Quiz 1: Time, Ordering and Global States

Solutions

1. Consider a hardware clock $H(t)$ with a maximum drift rate of 0.3 seconds/second. Assume the clock is used to measure the time interval between $t = 10 : 50 : 00$ and $t' = 10 : 50 : 50$. What are the minimum and maximum values that can be obtained for the given time interval when measured using $H(T)$?

(a) minimum = 0.5 seconds, maximum = 1.5 seconds

(b) minimum = 25 seconds, maximum = 75 seconds

(c) They can't be determined, the roundtrip time needs to be known to estimate these values

(d) minimum = 35 seconds, maximum = 65 seconds

2. Consider two asynchronous distributed systems AS_1 and AS_2. Cristian's algorithm is used in both systems to synchronize clocks. In AS_1, the minimum transmission delay T_{min} is estimated to be 0.3 seconds and process p_1 records a round trip time T_{round} of 1.6 seconds. In AS_2, T_{min} is estimated to be 1.2 seconds and p_2 records a round trip time of 2.8 seconds. Which process can achieve a higher accuracy? Explain your answer.

3. In the Berkely algorithm for clock synchronization, the master sends the amount by which each clock requires adjustment, as opposed to the current timestamp of the estimated average clock. This is done to:

(a) Ensure the monotonicity condition is preserved

(b) Avoid introducing further uncertainty due to message transmission delays

(c) Reduce the amount of bandwidth used by sending smaller messages

(d) Reduce the number of computations made by slaves when updating their clocks

4. Give an example where a and b are concurrent events, yet the Lamport timestamp of a is smaller than the Lamport timestamp of b, that is, $L(a) < L(b)$.

5. What shortcoming of Lamport clocks do Vector clocks overcome?

6. Which set of events is concurrent?

(a) $[1, 2, 3], [3, 2, 4]$

(b) $[1, 0, 3], [2, 1, 1]$

(c) $[1, 1, 1], [2, 2, 2]$

(d) $[1, 1, 1], [1, 1, 1]$

7. Consider the figure below showing three processes P_1, P_2, P_3.
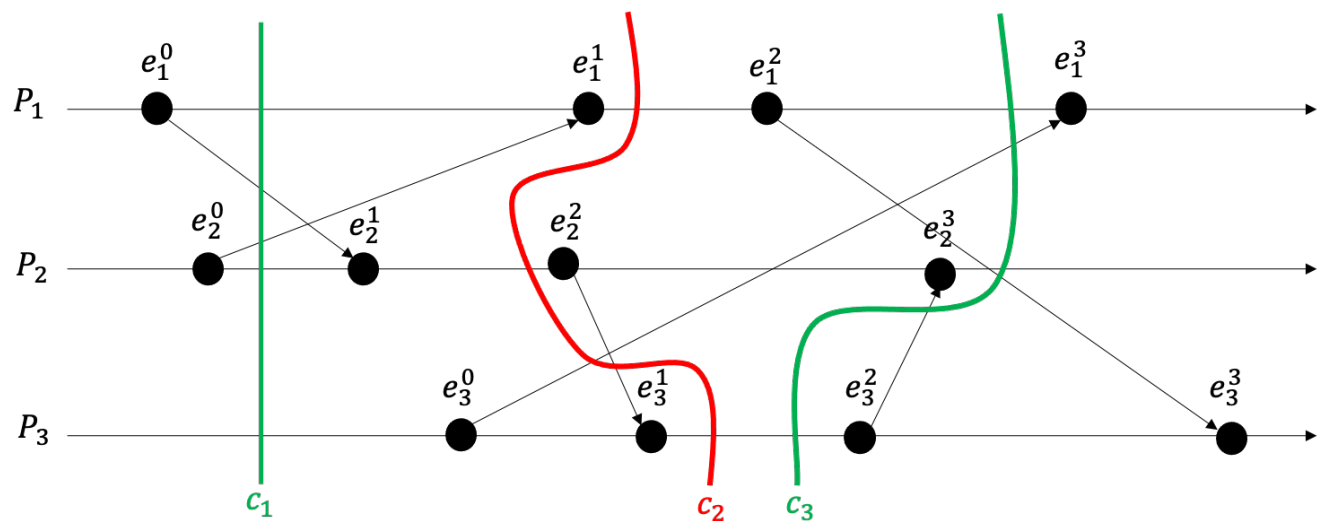
7.1 Give an example of a run that is not a linearization. Explain your answer.

7.2 Is the cut, shown by curve c_2 (red), a consistent cut? Explain your answer.

7.3 Is the state associated with c_3 (green) reachable from the state associated with c_1 (green)? Explain your answer.

8. With an example, show that the Chandy-Lamport algorithm will not record a consistent global state if channels are not FIFO.