

## Assignment 6

Groups of 2. Send your answers to [pitoura@cs.uoi.gr](mailto:pitoura@cs.uoi.gr) no later than Monday 19/5

### Clocks, Logical Clocks, Global State

1. A clock is reading 10:27:54.0 (hr:min:sec) when it is discovered to be 4 sec fast. Explain why it is undesirable to set it back to the right time at that point and show (numerically) how it should be adjusted so as to be correct after 8 secs have elapsed
2. A client attempts to synchronize with a time server. It records the round trip times and timestamps returned by the server in the table below.

Round-trip (ms)	Time (hr:min:sec)
22	10:54:23.674
25	10:54:25.450
20	10:54:28.342

Which of these times should it use to set its clock? To what time should it set it? Estimate the accuracy of the setting with respect to the server's clock. If it is known that the time between sending and receiving a message in this system is at least 8ms, do your answers change

3. By observing a chain of zero or more messages connecting events  $e$  and  $e'$  and using induction, show that  $e \rightarrow e' \Rightarrow L(e) \leq L(e')$
4.
  - (a) Show that  $V_i[j] \leq V_i[i]$
  - (b) Using (a), show that if events  $e$  and  $e'$  are concurrent then neither  $V(e) \leq V(e')$  nor  $V(e') \leq V(e)$ . Hence show that if  $V(e) < V(e')$  then  $e \rightarrow e'$ .

5. Problem 4 from the textbook

### Election and Mutual Exclusion

6. Problem 7 from the textbook

7. Give a formula for the maximum throughput of a mutual exclusion system in terms of the synchronization delay.

### Distributed Transactions

8. Extend the definition of two-phase locking to apply to distributed transactions. Explain how this is ensured by distributed transactions using two-phase locking locally.