CS 425 Distributed Systems, Fall 2007
University of Illinois at Urbana-Champaign
Solutions to Homework 1

Problem 1: If the channel is symmetric, then $t = t'$, $o = o_i + (t' - t)/2 \rightarrow o = o_i$, $o = o_i = (T_{i-2} - T_{i-3} + T_{i-1} - T_i)/2$.

Problem 2: $e_1^2 || e_2^0$, $e_1^2 || e_2^1$, $e_1^2 || e_2^2$.

Problem 3: The largest clock skew is C-A = -4ms. The worst case happens when this clock skew increases, i.e., it becomes more and more negative. Since 2*MDR = 4 ms/min, the minimum synchronization interval is $|-30-(-4)|/4 = 6.5$ minutes.

Problem 4:

- $P_1 =< 0,0,0,0 >, < 1,0,0,0 >, < 2,0,0,0 >, < 3,0,2,2 >, < 4,0,2,2 >$
- $P_2 =< 0,0,0,0 >, < 1,1,0,0 >, < 1,2,0,0 >$
- $P_3 =< 0,0,0,0 >, < 2,0,1,0 >, < 2,0,2,0 >, < 2,2,3,0 >, < 4,2,4,2 >, < 4,2,5,3 >$
- $P_4 =< 0,0,0,0 >, < 2,0,2,1 >, < 2,0,2,2 >, < 2,0,2,3 >$

Problem 5: All reasonable answers are acceptable. Here is one example of a pathological setting. Web servers are stateless, but suppose the web server is talking to a back-end database, and handling airline reservations for customers. Then, the cancellation of a customer's reservation may have a lower timestamp than the reservation itself! (Thus, the backend server would be in an inconsistent state because of the webserver's reversed clock value.)

Problem 6: All reasonable answers are acceptable. Here are two examples:

Liveness: You will get to the destination you are walking to. Traffic lights will eventually show the "Walk Sign".

Safety: No car will hit you. The pedestrian walk lines will not disappear and become invisible.

Problem 7: If the FIFO assumption is violated, then a message m in transit may jump ahead of a marker M in transit (on some communication channel). Thus the message m send will not be a part of the derived global snapshot/cut, but the receipt of message m will be a part of the cut. This would make the derived cut/global snapshot be inconsistent.

In the proof on slide 3-18, e_j may be in the cut, but if the marker jumped ahead (due to violation of FIFO), then e_i may not be in the cut.

Problem 8:

1. $< b, 0, 0 >$
2. $< b, 0, e >$

3. $< b, c, 0 >$
4. $< b, c, e >$
5. $< b, d, 0 >$
6. $< b, d, e >$
7. $< b, d, f >$