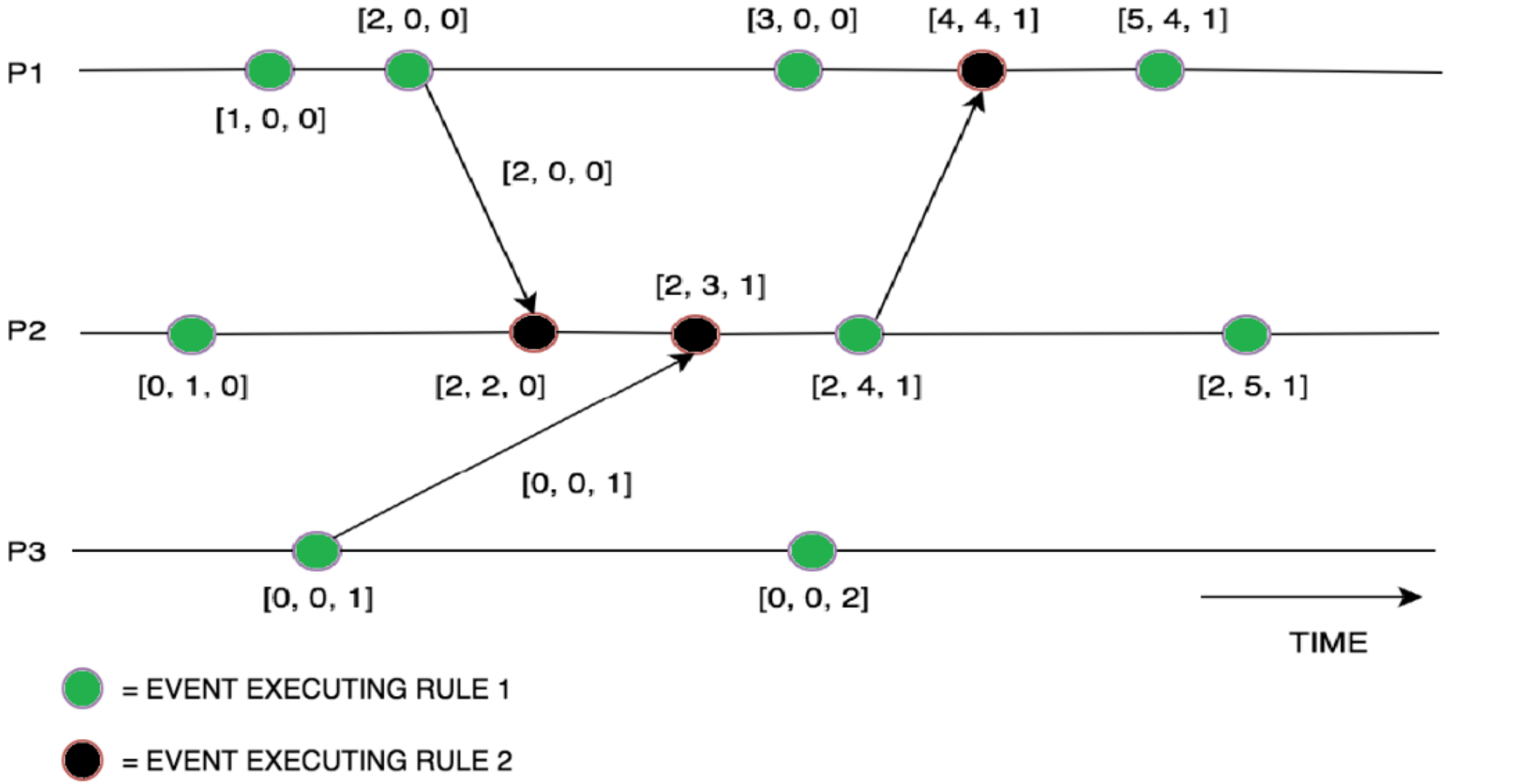
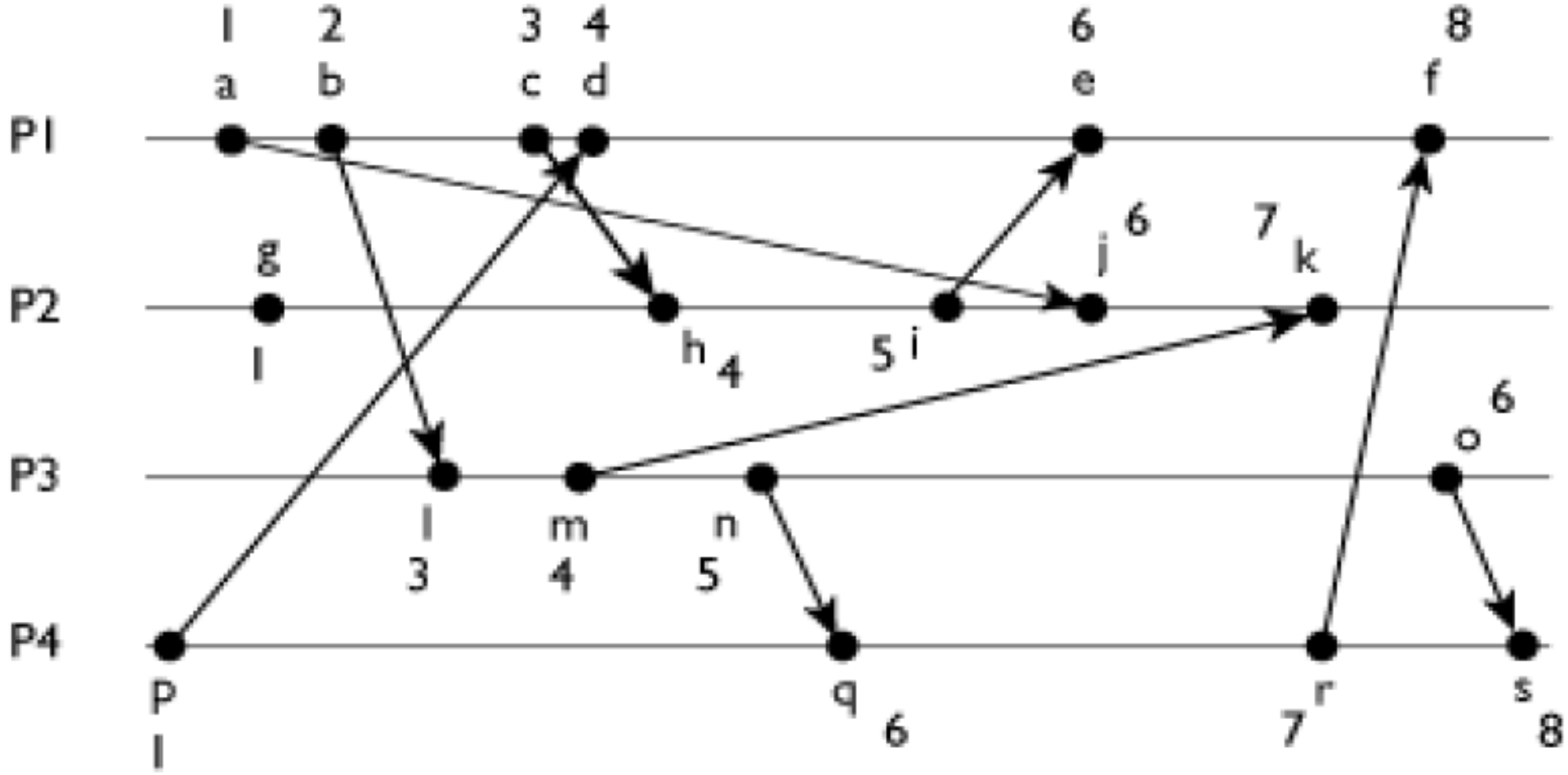
How does the vector clock algorithm work :

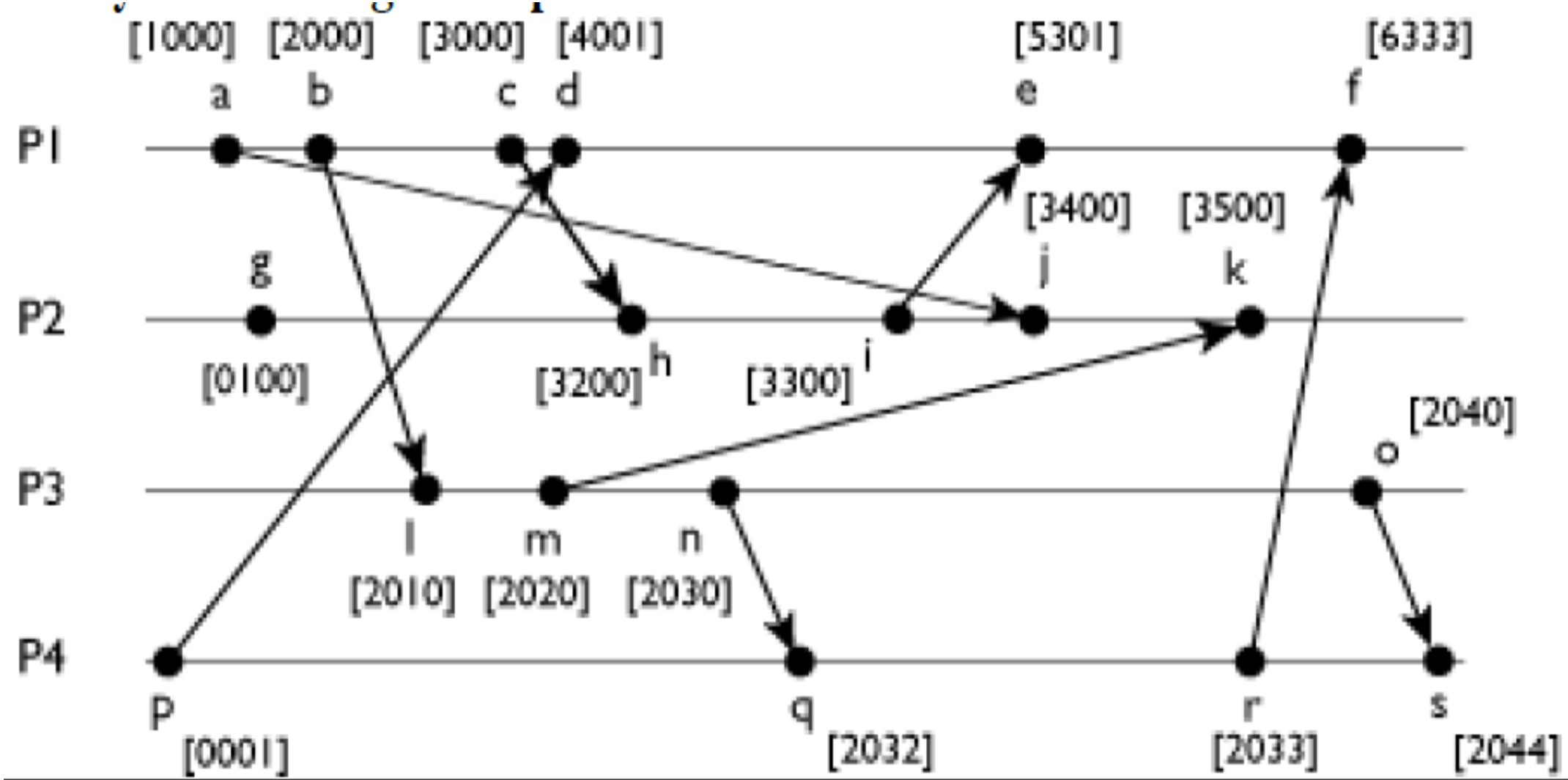
- Initially, all the clocks are set to zero.
- Every time, an Internal event occurs in a process, the value of the processes's logical clock in the vector is incremented by 1
- Also, every time a process sends a message, the value of the processes's logical clock in the vector is incremented by 1.

Every time, a process receives a message, the value of the processes's logical clock in the vector is incremented by 1, and moreover, each element is updated by taking the maximum of the value in its own vector clock and the value in the vector in the received message (for every element).


[2, 0, 0]
[3, 0, 0]
[4, 4, 1]
[5, 4, 1]
P1
[1, 0, 0]
[2, 0, 0]
[2, 3, 1]
P2
[0, 1, 0]
[2, 2, 0]
[2, 4, 1]
[2, 5, 1]
[0, 0, 1]
P3
[0, 0, 1]
[0, 0, 2]
TIME
= EVENT EXECUTING RULE 1
= EVENT EXECUTING RULE 2

Consider processes P1, P2, P3, and P4 executing in a distributed system with Lamport timestamps. Write vector timestamps for all the events given in the figure below.




[1000]
[2000]
[3000]
[4001]
[5301]
[6333]
a
b
c
d
e
f
P1
[3400]
[3500]
g
i
k
P2
[0100]
[3200]
h
[3300]
i
[2040]
o
P3
l
m
n
[2010]
[2020]
[2030]
P4
P
q
r
s
[0001]
[2032]
[2033]
[2044]

10.7 An NTP server B receives server A's message at 16:34:23.480 bearing a timestamp 16:34:13.430 and replies to it. A receives the message at 16:34:15.725, bearing B's timestamp 16:34:25.7.

Estimate the offset between B and A and the accuracy of the estimate.

10.7

Ans. Let a =T i-2 – T i-3 = 23.48 - 13.43 = 10.05;

b =T i-1 – T i = 25.7- 15.725 =9.975.

Then the estimated offset oi = (a+b)/2 = 10.013s, with estimated accuracy = ±di/2= ± (a-b)/2 = 0.038s (answers expressed to the nearest millisecond).

To estimate the offset between server B and server A, we can calculate the difference between the timestamps provided by each server.

Given:

Server B's timestamp when receiving the message from server A: 16:34:13.430

Server A's timestamp when receiving the message from server B: 16:34:25.7

Offset between B and A = Server A's timestamp - Server B's timestamp

= 16:34:25.7 - 16:34:13.430

= 12.270 seconds

To estimate the accuracy of the offset, we can use the difference in timestamps when server B receives the message from server A and when server A receives the message from server B.

Given:

Server B's timestamp when receiving the message from server A: 16:34:23.480

Server A's timestamp when receiving the message from server B: 16:34:15.725

Difference in timestamps = Server A's timestamp - Server B's timestamp

= 16:34:15.725 - 16:34:23.480

= -7.755 seconds

The negative sign indicates that server A's timestamp is earlier than server B's timestamp, which suggests that the clocks of the two servers may not be perfectly synchronized.

Therefore, the estimated offset between server B and server A is 12.270 seconds, and the accuracy of this estimate is approximately 7.755 seconds.

Given:

- Initial Lamport clock value: 0
- Drift rate: 1 millisecond per second

1. After 10 seconds:
    1. Lamport timestamp = t + drift * clock
    2. Lamport timestamp = 10 seconds + (1 millisecond/second) * 10 seconds
    3. Lamport timestamp = 10 seconds + 10 milliseconds
    4. Lamport timestamp = 10.010 seconds
2. After 100 seconds:
    1. Lamport timestamp = t + drift * clock
    2. Lamport timestamp = 100 seconds + (1 millisecond/second) * 100 seconds
    3. Lamport timestamp = 100 seconds + 100 milliseconds
    4. Lamport timestamp = 100.100 seconds
3. After 1000 seconds:
    1. Lamport timestamp = t + drift * clock
    2. Lamport timestamp = 1000 seconds + (1 millisecond/second) * 1000 seconds
    3. Lamport timestamp = 1000 seconds + 1000 milliseconds
    4. Lamport timestamp = 1001 seconds

After 1000 seconds, the Lamport clock has gained 1 second of extra time compared to the real time