

Congestion Control and Performance Analysis

Assigned reading: Peterson and Davie: Chapter 6. All problems carry equal weight. Please show all your work.

1. Random Early Detection

Consider a FIFO queue with an RED dropping policy, with $MaxP=0.02$, $MinThreshold=20$, $MaxThreshold=180$. The current $AvgLen=60$.

- a. Find the drop probability $P(count)$ for $count=1$ and $count=40$.
- b. Calculate the probability that none of the 40 packets are dropped.
- c. What is the probability that none of the 40 packets are dropped when $AvgLen=220$?

2. Fair Queuing

In this problem you will simply show the scheduling times for a link using the following version of weighted fair queuing. Packets are stored in per-flow queues and per-flow counters track how much data has been sent from each flow. The counters are zero at time zero, and time zero is the first decision time. At each decision time:

1. Enter packets arriving at the decision time, if any, into the appropriate queues.
2. If all queues are empty, set all counters to zero, and set the next decision time equal to the time of the next arrival. Done.
3. Let C_{min} denote the minimum counter value of flows with waiting packets. For any flow with no waiting packets and with counter value smaller than C_{min} , increase the flow's counter value to C_{min} . (A variation, not used here, invokes this “use it or lose it” step at packet completion times instead.)
4. Select the flow with the smallest counter value from among all flows with waiting packets. (A variation, not used here, is to select the flow with the smallest sum of counter value and packet length.) In case of ties, give preference to the alphabetically first flow. Schedule a packet for that flow, and increase the counter value of that flow by the length of the packet divided by the fair queuing weight for the flow. The next decision time is when transmission of the packet is completed. Done.

Assume there are three flows, A, B, and C, with arrivals as follows:

A: packets of length 5 arrive at times 10, 15, 20, 25, 30, 35, 40, 45, 50

B: packets of length 10 arrive at times 15, 30

C: packets of length 15 arrive at times 40, 80

- a. Suppose the flows each have weight one. Describe the scheduling by completing the following table. List the decision times in the top row. For each decision time, record the counter values just after step 3 or after “done” in step 2 is executed, and if a packet is scheduled, list which one.
- b. Repeat part (a), but now assume that A has weight 1, B has weight 2, and C has weight 3 (use a new table).

Time	10	15	25		105
Flow A	0	5	5		0
Flow B	0	0	10	...	0
Flow C	0	0	5		0
Packet	A1	B1	A2		-

3. TCP Congestion Performance

Consider a TCP system implementing slow start and congestion avoidance with fast retransmit and fast recovery. When a connection is setup the congestion window is initialized to one segment and the slow start threshold to 64 segments. To simplify the problem, assume that the timeout is equal to the RTT (an exact estimate) and specify time in units of RTT, such that one time slot is one RTT.

Packet transmissions are such that at each time slot the sender sends all packets in the congestion window. If ACK's are received in the next time slot, there is no timeout. In addition, to simplify matters either the entire window is acknowledged or none of its segments are acknowledged.

For a particular connection, ACK's are received in time slots 1-9, 11-29, 31-38, and 40-50. Timeouts occur in slots 10 and 30; in slot 40, three duplicate ACK's are received for the packets sent in time slot 39.

For the system described, plot both the congestion window and the slow start threshold (on the same graph) versus time (slots). Remember to consider the differences between slow start and congestion avoidance with fast retransmit and fast recovery when changing the congestion window.