The University of Melbourne
School of Computing and Information Systems
COMP90020 Distributed Algorithms

Tutorial Week 3: Logical Clocks

Notes

Clock Condition. For all events a, b: if $a \rightarrow b$ then $C(a) < C(B)$. This is satisfied if the following two conditions hold:

- $C1$. If a and b are events in process p_i and a comes before b, then $C_i(a) < C_i(b)$
- $C2$. If a is the sending of a message by process P_i and b is the receipt of that message by process P_j, then $C_i(a) < C_j(b)$

Exercises

10. This question is from last weeks tutorial, please attempt if you haven't already. An NTP server B receives server A's message at 16:34:23.480 bearing a timestamp 16:34:13.430 and replies to it. A receives the message at 16:34:15.725, bearing B's timestamp 16:34:25.7. Estimate the offset between B and A and the accuracy of the estimate.

11. Consider the following sequence of events at processes p_0, p_1, p_2 and p_3. Here s_i and r_i are corresponding send and receive events for all i, while a and b are internal events.

$$
\begin{array}{lllllll}
p_0: & s_1 & s_2 & r_5 & & & \\
p_1: & r_2 & s_5 & & & & \\
p_2: & r_1 & a & s_4 & r_3 & r_6 & \\
p_3: & s_3 & r_4 & b & s_6 & &
\end{array}
$$

Use Lamport's logical clock to assign clock values to these events (A diagram may help).

12. By considering a chain of zero or more messages connecting events e and e' and using induction, show that $e \rightarrow e' \Rightarrow L(e) < L(e')$

13. Using the same sequence of events from exercise *10*, draw a send/receive diagram to give Vector timestamps to each of the events.

14. Show that:

(a) $V_j[i] \leq V_i[i]$ for all i, j

(b) $e \rightarrow e' \Rightarrow V[e] < V[e']$

(c) $V(e) < V(e') \Rightarrow e \rightarrow e'$