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CS 542 – Computer Networks I: Fundamentals Fall 2023 HW1 (108 points)

Submission instructions

– Due date: Sunday, Oct. 29, 11:59 pm Central Time

– Late submissions and submissions violating these instructions will NOT be accepted.

– No handwritten submissions. No credit will be given for the handwritten submissions.

– Teamwork is allowed (max. 4 students/team). Individual submissions are also OK.

– Upload your HW (pdf format only) to Blackboard. Submissions in formats other than pdf will be disregarded. The Beacon students: upload your submissions to Lumina.

– One submission per team only. Write down names, A#, and section numbers of all the team members on the front page. Do not submit multiple copies of your HW (e.g. by each team member). It is very confusing and will be penalized. Clearly indicate how each team member contributed to your teamwork.

– Show your work and explain every step of your solution for full credit. Only partial credit will be given for a correct final answer with missing calculations, no supporting explanations or unclear justifications.

– My TAs Pranav Saji (psaji@hawk.iit.edu) and Aditya Sai Kolluru (akolluru@hawk.iit.edu) are responsible for grading this HW assignment. Feel free to ask questions is something is not clear but don't send me or my TAs:
- Your partial solutions with inquiries "Is that what you expect?".
- Questions, the answers to, may give explicit hints on how to solve the HW problems.

Student Name	Section	A#	Homework Contribution
Sanket Kulkarni	**01**	**A20537896**	**25%**
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1. Please give and explain your answers to the questions below. **(5 points)**

a. What is the range of addresses of the 64th block of Class A? **(1 point)**

Ans:

Subnet mask of Class A IP Address = 255.0.0.0 (1st byte is used for network address and remaining 3 bytes is for host address)

First address of 64th block Class A IP address will be 64.0.0.0 and the last address (broadcast address) is 64.255.255.255.

This means that all IP addresses in the range of 64.0.0.0 to 64.255.255.255 belong to the same network.

And from this the Range of useful IP address will be = 64.0.0.1 to 64.255.255.254

b. Consider fixed-length subnetting. What is the maximum number of created subnets if the desired number of subnets is: **(4 points)**

a) 2
b) 62
c) 122
d) 250

Ans:

Here,

Formula to calculate the maximum number of created subnets is = $2^{Number\ of\ Subnet\ Bits}$

By using the above formula, we can calculate the maximum number of created subnets as follows:

a)

Here,

Subnets = 2

2^1 = 2 (We only need 1 bit to get at least 2 subnets)

So, the maximum number of created subnets will be 2

b)

Here,

Subnets = 62

2^6 = 64 (We only need 6 bits to get at least 62 subnets)

So, the maximum number of created subnets will be 64

c)

Here,

Subnets = 122

2^7 = 128 (We only need 7 bits to get at least 122 subnets)

So, the maximum number of created subnets will be 128

d)

Here,

Subnets = 250

2^8 = 256 (We only need 8 bits to get at least 250 subnets)

So, the maximum number of created subnets will be 256

2. A network administrator uses the subnet mask 255.255.252.0 in the network 191.168.0.0. How many total subnets have been created, and what's the size of each subnet? Assume classful addressing. **(3 points)**

Ans:

- Subnet Mask Conversion Network of 255.255.252.0 = **11111111.11111111.11111100.00000000**
- A Class B network with classful addressing has 255.255.0.0 as its default subnet mask. This shows that host addresses can use the last 16 bits, which are set aside for the network component.
- To create subnets, the subnet mask 255.255.252.0 takes six (6) additional bits from the host component. These bits are used for subnetting, as shown by the "11111100" in the final two octets.
- So total subnets will be, 22 - 16 = 6, so $2^n = 2^6$ **= 64 total subnets.**

The total number of hosts in each subnet will determine the size.

It appears to be, 2^n =2^{10} **= 1024** And useful subnets block will 1022 because **1 for network address and 1 for broadcast address.** The subnet mask 255.255.252.0 generates subnets with 1022 host addresses that can be assigned to devices.

So, the answer is 64 total subnets
And Size of each subnets will be 1022

3. If you subnet the network 10.0.0.0 with a subnet mask of 255.255.240.0, what's the maximum number of subnets and hosts per subnet? Assume classful addressing. **(3 points)**

Ans:

10.0.0.0 is a Class A network. subnet mask of 255.255.240.0, Default mask is /8. So, as per the mask there are 12(8+4) bits allocated for subnets. Therefore, Number of subnets = 2^n, $2^{(\text{number of Host bits in subnet mask})}$.

In this classful addressing case, n is 12, so the maximum number of subnets is 2^{12} = 4096

Maximum number of subnets: 4096

Number of hosts per subnet: 32-20 = 12, $2^{12} - 2$ = 4094

For every subnet 2 addresses will be reserved - 1 for network address and 1 for broadcast address to allocate a host.

4. A network 10.5.6.0/24 is subnetted with a mask of 255.255.255.192. How many subnets are created and what is the third subnet's last usable IP address? **(4 points)**

Ans:

Here,

Given address = 10.5.6.0/24

Subnet mask = 255.255.255.192

prefix length is /24. And subnet mask will be /26 (8+8+8+2)

So, number of subnets will be, 26-24 = 2.

2^2 = 4 subnets

In this block total addresses will be (32 – 24 = 8) so 2^8 = 256 addresses.

- **For subnet 1:**
  First address: 10.5.6.0/26
  Last address: 10.5.6.63/26

- **For subnet 2:**
  First Address: 10.5.6.64/26
  Last Address: 10.5.6.127/26

- **For subnet 3:**
  First: 10.5.6.128/26

Last: 10.5.6.191/26

- **For subnet 4:**
  First: 10.5.6.192/26
  Last: 10.5.6.255/26

Here, subnet 3 range is from 10.5.6.128/26 to 10.5.6.191. From this last address will be for broadcast address. So, last usable address will be **10.5.6.190/26.**

5. An ISP has the block 192.100.0.0/16 and wants to allocate subblocks to organizations, each with 500 IP addresses. How many subblocks can be provided and what is their mask? **(4 points)**

Ans:

Since the block in this case is 192.100.0.0/16, the total number of networks that can be created is:

32 – 16 = 16, or (256 * 256) = 65536

The organization now wants to allocate 500 to each, but we may choose a rational amount that will exceed 500 which is 512.

Therefore, (256 * 256) / 512 = **128 subblocks can be provided**

Additionally, we used 128 subblocks, thus the extra bit is log (128) = 7.

Default mask is /16. The mask of subblock will therefore be as follows:

16+7 = **/23**

Therefore, 128 subblocks can be provided and their mask is /23

6. Find the network address, the direct broadcast address, and the number of addresses in the network, if one of the addresses is 183.70.230.23/20. **(4 points)**

Ans:

Here,

Given network address = 183.70.230.23/20

To find out first address or network address, we need to apply default mask, on given address.

Mask is /20 so it becomes 255.255.240.0

Destination address	10110111.01000110.11100110.00010111
Mask	11111111.11111111.11110000.00000000
Network address	10110111.01000110.11100000.00000000

So, network address in dotted decimal notation will be 183.70.224.0/20

Here total number of address will be 32 – 20 = 12, so 2^{12} = 4096.

And broadcast address will be,

183.70.224.0
+ 15.255
―――――――
183.70.239.255

So, the network address = 183.70.224.0/20

Broadcast address = 183.70.239.255

Number of addresses in a network = 4096

7. Divide the network 126.168.24.0/24 into 4 subnets. What is the subnet mask? Give the range of IP addresses for each subnet. Which of these addresses cannot be assigned to hosts? **(5 points)**

Ans:

Here,

we need 4 subnets. So extra bits will be log4 = 2.

Prefix length is /24 so subnet prefix length / subnet mask will be 24 + 2 = /26

Total addresses will be 32 - 24 = 6 so 2^6 = 256 addresses. Each will have 64 addresses.

So, ranges will be as follows

- **For subnet 1:**
  First Address: 126.168.24.0/26
  Last Address: 126.168.24.63/26
  Useful addresses: 126.168.24.1/26 to 126.168.24.62/26

- **For subnet 2:**
  First Address: 126.168.24.64/26
  Last Address: 126.168.24.127/26
  Useful addresses: 126.168.24.65/26 to 126.168.24.126/26

- **For subnet 3:**
  First Address: 126.168.24.128/26
  Last Address: 126.168.24.191/26
  Useful addresses: 126.168.24.129/26 to 126.168.24.190/26

- **For subnet 4:**
  First Address: 126.168.24.192/26
  Last Address: 126.168.24.255/26
  Useful addresses: 126.168.24.193/26 to 126.168.24.254/26

Here, all the first and last addresses in given subnets will not be usable because the first address assigned to network and last is assigned to broadcast address.

So, following are the addresses cannot be assigned to hosts:

- **Network addresses:**

126.168.24.0
126.168.24.64
126.168.24.128
126.168.24.192

- **Broadcast addresses:**

126.168.24.63
126.168.24.127
126.168.24.191
126.168.24.255

8. Can the following IP addresses be assigned to a host? Explain your answers. **(6 points)**

a. 255.255.255.255 **(1 point)**
Ans:

No. In many networking configurations, this IP address which is the final one is referred to as the broadcast address. And it cannot be given to certain hosts. So, the answer is we cannot assign this address to a host.

b. 127.32.45.0 **(1 point)**
Ans:

No. The IP address 127.32.45.0 is found in the loopback address which is reserved IPv4 address block 127.0.0.0/8. This indicates that no host on a network is assigned an address that falls between 127.0.0.0 and 127.255.255.255; Because it is reserved for loopback reasons.

In conclusion, on a normal network, 127.32.45.0 is reserved for loopback reasons and is not assigned to hosts. So, the answer is we cannot assign this address to a host because 127.32.45.0 is reserved for loopback reasons.

c. 43.0.0.0 (assume classless addressing; note that the mask is not given) **(2 points)**
Ans:

No. In order to figure out if a host can be assigned the IP address 43.0.0.0, we have to consider classless addressing as well as understand the network's environment. An IP address and a subnet mask that specify the network and host parts of the address are combined to form classless addressing.

However, the subnet mask is not given by the provided IP address 43.0.0.0. Understanding how the IP address is split into network and host components requires knowledge of the subnet mask. We cannot determine whether 43.0.0.0 is a valid address or not without the subnet mask. So, the answer is we cannot assign this address to a host without knowing its subnet mask.

d. 1.64.126.32 (assume classless addressing; note that the mask is not given) **(2 points)**
Ans:

No. An IP address and a subnet mask are used in classless addressing to identify the network and host parts of the address. We are unable to say for sure whether a host can be issued the IP address 1.64.126.32 without knowing the valid subnet mask.

So, the answer is we cannot assign this address to a host without knowing its subnet mask.

9. The block 172.16.0.0/16 is given. Create 3 subnets with the number of hosts given below. Find the subnet addresses and the subnet masks for each subnet. **(6 points)**

a. 1st subnet: 2000 hosts

Ans:

Here,

Address = 172.16.0.0/16

An initial subnet requires 2000 hosts. We have a limit to 2048 addresses at most. That is calculated as 2^{11} = 2048

Thus, the first subnet mask is 32 – 11 = /21

For this subnet, the network address will come first. Additionally, this subnet has a total of 2048 = 8.0 addresses.

Thus, 8.0 - 1 = 7.255 for the last address

```
  172.16.0.0
+        7.255
--------------
  172.16.7.255
```

So, the First address = 172.16.0.0/21
Last address = 172.16.7.255/21
Subnet address = 255.255.248.0
Subnet mask = 21

b. 2nd subnet: 500 hosts

Ans:

Here,

The 2nd subnet requires 500 hosts. We have a limit to 512 addresses at most. That is calculated as $2^9 = 512$

Thus, the second subnet mask is 32 – 9 = /23

For this subnet, the network address will be next address of last address of the 1st subnet i.e. 172.16.8.0/23. And total addresses in this subnet are 512(2 * 256) = 2.0.

Thus, 2.0 - 1 = 1.255 for the last address

```
  172.16.8.0
+      1.255
─────────────
  172.16.9.255
```

So, the First address = 172.16.8.0/23
Last address = 172.16.9.255/23
Subnet address = 255.255.254.0
Subnet Mask = /23

c. 3rd subnet: 100 hosts

Ans:

The 3rd subnet requires 100 hosts. We have a limit to 128 addresses at most. That is calculated as $2^7 = 128$

Thus, the third subnet mask is 32 – 7 = /25

For this subnet, the network address will be next address of last address of the 1st subnet i.e. 172.16.8.0/23. And total addresses in this subnet are 128.

Thus, for the last address we perform 128 - 1 = 127

```
  172.16.10.0
+        127
─────────────
  172.16.10.127
```

So, the First address = 172.16.10.0/25
Last address = 172.16.10.127/25
Subnet address = 255.255.255.128
Subnet Mask = /25

10. An ISP is allocated the block 128.45.32.0/24. This ISP needs to assign 16 addresses per customer. Find the mask for each of these subnets and give the first and last usable IP addresses for the first three subnets. **(4 points)**

Ans:

Here,

An ISP allocated the block = 128.45.32.0/24

The ISP needs to assign 16 addresses for each customer.

To calculate the mask, we can use the following formula:

log16 = 4

32 – n = 32 – 4 = 28 = /28

So, the mask is /28

- **For 1st subnet:**

<table>
<tr><td>First address</td><td colspan="2">128.45.32.0/28</td></tr>
<tr><td rowspan="2">Usable addresses:</td><td>First address</td><td>128.45.32.1/24</td></tr>
<tr><td>Last address</td><td>128.45.32.14/24</td></tr>
<tr><td>Last address</td><td colspan="2">128.45.32.15/28</td></tr>
</table>

- For 2nd subnet:

<table>
<tr><td>First address</td><td colspan="2">128.45.32.16/28</td></tr>
<tr><td rowspan="2">Usable addresses:</td><td>First address</td><td>128.45.32.17/24</td></tr>
<tr><td>Last address</td><td>128.45.32.30/24</td></tr>
<tr><td>Last address</td><td colspan="2">128.45.32.31/28</td></tr>
</table>

- For 3rd subnet:

<table>
<tr><td>First address</td><td colspan="2">128.45.32.32/28</td></tr>
<tr><td rowspan="2">Usable addresses:</td><td>First address</td><td>128.45.32.33/24</td></tr>
<tr><td>Last address</td><td>128.45.32.46/24</td></tr>
<tr><td>Last address</td><td colspan="2">128.45.32.47/28</td></tr>
</table>

11. A certain company wants to create two subnets to meet its network requirements. Find the suffix and prefix lengths for these subnets, one with 67 addresses and the other with 34 addresses. **(3 points)**

Ans:

a. For the subnet with 67 addresses:

Here,
Number of addresses = 67

To find the prefix and suffix lengths of the subnet we need to find the smallest power of 2 that is greater than or equal to given number of addresses i.e. 67.

In this case, 2^7 = 128, which is the smallest power of 2 that provides at least 67 addresses.

Therefore, the prefix length for Subnet 1 is calculated as below:

Prefix Length: 32 bits (IPv4 address length) – 7 bits = 25 bits (network bits)
Suffix Length: 32 - 25 = 7 bits (host bits)

b. For the subnet with 34 addresses:

Here,

Number of addresses = 34

To find the prefix and suffix lengths of the subnet we need to find the smallest power of 2 that is greater than or equal to given number of addresses i.e. 34.

In this case, 2^6 = 64, which is the smallest power of 2 that provides at least 34 addresses.

Therefore, the prefix length for Subnet 2 is calculated as below:

Prefix Length: 32 bits (IPv4 address length) – 6 bits = 26 bits (network bits)
Suffix Length: 32 - 26 = 6 bits (host bits)

12. The block of addresses 146.157.224.0/19 is divided into 3 subblocks. The 1st subblock is allocated to a group of 12 customers, each of which needs 64 addresses. The 2nd subblock is allocated to a group of 9 customers, each of which needs 32 addresses. The 3rd subblock is allocated to a group of 5 customers, each of which needs 16 addresses. **(16 points)**

a. Design the three subblock. Find the mask for each of them (i.e. for each subblock not for each customer). **(6 points)**

b. What is the range of addresses (find the first and last of them) allocated to the 10th customer in the 1st subblock? **(2 points)**

c. What is the range of addresses (find the first and last of them) allocated to the 5th customer in the 2nd subblock? **(2 points)**

d. What is the range of addresses (find the first and last of them) allocated to the 3rd customer in the 3rd subblock? **(2 points)**

e. How many addresses are still available after this allocation in each of the three subblocks? **(3 points)**

f. How many addresses are still available after this allocation in the entire original block? **(1 point)**

Ans:

Given,

The address is 146.157.224.0/19

This address is divided into 3 subblocks as follows:

1st subblock = 12 customers each of which needs 64 addresses

2nd subblock = 9 customers each of which needs 32 addresses

3rd subblock = 5 customers each of which needs 16 addresses

- For **first subblock** we need 64 addresses so,
  log64= 6 bits
  So, mask will be 32 - 6 = 26 = **/26**

- For **second subblock** we need 32 addresses so,
  log32 = 5 bits
  So, mask will be 32 – 5 = 27 = **/27**

- for **third subblock** we need 16 addresses so,
  log16= 4 bits
  So, mask will be 32 – 4 = 28 = **/28**

a)
Ans:

For 1st block = 12 customers = 64 address
First address of Block 1 = 146.157.224.0/26
1024 -1 = 1023.
Last address of Block 1 = 146.157.227.255.
Mask = /26

For 2nd block = 9 customers = 32 address
First address of Block 2 = 146.157.228.0/27
512 -1 = 511
Last address of block 2 = 146.157.229.255/27
Mask = /27

3rd block = 5 customers = 16 address
First address of Block 3 = 146.157.230.0/28
128 -1 =127.
Last address of block 3 = 146.157.230.127/28
Mask = /28

b)

Ans: As per the above table, the range of 10th customer in 1st subblock is as follows:

- Customer 10, first address =146.157.226.64/26
- Customer 10 last address = 146.157.224.127/26
- Range = 146.157.226.64/26 - 146.157.226.127/26

c)

Ans: As per the above table, the range of 5th customer in 2nd subblock is as follows:

- Customer 5 first address =146.157.228.128/27
- Customer 5 last address = 146.157.228.159/27
- Range = 146.157.228.128/27 - 146.157.228.159/27

d)

Ans: As per the above table, the range of 3th customer in 3rd subblock is as follows:

- Customer 3 first address = 146.157.230.32/28
- last address for 3rd customer = 146.157.230.47/28
- Range for it will be: 146.157.230.32/28 - 146.157.230.47/28

e)

Ans:

- For 1st block, 1024 – 768 = 256 addresses
- For 2nd block 512 – 288 = 224 addresses
- For 3rd block 128 – 80 = 48 addresses

f)

Ans:

The addresses available:

32-19(prefix)= 13

2^{13} = 8192

- Total first block addresses: 12 * 64 = 768
- Total second block addresses: 9 * 32 = 288
- Total third block addresses: 5 * 16 = 80

So,

Available addresses: 8192 – 768 – 288 - 80 = 7056

13. Is the delivery direct or indirect? **(4 points)**

a. A host with the IP address 131.16.192.4/16 sends a packet to a host with the IP address 132.16.128.19/18. Explain your answer.

Ans:

Here,

We need to first compare the sender and receiver's network addresses and subnet masks to determine if the packet was delivered directly or indirectly.

- **Sender's IP address:** 131.16.192.4/16
- **Receiver's IP address:** 132.16.128.19/18

The subnet masks (/16 and /18) in both scenarios indicate that the network address is represented by the first 16 bits and first 18 bits respectively. Now, let's compare the network addresses:

- **Sender’s Network Address:** 131.16.0.0/16 (First 16 bits are fixed)
- **Receiver’s Network Address:** 132.16.128.0/18 (First 18 bits are fixed)

The sender and the recipient are on separate subnets since the first 16 bits of the address provided by the sender (131.16) do not match the first 18 bits of the receiver's address (132.16.128). This indicates that a direct delivery of the packet within the local network is not possible.

As a result, the packet would be delivered indirectly from the host with IP address 131.16.192.4/16 to the host with IP address 132.16.128.19/18. To get to the destination subnet, the packet must be routed via routers and other networking devices.

Therefore, this is an indirect delivery.

b. A host with the IP address 87.136.56.126/25 sends a packet to a host with the IP address 87.136.56.111/25. Explain your answer.

Ans:

Here,

We need to first compare the sender and receiver’s network addresses and subnet masks to determine if the packet was delivered directly or indirectly.

- **Sender’s IP address:** 87.136.56.126/25
- **Receiver’s IP address:** 87.136.56.111/25

The subnet masks (/25 and /25) in both scenarios indicate that the network address is represented by the first 25 bits for both the addresses respectively. Now, let's compare the network addresses:

- **Sender’s Network Address:** 87.136.56.0/25 (First 25 bits are fixed)
- **Receiver’s Network Address:** 87.136.56.0/25 (First 25 bits are fixed)

As we can see both the sender’s and receiver’s network address matches. The packet would be delivered directly from the host having IP address 87.136.56.126/25 to the host having IP address 87.136.56.111/25 since both the sender and the receiver have IP addresses that are within the same subnet (87.136.56.0/25). Since they are connected to the same local network, there is no need for the devices to communicate with one another via intermediary networks or devices.

Therefore, this is a direct delivery.

14. Why do we need both the IP addresses and the physical addresses in networking? **(3 points)**

Ans:

Both physical addresses and IP addresses have different functions in computer networking and are essential for a network to operate properly.

- **Why we need IP addresses:**

i. **Logical Addressing:**

Devices on the network are uniquely identified by their IP addresses. And for communication via the internet to be made possible, each device that is linked to a network needs to have its own IP address.

ii. **Routing:**

Data packets need IP addresses in order to be routed between networks. IP addresses are used by routers to identify a packet's subsequent hop on its path to the target network.

- **Why we need physical addresses:**

i. **Hardware Communication at a Low Level:**

Within a network segment, MAC (Media Access Control) addresses are used for local identification. The manufacturer applies a unique MAC address onto each network interface card (NIC) of a device.

ii. **Data Link Layer Communication:**

Devices connected to the exact same physical network utilize MAC addresses to speak with one another directly. Devices on the same local network sends information to the data link layer using their MAC addresses to interact with each other.

- **Why we need both?**

i. **Routing and Forwarding:**

In order for router to route packets between networks, they require IP addresses. IP addresses are used by routers to decide where to deliver data. The MAC address is utilized for the final transmission of the data to the designated device inside the network after it has reached the relevant local network.

ii. **Hierarchical Addressing:**

IP addresses offer a hierarchical addressing method that facilitates effective routing over vast networks, such as the internet. MAC addresses are only used to interact between a local network segment and lack this hierarchical structure.

In conclusion, MAC addresses are required because they are used to provide physical, local identity for devices within the exact same network segment and provide direct communication at the data link layer and IP addresses are needed because they are used to provide logical, global identification and ease routing between other networks. Computer networks cannot operate effectively or dependably without both addresses.

15. For the routing tables given below, draw the network configuration including all the 4 routers (i.e. not each router separately). Indicate the next-hop addresses in the figure. **(12 points)**

R1:

Mask	Network Address	Next-Hop Address	Interface Number
/24	223.153.9.0	-----------	M0
/24	200.156.72.0	-----------	M1
/16	191.194.0.0	12.0.213.12	M2
/16	135.65.0.0	223.153.9.126	M0
/16	128.98.0.0	12.0.213.12	M2
/8	12.0.0.0	-----------	M2
/8	126.0.0.0	223.153.9.126	M0
Default	Default	unspecified	M3

R2:

Mask	Network Address	Next-Hop Address	Interface Number
/16	191.194.0.0	-----------	M0
/16	128.98.0.0	-----------	M1
/8	12.0.0.0	-----------	M2
Default	Default	12.163.31.4	M2

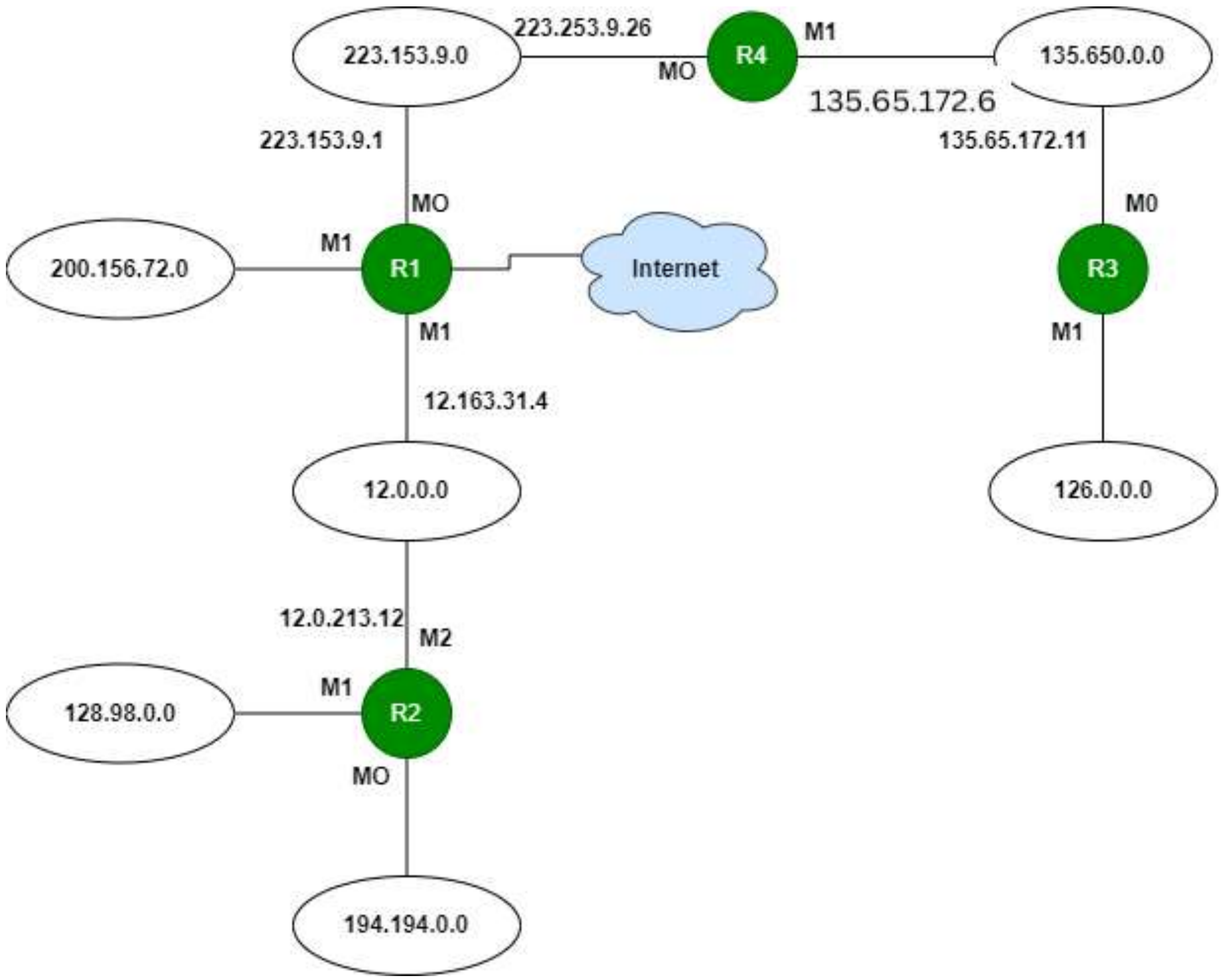
R3:

Mask	Network Address	Next-Hop Address	Interface Number
/16	135.65.0.0	-----------	M0
/8	126.0.0.0	-----------	M1
Default	Default	135.65.13.6	M0

R4:

Mask	Network Address	Next-Hop Address	Interface Number
/24	223.153.9.0	-----------	M0
/16	135.65.0.0	-----------	M1
/8	126.0.0.0	135.65.172.11	M1
Default	Default	223.153.9.1	M0

Ans:



16. Consider the network configuration given below. Assume classful addressing. **(14 points)**

a. Are there any errors in this figure? If so, correct them. **(2 points)**

Ans:

Given the assumption of classful addressing:

Class A addresses range from 0.0.0.0 to 127.0.0.0 and have a default prefix of /8.
Class B addresses range from 128.0.0.0 to 191.255.0.0 and have a default prefix of /16.
Class C addresses range from 192.0.0.0 to 223.255.255.0 and have a default prefix of /24.

The provided network configuration has a tiny error because the host address 163.10.60.60 is not part of the specified network address 163.0.0.0. Since it is a Class B address and the first two bytes are required for net-id allocation, the host id should have been 163.0.60.60

b. Create a routing table for <u>each</u> router given in this figure. Indicate class, network address, next-hop address and interface number in each routing table. **(12 points)**

Ans:

R1:

Mask	Network Address	Next-Hop Address	Interface Number
/24	223.0.144.0	126.123.245.10	M1
/24	192.217.22.0	126.10.10.10	M1
/16	191.54.0.0	126.10.10.10	M1
/16	163.0.0.0	-----------------	M0
/8	126.0.0.0	-----------------	M1
/8	100.0.0.0	126.1.1.1	M1
/8	95.0.0.0	-----------------	M2
Default	Default	126.123.245.10	M1

R2:

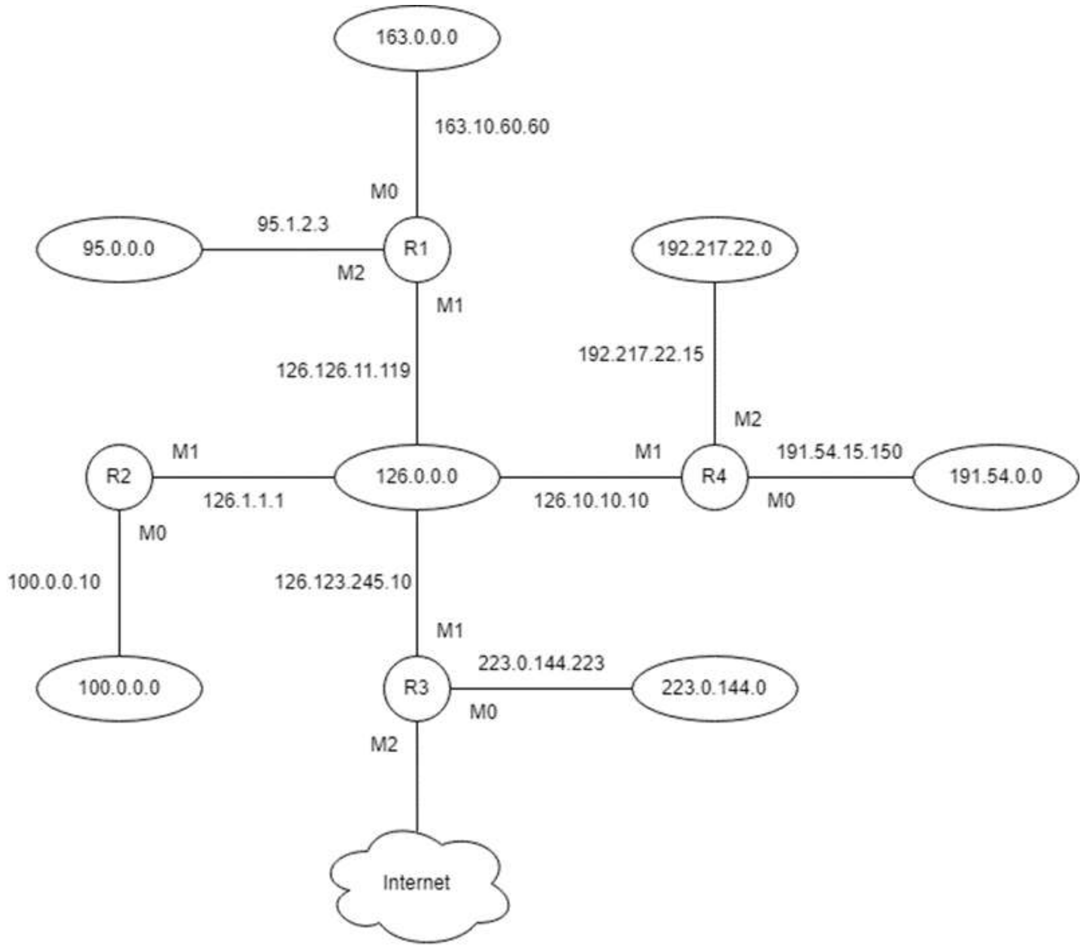
Mask	Network Address	Next-Hop Address	Interface Number
/24	223.0.144.0	126.123.245.10	M1
/24	192.217.22.0	126.10.10.10	M1
/16	191.54.0.0	126.10.10.10	M1
/16	163.0.0.0	126.126.11.119	M1
/8	126.0.0.0	----------------	M1
/8	100.0.0.0	----------------	M0
/8	95.0.0.0	126.126.11.119	M1
Default	Default	126.123.245.10	M1

R3:

Mask	Network Address	Next-Hop Address	Interface Number
/24	223.0.144.0	---------------	M0
/24	192.217.22.0	126.10.10.10	M1
/16	191.54.0.0	126.10.10.10	M1
/16	163.0.0.0	126.126.11.119	M1
/8	126.0.0.0	----------------	M1
/8	100.0.0.0	126.1.1.1	M1
/8	95.0.0.0	126.126.11.119	M1
Default	Default	----------------	M2

R4:

Mask	Network Address	Next-Hop Address	Interface Number
/24	223.0.144.0	126.123.245.10	M1
/24	192.217.22.0	-------------	M2
/16	191.54.0.0	-------------	M0
/16	163.0.0.0	126.126.11.119	M1
/8	126.0.0.0	-------------	M1
/8	100.0.0.0	126.1.1.1	M1
/8	95.0.0.0	126.126.11.119	M1
Default	Default	126.123.245.10	M1



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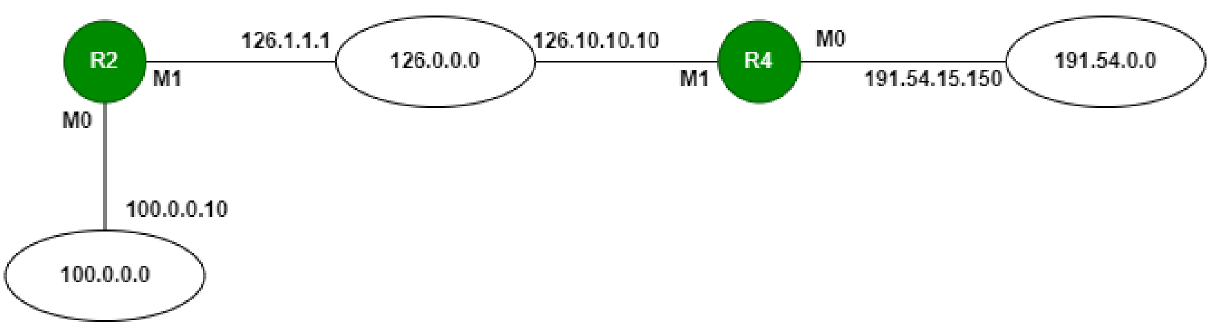
17. Consider the network configuration given above in Question 16. Assume <u>classful addressing</u>. Explain how the following packets are routed in this network (consider the entire network, not a single router). **(6 points)**

a. Host 100.235.37.18 sends a packet to destination 191.54.17.05
Ans:



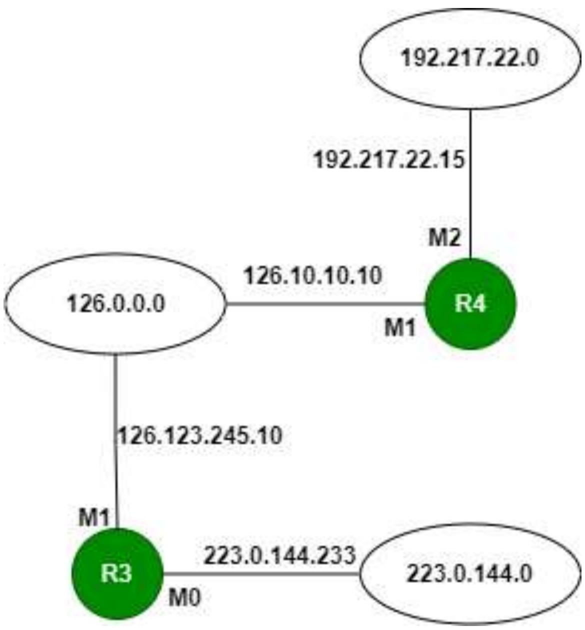
Explanation:

- **Host to R2:** The originating host, 100.235.37.18, sends the packet to its default gateway, which is likely Router R2 since R2 manages the 100.0.0.0/8 network.

- **R2 to R4:** R2 checks its routing table. The route for the 191.54.0.0/16 network points directly to R4 via interface M1, so it sends the packet to 192.217.22.15, which is R4's connected interface.

- **R4 to Destination:** R4 is directly connected to the 191.54.0.0/16 network. It then forwards the packet directly to the destination 191.54.17.05.

b. Host 192.217.22.173 sends a packet to destination 223.0.144.2
Ans:

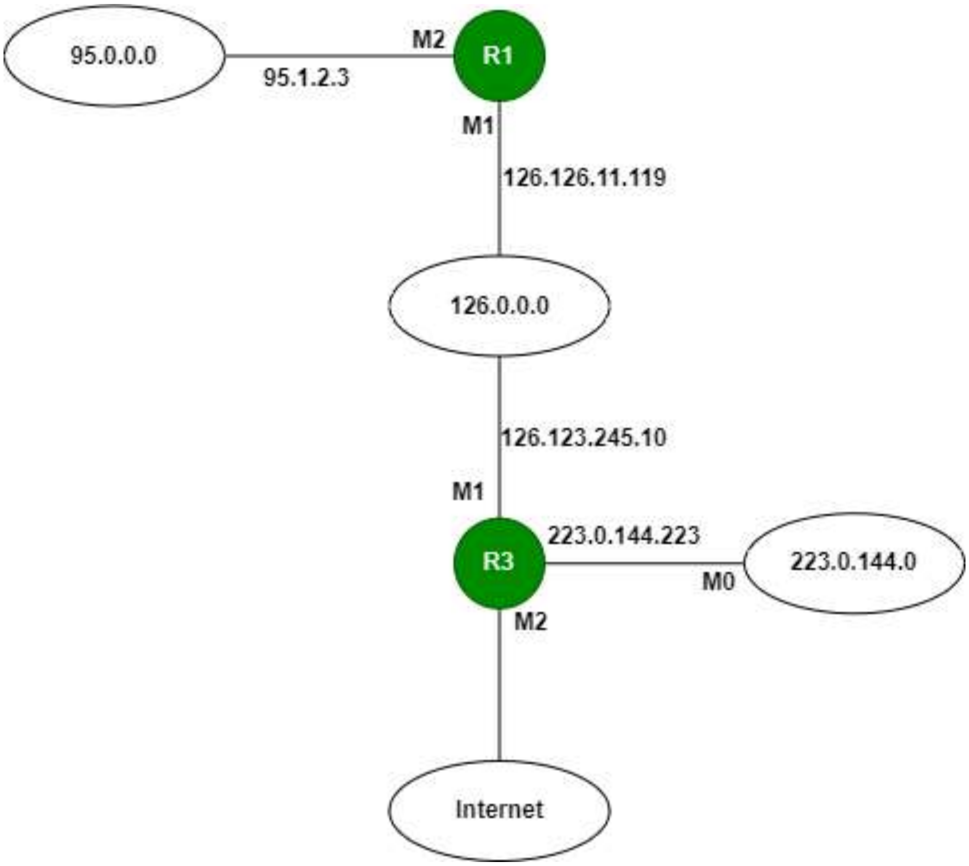


Explanation:

- **Host to R1:** The originating host 192.217.22.173 is directly connected to R1, so it sends the packet there.
- **R1 to R4:** R1 finds that the most specific route to 223.0.144.2 is via its default route pointing to 126.126.11.119, which leads to R3.
- **R3 to Destination:** R3, being directly connected to the 223.0.0.0/8 network, delivers the packet to the final destination 223.0.144.2

c. Host 95.12.234.7 sends a packet to destination 127.201.165.11

Ans:



Explanation:

The address 127.0.0.0/8 is a loopback address, reserved for local machine communication. Typically, no packets with a destination in the loopback range should ever be sent on a network. If, hypothetically, the host did send such a packet, it would be discarded by R1, its connected router.

18. Convert the hexadecimal IP address 0xC0A801A2 to the dotted decimal and binary notations. Determine the class of this address in each of these notations. **(4 points)**

Ans:

Given,

Hexadecimal IP address = 0xC0A801A2

In the hexadecimal numbering system, two digits are used to represent one byte, or eight bits in the dotted decimal numbering system.

Decimal	Binary	Hexadecimal	Decimal	Binary	Hexadecimal
0	0000	0	8	1000	8
1	0001	1	9	1001	9
2	0010	2	10	1010	**A**
3	0011	3	11	1011	**B**
4	0100	4	12	1100	**C**
5	0101	5	13	1101	**D**
6	0110	6	14	1110	**E**
7	0111	7	15	1111	**F**

Given Address	C0	A8	01	A2
Equivalent Binary Format	11000000	10101000	00000001	10100010

Place Value	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	Place value in Decimal
1st Byte	1	1	0	0	0	0	0	0	192
2nd Byte	1	0	1	0	1	0	0	0	168
3rd Byte	0	0	0	0	0	0	0	1	1
4th Byte	1	0	1	0	0	0	1	0	162

The address in dotted decimal format is: 192.168.1.162

The address in binary format is: 11000000 10101000 00000001 10100010

The class of this address is Class C. Class C ranges from 192.0.0.0 to 223.255.255.255

19. Convert the decimal number 218892292 to the base 256 numbering system. **(2 points)**

Ans:

Given,

Decimal number = 218892292

We need to constantly divide the decimal number 218892292 by 256 while keeping the track of the remainders in order to convert it to the base 256 numbering system. The conversion is carried out as follows:

- 218892292 ÷ 256 = 855048 with a remainder of 4
- 854675 ÷ 256 = 3340 with a remainder of 8
- 3333 ÷ 256 = 13 with a remainder of 12
- 13 ÷ 256 = 0 with a remainder of 13

Then we need to read the remainders from bottom to top. So, 218892292's base 256 representation is 13.12.8.4 in the base 256 numbering system.

The decimal number = 218892292

The base 256 numbering system = 13.12.8.4