Homework #2 - [Chapter 3]

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(CS 372)

1. a)

- Window size (N) = 4
- SN range = 1,024
- k = next in-order sn

① Assuming k is the receiver acknowledging all $k-1$ pkts, then the sender's window can be in range of $[k, k+N-1]$.

② Assuming that sender's window contain $k-1$ & N pkts w/ include $k-1$, then we have sender's window be $[k-N, k-1]$

Then with these two cases and knowing window size = 4 we can conclude that at t time, set of possible SN is : **Answer**: $t = [k-N, k]$

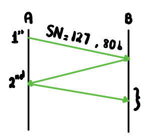
b) If no N ACKs have been received by the sender, the ACK is still propagating back so window will be $[k-N, k-1]$. This mean the sender does send all the pkt of $k-N$ where ACK could never be less than $k-N-1$ to $k-1$. So the possible value of ACK field in all possible messages is:

Answer: $k-N-1$ to $k-1$

2.

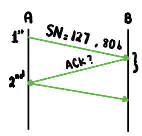
- Host B received up to 126 bytes from A (Send acknowledge once received from A) (A send back-to-back)
- 1^{st} seg = 80 bytes & 2^{nd} seg = 40 bytes data
  - SN = 127
- SP = 302
- DP = 80

a)



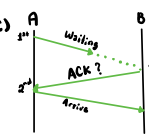
$\}$ $\overset{SN}{127+80 = 207}$, $\overset{SP}{302}$, $\overset{DP}{80}$ $\Big\}$ **Answer**: Sequence # = 207 , Source Port = 302, Destination Port = 80

b)



$\}$ $ACK^{1st} = 127 + 80 = 207$, $\overset{SP}{80}$, $\overset{DP}{302}$ $\Big\}$ **Answer**: $ACK^{1st} = 207$, Source Port = 80 , Destination Port = 302

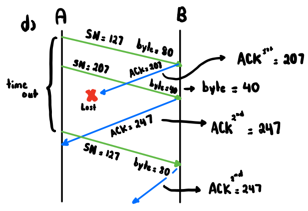
c)



$\}$ ACK = 127 since it is still waiting for bytes 127 onwards

Answer: $ACK^{1st} = 127$

d)



$\Big\}$ **Answer**

3. * $\alpha = 0.1$ * EstimatedRTT = $(1-\alpha)$EstimatedRTT + αSampleRTT

* SampleRTT_1 = most recent & SampleRTT_2 = next most recent

a) $\text{EstimatedRTT}_4 = \underset{0.1}{(1-\alpha)^3}\text{SampleRTT}_4 + (1-\alpha)^2\text{SampleRTT}_3 + (1-\alpha)\text{SampleRTT}_2 + \alpha\text{SampleRTT}_1$

Answer: $\text{ERTT}_4 = 0.9^3\text{SRTT}_4 + 0.9^2\text{SRTT}_3 + 0.9\,\text{SRTT}_2 + 0.1\,\text{SRTT}_1$

b) Knowing from part A, we can determine the generalize formula to be:

Answer: $(1-\alpha)^{n-1}\text{SampleRTT}_n + \frac{\alpha}{1-\alpha}\sum_{j=1}^{n-1}(1-\alpha)^j\ \text{SampleRTT}_j$

c) If we move to ∞ from B, we get:

Answer: $\lim_{\to\infty}\text{EstimatedRTT}^{\infty} = \frac{\alpha}{1-\alpha}\sum_{j=1}^{\infty}(1-\alpha)^j\,\text{SRTT}_j \rightarrow \frac{1}{9}\sum_{j=1}^{\infty}(0.9)^j\,\text{SRTT}_j$

* It is called for exp. moving average as the EstimatedRTT depend on previous recent SampleRTT to get the next EstimatedRTT which will produce the exp. moving average.

4. a) The interval where TCP have a slow start is:

Answer: $t = [1, 6]$ & $[23, 26]$

b) The interval where TCP have a congestion avoidance is:

Answer: $t = [6, 16]$ & $[17, 22]$

c) Looking at the event loss at transmission round at $t = 15$, we see CongWin ≈ 42 and take $\frac{42}{2} = 21$ where $t = 16$ start at the threshold, then:

Answer: This is a triple duplicate ACK

d) Looking at the event loss at transmission round at $t = 22$, we see CongWin ≈ 26 and take $\frac{26}{2} = 13$ where $t = 23$ start at 1 where set CongWin to 1, then:

Answer: This is a timeout event

e) The ssthreshold (initial) at the first transmission round is:

Answer: threshold ≈ 32

f) The ssthreshold at the 18^{th} transmission round is:

Answer: CongWin $= \frac{42}{2} = 21$

g) The ssthreshold at the 24^{th} transmission round is:

Answer: CongWin $= \frac{26}{2} = 13$

h) The 70^{th} segment would be around 7^{th} transmission round.

* We can see this as 1^{st} trans. = 1 segs, 2^{nd} trans = 2-3 segs, 3^{rd} trans. = 4-7 segs., ..., 7^{th} trans = 64-96 segs.

Answer: 7^{th} transmission round

i) Assuming pkt loss after the 26^{th} round by triple ACK, we can see the 26^{th} round = CongWin at 8 and we can take $\frac{8}{2} = 4$

Answer: CongWin & ssthres = 4

j) TCP Tahoe use instead TCP Reno & assume triple ACKs received at round 16^{th}, the ssthreshold & congWin at 19^{th} ➜ CongWin set to 1 at 19^{th} & ss thres = 21 ← $\frac{42}{2}$

Answer: CongWin = 1 & ssthreshold = 21

h) If Tahoe is used, timeout at 22nd round, the pkts send from $17-22^{th}$ round

* 17^{th} = 1 pkt
* 18 = 2 pkts
* 19 = 4 pkts
* 20 = 8 pkts
* 21 = 16 pkts
* 22 = 21 pkts ← threshold

} Add to get 52 pkts, increase exponentially

Answer: 52 pkts

5. a)
* Assume cwnd increase by 1 MSS
* TCP uses AIMD for its congestion control w/o slow start
* Constant RTT

} * Take 1 RTT to increase CongWin = 7 MSS follow that:

→ 2RTT = 8 MSS
3RTT = 9 MSS
4RTT = 10 MSS
5RTT = 11 MSS
6RTT = 12 MSS

} Answer: Take 6RTT from cnwd 6 → 12 MSS

b) Avg. throughout in time = 6RTT ➜ $\frac{(6+7+8+9+10+11)}{6} \frac{MSS}{RTT}$

Answer: Avg. throughout 8.5 $\frac{MSS}{RTT}$

7.
* 10 Mbps link → 1.0×10^7 bps
* TCP segment size 1,500 bytes → 12,000 bits
* s = 150 msec ↓ 0.15 sec, ignore slow start

a) $\frac{(1.0 \times 10^7)(0.15)}{12,000} = 125$ segs. → Answer: Max window size = 125 segments

b) Avg. window size? ➜ $\frac{3W}{4} = \frac{3 \cdot 125}{4} \approx 94$ seg.
& Avg. throughput? ➜ $\frac{3W \cdot MSS}{4\ RTT} = \frac{94 \cdot (12,000)}{0.15} = 7.52 \times 10^6$ bps

} Answer: Avg. window size = 94 & Avg. throughput = 7.52×10^6 bps

c) We would take the $\frac{W}{2} \cdot \overset{avg.}{RTT} = \frac{125}{2} \cdot 0.15 = 9.4$ sec } Answer