Distributed Data Systems

DIANE WOODBRIDGE, PH.D

Content

MongoDB

- Sharding
- Replication
- CAP Theorem

Content

MongoDB

- **Sharding**
- Replication
- CAP Theorem

Distribution Models

Single Server Model vs. Distribution Model

- If we can get away without distribution, we should choose a single-server approach.
    - This eliminates all the complexities and easy to manage operations.
    - Ex. Graph Database

Distribution Models

Aggregate

- Collection of related objects treated as a unit.
- Natural unit for distribution.

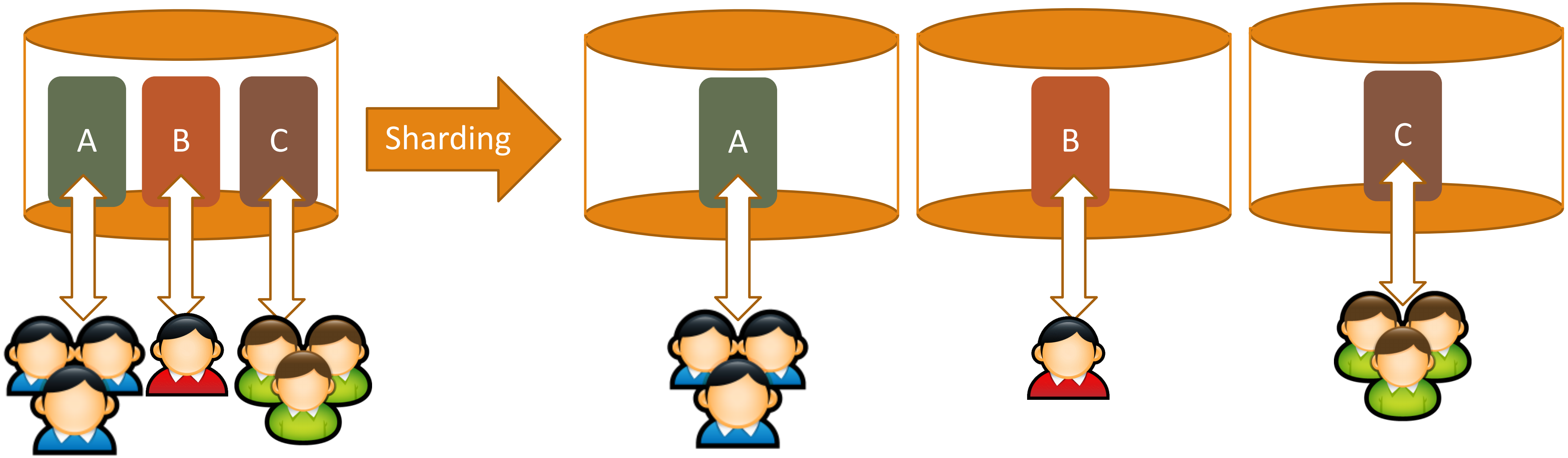
Two ways for data distribution

- Sharding : Place different data on different nodes.
- Replication : Copy the same data over multiple nodes.
  - Primary-Secondary Replication
  - Peer-to-Peer Replication (See Appendix)

Distribution Models

Sharding

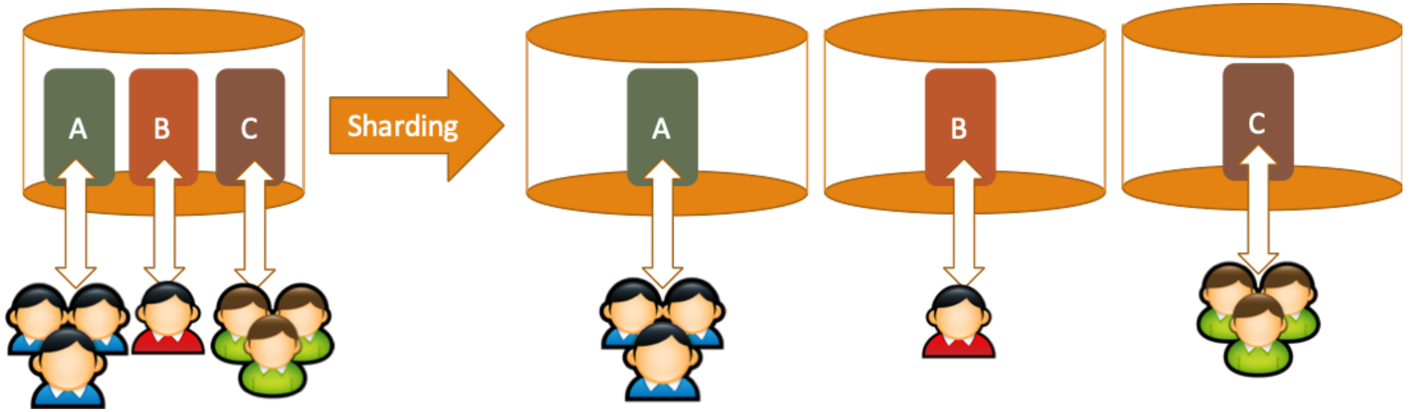
- Distributing data into different servers, and each of them does its own reads and writes. ➔ Improves scalability.



Distribution Models

Sharding

- Things to consider
  1. Locate the data commonly accessed together on the same node (Aggregate and/or Data accessed sequentially together.).
  2. Physical location.
  3. Keep the load even.
- Pros : Improves read and writes.
- Cons : Low resilience.



MongoDB and Sharding

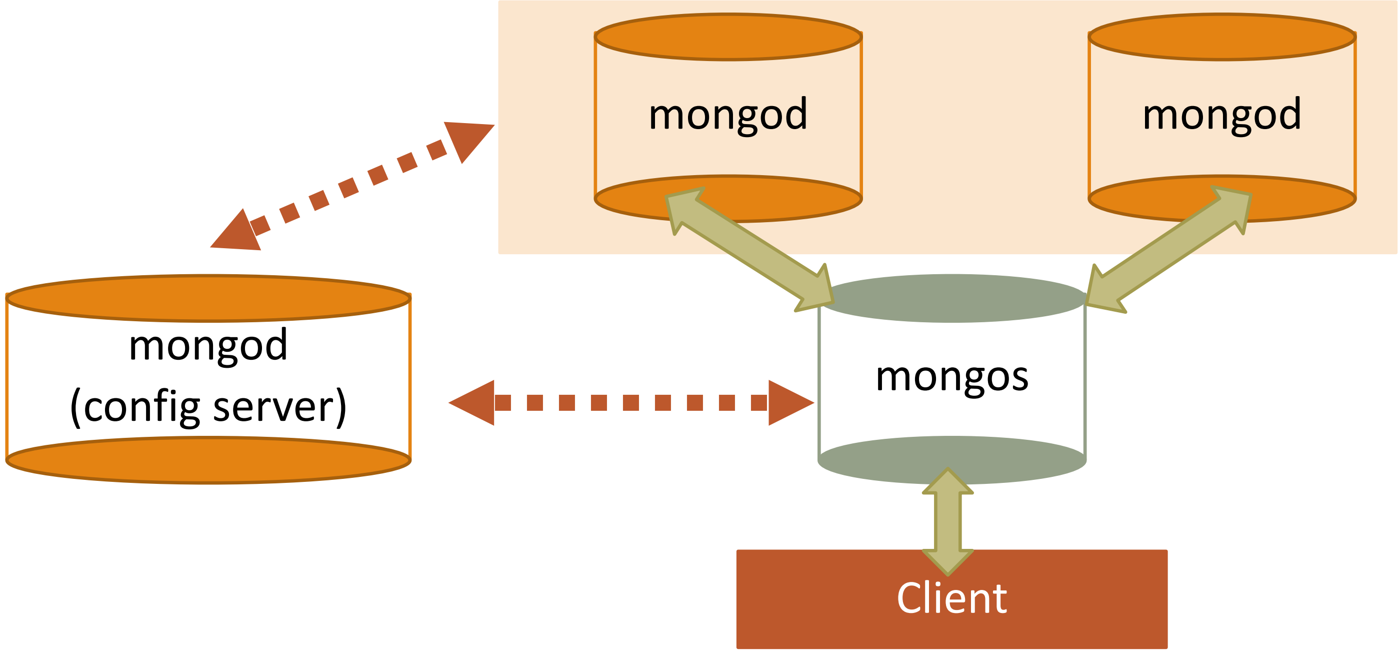
Sharding

- MongoDB supports auto-sharding.
  - Database takes the responsibility of allocating data to shards, balancing data across shards, ensuring data access goes to the right shard.

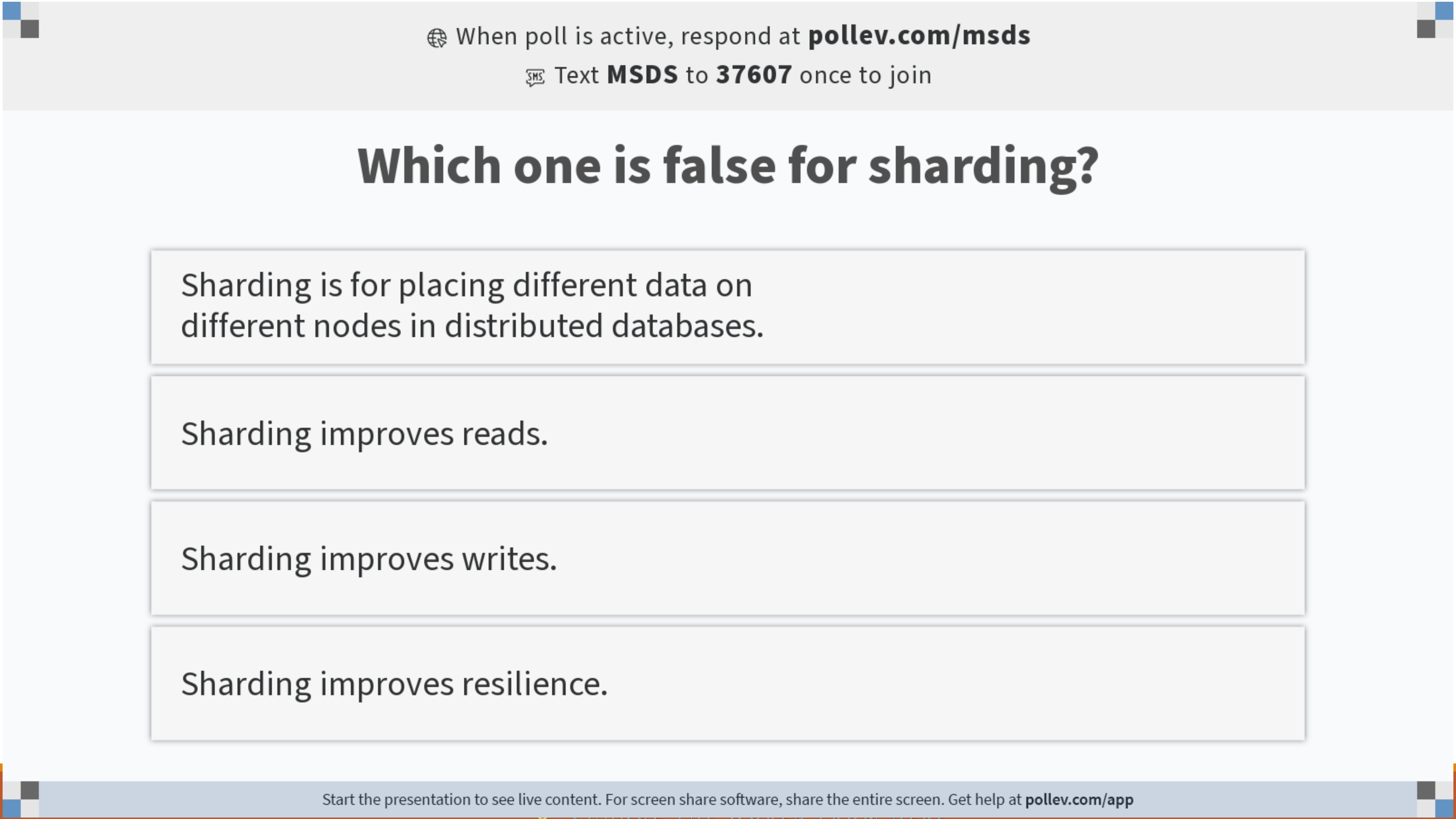
MongoDB and Sharding

Sharding

- mongod : Primary database process (a daemon) that runs on an individual server.
- mongos : Routing process to manage storing different data on different servers and query against the right server.



https://docs.mongodb.com/manual/core/sharded-cluster-components/



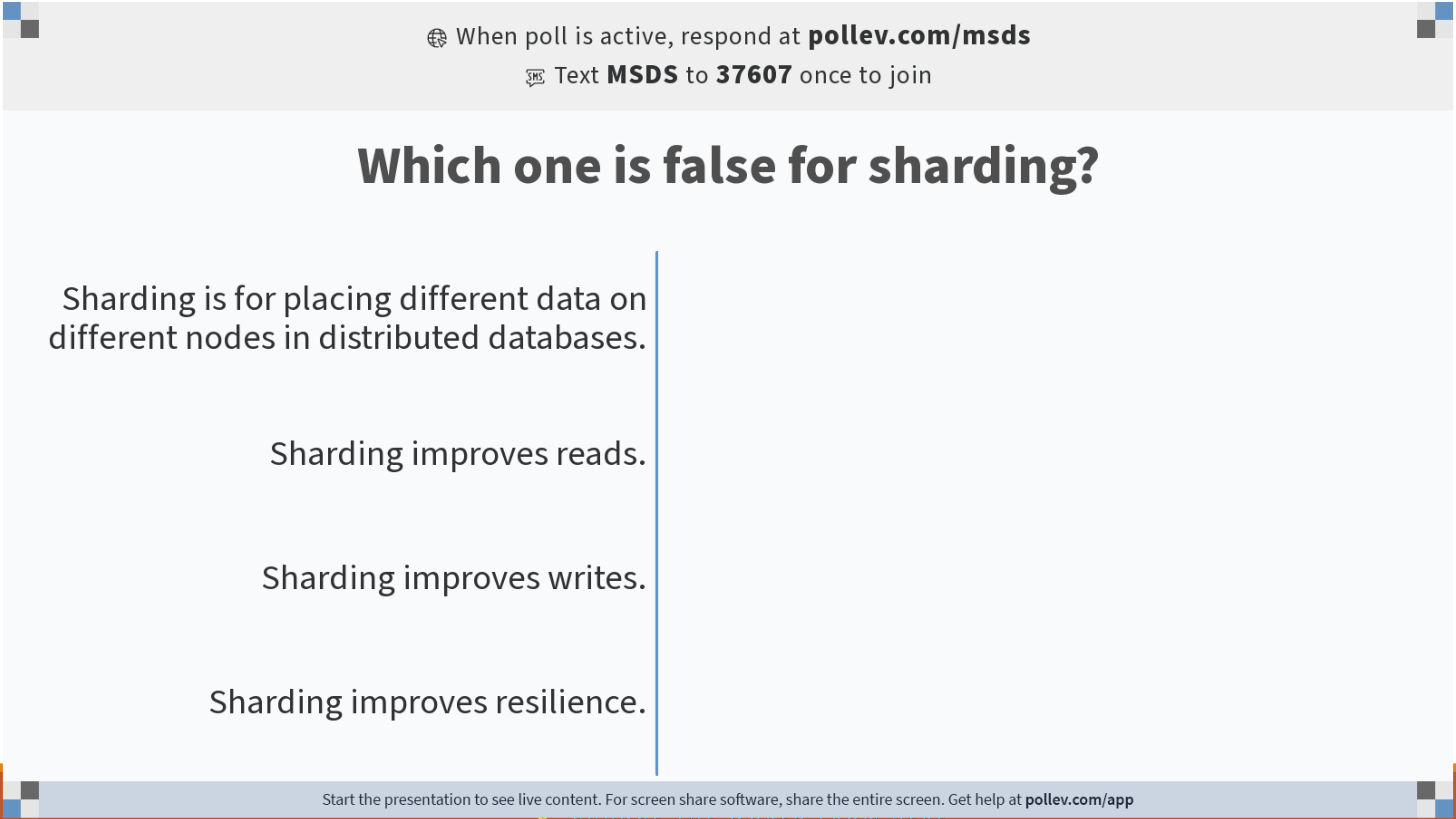
When poll is active, respond at **pollev.com/msds**

Text **MSDS** to **37607** once to join

Which one is false for sharding?

- Sharding is for placing different data on different nodes in distributed databases.
- Sharding improves reads.
- Sharding improves writes.
- Sharding improves resilience.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**



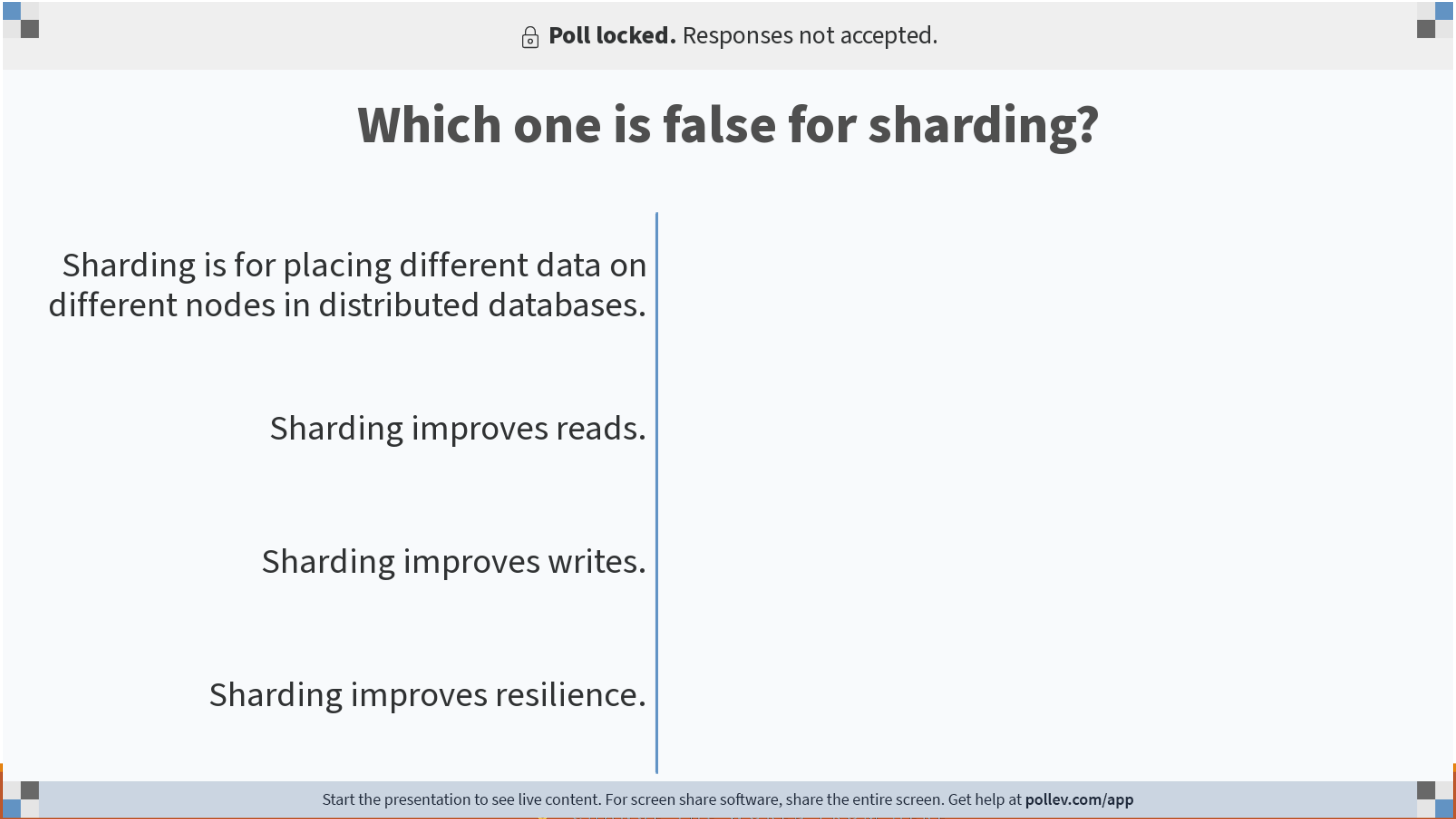
When poll is active, respond at **pollev.com/msds**

Text **MSDS** to **37607** once to join

Which one is false for sharding?

- Sharding is for placing different data on different nodes in distributed databases.
- Sharding improves reads.
- Sharding improves writes.
- Sharding improves resilience.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**



Poll locked. Responses not accepted.

Which one is false for sharding?

Sharding is for placing different data on different nodes in distributed databases.

Sharding improves reads.

Sharding improves writes.

Sharding improves resilience.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

Content

MongoDB

- Sharding
- **Replication**
- CAP Theorem

Distribution Models

Replications: Copy the same data over multiple nodes.

- Replication provides redundancy and increases data availability.
  - Provides fault tolerance against the loss of a single database server.

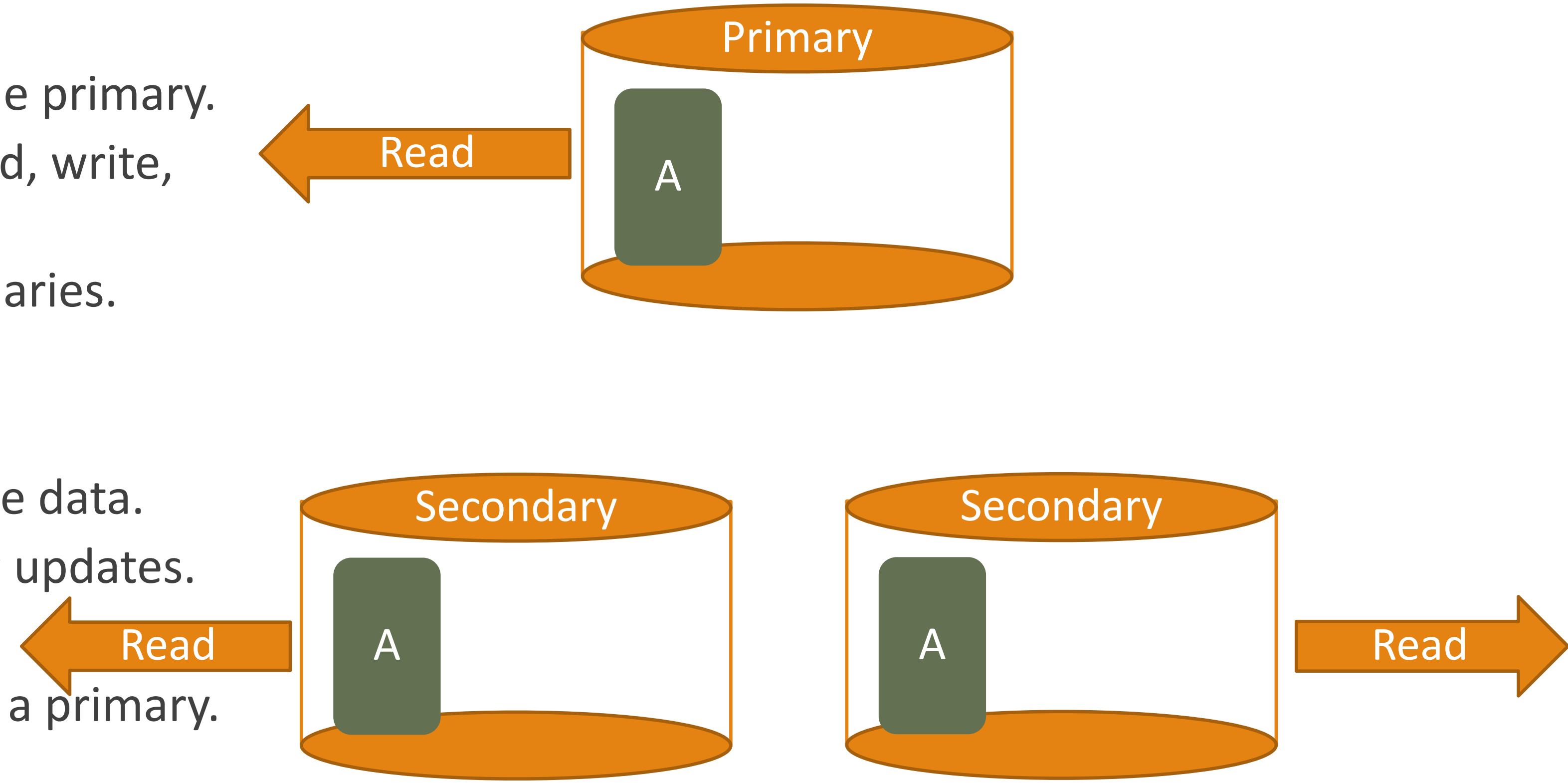
- Types
  - Primary-Secondary replication
  - Peer-to-peer replication (See Appendix)

Distribution Models

MongoDB : By default, you cannot read from secondaries. However, you can configure it to allow.

Replications

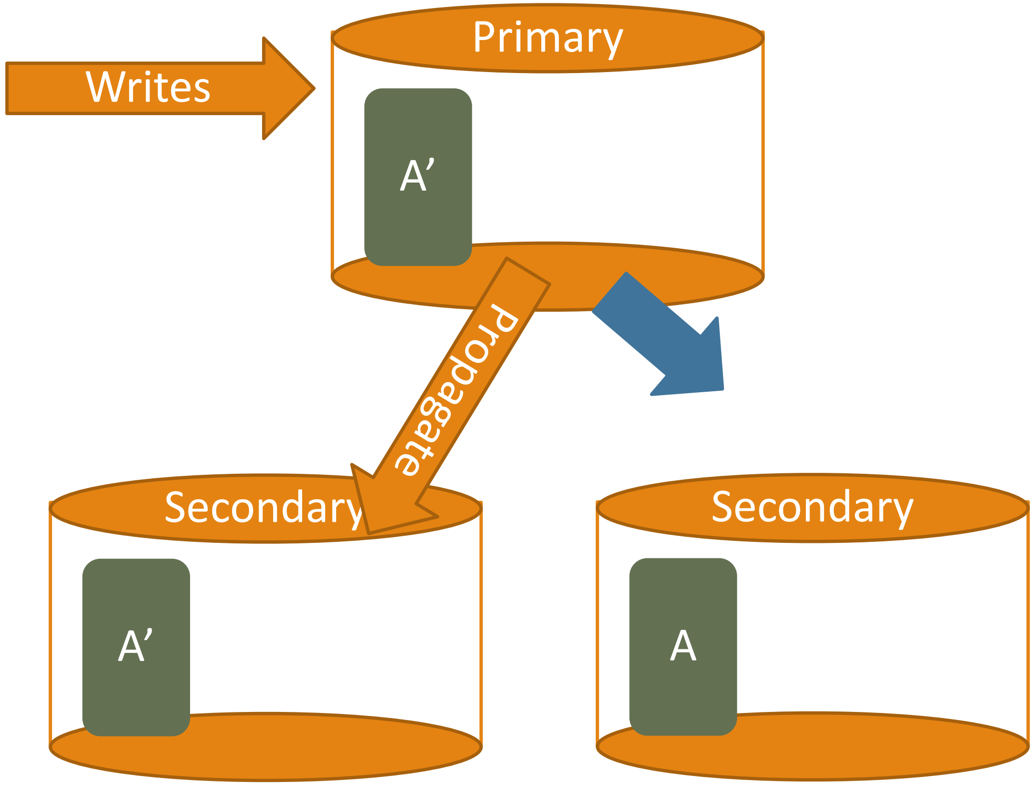
- Primary-Secondary replication : Synchronize secondaries with the primary.
  - Clients can send a primary read, write, create index, etc. requests.
  - Clients cannot write to secondaries.
  - Structure
    - Primary
      - Authoritative source for the data.
      - Responsible for processing updates.
    - Secondaries
      - Contains copied data from a primary.



Distribution Models

Replications

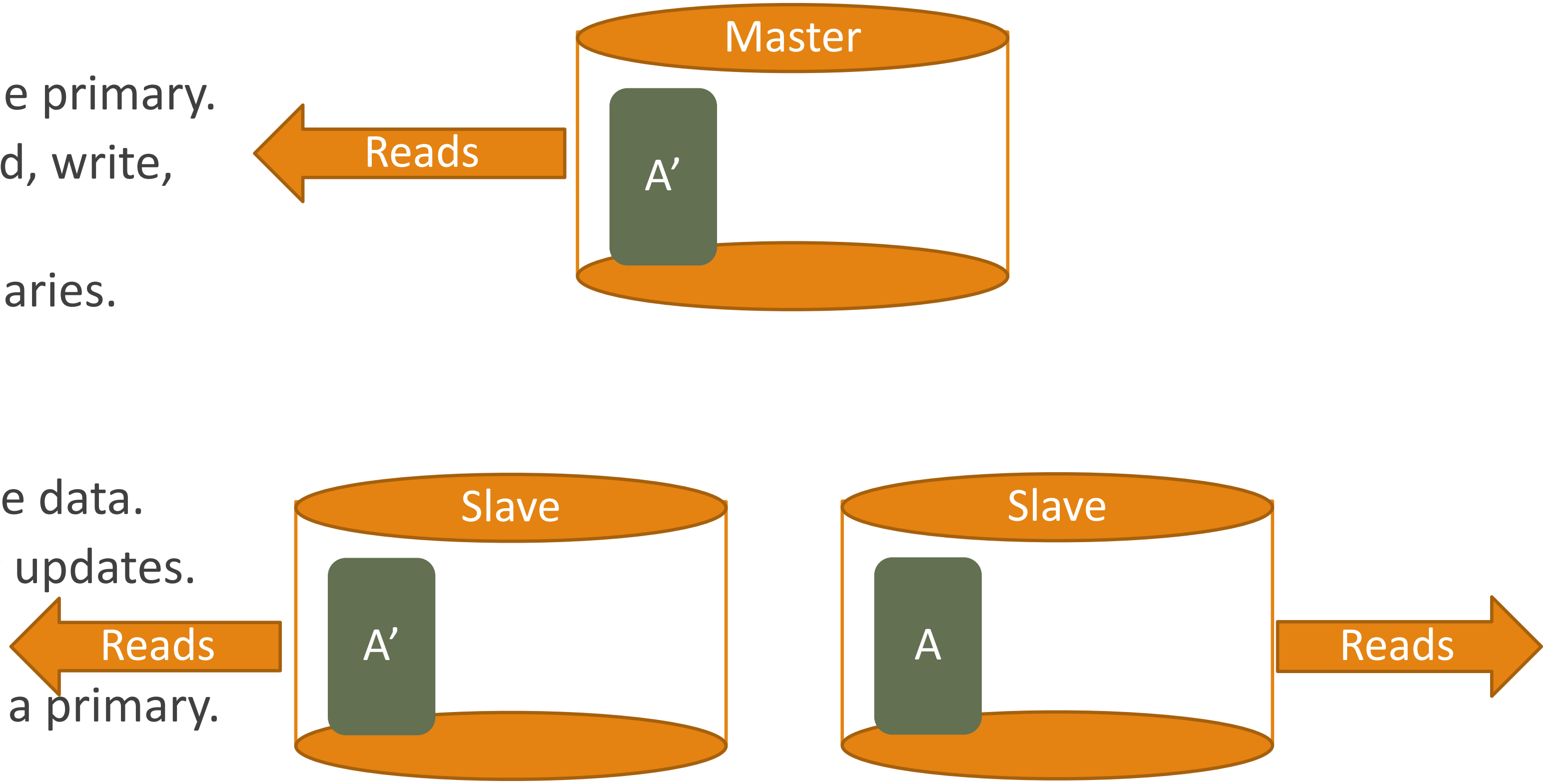
- Primary-Secondary replication : Synchronize secondaries with the primary.
  - Clients can send a primary read, write, create index, etc. requests.
  - Clients cannot write to secondaries.
  - Structure
    - Primary
      - Authoritative source for the data.
      - Responsible for processing updates.
    - Secondaries
      - Contains copied data from a primary.



Distribution Models

Replications

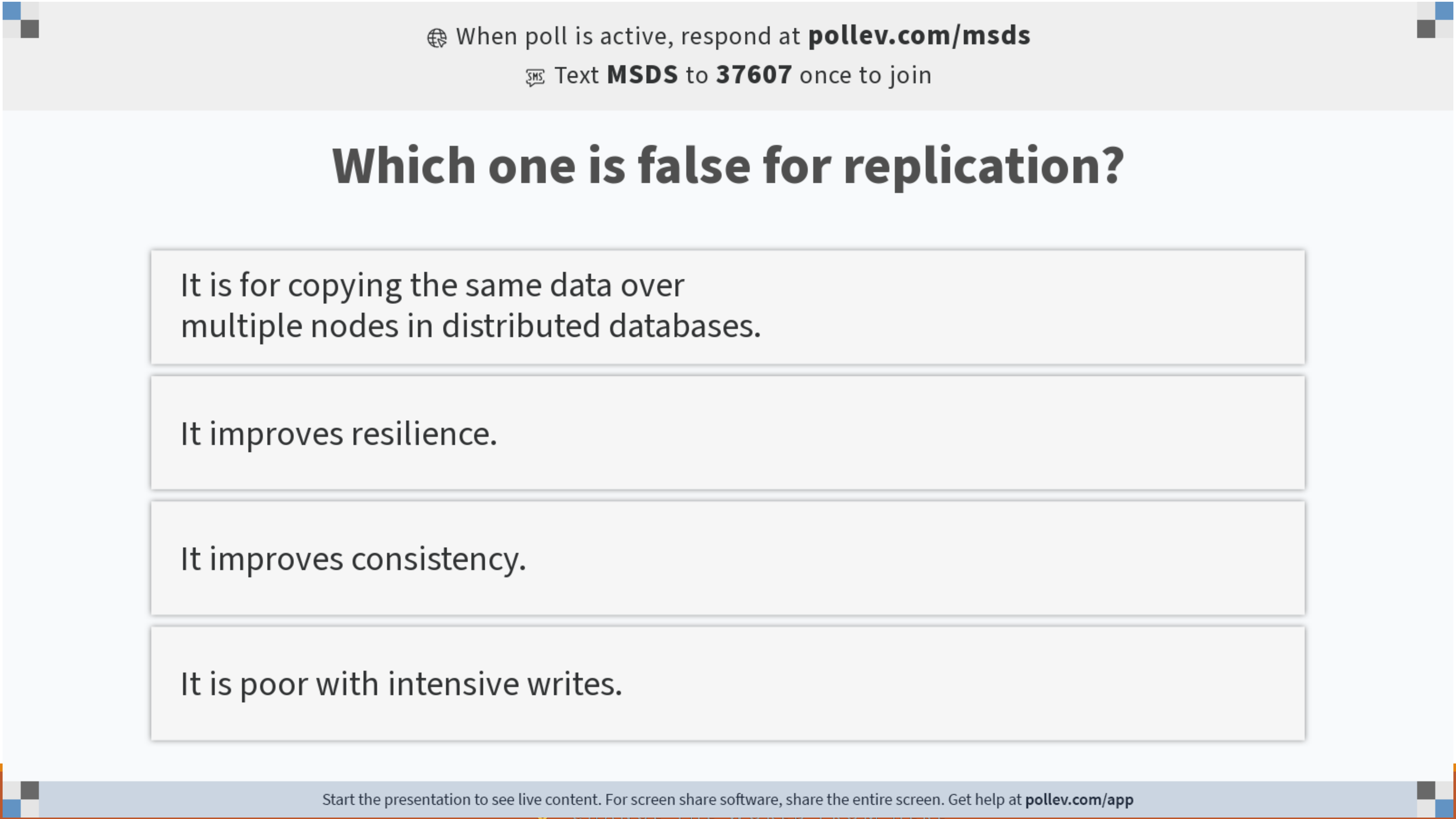
- Primary-Secondary replication : Synchronize secondaries with the primary.
  - Clients can send a primary read, write, create index, etc. requests.
  - Clients cannot write to secondaries.
  - Structure
    - Primary
      - Authoritative source for the data.
      - Responsible for processing updates.
    - Secondaries
      - Contains copied data from a primary.



Distribution Models

Replications

- Primary-Secondary replication : Synchronize secondaries with the primary.
  - Pros
    - Good scalability with intensive read.
    - Read resilience.
  - Cons
    - Poor with intensive writes.
    - Inconsistency.



When poll is active, respond at **pollev.com/msds**

Text **MSDS** to **37607** once to join

Which one is false for replication?

- It is for copying the same data over multiple nodes in distributed databases.
- It improves resilience.
- It improves consistency.
- It is poor with intensive writes.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

When poll is active, respond at **pollev.com/msds**

Text **MSDS** to **37607** once to join

Which one is false for replication?

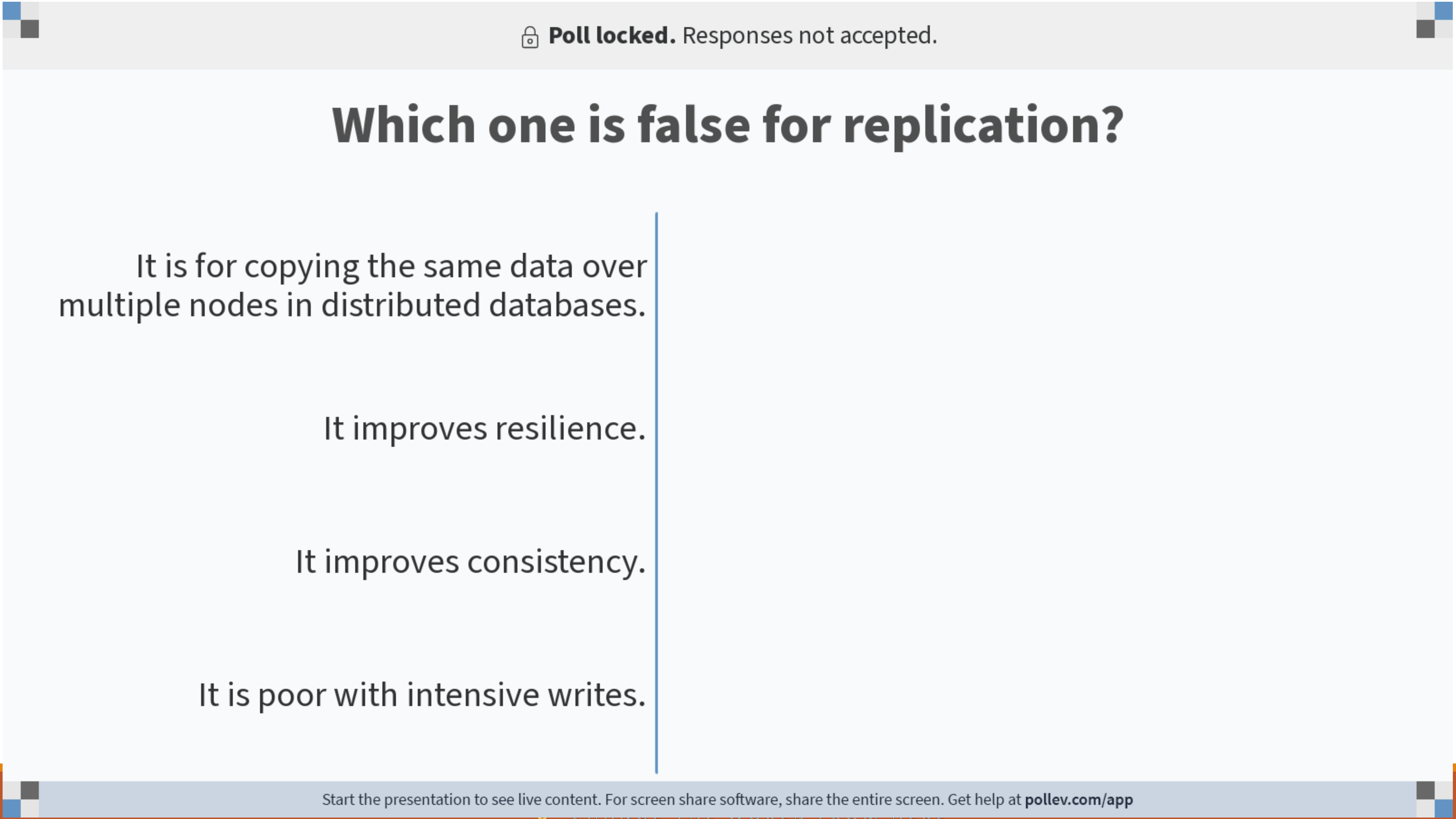
It is for copying the same data over multiple nodes in distributed databases.

It improves resilience.

It improves consistency.

It is poor with intensive writes.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**



Poll locked. Responses not accepted.

Which one is false for replication?

It is for copying the same data over multiple nodes in distributed databases.

It improves resilience.

It improves consistency.

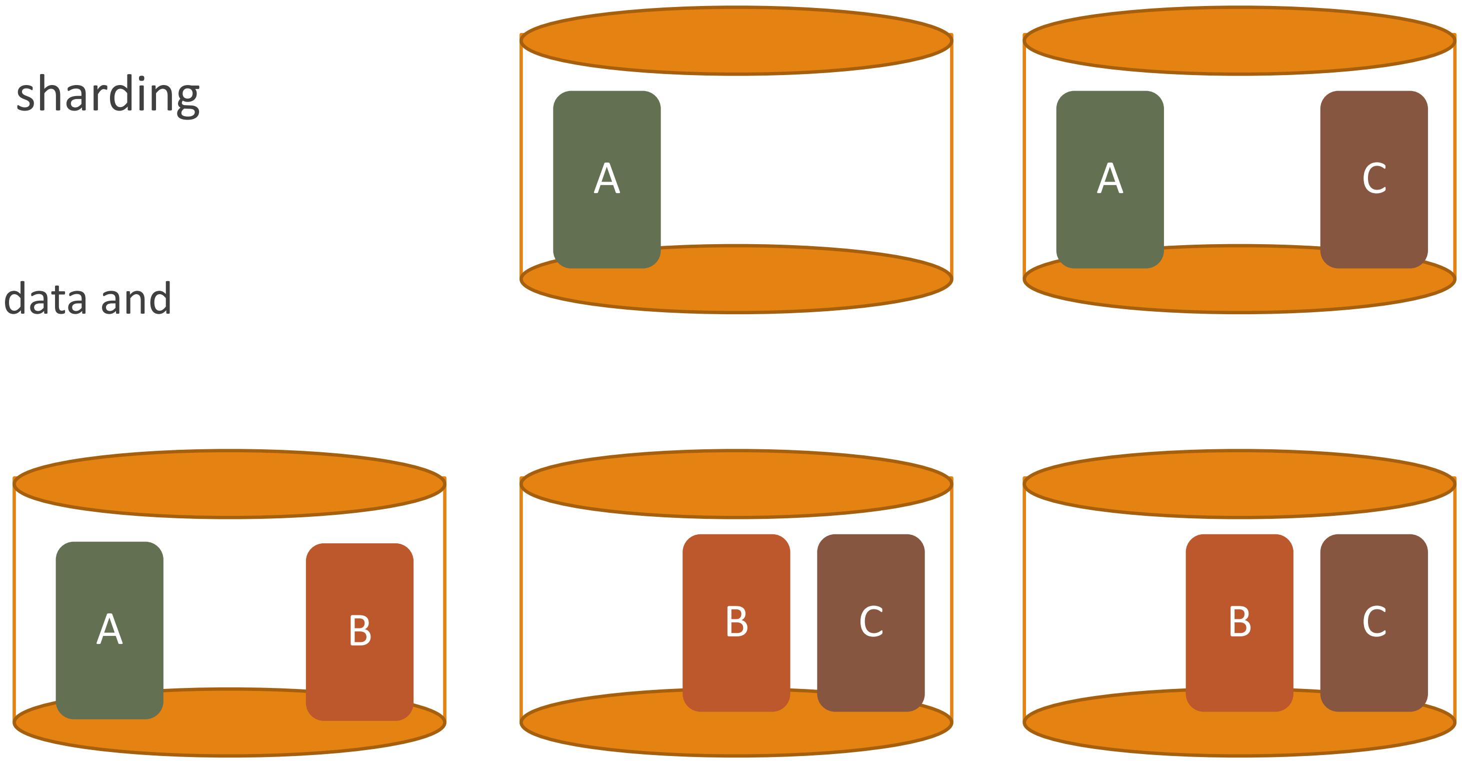
It is poor with intensive writes.

Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

Distribution Models

Sharding + Replications

- **Scalability + Fault Tolerance**
- Primary-Secondary replication and sharding
  - Multiple nodes.
    - Each data only has one primary.
    - A node can be a primary for some data and secondary for others.



Primary for one shard

Primary for one shard
Secondary for one shard

Secondary for two shard

Primary for one shard
Secondary for one shard

Secondary for two shards

Content

MongoDB

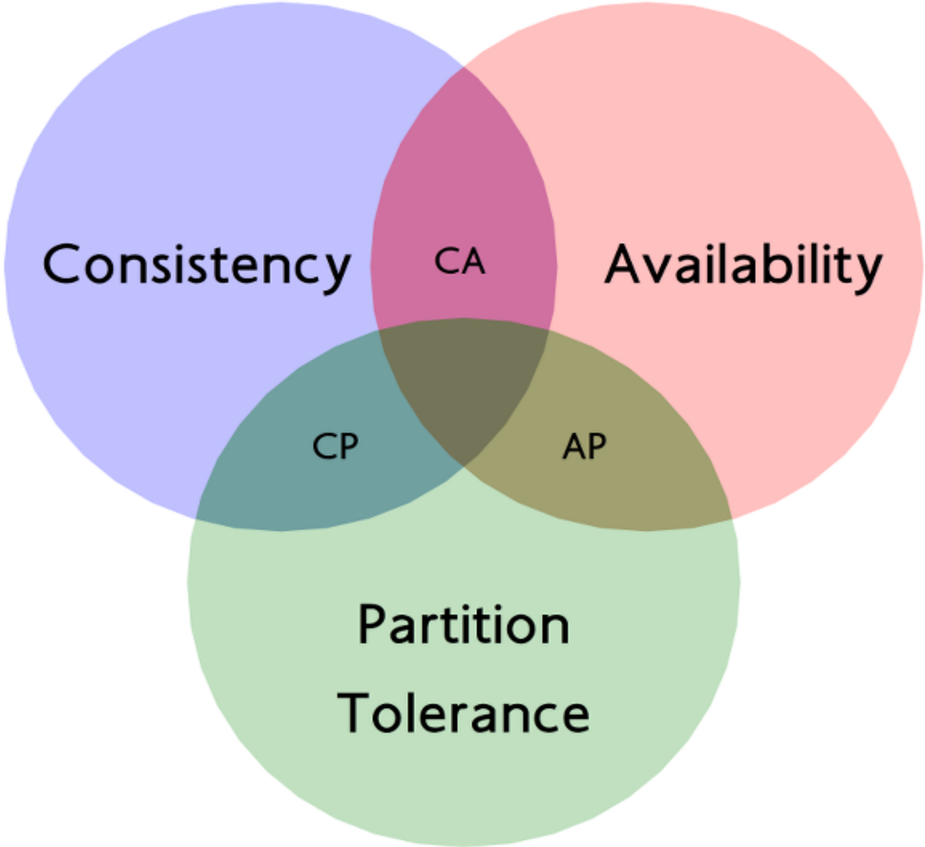
- Sharding
- Replication
- **CAP Theorem**

CAP Theorem

Relaxing Consistency/Availability

- CAP Theorem
  1. Consistency
     - All nodes have the most recent data.
  2. Availability
     - Every request received by a non-failing node must return a response.
  3. Partition Tolerance
     - Clusters can survive from communication breakages in the cluster.

➔ **You can only get two.**



http://blingtechs.blogspot.com/2016/02/cap-theorem.html

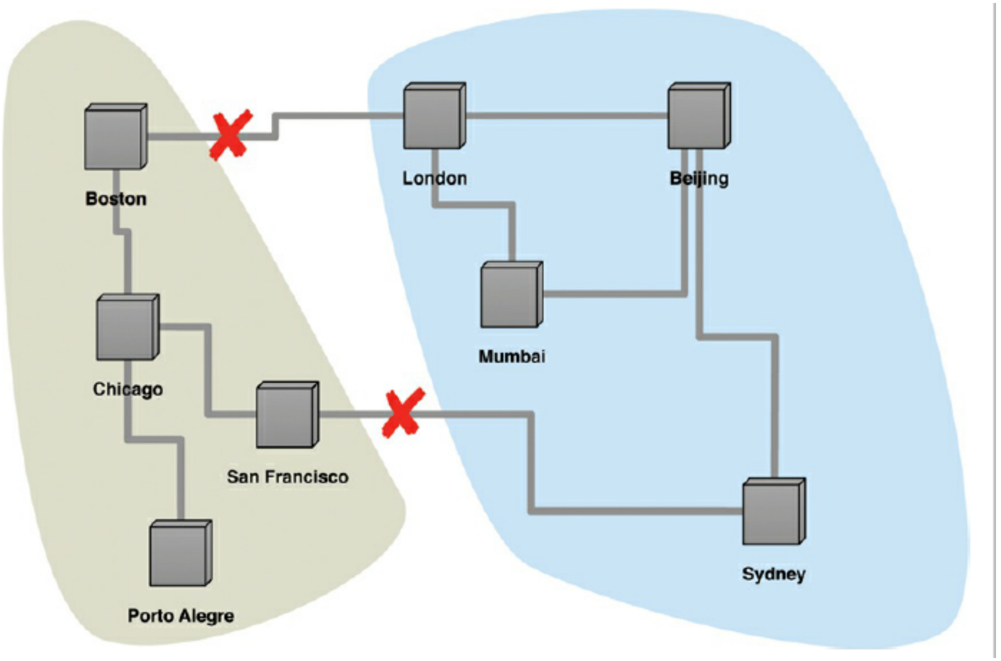
CAP Theorem

Relaxing Consistency/Availability

- CAP Theorem
  1. Consistency
     - All nodes have the most recent data.
  2. Availability
     - Every request received by a non-failing node must return a response.
  3. Partition Tolerance
     - Clusters can survive from communication breakages in the cluster.

➔ **You can only get two.**

ACID addresses an individual node's data consistency.
CAP addresses cluster-wide data consistency .

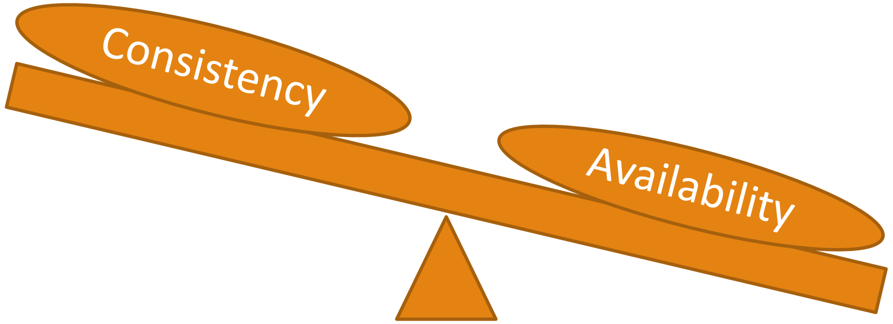


http://blingtechs.blogspot.com/2016/02/cap-theorem.html

CAP Theorem

Relaxing Consistency/Availability

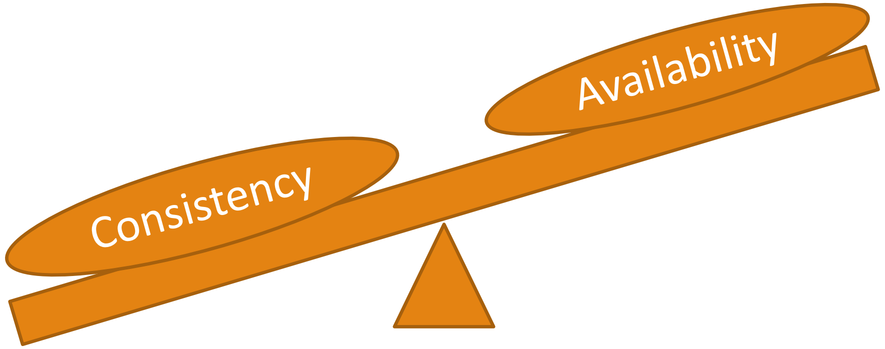
- CAP Theorem and Distributed Database
  - Requirement - Partition-Tolerance *
  - Availability or Consistency??
    - Availability – Shopping
    - Consistency – Stock Market



CAP Theorem

Relaxing Consistency/Availability

- CAP Theorem and Distributed Database
  - Requirement - Partition-Tolerance *
  - Availability or Consistency??
    - Availability – Shopping
    - Consistency – Stock Market



CAP Theorem

Relaxing Consistency/Availability

- CAP Theorem
  1. Consistency
     - All nodes have the most recent data.
  2. Availability
     - Every request received by a non-failing node must return a response.
  3. Partition Tolerance
     - Clusters can survive from communication breakages in the cluster.

➔ **You can only get two.**

mongoDB

https://www.ibm.com/cloud/learn/cap-theorem

Content

MongoDB

- Sharding
- Replication
- CAP Theorem

Day 5 - Comments (What you liked/disliked so far? What should I do for you?)

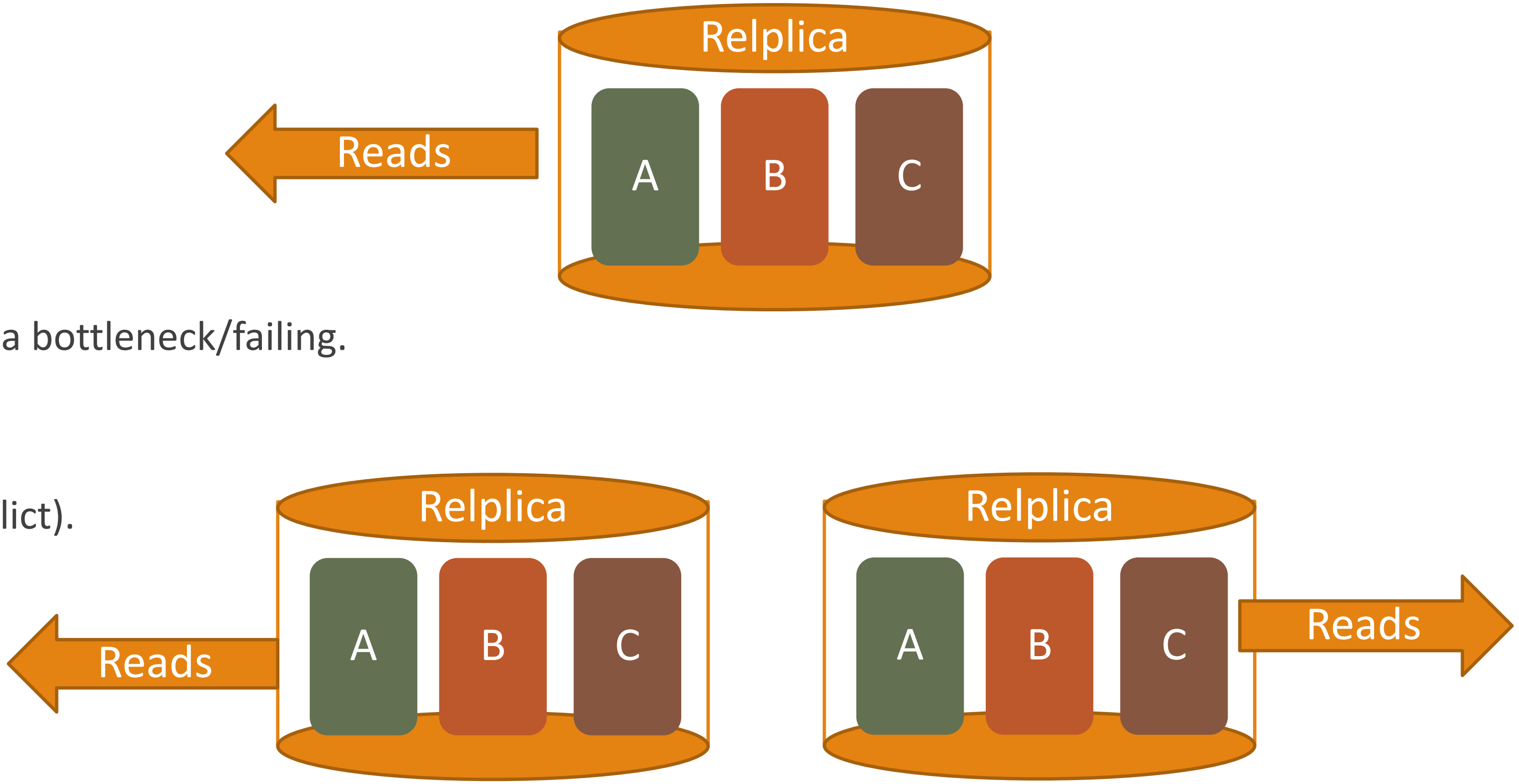
Start the presentation to see live content. For screen share software, share the entire screen. Get help at **pollev.com/app**

Appendix

Distribution Models

Replications

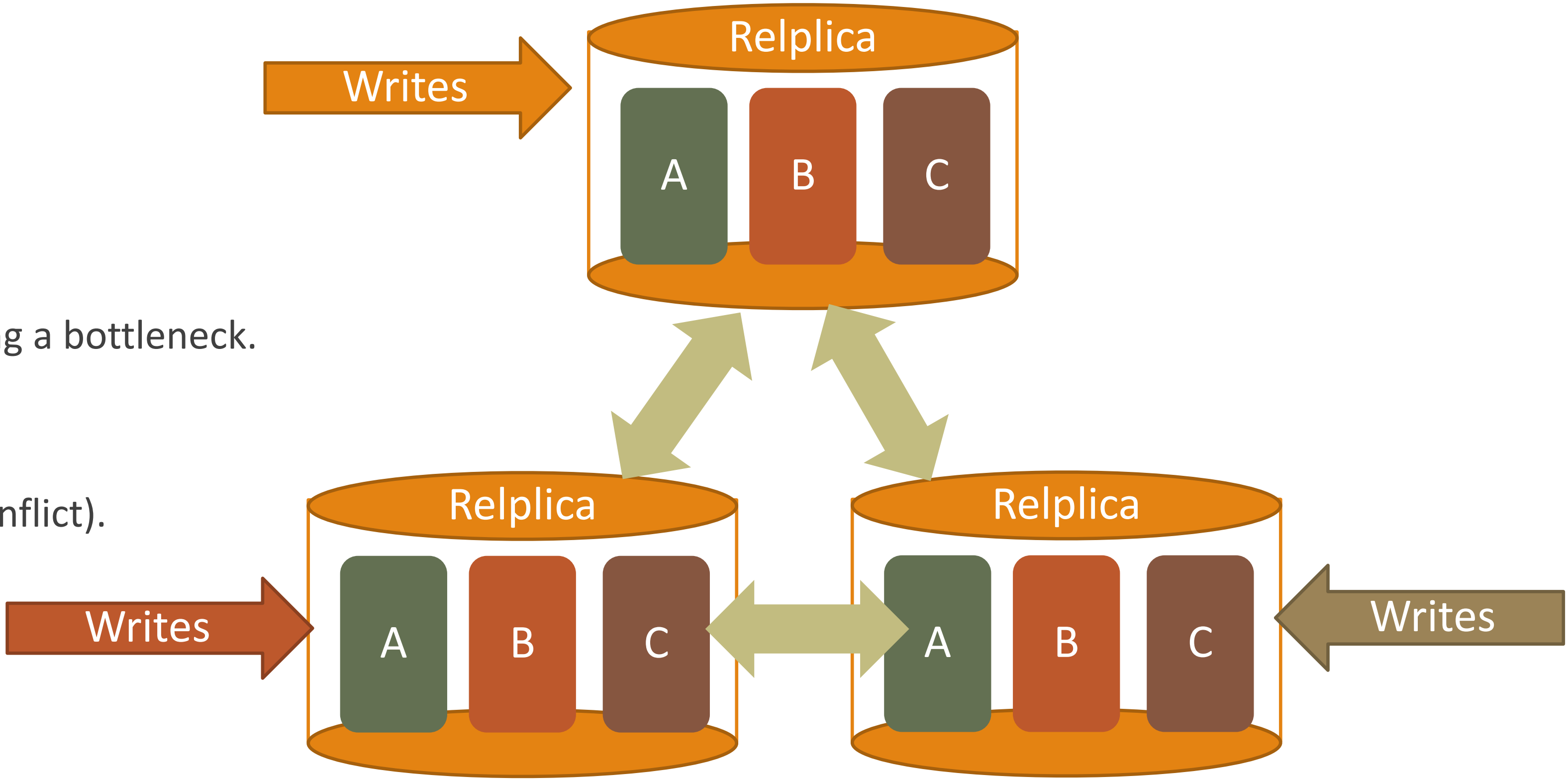
- Peer-to-peer replication
  - All replicas have equal weight.
  - All replicas accept reads/writes.
  - Pros
    - Higher availability.
      - No worries about one node being a bottleneck/failing.
    - Good performance.
  - Cons
    - Inconsistent write. (Write-write conflict).



Distribution Models

Replications

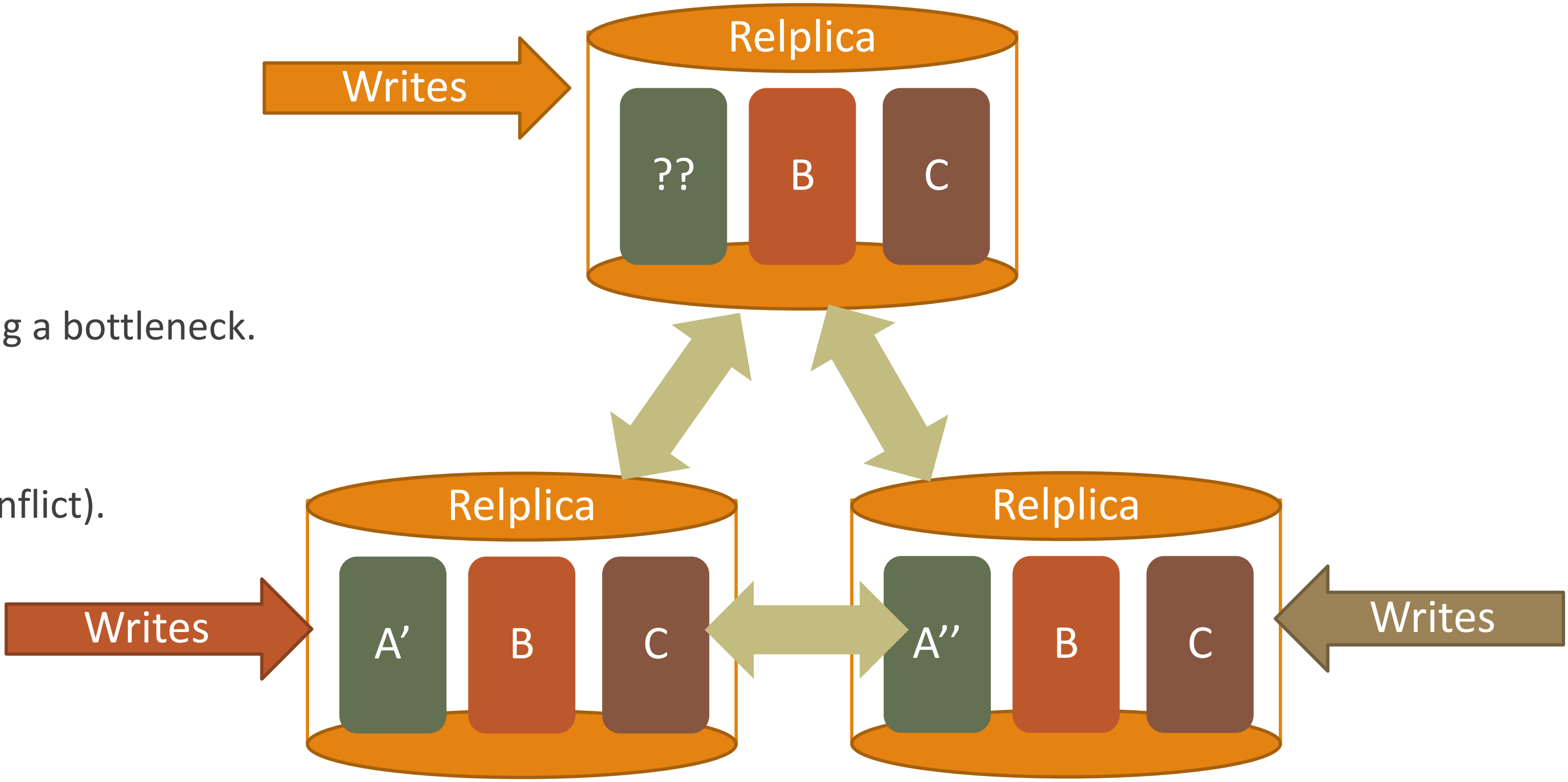
- Peer-to-peer replication
  - All replicas have equal weight.
  - All replicas accept reads/writes.
  - Pros
    - Higher availability.
      - No worries about one node being a bottleneck.
    - Good performance.
  - Cons
    - Inconsistent write. (Write-write conflict).



Distribution Models

Replications

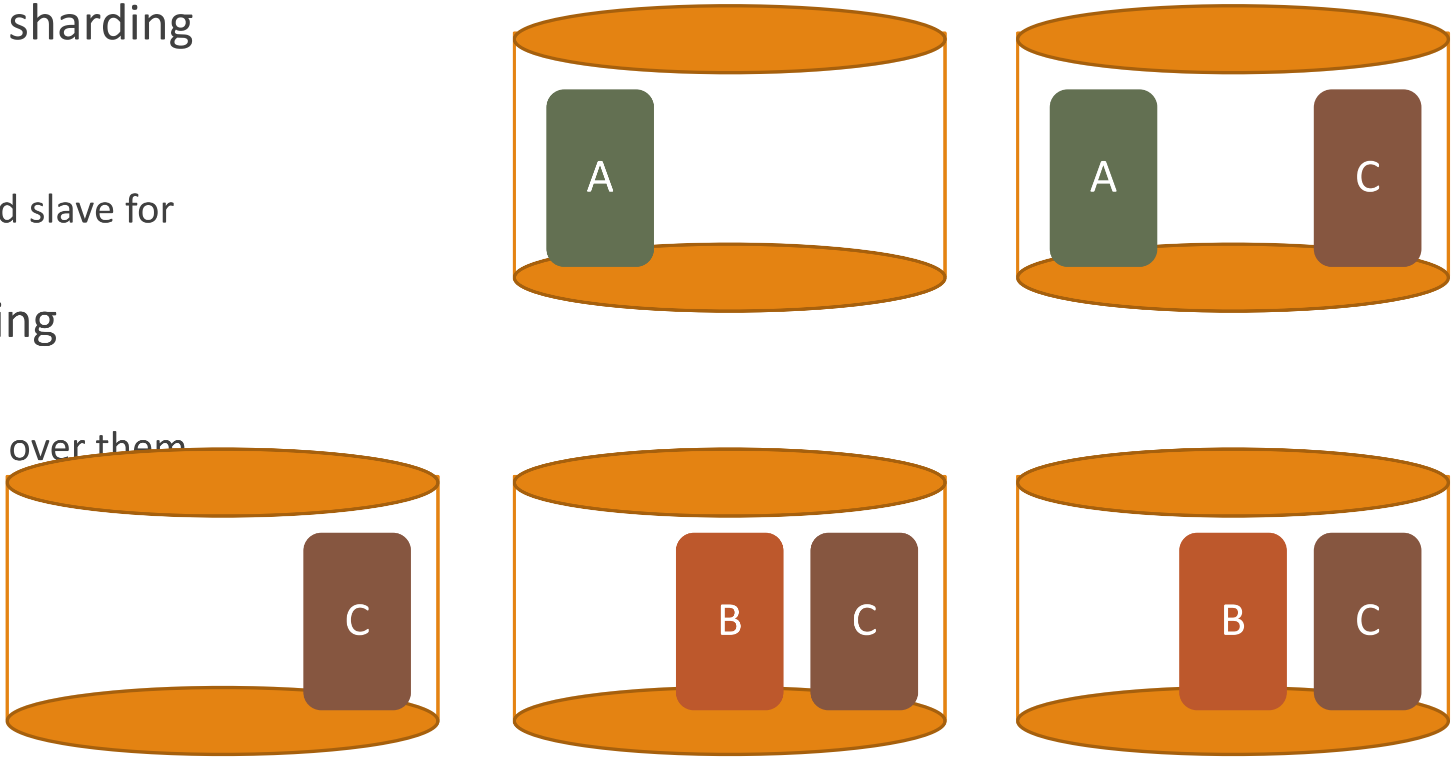
- Peer-to-peer replication
  - All replicas have equal weight.
  - All replicas accept reads/writes.
  - Pros
    - Higher availability.
      - No worries about one node being a bottleneck.
    - Good performance.
  - Cons
    - Inconsistent write. (Write-write conflict).



Distribution Models

Sharding + Replications

- Primary-Secondary replication and sharding
  - Multiple masters.
  - Each data only has one master.
  - A node can be a master for some data and slave for others.
- Peer-to-peer replication and sharding
  - Common for column-family databases.
  - Many nodes in a cluster with data shared over them.



Master for one shard

Master for one shard
Slave for one shard

Slave for one shard

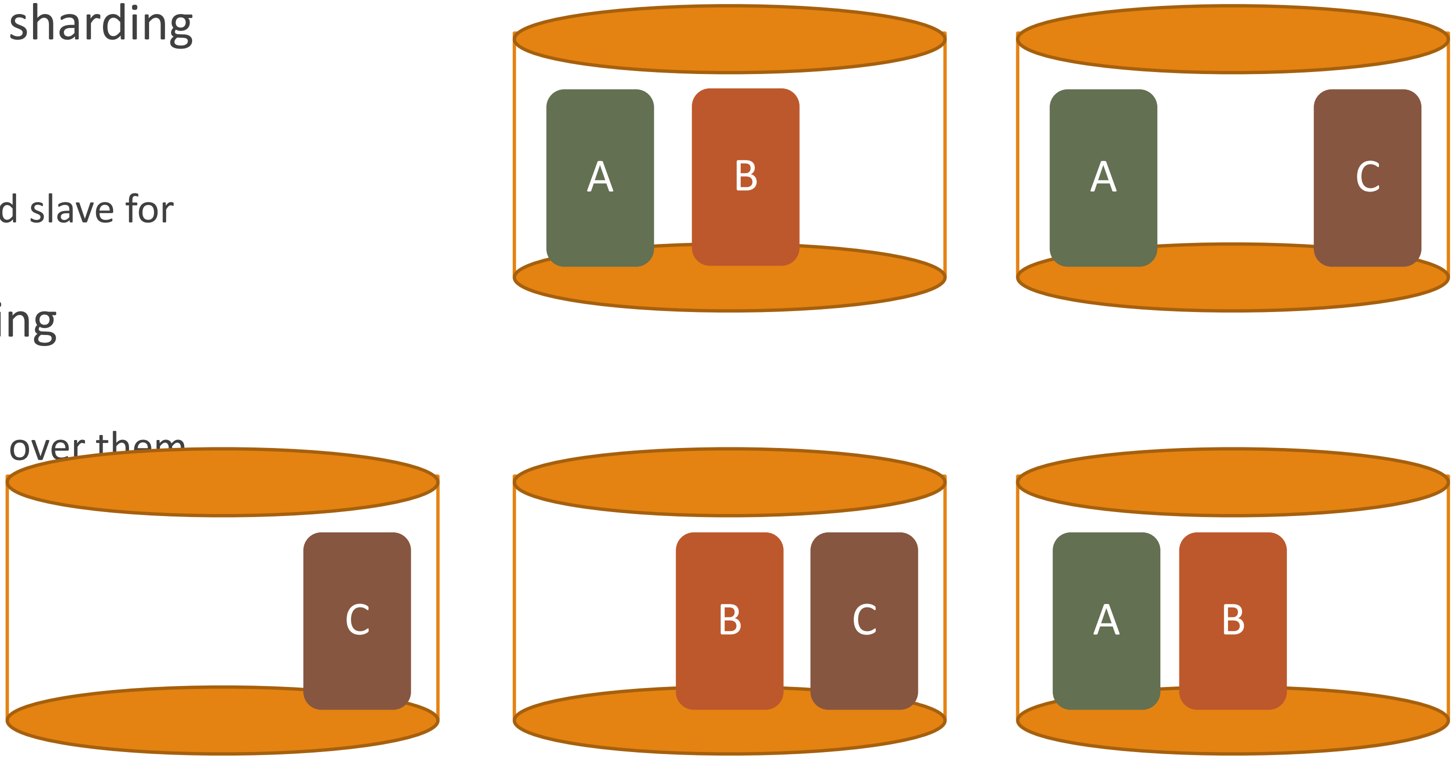
Master for one shard
Slave for one shard

Slave for two shards

Distribution Models

Sharding + Replications

- Primary-Secondary replication and sharding
  - Multiple masters.
  - Each data only has one master.
  - A node can be a master for some data and slave for others.
- Peer-to-peer replication and sharding
  - Common for column-family databases.
  - Many nodes in a cluster with data shared over them



Reference

1. MongoDB, Convert a Replica Set to a Sharded Cluster, https://docs.mongodb.com/manual/tutorial/convert-replica-set-to-replicated-shard-cluster/