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Protocols and Computer Networks Exercise 7

A TCP sender runs Reno TCP. At time t = 1.00 seconds, cwnd = ssthresh = 64.

The timeout RTO is 5 seconds. Transmission time on the line is negligible.

The receiver returns an ACK for every 4 received segments.

At time t = 1.00 seconds the sender starts to transmit a window of 64 segments and receives the following ACKs:

	ACK Time	ACK Field in TCP Header	Last ACKed Packet	ΔRTT
1	1.10	5	4	
2	1.22	9	8	
3	1.34	13	12	
4	1.47	17	16	
5	1.61	21	20	
6	1.76	25	24	
7	1.93	29	28	
8	2.10	33	32	
9	2.29	37	36	
10	2.49	41	40	
11	2.71	45	44	
12	2.94	49	48	
13	3.19	53	52	
14	3.45	57	56	
15	3.73	61	60	
16	4.03	61	60	
17	4.36	61	60	
18	4.70	61	60	

1. In one sentence, what can be learned about the trend of ACK arrival times?

2. On the basis of the table above, complete the following table up to the 68th segment, according to Reno

	ACK Time	ACKed Packet	cwnd	ssthresh	
1	1.10	4	64	64	
2	1.22	8	65	64	
3	1.34	12	66	64	
4	1.47	16	67	64	

3. We can evaluate the operation of TCP Vegas with the following parameters:

- Compute ΔRTT = ACK_time − previous_ ACK_time for each ACK
- expected throughput = 50
- diff = expected throughput – measured throughput
- α = 25
- β = 35
- $RTT_{Vegas\text{-}timeout}$ = 0.250

Using the ACK times in the table above, compare the cwnd that Vegas would set with the Reno cwnd.

a. Complete the table below up to the 16th ACK

b. Explain briefly what will happen after the 16th ACK

	ACK Time	ΔRTT	ACKed Packet	ACKs	Reno cwnd	Measured Throughput	diff	Vegas cwnd	
1	1.10	0.10	4	4	64	4 / 0.1 = 40	10	64	
2	1.22	0.12	8	4	65	4 / 0.12 = 33	17	65	
3	1.34	0.12	12	4	66	33	17	66	
4	1.47	0.13	16	4	67	31	19	67	

4. We can evaluate the operation of Modified Congestion Control (MCC) with the following parameters:

- We simplify the calculation to

$$\text{BWE} = \text{weighted average of } \frac{\text{packets ACKed}}{\Delta\text{RTT for bits_to_ACK}}$$

$$\text{BWE_s[k]} = \frac{\text{packets ACKed}}{\text{now} - \text{last_ACK_time}}$$

$$\text{BWE[k]} = (1-\beta) \times \frac{\text{BWE_s[k] + BWE_s[k-1]}}{2} + \beta \times \text{BWE[k-1]}$$

On three dupACKS

$$\text{ssthresh} = \text{BWE}$$
$$\text{cwnd} = \min(\text{ssthressh}, \text{cwnd})$$

- β = 0.9
- ΔRTT_{min} = 0.10
- ΔRTT[1] = 0.10
- BWE_s[0] = BWE[0] = 40

Complete the table below up to the 18th segment ACK

	ACK Time	ΔRTT	ACK	ACKs	Reno cwnd	Reno ssthresh	BWE_s	BWE	MCC ssthresh	MCC cwnd	
1	1.10	0.10	4	4	64	64	40	40	64	64	
2	1.22	0.12	8	4	65	64	33	40	64	65	
3	1.34	0.12	12	4	66	64	33	39	64	66	
4	1.47	0.13	16	4	67	64	31	38	64	67	