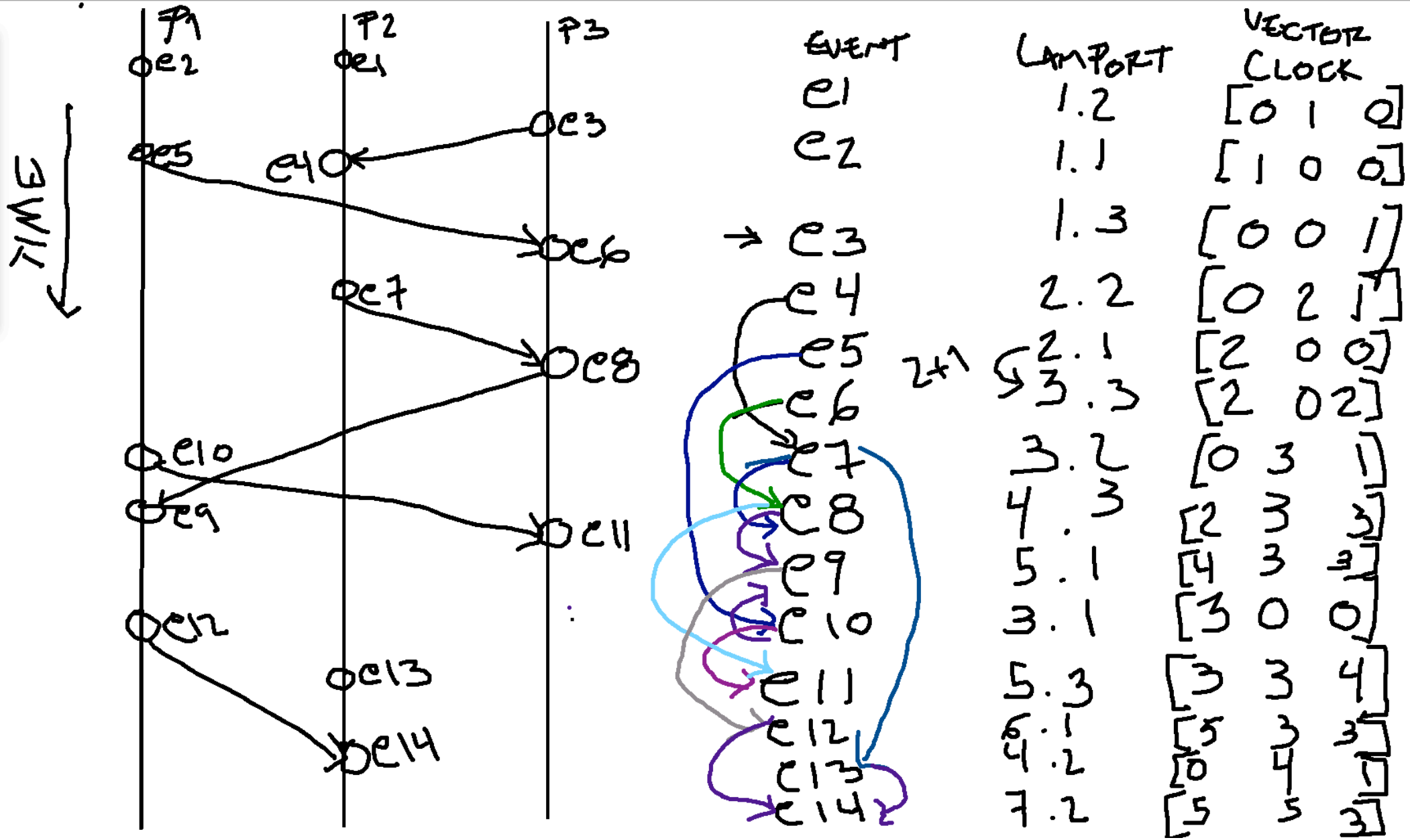


EVENT	LAMPORT	VECTOR CLOCK
e1	1.2	[0 1 0]
e2	1.1	[1 0 0]
→ e3	1.3	[0 0 1]
e4	2.2	[0 2 1]
e5	2.1	[2 0 0]
e6	3.3	[2 0 2]
e7	3.2	[0 3 1]
e8	4.3	[2 3 3]
e9	5.1	[4 3 3]
e10	3.1	[3 0 0]
e11	5.3	[3 3 4]
e12	6.1	[5 3 3]
e13	4.2	[0 4 1]
e14	7.2	[5 5 3]

2+1

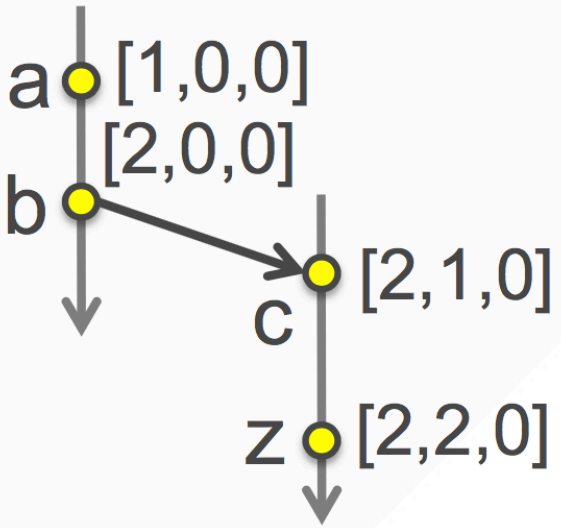
IS e4 DESCENDANT
FROM e2
T (F)

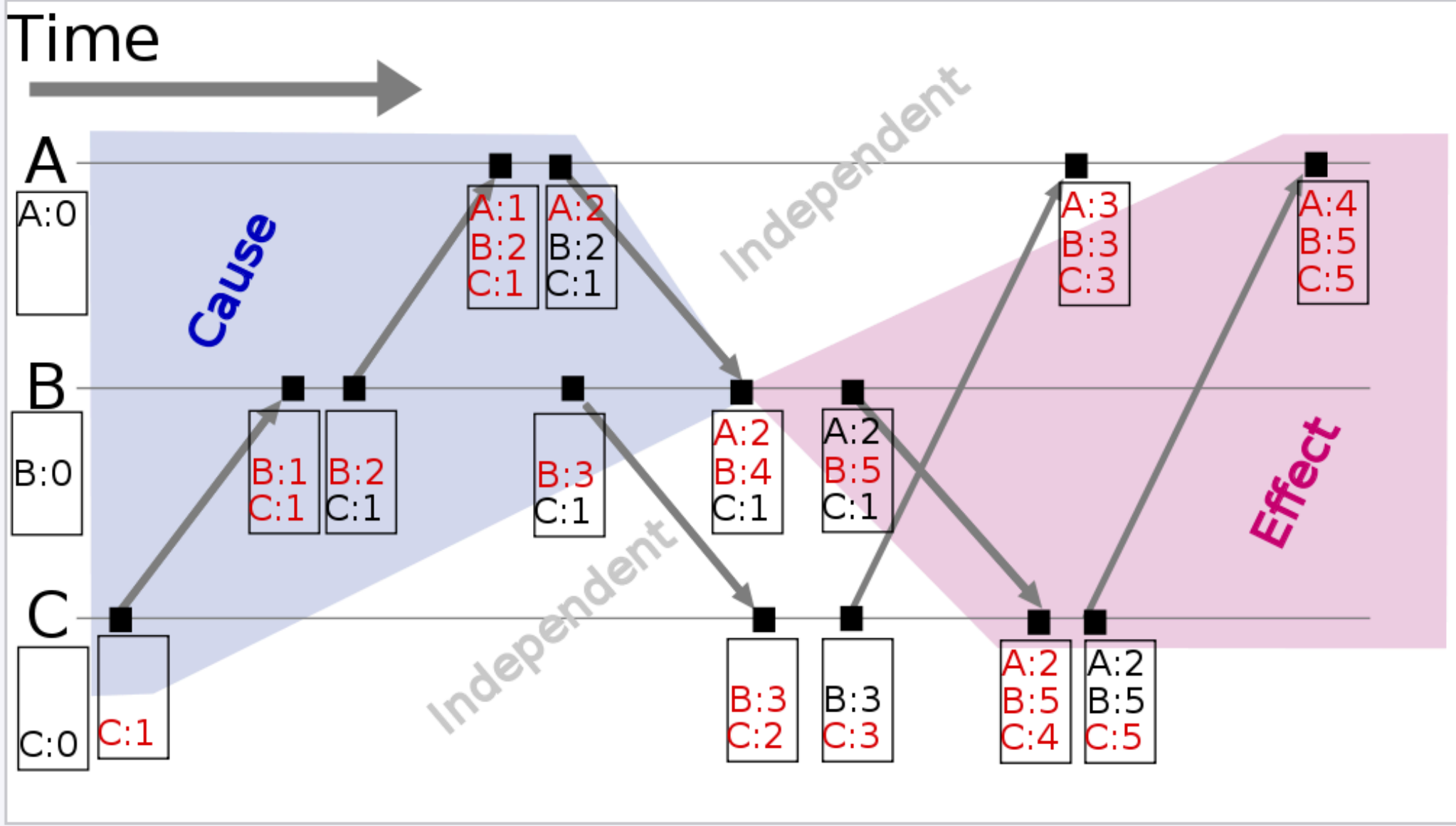
IS e10 DESCENDANT
FROM e2
(T) F

IS e9 DESCENDANT
FROM e6
(T) F

VECTOR CLOCKS CAN ESTABLISH CAUSALITY

- Rule for comparing vector clocks:
  - V(**a**) = V(**b**) when $\mathbf{a}_k = \mathbf{b}_k$ for all *k*
  - V(**a**) < V(**b**) when $\mathbf{a}_k \leq \mathbf{b}_k$ for all *k* and V(**a**) ≠ V(**b**)
- **Concurrency: *a* // *b*** if $\mathbf{a}_i < \mathbf{b}_i$ and $\mathbf{a}_j > \mathbf{b}_j$, some *i*, *j*
- V(a) < V(z) **when** there is a chain of events linked by → between a and z





Example of a system of vector clocks. Events in the blue region are the causes leading to event B4, whereas those in the red region are the effects of event B5