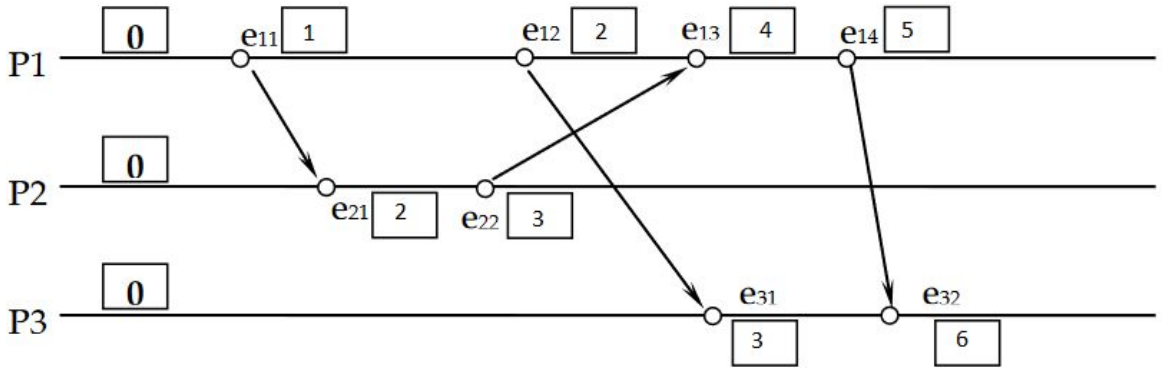
1. **In the group, analyze the Lamport protocol. Can it distinguish *in all cases* causality relationships from others that are not? Use an example developed by yourself to answer this question.**

No, Lamport protocol does not distinguish in all cases causality relationships from others that are not. The values of the marks associated with the events do not fully express the order relation between the events.

This issue is that if Ci(x) < Cj(y) then it does not imply necessarily that x → y .



In this example we can check that C(e31) < C(e13) given that i 3 < 4 but we know at the same time that they are concurrent thus proving that the implication sometimes is not true.

However, when we find two events with the same mark we can affirm that the two events are concurrent.

2. **We have verified that the Lamport protocol, which is simple and efficient, is not very accurate. Discuss in the group what additional information the protocol should include to cover its deficiencies.**

Vector clocks protocol will allow, added to Lamport protocol's idea, to distinguish the causality relationships between events. The vector clocks will indicate the number of events that have occurred in the rest of processes, and this way being able to make causality relationships in any case.

3. **We will collect the ideas to develop a new protocol, more precise than that of Lamport. See the Notes of Topic 2 (Section 2.3.3). To check if the new protocol resolves situations in which the basic protocol was ambiguous, we will define a partial order relationship between the vector clocks.**

Vector clock's protocol establishes that in each process, Pi, there is a vector with N elements (where N is the number of processes there are), in which each element will indicate the local logical clock value of that process. With this mechanism, the vector will have the last logical clock value known, which is updated each time it communicates with that process.

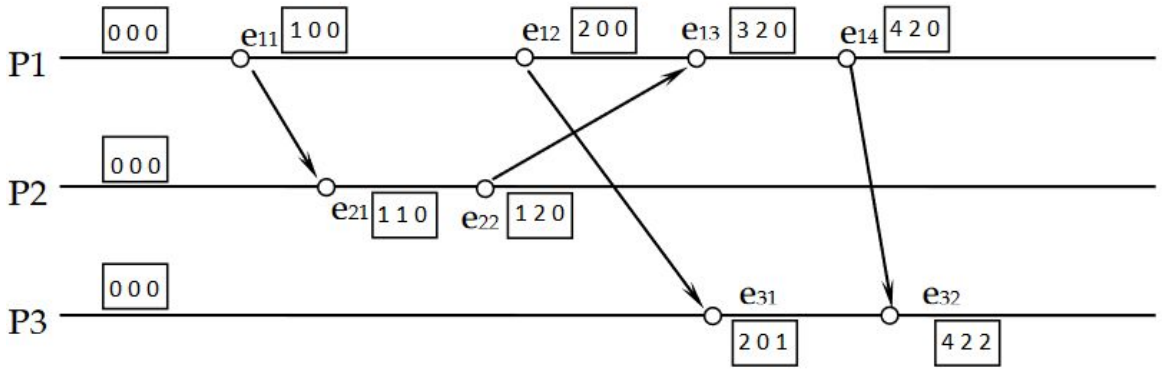
The algorithm is easy, it initializes the vector of each process with 0s.

Next, each event that occurs in the process, increases the value of the local process by 1.

Each time a process communicates with another process, apart from the message it is sending, it will also send a copy of its vector. The receiver will compare each value of the vector, saving always the maximum value of it.

4. **Write a brief report that demonstrates, on the example you had chosen, why the new protocol is capable of resolving situations that the basic Lamport protocol did not solve.**

The new protocol uses a vector clock with the values of the various processes in each column.



In our case we use the vector clocks to ascertain whether an event is causally related because of the nature of the updating of the values of each process, something we couldn't do before