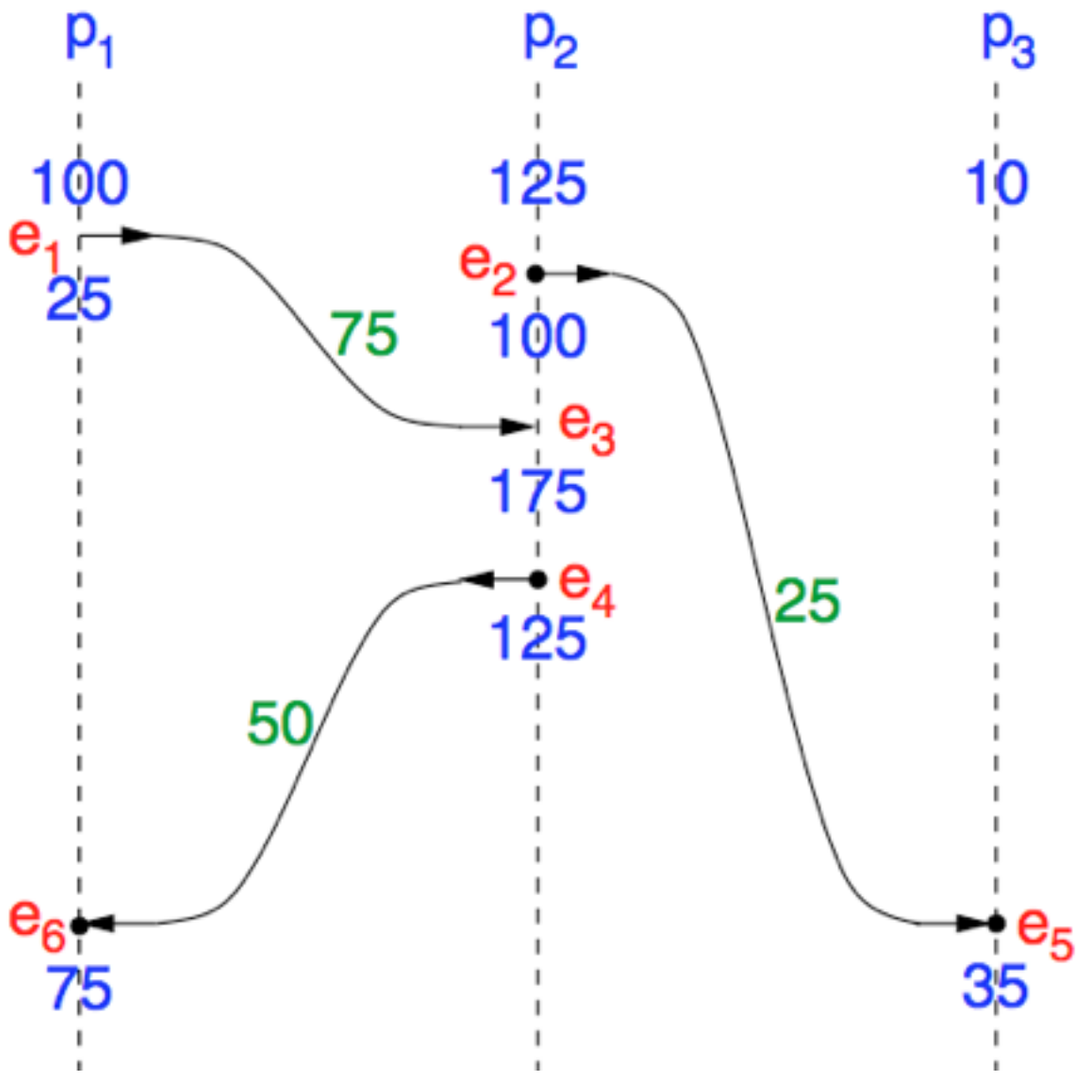
Exercise 1

- Suppose Chandy and Lamport's distributed snapshot algorithm is initiated by process p_1 just after event e_1 in the following computation.



- Sketch how markers would be exchanged during the execution of the algorithm in this case.
- Which events are included in the set H?
- Which state components are noted down in the various processes, as the execution of the algorithm proceeds?
- Which global state S^* is discovered by the algorithm in this case?

Exercise 2

- Two processes *p* and *q* are connected in a ring using two channels, and they constantly rotate a message *m*.
- At any one time, there is only one copy of *m* in the system.
- Each process's state consists of the number of times it has received *m*.
- *p* sends *m* first.
- At a certain point, *p* has the message and its state is 101.
- Immediately after sending *m*, *p* initiates the snapshot algorithm.

  Explain the operation of the algorithm in this case, giving the possible global state(s) reported by it.

Exercise 3

- A **run** of a distributed computation is a **total ordering R of its events** that corresponds to an **actual execution**
- An **observation** is a **total ordering Ω of events** constructed from within the system
- A **single run may have many observations**
- An **observation** can correspond to:
  - A consistent run
  - A run which is not consistent
  - No run at all

  Homework: can you find example of the three cases? Can you explain why this happens?

Exercise 4

- We use the passive approach in which processes send notifications of events relevant to Φ to the monitor p_0

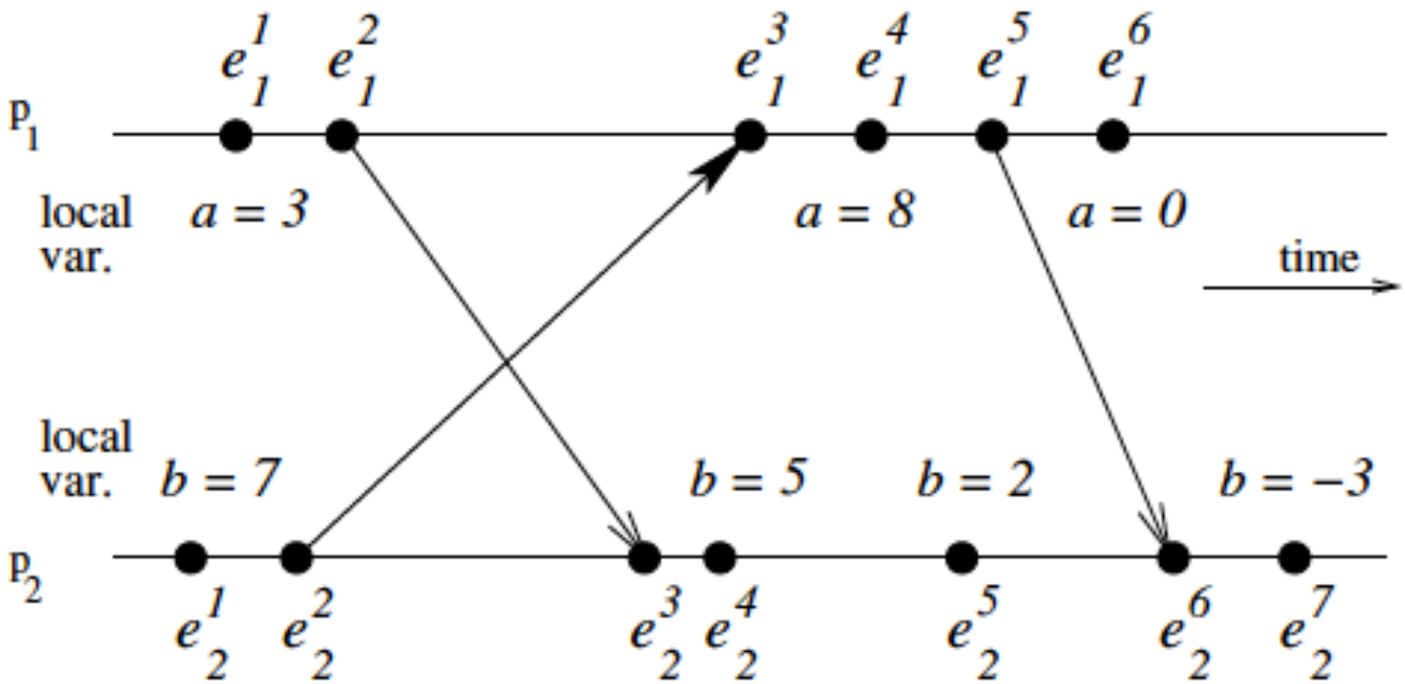
- Events are tagged with vector clocks

- The monitor collects all the events and builds the lattice of global states

- **HOMEWORK:** HOW?

Exercise 5

- Given the following computation, construct the lattice of global states.



- Check if **Definitely(a + b = 10)** and **Possibly(a + b = 5)** are **true** or **false**

- In case of **true**, indicate all the global states in which the property holds

Exercise 6

- From exam in 2014:

State whether each of the following is *True* or *False* (the symbol "¬" is the well known negation operator, also called logical complement). In case of *False*, justify your answers (for instance, by means of a counterexample).

a) $Possibly(\phi) \Longrightarrow \neg Definitely(\phi)$

b) $Possibly(\phi) \Longrightarrow Definitely(\phi)$

c) $Possibly(\phi) \Longrightarrow Definitely(\neg\phi)$

d) $Possibly(\phi) \Longrightarrow \neg Definitely(\neg\phi)$

e) $Definitely(\phi) \Longrightarrow Possibly(\phi)$

f) $Definitely(\phi) \Longrightarrow Possibly(\neg\phi)$

g) $Definitely(\phi) \Longrightarrow \neg Possibly(\phi)$

h) $Definitely(\phi) \Longrightarrow \neg Possibly(\neg\phi)$