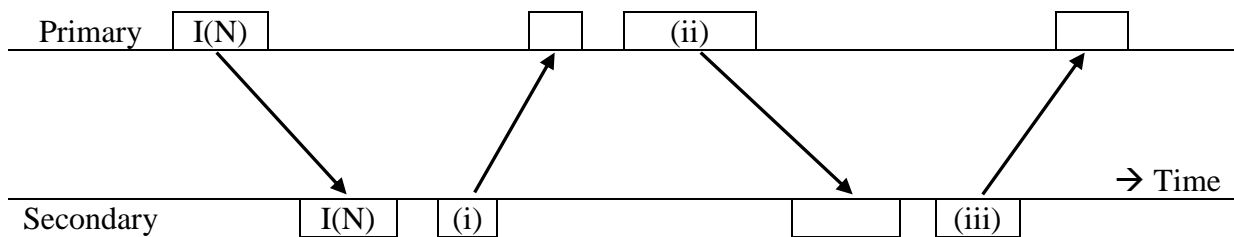| Subject :	SEHH2238 : Computer Networking
Lab/Tutorial :	Session 4 : Data Link Control (Solution)

1) ARQ Control Scheme

Fill in the name of frame being transmitted

(a) Error Free
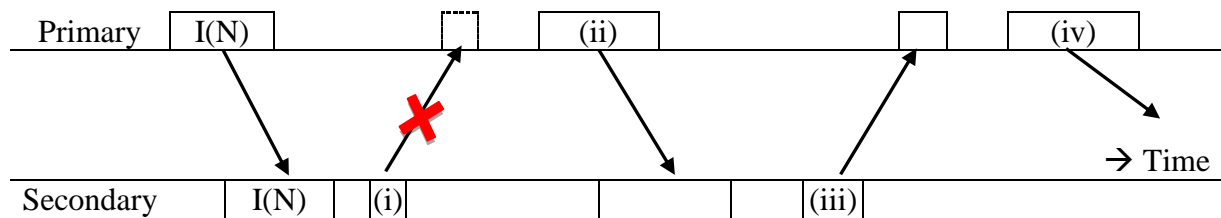   (i) ___ACK(N+1)___   (ii) ___I(N+1)___   (iii) ___ACK(N+2)___

Primary   I(N)   (ii)

→ Time

Secondary   I(N)   (i)   (iii)

(b) Loss ACK
   (i) _ACK(N+1)_   (ii) ___I(N)___   (iii) __ACK(N+1)__   (iv) ___I(N+1)___

Primary   I(N)   (ii)   (iv)

→ Time

Secondary   I(N)   (i)   (iii)

2) Stop-and-Wait ARQ

1.   A system uses the Stop-and Wait ARQ Protocol. If each frame carries 1000 bits of data, how long does it take to send 1 million bits of data if the distance between the sender and receiver is 5000 km and the propagation speed is 2×10^8 ms^{-1}? Assume the channel data rate is 1 Mbps and ignore processing delays and ACK transmission time. Further assume that no data or control frame is lost or damaged. Also ignore the overhead due to the header and trailer.

.... Repeat 1000 times
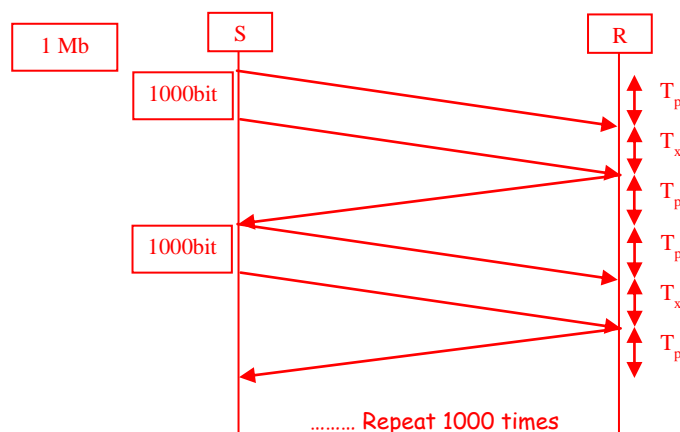
For a round trip:

Transmission delay (T_x) for I-frame = 1000 bit / 1Mbps = 0.001s
Propagation delay (T_p) for I-frame = 5000 km / (2×10^8 ms^{-1}) = 0.025s
Transmission delay (T_x) for ACK = 0s
Propagation delay (T_p) for ACK = 5000 km / (2×10^8 ms^{-1}) = 0.025s
Round trip delay = 0.001 + 0.025 + 0 + 0.025 = 0.051s

No. of round trip = 1 Mb / 1000 bits = 1000

Total delay = 0.051 x 1000 = 51s

2. Continue from the previous question. Further assume that there is a data frame lost in every 10 data frames sent. Sender retransmits the lost frame after a timeout of 100 ms. How long does it take to send 1 million bits of data?
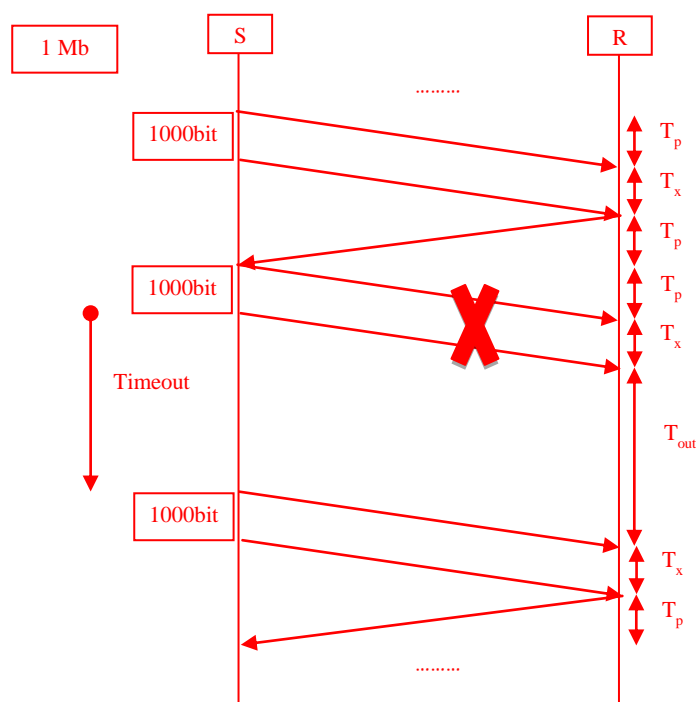
Time for transmitting 1 Mb without lost = 51s

Time for each timeout event = $T_x + T_{out}$ = 0.001 + 0.1 = 0.101s
No. of frame lost = 1000 / 10 = 100
Lost also happens in retransmitted frames = 100 / 10 = 10, and 10 / 10 = 1

Total delay = 51 + 0.101 x (100 + 10 + 1) = 62.211s

3) Bit Stuffing

1. Bit stuff the following data

0001111111001111101000111111111110000011111

What should be the content of the data frame to be sent? (Ignoring the header and trailer)

00011111**0**110011111**0**01000111110**0**11111**0**10000111110**0**