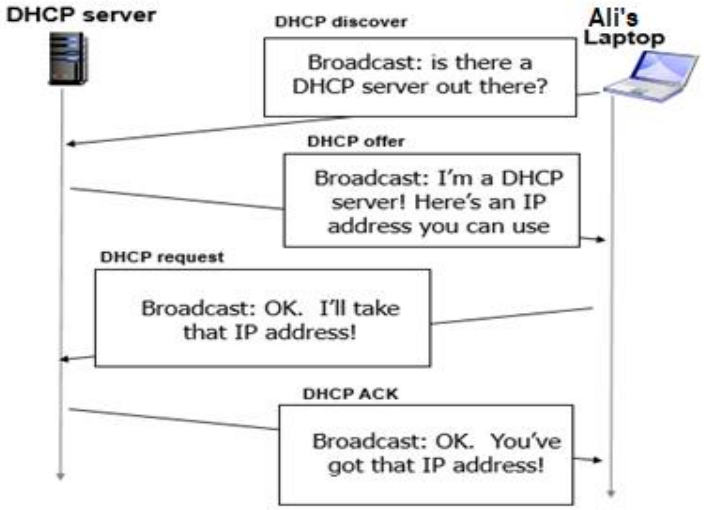
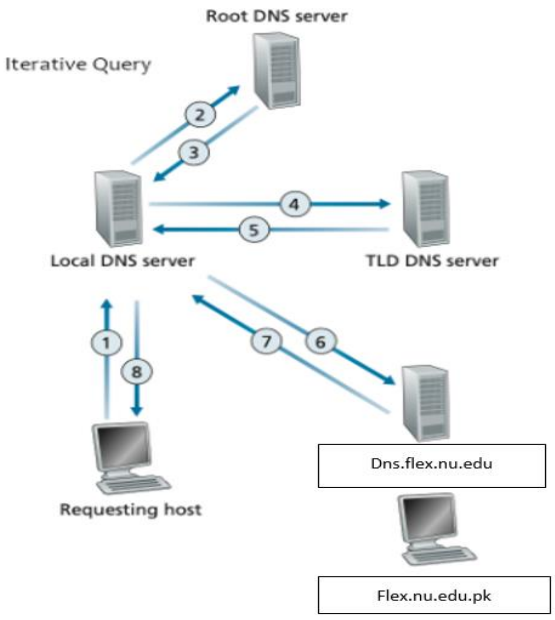
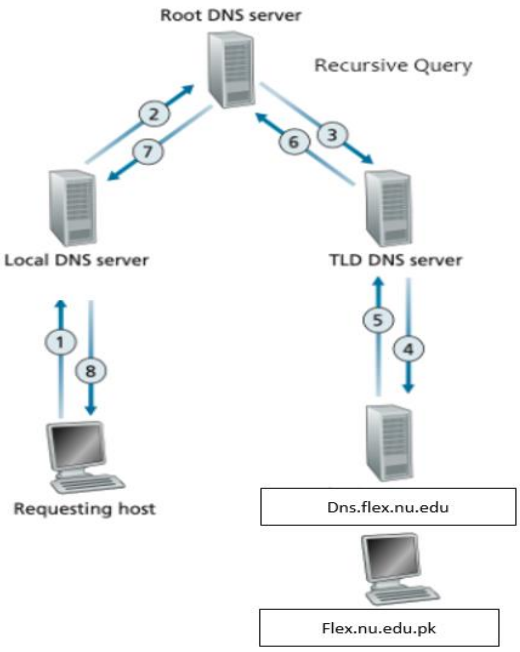
Question # 1: **[CL0-1]** **[4 x 5 = 20 Points]**

Part a) Answer:Connects to especially setup-up WiFi connection. Set OS to get IP address using DHCP (50% marks if there are missing exchanges).



Part b) Answer:





Part c)

i) Answer: It takes 11RTT for the first client to obtain the IP address for google.com.

ii) Answer: It takes 2 RTT for the Bilal (as the IP address is already in local domain server)

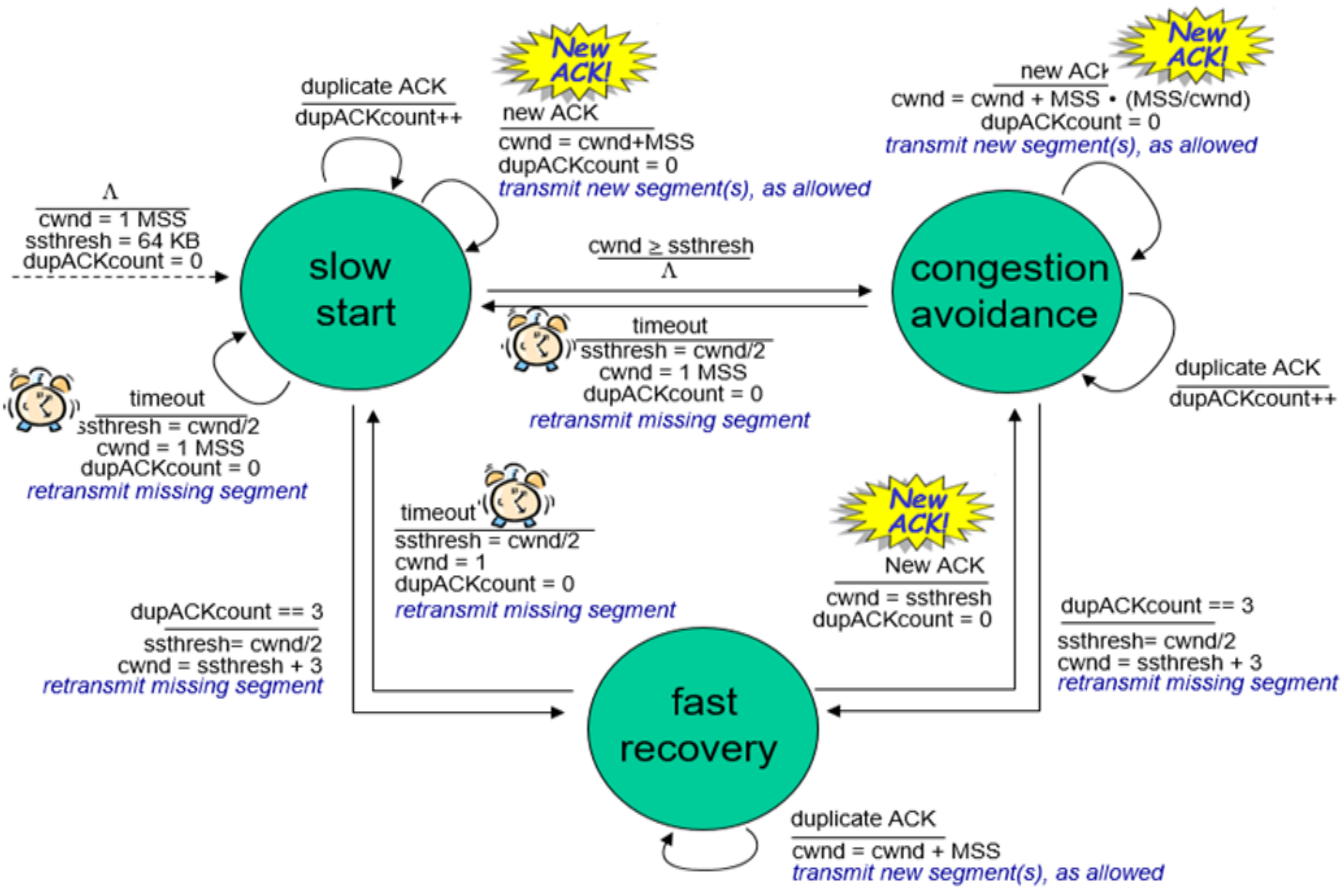
Part d) Answer:

This is a similar to the file upload to multiple peer we studied in the class.

- Client-server model need more computer, storage and network bandwidth as the number of users accessing the shared file folders grows to a large number (video lecture where size is ~1000s of MB).
- A P2P based application on each peer (like Bit torrent running on LAN) will allow a new users to use multiple copies of lectures those stored on different peers (as well as server copy) to take part of the download. Each peer PC will provide the bandwidth hence removing the bottleneck.

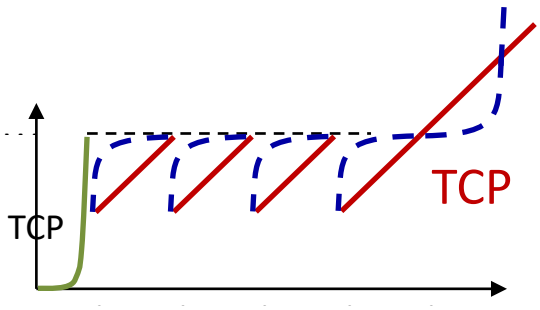
Question # 2: **[CL0-2]** **[10 + 5 + 5 = 20 Points]**

Part a) Answer:



Part b) Answer:

- W_{max}: sending rate at which congestion loss was detected
- congestion state of bottleneck link probably hasn't changed much
- after cutting rate/window in half on loss, initially ramp to to W_{max} *faster*, but then approach W_{max} more *slowly*
- K: point in time when TCP window size will reach W_{max}
- K itself is tuneable
- increase W as a function of the *cube* of the distance between current time and K
- larger increases when further away from K
  - smaller increases (cautious) when nearer K



Part c) Answer:

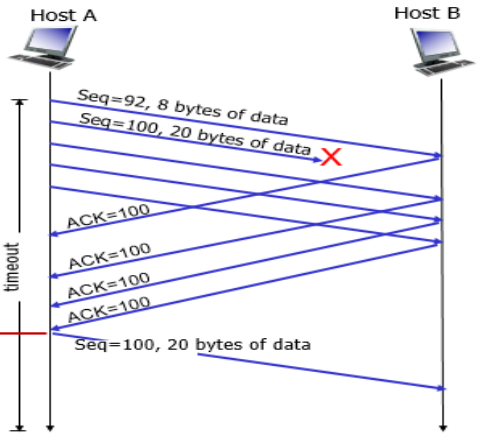
TCP fast retransmit

TCP fast retransmit

if sender receives 3 additional ACKs for same data ("triple duplicate ACKs"), resend unACKed segment with smallest seq #

- likely that unACKed segment lost, so don't wait for timeout

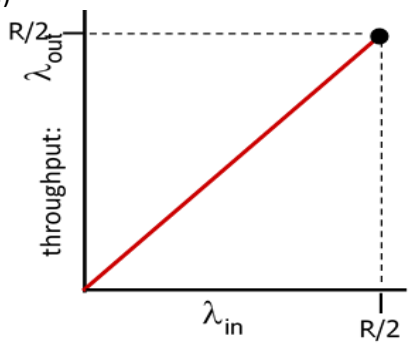
Receipt of three duplicate ACKs indicates 3 segments received after a missing segment – lost segment is likely. So retransmit!



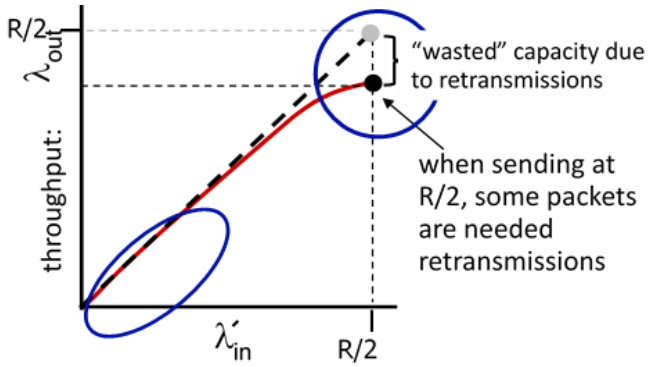
Question # 3: **[CL0-2]** **[7.5 + 7.5 + 5 = 20 Points]**

Part a) Answer:

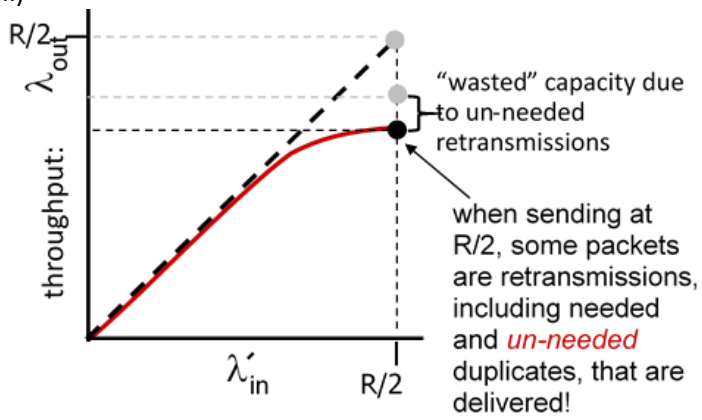
i)



ii)



iii)



Part b) Answer:

i)

Match	Action
IP Src = 10.1.*.* ; IP Dst = 10.3.*.*	Forward(3)

ii)

Match	Action
Ingress Port = 1 ; IP Src = 10.1.*.* ; IP Dst = 10.3.*.*	Forward(4)

iii)

Match	Action
Ingress port = 2 ; IP Dst = 10.3.0.1	Forward(3)
Ingress port = 2 ; IP Dst = 10.3.0.2	Forward(4)

Part c)

i) Answer:

$$U_{sender} = \frac{L/R}{RTT+L/R} = \frac{10000/5Gbps}{50ms+10000/5Gbps} = 0.0000399$$

ii) Answer:

$$U_{sender} = \frac{3L/R}{RTT+L/R} = \frac{3 \times 10000/5Gbps}{50ms+10000/5Gbps} = 0.0001199$$

Question # 4: **[CL0-2]** **[7.5 + 7.5 + 5 = 20 Points]**

Part a) Answer: **[First row 0.5points, Each highlighted 1 point, Forwarding table 0.5point each total 3 points]**

N	D(B)	D(C)	D(D)	D(E)	D(F)	D(G)
A	1,A	3,A	∞	∞	10,A	∞
AB		2,B	8,B	6,B	10,A	3,B
ABC			8,B	5,C	10,A	3,B
ABCG			8,B	5,C	10,A	
ABCGE			7,E		7,E	
ABCGED					7,E	

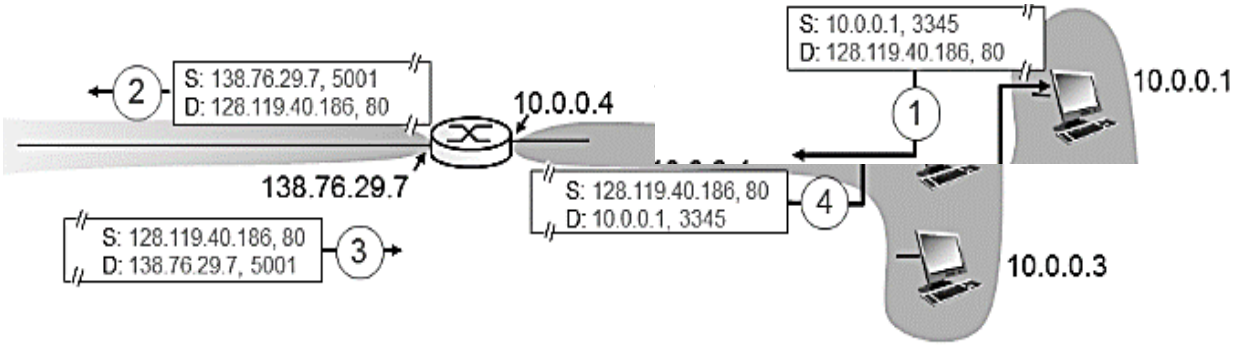
Forwarding Table	
Destination	**Outgoing link**
B	(A, B)
C	(A, B)
D	(A, B)
E	(A, B)
F	(A, B)
G	(A, B)

Part b) i) If all packets at 20,000 bits long, it takes 200 usec to send the packet over a 100Mbps link, 400 usec to send over a 50 Mbps link, and 20 usec to send over a gigabit link. The sum of the three link transmission times is thus 620 usec. The sum of the propagation delays is 200+50=250 msec. The total end-end delay is 250.620 msec.

ii) 50 Mbps, the bottleneck link speed.

iii) Answer: We assume that requests are serially satisfied. 35 % of the requests can be delivered at 50 Mbps and 65% of the requests can be delivered at 1 Gbps. So the average rate is 667.5 Mbps.

Part c)



Question # 5: **[CL0-3]** **[2 x 10= 20 Points]**

Part a)

Subnet No.	Network Address	Custom Subnet Mask	Host Range	No. Of Hosts
Department-1 LAN-1	192.168.9.0/26	255.255.255.192	192.168.9.1 --- 192.168.9.62	62
Department-1 LAN-2	192.168.9.64/25	255.255.255.128	192.168.9.65 --- 192.168.9.190	126
Department-2 LAN-1	192.168.9.192/28	255.255.255.240	192.168.9.193 --192.168.9.206	14
Department-2 LAN-2	192.168.9.208/27	255.255.255.224	192.168.9.209 --192.168.9.238	30

Part b) i)Because there are less than eight but more than 4 nodes in each subnet

So let's assign the **left** subnet XX.YY.ZZ.xxxx0***/29, Each x is a bit and the *'s are address.

For the right subnet, well use XX.YY.ZZ.xxxx1***/29.

A will have an IP address of XX.YY.ZZ.xxxx0000 and **B** will have an IP address of XX.YY.ZZ.xxxx1000.

ii) XX.YY.ZZ.xxxx/28

iii) Yes. use to determine the MAC address to send frames to, containing datagrams that need to be routed through the router.

iv) (1) & (2): ETH source: aa:12;F3:5C:01:BC, ETH dest: 20:FF:3A:BC:01:4E
IP source: XX.YY.ZZ.xxxx0000; IP dest: XX.YY.ZZ.xxxx1000 see (a) above
(3) ETH source: 10:D4:E1:A*:97:FO, ETH dest: BB:89:34:E7:01:3B
IP source: XX.YY.ZZ.xxxx0000; IP dest: XX.YY.ZZ.xxxx1000 same as (1) above

v) 5 other hosts in the left network (as well as the leftmost interface on the router).