

# Large Scale Software Engineering

## VTime

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Mike Helmick  
University of Cincinnati  
CS6028  
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# Leslie Lamport

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- [http://en.wikipedia.org/wiki/Leslie\\_Lamport](http://en.wikipedia.org/wiki/Leslie_Lamport)

# Time

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- Time is fundamental to our way of thinking
- The concepts of before and after, of temporal ordering is universal
  - It also is pervasive in our thinking about programs and systems

# Ordering

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- A user must sign up for an account before they are allowed to post
- A message is deleted from the backing store after the user presses the delete button
- (from paper) - airline reserve ration system - a request for a reservation should be allowed if it is made before the seat is filled

# Distributed Systems

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- Ordering is easy in a single threaded program, running on a single machine
- Our reasoning about temporal ordering doesn't hold up in distributed systems

# Distributed System Definition

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- “A collection of distributed processes which are spatially separated, and which communicate with one another by exchanging messages”
  - Spatially separated:
    - Could be different processes on the same system
    - Could be systems next to each other in the same rack
    - More likely - a collection of processes on different machines in the same data center AND in other data centers with significant geographic distance between them

# Happened Before

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- In a distributed system, it can be impossible to say that given two events, which one occurred first
- “happend before”
  - is only a partial ordering of events in the system