Networks and Distributed Systems	**Homework 7: Time**
CS3700 Spring 2015	**March 22, 2015**

This homework is due at the beginning of class on April 1, 2015 and is worth 1.5% of your grade.

Name: _____

CCIS Username: _____

Problem	**Possible**	**Score**
1	20	
2	20	
3	30	
Total	70	

1. At 13:47:54.102 (hr:min:sec) local time, server *B* requests the time from *A*. At 13:47:54.802 local time, server *B* receives a reply from timeserver A with the timestamp of 13:47:53.752.

1a. What is the drift of *B*'s clock with respect to *A*'s clock (assume there is no processing time at the *B* to reply to the message). (10 pts)

1b. Assume that *A* and *B*'s clocks were equal at some time in the past. Is *B*'s clock going too fast or too slow, relative to *A*'s clock? (5 pts)

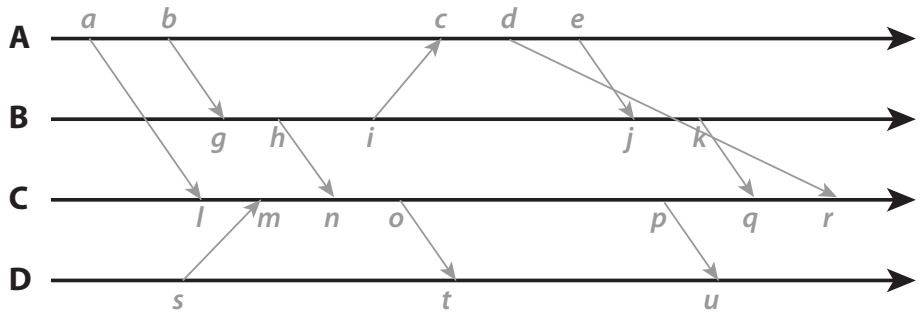
1c. At a high level, how should *B* adjust its clock to eventually come back in sync with *A*'s clock? (5 pts)

2. Recall our discussion of how Network Time Protocol (NTP) works in class. Let's assume that NTP uses Cristian's method for clock updates.

2a. Suppose that you are running NTP over a network where you were guaranteed that the one-way delay between any two hosts was identical (i.e., there are no asymmetric delays in the network) and that the processing time for NTP messages was 0. In this case, how accurate would NTP be? Justify your answer. (10 pts)

2b. Suppose instead that you are running NTP over a network where you know the delay $A \rightarrow B$ was $3\times$ longer than the delay $B \rightarrow A$. When A would attempt to synchronize its clock using B as a NTP server, how should A update it's clock for the highest accuracy? (10 pts)

3. Consider the timeline below with four nodes *A*, *B*, *C*, and *D*.



3a. List the Lamport timestamps for each event shown in the timeline. Assume that each process maintains a logical clock as a single integer value starting at 1 as a Lamport clock. Provide timestamps for each labeled event *a*..*u* in the table below. (10 pts)

Event	Lamport ts	Event	Lamport ts	Event	Lamport ts	Event	Lamport ts
a		b		c		d	
e		g		h		i	
j		k		l		m	
n		o		p		q	
r		s		t		u	

3b. List the Vector timestamps for each event shown in the timeline in the table below. (10 pts)

Event	Vector ts	Event	Vector ts	Event	Vector ts	Event	Vector ts
a		b		c		d	
e		g		h		i	
j		k		l		m	
n		o		p		q	
r		s		t		u	

3c. Recall that we can detect a causality violation using vector timestamps by comparing the timestamp of a newly received message to the local time. If the message's timestamp is less than the local time vector, a (potential) causality violation has occurred. In this timeline, did any causality violations occur? If so, which event(s) do these correspond to? (10 pts)