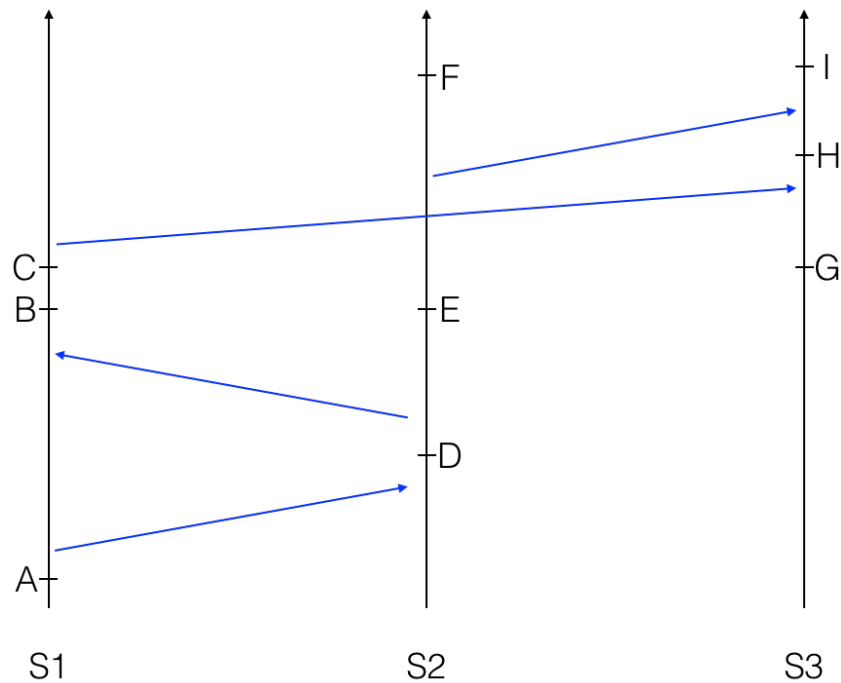


## CSE 452/M552 Problem Set 1

Due: Wednesday April 18, 9pm



### Problem 1: Happens Before

Above is a space-time diagram. For event C, list the labeled events (A-I) that “happen before” event C, those labeled events (A-I) where C “happens before” the event, and those (A-I) that are concurrent with C.

### Problem 2: Lamport Clocks

Assume that the labeled events (plus message sends and receives) are the only events, all clocks start at 0, clocks are incremented before assigning a timestamp to an event, and clocks are incremented when both sending and receiving messages. Assign every event its Lamport clock timestamp. Hint: Event A has timestamp 1 and D has timestamp 4.

### Problem 3: Vector Clocks

Using the same events and assumptions, label every event with its Vector Clock value.

## Problem 4: Primary Backup

In class, we suggested your solution to Lab 2 should obey certain constraints. In a sentence, explain why the constraint is needed, that is, why a violation of the constraint would cause a problem.

- a) State transfer from primary to backup must include data on which RPC calls have received replies, and what the response was.
- b) The backup must accept a request forwarded by the primary iff the request and the backup have the same notion of the current view.
- c) The backup may accept a request forwarded by the primary even though both the request and the backup are in an old view that has since been changed by the view server.
- d) On a read request (that has not been previously served), the primary must wait for the backup to accept the request before the primary can reply to the client with the data.

## Problem 5: Virtual Machine Primary Backup

For the VMware virtual machine primary backup system we discussed in class, answer in a sentence:

- a) What happens if the primary fails after receiving network input but before sending its log entry to backup?
- b) Why can the same output be produced by both the primary and backup?