EECS 122: Introduction to Communications Networks

Spring 2004
Assignment 5
Due: April 2, 2004

Problem 1 [10 points]
Peterson & Davie, Chapter 5, exercise 9.

Problem 2 [10 points]
Peterson & Davie, Chapter 5, exercise 17

Problem 3 [15 points]
Peterson & Davie, Chapter 6, exercise 17 [10 points] & 18 [5 points]

Problem 4 [15 points]
Peterson & Davie, Chapter 6, exercise 28

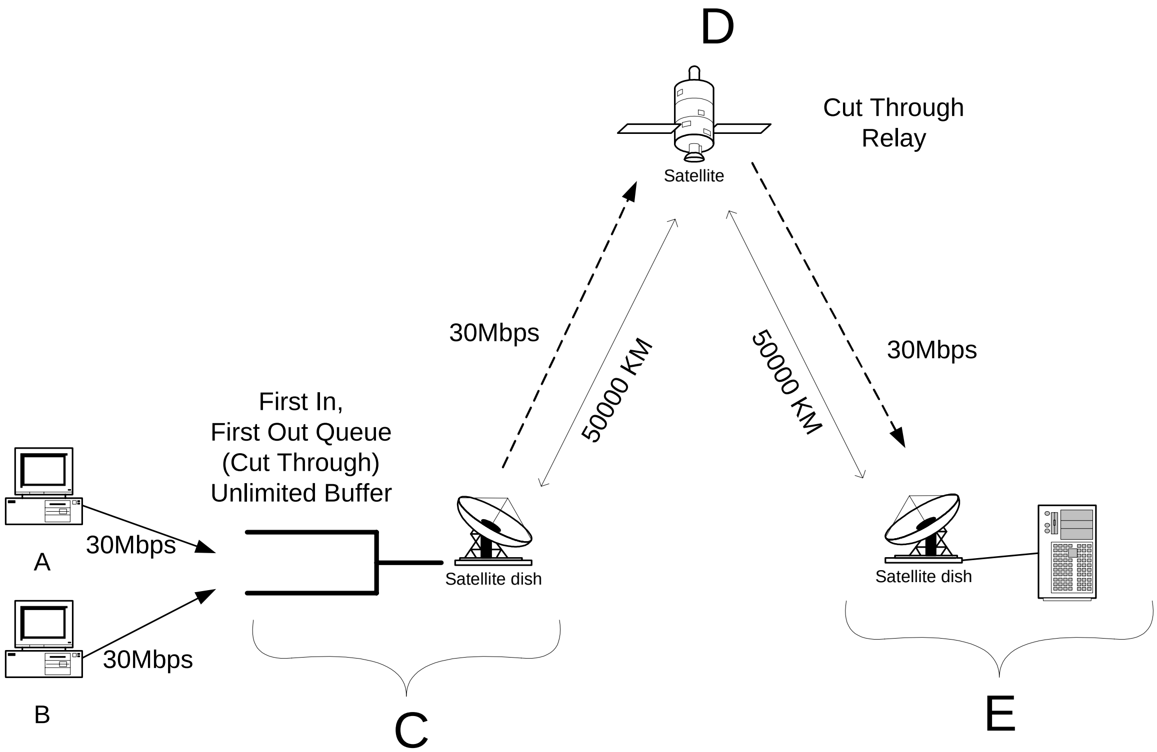
Problem 5 [10 points]
Peterson & Davie, Chapter 6, exercise 32

Problem 6 [10 points]

(a) Suppose you and two friends named Alice and Bob share a 200 Kbps DSL connection to the Internet. You need to download a 100MB file using FTP. Bob is also starting a 100MB file transfer, while Alice is watching a 150Kbps streaming video using UDP. You have the opportunity to unplug either Alice or Bob's computer at the router, but you can't unplug both. To minimize the transfer time of your file, whose computer should you unplug and why? Assume that the DSL connection is the only bottleneck link, and that your connection and Bob's connection have a similar round trip time. [5 points]

(b) What if the rate of your DSL connection were 500Kbps? Again, assuming that the DSL connection were the only bottleneck link, which computer should you unplug? [5 points]

Problem 7. [30 points]



Suppose Station **A** has an unlimited amount of data to transfer to Station **E**. Station **A** uses a sliding window transport protocol with a fixed window size. Thus, Station **A** begins a new packet transmission whenever, the number of unacknowledged packets is less than *W* and any previous packet being sent from **A** has finished transmitting.

The size of the packets is 10000 bits (neglect headers). So for example if $W>2$, station A would start sending packet 1 at time $t = 0$, and then would send packet 2 as soon as packet 1 finished transmission, at time $t = 0.33$ms. Assume that the speed of light is 3×10^8 m/s.

(a) Suppose station **B** is silent, and that there is no congestion along the acknowledgement path from **C** to **A**. (The only delay acknowledgements face is the propagation delay to and from the satellite.) Plot the average throughput as a function of window size *W*. What is the minimum window size that **A** should choose to achieve a throughput of 30Mbps? Call this value W^*. With this choice of window size, what is the average packet delay (time from leaving **A** to arriving at **E**)? [10 points]

(b) Suppose now that station **B** also has an unlimited amount of data to send to **E**, and that station **B** and station **A** both use the window size W^*. What throughput would **A** and **B** get for their flows? How much average delay do packets of both flows incur? [5 points]

(c) What average throughput and delays would **A** and **B** get for their flows if **A** and **B** both used window size $0.5W^*$? What would be the average throughput and delay for each flow if **A** used a window size of W^* and **B** used a window size of $0.5W^*$. [5 points]

(d) Imagine you are station **A** and you would like your flow to have a high throughput and low delay. You quantify your preferences with the following utility function: If R_a is the average throughput of your flow in Mbps, and D_a is your average delay in seconds, you want to maximize $J_a (R_a, D_a)$ where

$$J_a(R_a, D_a) = R_a - 3D_a.$$

You have no regard for how well **B**'s flow performs. Station **B**, will either pick a window of W^* or $0.5W^*$, but you won't know which he picks until after you decide your window size. Should you pick W^* or $0.5W^*$ as your window size? [5 points]

(e) Assume that station **B** picked the same window as you did in part (d). What would be the combined value of both of your utilities? The combined utility has the expression:

$$J_a (R_a, D_a) + J_b (R_b, D_b) = R_a + R_b - 3D_a - 3D_b.$$

Now suppose a central planner picked your and your opponent's window sizes. Could the planner achieve a higher combined utility? If so, what value could the planner achieve? [5 points]
(Hint: compare different combinations of window sizes for **A** and **B**: ($0.5W^*$,$0.5W^*$), ($0.5W^*$,W^*), etc.)