DIGITAL ASSIGNMENT - II

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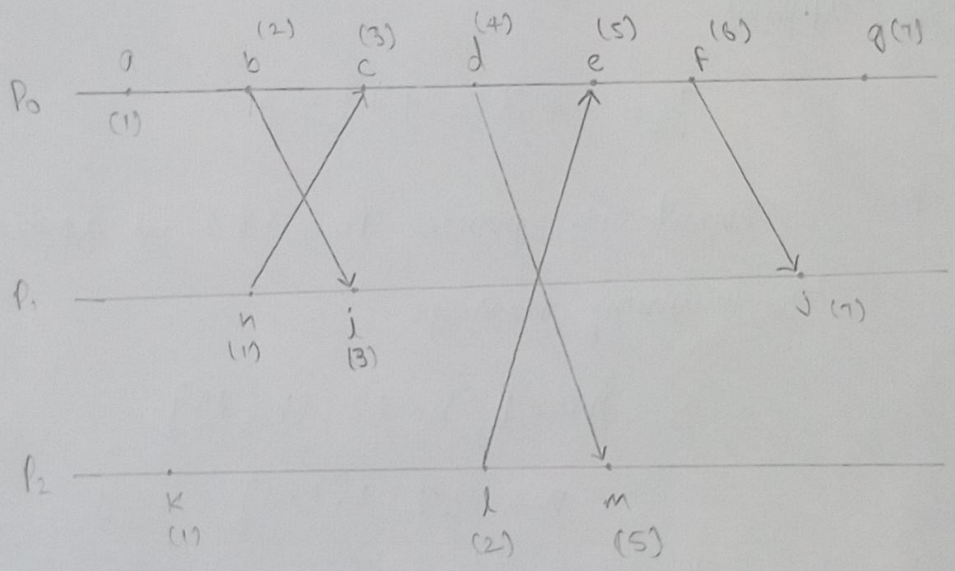
Q.1. Consider the figure, assume that initial logical clock values are all initialized to 0.

a) List the Lamport timestamps for each event and provide timestamps for each labeled event.



Assuming $d = 1$

Implementation Rules [IR]:

IR1: $C_i(\text{event } 2) = C_i(\text{event } 1) + d$

Dealing with only events of one process.

IR2 : $C_j(\text{event } 2) = \max[(C_j(\text{event } 1)) + d, t_m + d]$

Dealing with process events having communication with each other.

i) Since $d = 1$, for all first events of all processes will be 1.

P_0	P_1	P_2
$a = 1$	$h = 1$	$k = 1$

ii) For internal process b to P_0, IR1 will be applied.

$$b = 1 + d = 1 + 1 = 2$$

iii) c event in process P_0, IR2 is applied due to incoming message.

$$c = \max[(b+d), (h+d)]$$

$$= \max[2+1, 1+1] = 3$$

iv) i event in process P_1, IR2 is applied due to incoming message

$$i = \max[(h+d), (b+d)]$$

$$= \max[1+1, 2+1] = 3$$

v) For internal event d in P_0, IR1 will be applied.

$$d = 3 + 1 = 4$$

vi) For internal event l in process P_2, IR1 will be applied.

$$\underline{l} = 1+1 = 2$$

vii) e event, IR2 will be applied due to incoming message

$$\underline{e} = \max[(d+3), (l+d)]$$
$$= \max[4+1, 2+1]$$
$$= 5$$

viii) m event in P_2 has incoming message, so IR2 is applied.

$$m = \max[(l+d), (d+d)]$$
$$= \max[2+1, 4+1]$$
$$= 5$$

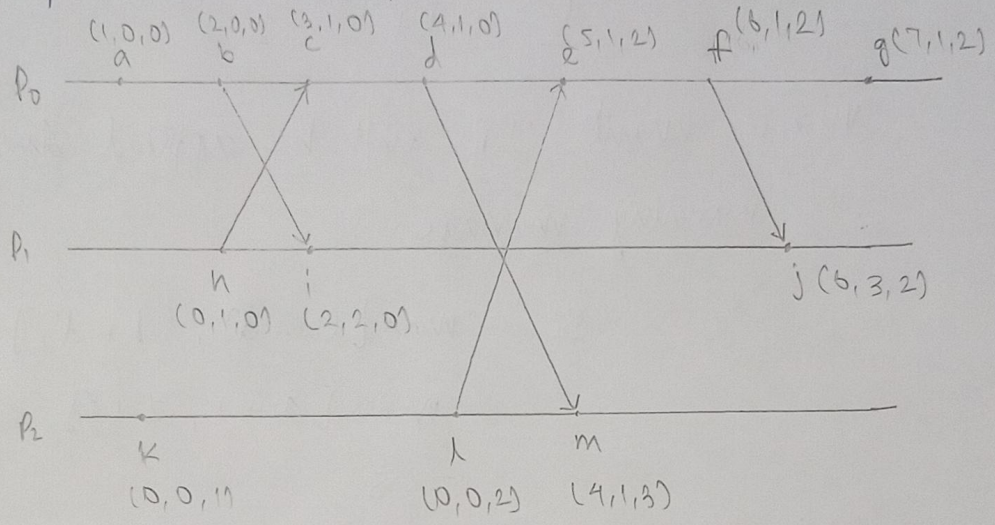
ix) For internal events f and g, IR1 is applied

$$\underline{f} = e+d = 5+1 = 6$$
$$\underline{g} = f+d = 6+1 = 7$$

x) For event j in process P_1, IR2 will be applied,

$$\underline{j} = \max[(i+d), (f+d)]$$
$$= \max[6+1, 3+1] = 7$$

b) List the Vector clock timestamps for each event and provide timestamps for each labeled event.



Assuming $d=1$

Implementation Rules [IR]:

[IR1]: Clock C_i is incremented b/w any two successive events in process P_i

$$C_i[i] := C_i[i] + d \quad (d > 0)$$

[IR2]: Event a sending message m by process P_i, then message m is assigned a vector timestamp $t_m = C_i(a)$; on receiving the same message m by process P_j, C_j is updated as

$$\forall k, \; C_j[k] := \max(C_j[k], t_m[k])$$

i) Events a, h and k are internal events to processes P_0, P_1 and P_2 respectively. So IR1 will be applied.

$\underline{a} \rightarrow (1,0,0)$ $\underline{h} \rightarrow (0,1,0)$ $\underline{k} \rightarrow (0,0,1)$

ii) For internal events b and l in P_0 and P_2 respectively, IR1 will be applied.

$\underline{b} \rightarrow (2,0,0)$ $\underline{l} \rightarrow (0,0,2)$

iii) Events c and i processes there is a incoming messages so IR2 will be applied.

$c \rightarrow \max[(3,0,0), (3,1,0)] \forall k$

$\underline{c} \rightarrow (3,1,0)$

$i \rightarrow \max[(2,0,0), (0,2,0)] \forall k$

$\underline{i} \rightarrow (2,2,0)$

iv) Event d is internal event to proces P_0, so IR2 is applied.

$d \rightarrow (4,1,0)$

v) Processes P_0 and P_2 have e and m events respectively, having incoming messages, IR2 will be applied.

$$e \rightarrow \max[(5,1,0),(0,0,2)] \; \forall k$$

$$\underline{e} \rightarrow (5,1,2)$$

$$m \rightarrow \max[(0,0,3),(4,1,0)] \; \forall k$$

$$\underline{m} \rightarrow (4,1,3)$$

vi) for internal events f and g to process P_0, IR1 will be applied.

$$\underline{f} \rightarrow (6,1,2)$$

$$\underline{g} \rightarrow (7,1,2)$$

vii) Event j in P_1 has incoming message, IR2 will be applied.

$$j \rightarrow \max[(2,3,0),(6,1,2)]$$

$$\underline{j} \rightarrow (6,3,2)$$