to is the imaginary piece of wire that is looped from the output of the interface to the input.
- It is used mainly for diagnostics and troubleshooting and connect to servers running on local machine.



```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ping 127.0.0.1
PING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
64 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.056 ms
64 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.065 ms
64 bytes from 127.0.0.1: icmp_seq=3 ttl=64 time=0.064 ms
^C
--- 127.0.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2039ms
rtt min/avg/max/mdev = 0.056/0.061/0.065/0.004 ms
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$
```

Answer 5 :-

(a)

Host **Time**	**Instagram.com** **(17 hopes common To all three Routes)** **No. of Hopes**	**Amazon.com** **(21 hopes common To all three Routes)** **No. of Hopes**	**Amazon.in** **(9 hopes common to all three Routes)** **No. of Hopes**	**Google.com** **(9 hopes common to all three Routes)** **No. of Hopes**	**Facebook.com** **(12 hopes common to all three Routes)** **No. of Hopes**	**Flipart.com** **(9 hopes common To all three Routes)** **No. of Hopes**
Morning	**33**	**37**	**27**	**12**	**14**	**28**
Afternoon	**32**	**33**	**32**	**12**	**11**	**29**
Evening	**34**	**45**	**32**	**12**	**13**	**28**

(b) Reason for change in route to same host at different time of the day:

- Since packets are sent via the route with less traffic due to presence of load balancers and use of packet switching
- Also there are multiple server location for same hosts leading to different routes
- Routing may change due to considerations of different servers along the way, such as server load and availability. If the routing is not dynamic and let's say a server is down, it will lead to undelivered requests
- The same company host doesn't means that they are on the same network architecture, so route and ping might be different if they are connected to different network elements (proxy, firewall, load balancers)

(c) **Explanation for not finding complete paths to some hosts:**

- Sometimes people block ICMP/ping packets (due to firewall rules) for security reasons like preventing hackers from getting information about open ports and staving off denial of service attacks. When ping is blocked, the server doesn't respond at all, resulting in "request timed out" messages that prevent traceroute from ever being able to map the path to the final destination.
- May also occur due to interrupted Internet connection or timed out request.

(d) **Yes, it is possible to find the route to certain hosts which fail to respond with ping experiment .** Ping works on straight ICMP (Internet control Message Protocol) Traceroute works very different from ping even though it uses ICMP. Traceroute works by targeting the final hop, but liming the TTL (Time To Live) and waiting for a time exceeded message, and then increasing it by one for the next iteration. Therefore the response it gets is not an ICMP echo reply to the ICMP echo request from the host along the way, but a time exceeded message from the host. There are some hops, which don't give an ICMP echo reply so, we don't get a reply for ping request but we are able to trace the route.

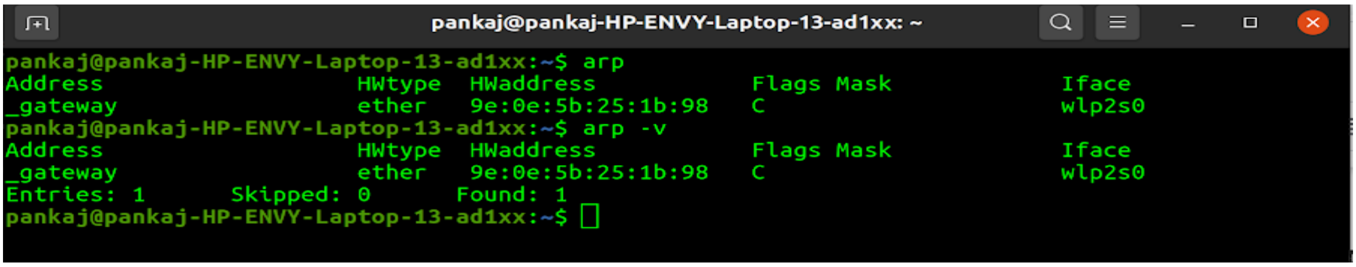
'traceroute –T host-ip' will find route to host-ip via sending TCP probes.

Answer 6 :

(a) Full ARP table for your machine : 'arp'

arp or address resolution protocol manipulates/display the kernel's IPv4 network neighbor cache. ARP comes into play when the sending computer on network wants to know the destination MAC address (of other computer on network). Sending host will send an ARP Request and the destination host will reply with a message ARP Reply containing it's mac address and hence an entry being added.

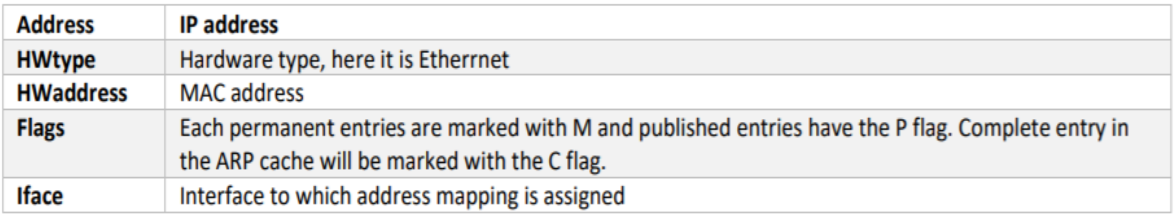
Command to show full ARP table : arp



pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx: ~

```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ arp
Address                  HWtype  HWaddress           Flags Mask            Iface
_gateway                 ether   9e:0e:5b:25:1b:98   C                     wlp2s0
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ arp -v
Address                  HWtype  HWaddress           Flags Mask            Iface
_gateway                 ether   9e:0e:5b:25:1b:98   C                     wlp2s0
Entries: 1      Skipped: 0      Found: 1
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

Explanation:



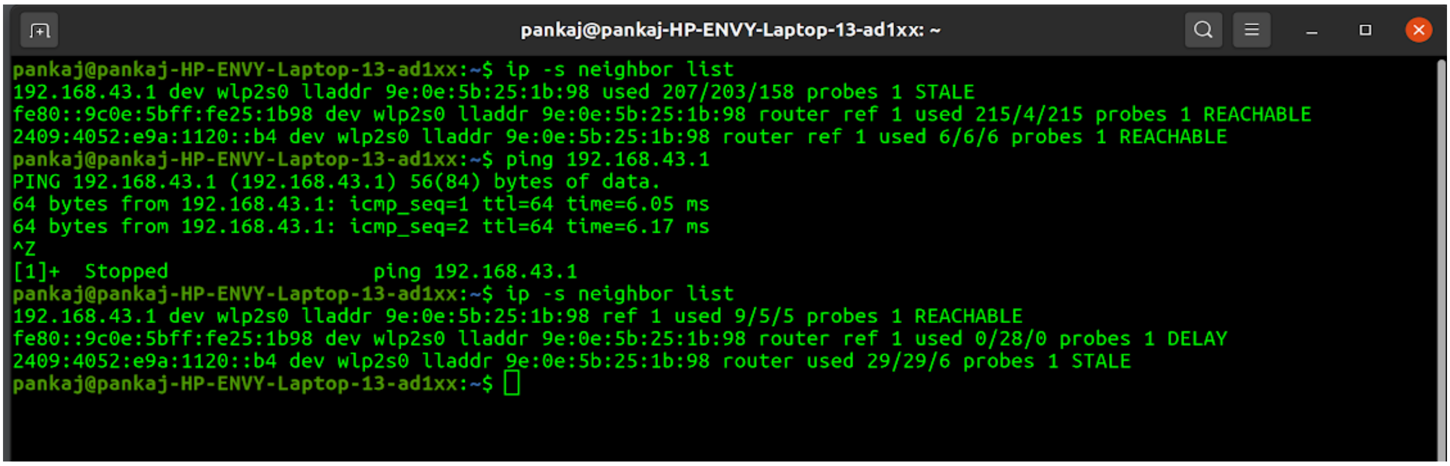
Address	**IP address**
HWtype	Hardware type, here it is Etherrnet
HWaddress	MAC address
Flags	Each permanent entries are marked with M and published entries have the P flag. Complete entry in the ARP cache will be marked with the C flag.
Iface	Interface to which address mapping is assigned

(b) Adding and Deleting entries in ARP table:

- **Adding : 'arp –s IP mac_address' :** bind particular ip with given mac_address. Note that entries manually added have flag M
- **Deleting : 'arp –d 192.168.0.105' :** deletes the IP from arp table

(c) How long do entries stay cached in ARP table :

- 60 seconds is the time for which entries stay cached.
- 'Ip –s neighbor list' However Entries in arp table are not deleted from newer linux kernel. There are subtle differences between an neighbor cache entry actually falling out of the cache entirely or just being marked as stale/invalid. When in the STALE state, if some ip is pinged it will send the packet to mac address corresponding to it right away. A second or so later it will usually send an ARP request to that ip and it's cache is updated back to a REACHABLE state. Similarly after some time REACHABLE will become STALE.



pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx: ~

```
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ip -s neighbor list
192.168.43.1 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 used 207/203/158 probes 1 STALE
fe80::9c0e:5bff:fe25:1b98 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 router ref 1 used 215/4/215 probes 1 REACHABLE
2409:4052:e9a:1120::b4 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 router ref 1 used 6/6/6 probes 1 REACHABLE
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ping 192.168.43.1
PING 192.168.43.1 (192.168.43.1) 56(84) bytes of data.
64 bytes from 192.168.43.1: icmp_seq=1 ttl=64 time=6.05 ms
64 bytes from 192.168.43.1: icmp_seq=2 ttl=64 time=6.17 ms
^Z
[1]+  Stopped                 ping 192.168.43.1
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ ip -s neighbor list
192.168.43.1 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 ref 1 used 9/5/5 probes 1 REACHABLE
fe80::9c0e:5bff:fe25:1b98 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 router ref 1 used 0/28/0 probes 1 DELAY
2409:4052:e9a:1120::b4 dev wlp2s0 lladdr 9e:0e:5b:25:1b:98 router used 29/29/6 probes 1 STALE
pankaj@pankaj-HP-ENVY-Laptop-13-ad1xx:~$ 
```

- **Trial And Error method to find the timeout:**

An approach similar to the binary search can be used to get the desired value. Connect the machine to a new network and then after every 5 mins, check of the entry in table is updated. Let the entry be updated in the i th check. This means that the cache was refreshed between the i-1 and the i check. Now disconnect from this network and wait for (i-1)*5 minutes + 2min + 30 sec. If the entry still exist at this me that means that the cache is cleared aer this me and before 5*i minutes. Apply this approach iteratively to get the result.

(d) yes, single ethernet card can have multiple IP's assigned to it, this process is known as IP aliasing. With this, one node on a network can have multiple connections to a network, each serving a different purpose. In a lot of scenarios, multiple IP addresses are used such as when a single server hosts multiple domain names, when we use two operating system simultaneously one background and another as virtual machine.

we use different two different ip addresses to communicate among them, even though the MAC address is same(MAC address of our machine). If IP's with same MAC address are on different subnet then there is no problem in packet routing as each router's table contains single ip with a specific MAC.

But if IP's with same MAC are on same subnet (be it on same machine or different machines), there will be conflict as router will not know to which ip it has to route as ARP table contains many IP's with same MAC hence less correct transmission.