CSCI/ECEN 5673: Distributed Systems
Spring 2017
Homework 1
Due Date: 02/07/2017

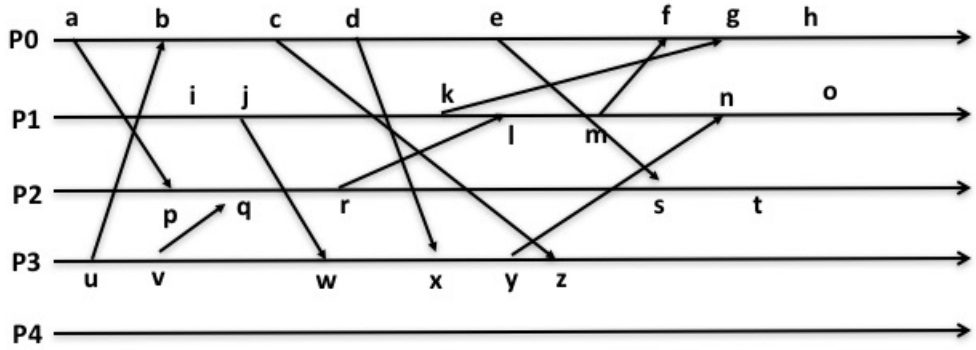
Please submit a hardcopy of your answers in class on Tuesday, February 07, 2017. Write your answers in the space provided. Please DO NOT use any extra space. The space provided is sufficient for answering the questions.

Topics covered: Limitations of distributed systems, happened-before relation, logical clocks and vector clocks.
Lecture Sets: zero and one.

Honor Code Pledge: On my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this work.

Name:

1. Consider the following figure that shows five processes ***(P0, P1, P2, P3, P4)*** with events ***a, b, c,*** ... and messages communicating between them. Assume that initial logical clock values are all initialized to ***0***.



a) **[20 Points]** Provide logical clock (C) values of each event shown.

b) **[20 Points]** Provide vector clock (V) values of each event shown.

c) **[10 Points]** Identify two events *ai* and *aj* to show that C(*ai*) < C(*aj*) does not necessarily imply *ai* → *aj*.

d) **[10 Points]** Assuming P0 < P1 < P2 < P3 < P4, provide the total ordering of all events constructed from the logical clock C. Is this total order unique?

e) **[10 Points]** Suppose process P4 sends a message m (send event is *aa* and the corresponding receive event is *bb*). Show how *aa* → *z*, *aa* → *t,* and *aa* and *b* are concurrent. Identify an event a_i ($a_i \neq aa$) such that a_i → *bb*.

2. **[30 Points]** Browse the NTP project webpage (*http://www.ntp.org*). Explain how NTP computes filter dispersion.