

CSE 515 — Winter 2004

Time, Clocks & Ordering of Events

Class 2

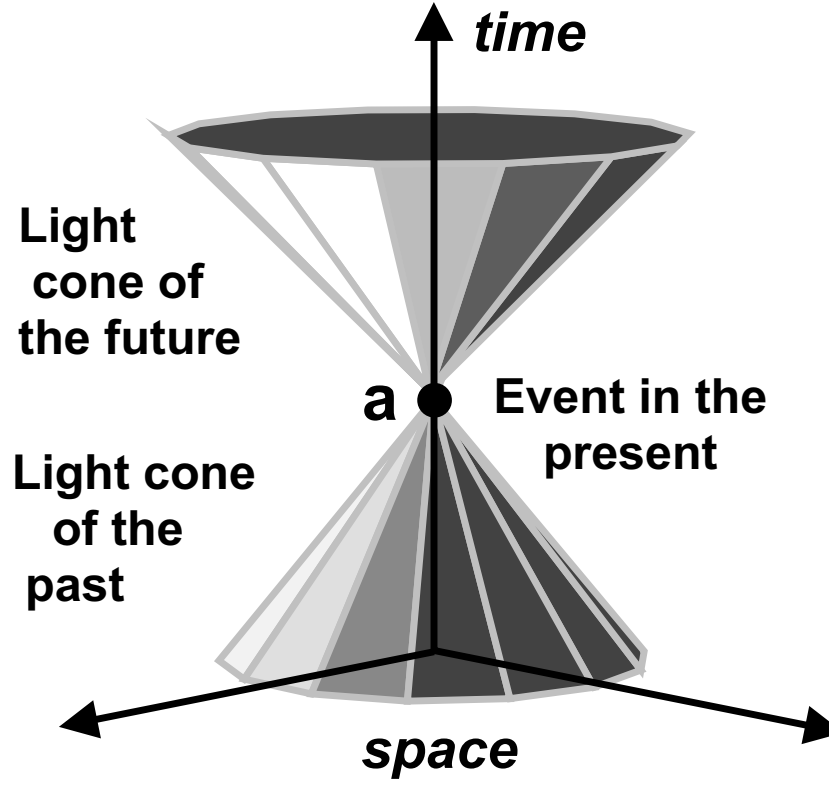


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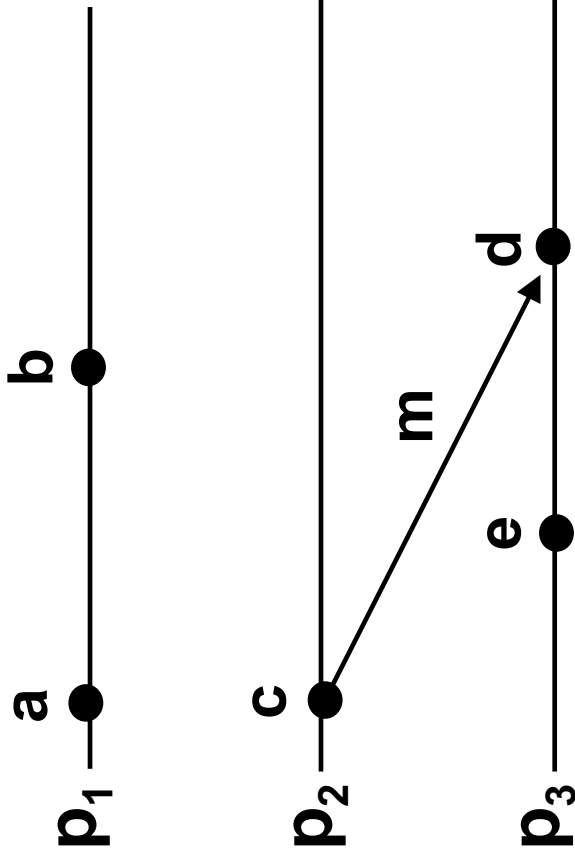
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Causality



Causality in Distributed Systems



Causality in Distributed Systems

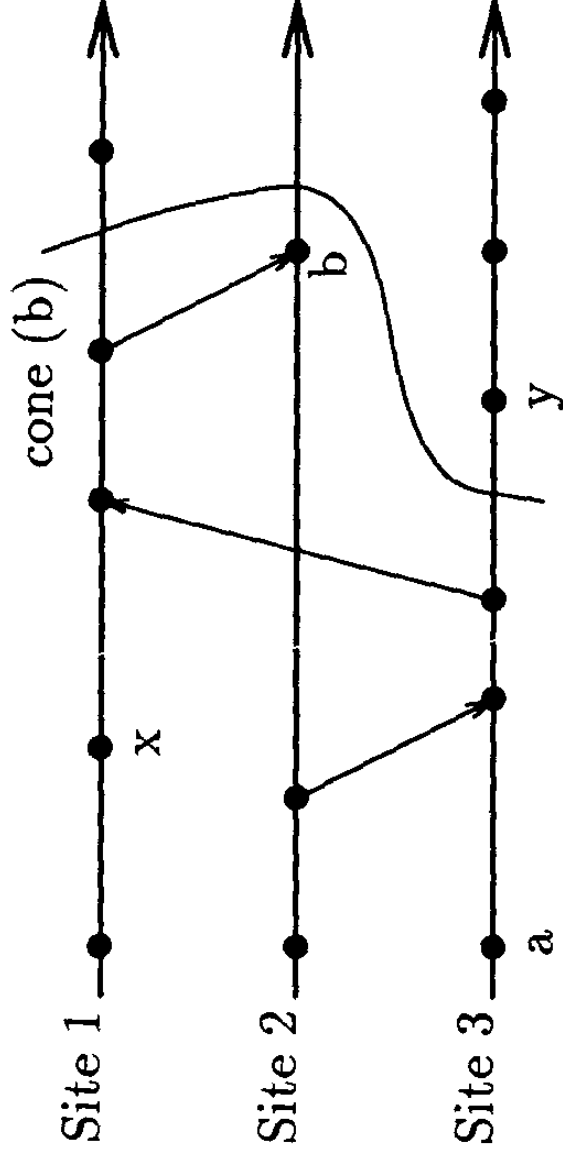
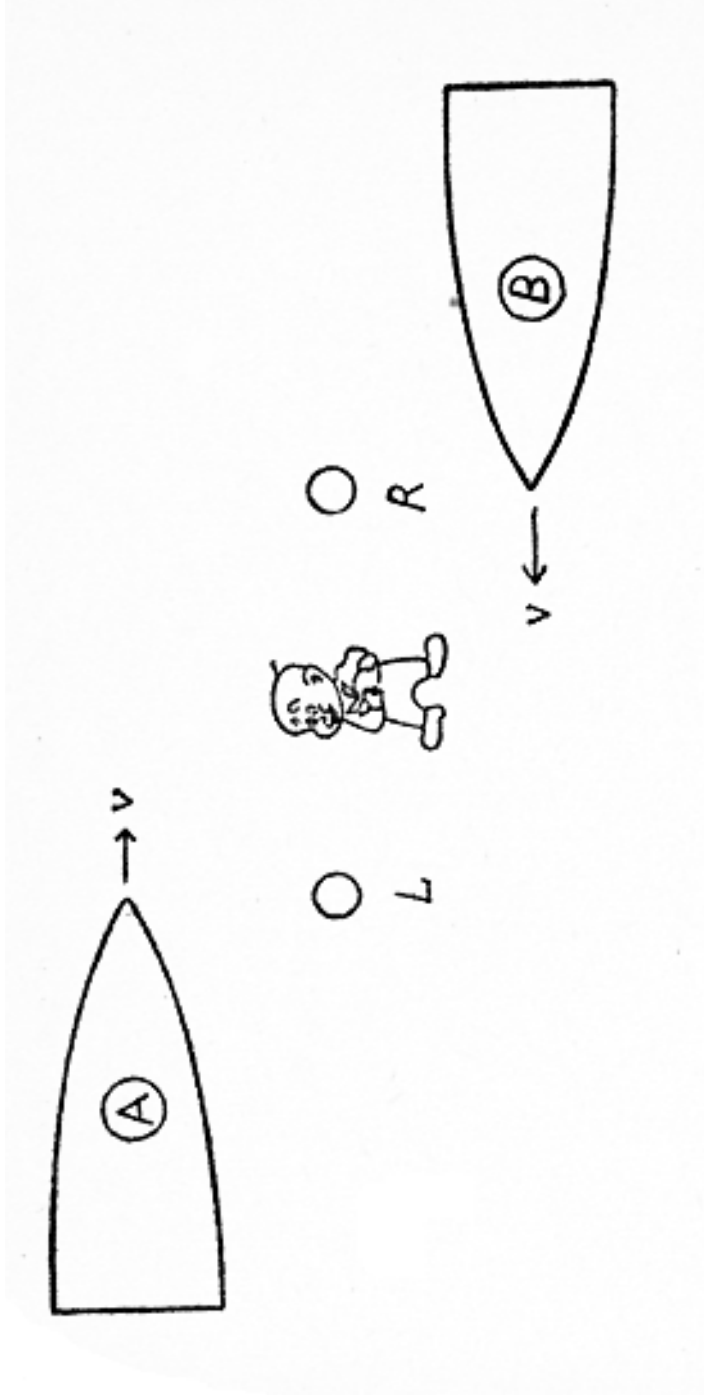


Figure 1: A distributed execution



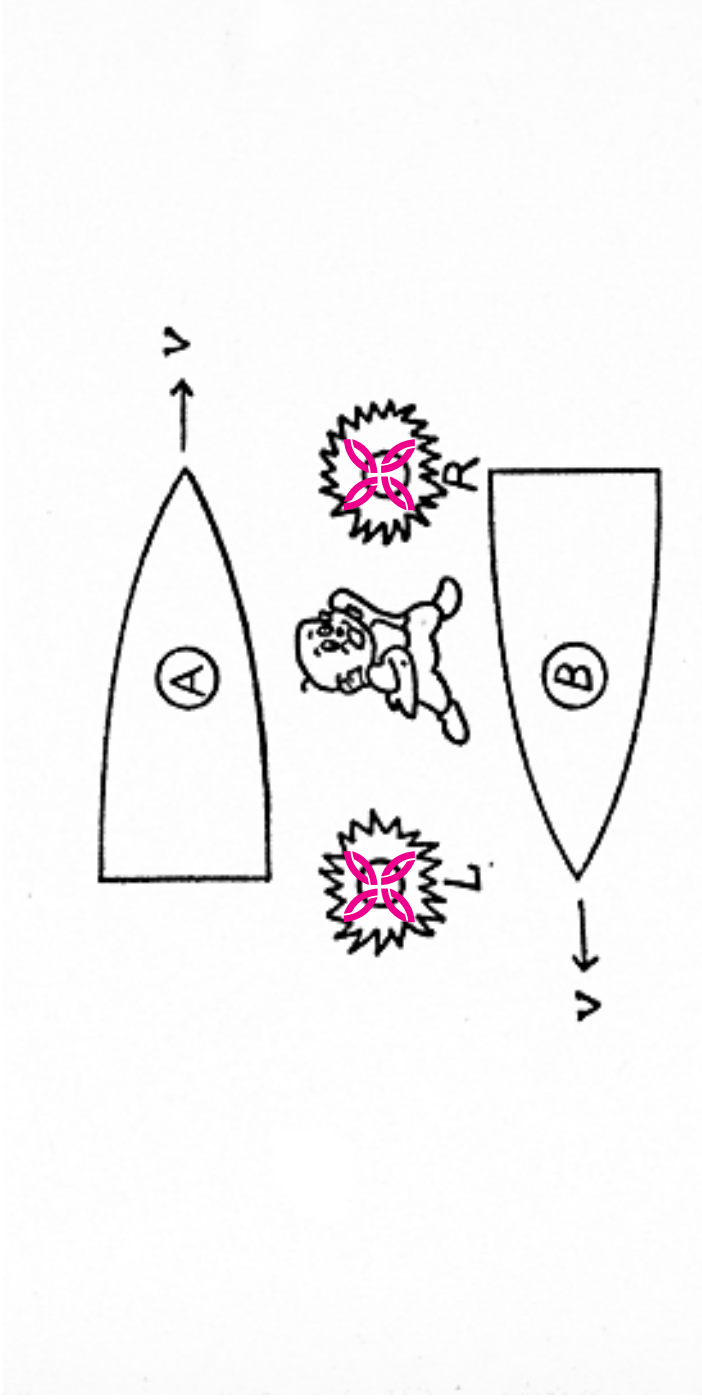
Two Spaceships



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



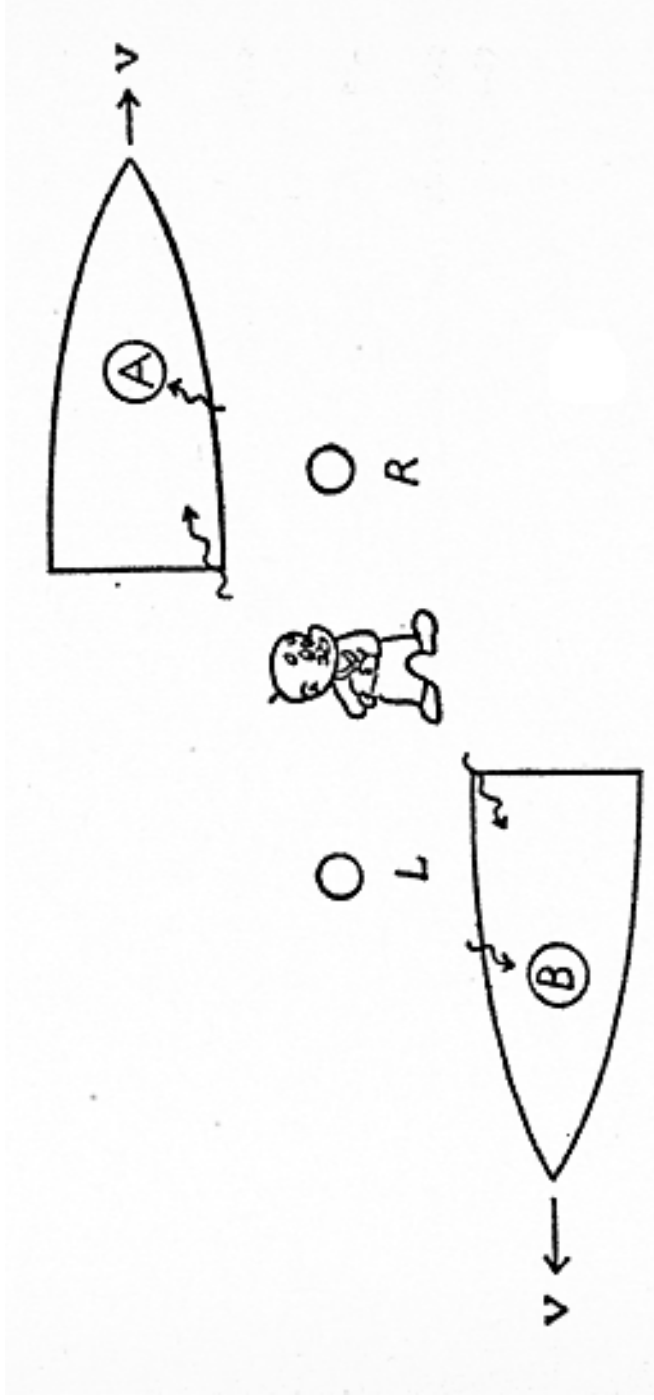
L and R explode...



The “spacean” sees explosions simultaneously



The Pilots observe the Explosions!

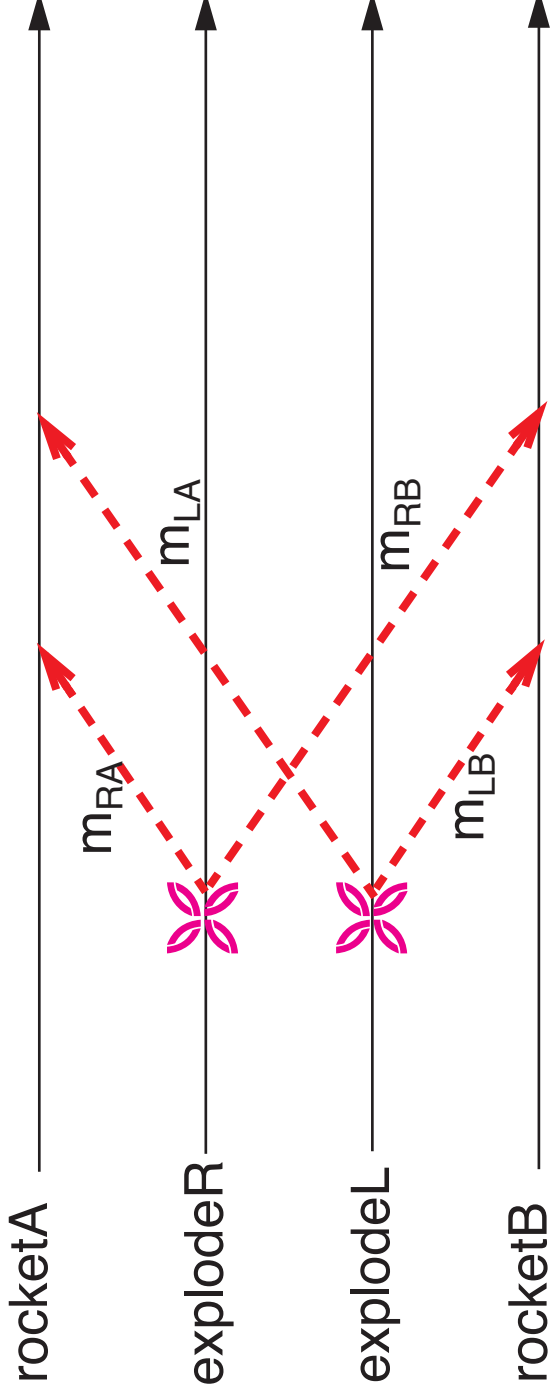


A sees event R first

B sees event L first



What about a Distributed System?

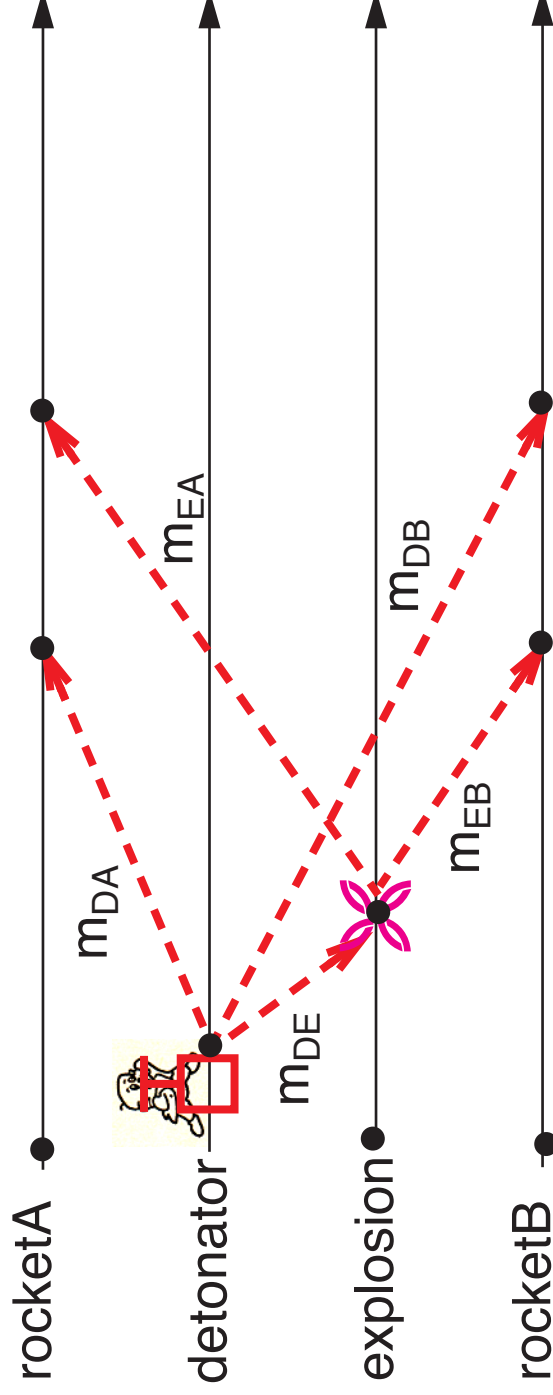


- Are the two  events simultaneous?

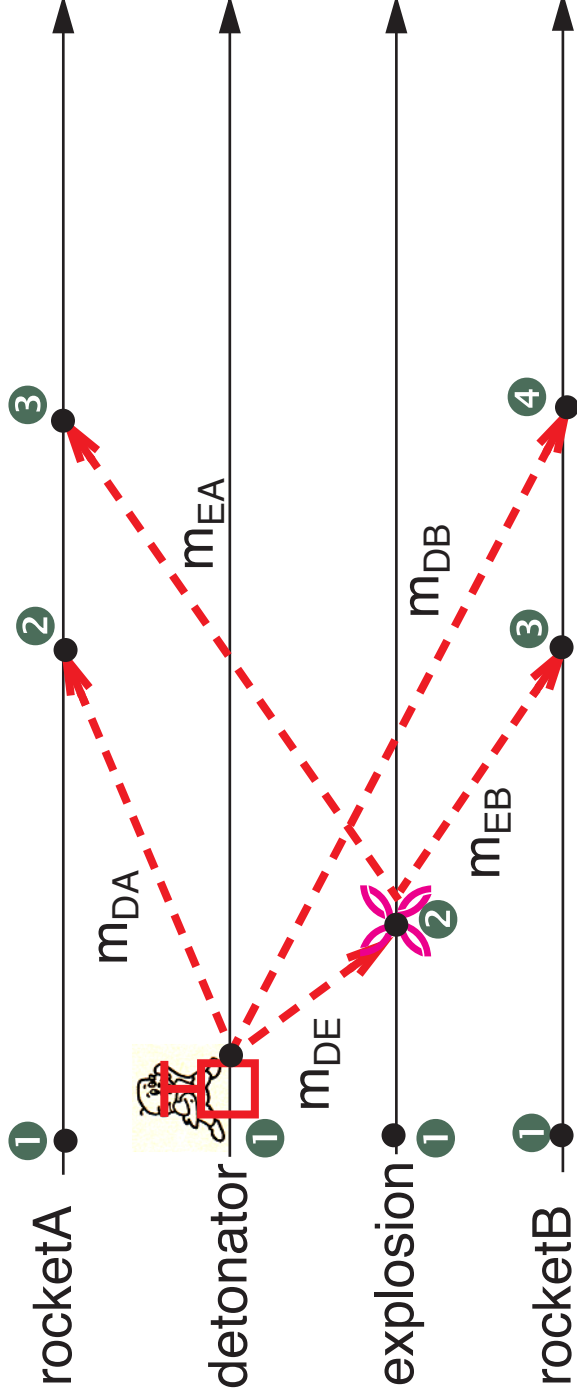


What about Causality?

- 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 precedes explosion, because $\text{send}(m_{DE}) \rightarrow \text{receive}(m_{DE})$

– 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

