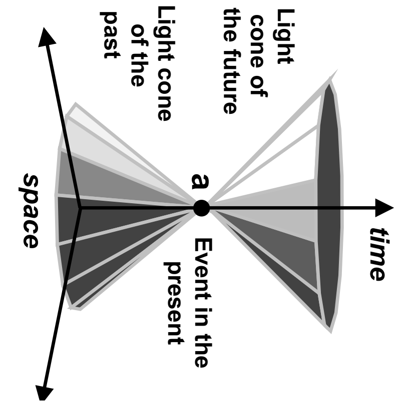
CSE 515 — Winter 2004

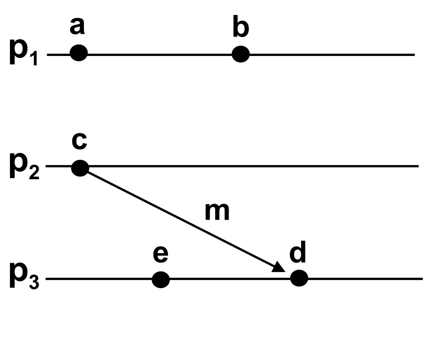
Time, Clocks & Ordering of Events

Class 2

Causality



Causality in Distributed Systems



Causality in Distributed Systems

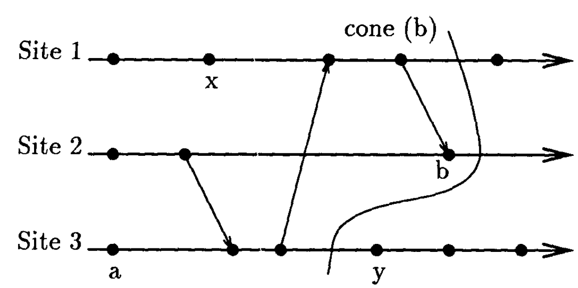
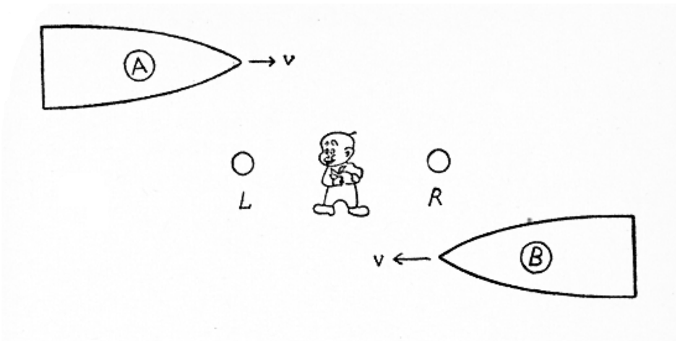


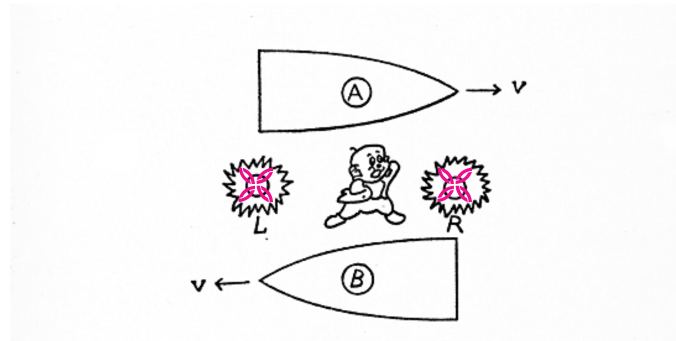
Figure 1: A distributed execution

Two Spaceships



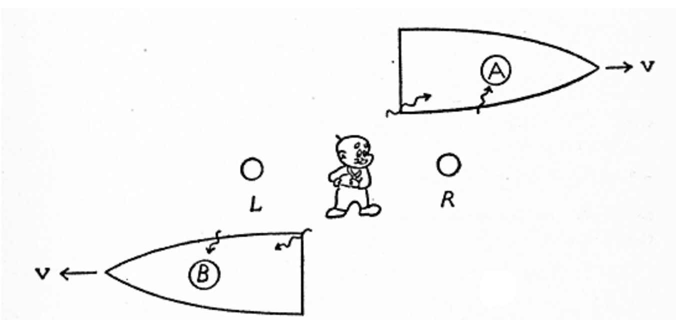
– Assume that A and B are travelling close to the speed of light.

L and R explode…



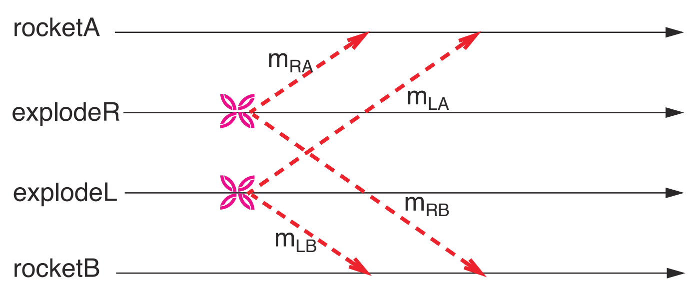
The "spacean" sees explosions simultaneously

The Pilots observe the Explosions!



A sees event R first
B sees event L first

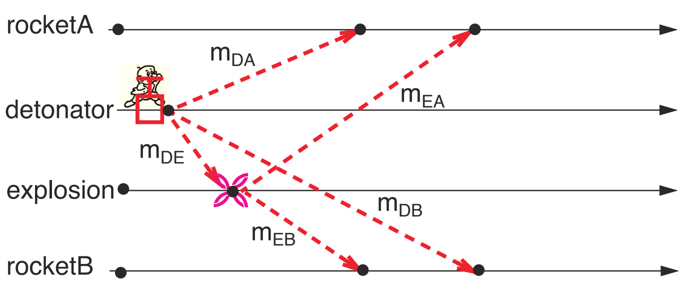
What about a Distributed System?



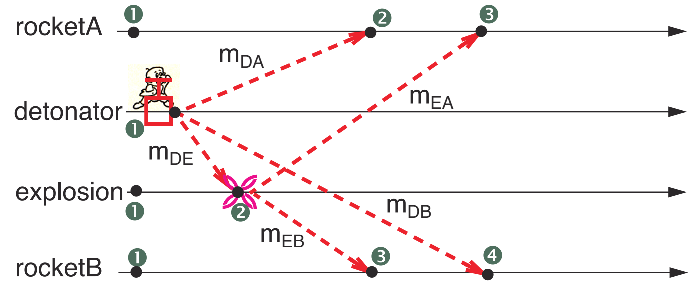
- Are the two  events simultaneous?

What about Causality?

- In relativity, if L *causes* R, the order of L and R must be the same for all observers
- Wouldn't this be a nice property for a distributed computer system?



Logical (Lamport) Clocks



- detonation preceeds explosion, because send(m_{DE}) $\rightarrow$ receive(m_{DE})
- what does B know about and ?

- Lamport clocks capture *potential* causal ordering: they cannot detect real causality.
- Causality is a partial order; Lamport clocks are a pre-order.
  - if $a \rightarrow b$, then $L(a) < L(b)$
  - $L(a) < L(b)$ *does not imply* that $a \rightarrow b$
  - $L(a) = L(b)$ implies $a \parallel b$
  - $a \parallel b$ *does not imply* that $L(a) = L(b)$

Vector Timestamps