CS 168 Section 7: Advanced Congestion Control

1. TCP Fast Recovery

Consider a TCP connection, which is currently in Congestion Avoidance (AIMD).

- The last ACK sequence number was 101 (the receiver expects the packet #101 for next).
- The CWND size is 10 (in packets).
- The packets #101-110 were sent at t = 0, 0.1, …, 0.9 (sec), respectively.
- The packet #102 is lost for its first transmission.
- RTT is 1 second.

Fill in the tables below, until the sender transmits the packet #116.

(a) Without Fast Recovery

- *On new ACK,* ***CWND = CWND +*** $\lfloor \mathbf{1/CWND} \rfloor$
- *On triple duplicate ACK,* ***SSTHRESH = CWND/2****, then* ***CWND = SSTHRESH***

t (s)	ACK (due to)	CWND	xmit
1.0	102 (101)	10+1/10	111
1.2	102 (103)	10+1/10	-

(b) Fast Recovery

- *On triple duplicate ACK,* ***SSTHRESH = CWND/2,*** *then* ***CWND = SSTHRESH + 3****, and enter fast recovery*
- *In fast recovery,* ***CWND += 1*** *on every duplicate ACK*
- *Exit fast recovery on new ACK, setting* ***CWND = SSTHRESH***

t (s)	ACK (due to)	CWND	xmit
1.0	102 (101)	10+1/10	111
1.2	102 (103)	10+1/10	-

(c) Consider a scenario where two packets are lost: #102 and #107. What would happen, if we have Fast Recovery or not?

2. TCP Throughput Equation

The following equation provides a simple way to estimate the throughput of a TCP connection, as a function of the loss probability (p) and the round-trip time (RTT).

$$\text{Throughput} = \sqrt{\frac{3}{2}} \frac{1}{RTT\sqrt{p}}$$

(a) Derive the above equation yourself!

(b) Alice wants to send a large amount of data to Bob, over a network path with RTT=100ms, p=0.01, and MSS=10,000bits. What is the expected throughput in Mbps? ($\sqrt{\frac{3}{2}} \approx 1.22$)

(c) Alice has two options to improve the throughput: halving either the RTT or the loss probability (p). If the both options cost the same, which one is more cost effective?

(d) Food for thoughts: Considering how the equation is derived, what assumptions does it need for accurate prediction? When is it possible that they may not hold in reality?

- e.g., RTT is predictable. ← RTT may fluctuate at a short time scale, for example, due to queueing delay.
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