Telecooperation Lab
Prof. Dr. Max Mühlhäuser

Telekooperation 1: Exercise WS15/16

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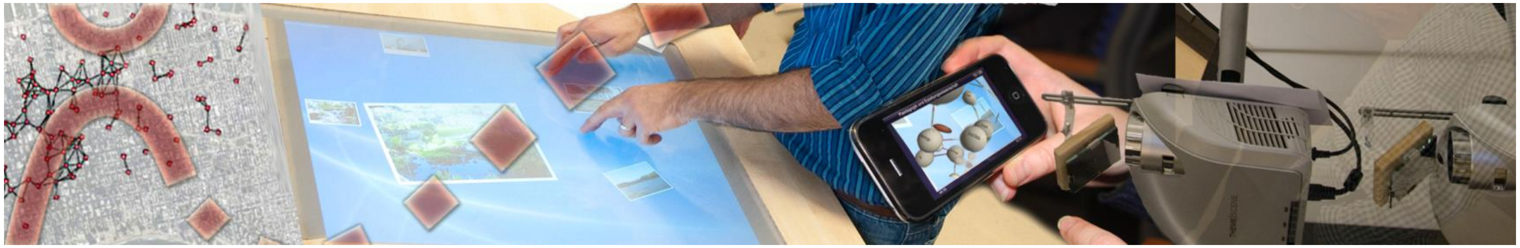
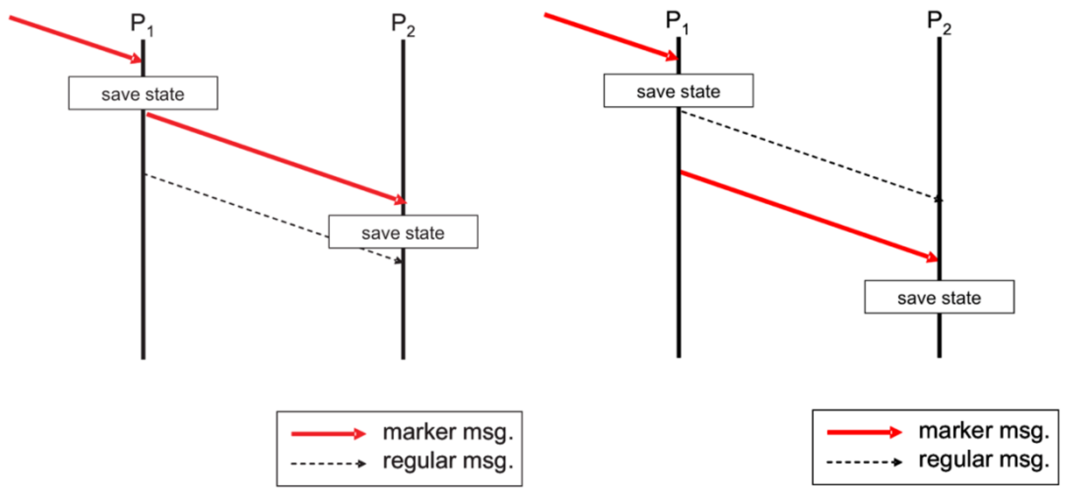


TK1 – EXERCISE
4.2.2016

- Solution 9th Exercise
- 10th (and last) Theory Exercise

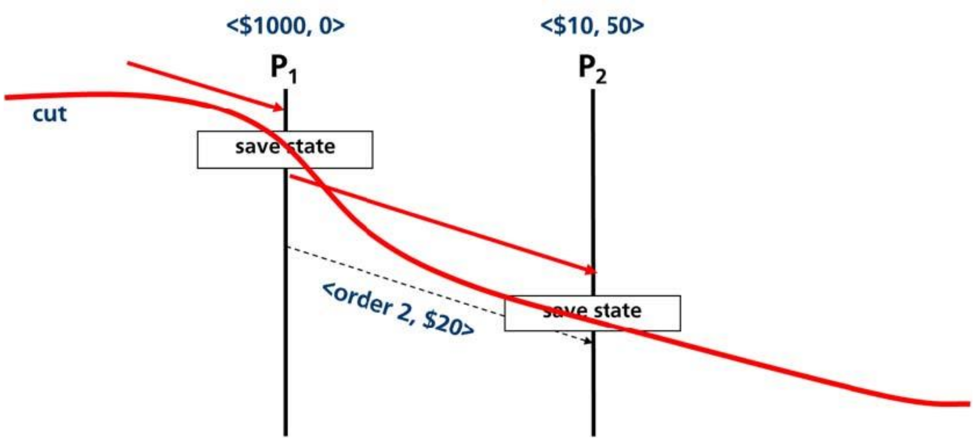
Task 1 a)

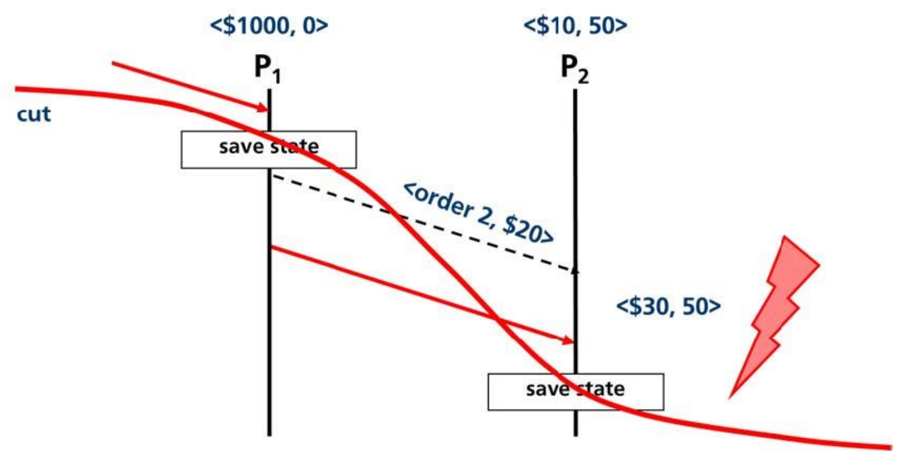


Figures 1.I and 1.II both show two processes P1 and P2, whose common state will be determined by using the 'snapshot'-algorithm by Chandy and Lamport. For this, the marker messages and the save state actions are illustrated in figure 1. Which illustration (i.e. 1.I or 1.II) is correct? Explain your decision and give examples for both figures (one example per figure). The examples should show that the recorded state reflects a consistent or inconsistent recorded state, respectively.

Task 1 a)

- Consider an online order of two items with a total of $20





P1: <$1000, 0> C1: < >
P2: <$10, 50> C2: < >

→ Consistent global state

P1: <$1000, 0> C1: < >
P2: <$30, 50> C2: < >

→ Inconsistent global state

Task 1 b)

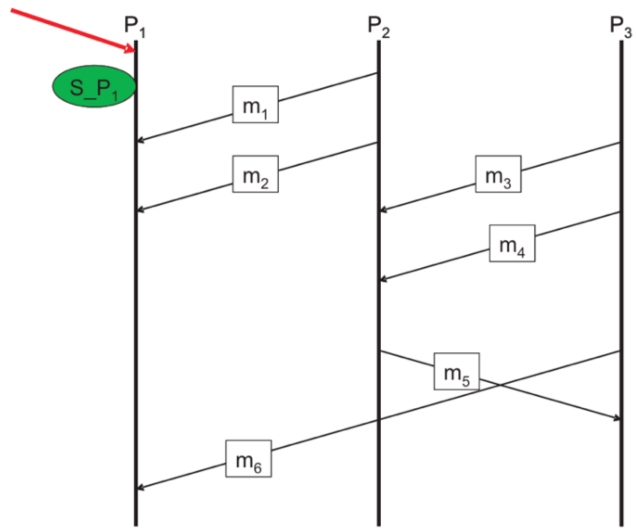
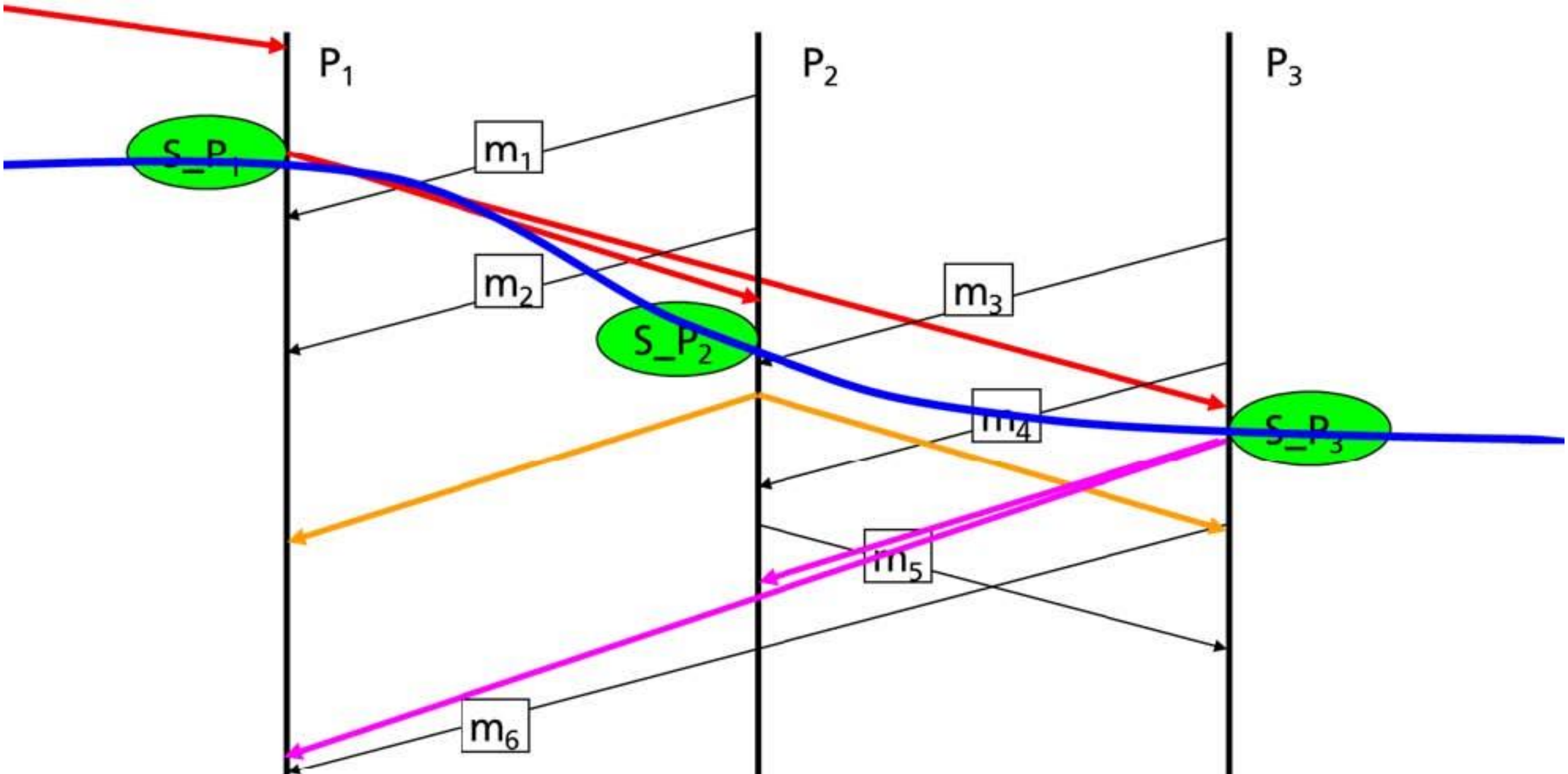


Figure 2 shows the processes P1, P2 and P3, and the messages m1, m2, …, m6. Process P1 receives a marker message and records its state in S_P1. Specify two possible recorded states, which might exist upon termination of the algorithm. For both states, sketch the recorded marker messages, as well as the states S_P2 and S_P3. A communication channel from process Pi to process Pj is to be designates as C(Pi, Pj).

Task 1 b)

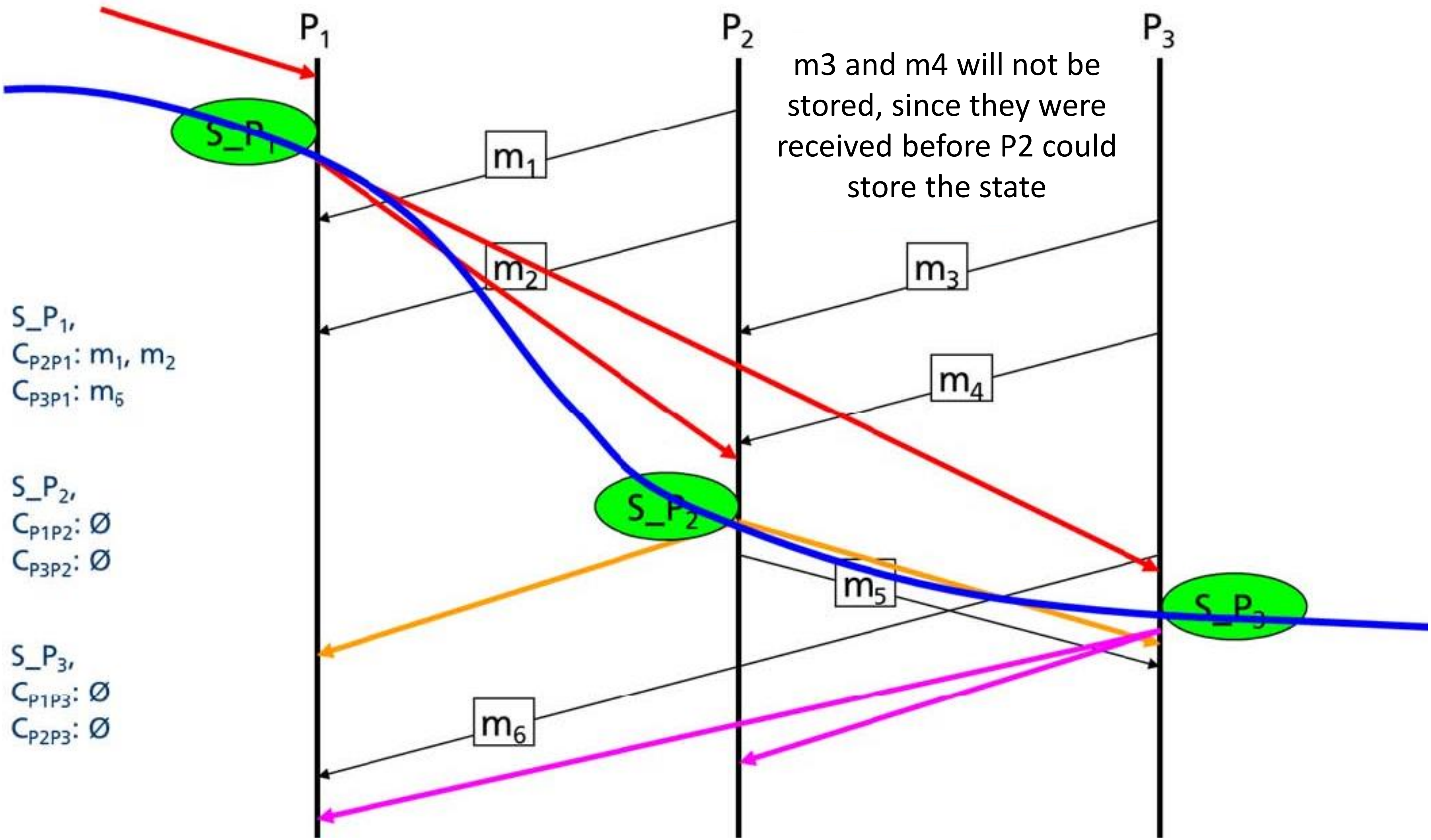


S_P_1,
C_{P2P1}: m_1, m_2
C_{P3P1}: Ø

S_P_2,
C_{P1P2}: Ø
C_{P3P2}: m_3, m_4

S_P_3,
C_{P1P3}: Ø
C_{P2P3}: Ø

Task 1 b)


P_1
P_2
P_3
m3 and m4 will not be stored, since they were received before P2 could store the state
S_P1
S_P2
S_P3
m_1
m_2
m_3
m_4
m_5
m_6
S_P_1,
C_{P2P1}: m_1, m_2
C_{P3P1}: m_6
S_P_2,
C_{P1P2}: Ø
C_{P3P2}: Ø
S_P_3,
C_{P1P3}: Ø
C_{P2P3}: Ø

Task 2

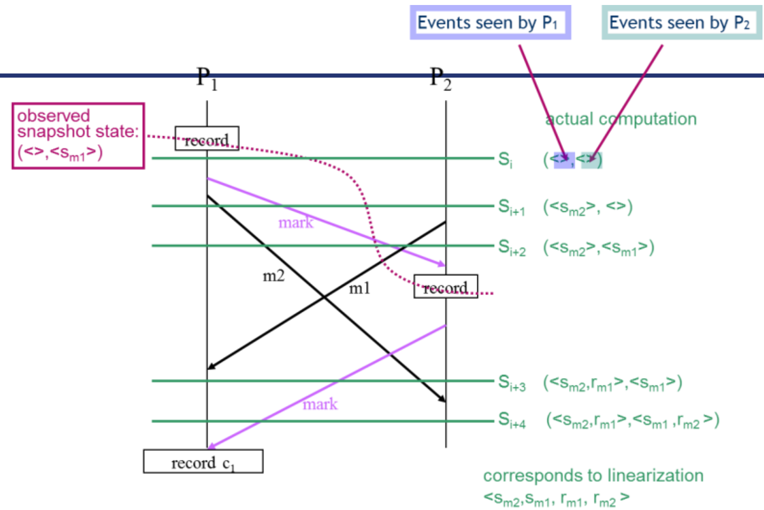


Figure 1: An example of a snapshot after applying the algorithm by Chandy and Lamport.

Figure 3 exemplifies the algorithm by Chandy and Lamport as discussed in the lecture. In addition to the real communication (messages m1 and m2), the figure depicts both marker messages and the recording of the states. The actual global system states are shown on the right, whereas the snapshot state is shown on the left.

Let Sys = s_m2, s_m1, r_m1, r_m2 be a consistent run that transforms state Si to Si+4. Furthermore, let S_init = Si and S_final = Si+4.

a) Determine the permutation Sys' = e'0 … such that S_snap can be reached from S_init and S_final from S_snap, respectively. Specify S_snap, as well as both pre-snap and post-snap events.

b) Sketch the communication flow, which arises from Sys'.

Snapshots: Chandy-Lamport (Lecture!)

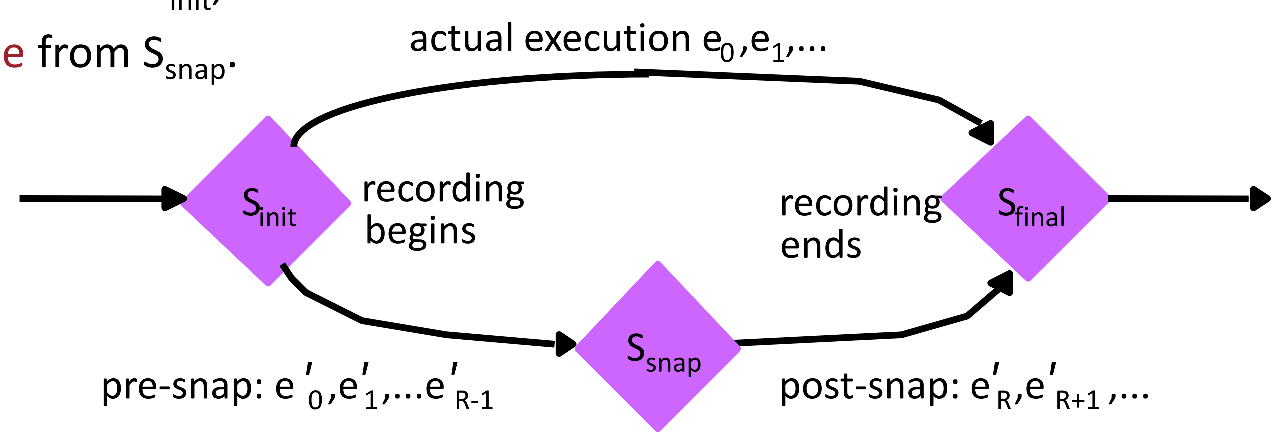
Reachability Theorem: let Sys = e_0, e_1, .. the linearization of a sys. execution

Let:

- S_{init} the initial global state of the system immediately before Chandy-Lamport snapshot-taking was initiated by the first process,
- S_{snap} the recorded snapshot state, and
- S_{final} the global system state after the algorithm terminated.

Then: there is a permutation Sys'= e'_0, e'_1, .. of Sys such that

- S_{init}, S_{snap} and S_{final} occur in Sys' and
- S_{snap} is reachable from S_{init}, and
- S_{final} is reachable from S_{snap}.



Task 2 a)

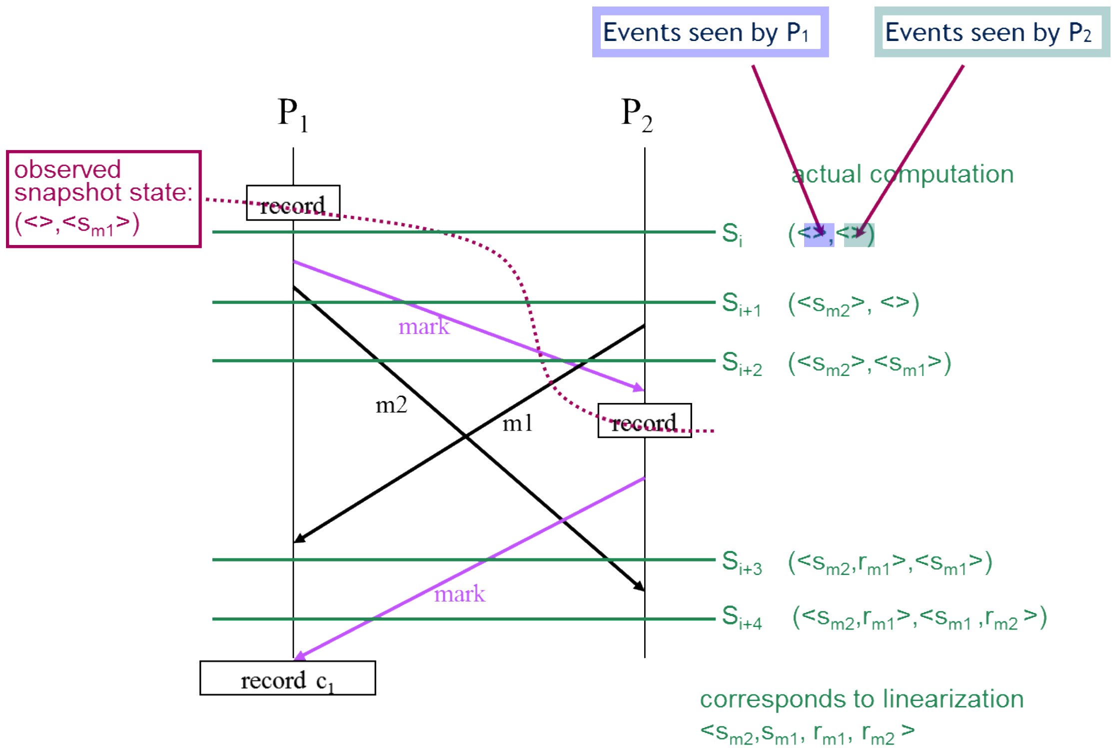


Figure 3: An example of a snapshot after applying the algorithm by Chandy and Lamport.

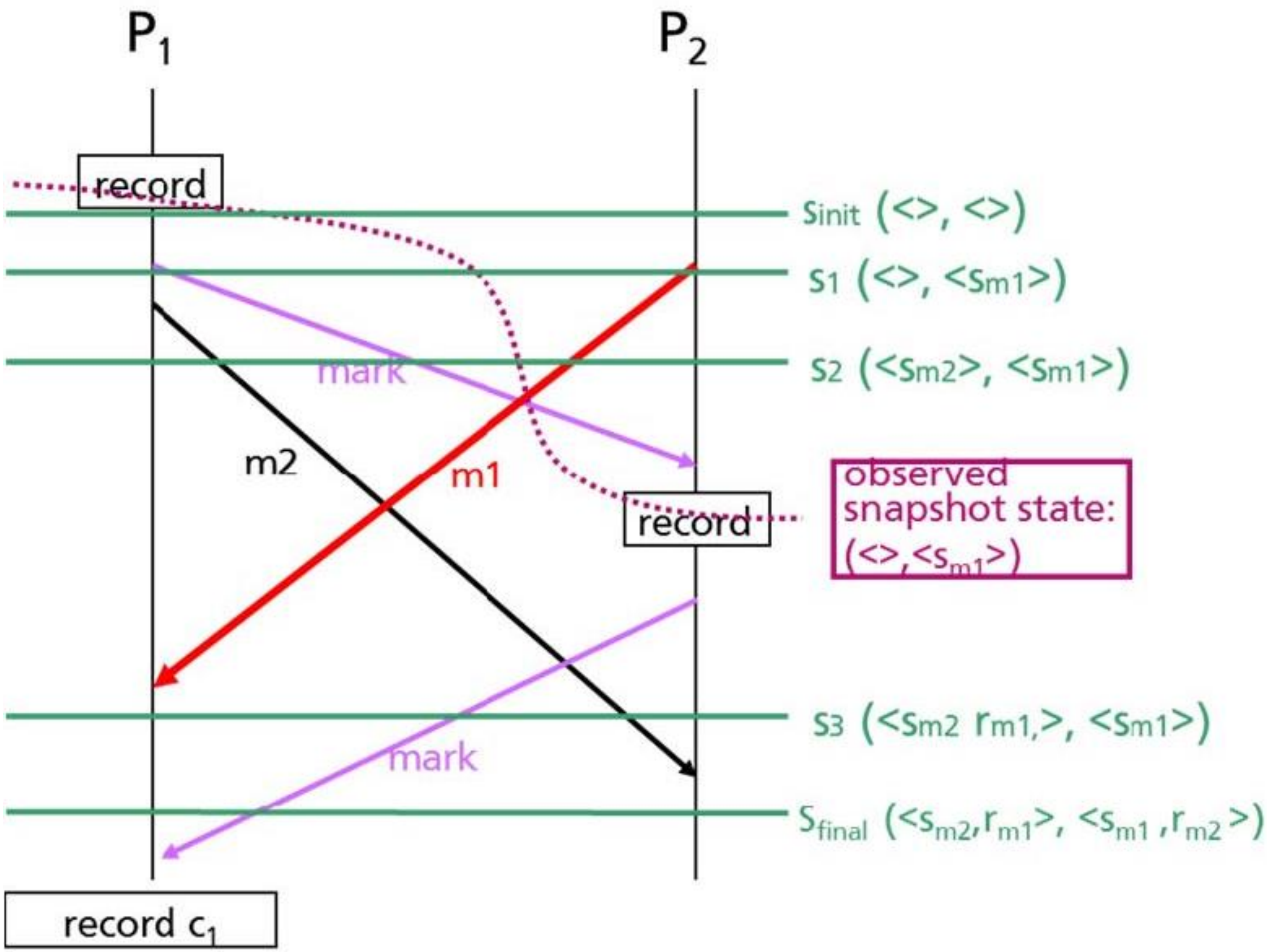
pre-snap = $\{s_{m1}\}$

post-snap = $\{s_{m2}, r_{m1}, r_{m2}\}$

Sys = $\langle s_{m2}, s_{m1}, r_{m1}, r_{m2} \rangle$

Sys' = $\langle s_{m1}, s_{m2}, r_{m1}, r_{m2} \rangle$

Task 2 b)



P1
P2
record
Sinit (<>, <>)
s1 (<>, <sm1>)
s2 (<sm2>, <sm1>)
mark
m2
m1
record
observed snapshot state: (<>,<sm1>)
s3 (<sm2 rm1,>, <sm1>)
mark
Sfinal (<sm2,rm1>, <sm1 ,rm2 >)
record c1