Topics: transport layer, routing

Q. 1 Assume that at the transport layer packet losses are i.i.d. with probability q. Consider the three reliable acknowledgment based transport layer protocols discussed in class: one-by-one, Go-back-W and Selective Repeat. It is easy to see that if $q = 0$ then the packet throughput, i.e., the average number of packets **successfully** transmitted per unit time, is the best for Selective Repeat followed by Go-back-W and one-by-one. Here, we shall analyze the interesting case of $q > 0$.

- Find an expression for packet throughputs of the above schemes in terms of RTT, tx and q.
- Find the optimal window sizes for Go-back-W and Selective Repeat (assuming tx is much smaller than RTT).
- Compare the throughputs for small positive q.
- If an optimal W can be computed for Selective Repeat, why do we not use that in TCP? Why do we have to do dynamic window (flow) control for TCP?

Q. 2 (Srikant and Ying, Exercise 7.2) Consider a single TCP-Reno connection over a link with bandwidth 15Mbps. Assume each packet has a size of $1,500$ bytes, and the round trip time is 80 msec. Further, we assume packet losses occur when the transmission rate exceeds the link capacity, and no time-out occurs during transmissions.

- What is the maximum possible window size (in terms of packets) for this TCP connection?

  Note: In reality, most versions of TCP-Reno set a maximum window size beyond which the window size cannot increase. In this problem, we assume that such an upper limit does not exist, but rather we are interested in computing the maximum window size limit that is naturally imposed by the available bandwidth and the RTT.

- What are the average window size and average throughput?

  Hint: the congestion window is set to one half of the previous value when a packet loss is detected.

- How many packets were transmitted during the slow-start phase?

Q. 3 (Another TCP) Recall the approximate differential equation based TCP Reno analysis done in class. Do a similar analysis for the following TCP variation? (You can make the same simplifying assumptions.)

In the congestion avoidance phase, the window W is increased to $W + \frac{1}{W}$ for each received ACK and the window W is reduced to 1 whenever there are 3 dupACKs.