Assignment-1
Computer Networks (UCS414)

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Soln-1 Given IP address : 172.31.5.0/22
This is a classless IP address since subnet mask is 22.
Thus, no. of host bits = 22
no. of network bits = 32-22 = 10

$(\text{IP address})_2$ = 10101100.00011111.00000101.00000000

a) Network address →
method-1 It could be found directly by making all the host bits (10 here) of the given IP address as 0.
$(\text{N/w address})_2$ = 10101100.00011111.00000100.00000000
$(\text{N/w address})_{10}$ = 172.31.4.0/22

method-2 Network address = $(\text{IP})_2$ AND $(\text{subnet mask})_2$ — (1)
∵ given subnet mask is 22 i.e. 255.255.252.0
$(\text{subnet mask})_2$ = 11111111.11111111.11111100.00000000

∴ (1) ⇒ = 10101100.00011111.00000100.00000000
AND 11111111.11111111.11111100.00000000

$(\text{N/w address})_2$ = 10101100.00011111.00000100.00000000

$(\text{N/w address})_{10}$ = 172.31.4.0/22

b) Broadcast address → all the host bits (10 here) are set to 1 in the n/w address

$(\text{Broadcast address})_2 = 10101100.00011111.00000111.11111111$

$(\text{Broadcast address})_{10} = 172.31.7.255$

c) First host address is the IP address that comes just after the network address.

Thus first host address = n/w address incremented by 1

$= (\text{n/w add})_2 + 1$

$= 10101100.00011111.00000100.00000000 + 1$

$= 10101100.00011111.00000100.00000001$

$= 172.31.4.1$

d) last host address is the IP address that is prior to the broadcast address.

Thus last host address $= (\text{Broadcast add})_2 - 1$

$= 10101100.00011111.00000111.11111111 - 1$

$= 10101100.00011111.00000111.11111110$

$= 172.31.7.254$

e) Total no. of hosts per subnet $= 2^{32-\text{netmask length}} - 2$

$\because$ here netmask length / no. of n/w bits = 22

Thus, no. of hosts per subnet $= 2^{32-22} - 2$

$= 1022$ hosts

Note → Here, we have subtracted 2 since by the all ones and all zeroes concept, 2 host numbers are reserved i.e. all zeroes → network / host address & all ones → broadcast address.

Solⁿ-2 given (subnet mask)$_{10}$: 255.255.240.0
CIDR notation = /20 (20 n/w bits)
$(\text{subnet mask})_2$ = 11111111.11111111.11110000.00000000

Thus maxᵐ no. of hosts per subnet = $2^{32-\text{no. of n/w bits}} - 2$
$= 2^{32-20} - 2$
$= 4096 - 2$
$= 4094$

Note → 2 is subtracted here ∵ first address (all zeroes or network id) and last/broadcast address (all ones) are not the usable hosts.
Thus it can handle maximum 4094 hosts.

Solⁿ-2 starting IP address = 198.16.0.0
= 11000110.00010000.00000000.00000000

Organization A →
no. of host bits needed for 4000 usable hosts will be,
∴ $2^h - 2 \geq 4000$
$\boxed{h=12}$ host bits (for minimum wastage)
⇒ $2^{12} - 2 = 4096 - 2 = 4094$

Note → ∵ IP address are always allocated in the power of 2.
Exactly 4000 addresses can't be allocated, thus, some extra IP addresses (94 here) will be allocated.
This will be the case for all the organizations.
∴ maxᵐ no. of host bit = 12 & no. of n/w bits = 32 - 12 = 20
no. of hosts required by A = 2^{12}

Thus starting address of the subnet ⇒
set all host bits (here 12) to 0
$(\text{starting address})_{10}$ = 198.16.0.0
$(\text{starting address})_2$ = 11000110.00010000.0000 0000.00000000

Note → Here the 2 hosts (i.e. first & last) are excluded (which is not followed generally).
If we haven't subtracted 2, organisations would have been allocated, A → 4096, B → 2048, C → 4096, D → 8192 usable hosts resp.

Subnet's broadcast address → set all host bits to 1
→ 11000110.00010000.00001111.11111111

(Subnet's broadcast address)$_{10}$ = 198.16.15.255

But, starting address (subnet ID) and subnet's broadcast address are not usable.

Thus, 1st IP address (usable) = (subnet ID)$_2$ + 1
= 198.16.0.1

last IP address (usable) = (broadcast address)$_2$ − 1
= 198.16.15.254

A's mask = 198.16.0.0/20

Organization B →

no. of host bits needed for 2000 usable hosts, will be

$2^h - 2 \geq 2000$

$\boxed{h = 11}$ host bits ⇒ no. of mask bits = 32 − 11 = 21

⇒ $2^{11} - 2$ = 2046 usable hosts will be assigned.

Starting IP address for B → set all host bits (here 11) of the (previous organization's broadcast address + 1) to 0.

∵ previous organization's broadcast address + 1
IP address is = 198.16.16.0

(Starting IP address for B)$_2$ = 11000110.00010000.00010000.00000000 (11 host bits)
= 198.16.16.0

Subnet's broadcast address → set all host bits of 198.16.16.0 to 1
= 11000110.00010000.00010111.11111111
= 198.16.23.255

Also, 1st IP address (usable) = (subnet ID)$_2$ + 1
= 198.16.16.1

last IP address (usable) = (broadcast add)$_2$ − 1
= 198.16.23.254

B'x mask = 190.16.16.0/21

Organization C →

no. of host bits needed for 4000 usable hosts,

$2^h - 2 \geq 4000$

$\boxed{h = 12}$ host bits

Thus, # n/w bits = 32 − 12 = 20 (CIDR value)

since, IP address will be assigned in power of 2,

$2^{12} - 2 = 4094$ hosts will be assigned.

∵ 1st available IP address (N/w id) = 190.16.23.254

Incremented by 1 and then set values of host bits to 0.

Thus, 1st available IP address = 190.16.24.0

= 11000110. 00010000 . 0001|1000. 00000000

n/w bits | host bits

Since, we have conflicting 1 in our host bits, so, we can't allocate this IP address

hence, we'll increment the n/w bit by 1

i.e. make 011 to 100.

⇒ (1st available IP address)$_2$

= 11000110. 00010000. 0010|0000. 00000000

in decimal → 190.16.32.0

Subnet's broadcast address = set all host bits to 1

= 11000110. 00010000. 0010|1111. 11111111

in decimal → 190.16.47.255

Also, 1st usable IP address = $(\text{subnet ID})_2 + 1$
= 198.16.32.1

last usable IP address = $(\text{broadcast address})_2 - 1$
= 198.16.47.254

C's mask : 198.16.32.0/20

<u>Organization D →</u>

no. of host bits needed for 8000 usable hosts,

$2^h - 2 \geq 8000$

$\boxed{h = 13}$ host bits

$\Rightarrow 2^{13} - 2 = 8190$ hosts will be assigned

No. of n/w bits = 32 − 13 = 19 n/w bits

we'll get 1st available IP address by (broadcast address of organization C + 1) and then setting all host bits to 0.

Thus, 1st IP address assigned = 198.16.48.0
= 11000110.00010000.00110000.00000000
n/w bits | host bits

Again a conflicting 1.
So, we can't allocate this IP address

we'll increament the n/w bit by 1,

Thus, $(\text{1st available IP address})_2$
= 11000110.00010000.01000000.00000000
= 198.16.64.0

Subnet's broadcast address → set all host bits to 1
= 11000110.00010000.0 101 1111.11111111
= 198.16.95.255

Also, 1st usable IP address = $(\text{subnet ID})_2 + 1$
= 198.16.64.1

last usable IP address = $(\text{broadcast add})_2 - 1$
= 198.16.95.254

D's mask : 198.16.64.0/19

Solⁿ-4 a) 135.46.63.10 → 10000111.00101110.00111111.00001010

let the no. of n/w bits = 22

⇒ CIDR notation = /22

or say, $(\text{subnet mask})_{10}$ = 255.255.252.0

in binary = 11111111.11111111.11111100.00000000

∵ N/w address = $(\text{given IP})_2$ AND $(\text{subnet mask})_2$

= 10000111.00101110.00111111.00001010

AND 11111111.11111111.11111100.00000000

10000111.00101110.00111100.00000000

= 135.46.60.0 /22

Since the given n/w address matches with interface 1, it will be sent to interface 1.

b) 135.46.57.14 → 10000111.00101110.00111001.00001110

let the no. of n/w bits = 22

⇒ CIDR notation = /22

or say, $(\text{Subnet mask})_{10}$ = 255.255.252.0

in binary = 11111111.11111111.11111100.00000000

∵ N/w address = $(\text{given IP})_2$ AND $(\text{subnet mask})_2$

= 10000111.00101110.00111001.00001110

11111111.11111111.11111100.00000000

AND 10000111.00101110.00111000.00000000

= 135.46.56.0/22

Since the given n/w address matches with interface 0, data packet will be sent to interface 0.

c) 135.46.52.2 → 10000111. 00101110. 00110100. 00000010

let the no. of n/w bits = 22

⇒ $(\text{subnet mask})_2$ = 11111111.11111111.11111100.00000000

N/w address = $(IP)_2$ AND $(\text{subnet mask})_2$

= 10000111.00101110.00110100.00000010

AND 11111111.11111111.11111100.00000000

10000111.00101110.00110100.00000000

= 135.46.52.0/22

(doesn't match)

let the no. of n/w bits = 23

⇒ $(\text{subnet mask})_2$ = 11111111.11111111.11111110.00000000

N/w address = $(IP)_2$ AND $(\text{subnet mask})_2$

= 10000111.00101110.00110100.00000010

AND 11111111.11111111.11111110.00000000

10000111.00101110.00110100.00000000

= 135.46.52.0/23

(doesn't match)

Since, there is no match, it will be passed to default (Router 2).

d) 192.53.40.7 → 11000000.00110101.00101000.00000111

let the no. of n/w bits = 23 ($(\text{Subnet mask})_{10}$ = 255.255.254.0)

N/w address = $(IP)_2$ AND $(\text{subnet mask})_2$

= 11000000.00110101.00101000.00000111

AND 11111111.11111111.11111110.00000000

11000000.00110101.00111000.00000000

= 192.53.40.0/23

As, the address matches with router 1, it'll be send to router 1.

e) 192.53.56.7 → 11000000. 00110101. 00111000. 00000111

let # n/w bits = 23

⇒ $(\text{subnet mask})_{10}$ = 255.255.254.0

N/w address = $(IP)_2$ AND $(\text{subnet mask})_2$

= 11000000. 00110101. 00111000. 00000111

AND 11111111. 11111111. 11111110. 00000000

11000000. 00110101. 00111000. 00000000

= 192.53.56.0/23

(doesn't match)

let # n/w bits = 22 $(\text{subnet mask})_{10}$ = 255.255.252.0

N/w address = $(IP)_2$ AND $(\text{subnet mask})_2$

= 11000000. 00110101. 00111000. 00000111

AND 11111111. 11111111. 11111100. 00000000

11000000. 00110101. 00111000. 00000000

= 192.53.56.0/22

(doesn't match)

As the given n/w address doesn't match, it will be passed to default route i.e. Router 2.

Sol^n-5 We have been given IPV6 address and asked to convert it to dotted decimal notation i.e. IPV4 address.

Steps to follow →

Separate all the 8 hexadecimal bits. Write each of them in 4 bit binary equivalent. Then, connect 2 of them together.

Thus, we'll have 4 octets now.

Diagramatically,

C22F1582

C | 2 | 2 | F | 1 | 5 | 8 | 2

1100 | 0010 | 0010 | 1111 | 0001 | 0101 | 1000 | 0010

11000010 | 00101111 | 00010101 | 10000010

11000010 . 00101111 . 00010101 . 10000010

$\boxed{194.47.21.130}$ Ans (class C network)

(required dotted decimal notation of given IP address)

Soln 6. • Address Resolution Protocol (ARP) plays an important role in communication among the hosts as ARP is used to find the unknown Physical (MAC) address whenever we have the IP address known.

- To find the unknown destination/target MAC address, an ARP request packet is sent by the host/source machine on the network.
- Switch broadcasts this request to all the machines on the LAN.
- When the IP address of a machine is matched as a destination address, this machine encapsulates its MAC address.
- Thus, an ARP reply packet is generated, which is recieved by the other machine. Thus, allowing communication possible b/w 2 hosts.

From the above snippet,

Protocol type IPV4 → 0x0800 | hardware size | protocol size | request packet | source MAC address | hardware type = 1 (ethernet) 00 01

08 00 06 04 00 01 00 07 0d af f4 54 18 a6 ac 01

00 00 00 00 00 00 18 a6 ad 9f

target/destination MAC address (unknown thus all bits 0) | Target IP address | source IP address

Thus, it is an ARP request Packet

1	0x800	
6	4	Request packet 2
01:07:0d:af:f4:54		
24.166.172.1		
All filled with zeroes		
24.166.173.159		

Thus,
source MAC address → 00:07:0d:af:f4:54:

Destination MAC address → 00:00:00:00:00:00

Note → Since, it is an ARP request packet,
destination MAC address is unknown right now.
But then, ARP request Packet is encapsulated in the frame.
Frame's destination address which is a broadcast address (all 48 bits set to 1) will be sent to all machines on the network.

11111111.11111111.11111111.11111111.11111111.11111111.11111111.11111111

Destination address → FF.FF.FF.FF.FF.FF.FF.FF
(hexadecimal)

source IP address → 18:a6:ac:01 (in IPV6)
↓ can be converted
24.166.172.1 (in IPV4)

destination IP address → 18:a6:ad:9f (in IPV6)
↓ can be converted
24.166.173.159 (in IPV4)

Type of ARP (0x0806) → Request Packet
(notation → 2)

Solⁿ 7 About Address → 127.0.0.1

- It is the loopback IP address and is known as "localhost."

where/why it is used →

- It is used to establish an IP connection to the same machine or computer being used by the end user.
- System administration & application developers commonly use 127.0.0.1 to test their applications.
- It is used to verify whether TCP/IP is working fine or not, without connecting it to any other computer on the network, thus, it helps in avoiding traffic.
- It also ensures network security.

How it is implemented →

- When establishing an IPv4 connection with 127.0.0.1 will normally be assigned a subnet mask 255.0.0.1.

If any public switch/router/gateway recieves a packet addressed to the loopback IP address, it is required to drop the packet without logging the information.

As a result, if a data packet is delivered outside the local host, by design, it will not accidentally arrive at a computer which will try to answer it.

Solⁿ 8 Datagram size / total packet size = H+D = 1000 bytes
∵ IP header length (H) = 20 bytes

Thus, Data length = 1000 − 20 = 980 bytes

given, MTU (of link) = 100 bytes

∴ Packet's data size > MTU → fragmentation

Also, length of data part of each fragment →

100 = 20 + Data part length / fragment

Thus, Data part length for 1 fragment = 100 − 20 = 80 bytes

$$\text{No. of fragments} = \frac{\text{size of data in unfragmented packet}}{\text{MTU data size or data in 1 fragment}}$$

$$= \left\lceil \frac{980}{80} \right\rceil = \lceil 12.25 \rceil = 13 \text{ fragments.}$$

ceil function

Thus, 980 bytes data will be send over MTU data size of 80 bytes in total of 13 fragments.

Solⁿ 9 ∵ the given IP address is of class B, first 2 octets (starting 16 bits) are reserved for N/w bits & last 2 octets (later 16 bits) are reserved for host bits.

So, first 6 bits of the 3rd octet are used for subnet and thus, now,

n/w bits = 16 + 6 = 22 bits

& # host bits left = 16 − 6 = 10 bits

→ ∵ Max^m no. of subnets = $2^{\text{no. of subnet bits}}$

$= 2^6 = 64$ (generally)

but actually, according to the RFC 950 specification, 1st & last subnet are invalid subnets.

∵ In classless IP,

1st subnet address (n/w id) is same as unsubnetted n/w id (1st IP address) (all host bits as zeroes)

Similarly, last su address (broadcast address) is same as unsubnetted broadcast address (all host bits as ones)

max^m no. of subnets $= 2^6 - 2 = \underline{62}$

→ ∵ max^m no. of hosts $= 2^{\text{host bits}} - 2$

$= 2^{10} - 2 = 1024 - 2 = \underline{1022}$

Note → here, we have subtracted 2, as the all host bits zeroes & all host bits ones addresses i.e. n/w ID & broadcast address are reserved & not usable.

Sol^n - 10

given IP address / mask	binary equivalent
57.6.96.0/21	00111001.00000110.011|00000.00000000
57.6.104.0/21	00111001.00000110.011|01000.00000000
57.6.112.0/21	00111001.00000110.011|10000.00000000
57.6.120.0/21	00111001.00000110.011|10000.00000000
	← starting 19 bits same →

Thus, here since, in all the IP addresses, first 19 bits are same for all addresses and all these IP addresses are adjacent (as shown in binary).

We also assume all will have the same next hop as X.X.X.X,

It is possible to aggregate them into following entry or say, we can combine the subnets into a single router to reduce the size of routing table & improve routing stability

(supernetting / summarization).

Since, starting 19 bits are same, we'll take CIDR value, or say # ~~host~~ n/w bits = 19.

Thus, Address / mask

$\boxed{57.6.96.0/\ 19}$ (assuming x.x.x.x (same) as next hop)

Ans Yes, it is possible to aggregate