CSCI 5010 – Fundamentals of Data Communications

Lab 3
IP Addressing

University of Colorado Boulder
Department of Computer Science
Network Engineering

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Summary

This lab is intended to be an overview of IP addressing, the two formats in which IP addresses can be represented (IPv4 and IPv6) and the difference between public and private IP addresses. This lab will be a baseline for future exploration into these topics used throughout this course.

The questions in the lab are intentionally vague. The purpose of this is for you not only to research, investigate, and learn the technologies, but also become proficient at interpreting both non-technical and technical questions. Being able to research and discover answers on your own will be critical as you progress in your career.

Objective 1: Public and Private IP addresses

1. Using the command prompt, find your laptop's IP address.
    a. Submit the IP address here (also note how the address was obtained (static/dynamic/etc.) [**1 point**]

ANS: by **ipconfig /all** command dynamic IPV4 address is obtained. (10.0.0.16)

```
C:\Users\Srivaishnavi>ipconfig /all

Windows IP Configuration

   Host Name . . . . . . . . . . . . : DESKTOP-9PTJJJ6
   Primary Dns Suffix  . . . . . . . :
   Node Type . . . . . . . . . . . . : Hybrid
   IP Routing Enabled. . . . . . . . : No
   WINS Proxy Enabled. . . . . . . . : No
   DNS Suffix Search List. . . . . . : hsd1.co.comcast.net

Ethernet adapter vEthernet (WSL):

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Hyper-V Virtual Ethernet Adapter
   Physical Address. . . . . . . . . : 00-15-5D-A3-DE-D6
   DHCP Enabled. . . . . . . . . . . : No
   Autoconfiguration Enabled . . . . : Yes
   Link-local IPv6 Address . . . . . : fe80::7d86:3a6:b9a9:e92c%50(Preferred)
   IPv4 Address. . . . . . . . . . . : 172.18.144.1(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.240.0
   Default Gateway . . . . . . . . . :
   DHCPv6 IAID . . . . . . . . . . . : 838866269
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-2A-1B-82-69-3C-18-A0-14-93-AE
   NetBIOS over Tcpip. . . . . . . . : Enabled

Ethernet adapter VirtualBox Host-Only Network:

   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : VirtualBox Host-Only Ethernet Adapter
   Physical Address. . . . . . . . . : 0A-00-27-00-00-0C
   DHCP Enabled. . . . . . . . . . . : No
   Autoconfiguration Enabled . . . . : Yes
   Link-local IPv6 Address . . . . . : fe80::60c3:f7e0:a17b:5b99%12(Preferred)
   IPv4 Address. . . . . . . . . . . : 192.168.56.1(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . :
   DHCPv6 IAID . . . . . . . . . . . : 201981991
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-2A-1B-82-69-3C-18-A0-14-93-AE
   NetBIOS over Tcpip. . . . . . . . : Enabled
```

```
Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . : hsd1.co.comcast.net
   Description . . . . . . . . . . . : Intel(R) Wi-Fi 6 AX201 160MHz
   Physical Address. . . . . . . . . : B0-3C-DC-86-BF-0F
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
   IPv6 Address. . . . . . . . . . . : 2601:281:8100:a010::80cc(Preferred)
   Lease Obtained. . . . . . . . . . : Monday, September 19, 2022 8:29:35 PM
   Lease Expires . . . . . . . . . . : Thursday, September 22, 2022 7:13:29 PM
   IPv6 Address. . . . . . . . . . . : 2601:281:8100:a010:dd53:d256:5730:de6f(Preferred)
   Temporary IPv6 Address. . . . . . : 2601:281:8100:a010:b5ac:a9a3:1757:dd9d(Preferred)
   Link-local IPv6 Address . . . . . : fe80::dd53:d256:5730:de6f%15(Preferred)
   IPv4 Address. . . . . . . . . . . : 10.0.0.16(Preferred)
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Lease Obtained. . . . . . . . . . : Monday, September 19, 2022 8:29:35 PM
   Lease Expires . . . . . . . . . . : Wednesday, September 21, 2022 8:29:35 PM
   Default Gateway . . . . . . . . . : fe80::1e93:7cff:fe7a:dbc0%15
                                       10.0.0.1
   DHCP Server . . . . . . . . . . . : 10.0.0.1
   DHCPv6 IAID . . . . . . . . . . . : 179322076
   DHCPv6 Client DUID. . . . . . . . : 00-01-00-01-2A-1B-82-69-3C-18-A0-14-93-AE
   DNS Servers . . . . . . . . . . . : 2001:558:feed::1
                                       2001:558:feed::2
                                       75.75.75.75
                                       75.75.76.76
   NetBIOS over Tcpip. . . . . . . . : Enabled

Ethernet adapter Ethernet 3:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : TAP-Windows Adapter V9
   Physical Address. . . . . . . . . : 00-FF-CB-C2-CF-94
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes

Ethernet adapter Bluetooth Network Connection:

   Media State . . . . . . . . . . . : Media disconnected
   Connection-specific DNS Suffix  . :
   Description . . . . . . . . . . . : Bluetooth Device (Personal Area Network)
   Physical Address. . . . . . . . . : B0-3C-DC-86-BF-13
   DHCP Enabled. . . . . . . . . . . : Yes
   Autoconfiguration Enabled . . . . : Yes
```

2. Navigate to the URL: www.ipchicken.com. What IP address does it indicate? Is it different from the address above? Why or why not? [**2 points**]

   Ans :: It indicates a different IP. And that's because it's a public IP. When I connect my device on a wifi-network, it has its own local ip address which differs from public IP address.

3. Execute a traceroute on your laptop to any URL. Provide a screenshot of the output [**1 point**].

```
C:\Users\Srivaishnavi>tracert www.colorado.edu

Tracing route to pantheon-systems.map.fastly.net [2a04:4e42:10::645]
over a maximum of 30 hops:

  1     4 ms     3 ms     2 ms  2601:281:8100:a010:1e93:7cff:fe7a:dbc0
  2    17 ms    10 ms     9 ms  2001:558:4070:1b::1
  3    12 ms     9 ms    12 ms  ae-252-1210-rur102.boulder.co.denver.comcast.net [2001:558:1c2:1c5::1]
  4    14 ms     9 ms    11 ms  2001:558:1c0:122::1
  5    15 ms    10 ms    10 ms  ae-29-ar01.denver.co.denver.comcast.net [2001:558:1c0:12f::1]
  6     *       22 ms     *     be-36041-cs04.1601milehigh.co.ibone.comcast.net [2001:558:3:2ff::1]
  7    19 ms     *        *     be-1413-cr13.1601milehigh.co.ibone.comcast.net [2001:558:3:1db::2]
  8    19 ms    13 ms    17 ms  be-304-cr13.champa.co.ibone.comcast.net [2001:558:3:133::1]
  9    51 ms     *        *     be-1113-cs01.champa.co.ibone.comcast.net [2001:558:3:178::1]
 10    20 ms    12 ms    20 ms  be-3111-pe11.910fifteenth.co.ibone.comcast.net [2001:558:3:5c::2]
 11    11 ms    14 ms    15 ms  2001:559::1386
 12    18 ms    11 ms    11 ms  2a04:4e42:10::645

Trace complete.
```

```
C:\Users\Srivaishnavi>tracert -4 www.colorado.edu

Tracing route to pantheon-systems.map.fastly.net [151.101.70.133]
over a maximum of 30 hops:

  1     1 ms     1 ms     1 ms  10.0.0.1
  2    12 ms    11 ms    21 ms  cm-1-acr02.boulder.co.denver.comcast.net [96.120.12.185]
  3    14 ms    15 ms    10 ms  ae-252-1210-rur102.boulder.co.denver.comcast.net [96.110.195.81]
  4    59 ms    11 ms    11 ms  ae-2-rur01.boulder.co.denver.comcast.net [96.108.139.193]
  5    17 ms    18 ms    13 ms  ae-29-ar01.denver.co.denver.comcast.net [162.151.50.249]
  6    11 ms    11 ms    10 ms  be-36011-cs01.1601milehigh.co.ibone.comcast.net [96.110.43.241]
  7    34 ms    13 ms     9 ms  be-1113-cr13.1601milehigh.co.ibone.comcast.net [96.110.39.98]
  8    21 ms    13 ms    28 ms  be-301-cr13.champa.co.ibone.comcast.net [96.110.36.193]
  9    20 ms    12 ms    10 ms  be-1313-cs03.champa.co.ibone.comcast.net [96.110.37.233]
 10    21 ms    14 ms    12 ms  be-3312-pe12.910fifteenth.co.ibone.comcast.net [96.110.33.138]
 11    40 ms    12 ms    10 ms  173.167.58.210
 12    19 ms    14 ms    10 ms  151.101.70.133

Trace complete.
```

a. Do all the IP addresses in the trace belong to the same network? What do these IP addresses represent? Is there any additional information you can obtain about these replies that you can gather? [**15 points**]

Ans: A) No. The Ip address change the network when packet transmit from private network to the public Network.

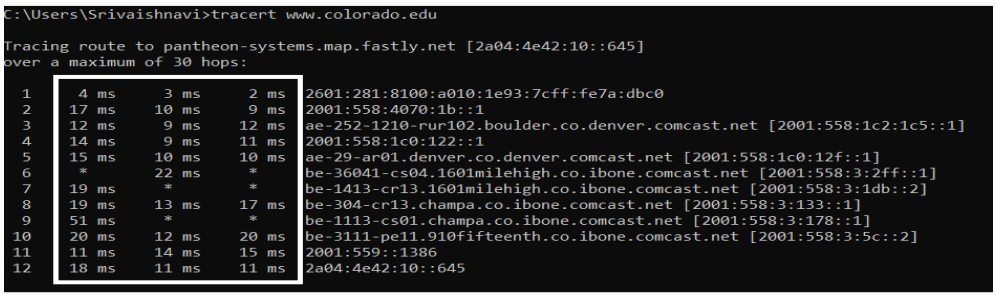
B) The first line of the traceroute describes what command is doing, it lists the destination IP address (151.101.70.133), and the maximum number of hops that will be used in the traceroute (30). The Ip addresses represent the network address of all the routers it pinged in between the pathway taken by a packet on an IP network from source to destination.

The information I gathered from replies:

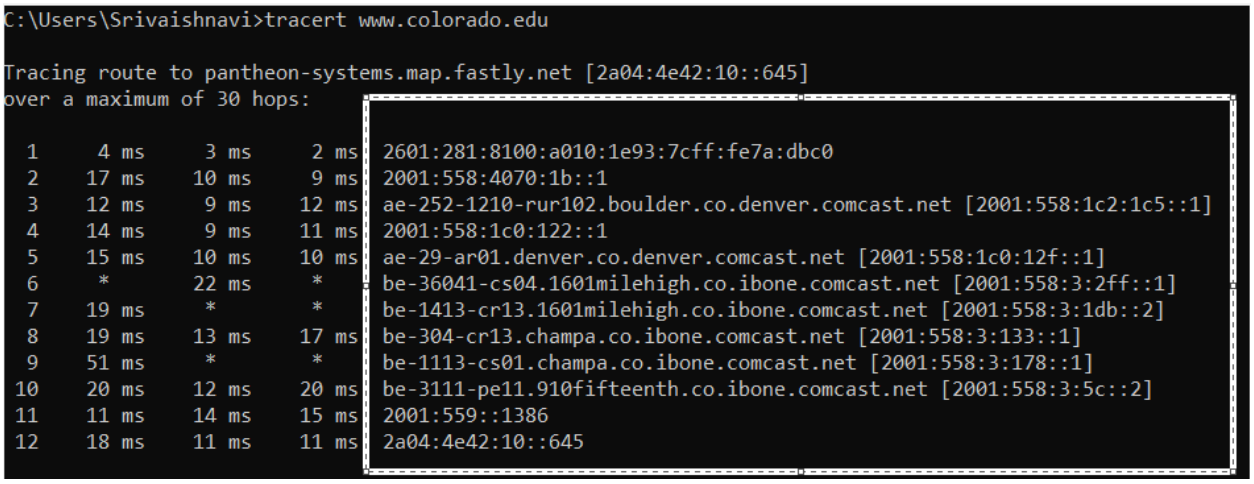
The first column represents the HOP numbers / no. of hops packet takes to move from sender to destination.

```
C:\Users\Srivaishnavi>tracert www.colorado.edu

Tracing route to pantheon-systems.map.fastly.net [2a04:4e42:10::645]
over a maximum of 30 hops:

  1    4 ms     3 ms     2 ms  2601:281:8100:a010:1e93:7cff:fe7a:dbc0
  2   17 ms    10 ms     9 ms  2001:558:4070:1b::1
  3   12 ms     9 ms    12 ms  ae-252-1210-rur102.boulder.co.denver.comcast.net [2001:558:1c2:1c5::1]
  4   14 ms     9 ms    11 ms  2001:558:1c0:122::1
  5   15 ms    10 ms    10 ms  ae-29-ar01.denver.co.denver.comcast.net [2001:558:1c0:12f::1]
  6    *       22 ms     *     be-36041-cs04.1601milehigh.co.ibone.comcast.net [2001:558:3:2ff::1]
  7   19 ms     *        *     be-1413-cr13.1601milehigh.co.ibone.comcast.net [2001:558:3:1db::2]
  8   19 ms    13 ms    17 ms  be-304-cr13.champa.co.ibone.comcast.net [2001:558:3:133::1]
  9   51 ms     *        *     be-1113-cs01.champa.co.ibone.comcast.net [2001:558:3:178::1]
 10   20 ms    12 ms    20 ms  be-3111-pe11.910fifteenth.co.ibone.comcast.net [2001:558:3:5c::2]
 11   11 ms    14 ms    15 ms  2001:559::1386
 12   18 ms    11 ms    11 ms  2a04:4e42:10::645
```

The next three columns represent the RTT(Round Trip Time), the time it takes for a packet to get a hop and back , displayed in milliseconds. By default, tracert sends 3 packets to each hop, so the output is three round trip times per hop. RTT is also referred as “Latency”



The next column is the IP address of the network the packet hops to reach from sender to destination



b. Which of these are private IP addresses and which of these are public? How did you differentiate, and why would some be public and some private? [**10 points**]

```
C:\Users\Srivaishnavi>tracert -4 google.com

Tracing route to google.com [142.250.69.238]
over a maximum of 30 hops:

  1     *        4 ms     3 ms  10.0.0.1
  2    12 ms     *       12 ms  cm-1-acr02.boulder.co.denver.comcast.net [96.120.12.185]
  3    19 ms    10 ms    11 ms  ae-252-1210-rur102.boulder.co.denver.comcast.net [96.110.195.81]
  4    13 ms    52 ms    16 ms  ae-2-rur01.boulder.co.denver.comcast.net [96.108.139.193]
  5    18 ms    24 ms    11 ms  ae-29-ar01.denver.co.denver.comcast.net [162.151.50.249]
  6    20 ms    12 ms    15 ms  be-36031-cs03.1601milehigh.co.ibone.comcast.net [96.110.43.249]
  7    19 ms    24 ms    10 ms  be-3302-pe02.910fifteenth.co.ibone.comcast.net [96.110.38.122]
  8    21 ms    39 ms    10 ms  50.248.118.30
  9    19 ms    16 ms    10 ms  108.170.252.193
 10    19 ms    11 ms     9 ms  142.251.61.181
 11    35 ms    11 ms    11 ms  den08s05-in-f14.1e100.net [142.250.69.238]
```

Except 10.0.0.1 in the above screenshot rest all the IP's are Public IP Addresses. Private and Public address can be differentiated by the class range. Any addresses in the range of Class A : 10.0.0.0 – 10.255.255.255, 172.16.0.0 – 172.31.255.255, 192.168.255.255 are Private IP address and the rest are Public IP address ex : 8.8.8.8/ 17.64.12.19.

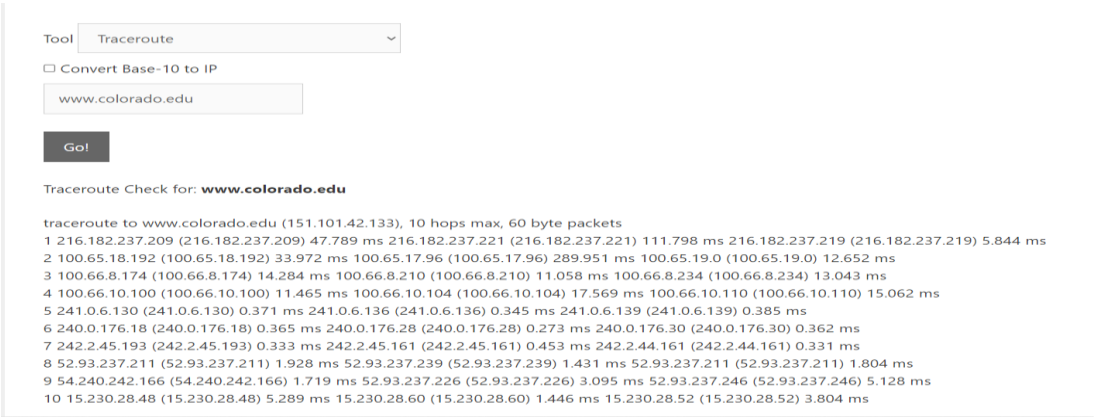
A private IP address is the address with in the host's LAN network. Where as Public IP is the ip address of WAN. When the host is trying to reach internet, the private address gets converted to Public IP. So the tracert shows both Private and Public addresses.

4. What are the IPv6 address that your system obtained? [**1 point**]

```
C:\Users\Srivaishnavi>tracert www.colorado.edu

Tracing route to pantheon-systems.map.fastly.net [2a04:4e42:10::645]
over a maximum of 30 hops:

  1     4 ms     3 ms     2 ms  2601:281:8100:a010:1e93:7cff:fe7a:dbc0
  2    17 ms    10 ms     9 ms  2001:558:4070:1b::1
  3    12 ms     9 ms    12 ms  ae-252-1210-rur102.boulder.co.denver.comcast.net [2001:558:1c2:1c5::1]
  4    14 ms     9 ms    11 ms  2001:558:1c0:122::1
  5    15 ms    10 ms    10 ms  ae-29-ar01.denver.co.denver.comcast.net [2001:558:1c0:12f::1]
  6     *       22 ms     *     be-36041-cs04.1601milehigh.co.ibone.comcast.net [2001:558:3:2ff::1]
  7    19 ms     *        *     be-1413-cr13.1601milehigh.co.ibone.comcast.net [2001:558:3:1db::2]
  8    19 ms    13 ms    17 ms  be-304-cr13.champa.co.ibone.comcast.net [2001:558:3:133::1]
  9    51 ms     *        *     be-1113-cs01.champa.co.ibone.comcast.net [2001:558:3:178::1]
 10    20 ms    12 ms    20 ms  be-3111-pe11.910fifteenth.co.ibone.comcast.net [2001:558:3:5c::2]
 11    11 ms    14 ms    15 ms  2001:559::1386
 12    18 ms    11 ms    11 ms  2a04:4e42:10::645
```

5. Repeat **Obj1.2** using any tool of your choice? What IPv6 address do you see on the public domain? Is it same as the seen above? Why or Why not?? [**10 points**]

   By repeating the tracert function using the tools available online.Its not the same as above in the traceert command executed in the cmd. The hops and pacet tramsission values is different here, so the less the hops the packet takes the more network congestion happens.



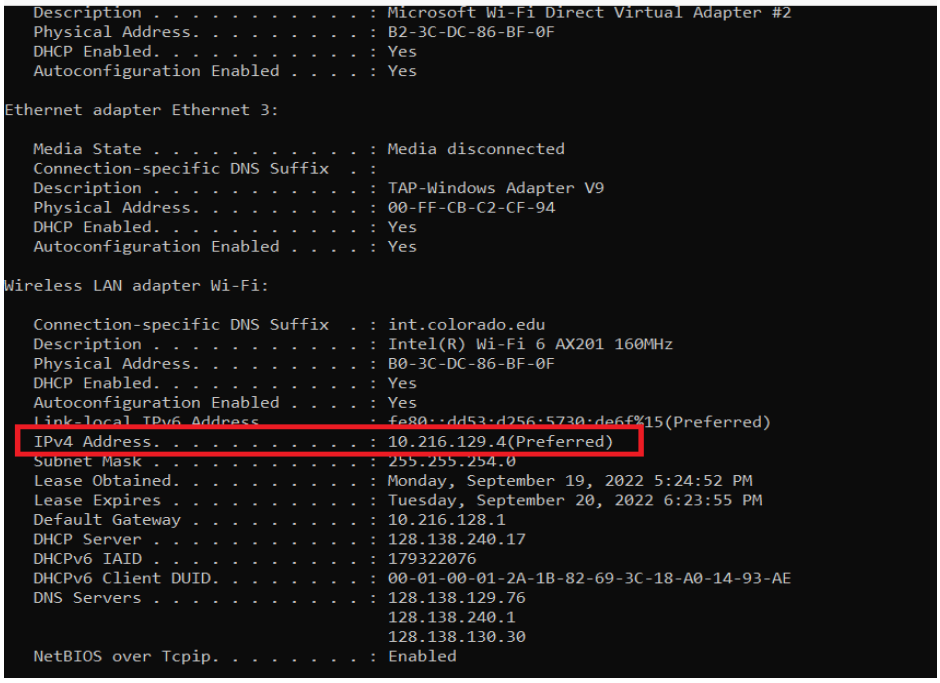
Objective 2: IP Address Format

1. While connected to the CU campus network, run the command to find your laptop's IP address from the command prompt again.

a. How many IP addresses do you come across? Do you see both IPv4 and IPv6 addresses?

I am connected to UCB Guest, and I am able to see only IPV4 address in the wireless LAN wi-fi module. I come across only one IPV4 address relevant to my UCB-Guest wifi connection, rest of them are virtual host network ip addresses.

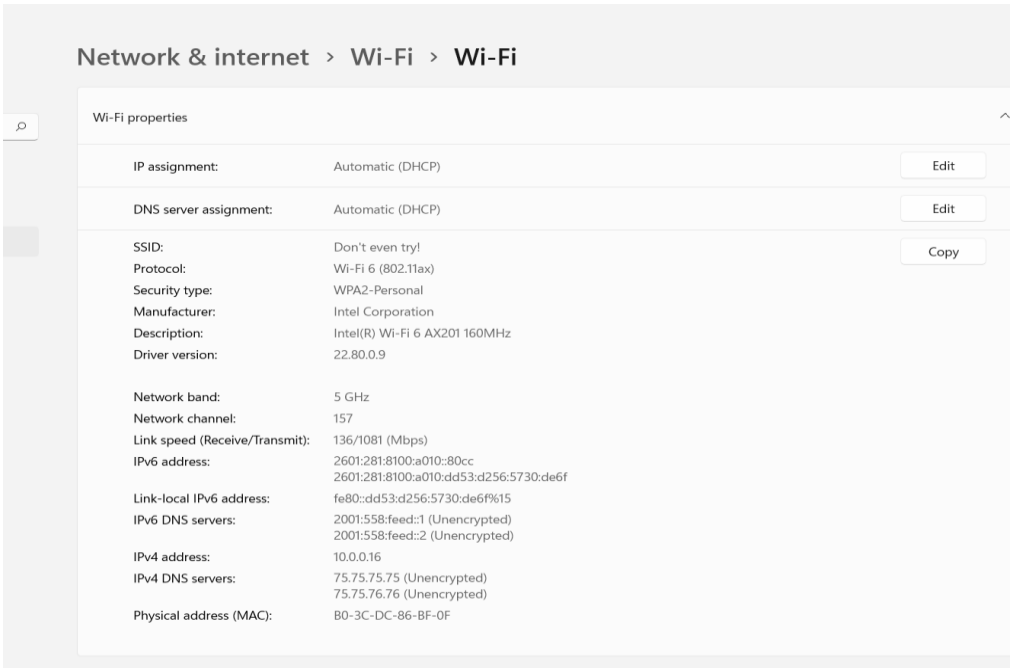
b. Indicate in screenshot [**5 points**]

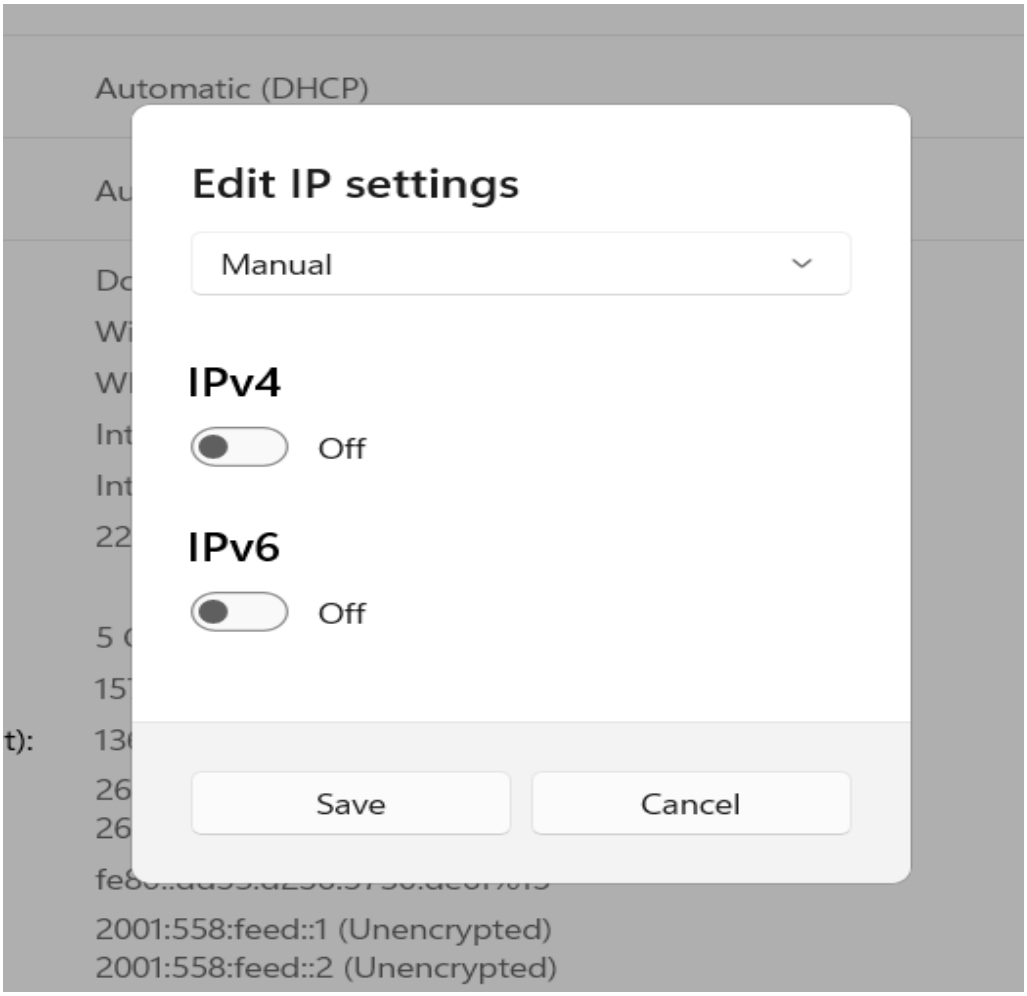


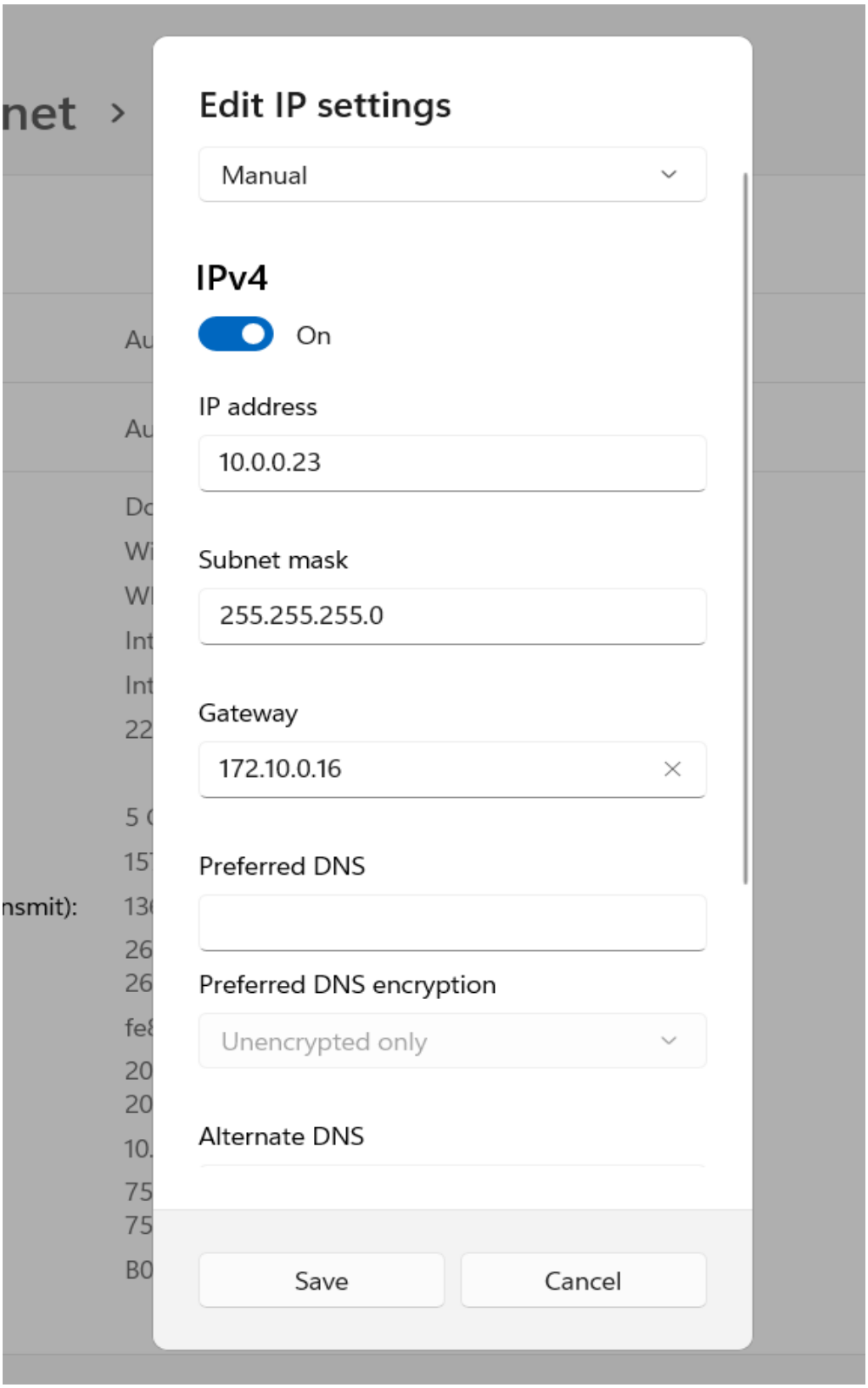
2. Can you configure an IP address of your choice instead allowing the host to receive an IP address dynamically? If so, include a summary of how you can statically assign an IPv4 address, and provide the screenshot indicating that you have statically configured the IP address [**10 points**]

One way to do it ::

Windows > Internet & Network settings > Edit Ip addresses > Choose Manual > Enable IPV4 to “On” > Enter the “IPv4” address you like to add > Save.


Network & internet › Wi-Fi › Wi-Fi
Wi-Fi properties
IP assignment: Automatic (DHCP) Edit
DNS server assignment: Automatic (DHCP) Edit
SSID: Don't even try! Copy
Protocol: Wi-Fi 6 (802.11ax)
Security type: WPA2-Personal
Manufacturer: Intel Corporation
Description: Intel(R) Wi-Fi 6 AX201 160MHz
Driver version: 22.80.0.9
Network band: 5 GHz
Network channel: 157
Link speed (Receive/Transmit): 136/1081 (Mbps)
IPv6 address: 2601:281:8100:a010::80cc
2601:281:8100:a010:dd53:d256:5730:de6f
Link-local IPv6 address: fe80::dd53:d256:5730:de6f%15
IPv6 DNS servers: 2001:558:feed::1 (Unencrypted)
2001:558:feed::2 (Unencrypted)
IPv4 address: 10.0.0.16
IPv4 DNS servers: 75.75.75.75 (Unencrypted)
75.75.76.76 (Unencrypted)
Physical address (MAC): B0-3C-DC-86-BF-0F

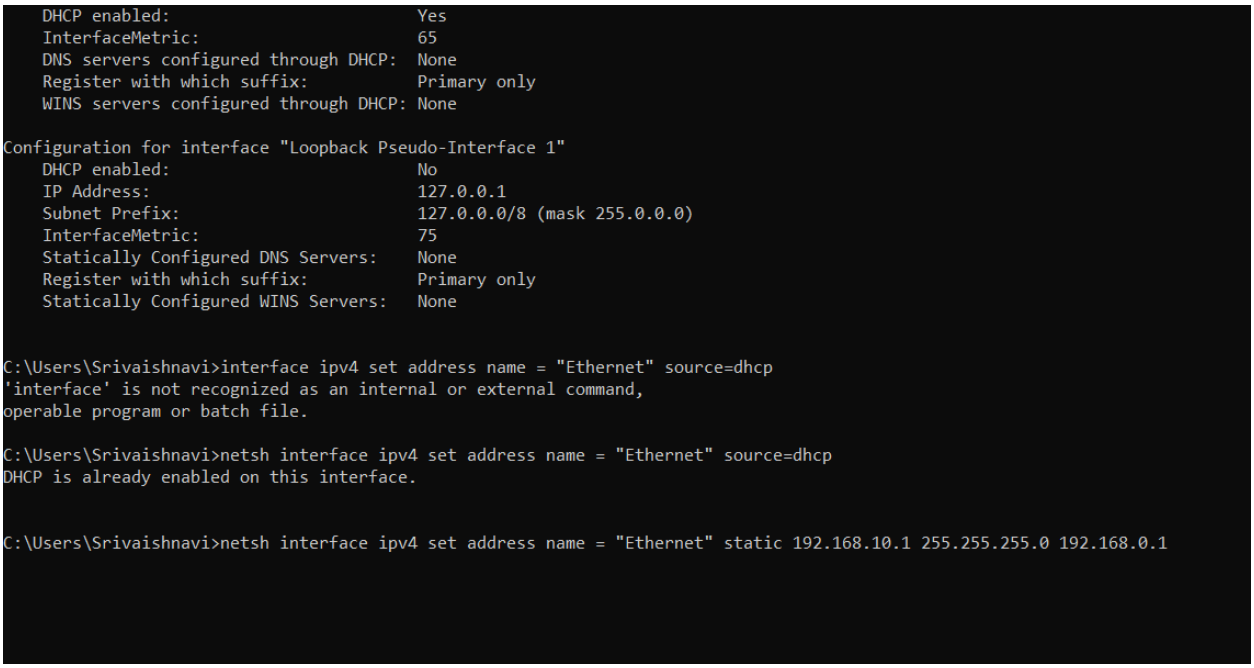

Automatic (DHCP)
Edit IP settings
Manual
IPv4
Off
IPv6
Off
Save
Cancel
2001:558:feed::1 (Unencrypted)
2001:558:feed::2 (Unencrypted)


net ›
Edit IP settings
Manual
IPv4
On
IP address
10.0.0.23
Subnet mask
255.255.255.0
Gateway
172.10.0.16
Preferred DNS
Preferred DNS encryption
Unencrypted only
Alternate DNS
Save
Cancel

Other way to do it is using CMD ::

First do “netsh interface ipv4 show config”

And then execute below commands to statically assign IP address



3. Explain the formatting of IPv4 and IPv6 addresses. [**2 points**]

   An128bit IPv6 address has the following format: y : y : y : y : y : y : y : y where y is called a segment and can be any hexadecimal value between 0 and FFFF. An IPv6 normal address must have eight segments.

   The following list shows examples of valid IPv6 (Normal) addresses:

   2001 : db8: 3333 : 4444 : 5555 : 6666 : 7777 : 8888

   2001 : db8 : 3333 : 4444 : CCCC : DDDD : EEEE : FFFF

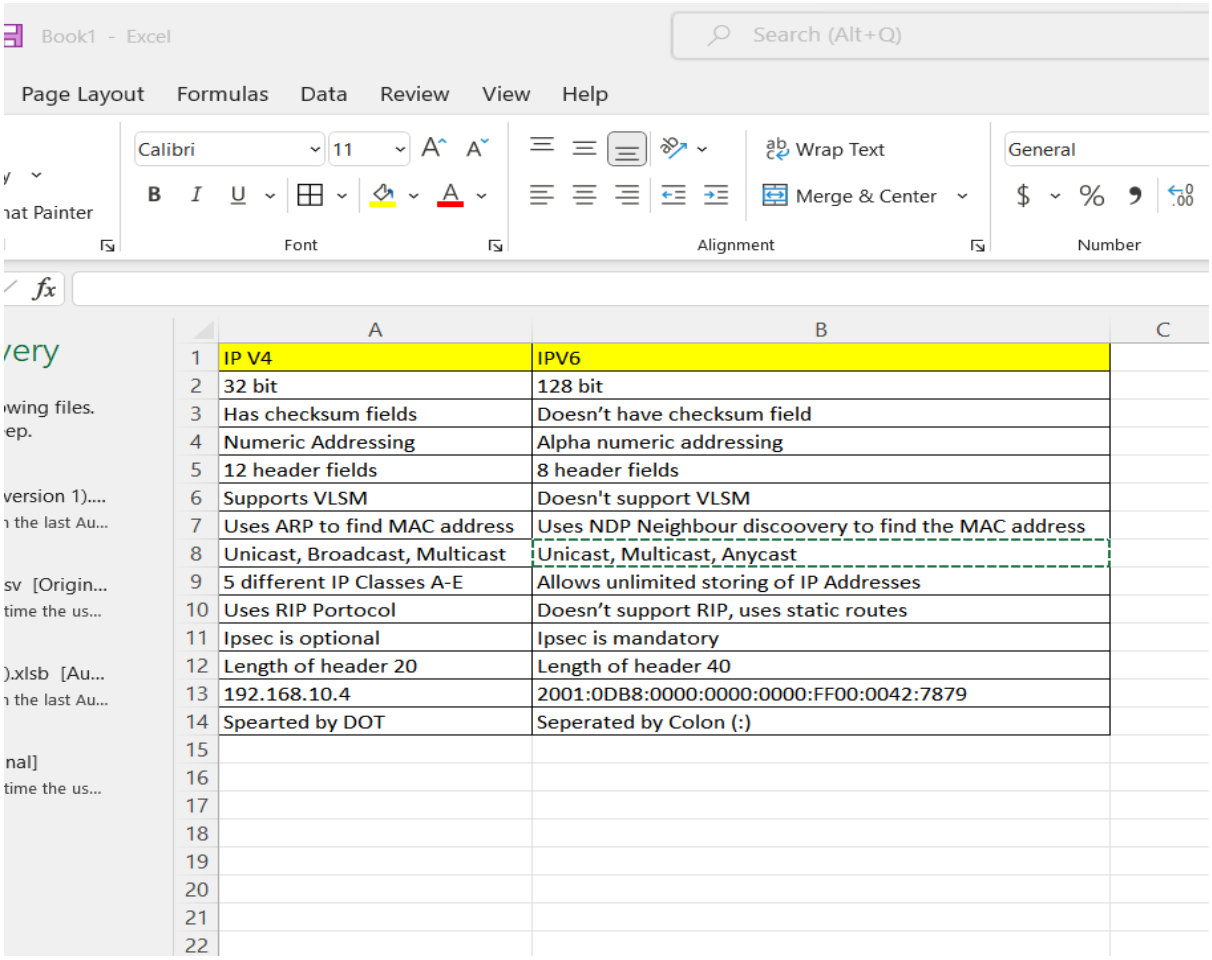
IPV4 is a 32 bit Ip address. An IPv4 address has the following format: x . x . x . x where x is called an octet and must be a decimal value between 0 and 255. valid IPv4 addresses:

1 . 2 . 3 . 4 192.168.10.0

01 . 102 . 103 . 104

Objective 3:

Using what you have learned from the in class lectures, and from Objective 1 and Objective 2 of this lab, describe the difference between private and public addresses and the need for ipv6 addressing. [**10 points**]



	A	B	C
1	IP V4	IPV6	
2	32 bit	128 bit	
3	Has checksum fields	Doesn't have checksum field	
4	Numeric Addressing	Alpha numeric addressing	
5	12 header fields	8 header fields	
6	Supports VLSM	Doesn't support VLSM	
7	Uses ARP to find MAC address	Uses NDP Neighbour discoovery to find the MAC address	
8	Unicast, Broadcast, Multicast	Unicast, Multicast, Anycast	
9	5 different IP Classes A-E	Allows unlimited storing of IP Addresses	
10	Uses RIP Portocol	Doesn't support RIP, uses static routes	
11	Ipsec is optional	Ipsec is mandatory	
12	Length of header 20	Length of header 40	
13	192.168.10.4	2001:0DB8:0000:0000:0000:FF00:0042:7879	
14	Spearted by DOT	Seperated by Colon (:)	
15			
16			
17			
18			
19			
20			
21			
22			

Objective 4: IPv4 subnetting

1. What is the difference between classful and classless IPv4 addressing? Why do we need classless addressing and subnetting? [**5 points]**

   A classful addressing is a method of allocating ip addresses by divinding them into 5 categories. A classless addressing is a method that is designed to replace the classful addressing to minimize the exhaustion of available IPV4 addressing.

   We need Classless addressing to reduce the wastage of IP addresses. In any given class range, there could be millions of connected devices, and the subneeting is used to narrow down the IP address to usage within range of devices.

   Use the CPT file uploaded on canvas and configure the topology using the subnet 192.168.100.0/24 efficiently. Write down the Interface IPs and subnet details in the space provided on the CPT. [**25 points**]

2. List 2 points to be noted for efficient subnetting? [**3 points**]
   1. Identify the smallest subnet mask that can support the number of hosts required for each LAN.
   2. the smallest IP address that may be assigned to a host in the subnet This is the network address, plus 1.
   3. the highest IP address that may be assigned to a host in the subnet. This is the broadcast address, minus 1.

Report Questions:

1) The network graph is shown in Figure. 2.

(a) Host H1 sends a packet to the destination 128.96.34.126. Explain how this packet traverses in the network described below. You need to describe who received the packet and what are their reactions. Also trace the return path that is taken. [**2 point**]
Unable to find “128.96.34.126” in the below figure -2 , so instead explaining using “128.96.34.128” Host1 connects to Host2 via R1 on the network 128.96.34.1 and gets forwarded to 128.96.34.130 from their it searches for IP address in the routing table and sends out ARP via Default gateway to find the MAC . And once it receives the destination MAC, its stores in the MAC table and forwards the packet to destination via R1 128.96.34.130. The same thing happens on return except the source and destination MAC address will already be present in the MAC table so the packet gets directly transmitted back.

(b) Host H3 sends a packet to the destination H1 (128.96.34.15). Explain how this packet traverses in the network. [**3 point**]

Host3 sends the packet to R2 and R2 learns the IP address and stores the source IP in routing table and perform ARP via default gateway to look up the MAC address and stores the MAC address and sends out the data via R2 to R2. R1 learns the source and estination IP address, looks and fstores the ip’s is routing table, performs ARP lookup to find the destination MAC and forrwads the packet to the HOST using from R1
.

(c) The subnet of H1 has now two different teams and would like to split it into two subnets. Please add one more subnet and add R3 and change the network configurations as you need. Note that you are allowed to modify the network as least disruptive as possible. [**3 point**]

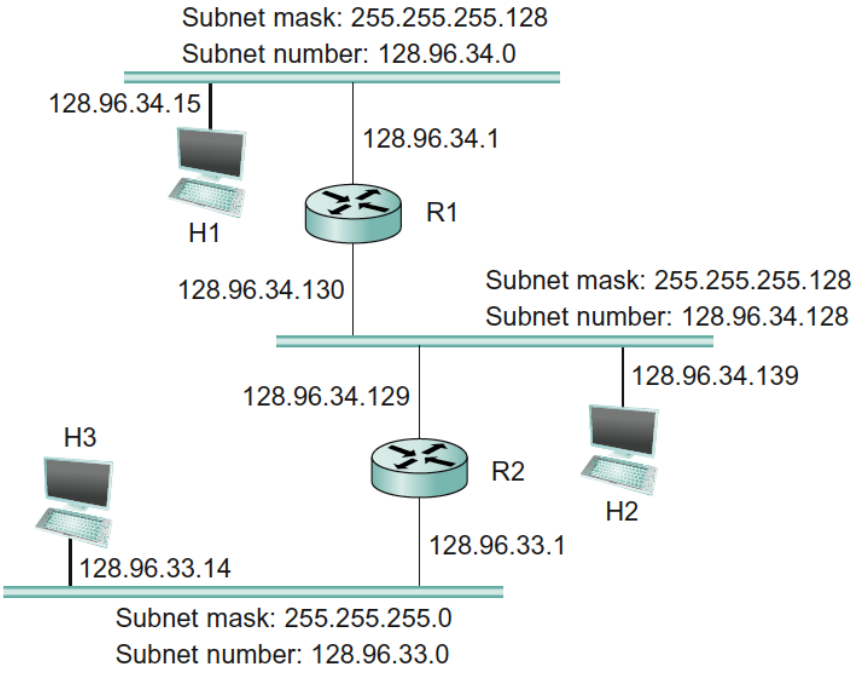


Figure 2.

2) Problem 2

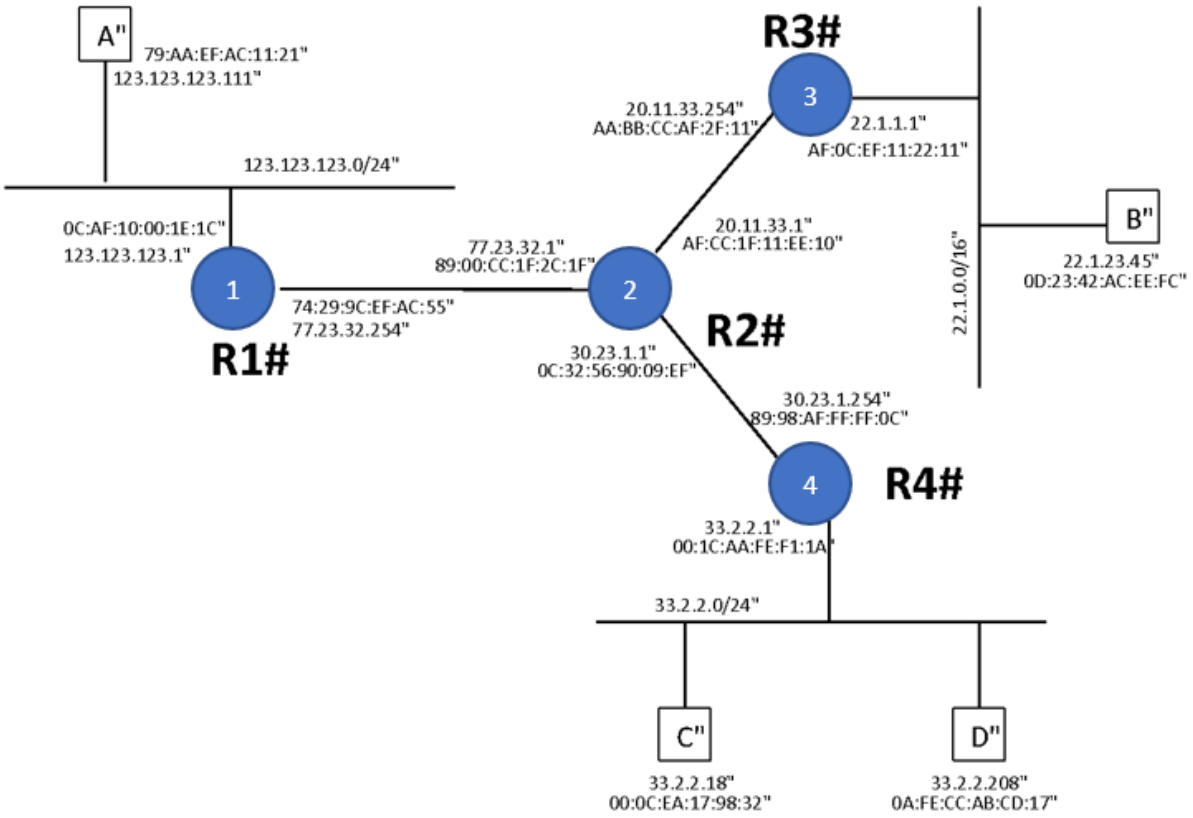


Figure. 3

Above in Figure 3 is the network graph with 4 routers (R1, R2, R3, R4) and 4 hosts (A, B, C, D). Each router interfaces and hosts are labeled with both IP and MAC address, Routing is enabled so that any two hosts can communicate with each other and also the default gateway of each host is set to its gateway router.

(a) Suppose that A send an IP packet to B through R1, R2, R3. Write down the IP packet's content (src MAC, dst MAC, src IP, dst IP) along the path in the Table given below: [**10 points**]

	src MAC	dst MAC	src IP	dst IP
A -> R1	79:AA:EF:AC:11:21	OC:AF:10:00:1E:1C	123:123:123:111	123:123:123:1
R1 -> R2	74:29:9C:EF:AC:55	89:00:CC:1F:2C:1F	77:23:32:254	77:23:32:1
R2 -> R3	AF:CC:1F:11:EE:10	AF:0C:EF:11:22:11	20:11:33:1	22:1:1:1
R3 -> B	AF:0C:EF:11:22:11	0D:23:42:AC:EE:FC	22:1.1.1	22.1.23.45

Table. 1

(b) When C sends out an ARP query for its default gateway, what is the reply to that query? [**2 points**]

A) The ARP Lookup will get the response as a MAC Address – 00:0c:EA:17:98:32

Total Score = _____/__120__