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Thoughts on Transaction and Consistency Models

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RDBMS
(Oracle, MySQL)
New Gen.
OLAP
(vertica, aster,
greenplum)
Non-relational
Operational
Stores
("NoSQL")
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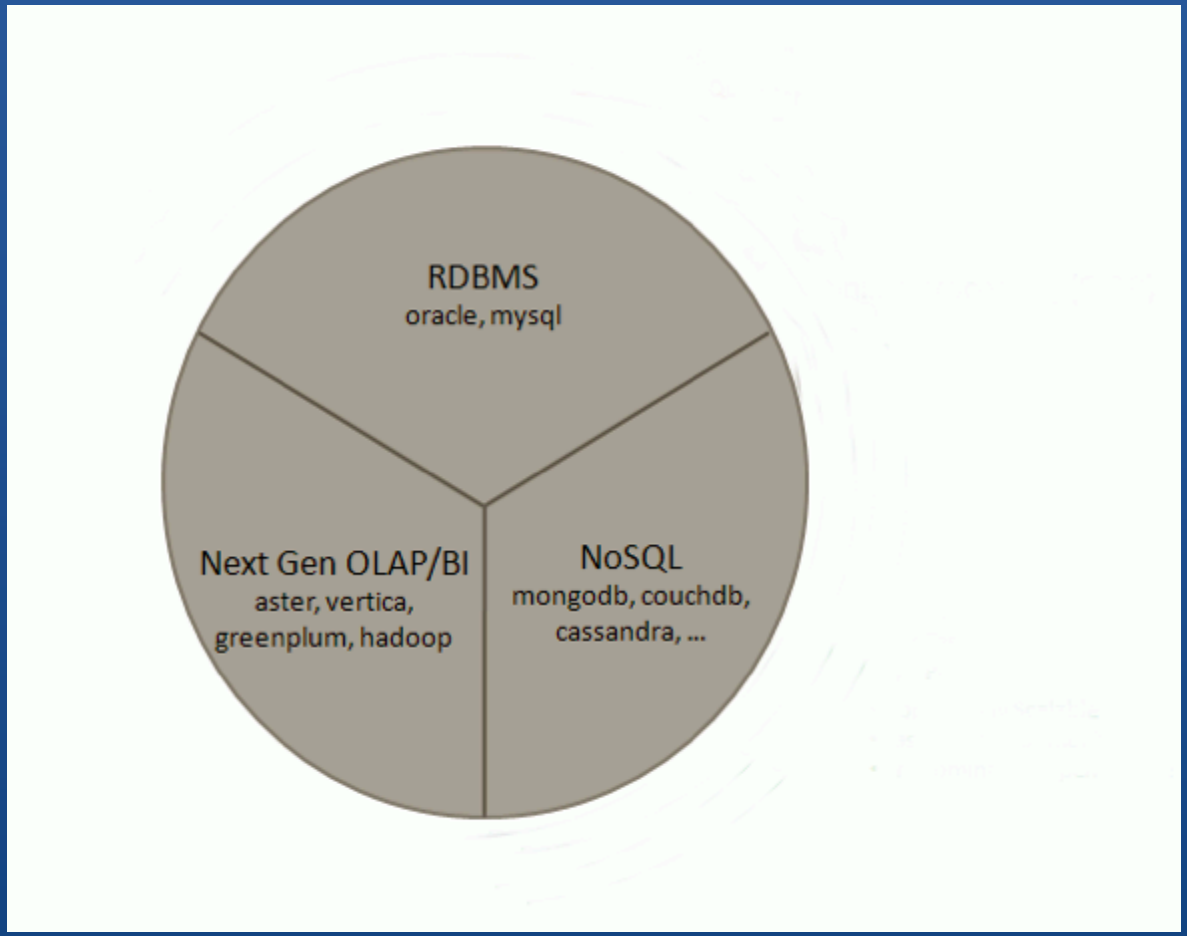
The database world is changing

Document Datastores, Key Value, Graph databases



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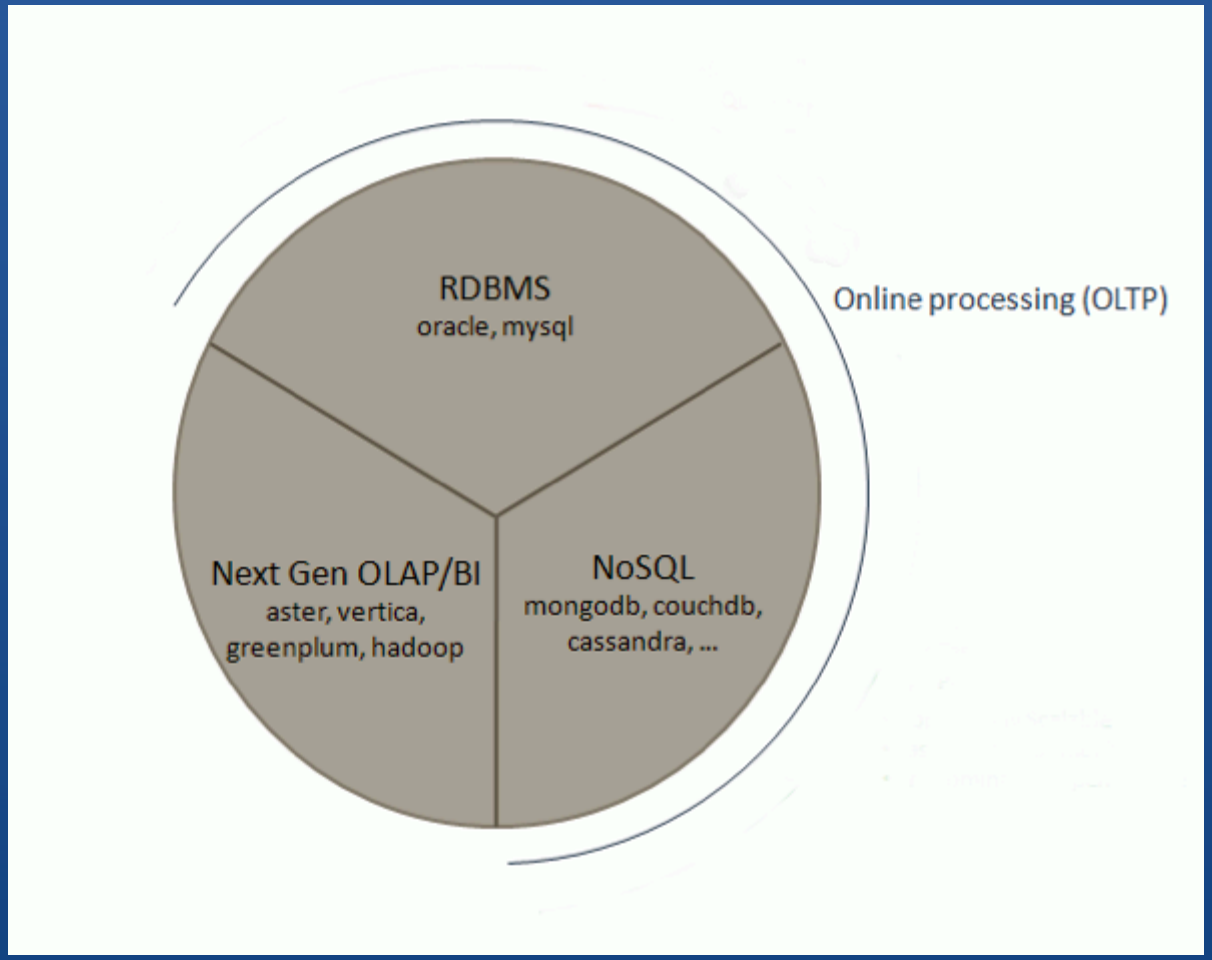
The database world is changing

Transactional model



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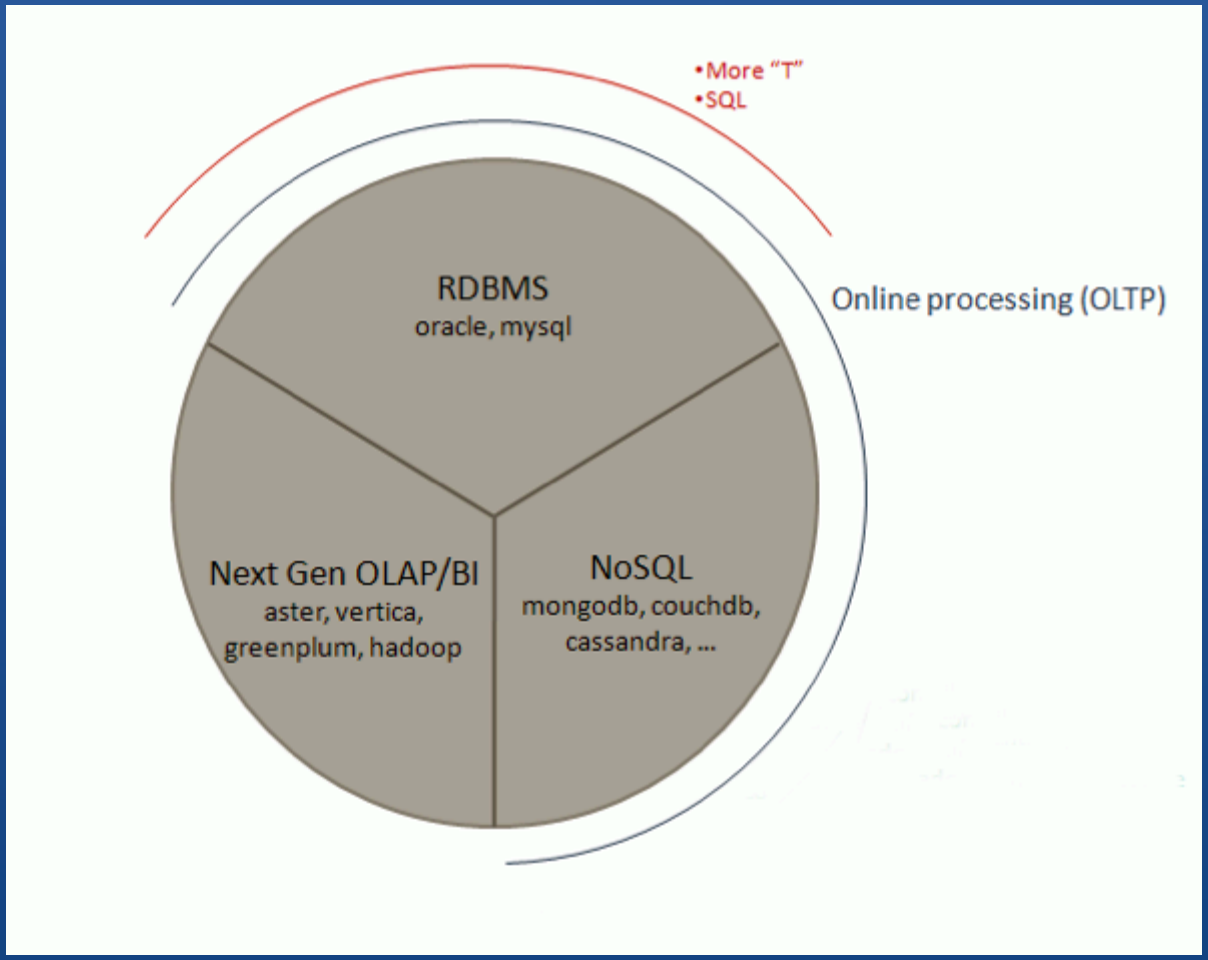
The database world is changing

Full Acid



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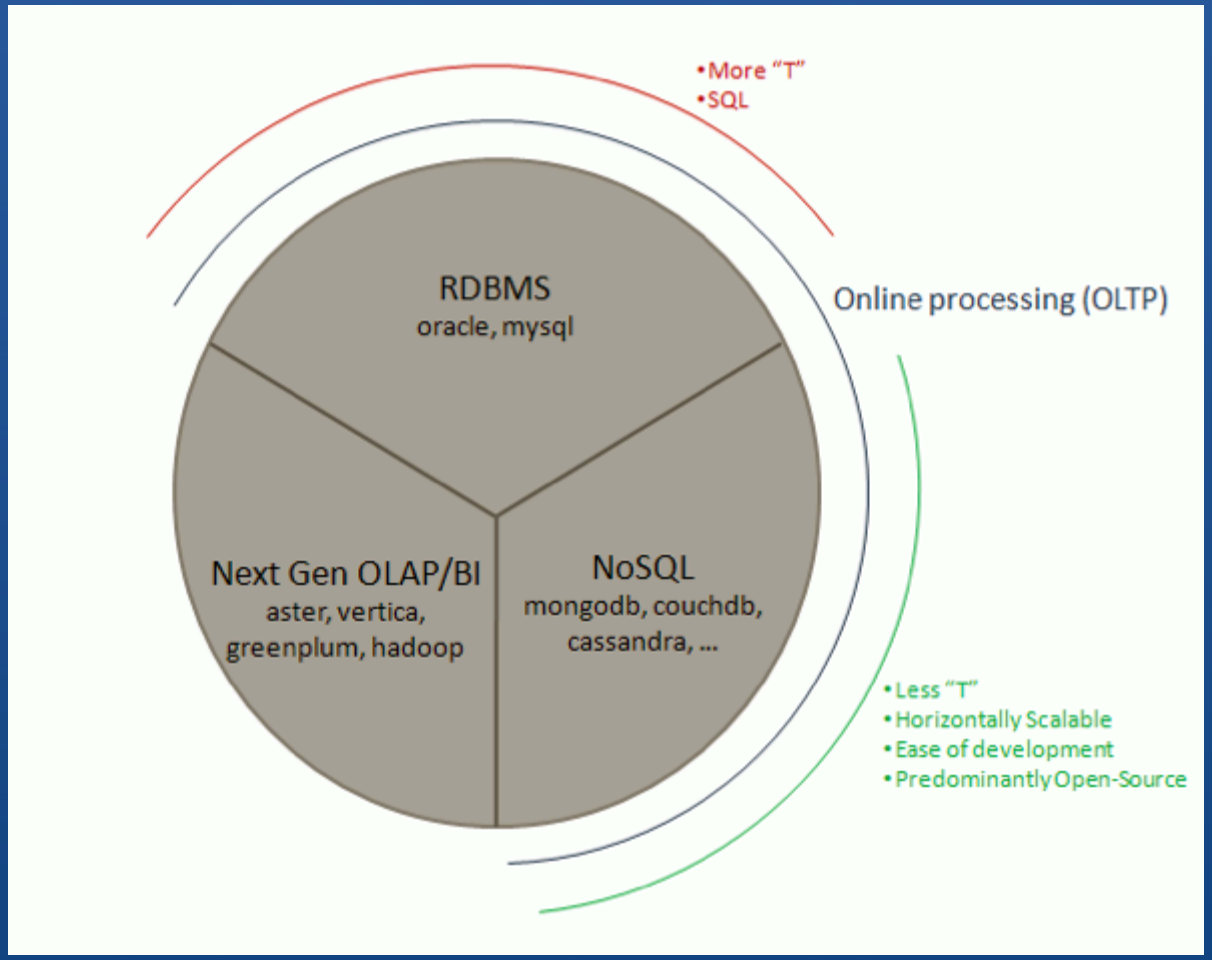
The database world is changing



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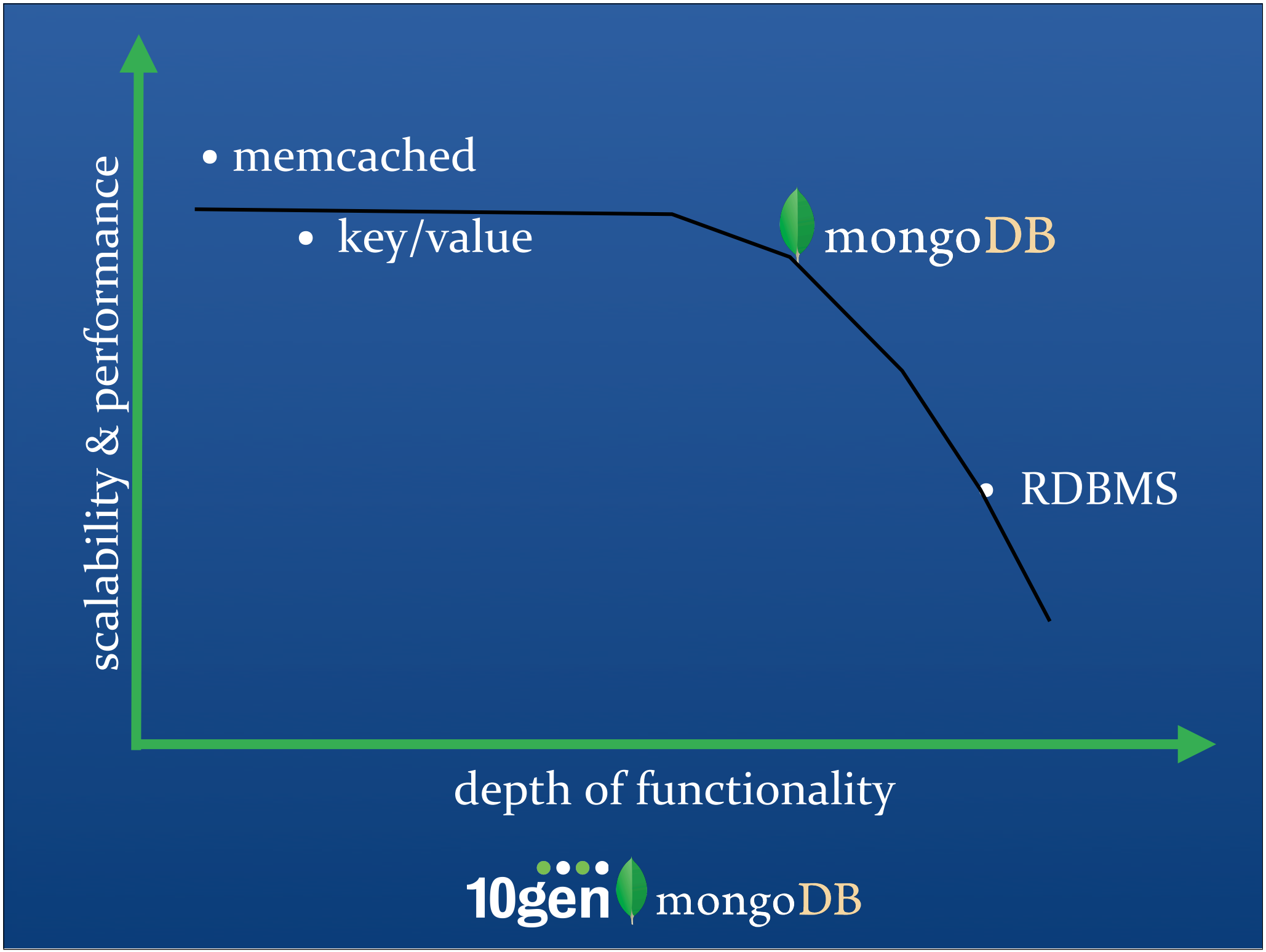
scalability & performance
• memcached
• key/value
mongoDB
• RDBMS
depth of functionality
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CAP

It is impossible in the asynchronous network model to implement a read/write data object that guarantees the following properties:

- *Availability*
- *Atomic consistency in all fair executions (including those in which messages are lost).*

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- *Availability*
- *Atomic consistency in all fair executions (including those in which messages are lost).*

Or: If the network is broken, your database won't work

But we get to define "won't work"

Consistency Models - CAP

- Choices are Available-P (AP) or Consistent-P (CP)
- Write Availability, not Read Availability, is the Main Question

- It's not all about CAP

  Scale, Reduced latency:

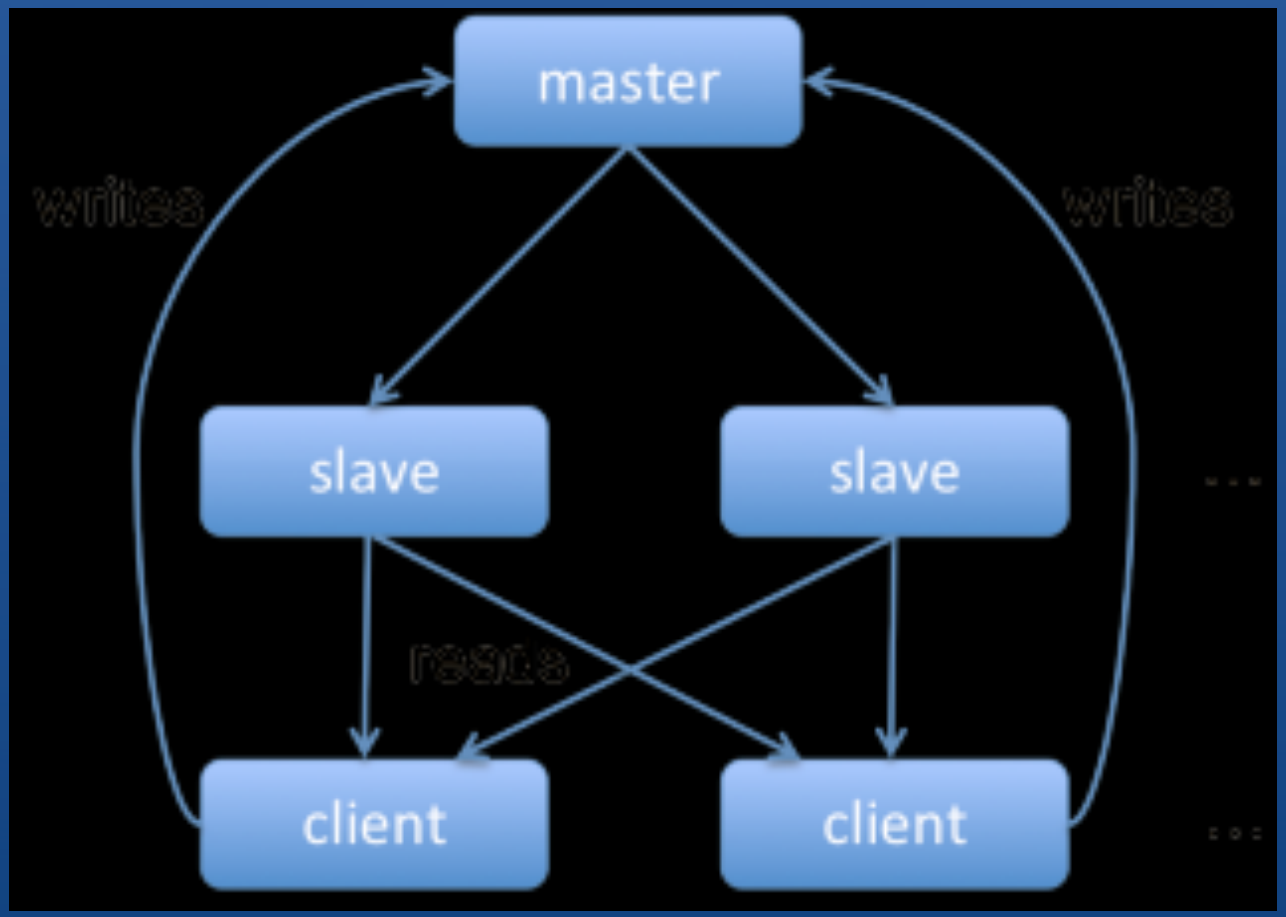
  - Multi data center
  - Speed
  - Even load distribution

Examples of Eventually Consistent Systems

- Eventual Consistency:
  - "The storage system guarantees that if no new updates are made to the object, eventually all accesses will return the last updated value"

- Examples:
  - DNS
  - Async replication (RDBMS, MongoDB)
  - Memcached (TTL cache)

Eventual Consistency



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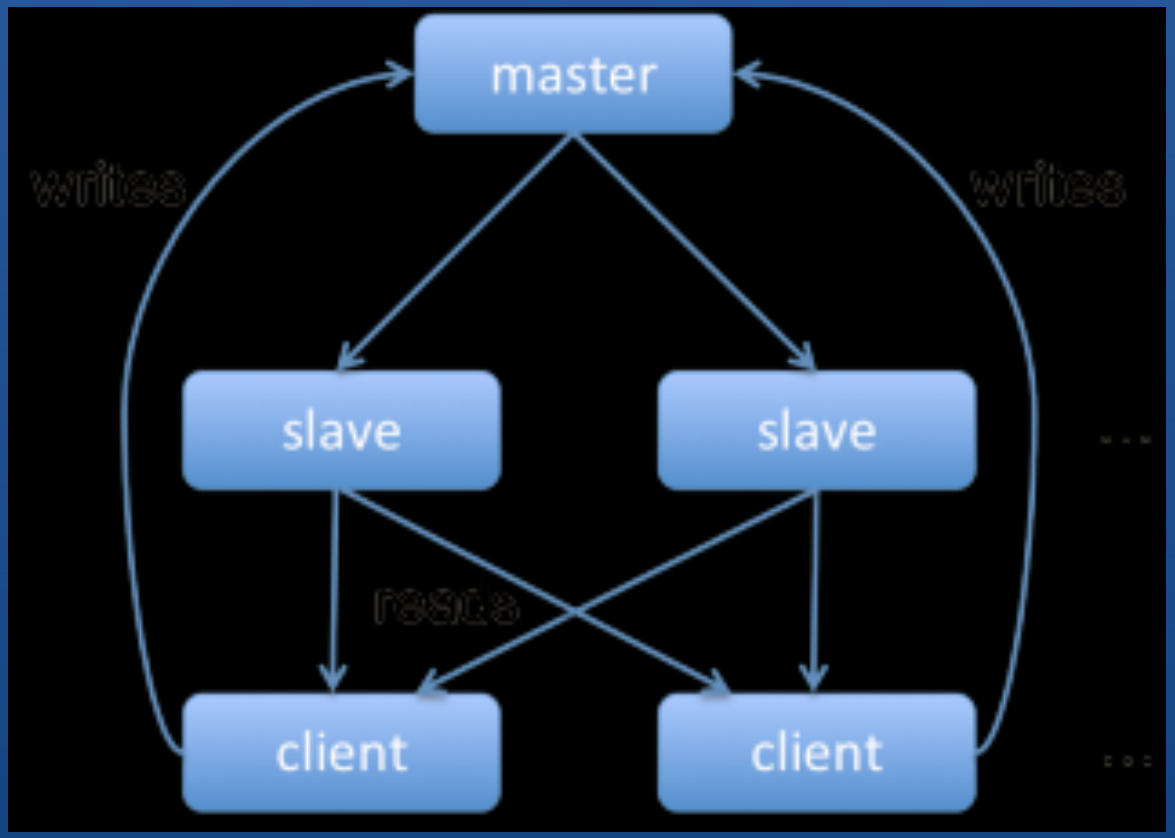
Eventual Consistency



Read(x) : 1, 2, 2, 4, 4, 4, 4 …

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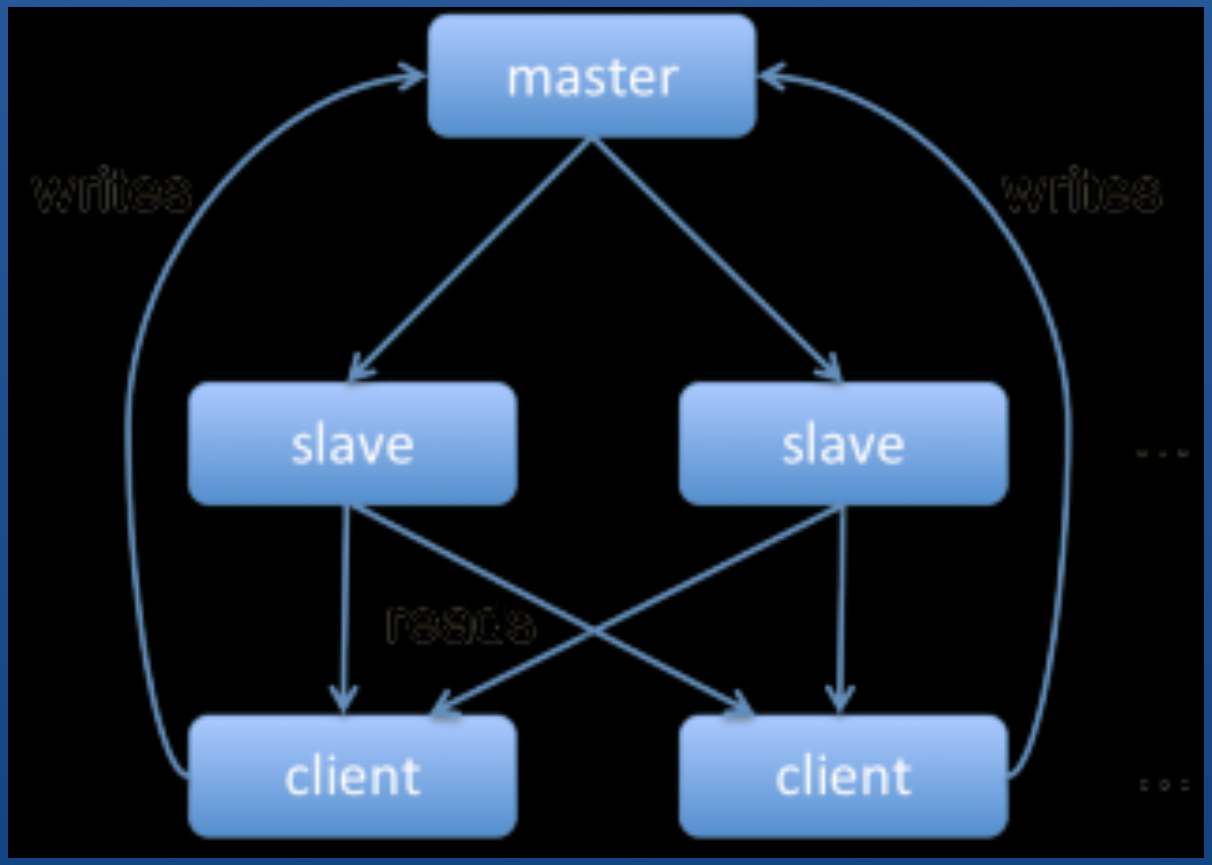
Could we get this?



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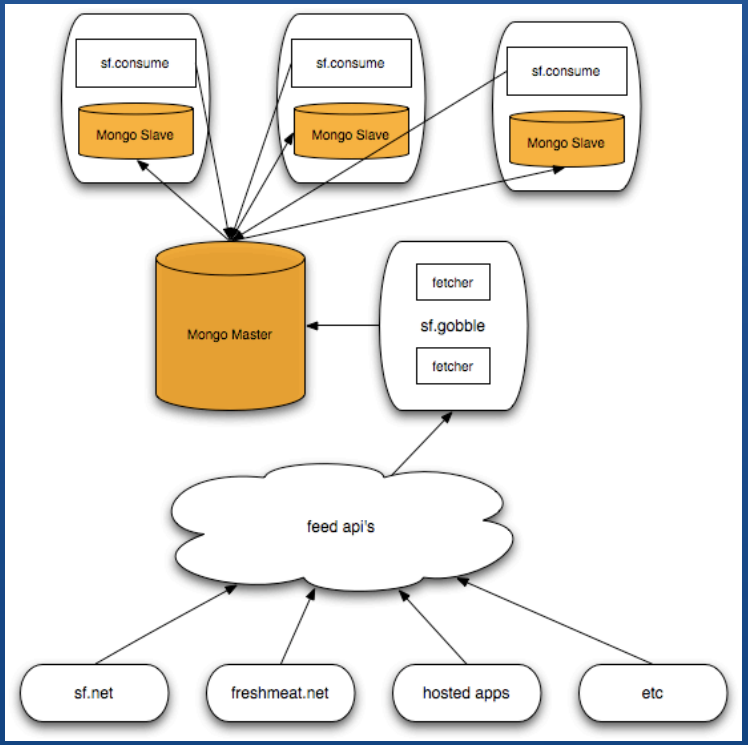
Monotonic read consistency

Prevent seeing writes out of order



- Appserver and slave on same box
- Appserver only reads from Slave

- Eventually consistent
- Guaranteed to see reads in order

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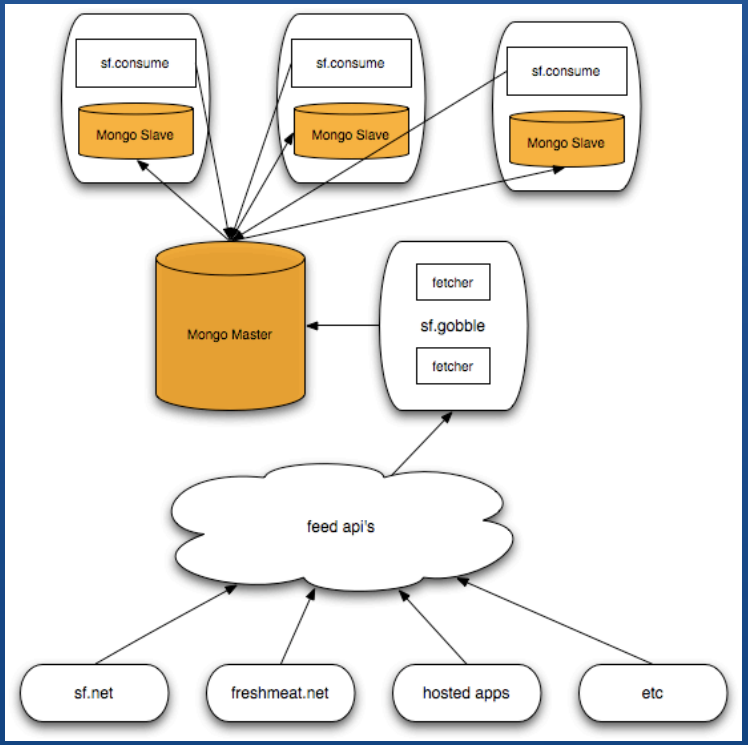
Monotonic read consistency

Prevent seeing writes out of order



- Appserver and slave on same box
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- Eventually consistent
- Guaranteed to see reads in order

- Failover ?

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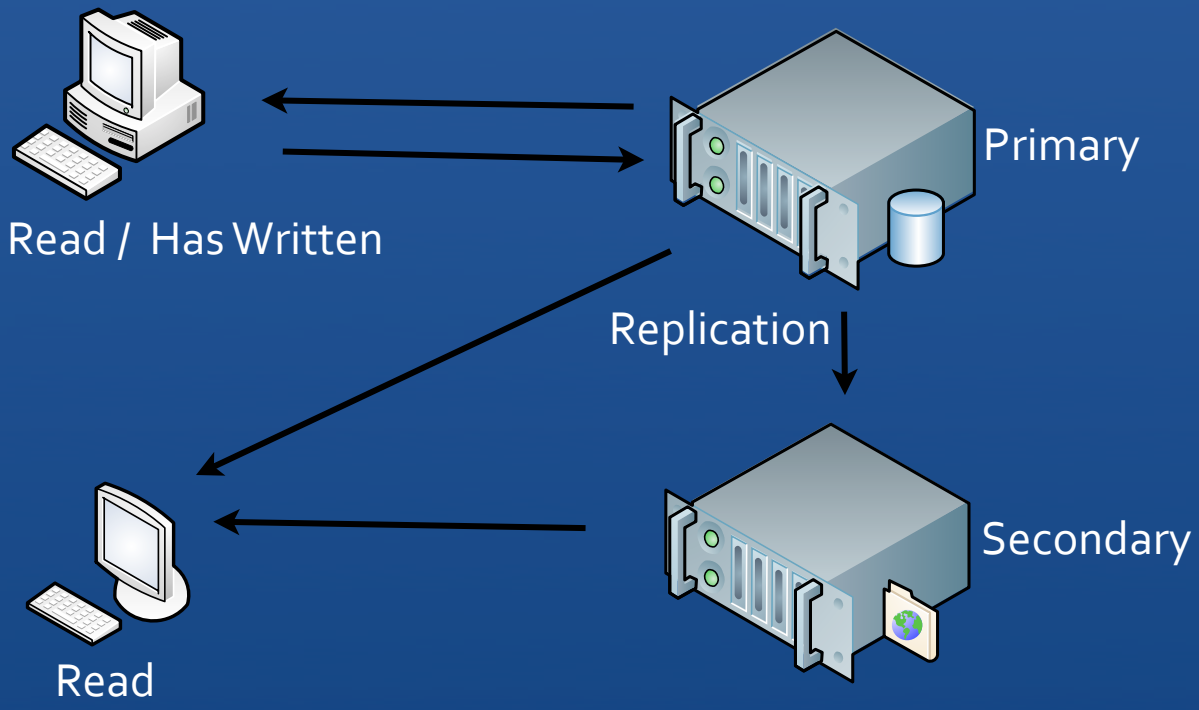
RYOW Consistency



- Read Your Own Writes
- Eventually consistent for readers
- Immediately consistent for writers

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Amazon Dynamo

- R: # of servers to read from
- W: # servers to get response from
- N: Replication factor
  - R+W>N has nice properties

Example

Example 1

R + W <= N

R = 1
W = 1
N = 5

Possibly Stale data
Higher availability

Example

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R + W <= N

R = 1
W = 1
N = 5

Possibly Stale data
Higher availability

Example 2

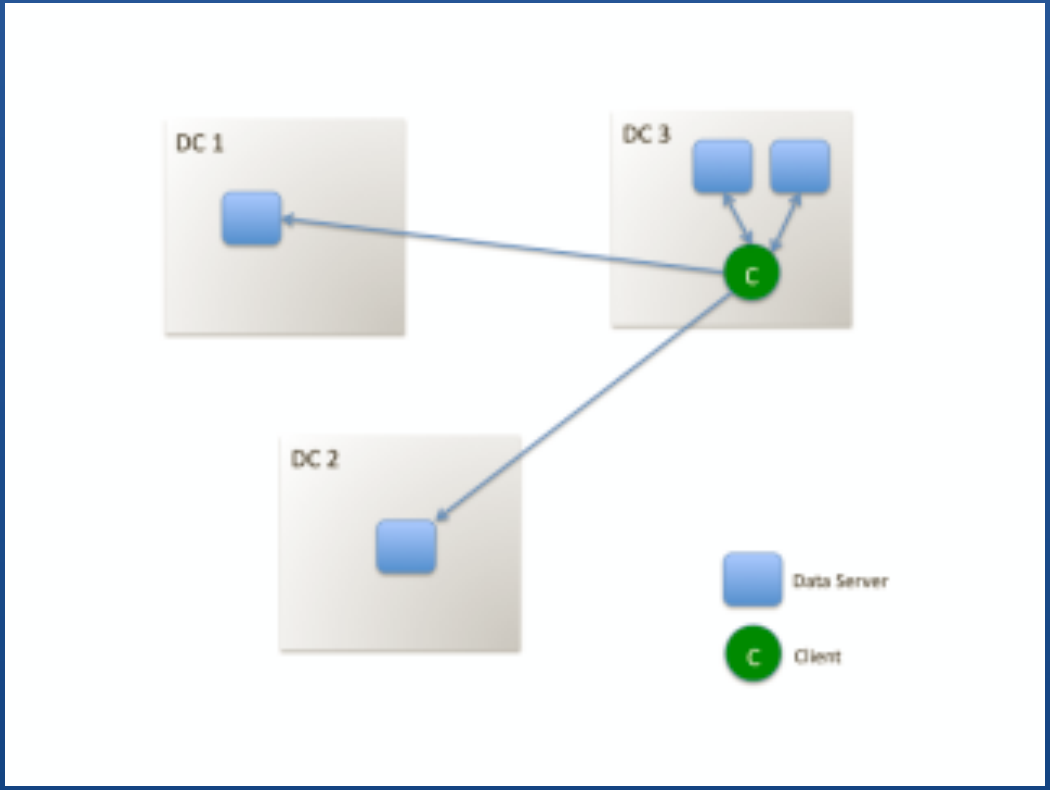
R + W > N

R = 2
W = 1
N = 2

R = 1
W = 2
N = 2

Consistent data

R + W > N



If R+W > N, we can't have both fast local reads and writes at the same time if all the data centers are equal peers

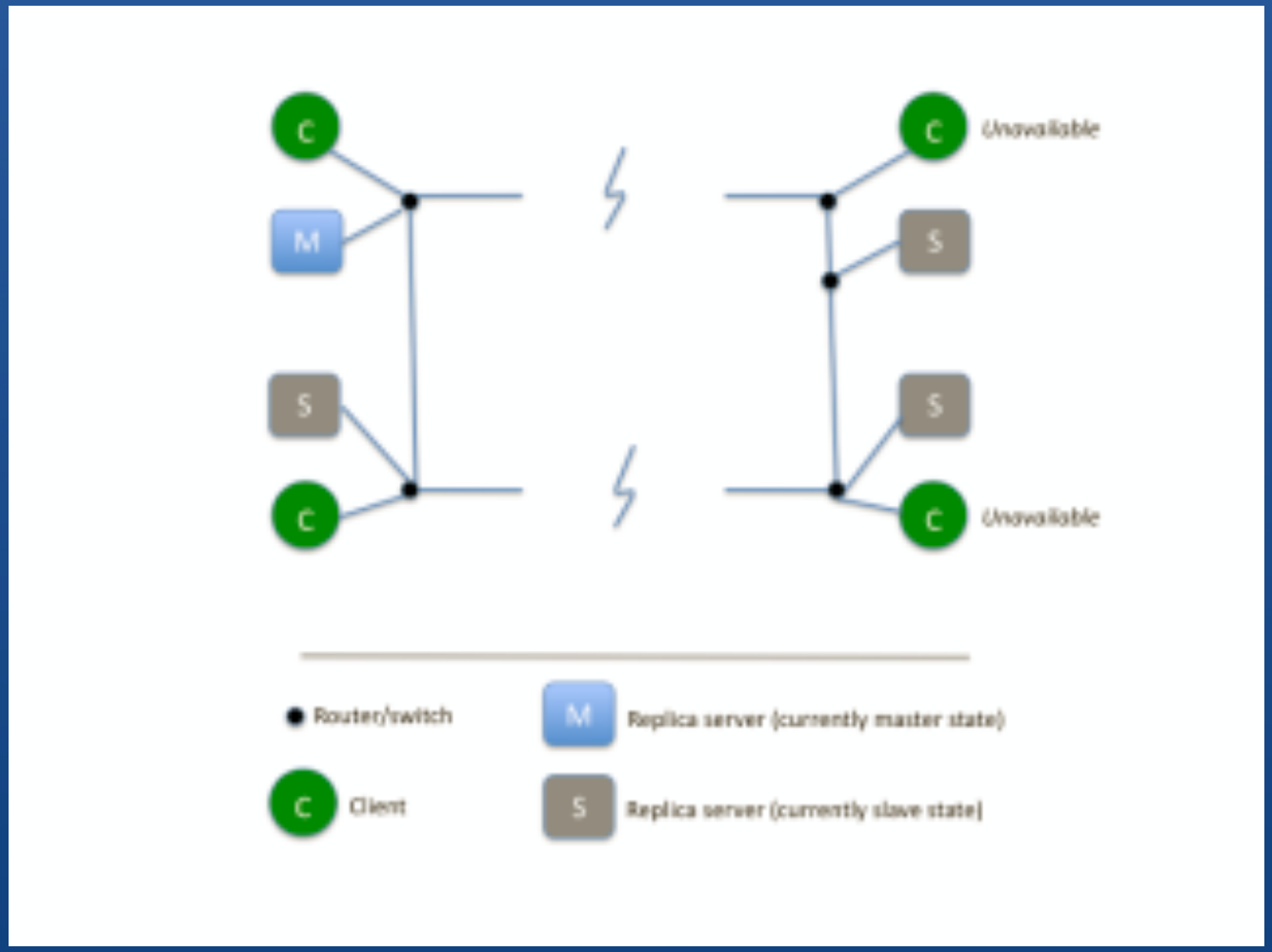
Consistency levels

- Strong: W + R > N
- Weak / Eventual : W + R <= N
- Optimized Read: R=1, W=N
- Optimized Write: W=1, R=N

Multi Datacenter Strategies

- DR
  - Failover
- Single Region, Multi Datacenter
  - Useful for Strong or Eventual Consistency
- Local Reads, Remote Writes
  - All writes to master on WAN, EC on Slaves
- Intelligent Homing
  - Master copy close to user location

Network Partitions



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Network Write Possibilities

- Deny all writes
  - Still Read fully consistent data
  - Give up write Availability

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Network Write Possibilities

- Deny all writes
  - Still Read fully consistent data
  - Give up write Availability
- Allow writes on one side
  - Failover
  - Possible to allow reads on other side
- Allow writes on both sides
  - Available
  - Give up consistency

Multiple Writer Strategies

- Last one wins
  - Use Vector clocks to decide latest

- Insert

  Inserts often really means

  if (!exists(x)) then set(x)

  exists is hard to implement in eventually consistent systems

Multiple Writer Strategies

- Delete

```
op1: set( { _id : 'joe', age : 40 } }
op2: delete( { _id : 'joe' } )
op3: set( { _id : 'joe', age : 33 } )
```

- Consider switching 2 and 3
- Tombstone: Remember delete, and apply last-operation-wins

- Update

update users set age=40 where _id='joe'

However:

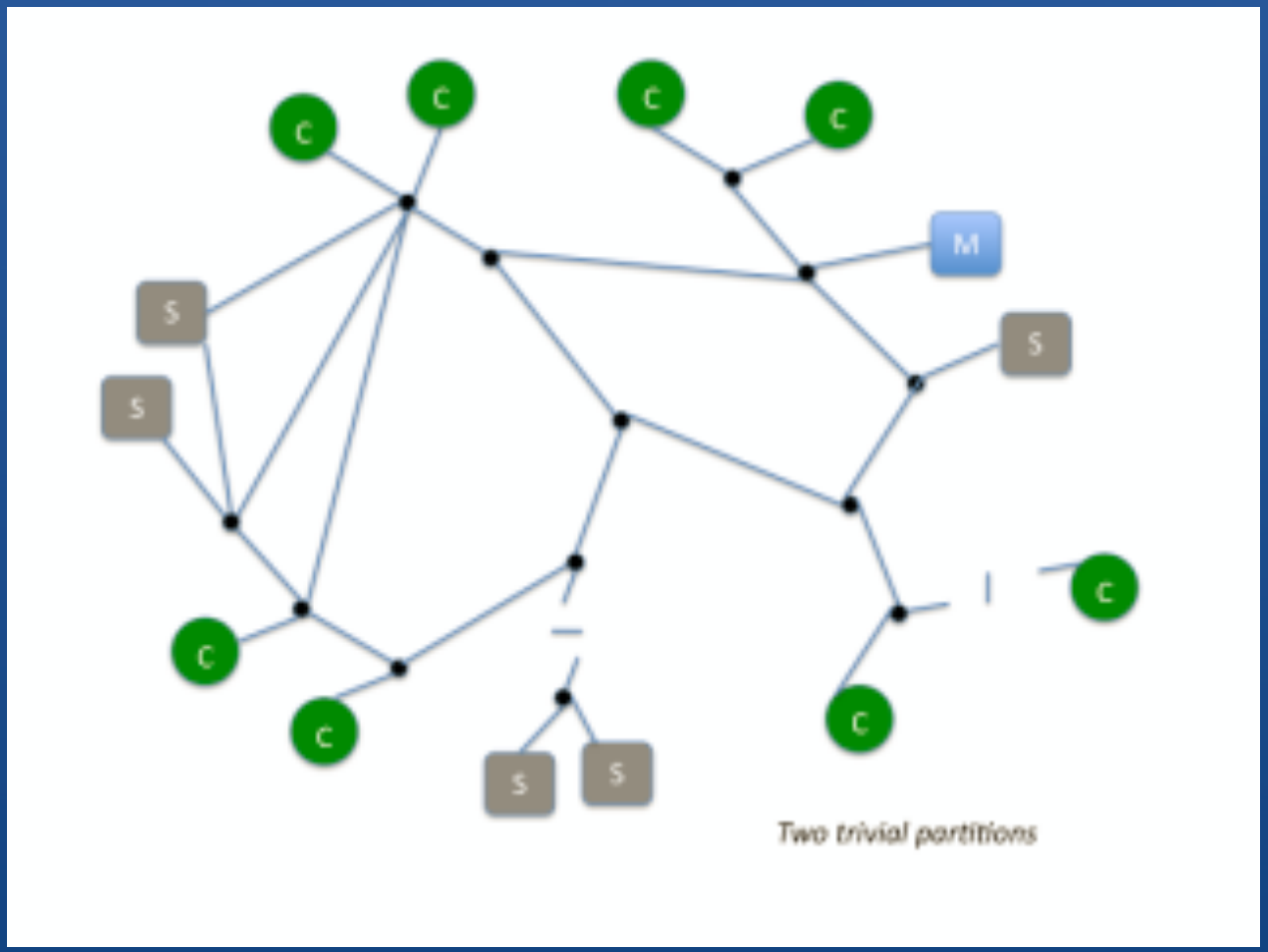
```
op1: update users set age=40 where _id='joe'
op2: update users set state='ca' where _id='joe'
```

Multiple Writer Strategies

- Programatic Merge
  - Store operations, instead of state
  - Replay operations
  - Did you get the last operation ?
  - Not immediate

- Communtative operations
  - Conflict free?
  - Fold-able
  - Example: add, increment, decrement

Trivial Network Partitions



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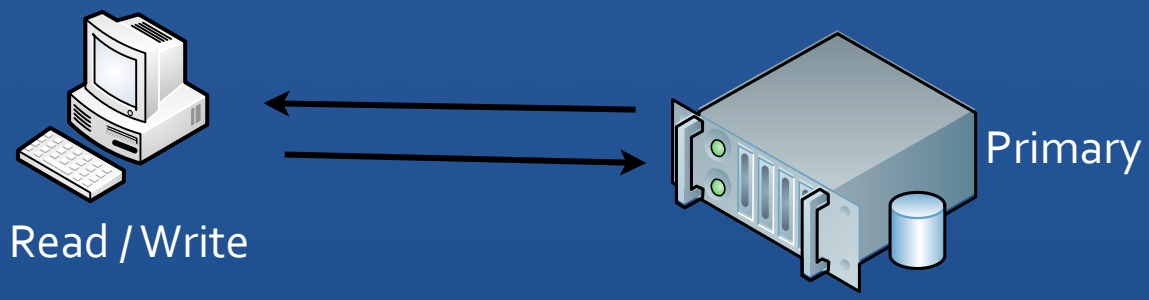
MongoDB Options

MongoDB Transaction Support

- Single Master / Sharded

- MongoDB Supports Atomic Operations on Single Documents
  - But not Rollback
- $ operators
  - $set, $unset, $inc, $push, $pushall, $pull, $pullall
- Update if current
  - find followed by update
- Find and modify

MongoDB



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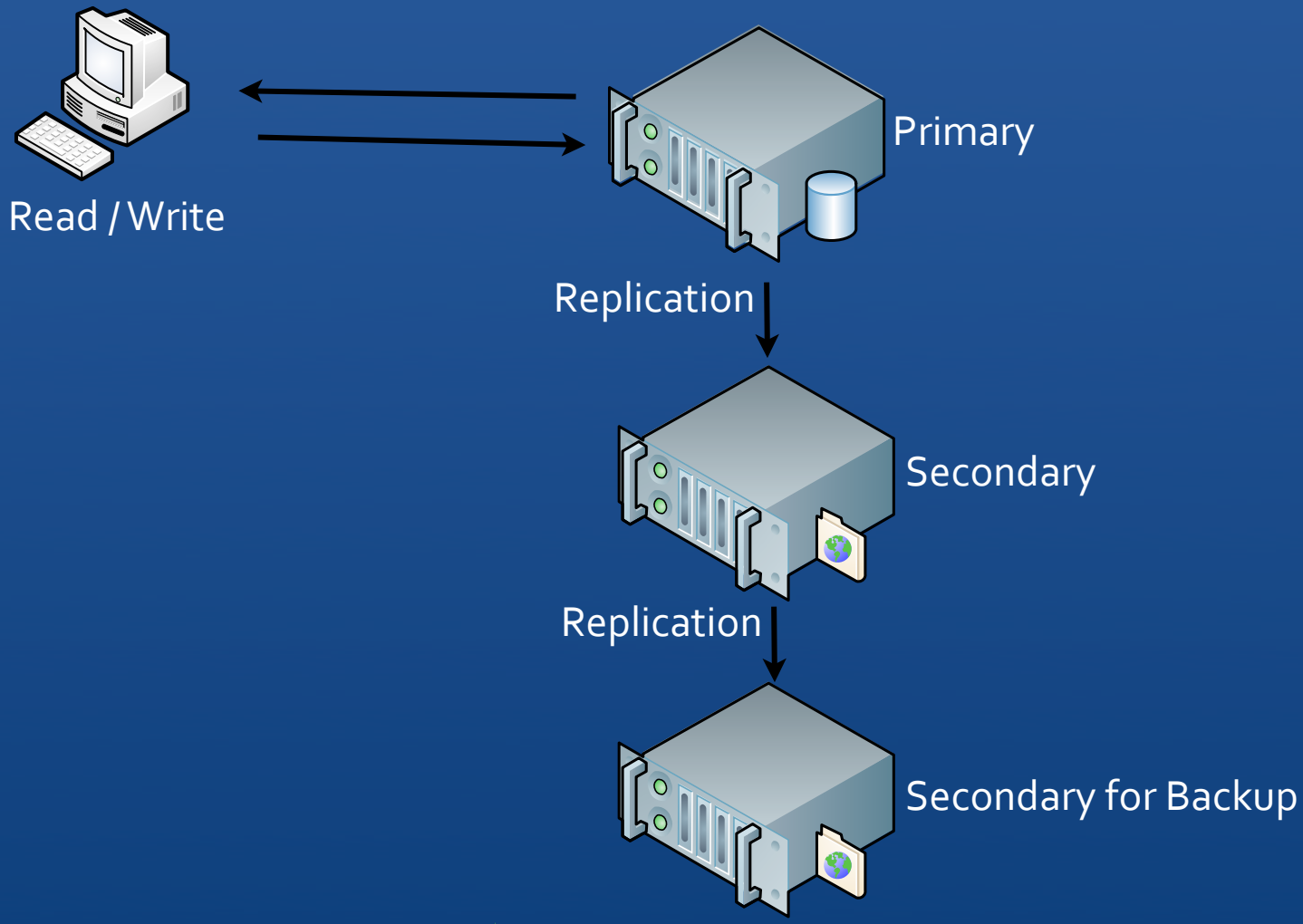
MongoDB



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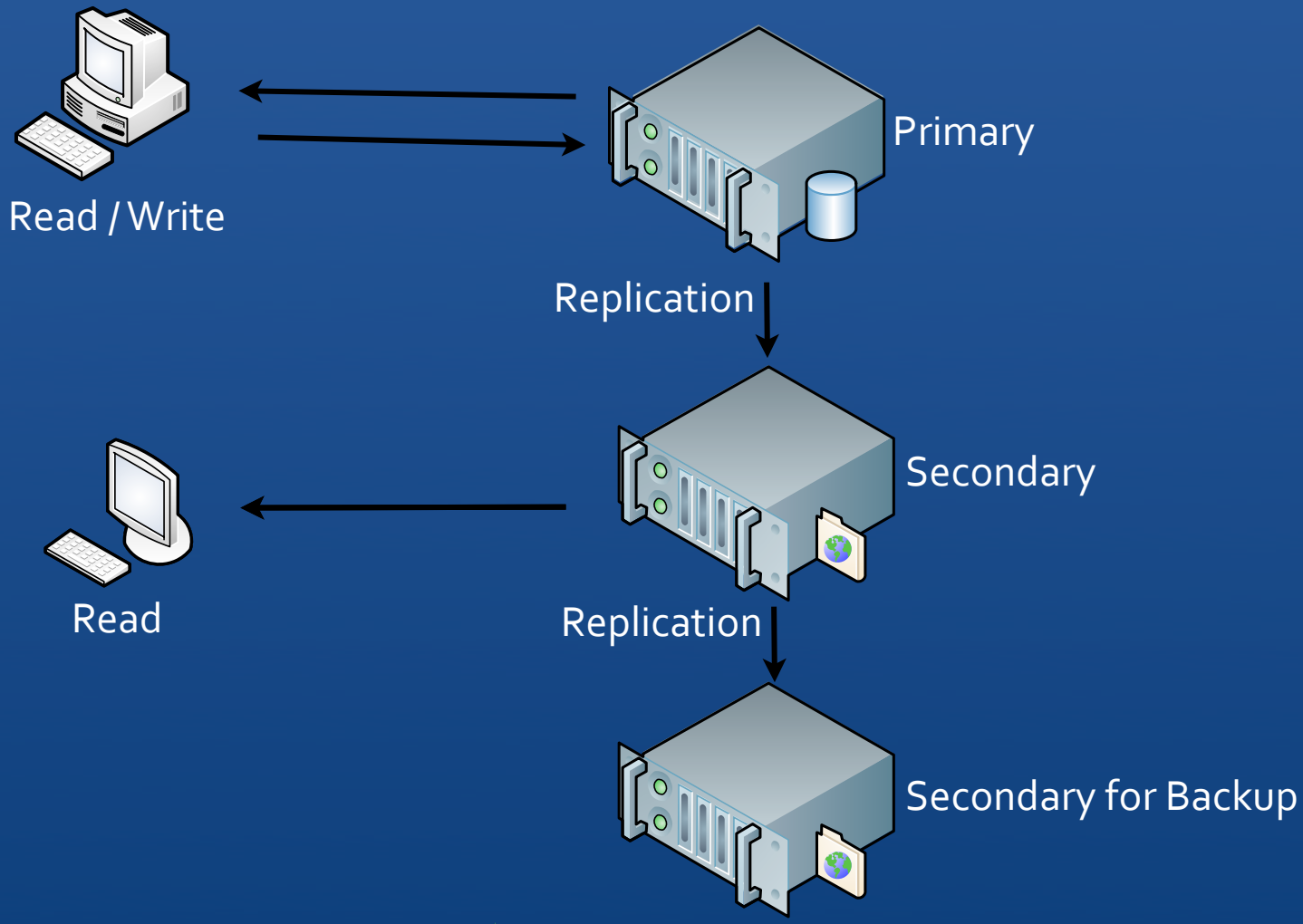

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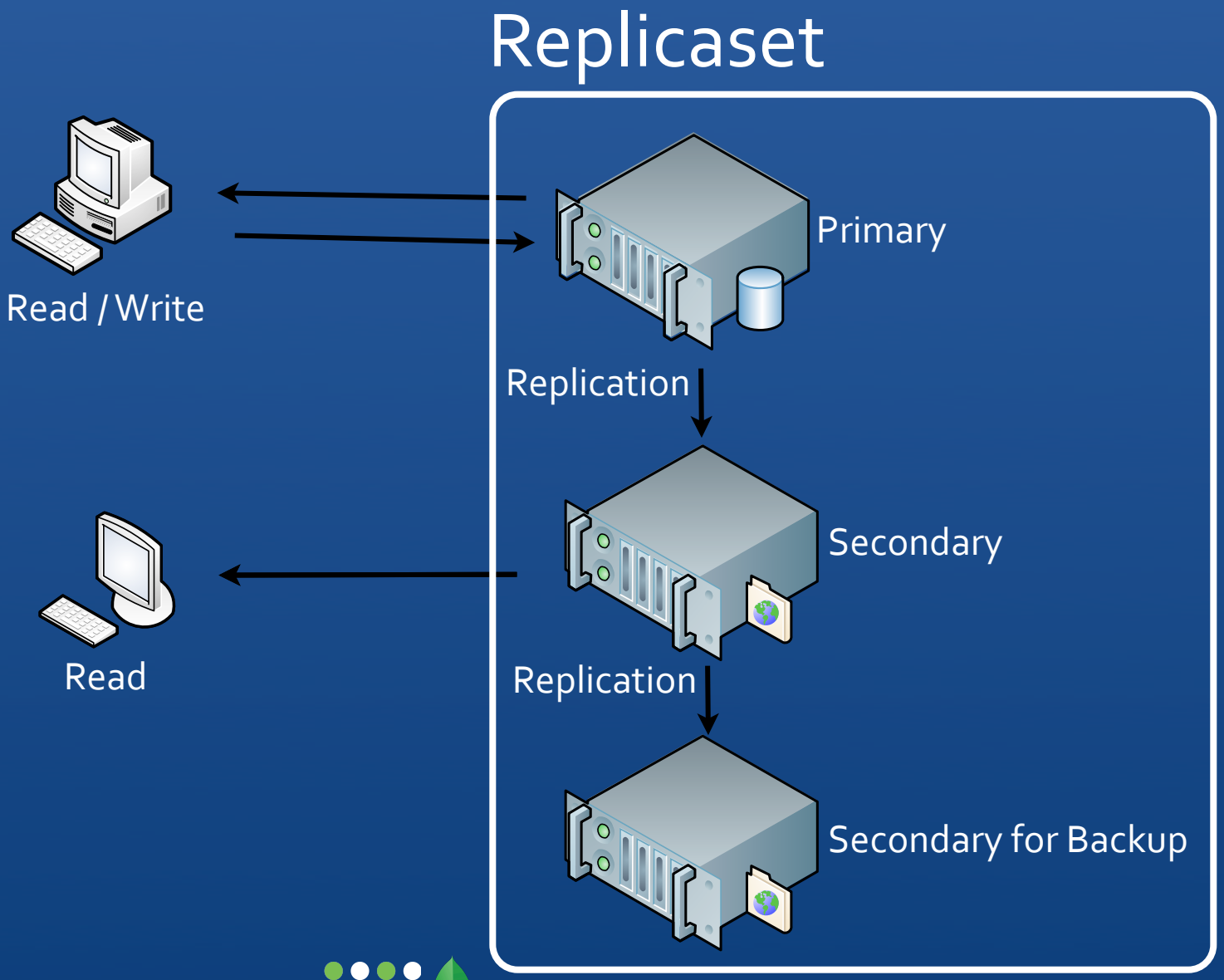
MongoDB



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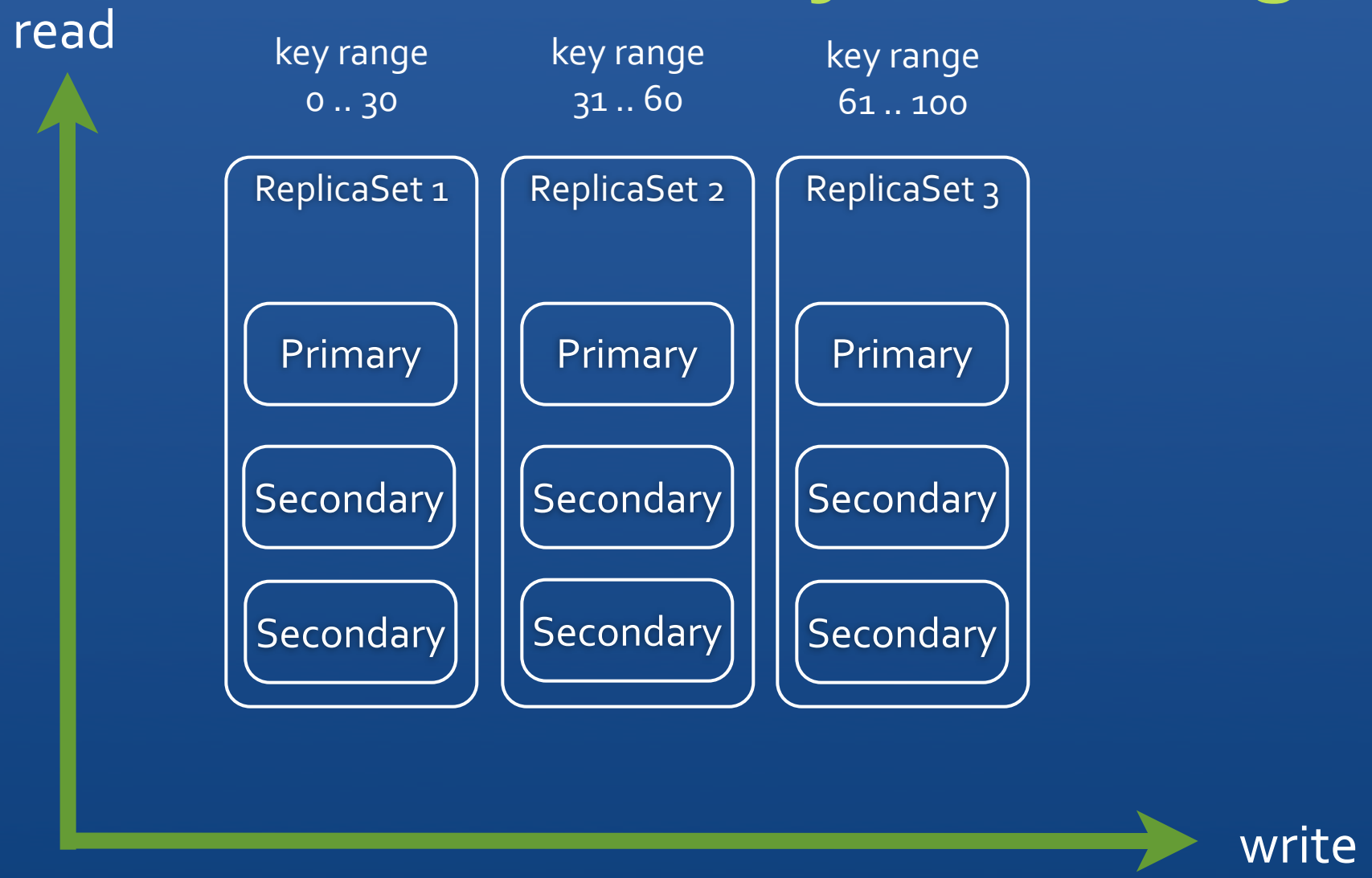
Write Scalability: Sharding



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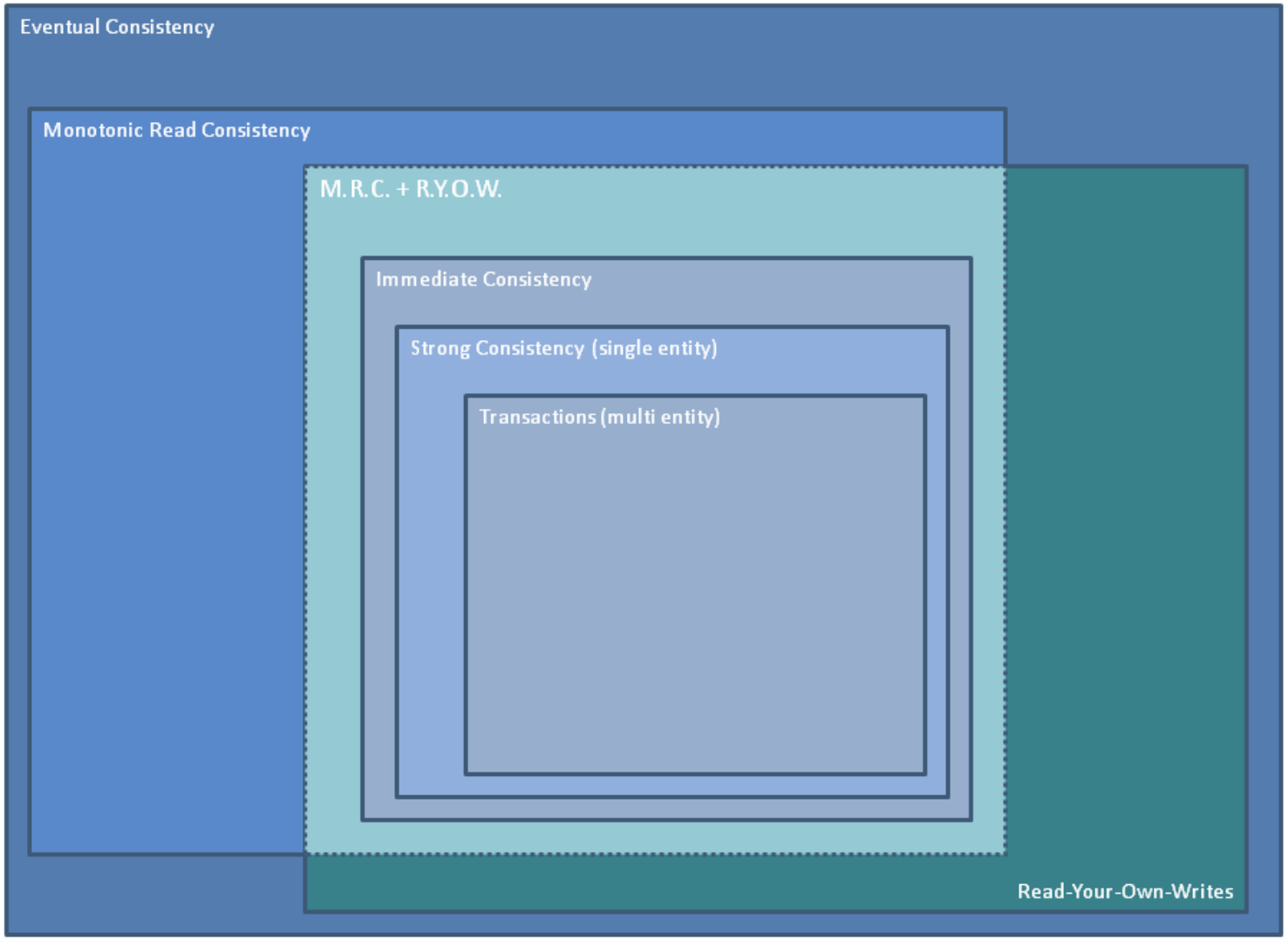

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Sometimes we need global state / more consistency

- Unique key constraints
  - User registration
- ACL changes

Could it be the case that…

uptime(CP + average developer)

>=

uptime(AP + average developer)

where uptime:= system is up and non-buggy?

Thank You :-)
@rogerb

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