Solver: Jesslyn Chew Sze Yu

1)

a) $r_{NTU\text{-}SMU\text{-}SUTD}$ = (1 – 0.03) (1 – 0.01)
= 0.9603
$r_{NTU\text{-}SIT\text{-}NUS\text{-}SUTD}$ = (1 – 0.02) (1 – 0.02) (1 – 0.01)
= 0.950796
$b_{NTU=SUTD}$ = (1 – 0.9603) (1 – 0.950796)
= **0.00195**

b) $b_{NTU=SUTD} = 0.00195 * p_{new}$
$1 - 0.9999 = b_{NTU=SUTD}$
$0.0001 = 0.00195 * p_{new}$
p_{new} = **0.0513**

c) T_{prop} for NTU-SMU = 10ms
T_{prop} for SMU-SUTD = 5ms
Data frame = 2000 bits = 2kb
NTU-SMU: sliding-window protocol N=2
SMU-SUTD: stop-and-wait protocol
$2T_{frame}$ SMU-SUTD + 4 T_{prop} SMU-SUTD = $2T_{frame}$ NTU-SMU + $3T_{prop}$ NTU-SMU
2 (2 kb ÷ r_X kbps) + 4(5 ms) = 2 (2kb ÷ 200 kbps) + 3(10 ms)
(4000 ÷ r_x) ms + 20 ms = (4000 ÷ 200) + 30 ms
(4000 ÷ r_x) + 20 = 50
(4000 ÷ r_x) = 30
r_x = 4000 ÷ 30 = **133.33 kbps**

2)

a)

i) Recall from lecture, Frame Transmission ≥ 2 end-to-end signal propagation time
Frame size * Frame transmission rate ≥ 2T
Frame size * 10Mbps ≥ 2T

ii) Frame transmission time = 64 bytes ÷ 10 Mbps
= 64 * 8 ÷ 10^6 ÷ 10 Mbps
= 51.2 µs
51.2 µs = 2T = 2 * length ÷ 100 m/µs
length = **2560 m**

b) Frame transmission time without delay = 51.2 µs

i) In this scenario, $T = 2 \times length \times T_{prop} + delay$
$51.2\mu s = 2(2 \times length \div 100 + 0.5\mu)$
$length = \mathbf{1255}\boldsymbol{m}$

ii) A switch forwards the received signals only to the destination. When 2 transmissions arrive at the switch at the same time, they will be stored in different buffers so that their frame van be forwarded later. Therefore, there will be no collisions.

c) Collision detection is different as it is hard to receive and sense collision when transmitting due to weak received signals. There is also the hidden terminal problem which results in not being able to sense all carriers and collisions.
WLAN avoids collision by using the CSMA/CA method. This is done by having the sender to reserve channel for a long data frame. The sender first transmits a small request-to-send (RTS) packet to receiver using CSMA and the receiver broadcast clear-to-send (CTS) in response to RTS. This CTS is heard by all nodes, resulting in only the sender transmitting the data frame to it and defers the other stations from transmissions.

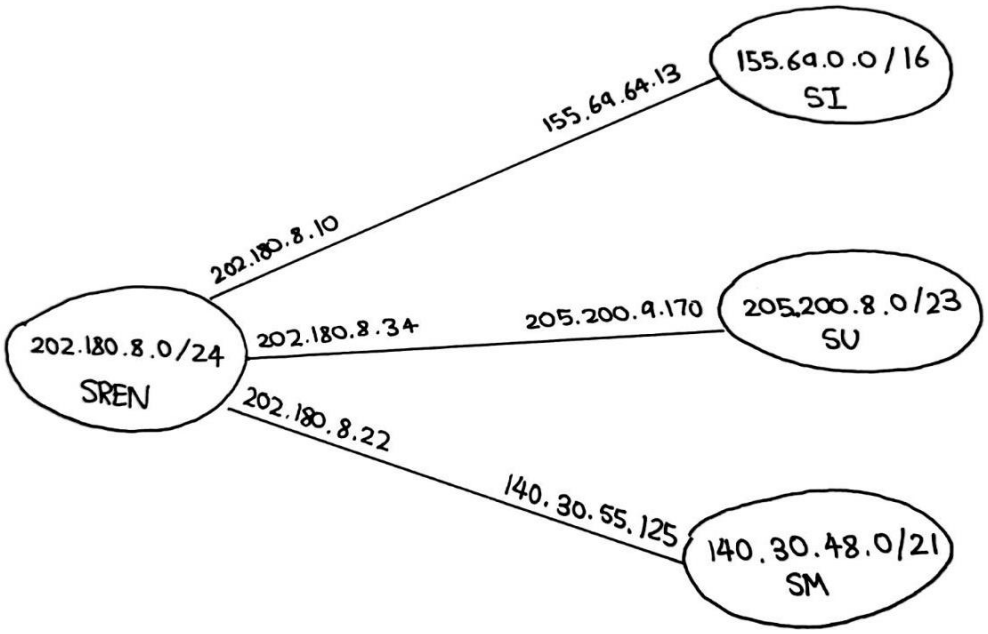
3)

a) 133.23.1011 0000.0
[Editor's note: Check that the underlined portion of the subnet is the same]
i) 133.23.1011 0000.1 → Valid
ii) 133.23.1011 0100.55 → Valid
iii) 133.23.1100 0010.22 → Not Valid
iv) 133.23.1011 1111.255 → Not Valid
v) 133.23.1011 0000.160 → Valid

b) IP address block of SI:
155.69.18.15 = 155.69.0001 0010.15
155.69.129.10 = 155.69.1000 0001.10
155.69.64.13 = 155.69.0100 0000.13
155.69.0.0/16

IP address block of SU:
205.200.9.170 = 205.200.0000 1001.170
205.200.8.120 = 205.200.0000 1000.120
205.200.8.0/23

IP address block of SM:
140.30.49.30 = 140.30.0011 0001.30
140.30.55.125 = 140.30.0011 0111.125
140.30.48.0/21



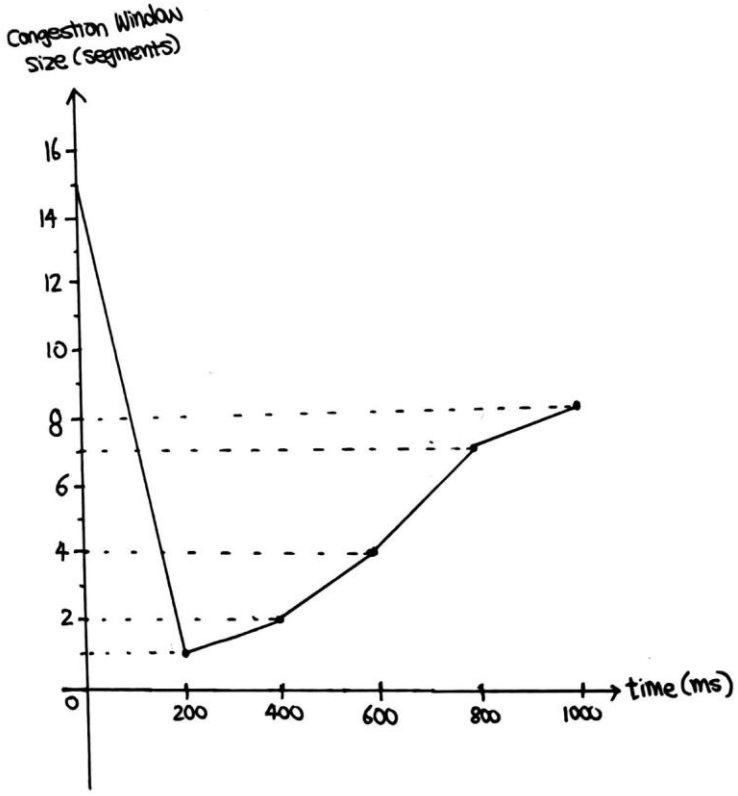
c) $98 = 0110\ 0010_2$
$99 = 0110\ 0011_2$
$100 = 0110\ 0100_2$
$101 = 0110\ 0101_2$
$102 = 0110\ 0110_2$
$105 = 0110\ 1001_2$
Now we can determine which network can be combined (supernet). Note that the network must be contiguous to able to build a bigger network. [https://www.geeksforgeeks.org/supernetting-in-network-layer/] This results in 3 supernets, one for the 4 of the contiguous networks, one for the last contiguous network (since there are 5 and you can only fit 4), and the last .105 network.
Ans: 193.169.96.0/22, 193.169.102.0/24, 193.169.105.0/24

4)

a) $\frac{cwnd \times MSS}{RTT} = throughput$

$$Throughput = \frac{(64 \times 3000 \times 8\ bits)}{200\ ms}$$
$$= \frac{1536000}{200 \times 10^{-3}}$$
$$= 7680000$$
$$= 7.68\ Gbps$$ < Transmission bandwidth

b) ssthresh $= \lfloor 15/2 \rfloor = 7$



c)

Packet	Function
P_1	ARP request for 155.69.8.8
P_2	ARP reply
P_3	DNS request for www.singa.net.sg
P_4	DNS reply 155.69.8.12
P_5	ARP request for 155.69.8.12
P_6	ARP reply
P_7	Ping request packet to www.singa.net.sg

--End of Answers--