Dynamo

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What have we looked at so far ?


I DON'T ALWAYS
BUILD SYSTEMS
BUT WHEN I
DO I BUILD
APPROPRIATE ONES

Assumptions

- CAP Theorem
- SQL and NoSQL
- Hashing

Origin’s of Dynamo

This is year 2004

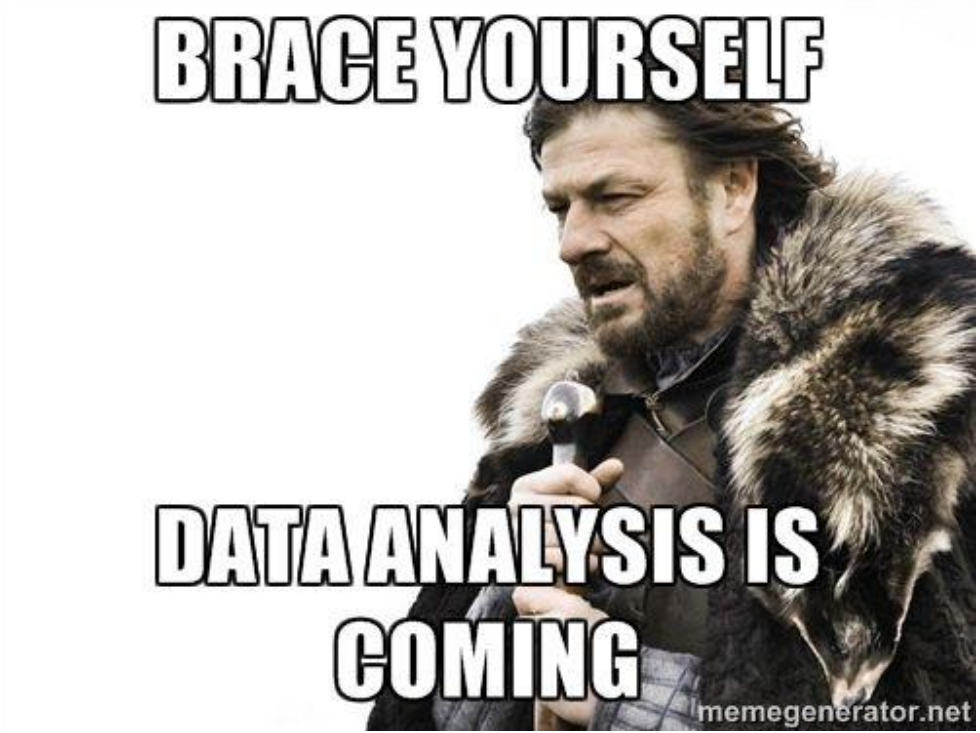
One Amazon was growing and other shrinking

What led to Dynamo ?

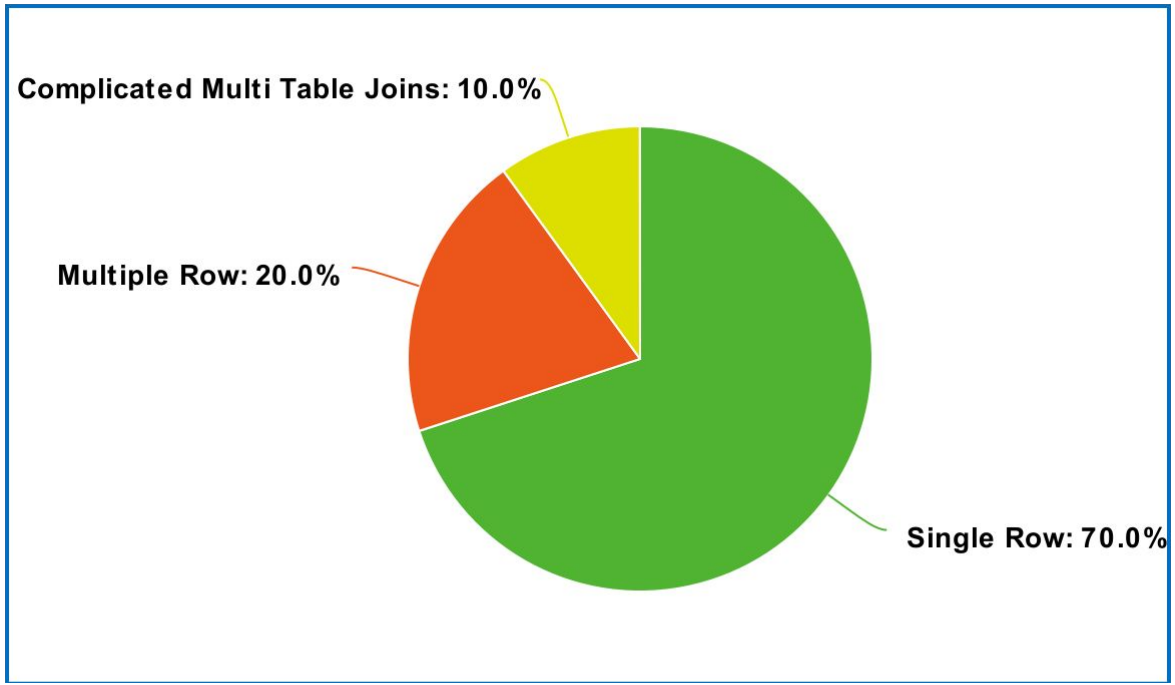
What led to Dynamo ?

- Amazon was using Oracle enterprise edition
- Despite access to experts at Oracle, the DB just couldn't handle the load.

What did folks at Amazon Do ?



Query Analysis



90% of operations weren't using the JOIN functionality that is core to a relational database

Goals which Dynamo wanted to achieve

- ~~Highly~~ Always available
- Consistent performance
- Horizontal Scaling
- Decentralized

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- ~~Highly Always available~~
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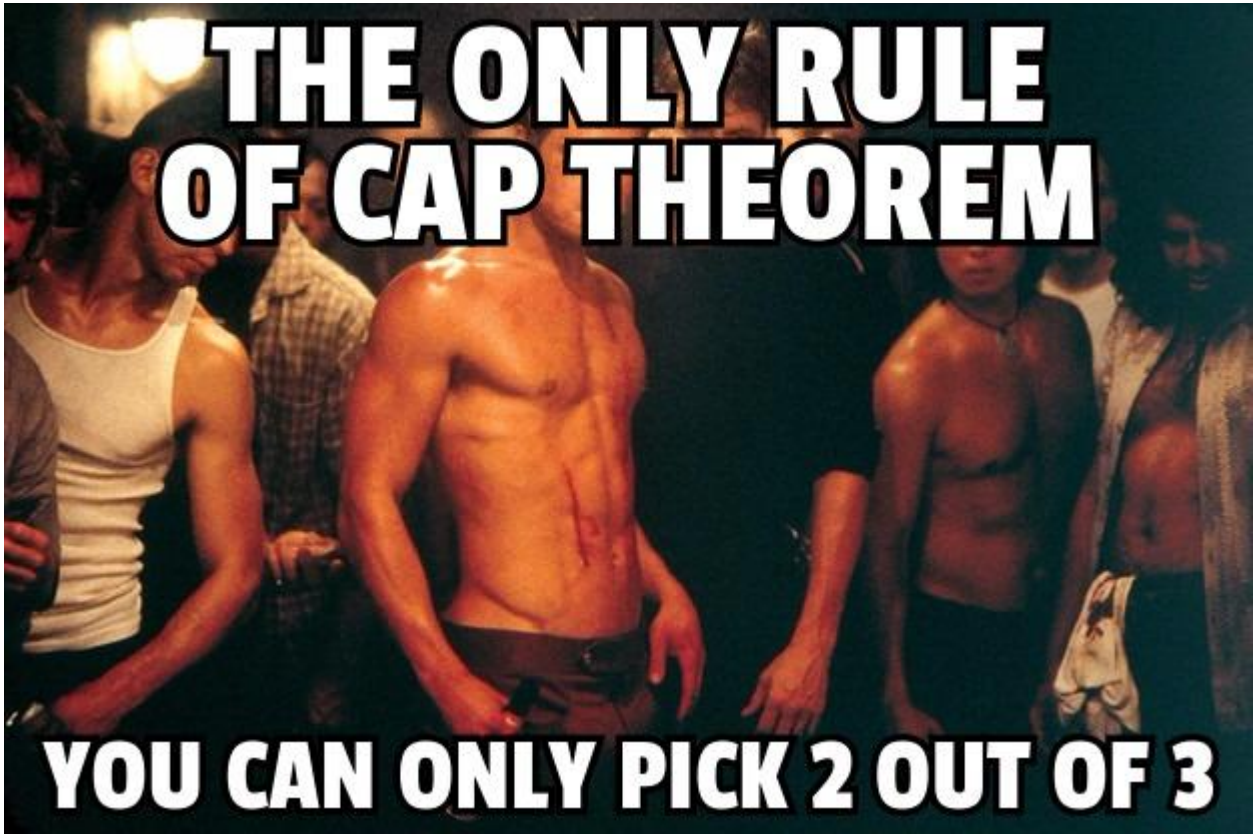
- ~~Horizontal Scaling~~
- ~~Decentralized~~

Major aspects of Dynamo design

- Interface
- Data Partitioning
- Data Replication
- Load Balancing
- Eventual Consistency
- And a lot of other this and that, hopefully we will cover all of it.

Consistency Model



Eventually Consistent

- The reads can contain stale data for some bounded time .

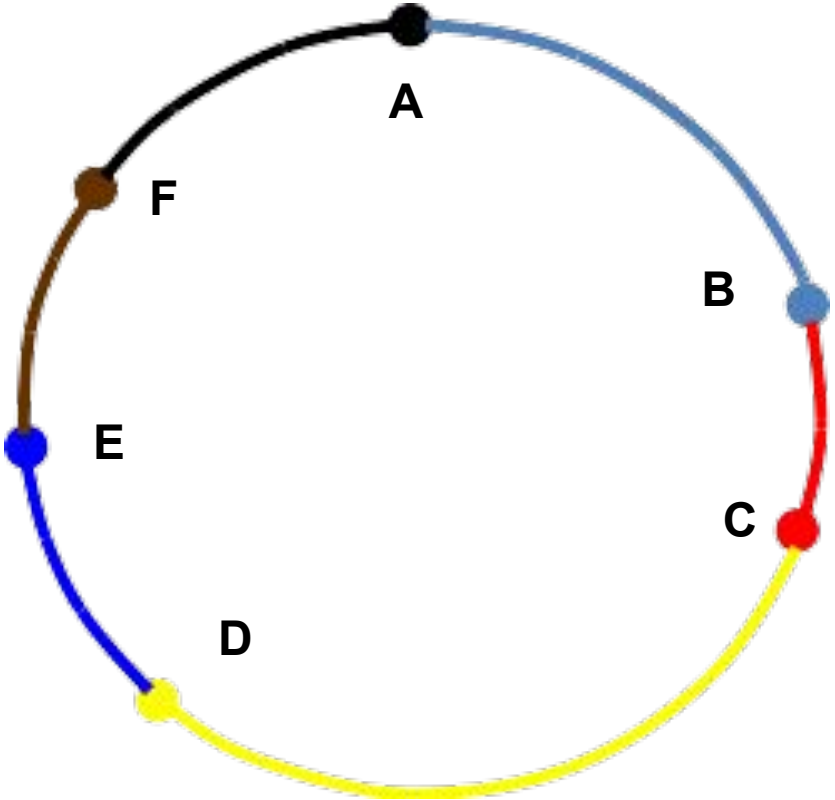
Amazon chose Eventual Consistency Model

- Application will work just fine with eventual consistency

- They needed a scalable DB

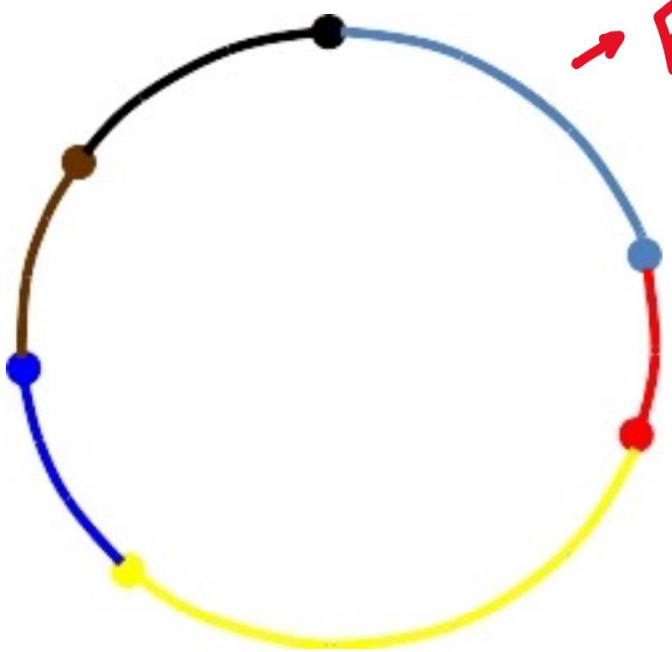
Let’s Finally get to Dynamo !!

This is Dynamo !!



Origin of this ring ?

- **Consistent Hashing ?**
- How can we increase or decrease number of nodes in distributed cache without re-calculating the full distribution of hash table ?

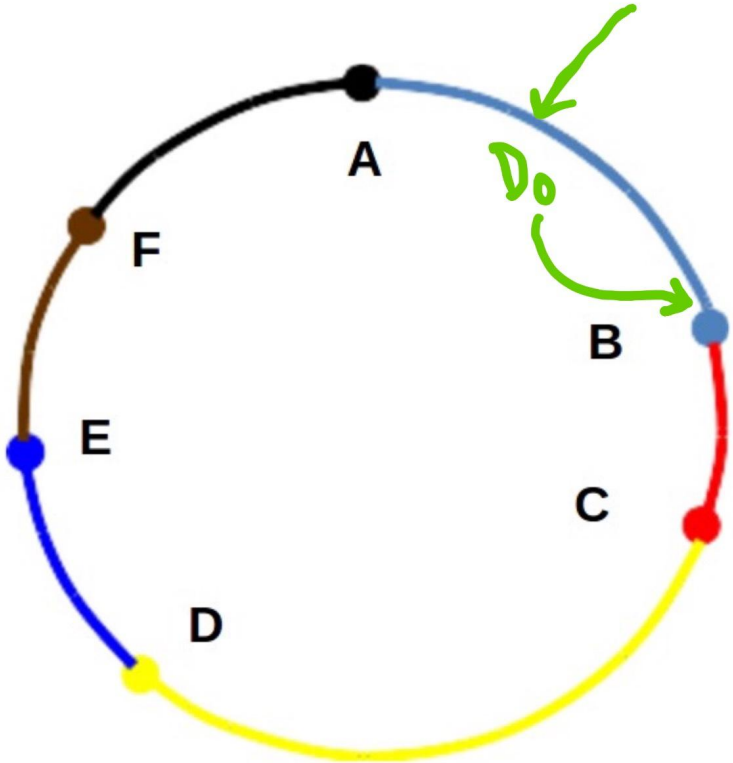


→ 128 bit hash space

→ First one overlaps last one (circle)

- Each node is assigned a spot in the ring

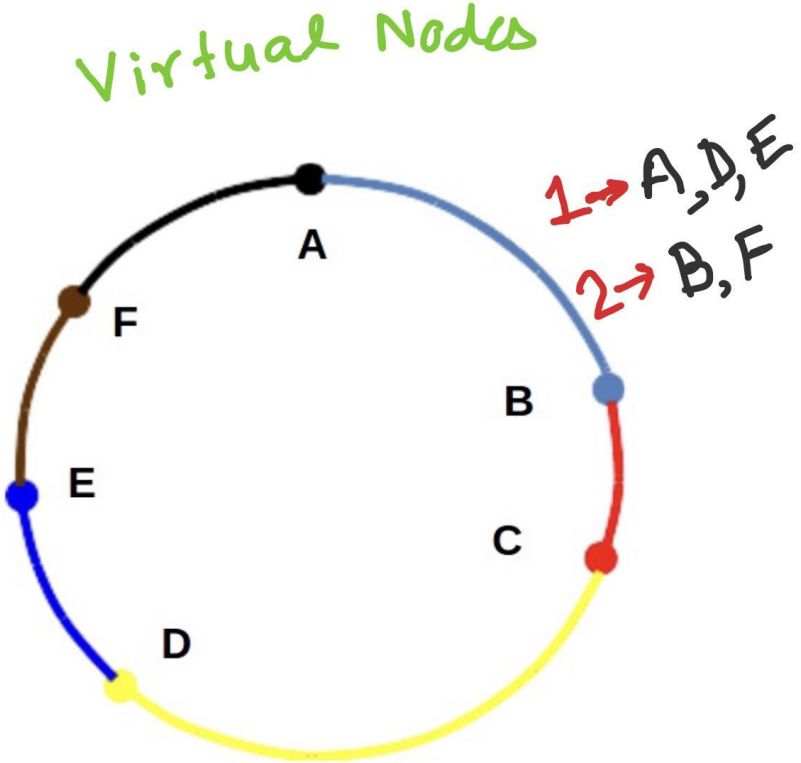
- A data point is the responsibility of the first node in the clockwise direction (**coordinator node)**



Some issues with Consistent Hashing

- Random Assignment

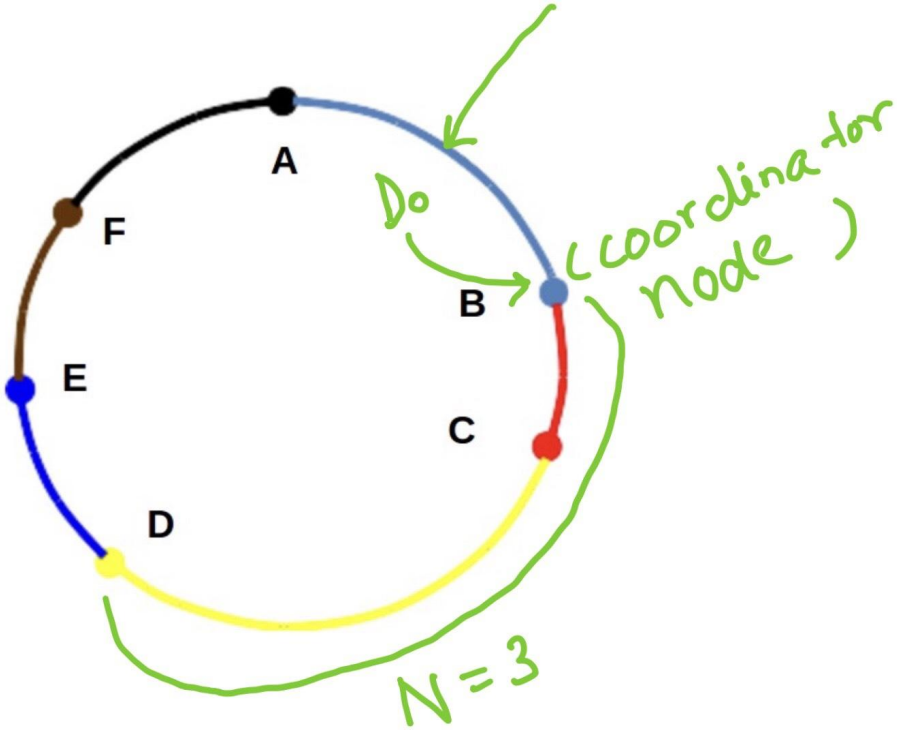
- Heterogeneous Performance of Node



How replication work ?

- The coordinator node replicates to next N-1 nodes.

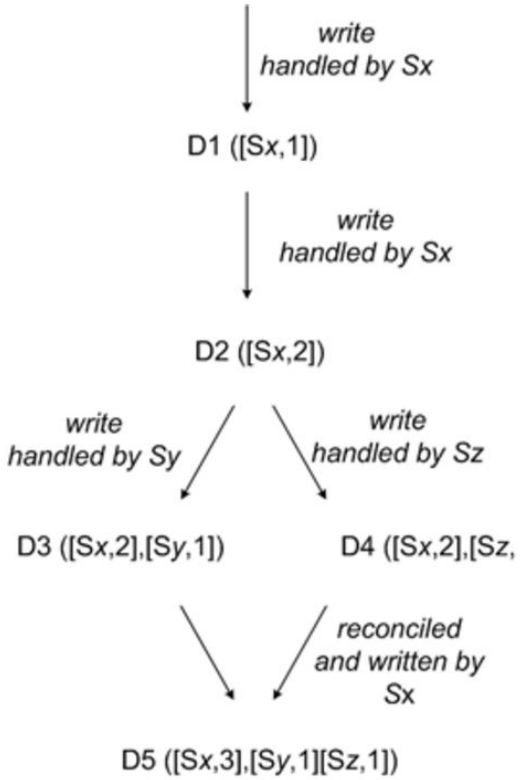
- N is the replication factor



Data Versioning

- Eventual Consistency
- Multiple Versions of same data might exist in systems
- Come Vector Clocks

Vector Clocks



Dynamo DB deployment

- Loadbalancer

- Client Aware library

Dynamo DB query interface

- get() and put() operations

- Configurable R and W.

- R = Min Number of Nodes to read from before returning
- W = Min number of Nodes on which data should be written before returning

Making Dynamo Consistent

- If R+W > N
  - Dynamo becomes consistent

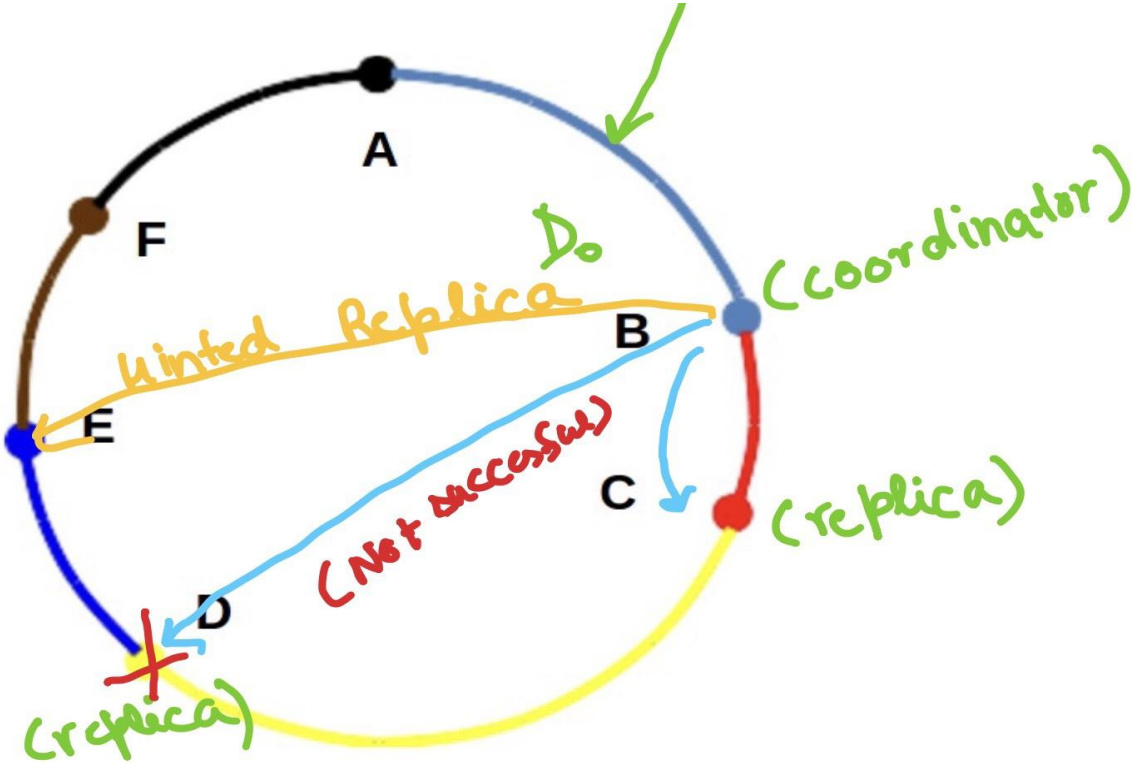
- Availability and Performance takes a hit.

Handling Failures

- Hinted Handoff

- Replica Synchronization

Hinted Handoff

- 

Replica Synchronization

- Each node maintains separate Merkle Tree of the key ranges it's handling

- A background job runs trying to do a quick match and find which set of replicas need to be merged.

Failure Detection

- If a node is not reachable the request is routed to the next node,

- No need to explicitly detect failure. As node removal is explicit operation.

Differences between GFS/BigTable and Dynamo

- No centralized control

- No locks on data.

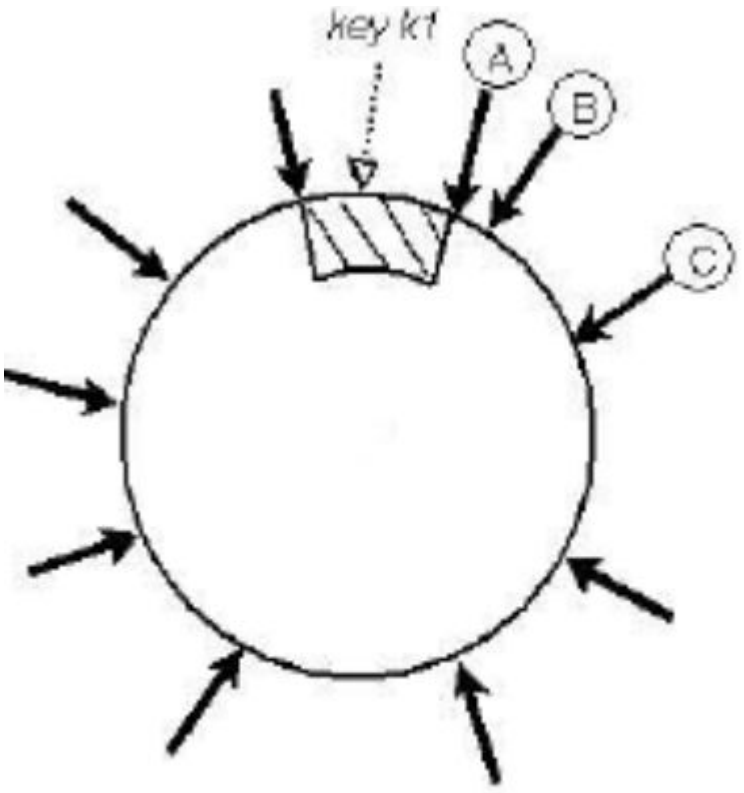
Optimizations done later

- Instead of write to disk, write to buffer
- Separate writer , write to disk
- Faster write performance

Change in key partition strategy

- The one described -
  - Random
  - Hash space not uniform

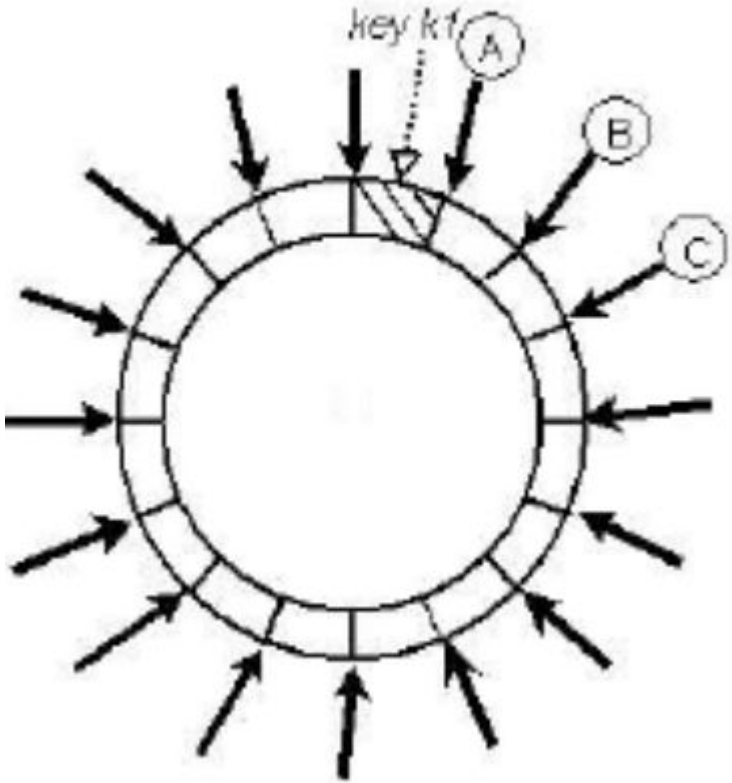
- Problems-
  - Data copy difficult
  - Merkle Tree reconstructed



New Partition Strategy

- Divide hash space equally in Q portions
- Each node S is given Q/S tokens
- A new node randomly picks it's Q/S+1 tokens
- A removal of node randomly distributes Q/S

  tokens



Impact

- A lasting impact on industry, forced SQL advocated to build distributed SQL DB's
- Cassandra, Couchbase
- Established scalability of NoSQL databases.

Questions

Adding a node to the ring

- The administrator issues a request to one of the node in the ring.

- The serving request node makes a persistent copy of the membership change and propagates via gossip protocol

Node on startup