COMP/ELEC 429/556 Fall 2017
Homework #2

Assigned 11/16/2017

Due 11/28/2017 11:55pm

Submit Electronically to Canvas

(Hard deadline, no slip day may be used)

This homework is worth 10% of your final grade

IMPORTANT: To be completed by each student individually. See syllabus for policy details. Type set your responses either in the space provided in this document or in a separate document. No hand-written responses will be accepted.

Name: ___________________________

Email: ___________________________

Student ID: ______________________

Notations: K=1,000, M=1,000,000, G=1,000,000,000, 1 byte (B) = 8 bits (b).

Problem 1 (15 points) Given the following intra-domain routing table and inter-domain routing table at a router, construct the final routing table for all destination networks learned. Your final routing table should have three columns: Address Pattern, CIDR Mask, and Next Hop.

Intra-domain routing table

Address Pattern	CIDR Mask	Next Hop
128.42.222.3	255.255.255.0	R1
128.42.128.4	255.255.128.0	R2
18.0.0.0	255.0.0.0	R4
128.42.127.3	255.255.248.0	R6
128.42.216.0	255.255.248.0	R5
128.42.128.4	255.255.0.0	R3

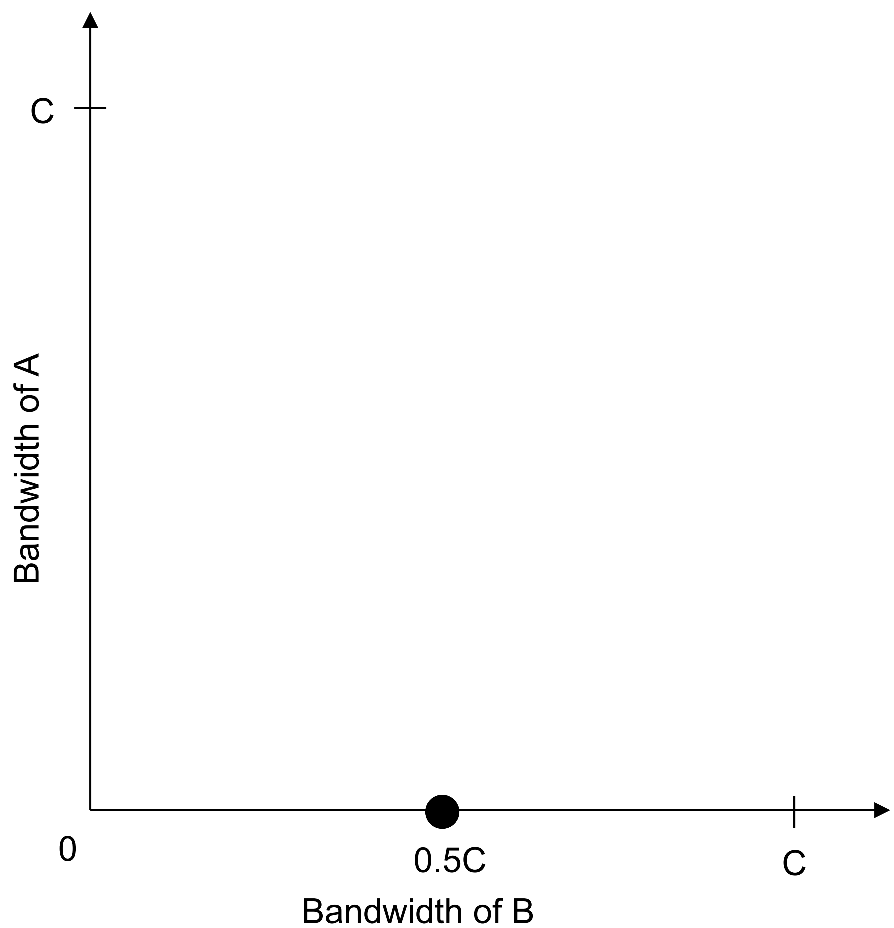
Inter-domain routing table

Address Pattern	CIDR Mask	BGP Next Hop
128.2.111.0	255.255.255.0	128.42.60.1
12.222.128.0	255.255.128.0	18.111.12.1
133.0.0.0	255.0.0.0	128.42.120.32
36.33.88.0	255.255.248.0	128.42.226.4
73.128.222.0	255.255.248.0	128.42.124.45
55.34.0.0	255.255.0.0	128.42.220.121

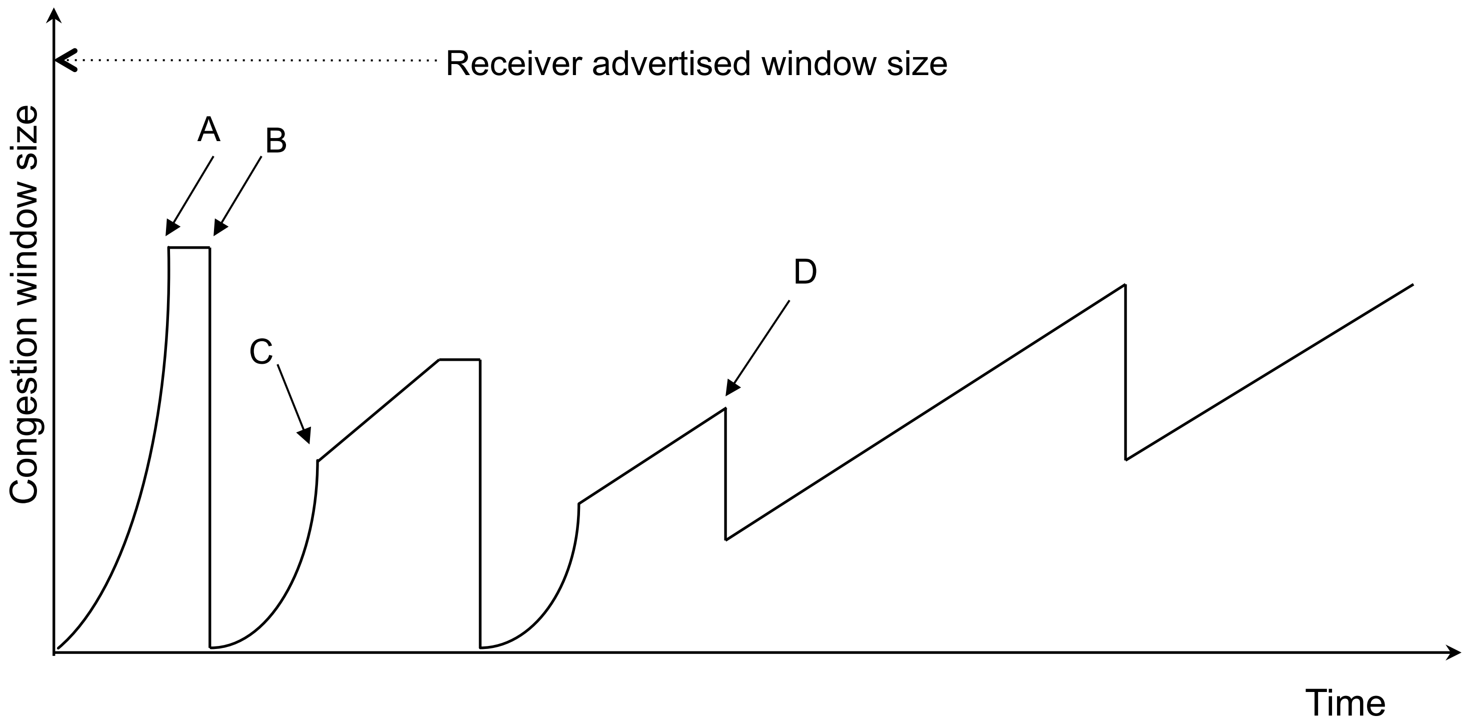
Problem 2 (15 points): Consider the following window based congestion control algorithm:

• When no congestion is detected, the sender's window size cwnd is increased by 5 units every round trip time, i.e. cwnd = cwnd + 5.
• When congestion is detected, the sender's window size is decreased by a third, i.e. cwnd = 2*cwnd/3.

Suppose two traffic flows A and B compete for bandwidth at a bottleneck link with capacity C using the above congestion control algorithm. Assume flow A and B have the same round-trip time. Assume also that initially, B is allocated 50% of the bottleneck bandwidth (i.e. 0.5C) and A is allocated nothing. Complete the following flow bandwidth allocation diagram to show the evolution of the bandwidth allocations for A and B, and use it to argue whether flow A and B will eventually share the bottleneck bandwidth fairly.



Problem 3 (25 points) Below is a graph showing the congestion window size of a TCP Reno connection over time. 4 points have been labeled below from A to D. Explain what happened to the TCP Reno connection at each of the labeled points in the graph to cause the abrupt transition at that labeled point, and explain the corresponding actions taken by TCP Reno.



Problem 4 (20 points): Host A is transferring a file of size L to host B using a TCP connection. Host A sends the file data in fixed size segments (or packets) equal to the Maximum Segment Size (MSS), a predetermined value, which gives the maximum number of data bytes that can be sent in a TCP segment. Host B sends an acknowledgement immediately upon receiving a data segment. Let R be the round trip delay between A and B. The transmission delay to send a data segment is T. Assume R to be larger than 5*T. Assume the transmission delay to send an acknowledgement is negligible. The <u>advertised receiver window size</u> of host B is W. In this problem, we are only concerned with the data transmission phase of TCP. We assume the TCP connection is already established. TCP performs the slow start and congestion avoidance mechanisms accordingly. There is no error or packet loss during transmission.

(a) Given W = 2*MSS, L = 12*MSS, how long does it take for the file to be sent and acknowledged? (15 points)

(b) Given W = 3*MSS, L = 12*MSS, how long does it take for the file to be sent and acknowledged? (5 points)

Problem 5 (25 points): Suppose two flows A and B are arriving at a weighted fair queuing (WFQ) scheduler. For simplicity, the link capacity is 10 bits per second. The two flows have equal weight of 1. The arrival times and packet sizes are shown in the tables below.

Flow A

Packet #	Arrival time (second)	Pkt size (bits)
1	0	5
2	1	5
3	3	10
4	4	5
5	6	5

Flow B

Packet #	Arrival time (second)	Pkt size (bits)
1	0	5
2	0.5	10
3	2	10
4	3	5
5	4	10

(a) Compute the real start time and the real finish time of every packet in the fluid flow system. You may draw a fluid flow system picture to help illustrate your answers. (10 points)

(b) Write down the packet transmission order in the actual packet system. Use the notation “A.1” to denote the first packet of flow A. Explicitly indicate when multiple packets’ transmission order is interchangeable. (5 points)

(c) Recall that the system virtual time V(t) is the number of rounds of service the WFQ scheduler has given at time t. V(0) = 0. One round of service is provided when 1 bit of service is given to every flow that has traffic to send. When a packet of flow A arrives at the system at time t, its virtual start time is either the current system virtual time V(t) or the virtual finish time of the previous packet in flow A, whichever is larger. For this problem, the virtual finish time of a packet is its virtual start time plus the packet's size in bits since flow weights are 1. Compute the virtual start time and the virtual finish time of every packet in the system. (10 points)