

# Distributed Computing III

*Murphy was an optimist*

CSSE6400

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Question

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- Timeout

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What to do if fault is detected?

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### Answer

- Retry
- Restart



### Definition 1. Idempotency

Repeating an operation does not change receiver's state.

# Byzantine Generals Problem



- $n$  generals need to agree on plan
- Can only communicate via messenger
- Messenger may be delayed or lost
- Some generals are traitors
  - Send dishonest messages
  - Pretend to have not received message

Question

How to order asynchronous messages?

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How to order asynchronous messages?

## Answer

- Timestamps?
  - Can't keep clocks in sync
  - Limited clock precision

Consistency

Eventual Consistency weak guarantee

Linearisability strong guarantee

Causal Ordering strong guarantee

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- Multi-leader replication can't be linearised
- Leaderless replication
  - Lock value on quorum before writing

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## Causal Order

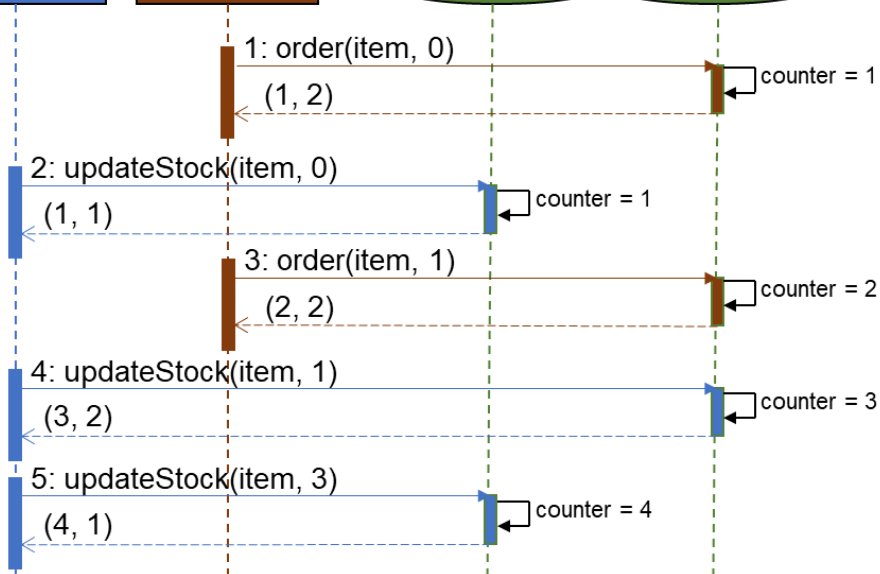
- Order is based on causality
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- Single-leader replication
  - Record sequence number of writes in log
  - Followers read log to execute writes
- Lamport timestamps

Inventory  
Updater

Order

ProductDB1

ProductDB2



## Definition 2. Consensus

A set of nodes in the system agree on some aspect of the system's state.

## Consensus Properties

**Uniform Agreement** All nodes must agree on the decision

**Integrity** Nodes can only vote once

**Validity** Result must have been proposed by a node

**Termination** Every node that doesn't crash must decide

### Definition 3. Atomic Commit

All nodes participating in a distributed transaction need to form consensus to complete the transaction.



## Two-Phase Commit

**Prepare** Confirm nodes can commit transaction

**Commit** Finalise commit once consensus is reached

- Abort if consensus can't be reached

