Distributed Computing III

Murphy was an optimist

CSSE6400

Richard Thomas

May 9, 2022

Question

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Answer

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- Timeout

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Answer

- Retry
- Restart

Definition 1. Idempotency

Repeating an operation does not change receiver's state.

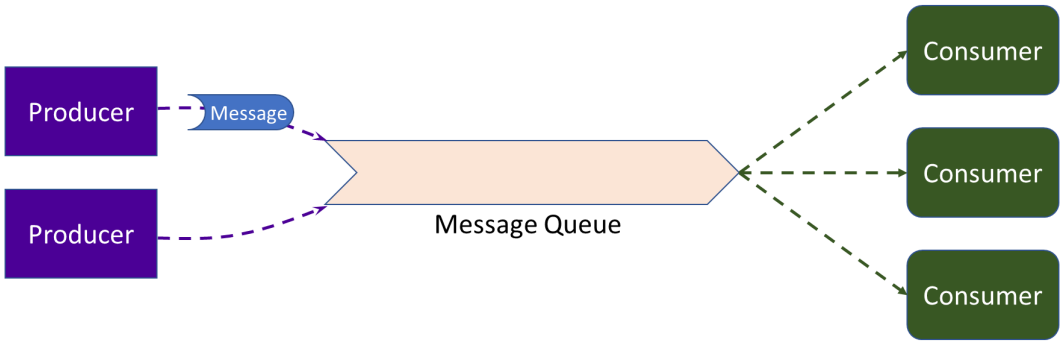
Byzantine Generals Problem

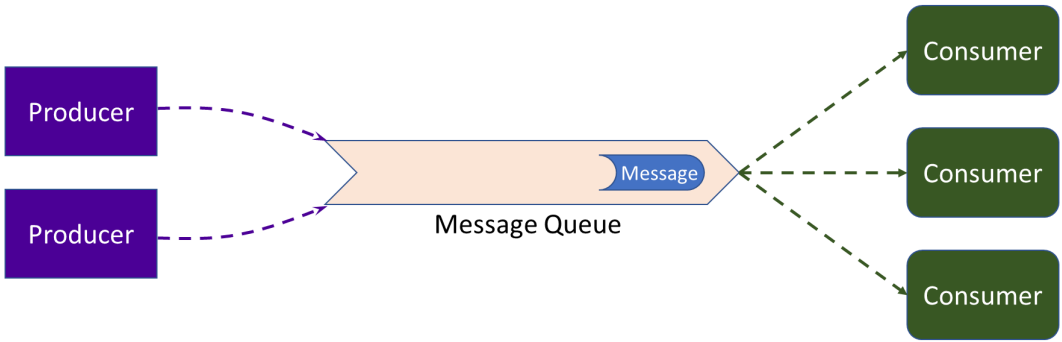
- *n* generals need to agree on plan
- Can only communicate via messenger
- Messenger may be delayed or lost
- Some generals are traitors
  - Send dishonest messages
  - Pretend to have not received message

Definition 2. Poison Message

A message that causes the receiver to fail.

Normal Message Flow


Producer
Message
Producer
Message Queue
Consumer
Consumer
Consumer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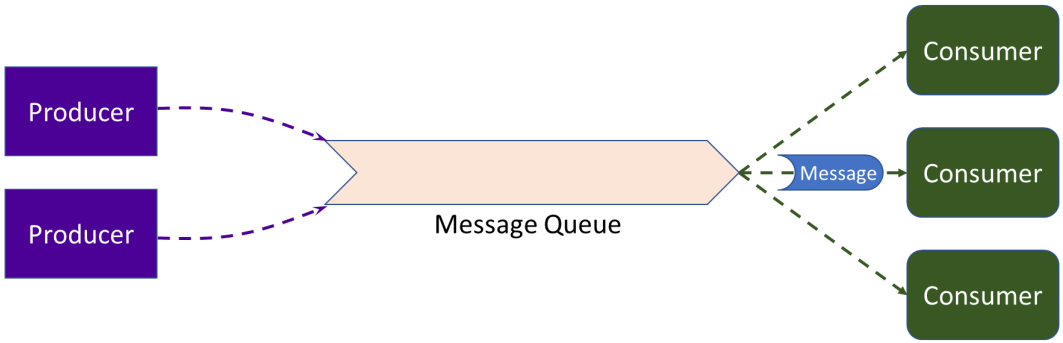
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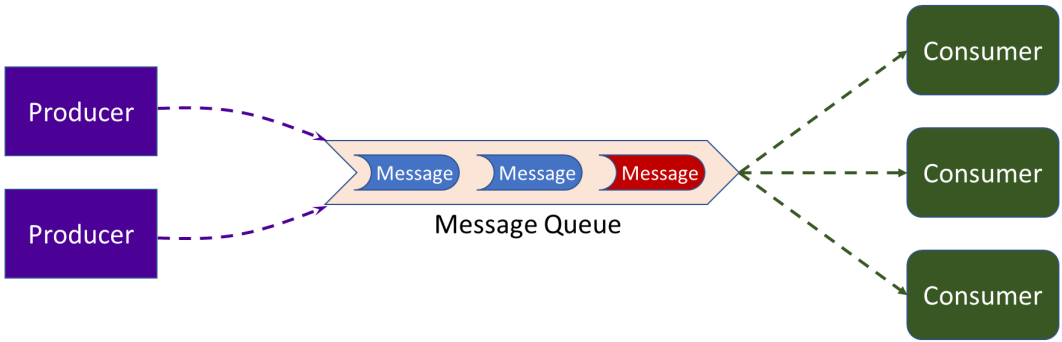
Poison Message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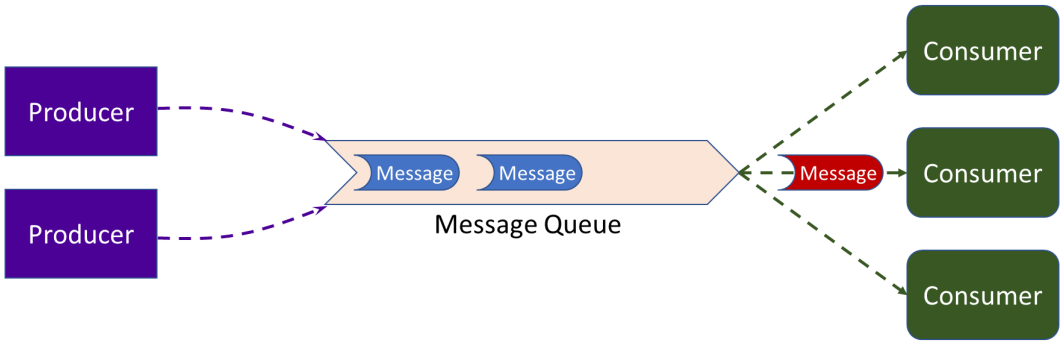
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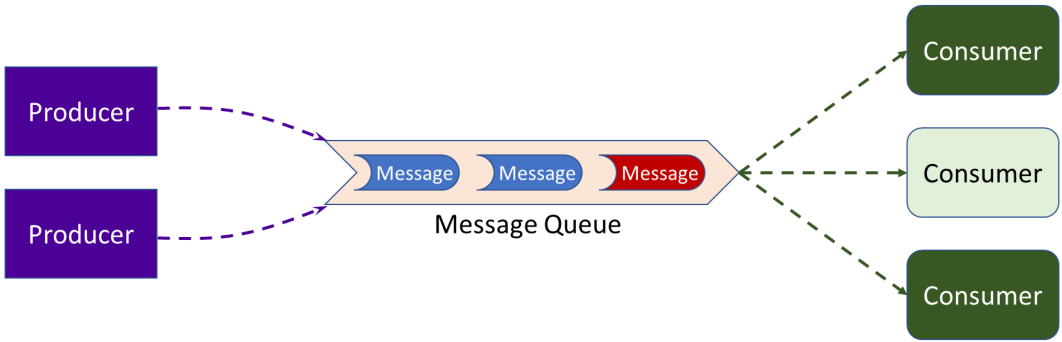
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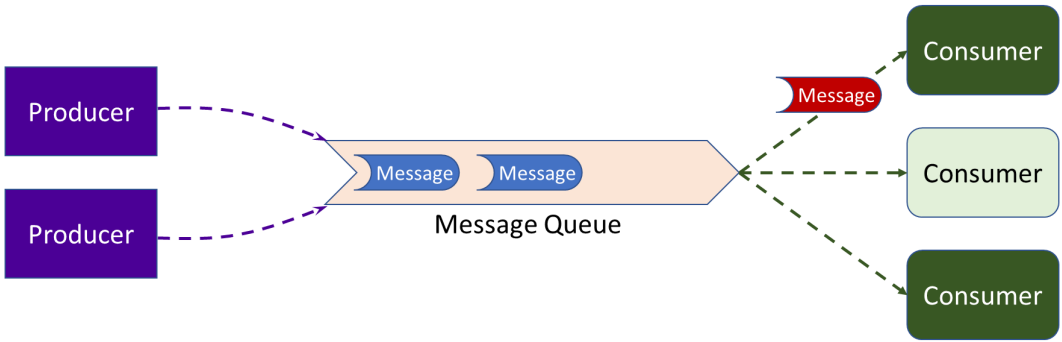
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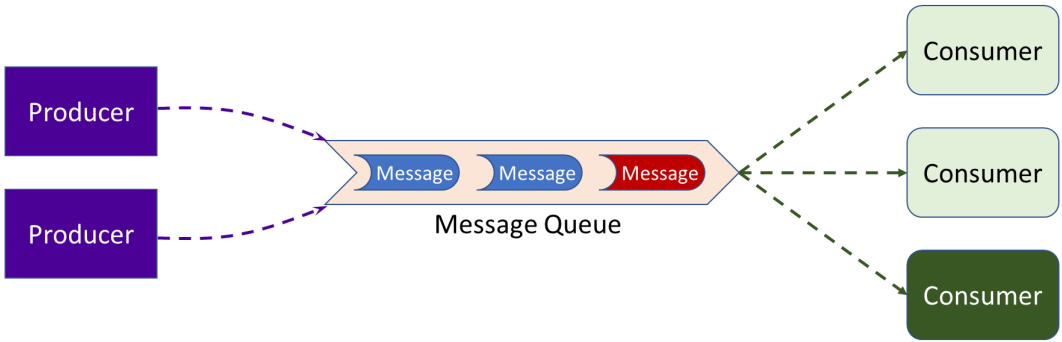
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- Content is invalid
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Answer

- Content is invalid
  - e.g. Invalid product id sent to purchasing service
  - Error handling doesn't cater for error case
- System state is invalid
  - e.g. Add item to shopping cart that has been deleted
  - Logic doesn't handle out of order messages
    - Insidious asynchronous faults

Detecting Poison Messages

Retry counter – with limit

- Where is counter stored?
  - Memory – What if server restarts?
  - DB – Slow
  - Must ensure counter is reset, regardless of how message is handled
    - e.g. Message is manually deleted

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Message service may have a timeout property

- Message removed from queue
  - Pending messages get older while waiting for poison message
  - Transient network faults may exceed timeout

Detecting Poison Messages

Monitoring service

- Trigger action if message stays at top of queue for too long
- Can check for queue errors
  - No messages are being processed
  - Restart message service

Handling Poison Messages

Discard message

- System must not require guarantee of message delivery
- Suitable when message processing speed is most important

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Discard message

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Always retry

- Requires mechanism to fix message
  - Often requires manual intervention
- Suitable when message delivery is most important
- Very long delays in processing

Handling Poison Messages

Dead-letter queue

- Long transient failures result in adding many messages
  - e.g. Network failure
- Requires manual monitoring and intervention
- System must not require strict ordering of messages
- Suitable when message processing speed is important

Handling Poison Messages

Retry queue

- Transient failures also added
- Use a previous strategy to deal with poison messages
- System must not require strict ordering of messages
- Suitable when message processing speed is very important
  - Main queue is never blocked
  - Receivers need to process from two message queues

Definition 3. Poison Pill Message

Special message used to notify receiver it should no longer wait for messages.

Question

Why use a poison pill message?

Question

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Answer

Graceful shutdown of system.

Question

How to order asynchronous messages?

Question

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

Linearisability

- Once value is written, all reads see same value
  - Regardless of replica read from

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- Leaderless replication
  - Lock value on quorum before writing

Causal Order

- Order is based on causality
  - What event needs to happen before another
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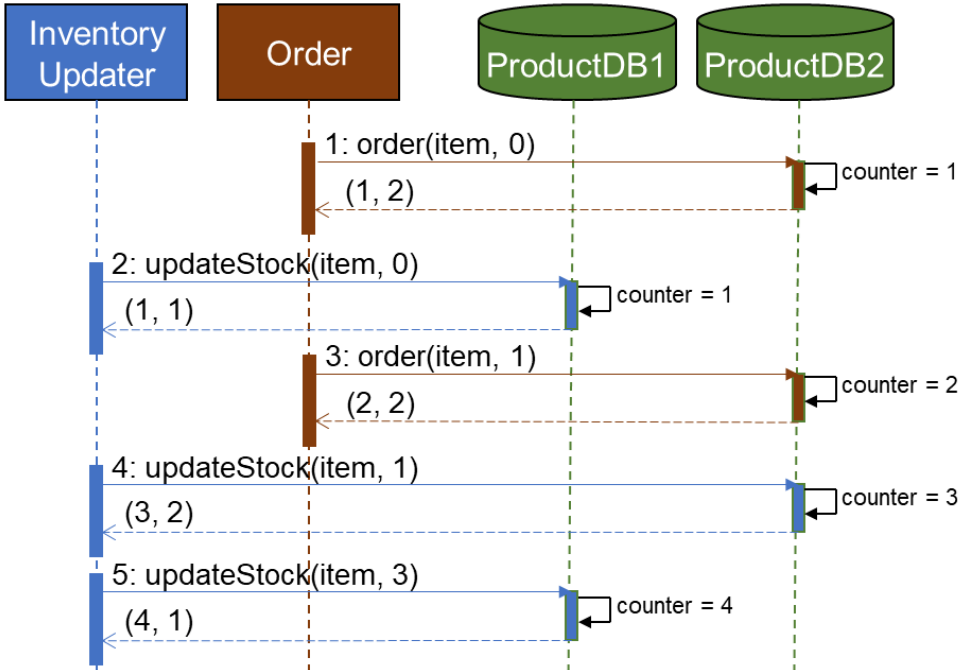
- Lamport timestamps


Inventory Updater
Order
ProductDB1
ProductDB2
1: order(item, 0)
(1, 2)
counter = 1
2: updateStock(item, 0)
(1, 1)
counter = 1
3: order(item, 1)
(2, 2)
counter = 2
4: updateStock(item, 1)
(3, 2)
counter = 3
5: updateStock(item, 3)
(4, 1)
counter = 4

Definition 4. 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 5. Atomic Commit

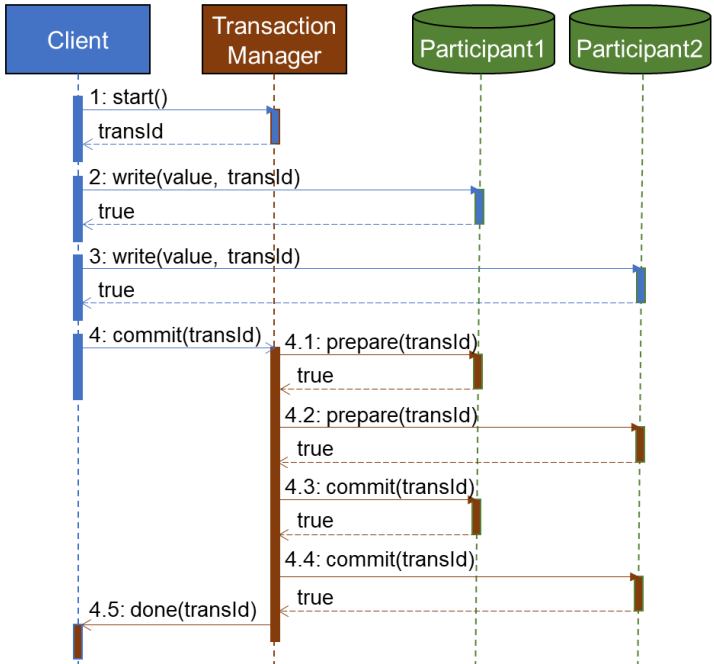
All nodes participating in a distributed transaction need to form consensus to complete the transaction.

Two-Phase Commit

Prepare Confirm nodes can commit transaction

Commit Finalise commit once consensus is reached

- Abort if consensus can't be reached


Client
Transaction Manager
Participant1
Participant2
1: start()
transId
2: write(value, transId)
true
3: write(value, transId)
true
4: commit(transId)
4.1: prepare(transId)
true
4.2: prepare(transId)
true
4.3: commit(transId)
true
4.4: commit(transId)
true
4.5: done(transId)