Computer Networks – Assignment 1

Team members:

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1. ***X.Y.Z.0 (where X≠0, Y≠0, Z≠0) is an IP address. Can it be assigned to a host? If so, give an example. Explain your answer. Assume:***
    a. ***classful addressing (2 points)***
    Yes, the below example proves the same,
    IP: 129.Y.22.0
    Class: B
    Network mask: 255.255.0.0
    Network IP: 129.Y.0.0
    Last IP: 191.Y.255.255
    In the above example IP can be assigned to a host since it's not network or broadcast address

    b. ***classless addressing (2 points)***
    Yes, in certain scenarios it can be assigned to a host, but it depends on the subnet mask. One such example is X.Y.Z.0/22 say if Z = 50. Then X.Y.50.0/22 is the network address, and the last/broadcast address is
    = X.Y.50.0/22 + 1024 -1
    = X.Y.50.0/22 +1023
    = X.Y.50.0/22 + 3.255
    = X.Y.53.255/22
    Here X.Y.50.0 can be assigned to a host for the block of addresses with X.Y.50.0/22 … X.Y.53.255/22

2. ***A network of Class B has a subnet mask 255.255.240.0. What is the maximum number of hosts per subnet? (2 points)***
    255.255.240.0 3rd octet in binary is equivalent to 11110000 which implies the mask is /20
    Number of hosts per subnet = 2^{32-20} – 2(for network and broadcast addresses)
    = 2^{12} - 2
    = 4096 -2
    = 4094 hosts per subnet

3. ***Convert an IP address given as the hexadecimal number A5041109 to the dotted decimal notation. What is the class of this address? (5 points)***
    $(A5041109)_{16} = (10 \times 16^7) + (5 \times 16^6) + (0 \times 16^5) + (4 \times 16^4) + (1 \times 16^3) + (1 \times 16^2) + (0 \times 16^1) + (9 \times 16^0) = (2768507145)_{10}$

0		165		42244		10814481		2768507145
165		4		17		9		

The IP address is 165.4.17.9
The class of the IP is B.

4. ***Find the last address of a block assigned to the network 100.0.0.0/17. (3 points)***

The number of addresses for the given network is $2^{32-17} = 2^{15} = (32768 - 1)_{10} = 32767$ the equivalent to base 256 is as below

0		127		32767
127		255		

i.e., 0.0.127.255

100.0.0.0 + 0.0.127.255 = 100.0.127.255/17 is the last address for the given network.

5. ***Convert the decimal number 7701.01568603515625 to a base 256 number.***

In this problem % => modulus or remainder
Real part: 7701
Step 1:
X = 7701
Ans = X % 256 = 7701.01568603515625 % 256 = 21 (LSB octet)
X = X / 256 = 30

Step 2:
X = 30
Ans = X % 256 = 30
X= X / 256 = 0
We will stop here for real part.

For fractional part: .01568603515625

Step 1:
.01568603515625 * 256 = 4.015625

answer: 4

Step 2:
.015625 * 256 = 4

answer: 4
We will stop here.

The base 256 number for the given decimal is 30.21,4.4

6. ***What is the value of the following division (all the numbers are given in the base 256 system)*** $\frac{\mathbf{50.110.25.25.0}}{\mathbf{10.22.05.05}}$ ***? Give the result as a base 256 number. Don't use decimal or binary systems in your calculations.***

$$\frac{50x256^4 + 110x256^3 +25x256^2 +25x256^1 + 0x256^0}{10x256^3 +22x256^2 +5x256^1 + 5x256^0}$$

We now take the common factors in the denominator and eliminate the $0X256^0 = 0$

$$\frac{5x\ 256(10x256^3 + 22x256^2 +5x256^1 +5x256^0)}{10x256^3 +22x256^2 +5x256^1 + 5x256^0}$$

Since both the numerator and denominator have the same value, we strive them out.

$$\frac{5x\ 256\cancel{(10x256^3 + 110x256^2 +25x256^1 +25x256^0)}}{\cancel{10x256^3 +22x256^2 +5x256^1 + 5x256^0}}$$

$= 5x256^1 + 0x256^0$

$= (5.0)_{256}$

Answer is $(0.0.5.0)_{256}$

7. ***Consider a host whose address is 156.143.10.55/21 (4 points)***

a. What is the network address?

The below table shows the solution

Second row represents the number bits to be masked.

156	143	10	55
8	8	5	0
156	143		0

00001010	
11111000	
00001000	8

The network address of the given host is 156.143.8.0/21

b. How many addresses can be assigned to hosts in this network?

Number of addresses in this network = $2^{32-21} = 2^{11} = 2048$

Number of addresses that can be assigned to a host = 2048 -2 = 2046

c. What is the first available IP address that can be assigned to a host?

First available IP address that can be assigned to host is
= Network IP + 1
= 156.143.8.1/21

d. What is the last available IP address that can be assigned to a host?

Last available IP address is
= Network IP + number of IPs - 2
= 156.143.8.0 + 2048 – 2
= 156.143.8.0 + 2046
= 156.143.8.0 + 0.0.7.254
= 156.143.15.254/21

8. ***An organization is granted block 131.120.208.0/21. The network administrator wants to create 32 subnets.***
   a. ***Find the subnet mask. (1point)***

      We need 32 subnets which implies that we need to add $\log_2(32) = 5$ to the prefix.
      The subnet prefix is then /21+5 = /26
      The subnet mask is 255.255.255.192

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

      Each subnet will have $2^{32-26} = 2^6 = 64$ addresses.

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

The first address of the block will the first address of the subnet i.e., the subnet address.

131	120	208	0
8	8	8	2
131	120	208	0

131.120.208.0/26 is the first address of the subnet.
Each subnet has 64 addresses.
The last address or the direct broadcast address of the given block is 131.120.208.0 + 64 -1
= 131.120.208.63/26

d. ***Find the 4th and 57th addresses in the last subnet. (4 points)***

The last address of the last subnet is last address of the entire block. Using this we can find the 4th and the 57th addresses of the last subnet. We know each subnet has 64 addresses, so the

4th address = last address – (64 – 3) – 1 = last address – 58

Last address = first address + 211 - 1 = 131.120.208.0 + 2047 = 131.120.208.0 + 0.0.7.255 = 131.120.215.255/26

4th address = 131.120.215.255 -58 = 131.120.215.195
57th address = last address – (64 – 56) – 1 = last address – 6 = 131.120.215.255 – 7 = 131.120.215.248/26

9. ***Give the mask in the dotted-decimal notation:***

a. For a block of ClassB which results in 128 subnets. (1point)
For a class B to result in 128 subnets we append the NetID with $\log_2(128) = 7$ 1 bits. Therefore, the mask would be, 255.255.254.0

Default mask of class B	255	255	0	0
Subnet mask	255	255	254	0
	11111111	11111111	11111110	0
			Add 7 1 bits	

b. Which combines 128 blocks of Class C into a supernet. (1 point)
For a class C to result in 128 supernet we remove $\log_2(128) = 7$ 1 bits left. Therefore, the mask would be, 255.255.128.0

Default mask	255	255	255	0
Subnet mask	255	255	128	0
	11111111	11111111	10000000	0
			remove 7 1 bits	

10. Can the following IP addresses be assigned to hosts? Assume classful addressing. Explain your answer.

a. 13.254.255.255 (1 point)
Class: A
Network mask: 255.0.0.0
Network IP: 13.0.0.0
Last IP: 13.255.255.255
Yes, can be assigned to host since it's not network or broadcast address

b. 222.222.222.222 (1 point)
Class: C
Network mask: 255.255.255.0
Network IP: 222.222.222.0
Last IP: 222.222.222.255
Yes, can be assigned to host since it's not network or broadcast address

c. 191.255.255.0 (1 point)
Class: B
Network mask: 255.255.0.0
Network IP: 191.255.0.0
Last IP: 191.255.255.255
Yes, can be assigned to host since it's not network or broadcast address

d. 127.1.1.1 (1 point)
Class: A
Network mask: 255.0.0.0
Network IP: 127.0.0.0
Last IP: 127.255.255.255
No, cannot be assigned to host since it's loopback address and reserved for network

e. 255.255.255.255 (1 point)
Class: E
Network mask: NA
Last IP: 255.255.255.255
No, cannot be assigned to host since it's the limited broadcast address.

f. 195.111.244.255 (1 point)
Class: C
Network mask: 255.255.255.0
Network IP: 195.111.244.0
Last IP: 195.111.244.255
No, cannot be assigned to host since it's the broadcast address.

11. ***The 24th address of a block allocated to a certain organization is 110.55.79.151. The organization needs 124 addresses for its 124 users. Find the mask and define this block of addresses. Is there any wastage of the IP addresses? If yes, how many addresses are wasted? Assume that there are 2 routers in this network. (4 points)***

To find the network address of the block assigned, we subtract 23 IP addresses from the 110.55.79.151 since it's the 24th address of the block.
Therefore, network address = 110.55.79.128.
From the question we can derive the following requirements
124 hosts are required.
2 IP addresses for Network and broadcast address
2 IP addresses for the router
So, in total we would need 128 addresses.

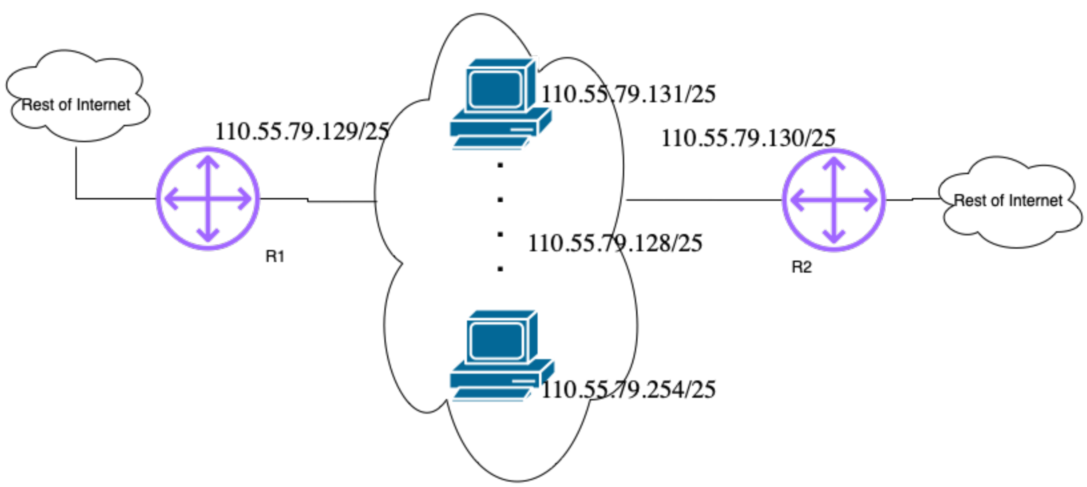
To calculate the mask: $\log_2(128) = 7$. Therefore, the mask = 32-7 = 25

1st address of this block = Network address = 110.55.79.128/25
Last address of this block = Broadcast address = 110.55.79.255/25

1st available address = Router R1 address = 110.55.79.129/25
2nd available address = Router R2 address = 110.55.79.130/25

User address range = 110.55.79.131/25 … 110.55.79.254/25

No addresses are wasted in this case.



12. ***A block of addresses 110.200.240.0/20 is granted to an ISP. These addresses are allocated to two groups of customers. The first group has 12 customers, each of which needs 64 addresses. The second group has 12 customers, each of which needs 128 addresses. Show the range of addresses for the 8th customer of the first group and the***

8^{th} customer of the second group. How many addresses are still available after this allocation? (5 points)

Total number of addresses available which is granted by the ISP: $2^{32-20} = 2^{12} = 4096$

Number of addresses required by 1^{st} group: 12 * 64 = 768
Subnet mask for the 1^{st} group: $32 - \log_2(64) = 32 – 6 = 26$
The first address of the block: 110.200.240.0/20
The first address of the 1^{st} group: 110.200.240.0/26
The first address of the 1^{st} group's 8^{th} customer:
first address of the first group + (7*64)
110.200.240.0/26 + 448
110.200.240.0/26 + 1.192
110.200.241.192/26
The last address of the 1^{st} group's 8^{th} customer:
first address of the 1^{st} group's 8^{th} customer + 64 - 1
110.200.241.192/26 + 63
110.200.241.255/26
The block of addresses of 1^{st} group's 8^{th} customer:
110.200.241.192/26 … 110.200.241.255/26

Number of addresses required by 2^{nd} group: 12 * 128 = 1536
Subnet mask for the 2^{nd} group: $32 - \log_2(128) = 32 – 7 = 25$

The first address of the 2^{nd} group:
block address + 12*64
110.200.240.0/25 + 768
110.200.240.0/25 + 3.0
110.200.243.0/25
The first address of the 2^{nd} group's 8^{th} customer:
first address of the second group + (7*128)
110.200.243.0/25 + 896
110.200.243.0/25 + 3.128
110.200.246.128/25
The last address of the 2^{nd} group's 8^{th} customer:
first address of the 1^{st} group's 8^{th} customer + 128 - 1
110.200.246.128/25 + 127
110.200.246.255/25
The block of addresses of 1^{st} group's 8^{th} customer:
110.200.246.128/25… 110.200.246.255/25

The number of addresses which are available after the allocation are:

Total number of addresses available – (Number of addresses required by the 1st group + Number of addresses required by the 2nd group)

= 4096 – (768 + 1536)

= 1792

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

Mask	*Network address*	*Interface*
/27	***150.66.75.0***	***M0***
/26	***102.60.87.0***	***M1***
/25	***102.60.87.128***	***M2***
/24	***98.105.132.0***	***M3***
Default	***Default***	***M4***

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

We check the routing table for each of the incoming addresses. In the routing table we apply mask for the packet until it is found, if the match is not found then the packet is routed to the default router/address.
A match implies that the network address in the routing table and the destination IP address after the mask is same or equal.

a. 150.66.75.31

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	150.66.75.0	yes

Interface Number: M0

b. 150.66.77.31

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	150.66.77.0	No
/26	102.60.87.0	M1	150.66.77.0	No
/25	102.60.87.128	M2	150.66.77.0	No
/24	98.105.132.0	M3	150.66.77.0	No
Default	Default	M4	yes	

Interface number: M4

c. 102.60.87.50

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	102.60.87.32	No
/26	102.60.87.0	M1	102.60.87.0	Yes

Interface number: M1

d. 102.60.87.200 (1 point)

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	102.60.87.192	No
/26	102.60.87.0	M1	102.60.87.192	No
/25	102.60.87.128	M2	102.60.87.128	Yes

Interface number: M2

e. 102.60.87.88 (1 point)

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	102.60.87.64	No
/26	102.60.87.0	M1	102.60.87.64	No
/25	102.60.87.128	M2	102.60.87.0	No
/24	98.105.132.0	M3	102.60.87.0	No
Default	Default	M4	yes	

Interface number: M4

f. 98.105.133.1 (1 point)

Mask	Network address	Interface	Destination IP after mask	found?
/27	150.66.75.0	M0	98.105.133.0	No
/26	102.60.87.0	M1	98.105.133.0	No
/25	102.60.87.128	M2	98.105.133.0	No
/24	98.105.132.0	M3	98.105.133.0	No
Default	Default	M4	yes	

Interface number: M4

14. The routing tables for routers R1, R2, R3 and R4 are given. Draw the possible network configuration with all these four routers. Indicate the next-hop addresses in the figure. **(10 points)**

R1:

Mask	Network Address	Next-Hop Address	Interface Number
/24	60.65.56.0	101.161.32.67	M2
/24	129.125.7.0	140.127.45.78	M1
/16	170.170.0.0	-----------	M0
/16	101.161.0.0	-----------	M2
/16	140.127.0.0	-----------	M1
Default	Default	170.170.4.6	M0

R2:

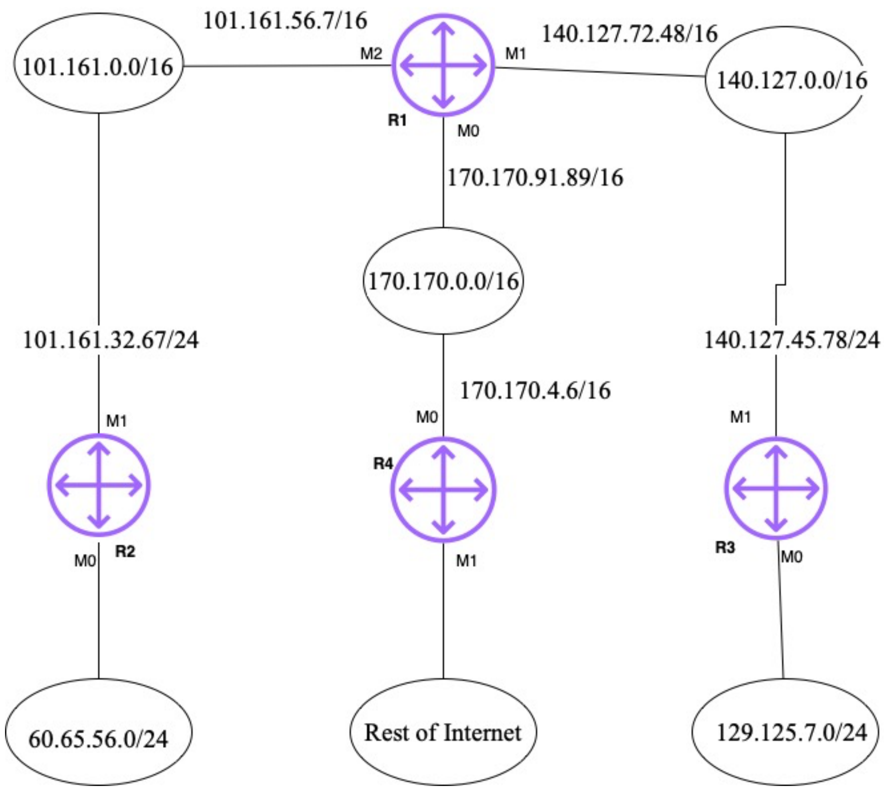
Mask	Network Address	Next-Hop Address	Interface Number
/24	60.65.56.0	-----------	M0
/16	101.161.0.0	-----------	M1
Default	Default	101.161.56.7	M1

R3:

Mask	Network Address	Next-Hop Address	Interface Number
/24	129.125.7.0	-----------	M0
/16	140.127.0.0	-----------	M1
Default	Default	140.127.72.48	M1

R4:

Mask	Network Address	Next-Hop Address	Interface Number
/24 /24	129.125.7.0 60.65.56.0	170.170.91.89 170.170.91.89	M0 M0
/16	140.127.0.0	170.170.91.89	M0
/16	101.161.0.0	170.170.91.89	M0
/16	170.170.0.0	-----------	M0
Default	Default	-----------	M1



15. ***Consider the network configuration below. A packet with the destination address 160.14.8.56 has arrived at router R3. Show how it is forwarded. Assume classful addressing. Create routing tables for R1, R2, and R3.***

Routing tables for the given network,

R1

Class	network address	next hop address	Interface
Class B	179.180.0.0	130.101.17.32	M0
Class B	160.14.0.0	-----	M2
Class B	137.79.0.0	-----	M1
Class B	130.101.0.0	-----	M0
Class B	Default	130.101.31.18	M0

R2

Class	network address	next hop address	Interface
Class B	179.180.0.0	130.101.17.32	M1
Class B	160.14.0.0	130.101.19.20	M1
Class B	137.79.0.0	130.101.19.20	M1
Class B	130.101.0.0	-----	M1
Class B	Default	-----	M0

R3

Class	network address	next hop address	Interface
Class B	179.180.0.0	-----	M0
Class B	160.14.0.0	130.101.19.20	M1
Class B	137.79.0.0	130.101.19.20	M1
Class B	130.101.0.0	-----	M1
Class B	Default	130.101.31.18	M1

When the IP arrives at the router R3, we check the class which it belongs to, since it's first octet is 160, it belongs to class B. but, to find this class the router shifts the copy of this address 28 bits towards the right, resulting in 1010 which is 10, thus class B.
We now find the network ID which the current IP belongs to, we use the subnet mask 255.255.0.0 on the packet.
Therefore, the Network IP which the packet belongs to is 160.14.0.0.
Now we search the table with class B, the matching network IP is found. The packet needs to be forwarded to router R1. Now the next hop address (130.101.19.20) and the interface number (M1) is sent to ARP.
Now, when the packet reaches the router R1, the packet is extracted from the frame and the packet is directed towards the network with network address 160.14.0.0 and the interface number M2. Here the next hop IP is the destination IP i.e., 160.14.8.56. and now the next hop address (160.14.8.56) and the interface number (M2) is now sent to the ARP.