Assignment 4

CS224

Note: *Solve all problems on your own.* Approach the instructor for clarifications.

1. We studied in class how TCP-Vegas reduces packet drops and queuing delays and improves throughput when compared to TCP-Reno. However, if TCP-Vegas flows share a network path with TCP-Reno flows then Reno flows tend to significantly reduce the throughput of the Vegas flows. Your task is to design a new variant of TCP with the following properties. We will ignore Slow Start for this problem and assume that all TCP flows only employ congestion avoidance. In your solution you will have to give the window increase and decrease rules for this new variant of TCP and also explain how it satisfies all the properties below. State any other assumptions you make.

   (a) It is purely an end-to-end congestion control protocol, that is, it does not require any special information from routers or explicit information about other TCP flows in order to perform congestion control.

   (b) It behaves like TCP-Vegas if all other competing flows on its network path employ TCP-Vegas. Let us assume that all TCP flows have the same RTT on the network path.

   (c) It behaves like TCP-Reno if there are some competing flows on its network path that employ TCP-Reno.

   (d) It adjusts its CongestionWindow based on inference of packet losses and/or queuing delays in the network.

2. (TCP analysis) In this problem we study "RTT-fairness" issues in TCP, that is do two TCP flows with different RTT's get the same bandwidth or not. Label two TCP flows $i = 1, 2$. Flow i has congestion window $w_i(t)$ bits at time t, RTT (which does not vary with time) of T_i sec, and instantaneous bitrate of $w_i(t)/T_i$. Assume that $w_i(0) = 0$. Both flows share the bandwidth C bits/sec of a particular link of the network. We say that both flows face "loss" at time t iff $\sum_i w_i(t)/T_i = C$ following which their congestion windows are immediately reset to 0. At all other time instants, the windows are incremented in an additive-increase fashion according to

$$\frac{dw_i(t)}{dt} = \frac{1}{T_i}.$$

   Note that this is a toy model of TCP Reno in the additive increase phase, where T_i represents the RTT (indeed Reno tries to increase the window by 1 every RTT). We have, of course, ignored Slow Start in this analysis.

   Compute and compare the total amount of data in bits transmitted by the two flows between consecutive "loss" events. How is the total amount of data of a flow dependent on its RTT? Is TCP Reno fair, in the sense that both competing flows get the same throughput?