CSCI 5010 – Fundamentals of Data Communications

Lab 3
IP Addressing

University of Colorado Boulder
Department of Computer Science
Network Engineering

Professor Levi Perigo, Ph.D.

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.

Note: Feel free to use your laptop or VMs provided for any objective.

Objective 1: Public and Private IP addresses

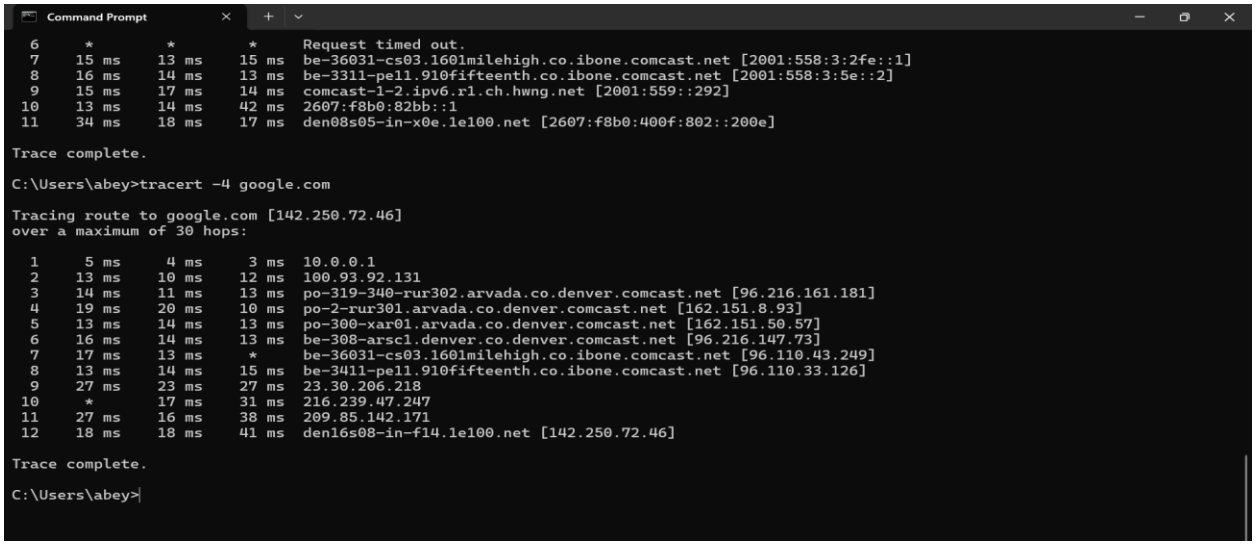
1. Using the command prompt, find your laptop's IP address.
    a. Submit the IP address here (also note how the address was obtained (static/dynamic/etc.) [**1 point**]

    The laptop's Ip address is 10.0.0.25 and since DHCP is enabled the IP address is dynamically assigned.

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**]

    The ip address shown is 73.153.70.217. Yes, it is different because my laptop's IP address is assigned by my router it is a private IP address and works within the local network whereas ipchicken's IP address is a public Ip and assigned by the Internet Service Providers.

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



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**]

No, The IP address in the trace does not belong to the same network. The first IP address is a private IP address the rest is generally a Public IP address. These IP addresses are the pathway it followed between the laptop and the destination. It passes through different routers to reach the destination. In some hops (7,10) the device does not respond to the traceroute. It takes a maximum of 30 Hops for a packet to move from one device to another. The round-trip time is time taken for the packet to reach the device and return.

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**]

The first IP address is a Private IP address it is the gateway of the network (home router). The second IP address is a carrier grade NAT, it used generally by the ISPs to manage large scale NAT. The rest of the IP addresses are public IP addresses. Private IP addresses range from 10.0.0.0 – 10.255.255.255, 172.16.0.0 – 172.31.255.255, 192.168.0.0 – 192.168.255.255 rest of the IP address are Public IP address. So by this I differentiated Public and Private IP addresses. Private IP addresses are used within the local network and Public IP addresses are assigned by ISPs to route traffic across the internet to reach external destinations.

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

   The IPv6 address that my system obtained is 2601:280:5f00:1af0:e84e:d6ec:302d:d56b

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 using test-ipv6.com it will display both ipv6 and ipv4 address. The IP address shown is 2601:280:5f00:1af0:e84e:d6ec:302d:d56b which is the same IPv6 address of my system. It means the system is using globally unique IPv6 addresses.

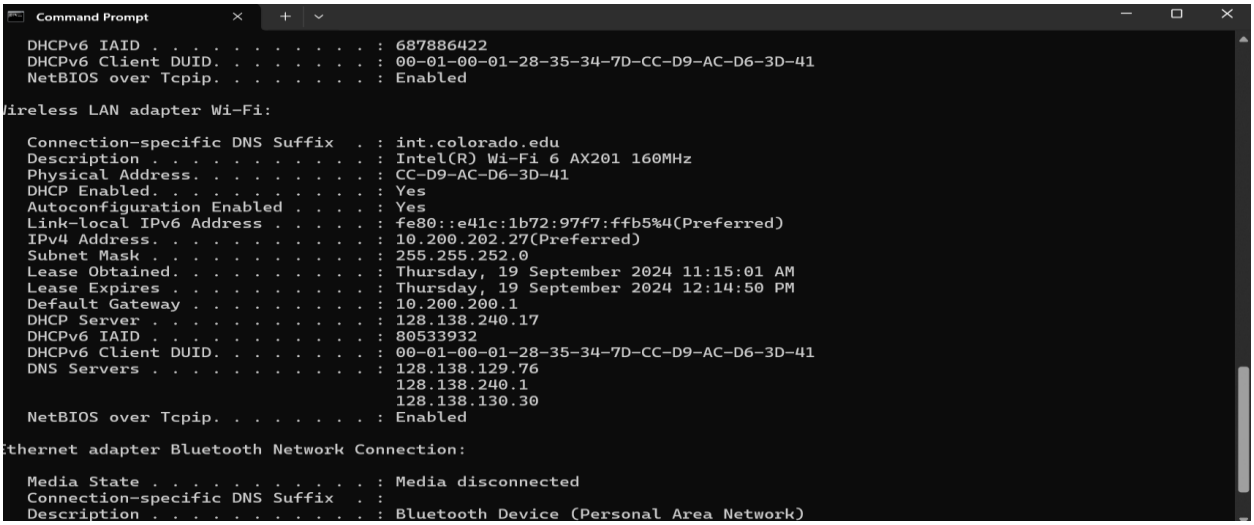
Objective 2: IP Address Format

Note: Prefer using your own laptop instead of the VM, since assigning a static IP to VM might result in losing connection.

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?

      Yes, I see the both IPv4 and IPv6 addresses there is link local IPv6 address as fe80::e41c:1b72:97f7:ffb5%4 and IP address as 10.200.200.0.

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

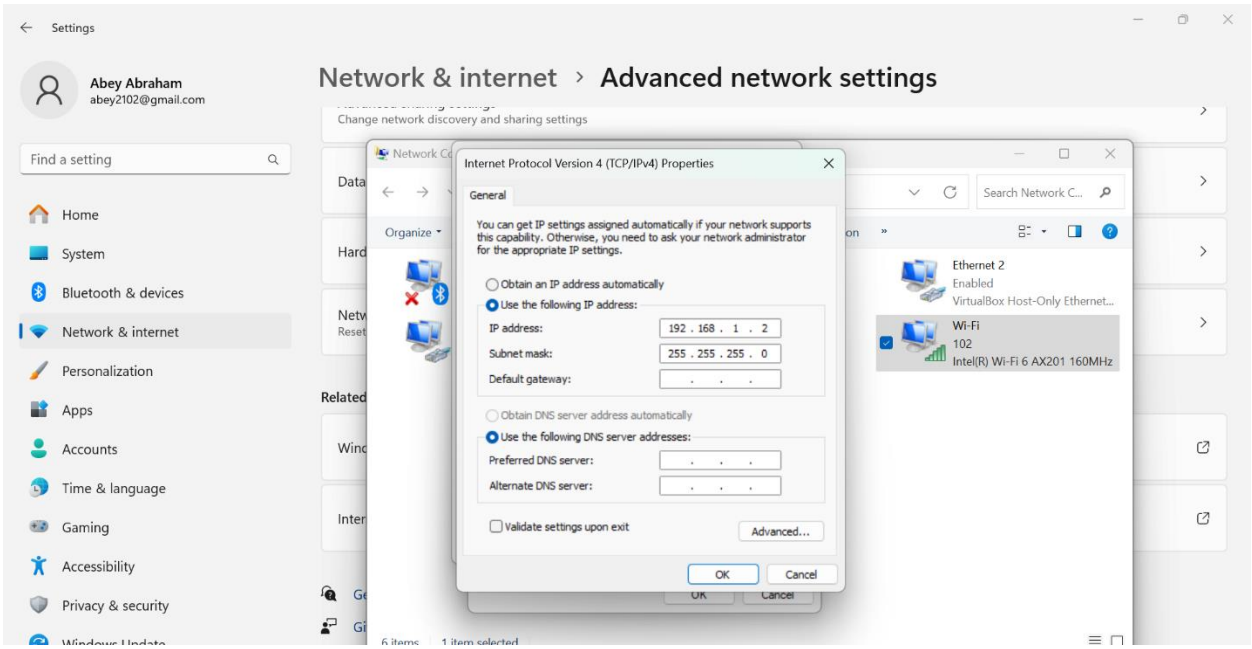


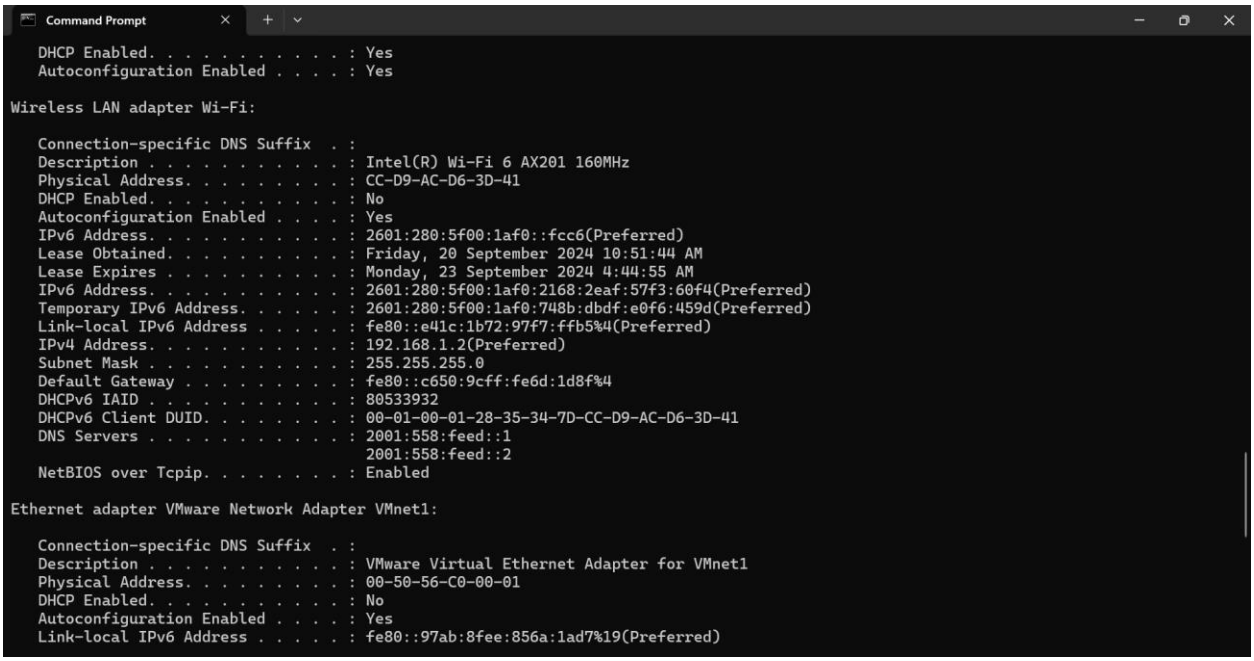
I see both IPv4 and IPv6 addresses, there is link local IPv6 address as fe80::e41c:1b72:97f7:ffb5%4 and IPv4 address as 10.200.202.27

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**]

Yes, we can statically assign IPv4 by going to the Network and sharing Center and change adapter settings and select properties.

In the list of items, select Internet Protocol Version 4 (TCP/IPv4) and click properties and you can enter the IP address statically and the subnet mask.





In this it shows the IP address I have assigned statically which is 192.168.1.2.

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

IPv4 address is 32 bits which is divided into 4 octets (each 8 bits) and each decimal value ranges from 0 to 255, expressed in dotted decimal format. IPv6 address is a 128-bit address

and expressed in terms colon separated hexadecimal format and is divided into 8 groups of 16 bits and each group is represented by 4 hexadecimal digits separated by colons.

References:

Windows: How to Assign a Static IP Address in Windows 10 or Windows 11 (howtogeek.com)

Mac: Use DHCP or a manual IP address on Mac - Apple Support

Note: At any time if you are having issues, revert to DHCP.

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**]

Private Network is reserved for local network such home, office. Its not routable to the global network, means that they cannot be directly accessed outside from the local network. Devices in the local network uses NAT (Network Address Translation) to communicate with the internet by assigning public IP address to the router. Public IP address can be accessed by anyone anywhere and it is assigned by ISPs. It is globally unique so that it can be identified. IPv6 supports autoconfiguration. It automatically sets the IP addresses without using DHCP. IPv6 is used for efficient routing, it doesn't need NAT to communicate.

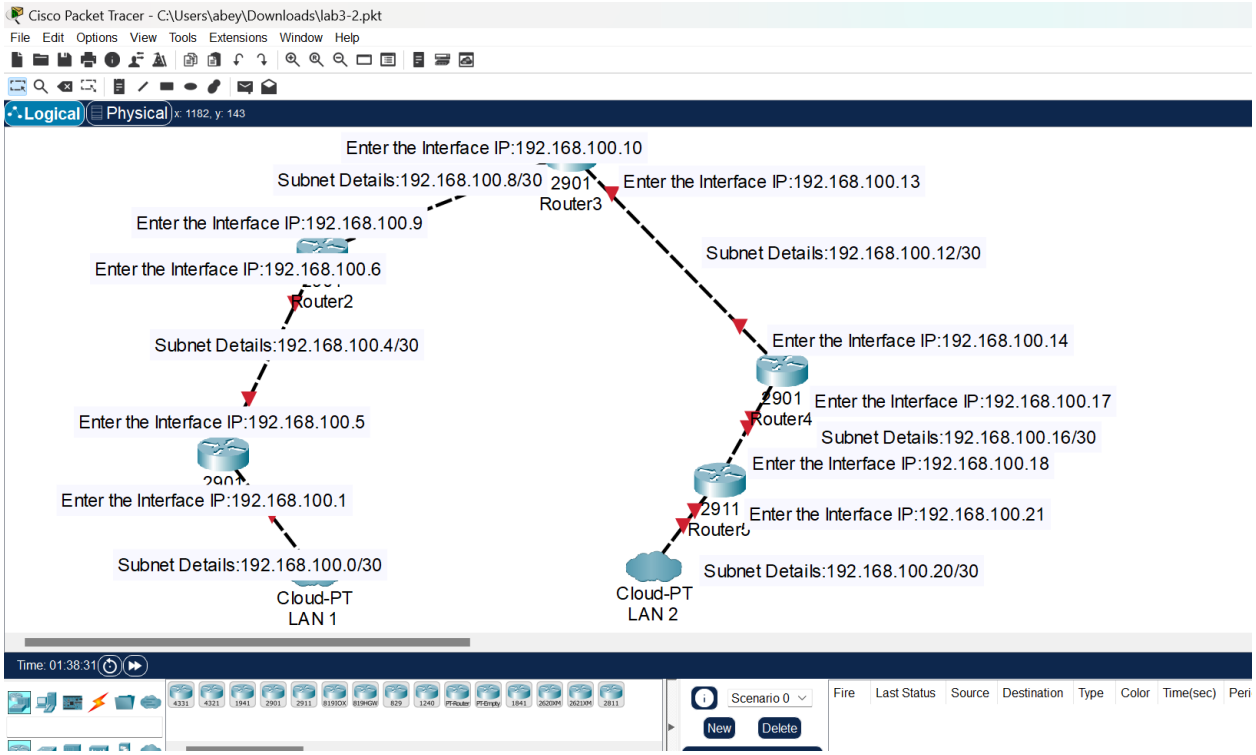
Objective 4: IPv4 subnetting

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

   In classful addressing the Ip addresses is divided into fixed classes (A, B, C, D and E) based on the first few bits on the IP address. Class A is used for very large networks, Class

B is used for medium size network and Class C is used for smaller networks. Classful IPv4 addressing leads to inefficient use of IP addresses. Classless addressing allows system administrators to choose subnet mask and allowing more efficient use of IP address and by using notation or CIDR we can adjust the network based on our needs without IP wastage. Classless addressing is needed to avoid wastage of IP addresses, and it provides a better allocation of IP addresses based on the network size. Subnetting breaks larger network in smaller network. Subnets can improve network performance, management and security.

2. 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**]



3. List 2 points to be noted for efficient subnetting? [**3 points**]

   Proper Subnet Size planning so that it does not lead to IP wastage. Based on the number of devices required in the network and subnet size should match. For example, we can use smaller subnets with fewer host bits for fewer devices than allocating more IP address than necessary.

   Ensuring there is no overlapping subnets, overlapping subnets can cause routing issues, network conflicts and lead to inefficient network traffic management.

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**]

   Host H1 checks if the Destination is in the same network, it will check whether it is in the same subnet but since it does know the MAC address it sends an ARP request. The ARP request (Broadcast) will go to all the available hosts and the default gateway but when they open the packet, since the Destination IP addresses is not intended for their respective devices, it will just drop the packet. Since there is no host such as 128.96.34.126 it will not get an ARP reply and therefore the ARP process will fail, and the packet will not be delivered. Hence Host H1 will eventually give up after the ARP process fails and packet will be dropped.

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

   At first, Host H3 checks if the Destination IP address is in the same network. Since it is in a different network it will send the packet to R2 which is the default gateway. It knows the MAC address of R2 by using ARP process only R2 will reply in unicast way with the MAC address because host H3 wants to send it to R2. Once the packet reaches R2 it will check the routing table since there is no entry again it will go through ARP process and only R1 will reply with its MAC address because it was intended for R1. So once R2 knows R1 MAC address it sends packet to R1 and the routing table is updated with an entry and checks if there is an entry for host H1 IP address. Again, using ARP process, it will get the MAC address of Host H1, and the packet is passed to Host H1. Host H1 sends a reply packet to Host H3.

   (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**]

I have added 1 more subnet and a router R3. The router 3 is placed below R1 so there is a subnet created between R1 and R3. The interface I have given to router 1 is 128.96.34.1/26 and between R1 and R3 I have given the interface IP as 128.96.34.65/26 and 128.96.34.66/26. So, subnet 1 is 128.96.34.0/26 (IP ranges from 128.96.34.0 - 128.96.34.63) an subnet 2 is 128.96.34.64/26 (IP ranges from 128.96.34.64 - 128.96.34.127).

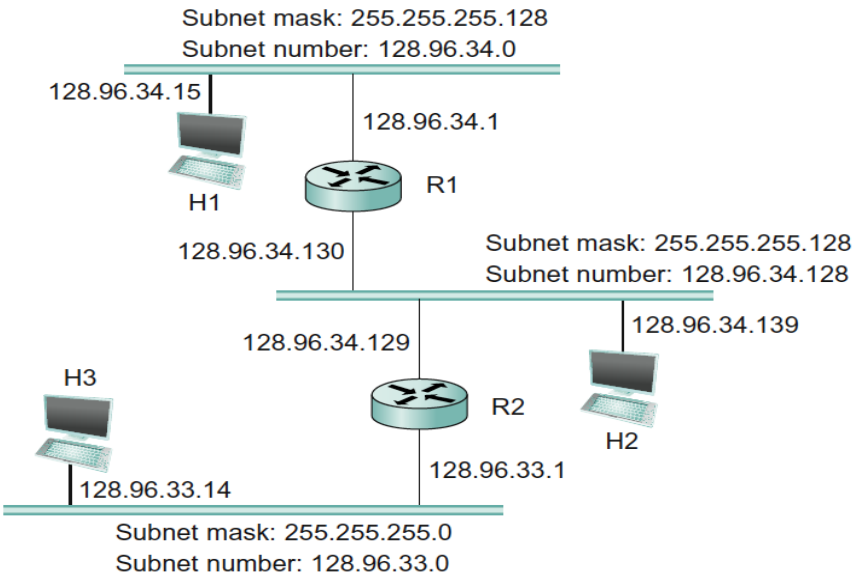


Figure 2.

2) Problem 2

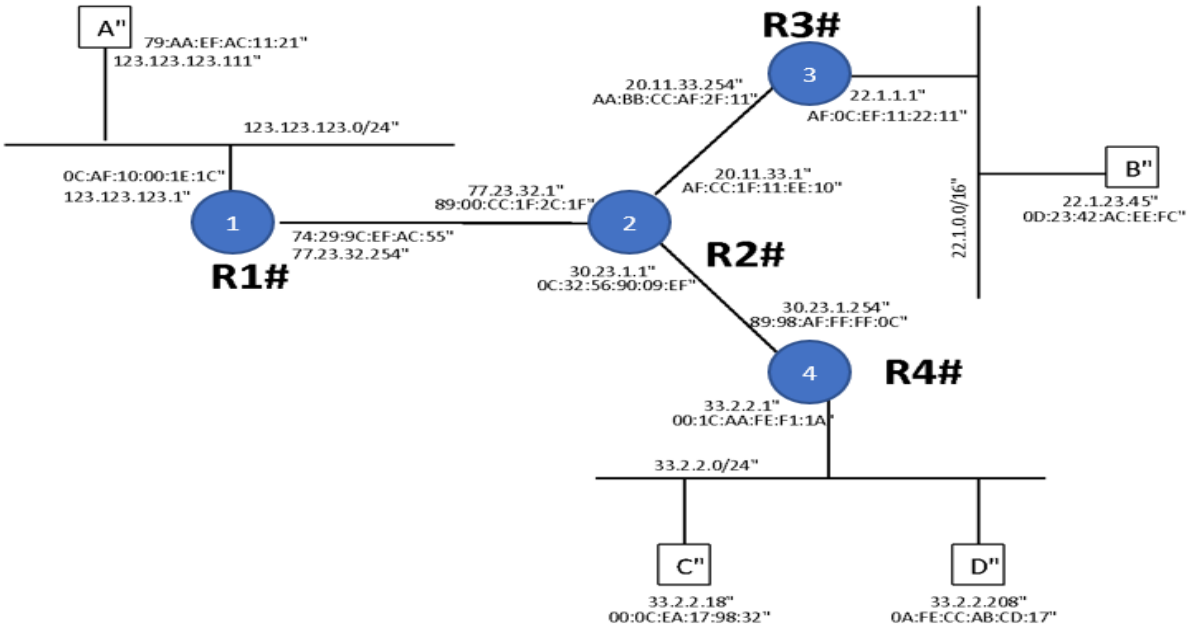


Figure. 3

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	0C:AF:10:00:1E:1C	123.123.123.111	22.1.23.45
R1 -> R2	74:29:9C:EF:AC:55	89:00:CC:1F:2C:1F	123.123.123.111	22.1.23.45
R2 -> R3	AF:CC:1F:11:EE:10	AA:BB:CC:AF:2F:11	123.123.123.111	22.1.23.45
R3 -> B	AF:0C:EF:11:22:11	0D:23:42:AC:EE:FC	123.123.123.111	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**]

ARP sends a query to get to know about the default gateway's MAC address. The default gateway is Router 4 (R4). Host C sends a ARP request who is 33.2.2.1 and it tells the source IP address, MAC address and it asking the MAC address of the router. since the query is dedicated to R4 it will reply back with the MAC address which is 00:1C: AA: FE:F1:1A.

Total Score = _____/__120__