THE UNIVERSITY OF SYDNEY

COMP3221 Lab 5

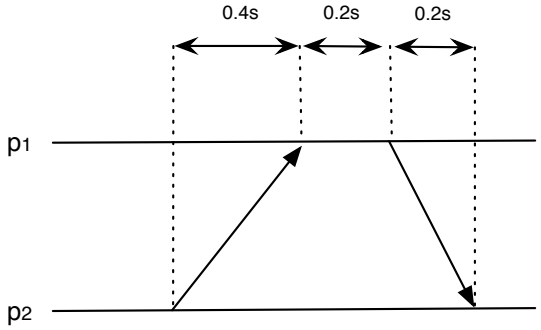
Physical and Logical Time

The goal of this lab is to synchronise distributed processes using Cristian's algorithm at the heart of NTP and to order distributed events using vector and logical clocks.

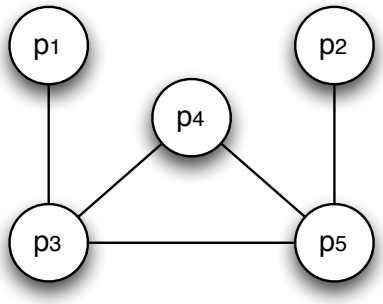
Exercise 1: Physical clocks

Cristian's algorithm. Let process p_2 try to synchronise with process p_1 by running Cristian's algorithm. Assume that both clocks increase at the same rate and that initially (at time T_1 when the query message is sent) the clock of p_1 is $C_{p_1}^{T_1} = 5h9mn29s950ms$ while the clock of p_2 is $C_{p_2}^{T_1} = 5h9mn30s300ms$, i.e., a difference of $350ms$. Consider the example depicted in Figure 1(a) where the query message takes 0.4s to be delivered while the response takes 0.2s and where 0.2s elapse between p_1 receiving the query and sending the response.

What is the value of Δ_{p_1}, the offset of p_1 relative to p_2? If it takes $0.1s$ for p_2 to unmarshal the response message, what will be the new clock value of p_2 at the time it adjusts it? What is the resulting time difference between the two clocks in the end? Why?



(a) Process p_2 tries to synchronise with p_1 with the Cristian's algorithm.



(b) Clock synchronisation using NTP, only process p_5 synchronises using an atomic clock.

Figure 1: Clock synchronisation in a distributed system

NTP. Consider the communication graph of Figure 1(b) where two nodes can communicate only if they are neighbours in the graph. Represent the strata of the NTP protocol if p_5 is the only process to synchronise itself using an atomic clock.

Duration: 20 min

Exercise 2: Vector clocks

Consider the distributed execution represented in Figure 2. Indicate the vector clock associated with each event.

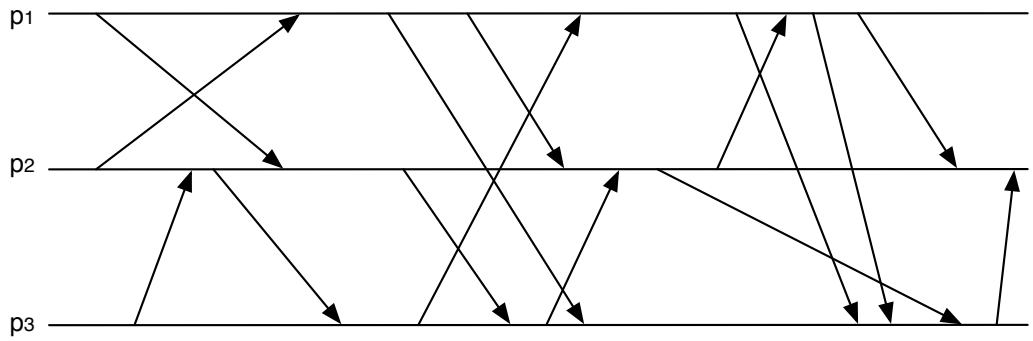


Figure 2: Ordering events of a distributed execution

Duration: 10 min

Exercise 3: Totally ordered broadcast

Consider the distributed execution of the totally ordered broadcast protocol among 4 processes as depicted in Figure 3. Four messages, denoted by A, B, C, and D are broadcast to the 4 processes (whatever the senders are). A circle indicates the reception of the corresponding message. A square indicates the reception of the final timestamp of the corresponding message. Initially, the four sites have logical clock, 4, 5, 7, 6 starting from top to bottom. Indicate

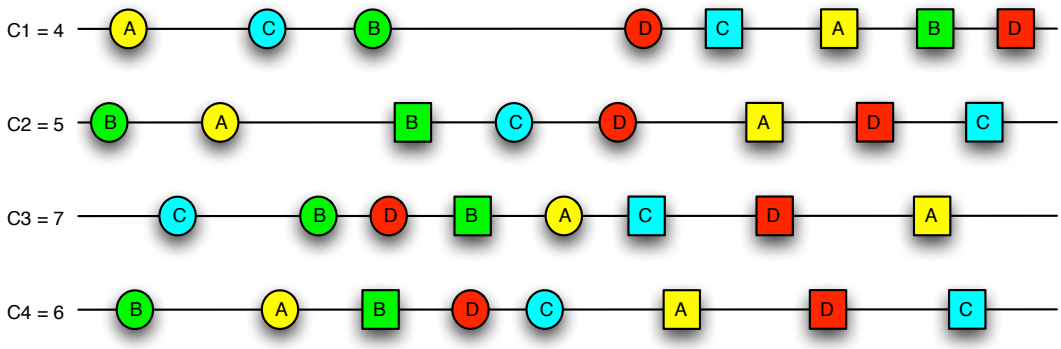


Figure 3: The total order broadcast of four messages, A, B, C, D on four processes

on the figure the logical clock values of each site at each event. What is the obtained total order of the message deliveries?

Duration: 20 min