ECE 358 Assignment 7

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1. Assuming loss rate is not 100 percent, then any data handed to the sender will eventually be received by the receiver intact(not corrupt). (This sometimes considered a liveness property, but I asked the prof in class if we can use it for this question and he said yes).

2. In general, assuming sequence number is non repeating(infinite number of sequence numbers, prof confirmed valid assumption on piazza), YES. Receiver check sequence number and discard if not next expecting seq number, thus ensuring

   1) the packages are accepted in order
   2) if sender receives an ack, then all packages with seq number smaller or equal to seq number in ack have been accepted by receiver.

   There is also special case we talked about in class where the receiver state machine breaks. The receiver state machine, when receiving a corrupt or out of order package, send back the last ack package it created. But the initialization of the receiver state machine in the slides creates an ack for a package it hasn't received yet. So if the very first package the receiver receives is an out of order package, it will send back an acknowledge to a package it hasn't received.

3. Yes, similiar senario may occur if sender window size is the same as the number of sequence numbers. Assume sequence numbers are 0, 1 and window size is 2. Receiver can't distinguish between

   1) Sender sends 0,1. Receiver receives 0, send ack for 0. Receiver receives 1, send ack for 1. Both acknowledgements are lost. Sender times out, send 0,1 again. Receiver receives retransmitted 0.
   2) Sender sends 0,1. Receiver receives 0, send ack for 0. Receiver receives 1, send ack for 1. Sender gets both ack. Sender sends new 0,1. Receiver receives new 0.

4. a) Can't tell if an acknowledgement is from receiver receiving the original transmission or an retransmission, thus can't estimate RRT for any packages that have been retransmitted.

   b) 3 Duplicate acks for the some sequence number means 3 packages with sequence number higher than that sequence number have been received, but the package with that sequence number still haven't been received. This implies the package with that

sequence number was probably lost in transit(rather than something like network is being slow), and therefore should be retransmitted.

5. handling case 1) after connection terminates, server gets request. server sends ack to client, since client is terminated, it doesn't send ack in response to server ack, server persumably times out waiting for ack therefore doesn't open a "half open connection".

   handling case 2) after connection terminates, server gets request. server sends ack to client, since client is termianted, it doesn't send ack in response to server ack, no connection is established and data(x+1) is rejected

6. If L is the loss rate, then the expectation is that 1/L packages are delivered before the first package is lost. Thus each cyle(increase cwnd from W/2 to W) delivers 1/L packages. (1)

   Since each successful roundtrip increases cwnd by one MSS. Let the unit of W be MSS, then $\frac{W}{2}$ roundtrips are required before cwnd increase from W/2 to W, completing one cyle. Thus each period requires $\frac{W}{2}$ roundtrips. In slide 105, observe the number of packages delivered in one cycle is the area under curver for one cycle. Thus number of packages delivered is
   $\frac{\frac{W}{2}+W}{2}_{MSS/roundtrip} * \frac{W}{2}_{roundtrips} = \frac{3}{8}W^2_{MSS}$. (2)

   Setting (1) equal to (2) yields $W = \frac{\sqrt{\frac{8}{3}}}{\sqrt{L}}_{MSS}$. Plugging this in: $T = \frac{0.75W}{RTT} = \frac{0.75*\sqrt{\frac{3}{8}}MSS}{RTT*\sqrt{L}} \approx \frac{1.22MSS}{RTT*\sqrt{L}}$