ELEC 3120: Computer Communication Networks

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Homework 3
Due: November 22 (Tuesday) 9:00 a.m.
Full marks: 60

Notes:

1) This assignment contains six problems, each with several parts. Answer them as clearly and concisely as possible and show how you obtain the answers. Solely giving the final numerical result without showing the procedure on how it is obtained will lead to a deduction of most of your points in the corresponding problem even if the numerical result is correct.
2) You may discuss ideas with others in the class, but your solutions and presentations must be your own. Do not look at anyone else's solutions or copy them from anywhere.
3) Please upload a scanned copy of your solutions to the Canvas System on the due date. No late submission will be accepted.

P1. (10 pts.) Consider that only a single TCP (Reno) connection uses one 20Mbps link which does not buffer any data. Suppose that this link is the only congested link between the sending and receiving hosts. Assume that the TCP sender has a huge file to send to the receiver, and the receiver's receive buffer is much larger than the congestion window. We also make the following assumptions: each TCP segment size is 1,000 bytes; the two-way propagation delay of this connection is 200 msec; and this TCP connection is always in congestion avoidance phase, that is, ignore slow start.

a. What is the maximum window size (in segments) that this TCP connection can achieve? (3pts.)

b. What is the average window size (in segments) and average throughput (in bps) of this TCP connection? (3pts.)

c. How long would it take or this TCP connection to reach its maximum window again after recovering from a packet loss indicated by 3 duplicate ACKs? (4pts.)

P2. (10 pts.) Recall the macroscopic description of TCP throughput. In the period from when the connection's rate varies from $W/(2*RTT)$ to W/RTT, only one packet is lost (at the very end of the period).

a. (5pts.) Show that the loss rate (fraction of packets lost) is equal to

$$L = \text{loss rate} = \frac{1}{\frac{3}{8}W^2 + \frac{3}{4}W}$$

b. (5pts.) Use the result above to show that if a connection has loss rate L, then its average rate is approximately given by

$$\approx \frac{1.22MSS}{RTT\sqrt{L}}$$

P3. (10 pts.) Consider a datagram network using 8-bit host addresses.

(a) Suppose a router uses longest prefix matching and has the following forwarding table. For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range. (5pts.)

Prefix Match	Interface
10	0
01	1
11	2
Otherwise	3

(b) If we update the forward table as follows. Please repeat (a) to give the associated range of destination host addresses and the number of addresses in the range. (5pts.)

Prefix Match	Interface
101	0
111	1
01	2
Otherwise	3

P4. (10 pts.) Consider sending a 2,400-byte datagram into a link that has an MTU of 260bytes. Suppose the original datagram is stamped with the identification number 21. How many fragments are generated? (5pts.) What are the values in the various fields in the IP datagram(s) generated related to fragmentation? (5pts.)

P5. (10 pts.) (a) Consider a subnet with prefix 192.168.56.64/26. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network. (5pts.) (b) Suppose an ISP owns the block of addresses of the form 192.168.56.128/26. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets? (5pts.)

P6. (10 pts.) Consider the SDN OpenFlow network shown in the following figure. Suppose that the desired forwarding behavior for datagrams arriving at s2 is as follows:

- any datagrams arriving on input port 1 from hosts h5 or h6 that are des-tined to hosts h1 or h2 should be forwarded over output port 2; (2pts.)
- any datagrams arriving on input port 2 from hosts h1 or h2 that are des-tined to hosts h5 or h6 should be forwarded over output port 1; (2pts.)
- any arriving datagrams on input ports 1 or 2 and destined to hosts h3 or h4 should be delivered to the host specified; (3pts.)
- hosts h3 and h4 should be able to send datagrams to each other. (3pts.)

Specify the flow table entries in s2 that implement this forwarding behavior.