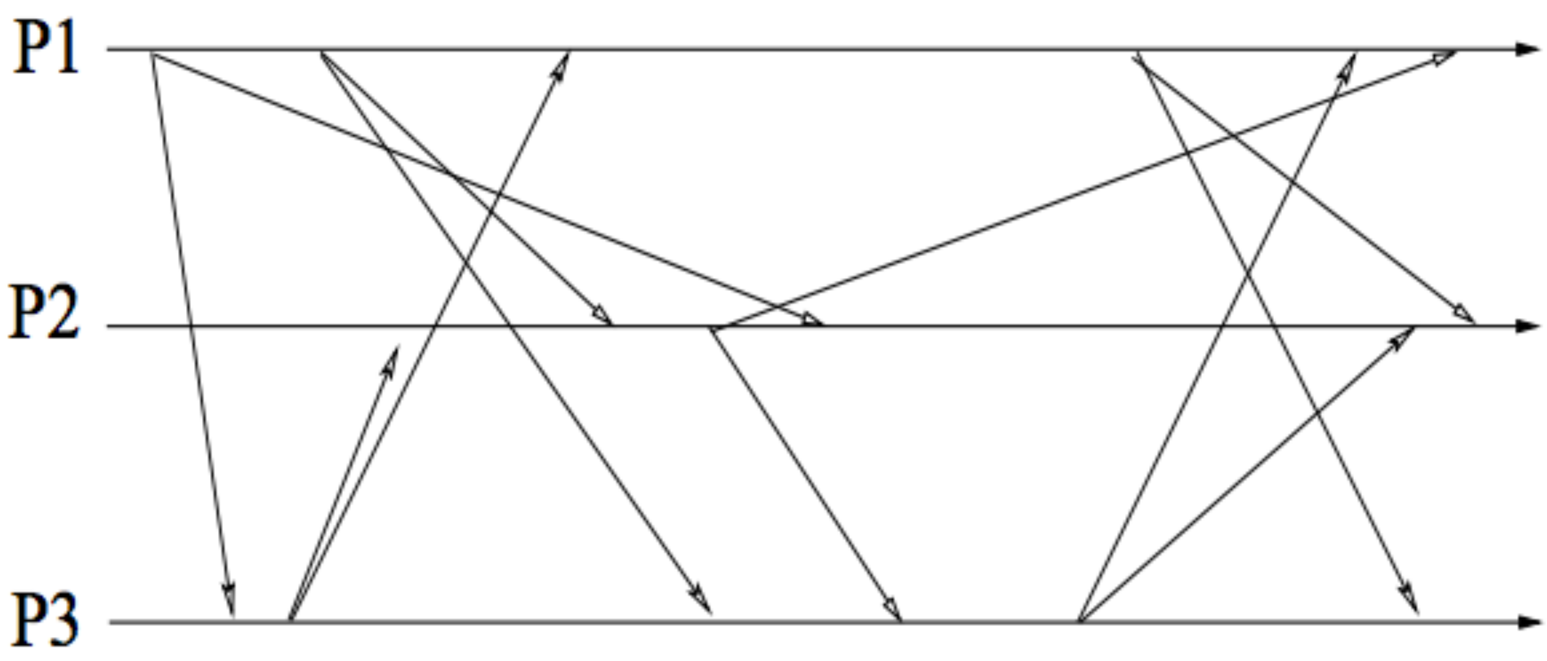
CSE 486/586 Non-Graded Practice Problem Set 1

Acknowledgement: This problem set heavily contains the material developed and copyrighted by Prof. Indranil Gupta at Illinois.

1. Can we design a complete and accurate failure detector? Why or why not?
2. Calibrations on a recent version of the Linux operating system showed that on the client side, there is a delay of at least 1.3 ms for a packet to get from an application to the network interface, and a similar minimum delay for the opposite path (network interface to application buffer). The corresponding minimum delays for the server are 0.15 ms and 0.35 ms respectively. What would be the accuracy of a run of the Cristian's algorithm between a client and server, both running this version of Linux, if the round trip time measured at the client is 5 ms?
3. Problem 14.2 from the textbook.
4. Problem 14.7 from the textbook.
5. Problem 14.15 from the textbook.
6. In the figure below, if all processes start with sequence numbers or vector timestamps (as applicable) containing all zeroes, for each of the following algorithms, mark the timestamps at the point of each multicast send and each multicast receipt. Also mark multicast receipts that are buffered, along with the points at which they are delivered to the application.
    a. FIFO ordering algorithm discussed in class
    b. Causal ordering algorithm discussed in class



7. Consider messages C1 ~ C3 in Figure 15.11 of the textbook. Suppose that the boxes indicate multicast message receipt events, not delivery events. How would you deliver the messages for each process in order to preserve,
    a. Total ordering?
    b. FIFO ordering?
    c. Causal ordering?
    d. Total and causal ordering?
8. Problem 15.20 from the textbook.
9. Explain why the impossibility of consensus proof (proofs of Lemmas 2 and 3 in the FLP paper) would break if the system were synchronous. Specifically, give at least one statement in the proof that may not hold in a synchronous system.
10. Problem 15.4 from the textbook.

11. In a group of 10 processes using the Ricart and Agrawala's algorithm for mutual exclusion, all the 10 processes simultaneously (in physical time) generate a request to enter the same critical section. What is the worst-case number of messages that the algorithm might transmit? (Calculate this number after everyone has exited their critical section.) You can assume that each process generates only one request for the critical section.

12. You are given a problem called 2-Leader Election that has the following Safety and Liveness requirements:

> Safety: For each non-faulty process p, p's elected = a set of two processes, OR = NULL.
>
> Liveness: For all runs of election, the run terminates AND for each non-faulty process p, p's elected is not NULL.

Modify the Bully Algorithm described in lecture to create a solution to the 2-Leader Election problem. You may make the same assumptions as the Bully Algorithm, e.g., synchronous network. Briefly discuss why your algorithm satisfies the above Safety and Liveness, even when there are failures during the algorithm's execution.