Q-1

NAT – Network Address Translation (1 marks)

Definition:

- Network Address Translation (NAT) is a process in which one or more local IP address is translated into one or more Global IP address and vice versa in order to provide Internet access to the local hosts.
- Operates on router or firewall.

- No marks are given if only definition is written in the answer.
- 0.5 marks - definition + if correct NAT table is shown.
- 0.5 marks - if how translation happens is described correctly with an appropriate example (No marks provided if the translation scheme is written in words without any example.)

DHCP – Dynamic Host Configuration Protocol(1 marks)

Definition:

- The Dynamic Host Configuration Protocol (DHCP) is a network management protocol, whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on a network so they can communicate with other IP networks. It is a client-server protocol.

- 0.5 marks – correct definition of DHCP, a simple example, what is lease time and what happens after expiration of lease time.
- 0.5 marks – if 4 step DORA procedure is described correctly with simple.
- No marks if only definition was written in the answer.

CIDR – Classless Inter-Domain Routing Protocol (1 marks)

- No marks provided if answer was describing what is CIDR and how it helps reduce wastage of IP which was happening in classful addressing scheme.
- 0.5 marks are given if student has explained how it helps reducing the routing table size.
- 0.5 marks are given if student has taken a nice and simple example.

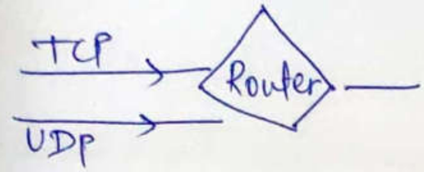
How these protocols help to manage Internet Address Space more efficiently?
0.5 marks for each i.e. 1.5 marks total.

NAT – allows to use same range of IP for multiple private networks connected to internet via NAT router.
CIDR – Helps to reduce routing table entry size using concept of VLSM.
DHCP – allows to allocate IP addresses to host as and when needed, and allows reuse of the same. As lease time is used so IP won't be blocked if client do not require.

- Marks are only given if student has explicitly mentioned the advantage of these three protocols (after every protocol or at the last after explaining all three protocols).
- No marks given for the same if student has written that "this is how it utilizes Internet Address Space more efficiently" after describing the protocol.
- The remaining 0.5 marks are up to the me. If I found that the student has explained some answer really well with a nice example.
- As the question asked specifically to mention all three protocols with a suitable example, if student has just explained protocols in words without any example no marks are given.
- I have tried to mention the key points that were missing in the answer in almost all the answer sheets.

Note: Detailed answer is discussed at the end of the solution file.

Q-2 [a] total : 2 marks



When Router experienced congestion, there can be possibilities of packet loss with two types. (1) TCP (2) UDP

If lost packet was TCP :→ TCP follows congestion policy and decreases transfer rate.

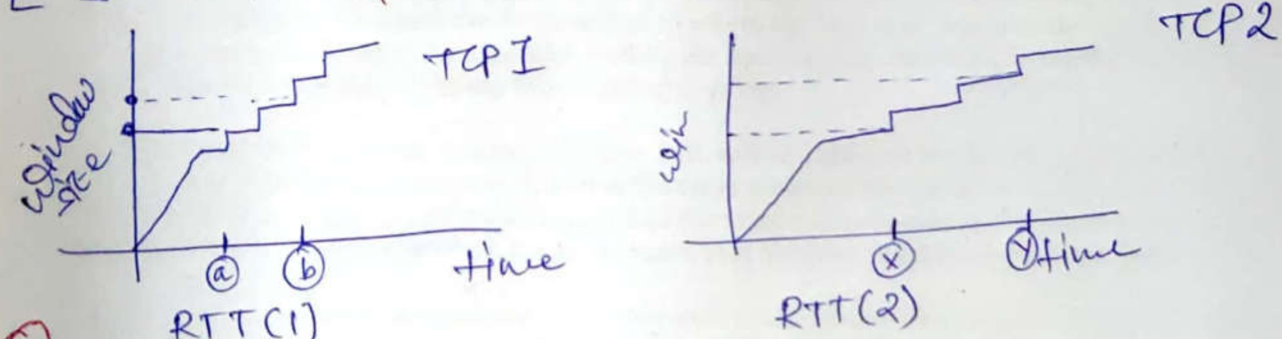
(1) → whereas UDP rate remain same.

And As conclusion UDP grab more bandwidth and resulted in higher throughput as compare to TCP.

If lost packet was UDP :→ UDP does not follow any congestion policy, so UDP flow remain same

(1) → TCP packets were not loss, so TCP sending rate will be the same.

[b] total : 2 marks



(1) For transmitting same bytes of data TCP 1 takes lesser time then TCP 2. As you can see in figure data transmission with lesser RTT(1) it will take b-a time which less then RTT(2) [Y-X]

→ As a result lesser RTT flow will grab more bandwidth very fast then higher one and resulted in higher throughput

$$\overline{X}_1 \propto \frac{1}{RTT_1} \quad \overline{X}_2 \propto \frac{1}{RTT_2} \quad [\overline{X} = \text{throughput}]$$

$$\frac{\overline{X}_1}{\overline{X}_2} \propto \frac{RTT_2}{RTT_1}$$

(1)

Q2 (c)

$\frac{1}{2}$ mark

estimated rtt = (1 - α) • estimated rtt + α • sample rtt   0<α<1

recommended α = 0.125

$\frac{1}{2}$ mark

Devrtt = (1 - β) × DevRTT + β | Sample rtt - estimated rtt |

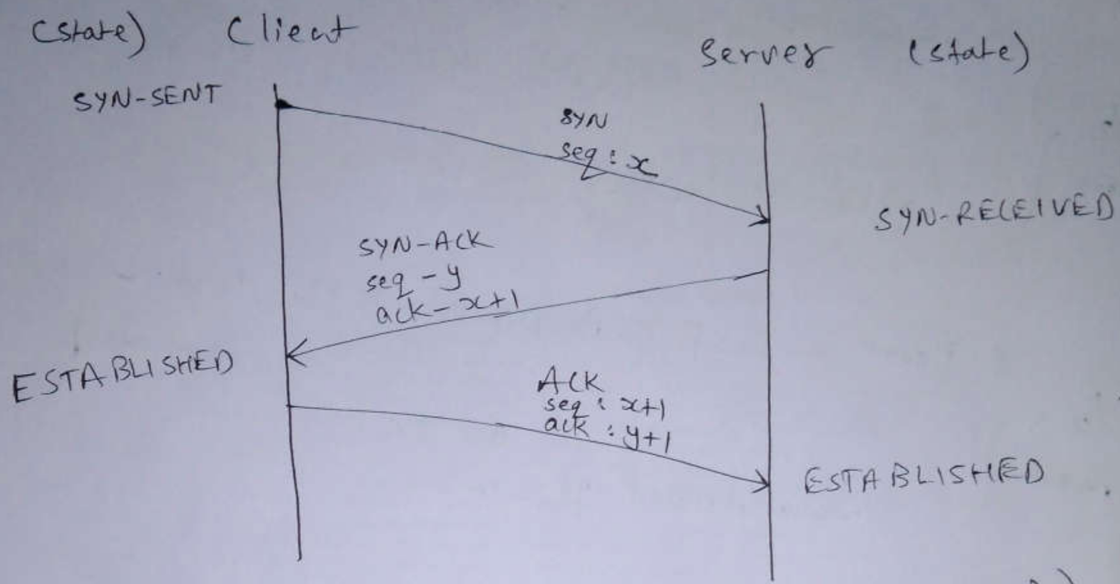
0 < β < 1

recommended β = 0.25

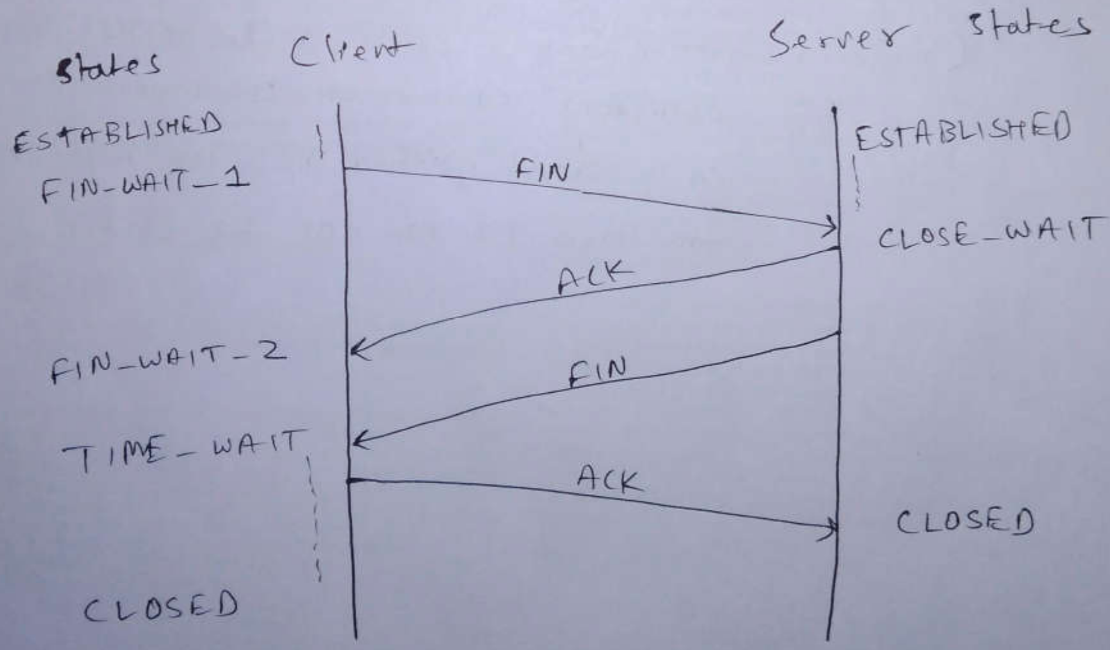
$\frac{1}{2}$ mark Time out = Estimatted rtt + 4 • Devrtt

Conclusion - rtt changes with each packet and estimating correct rtt is important so it should neither be too high or too low. It can not be static.

Q2 (d)



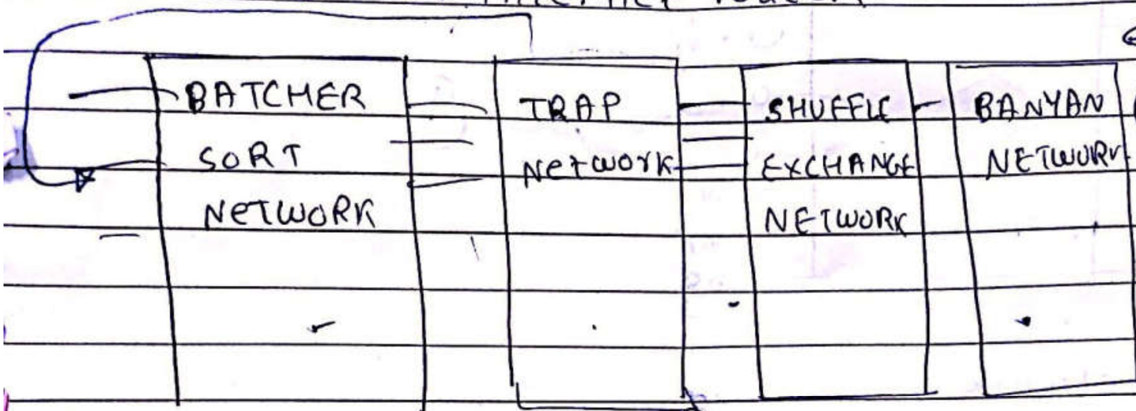
((Connection Establishment (1 mark))



(Connection termination (1 mark))

Q = 3

sort network, shuffle-exchange network & Banyan network for 8X8 Batcher-Banyan switch. what additional modules / functionalities are needed to make this switch perform as an internet router?



1 Mark

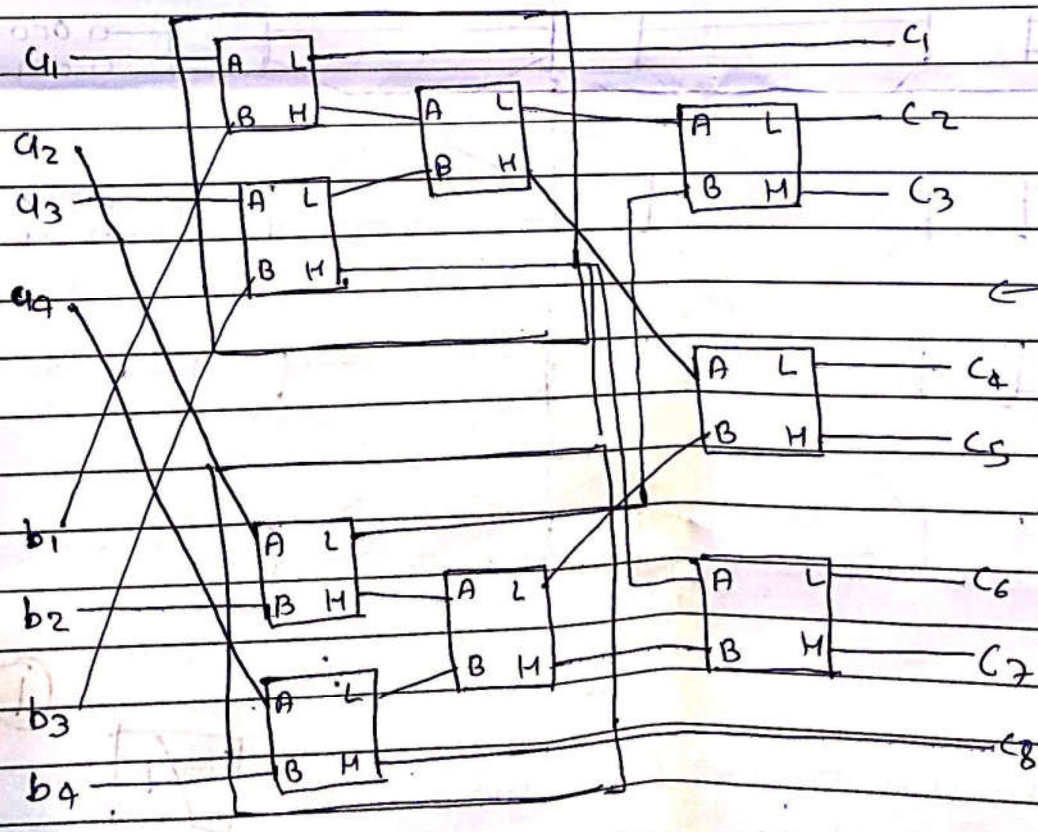
1

I → order

II. working of Trap module

1

→ sort Network for 8 inputs Required



1 Mark

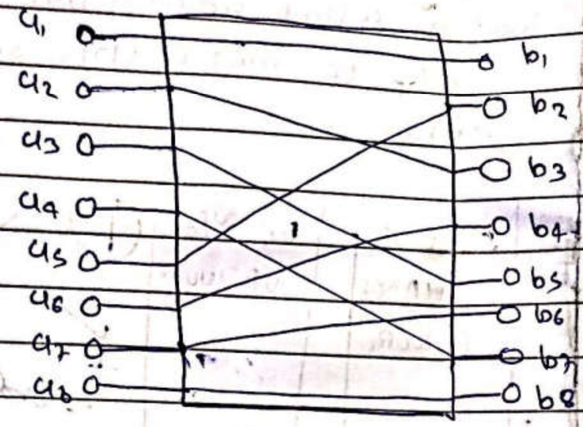
→ Require Trap Network to work as Router

1 Mark

Trap: detect multiple pkts for the same output

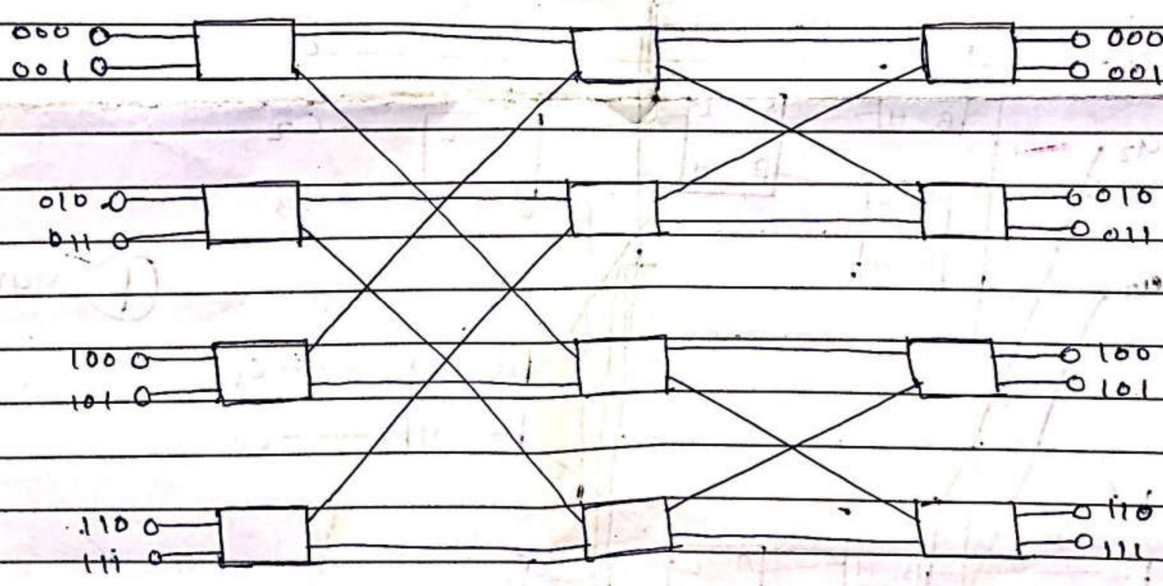
Require functionalities of Trap Network

* A shuffle-network



✓ (1) Mark

* Banyan network



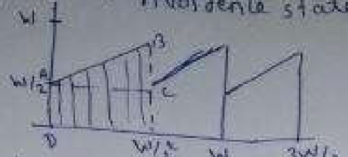
✓ (1) Mark

Note:
No Partial mark for figure either 0 or 1

$\boxed{0/1}$

Answer :- 4

(a) we will ignore slow start we will consider congestion Avoidence state



maximum value of window size is W, minimum value of window size is W/2 (during steady state)

Total window change = W/2

hence cycle duration = RTT × (W/2)

total data delivered = Area (ABC) + Area (ACDE)

$= \frac{1}{2}(w/2)^2 + \frac{1}{2}\left(\frac{w}{2}\right)^2$

$= \frac{w^2}{8} + \frac{w^2}{4} = \frac{3}{8}w^2$ (i)

total packet delivered $= \frac{1}{p}$ (ii) { because packet loss probability is p

from (i) and (ii)

$$\frac{1}{p} = \frac{3}{8}w^2$$

$$w = \sqrt{\frac{8}{3p}} \quad (iii)$$

There fore throughput($\bar{X}_0$) = $\dfrac{\text{data delivered per cycle}}{\text{time per cycle}}$

$$= \frac{3/8\, w^2 \times (MSS)}{RTT \times (w/2)}$$

$$= \frac{MSS}{RTT} \times \frac{3}{4} w$$

$$= \frac{MSS}{RTT} \times \frac{3}{4} \times \sqrt{\frac{8}{3p}} \quad \{fr$$

$$\boxed{(\bar{X}_0) = \frac{MSS}{RTT}\sqrt{\frac{1}{2p}} \quad (iv)}$$

Answer 4(b)

from (iv)

$$\bar{X} \propto \frac{1}{T\sqrt{p}}$$

If T is variable $(T \pm \Delta)$ $\Delta << T$

$$\bar{X} \propto \frac{1}{\sqrt{p}(T \pm \Delta)}$$

$$\bar{X} \propto \frac{1}{\sqrt{p}\, T(1 \pm \frac{\Delta}{T})}$$

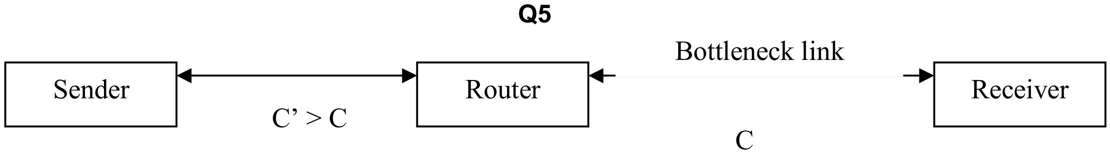
$$\bar{X} \propto \bar{X}_0 \left(1 \pm \frac{\Delta}{T}\right)^{-1}$$

$$\bar{X} \propto \bar{X}_0 \left(1 + C\left(\frac{\Delta}{T}\right)^2 + \dots\right)$$ on expanding

where C is some constant.

$$\boxed{\bar{X} \simeq \bar{X}_0 + \bar{X}_0\, c \left(\frac{\Delta}{T}\right)^2}$$

Q5



-
- Let us assume that capacity of router is C.
- If input rate is < C, no buffer is needed.
- But if input rate may go till R_{max},buffer of size $(R_{max} - C) * t$ is needed.
- For TCP , time for which input rate becomes >C is called T_{burst} .and it is order of RTT. So buffer size should be
$$(R_{max} - C) * RTT$$
- If R_{max} is order of c. this equation can be as following
$$B = C * RTT$$
- If there are n TCP flows ,
$$B = \frac{C * RTT}{\sqrt{n}}$$

- 1 marks only if logic is discussed or only one equation is written without justification
- 2 marks: both equations are written without proper justification

3 marks: both the equations are written with detailed justification

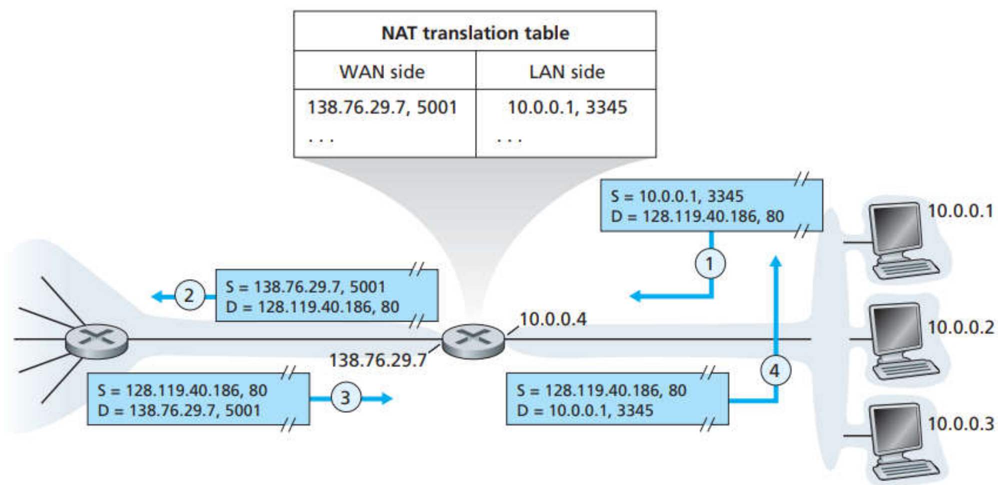
Detailed answer of question 1
NAT – Network Address Translation(1 marks)

Definition:

- Network Address Translation (NAT) is a process in which one or more local IP address is translated into one or more Global IP address and vice versa in order to provide Internet access to the local hosts.
- Operates on router or firewall.

Working:

- The router which have one interface in local (inside) network and one interface in global (outside) network is configured as NAT.
- When packet enters inside the network, the local IP is converted to public IP and vice-versa.
- If NAT runs out of addresses – an ICMP host unreachable is sent to the destination node.
- Subnet address 10.0.0/24 is reserved for realm with private addresses such as home network.



- These addresses cannot be used to address node in global network, as many private networks are there using these blocks of addresses.
- NAT router has its own IP address.
- In example given above, all traffic leaving router for larger internet has source IP address of 138.76.29.7 and same applies for entering traffic.
- DHCP server to provide addresses to computers within the NAT-DHCP-router-controlled home network's address space.
- NAT translation table: Suppose a user sitting in a home network behind host 10.0.0.1 requests a Web page on some Web server (port 80) with IP address 128.119.40.186. The host 10.0.0.1 assigns the (arbitrary) source port number 3345 and sends the datagram into the LAN. The NAT router receives the datagram, generates a new source port number 5001 for the datagram, replaces the source IP address with its WAN-side IP address 138.76.29.7, and replaces the original source port number 3345 with the new source port number 5001. When datagram arrives at the NAT router, the router indexes the NAT translation table using the destination IP address and destination port number to obtain the appropriate IP address (10.0.0.1) and destination port number (3345) for the browser in the home network. The router then rewrites the datagram's destination address and destination port number, and forwards the datagram into the home network.

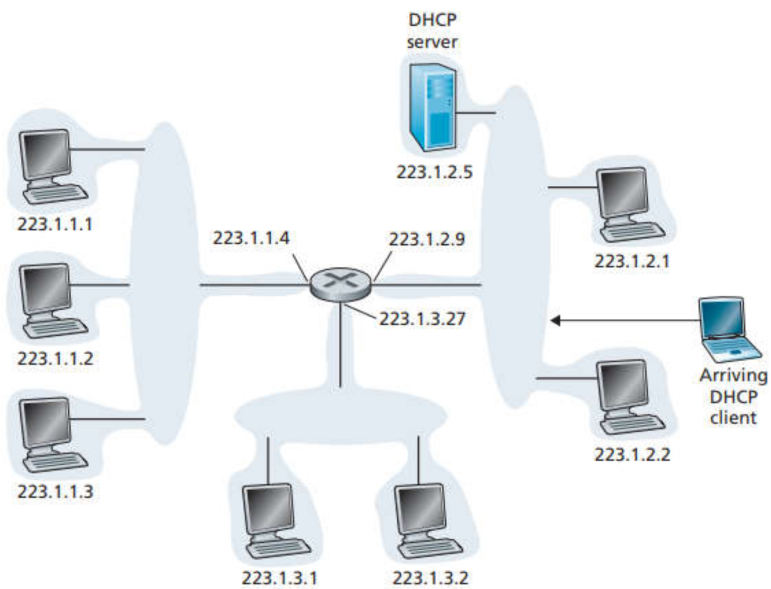
DHCP – Dynamic Host Configuration Protocol(1 marks)

Definition:

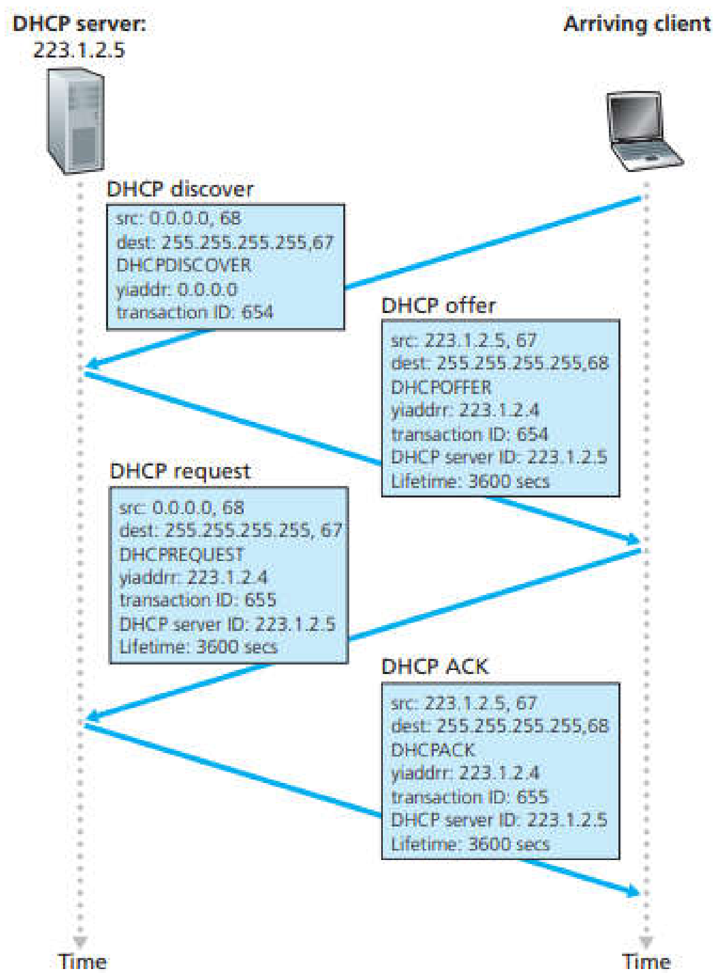
- The Dynamic Host Configuration Protocol (DHCP) is a network management protocol, whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on a network so they can communicate with other IP networks. It is a client-server protocol.

Working:

- A network administrator can configure DHCP so that a given host receives the same IP address each time it connects to the network, or a host may be assigned a temporary IP address that will be different each time the host connects to the network.
- Additional info provided by DHCP server: subnet mask, address of first hop router, lease time and address of local DNS server.
- Plug and play protocol.
- DHCP server allocates an arbitrary address from its current pool of available addresses; each time a host leaves, its address is returned to the pool.
- In simple scenario, each subnet will have a DHCP server, if not then router will provide address of DHCP server for that network.



- Figure shows a DHCP server attached to subnet 223.1.2/24, with the router serving as the relay agent for arriving clients attached to subnets 223.1.1/24 and 223.1.3/24.
- Four steps:
    - DHCP sender discovery: New host finds DHCP server to interact with. As host doesn't know IP of DHCP server, it broadcasts discovery message to all the nodes i.e. using 255.255.255.255
    - DHCP server offer(s): DHCP server receiving this discovery message, responds to client with broadcast message. Here client might get response from multiple DHCP server(s). DHCP server response contains: proposed IP, network mass, lease time.
    - DHCP request: From multiple/single offer, client will choose and reply send DHCP request sending back the provided parameters.
    - DHCP ack: Server responds with ACK message.



- Now client can use, DHCP allocated IP.
- After lease time expires, client has to request again to DHCP server.

CIDR – Classless Inter-Domain Routing Protocol (1 marks)