CS 542 - Assignment 1

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1. What is the range of addresses that can assign to users in the 2021 block of class C? (3 points)

Ans:

Class C addresses start with 192.0.0.0 to 223.255.255.255 with the first 3 bytes as Net Id and the last byte as Host Id. As the block number starts with 0, so the 2021st block will be 2020 ($= 2021 - 1$) to be added to the first address of class C.

- 2021st Block:

To find the first address of the 2021st block, we need to add $(2020)_{10}$ to the Net Id of the first address of class C in the base-256 number system.

Converting $(2020)_{10}$ to base-256:

Divisor	Dividend	Quotient	Remainder
256	2020	7	228
256	228	0	7

Therefore, $(2020)_{10}$ → $(7.228)_{256}$

To get the range of the addresses in the 2021st block class C, we must find the first and the last address of the given block.

- First Address:

  To find the first address of the 2021st block, we need to add $(7.228)_{256}$ with the Net Id $(192.0.0)_{256}$ and the rest of the bits will be all zeros. The summation of the Net Id is given as:

+/-	Byte1	Byte2	Byte3
	192	0	0
+		7	228
Result	**192**	**7**	**228**

  With Net ID 192.7.228 followed by zeros (0 bits), we can find the first address in the 2021st block as $\mathbf{192.7.228.0}$.

- Last Address:

  As this is a class C address and the number of Host Id bits is 8, so each block will have 256 ($= 2^8$) addresses. To find the last address of the 2021st block, we need to add 255 ($= 256 - 1$) to the first address of the block.

+/-	Byte1	Byte2	Byte3	Byte4
	192	7	228	0
+				255
Result	**192**	**7**	**228**	**255**

So, the last address in the 2021st block is $\mathbf{192.7.228.255}$.

The range of addresses that can assign to users in the 2021st block of class C is $\mathbf{192.7.228.0 - 192.7.228.255}$.

2. Convert the number C0514019 in the hexadecimal base to the dotted-decimal notation. What is the class of this address? (consider classful addressing). (5 points)

Ans:

- Hexadecimal is a base-16 numerical system. It uses 16 distinct symbols "0" — "9" to represent the value from 0 to 9, and "A" – "F" to represent the value from 10 – 15. Here we will be considering per 2 digits of the hexadecimal to be equivalent to 1 byte in dotted-decimal notation and convert it to base-256 by each byte.

Hexadecimal	Conversion	Base-256 System
$C0$	$12 * 16^1 + 0 * 16^0$	192
51	$5 * 16^1 + 1 * 16^0$	81
40	$4 * 16^1 + 0 * 16^0$	64
19	$1 * 16^1 + 9 * 16^0$	25

The equivalent number of $(C0514019)_{16}$ in dotted-decimal notation is $\mathbf{192.81.64.25.}$

3. Define the 1202 block of class B? (Give first and last address in the block) (3 points)

Ans:

Class B addresses start with 128.0.0.0 to 191.255.255.255 with the first 2 bytes as Net Id and the last 2 bytes as Host Id. As the block number starts with 0, so the 1202nd block will be 1201 ($= 1202 - 1$) to be added to the first block of class B.

- 1202nd Block:

To find the first address of the 1202nd block, we need to add $(1201)_{10}$ to the Net Id of the first address of class B in the base-256 number system.

Converting $(1201)_{10}$ to base-256:

Divisor	Dividend	Quotient	Remainder
256	2020	7	228
256	228	0	7

Therefore, $(1201)_{10}$ → $(4.177)_{256}$

To get the range of the addresses in the 1202nd block class B, we must find the first and the last address of the given block.

- First Address:
  To find the first address of the 1202nd block, we need to add $(4.177)_{256}$ with the Net Id $(128.0.)_{256}$ and the rest of the bits will be all zeros. The summation of the Net Id is given as:

+/-	Byte1	Byte2
	128	0
+	4	177
Result	**132**	**177**

  With Net ID 132.177 followed by zeros (0 bits), we can find the first address in the 1202nd block as $\mathbf{132.177.0.0}$.

- Last Address:
  As this is a class B address and the number of Host Id bits is 16, so each block will have $65536\ (=\ 2^{16})$ addresses. To find the last address of the 1202nd block, we need to add $65535\ (= 65536 - 1)$ to the first address of the block (i.e., $(255.255)_{256}$).

+/-	Byte1	Byte2	Byte3	Byte4
	132	177	0	0
+			255	255
Result	**132**	**177**	**255**	**255**

  So, the last address in the 1202nd block is $\mathbf{132.177.255.255}$.

The range of addresses that can assign to users in the 1202nd block of class B is $\mathbf{132.177.0.0 - 132.177.255.255}$.

4. Convert the decimal number 5141.01568603515625 to the base 256 number system. (5 points)

Ans:

To convert $(5141.015686035115625)_{10}$ to base-256 number system, we need to convert the integer part and the fraction part separately to base-256 and then we can combine them to obtain the result.

- Integer Part → 5141:

Divisor	Dividend	Quotient	Remainder
256	5141	20	21
256	20	0	20

Therefore, $(5141)_{10}$ → $(20.21)_{256}$

- Fraction Part → 0.015686035115625:

Multiplicand	Multiplier	Result	Integer Part
0.015686035	256	4.015625	4
0.015625	256	4	4

Therefore, $(0.015686035)_{10}$ → $(0{,}4.4)_{256}$ *["," is used as decimal point notation and "." as a separator of base-256 digits]*

Now, concatenating both the result we can write, $(5141.015686035)_{10}$ → $\mathbf{(20.21, 4.4)_{256}}$ *["," is used as decimal point notation and "." as a separator of base-256 digits]*

5. What is the value of $\frac{60.63.12.12.0}{20.21.04.04}$? Give results in 256 base system. (Given numbers are in 256 base system) (4 points)

Ans:

$$\therefore \frac{(60.63.12.12.0)_{256}}{(20.21.04.04)_{256}}$$

$$= \frac{(60 * 256^4 + 63 * 256^3 + 12 * 256^2 + 12 * 256^1 + 0 * 256^1)_{256}}{(20 * 256^3 + 21 * 256^2 + 04 * 256^1 + 04 * 256^0)_{256}}$$

$$= \frac{(258755791872)_{10}}{(336921604)_{256}}$$

$$= (768)_{10}$$

- Conversion of $(768)_{10}$ to base-256 number system:

Divisor	Dividend	Quotient	Remainder
256	768	3	0

Divisor	Dividend	Quotient	Remainder
256	3	0	3

Therefore, $(768)_{10}$ is equivalent to $\mathbf{(3.0)_{256}}$

6. An organization is granted the block 142.200.208.0/21. The administrator wants to create 16 subnets.

a. Find the subnet mask (1 point).

Ans:

The block given to us is 142.200.208.0/21. The administrator wants to create 16 subnets. So, the number of extra bits that need to be added to the default mask is $4 (= \log_2 16)$.

∴ The subnet mask will be, $\mathbf{/25\ (= 21 + 4)}$ *[in slash notation]* or $\mathbf{255.255.255.128}$ *[in dotted-decimal notation]*.

b. Find the number of addresses in each subnet (1 point)

Ans:

Here the number of bits of prefix $= 25$ *(same as the mask)*

∴ The number of bits of suffix $= 32 - prefix = 32 - 25 = 7$

∴ The number address in each subnet is given by,

$2^{\#Suffix\ Bits}\ addresses/subnet$

$= 2^7\ addresses/subnet$

$= 128\ addresses/subnet$

Therefore, the number of addresses in each subnet is **128 addresses.**

c. Find the subnet address and the direct broadcast address for the first subnet. (2 points)

Ans:

- Subnet Address:

The subnet address is the **first address of the given subnet**. The first address of the first subnet is nothing but the first address of the given network, that is 142.200.208.0 and the mask for this subnet is /25. So, the subnet address of the first block is $\mathbf{142.200.208.0/25}$**.**

- Direct-Broadcast Address:

The direct-broadcast address is the **last address of the given subnet**. There are 128 addresses in each subnet. So, to find the last address of the given subnet we need to add $(127)_{256}(= (128-1)_{10})$ to the first address of the subnet in the base-256 number system.

+/-	Byte1	Byte2	Byte3	Byte4
	142	200	208	0
+				127
Result	**142**	**200**	**208**	**127**

Therefore, the direct-broadcast address is $\mathbf{142.200.208.127/25}$**.**

d. Find the 4th and 99th addresses in the last subnet. (4 points)

Ans:

- 4^{th} address:

There are 128 addresses in each subnet. So, the 4^{th} address of the last subnet (i.e., 16^{th} subnet) is given by,

$((numer\ of\ previous\ subnets * size\ of\ each\ subnet)\ + 4 - 1)^{th}$ address

$= (((16-1) * 128)\ +\ 3)^{th}$ address

$= 1923^{rd}$ address

So, to get the 4^{th} address of the 16^{th} subnet we need to add $(1923)_{10}$ to the first address of the network in the base-256 number system.

Divisor	Dividend	Quotient	Remainder
256	1923	7	131
256	3	0	7

Therefore, $(1923)_{10} \rightarrow (7.131)_{256}$

+/-	Byte1	Byte2	Byte3	Byte4
	142	200	208	0
+			7	131

+/-	Byte1	Byte2	Byte3	Byte4
Result	**142**	**200**	**215**	**131**

So, the 4th address of the last subnet is **$\mathbf{142.200.215.131/25}$**.

- ### 99th address:

There are 128 addresses in each subnet. So, the 99th address of the last subnet (i.e., 16th subnet) is given by,

$((numer\ of\ previous\ subnets * size\ of\ each\ subnet)\ + 99 - 1)^{th}$ address

$= (((16-1) * 128)\ +\ 98)^{th}$ address

$= 2018^{th}$ address

So, to get the 99th address of the 16th subnet we need to add $(2018)_{10}$ to the first address of the network in the base-256 number system.

Divisor	Dividend	Quotient	Remainder
256	1923	7	226
256	7	0	226

Therefore, $(2018)_{10}$ → $(7.226)_{256}$

+/-	Byte1	Byte2	Byte3	Byte4
	142	200	208	0
+			7	226
Result	**142**	**200**	**215**	**226**

So, the 99th address of the last subnet is **$\mathbf{142.200.215.226/25}$**.

7. Give the mask in the dotted-decimal notation:

a. For a block of Class-A which results in 128 subnets (1 point)

Ans:

For class A, the default mask is /8. To have 128 subnets, it requires 7 $(= \log_2 128)$ extra one's bit. So, the mask, for a block of class A which results in 128 subnets, is **/15** $(= 8 + 7)$ *[in slash notation]* or **$\mathbf{255.254.0.0}$** *[in dotted-decimal notation]*.

b. Which combines 128 blocks of Class C into a supernet (1 point)

Ans:

For class C, the default mask is $/24$. To combine 128 blocks into a supernet, it requires 7 $(= \log_2 128)$ less one's bit. So, the mask, which combines 128 blocks of class C into a supernet, is $\mathbf{/17}\ (= 24 - 7)$ *[in slash notation]* or $\mathbf{255.255.128.0}$ *[in dotted-decimal notation]*.

8. Convert an IP address 254.128.64.32 to the binary notation (2 points)

Ans:

To convert the IP address to the binary notation, we need to convert each byte into binary. Then we can concatenate the binary numbers together to get the binary notation of the given IP address.

- Decimal to Binary Conversion:

#Byte	Value (in Decimal)	Value (in Binary)
1	254	11111110
2	128	10000000
3	64	01000000
4	32	00100000

The equivalent IP address of $254.128.64.32$ in binary notation is given as,

11111110 10000000 01000000 00100000.

9. The 14th address of a block assigned to a specific organization is 120.65.89.141. The organization needs 120 addresses to give to its 120 users. Find the mask and define this block of addresses. Is there any wastage of the IP addresses? If yes, how many? (Note: The number of router interfaces is 2) (4 points)

Ans:

- Mask:

The organization is given a block of $120.65.89.141$ and it needs 120 address to give its 120 users, so the number of suffix bits is 7 $(= \log_2 120 = \ 6.906890595608519\ \cong 7)$. Therefore, the mask for the block is $\mathbf{/25\ (= 32 - 7)}$ *[in slash notation]* or $\mathbf{255.255.255.254}$ *[in dotted-decimal notation]*.

- Block Definition:

To define the given block, we need to find the first and the last address of the block.

- First Address:

The 14th address of a block is 120.65.89.141. To find the first address of the block we need to subtract 13 $(= 14 - 1)$ from the given address in the base-256 number system.

+/-	Byte1	Byte2	Byte3	Byte4
	120	65	89	141
-				13
Result	**120**	**65**	**89**	**128**

∴The first address of the block is $\mathbf{120.65.89.128/25}$.

- Last Address:

The mask for the block is /25, which means the number of prefix bits is 25 and the number of suffix bits is 7 $(= 32 - 25)$. So, the total number of addresses in the block is 128 $(= 2^7)$. To find the last address we need to add 127 $(= 128 - 1)$ to the first address of the block in the base-256 number system.

+/-	Byte1	Byte2	Byte3	Byte4
	120	65	89	128
+				127
Result	**120**	**65**	**89**	**255**

Therefore, the last address of the block is $\mathbf{120.65.89.255/25.}$

The given block can be defined as a block with **128 addresses** and the range from **$\mathbf{120.65.89.128/25}$ to $\mathbf{120.65.89.255/25}$.**

- IP address wasted:

The total number of addresses in the given block is 128. The address allocation in the organization is given by,

- **120 addresses** are given to its 120 users.
- **1 address** is used as the network address, which is the first address of the block.
- **1 address** is used as the direct-broadcast address, which is the last address of the block.
- The connected router has 2 interfaces; one of the interfaces should connect with this block and the other interface will be connected to the rest of the internet. **1 address** will be assigned to one of the interfaces of the router which is connected to this block.

∴ The number of IP addresses used is $\mathbf{123}$ $(= \mathbf{120} + \mathbf{1} + \mathbf{1} + \mathbf{1})$ and the number of addresses wasted is $\mathbf{5}$ $(= \mathbf{128} - \mathbf{123})$**.**

10. A block of addresses 120.200.240.0/20 granted to an ISP. These addresses are allocated between two groups of customers. The first group has 20 customers, each of which needs 64 addresses, the second group has 20 customers, each of which needs 128 addresses. Show the subblocks and range of addresses for the 10th customer of the first group and the 10th customer of the second group. How many addresses are still available after this allocation? (5 points)

Ans:

From the above information, we can conclude that the address block 120.200.240.0/20 need to be divided into the first group with 20 subnets with 64 addresses in each subnet and 20 subnets with 128 addresses in each subnet.

- First Group:

There are 64 addresses in each subnet. So, the number of suffix bits is $6\ (= \log_2 64)$ and the prefix bits are $26\ (= 32 - 6)$. Therefore, the mask for each of these blocks is $/\mathbf{26}$ *[in slash notation]*.

So, the first address of the 10th customer or the 10th subnet is given by,

$(numer\ of\ previous\ subnets * size\ of\ each\ subnet)^{th}$ address

$= \left((10 - 1) * 64\right)^{th}$ address

$= 576^{th}$ address

So, to get the first address of the 10th subnet we need to add $(576)_{10}$ to the first address of the block in the base-256 number system.

Divisor	Dividend	Quotient	Remainder
256	576	2	64
256	2	0	2

Therefore, $(576)_{10}$ → $(2.64)_{256}$

+/-	Byte1	Byte2	Byte3	Byte4
	120	200	240	0
+			2	64
Result	**120**	**200**	**242**	**64**

So, the first address of the 10th subnet is $\mathbf{120.200.242.64/26}$.

Now, to get the last address of the 10th subnet we need to add $63\ _{10}\ (= 64 - 1)$ to the first address of the subnet in the base-256 number system.

+/-	Byte1	Byte2	Byte3	Byte4
	120	200	242	64
+				63
Result	**120**	**200**	**242**	**127**

Therefore, the last address of this subnet is $\mathbf{120.200.242.127/26}$.

Therefore, the subblock for the 10th customer of the first group has **64 addresses** and the range of the subblock is from $\mathbf{120.200.242.64/26}$ **to** $\mathbf{120.200.242.127/26}$.

- Second Group:

There are 128 addresses in each subnet. So, the number of suffix bits is 7 $(= \log_2 128)$ and the prefix bits are 25 $(= 32 - 7)$. Therefore, the mask for each of these blocks is $/\mathbf{25}$ *[in slash notation]*.

So, the first address of the 10th customer of the second group is given by,

$((numer\ of\ total\ subnets\ in\ the\ first\ group * size\ of\ each\ subnet\ of\ the\ first\ group) + (numer\ of\ previous\ subnets\ in\ the\ second\ group * size\ of\ each\ subnet\ of\ the\ second\ group))^{th}$ addresses

$= \left((20 * 64) + \left((10 - 1) * 128\right)\right)^{th}$ address

$= 2432^{nd}$ address

So, to get the first address of the 10th customer we need to add $(2432)_{10}$ to the first address of the block in the base-256 number system.

Divisor	Dividend	Quotient	Remainder
256	2432	9	128
256	9	0	9

Therefore, $(2432)_{10}$ → $(9.128)_{256}$

+/-	Byte1	Byte2	Byte3	Byte4
	120	200	240	0
+			9	128
Result	**120**	**200**	**249**	**128**

So, the first address of the 10th customer in the second group is $\mathbf{120.200.249.128/25}$.

Now, to get the last address of the 10th customer in the second group we need to add 127_{10} $(= 128 - 1)$ to the first address of this subnet in the base-256 number system.

+/-	Byte1	Byte2	Byte3	Byte4
	120	200	249	128
+				127
Result	**120**	**200**	**249**	**255**

Therefore, the last address of this subnet is $\mathbf{120.200.249.255/25}$.

Therefore, the subblock for the 10th customer of the second group has **128 addresses** and the range of the subblock is from $\mathbf{120.200.249.128/25}$ **to** $\mathbf{120.200.249.255/25}$.

- Available Address:

The ISP granted the IP address with mask $/20$. So, the number of suffix bits is 12 $(= 32 - 20)$.

There is a total of 4096 $(= 2^{12})$ addresses for the granted block and the total number address used is given by,

$(20 * 64) + (20 * 128)$ addresses

$= 3840$ addresses

Therefore, there are **256 addresses** $(= 4096 - 3840)$ still available after this allocation.

11. Find first address, last address, and number of addresses in the block, if one of the addresses in a block is 140.240.90.25/20 (3 points)

Ans:

- First Address:

To find the first address or network address we need to perform a logical **AND** operation between the given IP address and the mask. As the mask is 20 $(i.e.,\ 8 * 2 + 4)$, so we can perform this **AND** operation with the left 4 bits of the third byte from the left. The third byte is given as $(90)_{10}$ or $(01011010)_2$.

Now, $(Third\ Byte\ Value\ of\ the\ IP\ Address)$ $\boldsymbol{AND}$ $(Third\ Byte\ Value\ of\ the\ mask)$

$(01011010)_2$ $\boldsymbol{AND}$ $(11110000)_2$

$= (01010000)_2$

$= (80)_{10}$

In the network address first 16 bits will be all ones which are 255.255, the third byte is 80 and the rest of the bits will be all zeros.

Therefore, the network address or the first address is $\mathbf{255.255.80.0/20}$**.**

- Last Address:

One of the addresses in a block is given as $140.240.90.25/20$. So, the number of suffix bits is 12 ($= 32 - 20$). The number of suffix bits is 12. So, the total number of addresses is 4096 ($= 2^{12}$). To find the last address we need to add 4095 ($= 4096 - 1$) to the first address of the block in the base-256 number system.

Divisor	Dividend	Quotient	Remainder
256	4096	15	255
256	15	0	15

Therefore, $(4095)_{10}$ → $(15.255)_{256}$

+/-	Byte1	Byte2	Byte3	Byte4
	140	240	80	0
+			15	255
Result	**140**	**240**	**95**	**255**

So, the last address of the block is $\mathbf{140.240.95.255/20}$.

- Number of Addresses:

One of the addresses in a block is given as $140.240.90.25/20$. So, the number of suffix bits is 12 ($= 32 - 20$). The number of suffix bits is 12. So, the total number of addresses is $\mathbf{4096}$ **($= \mathbf{2^{12}}$).**

12. Consider the following routing table (the next-hop address is omitted):

Mask	Network Address	Interface
/27	144.56.55.0	M0
/26	123.80.97.0	M1
/25	123.80.97.128	M2
/24	118.114.132.0	M3
Default	Default	M4

Give the interface number for a packet whose destination IP address is:

i. 144.56.55.31 (1 point)

Ans:

To find the network address of the given IP address, we need to apply the masks in descending order. If the resultant network address is found, then the corresponding interface is chosen and if the resultant network address cannot be found in the routing table the default interface is chosen.

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
144.56.55.31	/27	31_{10} → 00010111_2	11100000_2	00000000_2 → 0_{10}	144.56.55.0

As the resultant network address for mask /27 is found in the routing table, so the interface number chosen is **M0**.

ii. 144.56.56.31 (1 point)

Ans:

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
144.56.56.31	/27	31_{10} → 00010111_2	11100000_2	00000000_2 → 0_{10}	144.56.56.0
144.56.56.31	/26	31_{10} → 00010111_2	11000000_2	00000000_2 → 0_{10}	144.56.56.0
144.56.56.31	/25	31_{10} → 00010111_2	10000000_2	00000000_2 → 0_{10}	144.56.56.0
144.56.56.31	/24	31_{10} → 00010111_2	00000000_2	00000000_2 → 0_{10}	144.56.56.0

As the resultant network address for all masks is not found in the routing table, so the interface number chosen is **M4**.

iii. 123.80.97.60 (1 point)

Ans:

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
123.80.97.60	/27	$60_{10} \rightarrow 00111100_2$	11100000_2	$00100000_2 \rightarrow 32_{10}$	123.80.97.32
123.80.97.60	/26	$60_{10} \rightarrow 00111100_2$	11000000_2	$00000000_2 \rightarrow 0_{10}$	123.80.97.0

As the resultant network address for mask /26 is found in the routing table, so the interface number chosen is **M1**.

iv. 123.80.97.200 (1 point)

Ans:

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
123.80.97.200	/27	$200_{10} \rightarrow 11001000_2$	11100000_2	$11000000_2 \rightarrow 192_{10}$	123.80.97.192
123.80.97.200	/26	$200_{10} \rightarrow 11001000_2$	11000000_2	$11000000_2 \rightarrow 192_{10}$	123.80.97.192
123.80.97.200	/25	$200_{10} \rightarrow 11001000_2$	10000000_2	$10000000_2 \rightarrow 128_{10}$	123.80.97.128

As the resultant network address for mask /25 is found in the routing table, so the interface number chosen is **M2.**

v. 123.80.97.88 (1 point)

Ans:

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
123.80.97.88	/27	$88_{10} \rightarrow 01011000_2$	11100000_2	$01000000_2 \rightarrow 64_{10}$	123.80.97.64
123.80.97.88	/26	$88_{10} \rightarrow 01011000_2$	11000000_2	$01000000_2 \rightarrow 64_{10}$	123.80.97.64

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
123.80.97.88	/25	$88_{10} \rightarrow 01011000_2$	10000000_2	$00000000_2 \rightarrow 0_{10}$	123.80.97.0
123.80.97.88	/24	$88_{10} \rightarrow 01011000_2$	00000000_2	$00000000_2 \rightarrow 0_{10}$	123.80.97.0

As the resultant network address for all masks is not found in the routing table, so the interface number chosen is **M4**.

vi. 118.114.133.1 (1 point)

Ans:

The masks are applied as given below:

Destination IP Address	Mask	IP Address in binary (only in the last byte) [A]	Mask in binary (only in the last byte) [B]	[A] AND [B]	Network Address
118.114.133.1	/27	$1_{10} \rightarrow 00000001_2$	11100000_2	$00000000_2 \rightarrow 0_{10}$	118.114.133.0
118.114.133.1	/26	$1_{10} \rightarrow 00000001_2$	11000000_2	$00000000_2 \rightarrow 0_{10}$	118.114.133.0
118.114.133.1	/25	$1_{10} \rightarrow 00000001_2$	10000000_2	$00000000_2 \rightarrow 0_{10}$	118.114.133.0
118.114.133.1	/24	$1_{10} \rightarrow 00000001_2$	00000000_2	$00000000_2 \rightarrow 0_{10}$	118.114.133.0

As the resultant network address for all masks is not found in the routing table, so the interface number chosen is **M4**.

13. The routing table of routers R1, R2, and R3 are given. Draw the possible network configuration with all 3 routers, not separate configurations corresponding to each routing table. Indicate the next-hop addresses in the figure. (10 points)

R1:

Mask	Network Address	Next-Hop Address	Interface Number
/24	80.70.56.0	100.160.32.67	M2
/24	130.135.7.0	150.137.45.78	M1

Mask	Network Address	Next-Hop Address	Interface Number
/16	180.170.0.0	----------------	M0
/16	100.160.0.0	----------------	M2
/16	150.137.0.0	----------------	M1
Default	Default	180.170.4.6	M0

R2:

Mask	Network Address	Next-Hop Address	Interface Number
/24	80.70.56.0	----------------	M0
/16	100.160.0.0	----------------	M1
Default	Default	100.160.56.7	M1

R3:

Mask	Network Address	Next-Hop Address	Interface Number
/24	130.135.7.0	----------------	M0
/16	150.137.0.0	----------------	M1
Default	Default	150.137.72.48	M1

Ans:

Considering the above routing tables for R1, R2, and R3, the possible network configuration diagram with all 3 routers is shown as below:

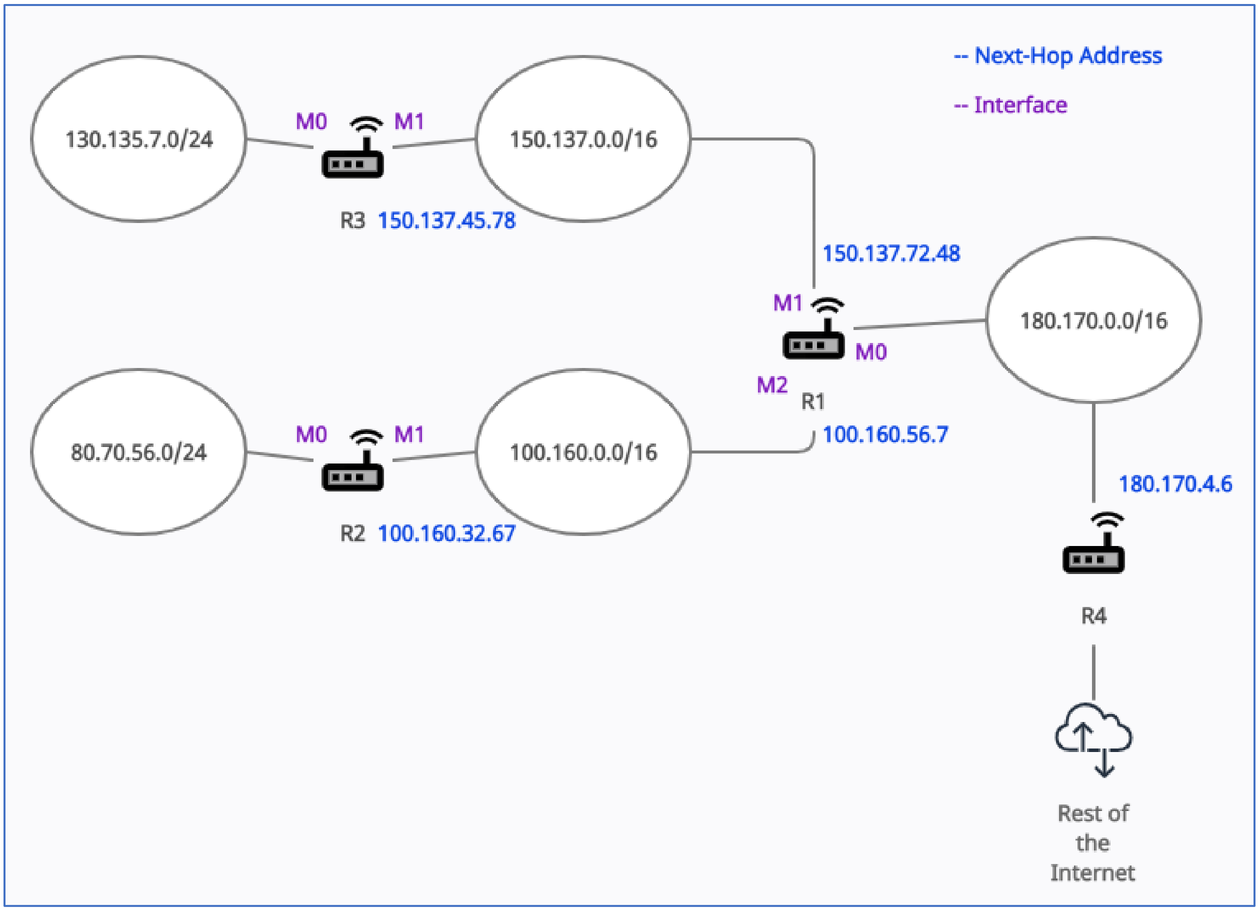
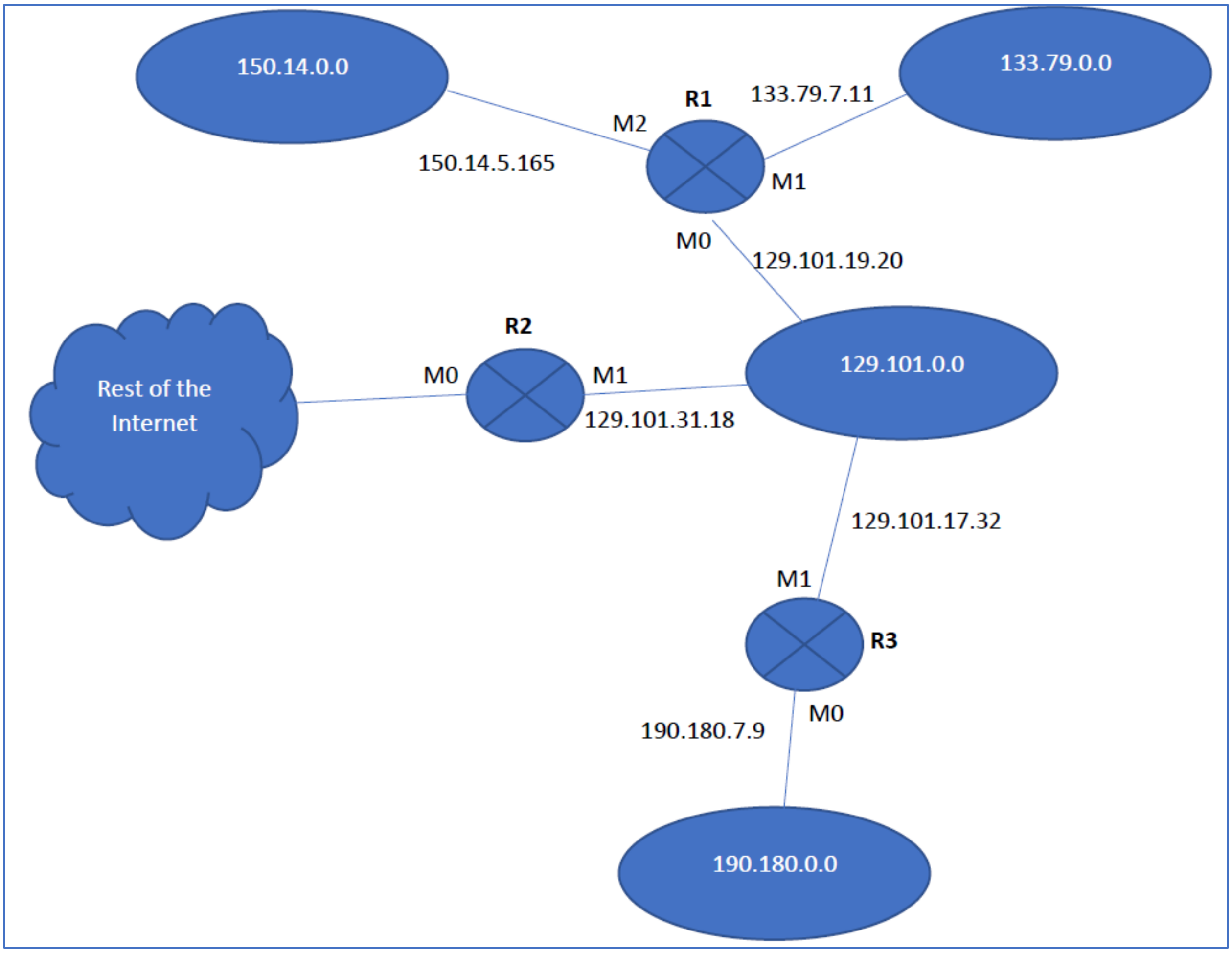


Figure 1: Network Diagram

14. Consider the network configuration below. A packet arrived at the router R3 with the destination address 150.14.8.56. Show how it is forwarded. (Assume classless addressing and mask of each network is /24) Create a routing table for R1 and R3. (10 points)



Ans:

The routing table is given as below:

- The routing table for router R1:

Mask	Network Address	Next-Hop Address	Interface Number
/24	150.14.0.0	-----------------	M2
/24	133.79.0.0	-----------------	M1
/24	129.101.0.0	-----------------	M0
/24	192.180.0.0	129.101.17.32	M0
Default	Default	129.101.31.18	M0

- The routing table for router R2:

Mask	Network Address	Next-Hop Address	Interface Number
/24	150.14.0.0	129.101.19.20	M1
/24	133.79.0.0	129.101.19.20	M1
/24	190.180.7.9	129.101.19.20	M1
/24	129.101.0.0	----------------	M1
Default	Default	----------------	M0

- The routing table for router R3:

Mask	Network Address	Next-Hop Address	Interface Number
/24	190.180.0.0	----------------	M0
/24	129.101.0.0	----------------	M1
/24	150.14.0.0	129.101.19.20	M1
/24	133.79.0.0	129.101.19.20	M1
Default	Default	129.101.31.18	M1

- Packet Forwarding:

The packet is at router R3 with destination address as $150.14.8.56/24$ *[in dotted-decimal notation]* or $(10010110\ 00001110\ 00001000\ 00111000\ )_2$ *[in binary notation]*. The mask is given as $/24$. The network address is extracted by masking off the leftmost 24 bits of the destination address; the result is $\mathbf{150.14.8.0/24.}$ The resultant network does not match with any entry in the routing table of router R3, so the default entry is chosen. The next-hop address $\mathbf{129.101.31.18}$ and the interface **M1** are passed to ARP. After this, the packet is forwarded to router **R2.**

Now, the packet is at router R2 with destination address as $150.14.8.56/24$ *[in dotted-decimal notation]* or $(10010110\ 00001110\ 00001000\ 00111000\ )_2$ *[in binary notation]*. The mask is given as $/24$. The network address is extracted by masking off the leftmost 24 bits of the destination address; the result is $\mathbf{150.14.8.0/24.}$ The resultant network does not match with any entry in the routing table of router R3, so the default entry is chosen. The interface **M0** is passed to ARP. After this, the packet is forwarded to the **Rest of the Internet.**