CS 425 Homework 2

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1. (a) All possible linearizations:

$$\boldsymbol{< A, B,\ C, F, H,\ I, D, E,\ J >}$$
$$\boldsymbol{< A, B,\ F, C, H,\ I, D, E,\ J >}$$
$$\boldsymbol{< A, B,\ F, H, C,\ I, D, E,\ J >}$$

$$\boldsymbol{< A, B,\ C, F, H,\ D, I, E,\ J >}$$
$$\boldsymbol{< A, B,\ F, C, H,\ D, I, E,\ J >}$$
$$\boldsymbol{< A, B,\ F, H, C,\ D, I, E,\ J >}$$

$$\boldsymbol{< A, B,\ C, F, H,\ D, E, I,\ J >}$$
$$\boldsymbol{< A, B,\ F, C, H,\ D, E, I,\ J >}$$
$$\boldsymbol{< A, B,\ F, H, C,\ D, E, I,\ J >}$$

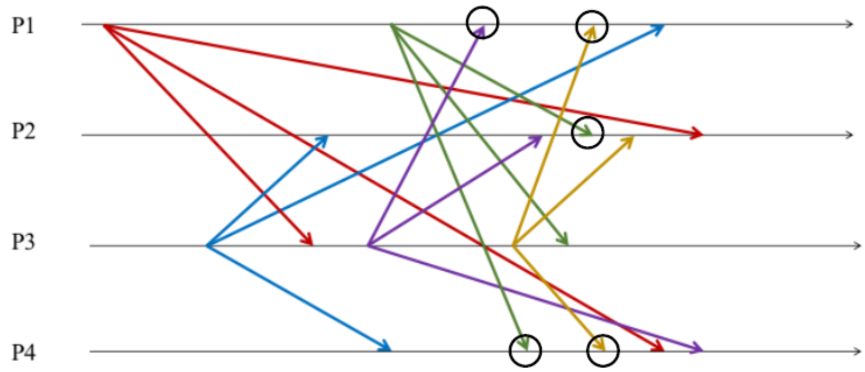
$$\boldsymbol{< A, B,\ F, H, I,\ C, D, E,\ J >}$$

   (b) There are in total **14** consistent global states:

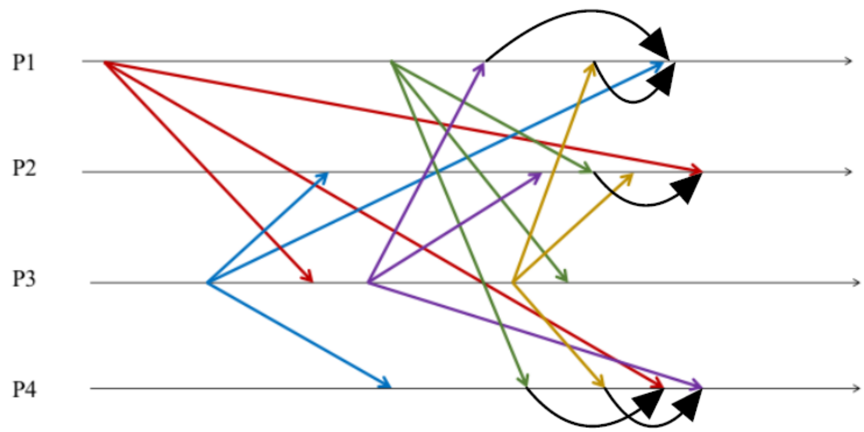
$$\boldsymbol{\{A\}}$$
$$\boldsymbol{\{B\}\{B, F\}\{B, H\}\{B, I\}}$$
$$\boldsymbol{\{C\}\{C, F\}\{C, H\}\{C, I\}}$$
$$\boldsymbol{\{D, H\}\{D, I\}}$$
$$\boldsymbol{\{E, H\}\{E, I\}\{E, J\}}$$

   (c) An example of an unstable global safety property:
   A state which will go into deadlock only when some of its preconditions are not met (e.g. certain linearizations).
   It can be made stable by **ensuring all its preconditions are met before entering the state (e.g. eliminating certain linearizations)**.

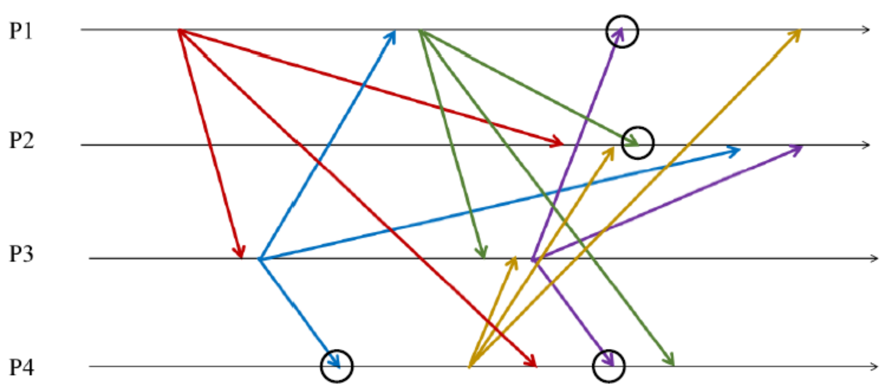
2. (a) (i)



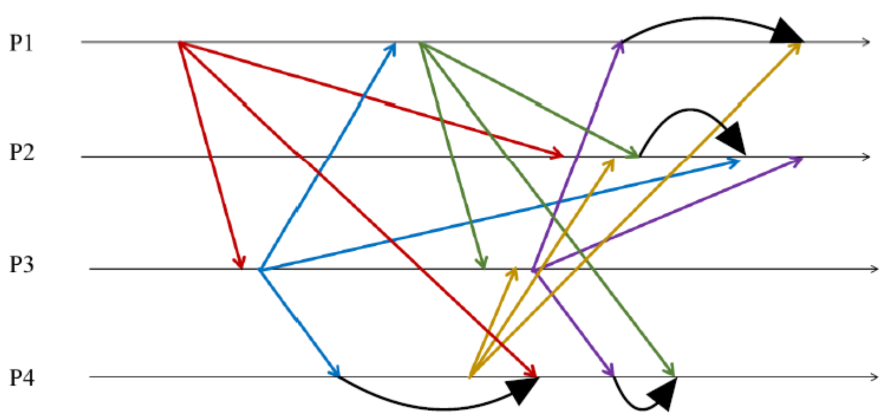
(ii)



(b) (i)



(ii)

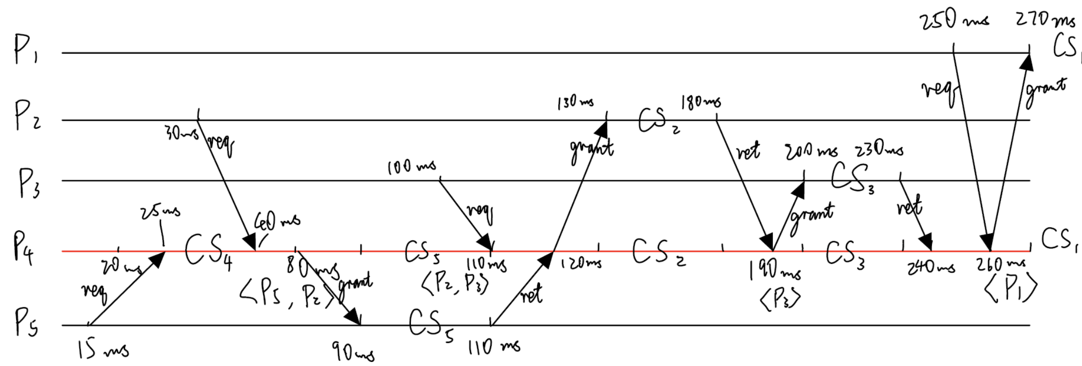


3. (a) **FALSE**.
Example: Suppose multicast **B** happens after receiving message from multicast **A**, total ordered multicast only requires that all the other processes deliver the multicasts issued by **A** and **B** in the same order, i.e. all in **{A, B}** or **{B, A}**.
But causal multicast requires that all the other processes must deliver **A** before **B**, i.e. in **{A, B}**, but must not be in **{B, A}**

(b) **FLASE**. Because FIFO only ensures causal ordering of a single communication channel, i.e. between 2 specific processes, but not among all processes.
Example: Suppose **P1** issues an **R**-multicast to **P2** and **P3**, and **P2** receives the multicast first. Then by the protocal of **R**-multicast, **P2** will immediately issue **B**-multicast to the same group, and this **B**-multicast could arrive at **P3** earlier than the **R**-multicast issued by **P1**, which violates causal ordering multicast since **B**-multicast by **P2** happens after **R**-multicast by **P1**, but **P3** will eventually deliver the message received from **B**-multicast first because it arrives first.

(c) **TRUE**.
Causal order and total order is two independent ordering of multicast. When two multicasts with logical order is issued, their relative delivery order is determined by the causal order property; when two multicasts are concurrent, their relative order of delivery across all processes just need to be consistent required by total ordering. So we can implement ISIS algorithm on top of causal multicast.

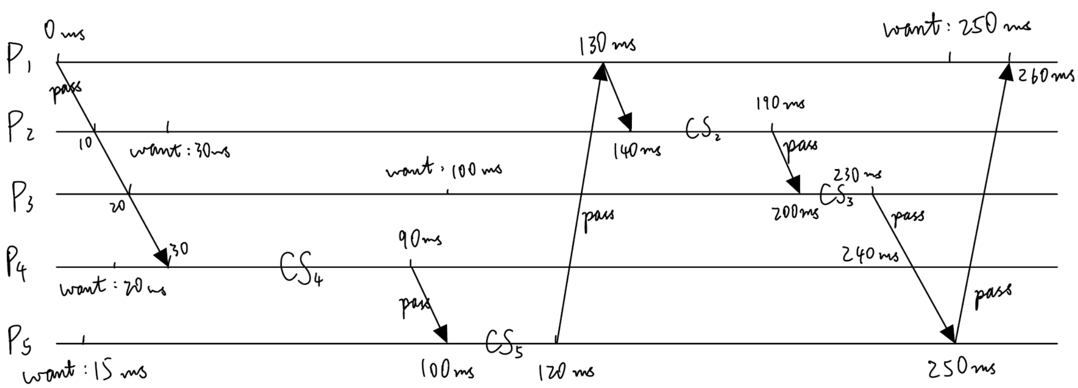
4. (a) The overall traffic is as follows:



So the starting time of critical section execution for each process is:

Process ID	Critical section start time
P1	270 ms
P2	130 ms
P3	200 ms
P4	20 ms
P5	90 ms

(b) The overall traffic is as follows:



So the starting time of critical section execution for each process is:

Process ID	Critical section start time
P1	260 ms
P2	140 ms
P3	200 ms
P4	30 ms
P5	100 ms