Slides capítulo 14:
Tempo

From **Coulouris, Dollimore, Kindberg and Blair**

Distributed Systems: Concepts and Design

Edition 5, © Addison-Wesley 2012

Figura 14.1
Diferença entre relógios

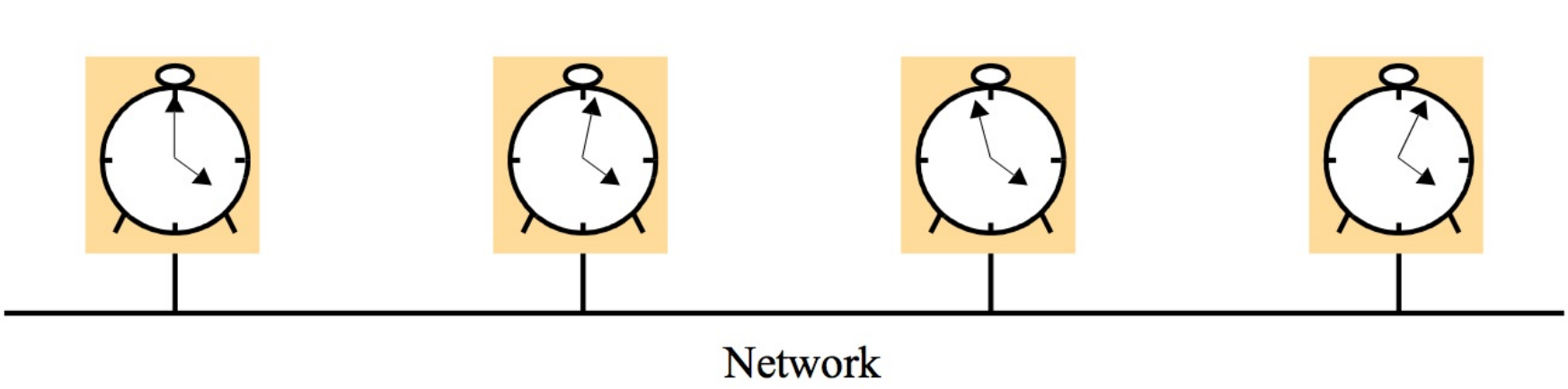


Figura 14.2
Sincronização de relógio usando servidor de tempo

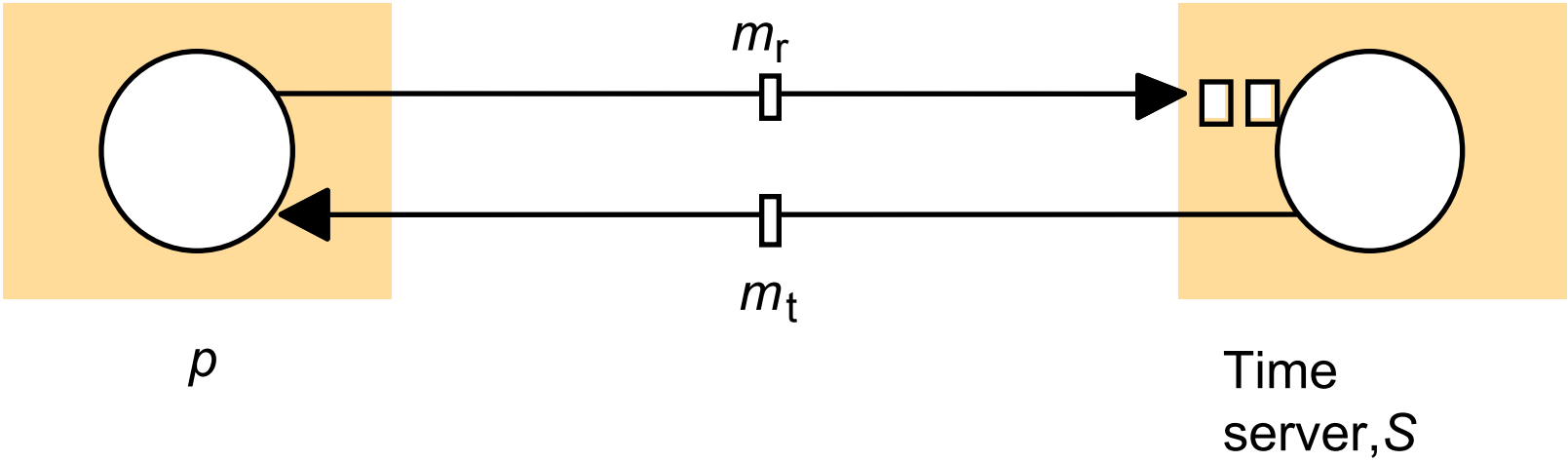
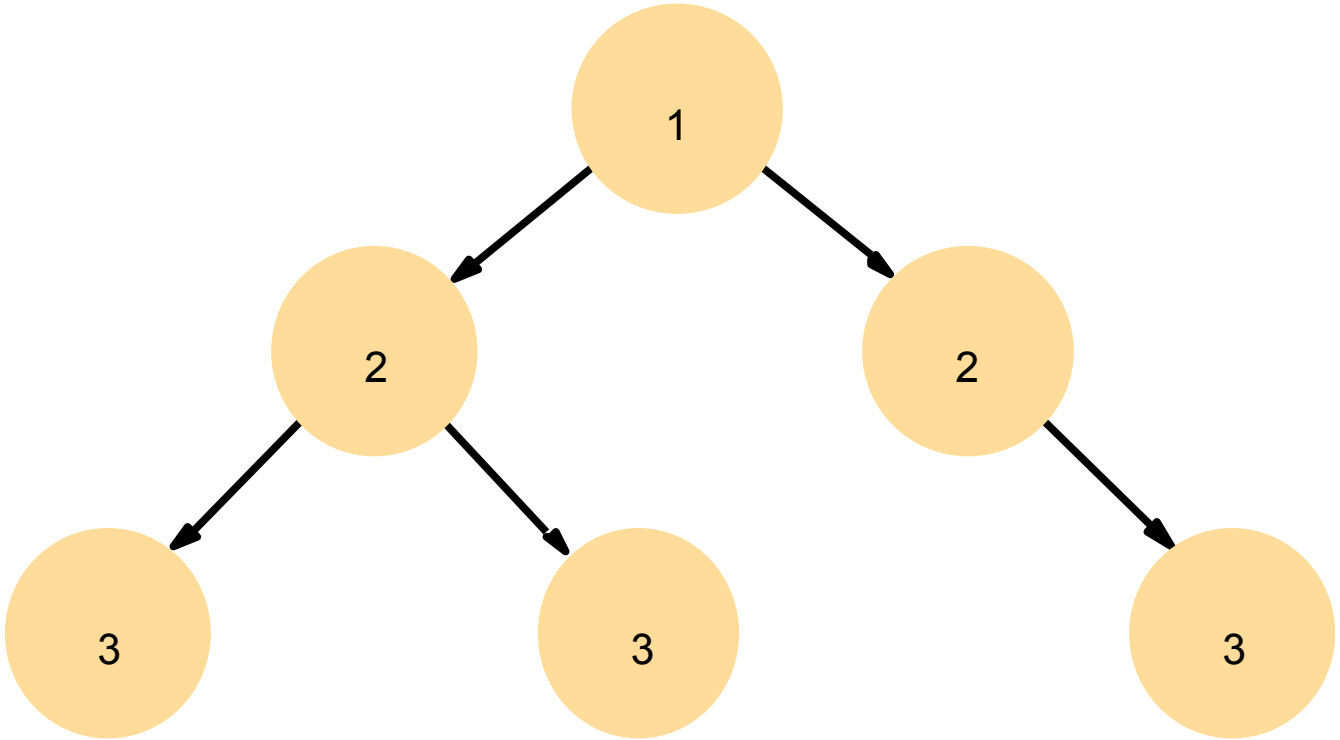


Figura 14.3
Exemplo de sincronização de relógio usando NTP



Setas indicam controle de sincronização e número indicam o estrato

Figura 14.4
Troca de mensagens entre um par de NTP peers

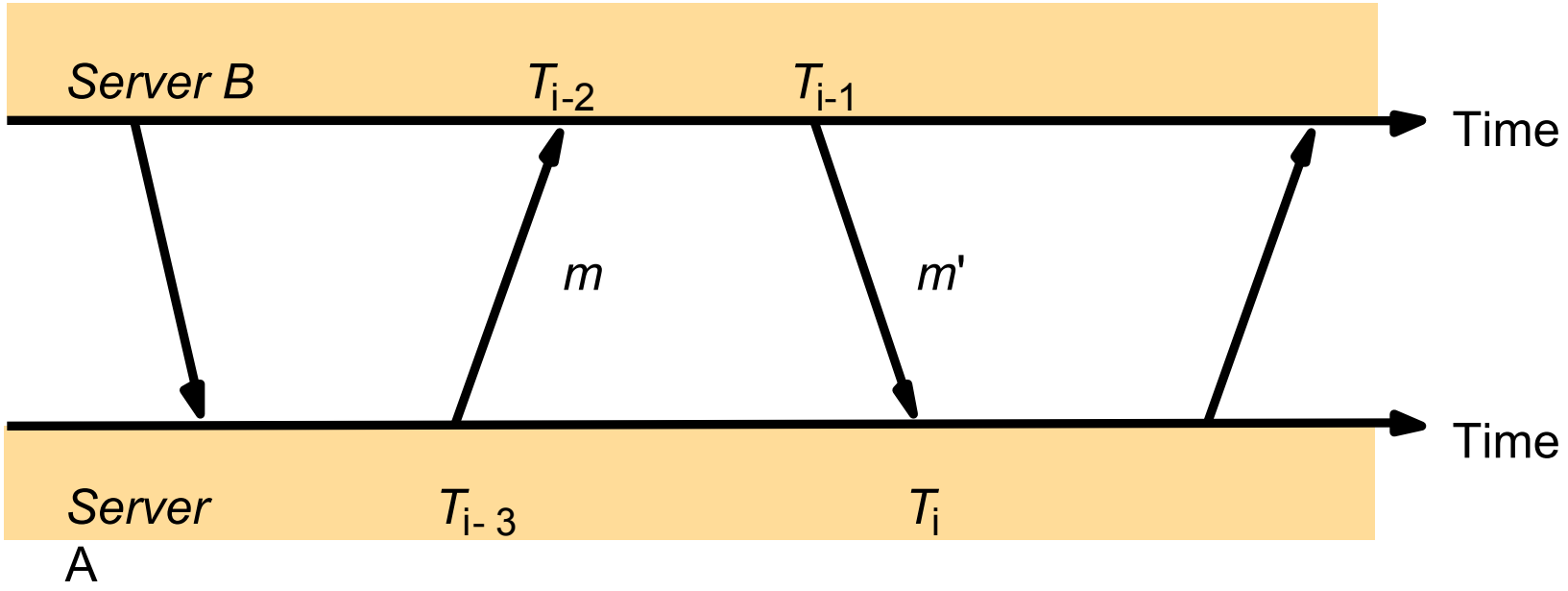


Figura 14.5
Eventos ocorrendo em três processos

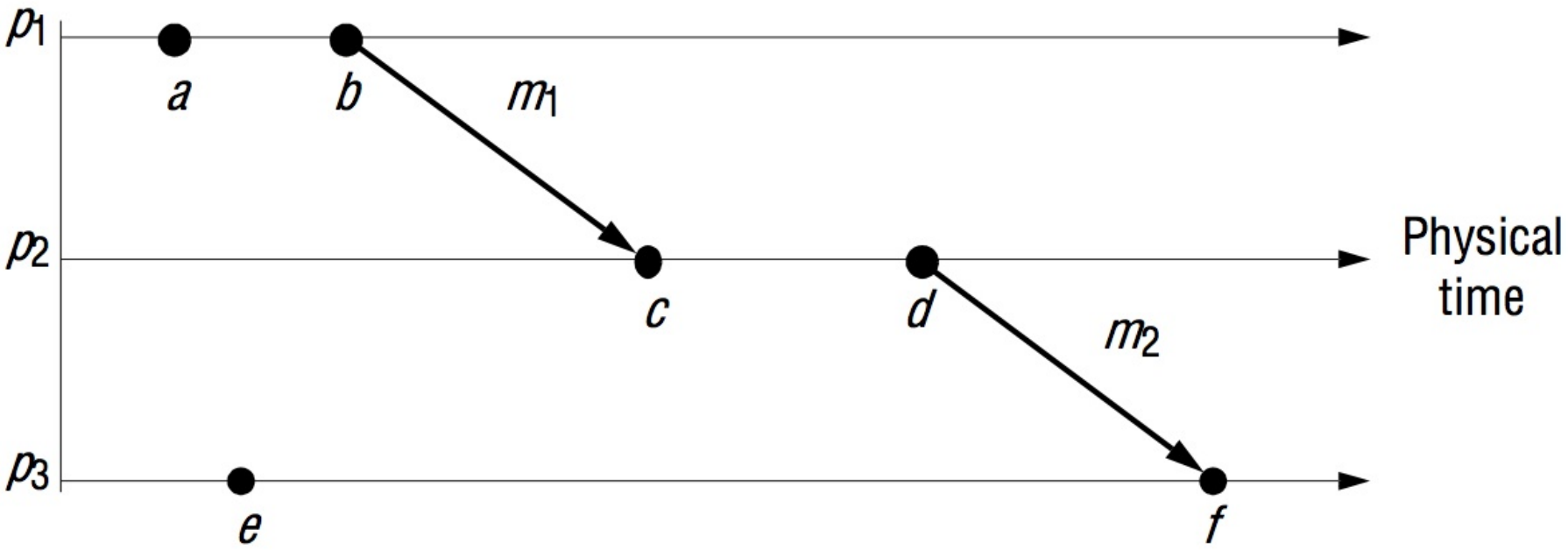
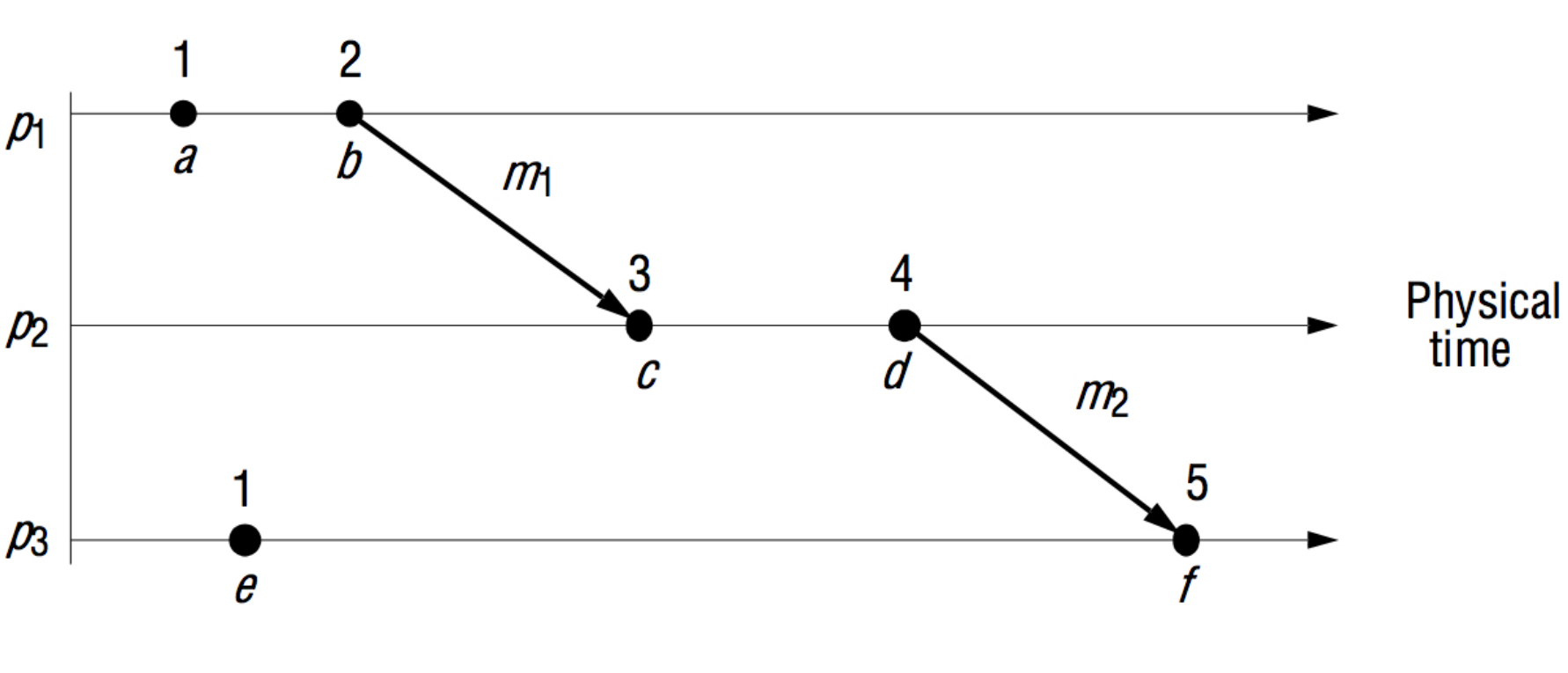
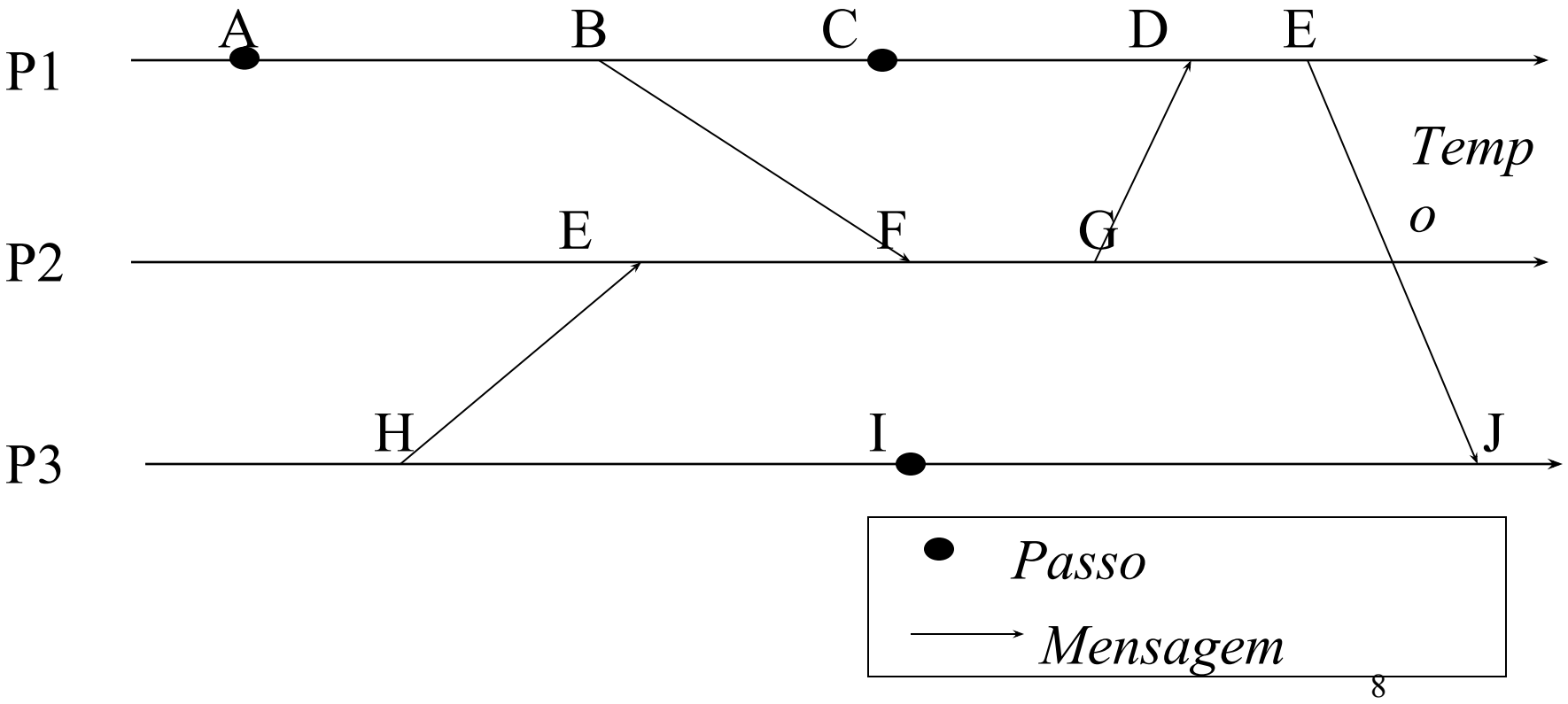
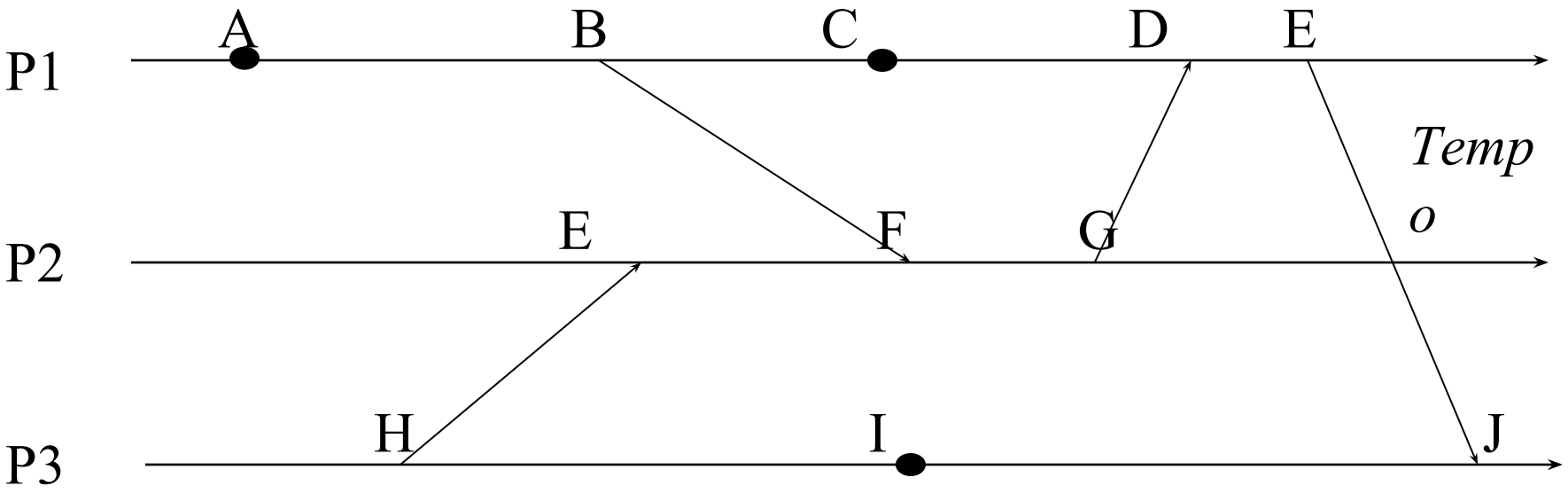


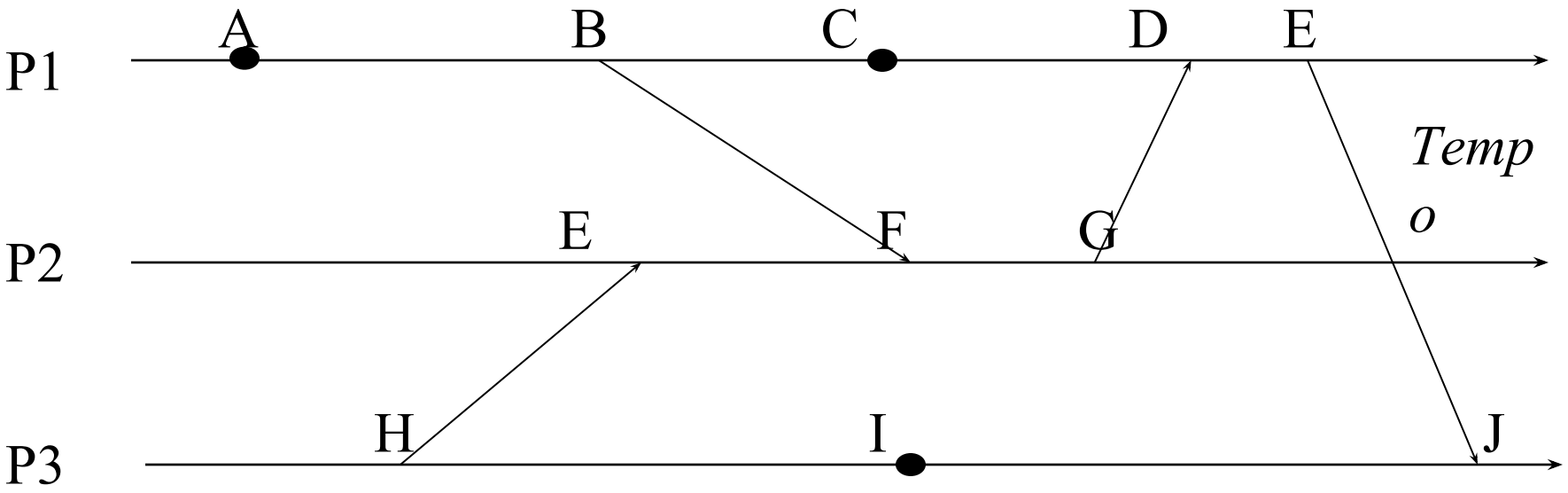
Figura 14.6
Lamport timestamps



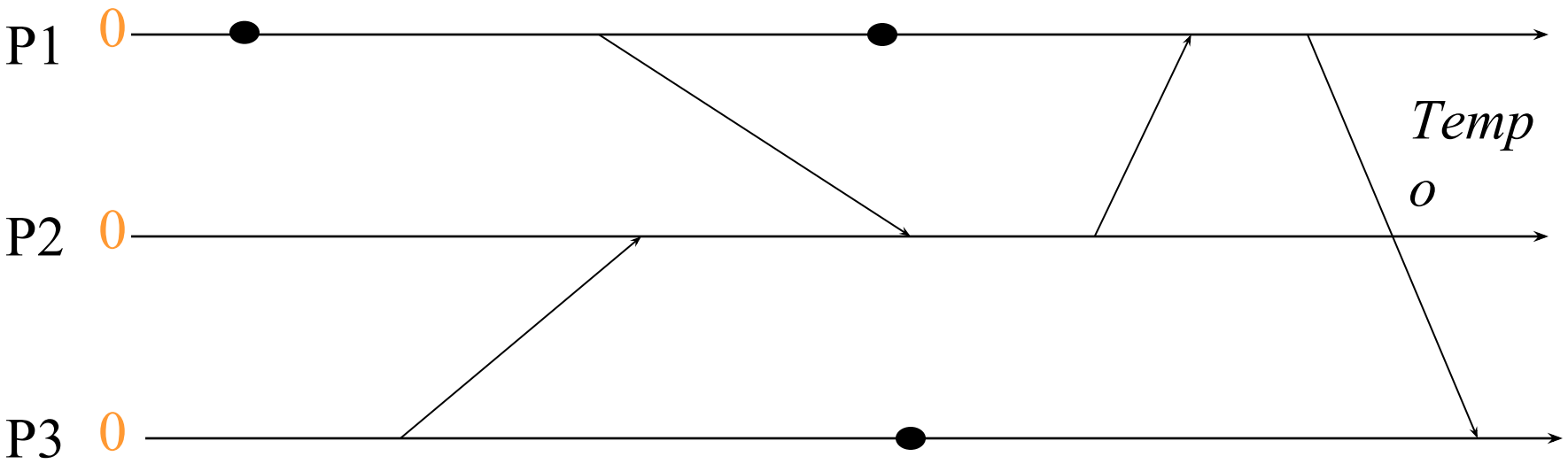

A
B
C
D
E
P1
Temp
o
E
F
G
P2
H
I
J
P3
Passo
Mensagem



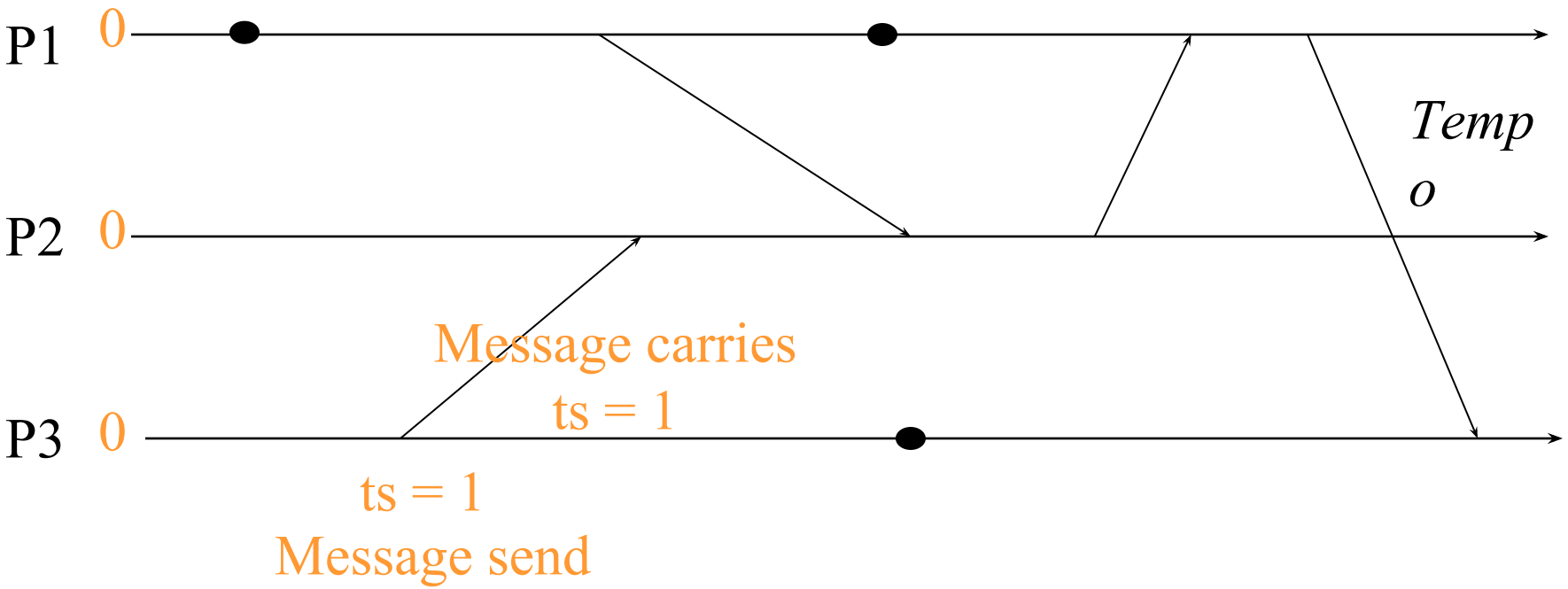
- A → B
- B → F
- A → F

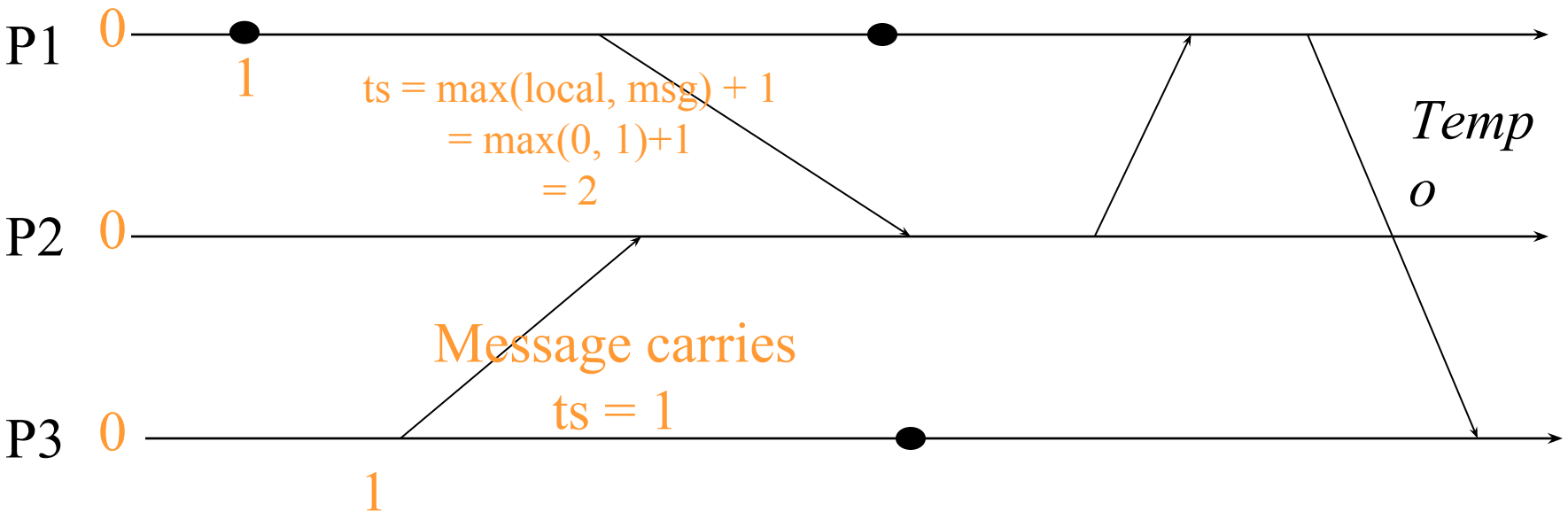


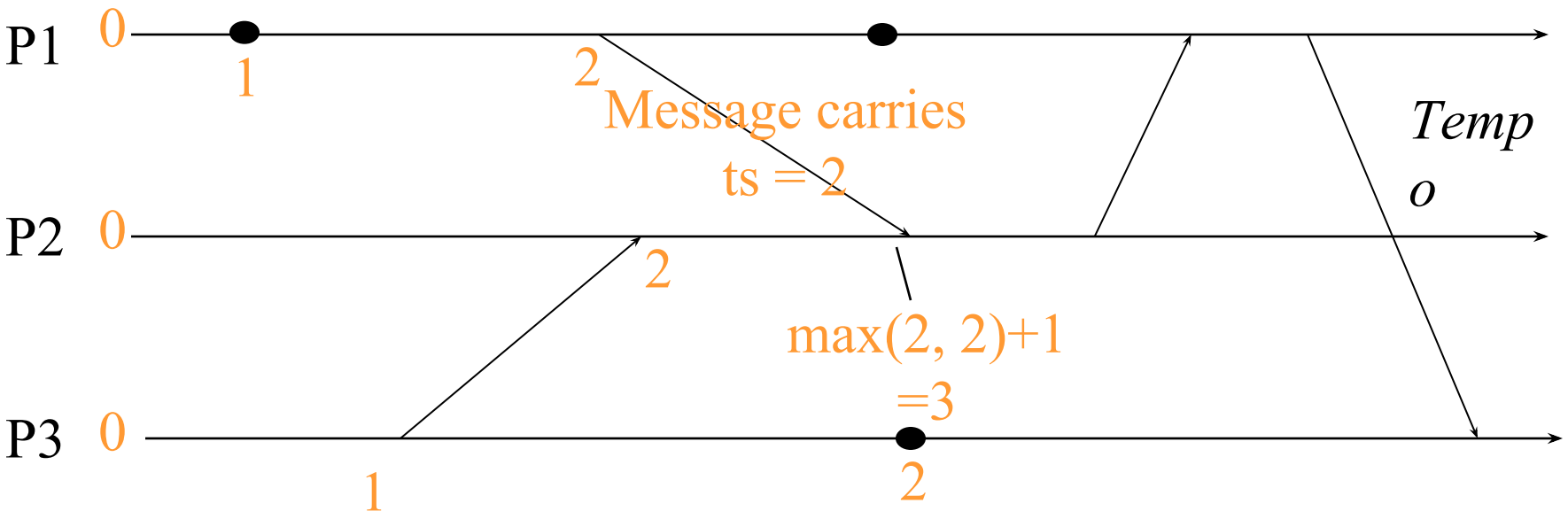
- H → G
- F → J
- H → J
- C → J

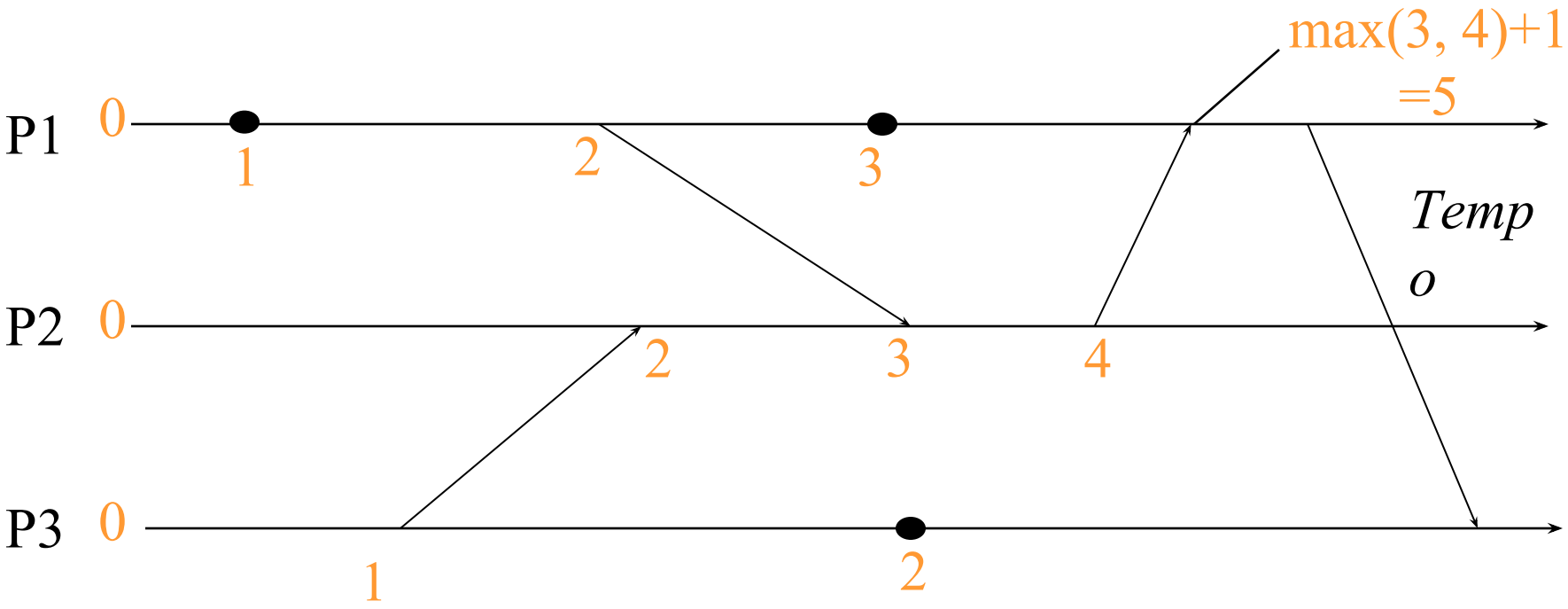


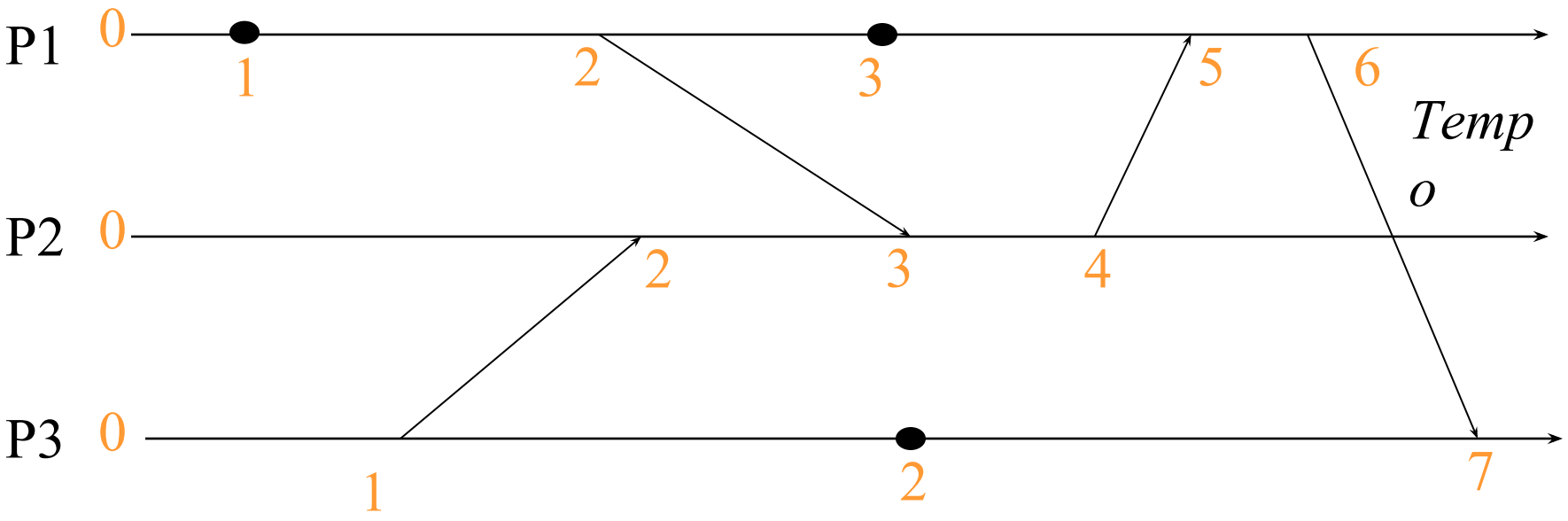
Contadores iniciais (clocks)

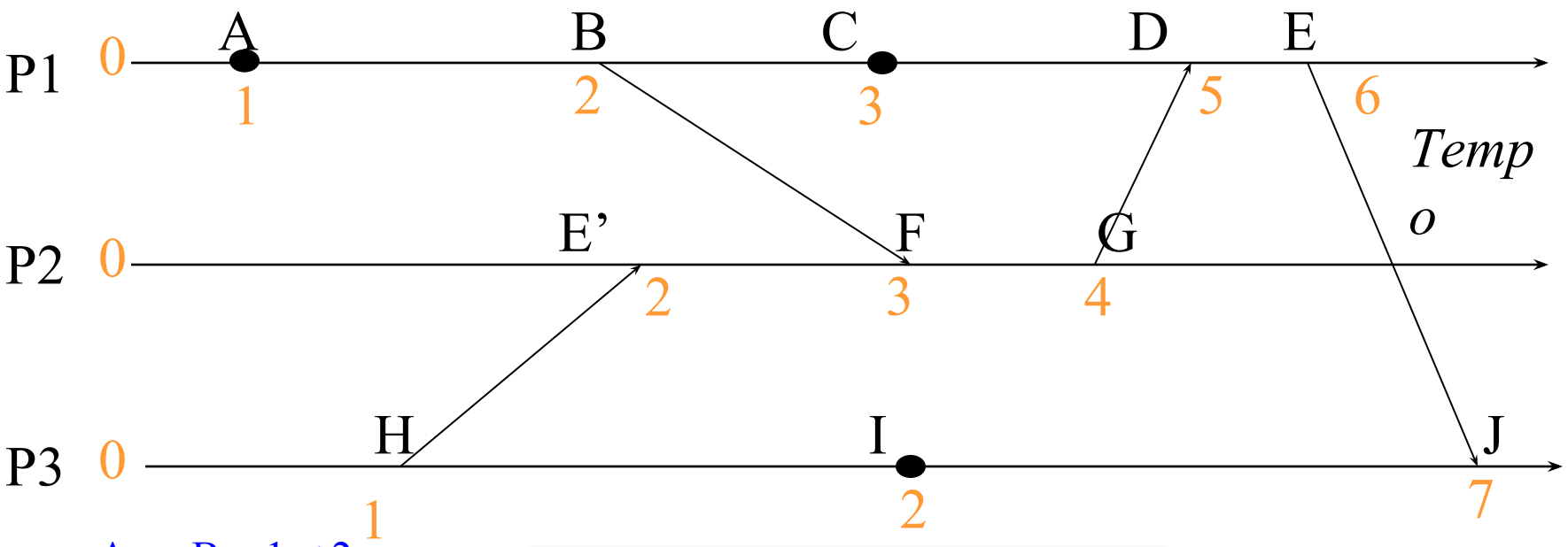

P1
0
P2
0
P3
0
Temp
o
Message carries
ts = 1
ts = 1
Message send


P1
0
1
ts = max(local, msg) + 1
= max(0, 1)+1
= 2
Temp
o
P2
0
Message carries
ts = 1
P3
0
1


P1
0
1
2
Message carries
ts = 2
Temp
o
P2
0
2
max(2, 2)+1
=3
P3
0
1
2


max(3, 4)+1
=5
P1
0
1
2
3
Temp
o
P2
0
2
3
4
P3
0
1
2


P1
0
1
2
3
5
6
Temp
o
P2
0
2
3
4
P3
0
1
2
7

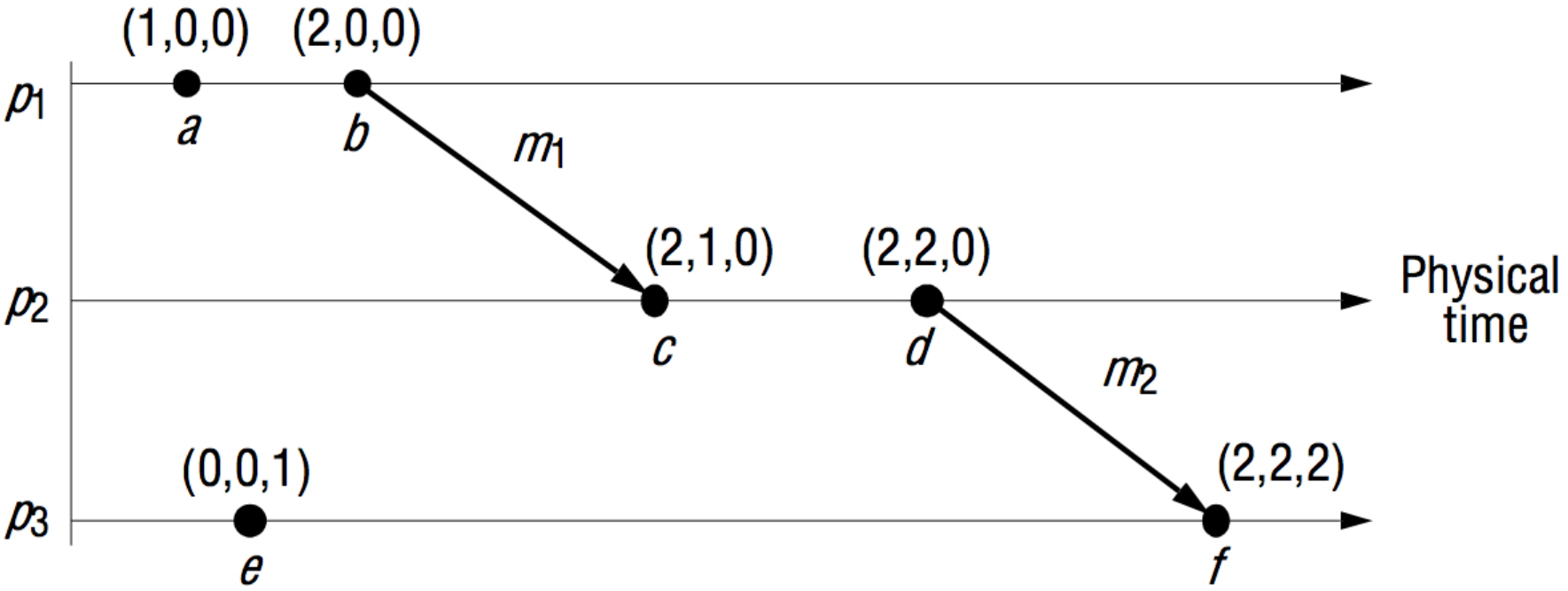


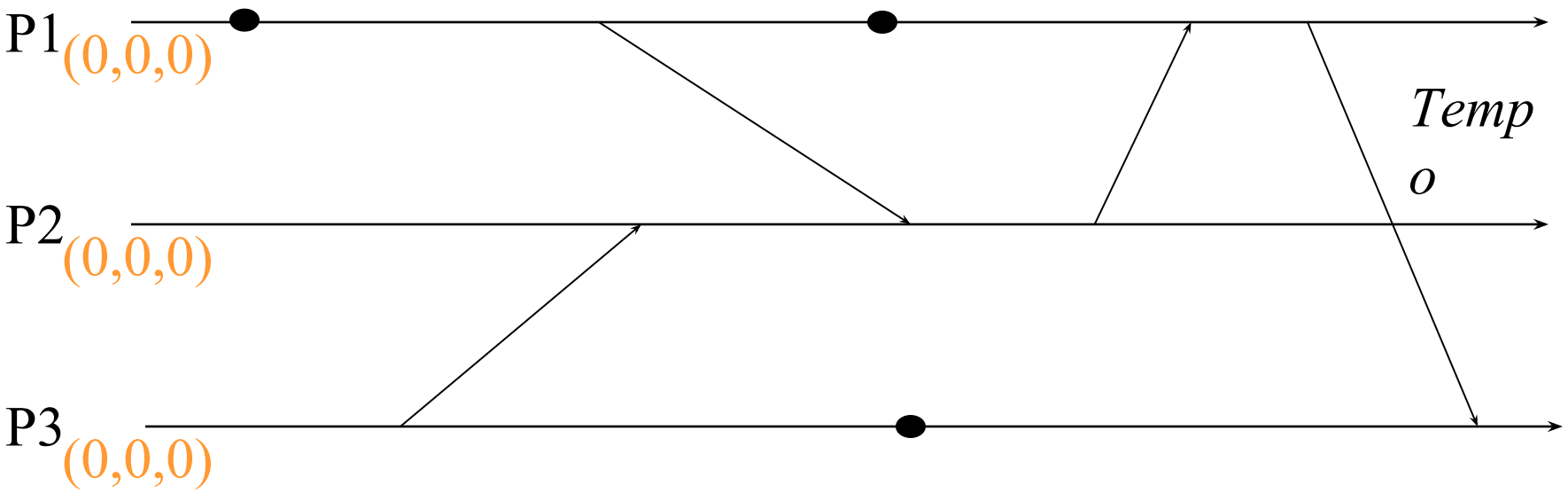
- A → B :: 1 < 2
- B → F :: 2 < 3
- A → F :: 1 < 3
- H → G :: 1 < 4
- F → J :: 3 < 7
- H → J :: 1 < 7
- C → J :: 3 < 7

Quais são os eventos concorrentes?

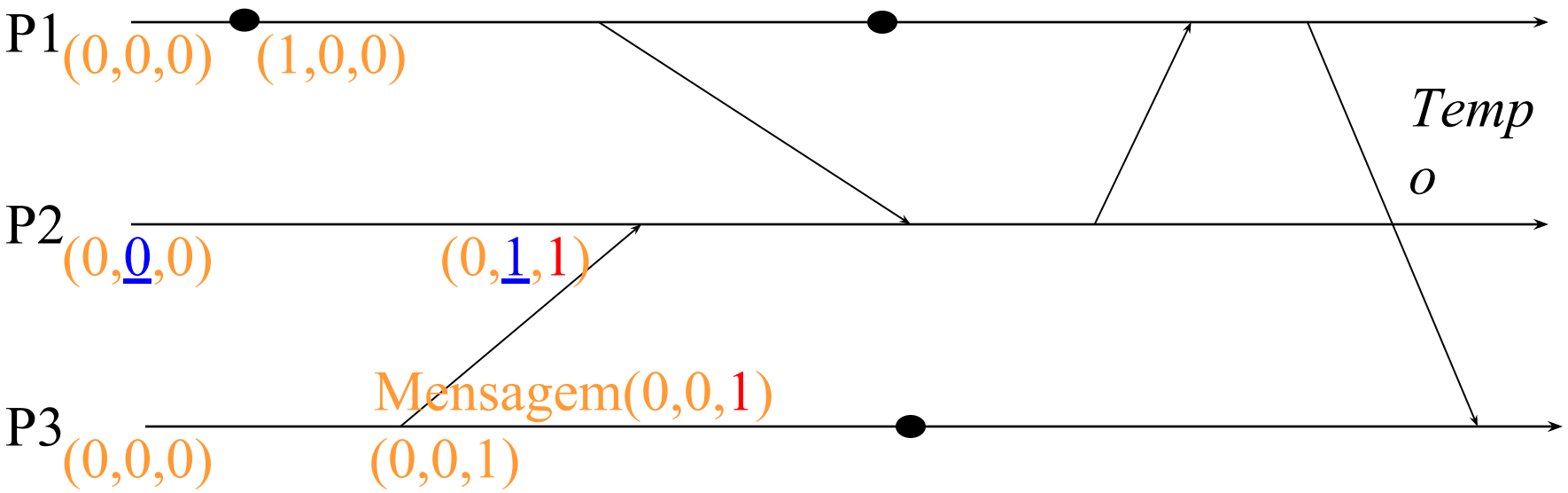
- ? C → F ? :: 3 = 3
- ? H → C ? :: 1 < 3

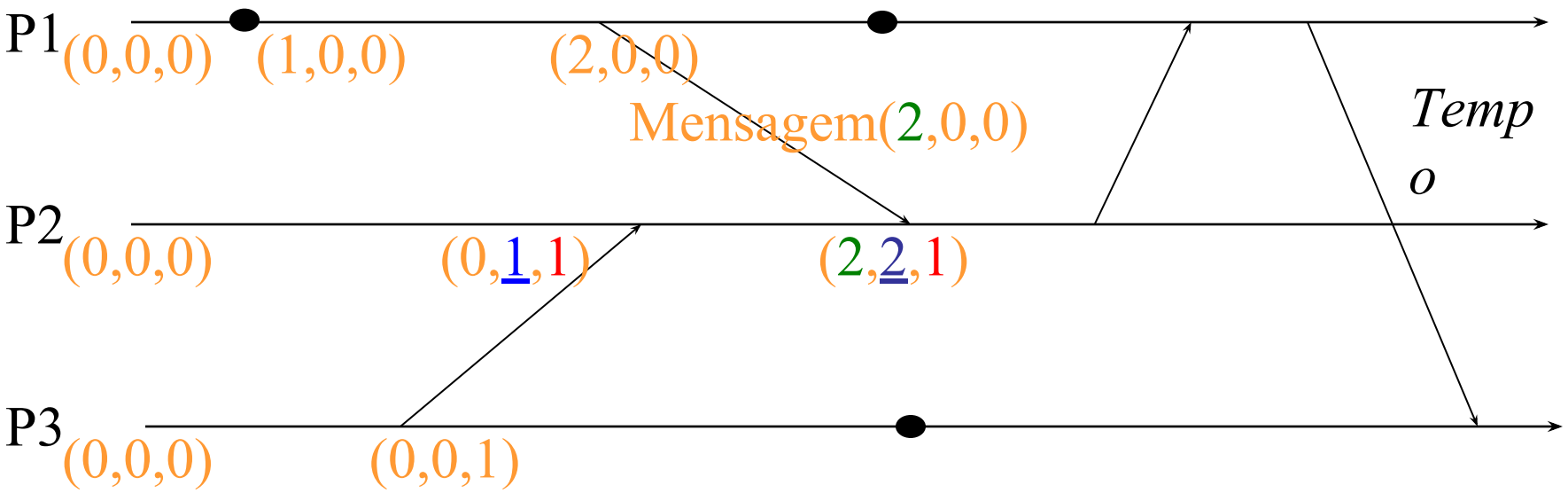
Figura 14.7
Vector timestamps dos eventos da Figura 14.5

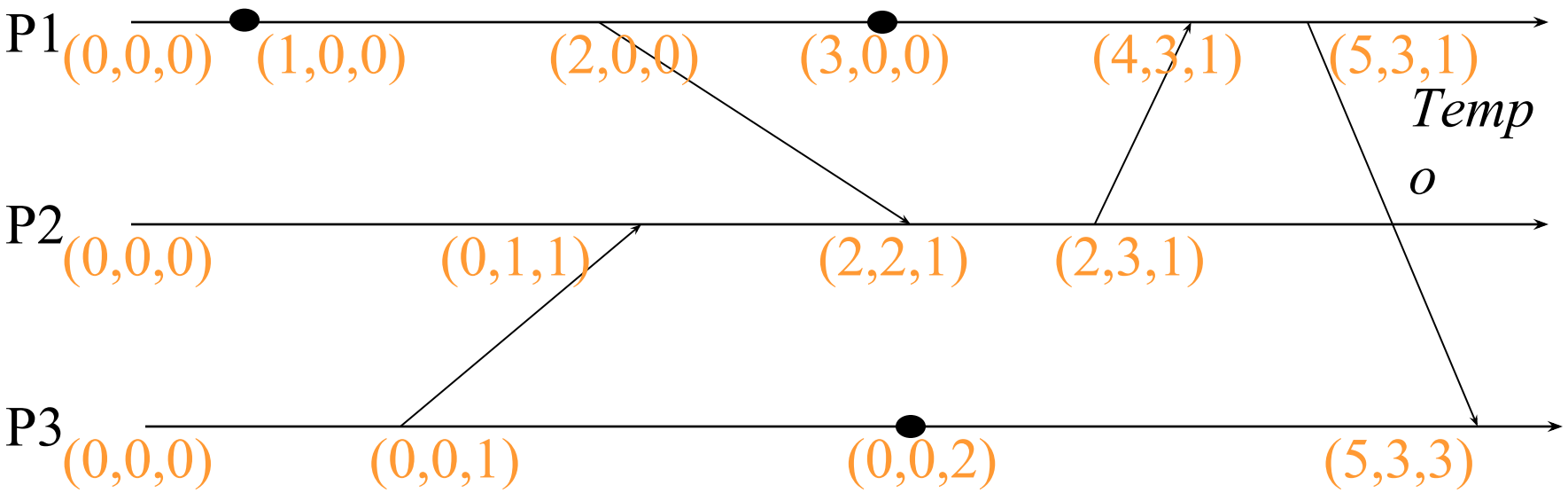


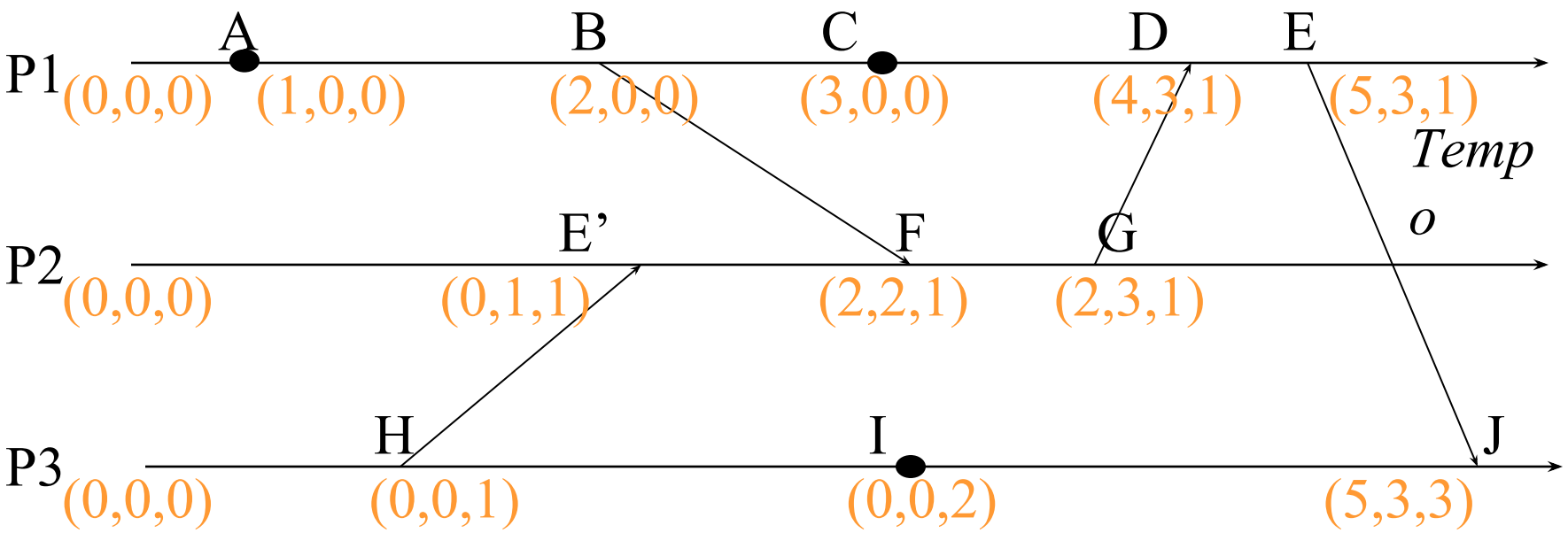


Contadores iniciais (clocks)


P1
(0,0,0)
(1,0,0)
Temp
o
P2
(0,0,0)
(0,1,1)
Mensagem(0,0,1)
P3
(0,0,0)
(0,0,1)


P1
(0,0,0)
(1,0,0)
(2,0,0)
Mensagem(2,0,0)
Temp
o
P2
(0,0,0)
(0,1,1)
(2,2,1)
P3
(0,0,0)
(0,0,1)


P1
(0,0,0)
(1,0,0)
(2,0,0)
(3,0,0)
(4,3,1)
(5,3,1)
Temp
o
P2
(0,0,0)
(0,1,1)
(2,2,1)
(2,3,1)
P3
(0,0,0)
(0,0,1)
(0,0,2)
(5,3,3)



- A → B :: (1,0,0) < (2,0,0)
- B → F :: (2,0,0) < (2,2,1)
- A → F :: (1,0,0) < (2,2,1)
- H → G :: (0,0,1) < (2,3,1)
- F → J :: (2,2,1) < (5,3,3)
- H → J :: (0,0,1) < (5,3,3)
- C → J :: (3,0,0) < (5,3,3)

Quais são os eventos concorrentes?

- C & F :: (3,0,0) ||| (2,2,1)
- H & C :: (0,0,1) ||| (3,0,0)

Ler capítulo 14.1 até o 14.4