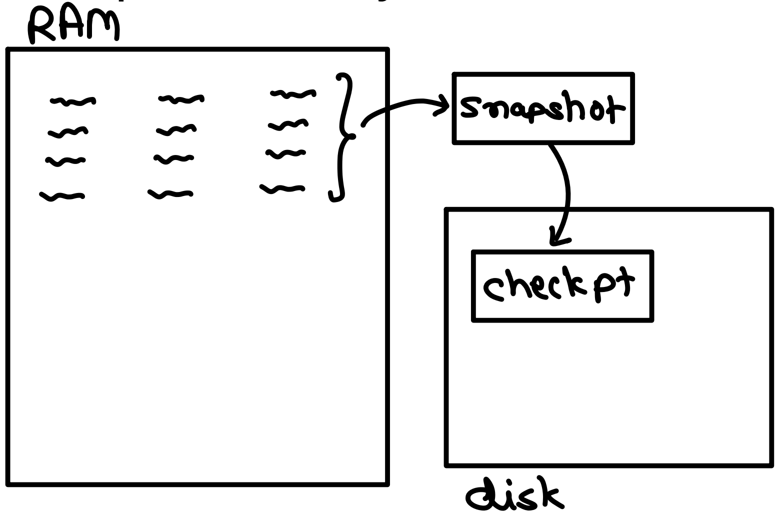
MongoDb Databases

Mongo - WiredTiger Storage

Storage engine is managing data in memory and on disk.
MongoDB 3.2 onwards default storage engine is *WiredTiger*; while earlier version it was MMAPv1. 5
WiredTiger storage engine:

- Uses document level optimistic locking for better performance.
- Per operation a snapshot is created from consistent data in memory.
- The snapshot is written on disk, known as checkpoint → for recovery.
- Checkpoints are created per 60 secs or 2GB of journal data.
- Old checkpoint is released, when new checkpoint is written on disk and updated in system tables.
- To recover changes after checkpoint, enable journaling.

collection-9-5033127685441071718.wt



Mongo - WiredTiger Storage

- WT uses write-ahead transaction in journal log to ensure durability.
- It creates one journal record for each client initiated write operation.
- Journal persists all data modifications between checkpoints.
- Journals are in-memory buffers that are created on disk per 50 ms.
- WiredTiger stores all collections & journals in compressed form.
- Recovery process with journaling:
  - Get last checkpoint id from data files.
  - Search in journal file for records matching last checkpoint.
  - Apply operations in journal since last checkpoint.
- WiredTiger use internal cache with size max of 256 MB and 50% RAM - 1GB along with file system cache.

Ext3 = Ext2 + Journaling

Journaled FS

✓ Ext3/4, NTFS, ...

Non-Journaled FS

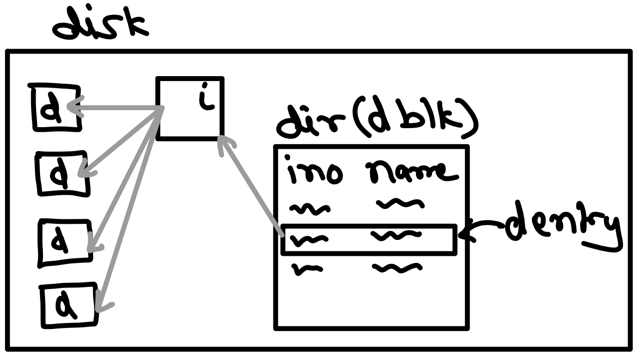
✓ Ext2, FAT32, ...

File creation in FS :

① metadata - inode

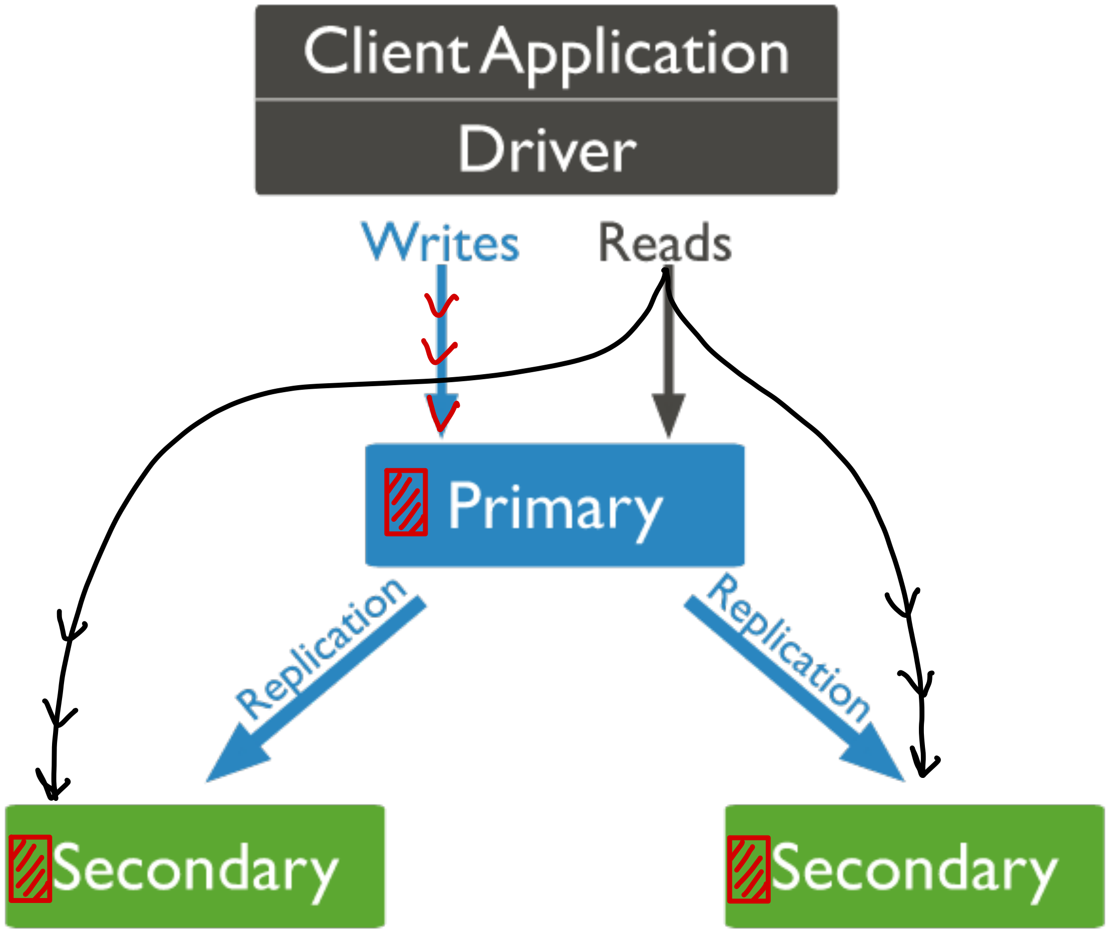
② data - data blocks

③ directory entry



Mongo - Replication

- A replica set is a group of mongod instances that maintain the same data set.
- Only one member is deemed the primary node, while other nodes are deemed secondary nodes.
- The secondaries replicate the primary's oplog.
- If the primary is unavailable, an eligible secondary will become primary.

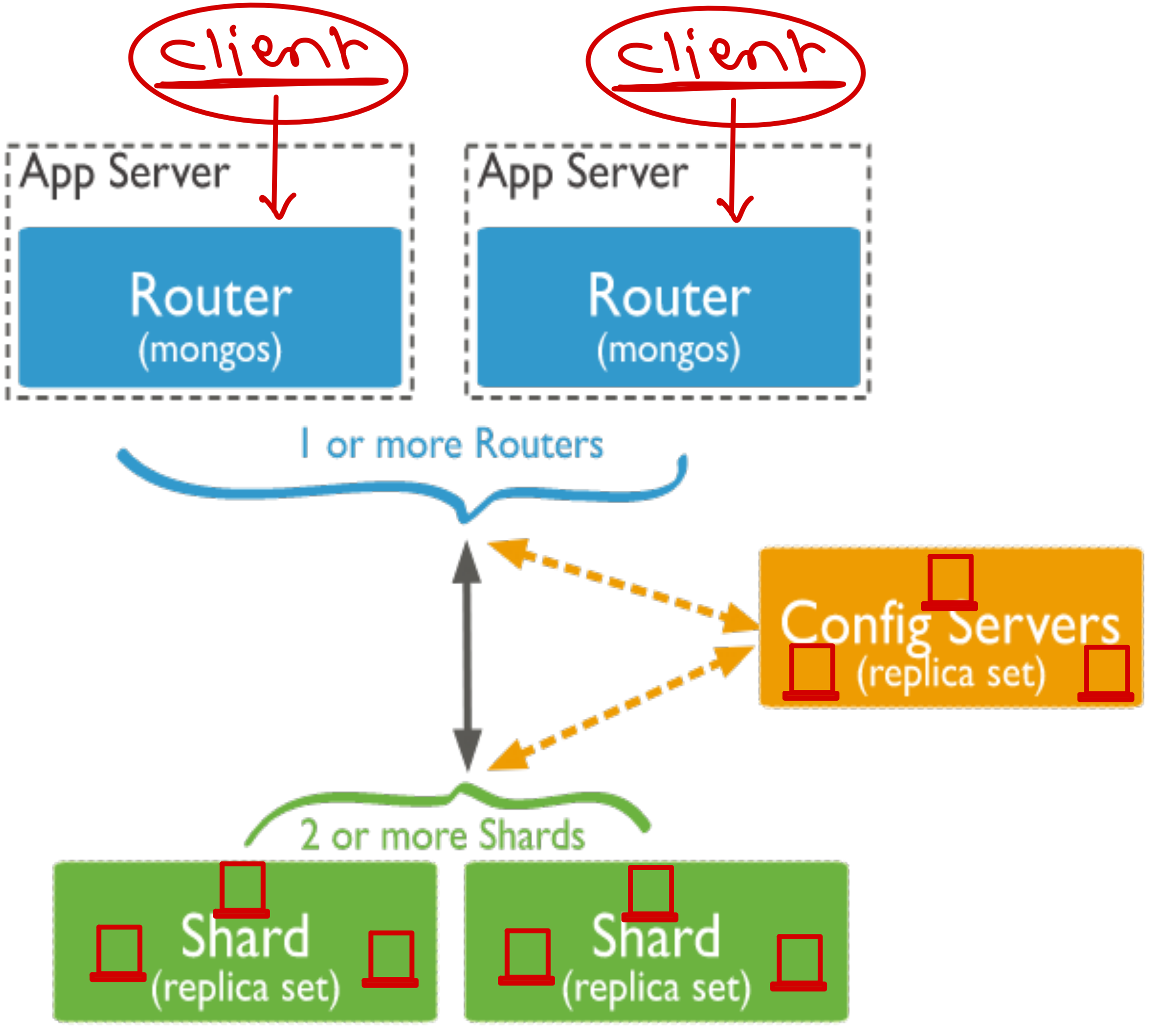


Mongo - Replication

- Secondary servers communicate with each other via heart-beat.
- Secondary applies operations from primary asynchronously.
- When primary cannot communicate a secondary for more than 10 seconds, secondary will hold election to elect itself as new primary. This automatic failover process takes about a minute.
- An arbiter (do not store data) can be added in the system (with even number of secondaries) to maintain quorum in case of election.
- By default client reads from primary, but can set read preference from secondary. Reading from secondary may not reflect state of primary; as read from primary may read before data is durable.

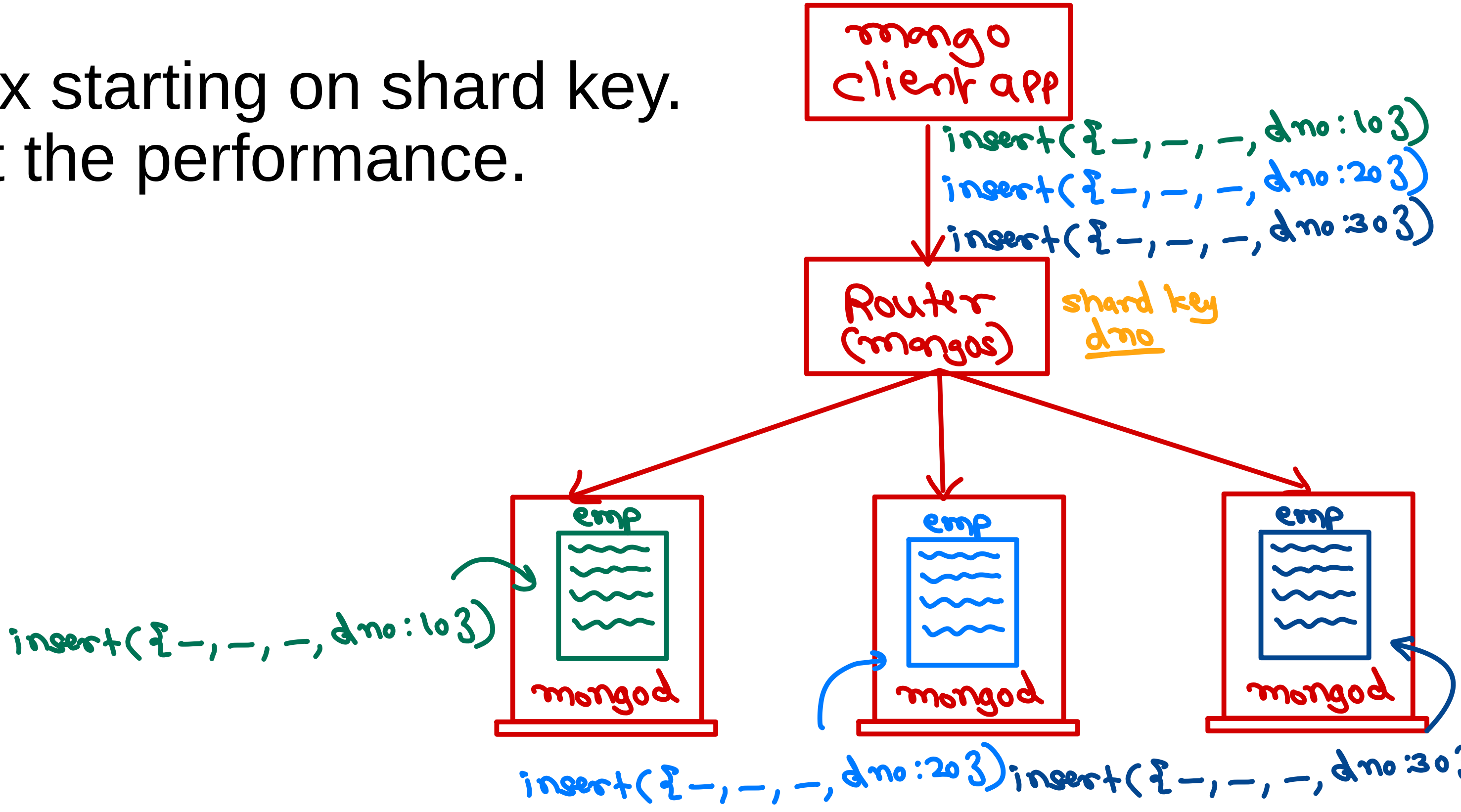
Mongo - Sharding

- Sharding is a method for distributing large data across multiple machines.
- This is mongodb approach for horizontal scaling/scaling out.
- shard: part of collection on each server (replica set).
- mongos: query router between client & cluster.
- config servers: metadata & config settings of cluster.



Mongo - Sharding

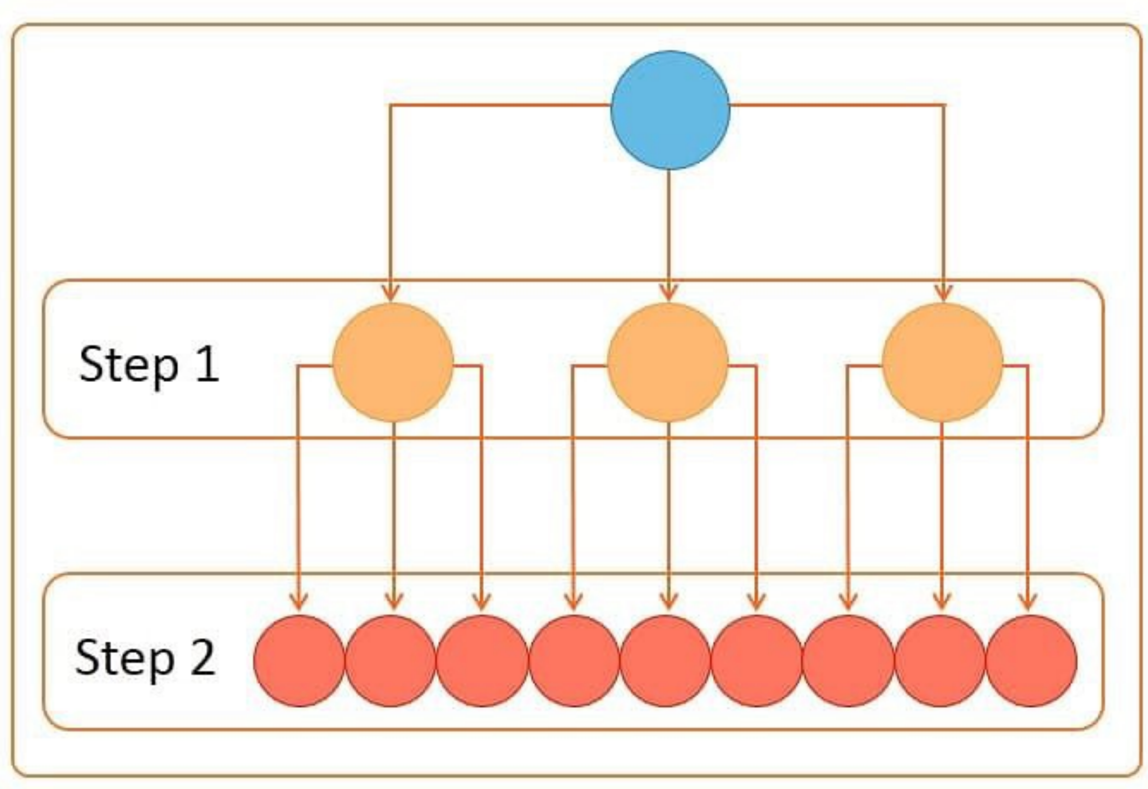
- Collections can be sharded across the servers based on shard keys.
- Shard keys:
  - Consist of immutable field/fields that are present in each document
  - Only one shard key. To be chosen when sharding collection. Cannot change shard key later.
  - Collection must have index starting on shard key.
  - Choice of shard key affect the performance.
- Advantages:
  - Read/Write load sharing
  - High storage capacity
  - High availability



Cassandra

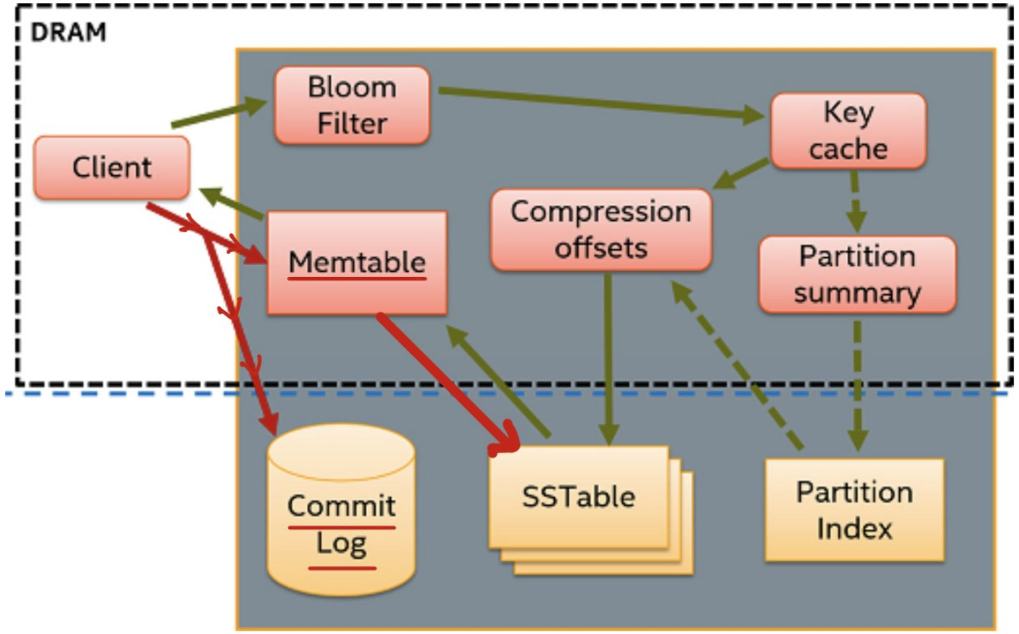
Gossip Protocol

- Cassandra uses a gossip protocol to communicate with nodes in a cluster
- It is an inter-node communication mechanism similar to the heartbeat protocol in Hadoop
- Cassandra uses the gossip protocol to discover the location of other nodes in the cluster and get state information of other nodes in the cluster
- The gossip process runs periodically on each node and exchanges state information with three other nodes in the cluster
- Eventually, information is propagated to all cluster nodes. Even if there are 1000s of nodes, information is propagated to all the nodes within a few seconds



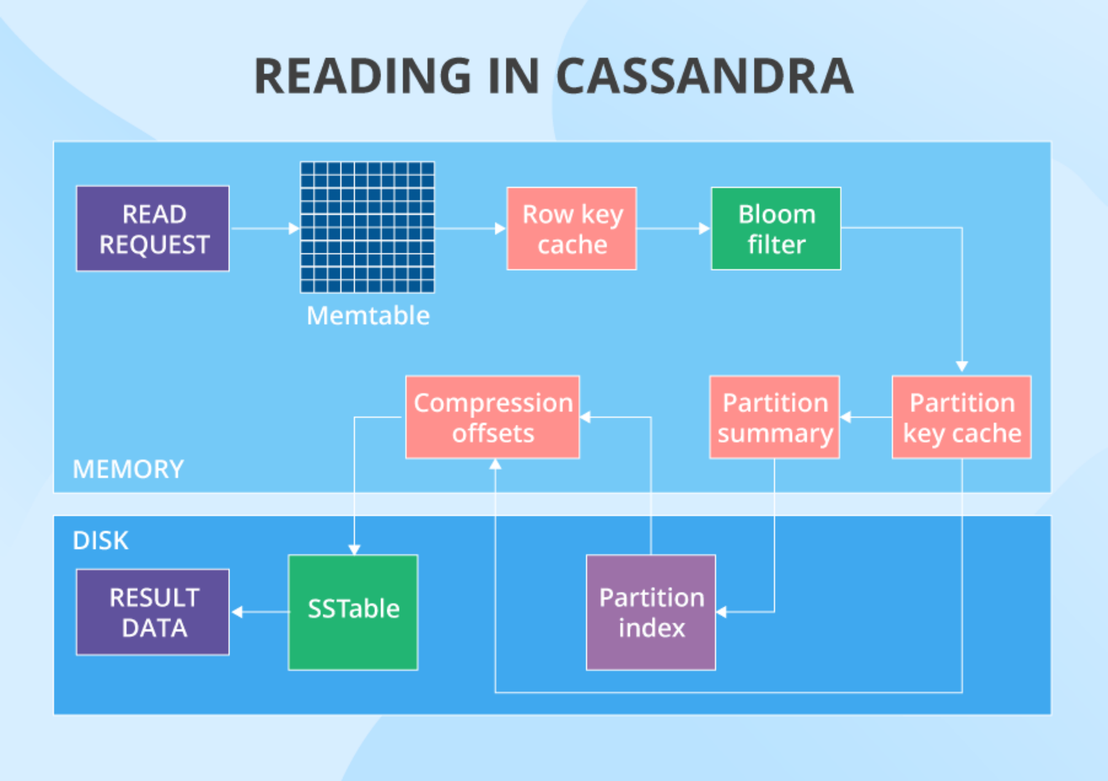
Architecture

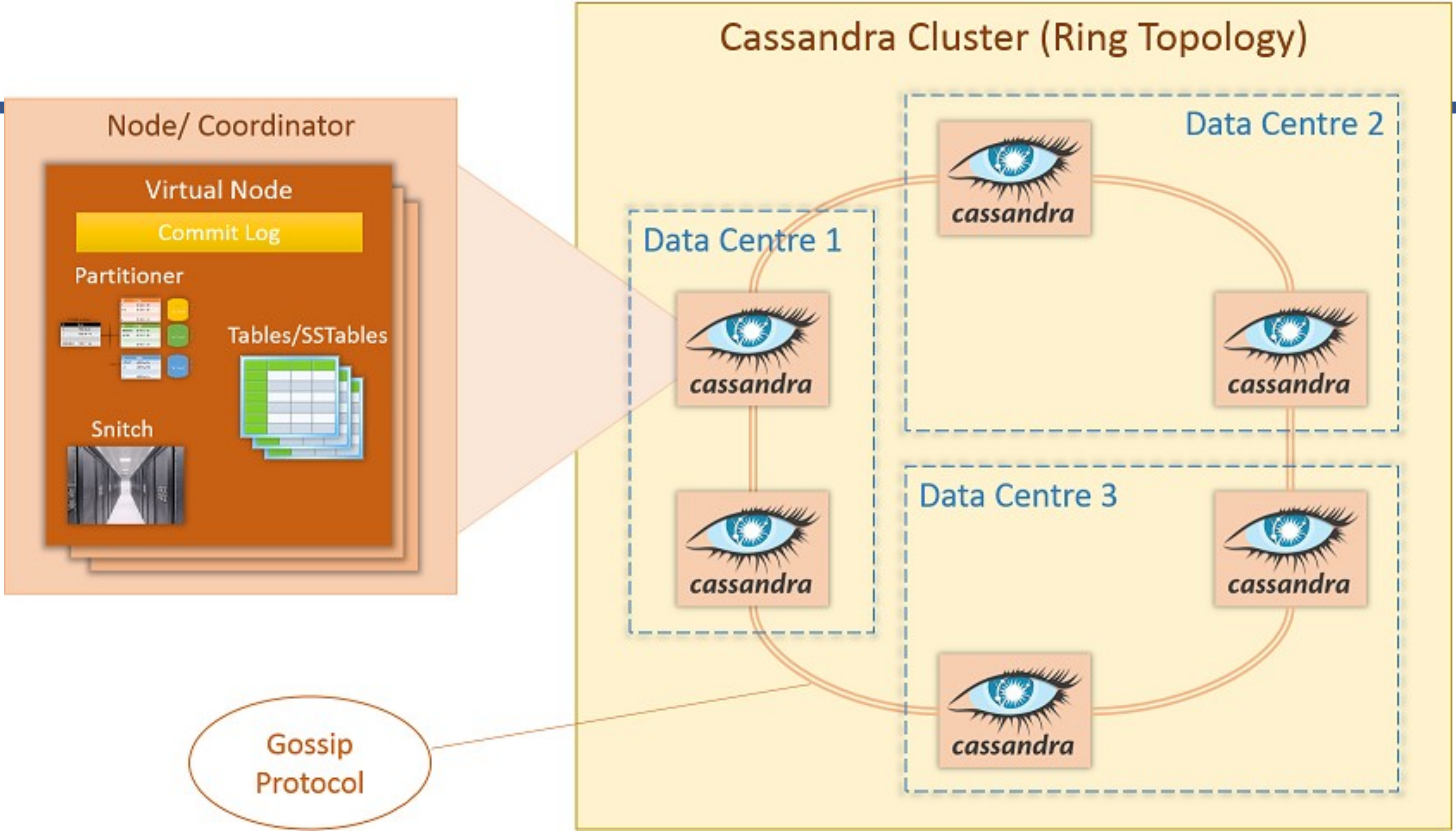
- **Commit Log**
  - Append only log of all mutations local to a node.
  - Client data commit log -> memtable.
  - Durability in the case of unexpected shutdown
  - On startup, any changes in log will be applied to tables
- **Memtable**
  - In-memory structures to write Cassandra buffers.
  - One active memtable per table.
- **Sorted String Table**
  - Immutable data files for persisting data on disk.
  - Multiple memtables merged into single SSTable.
- **LSM Tree** =log structure marge tree
  - Disk based data structure to provide low-cost
  - indexing for a file, in which records are to be
  - inserted at very high rate



Architecture

- **Bloom filter**
  - In the read path, Cassandra merges data on disk (in SSTables) with data in RAM (in memtables).
  - To avoid checking every SSTable data file for the partition being requested, Cassandra employs a data structure known as a bloom filter.
  - Bloom filters are a probabilistic data structure that allows Cassandra to determine one of two possible states
    - The data definitely does not exist in the given file
    - The data probably exists in the given file




Cassandra Cluster (Ring Topology)
Node/ Coordinator
Virtual Node
Commit Log
Partitioner
Tables/SSTables
Snitch
Data Centre 1
Data Centre 2
Data Centre 3
cassandra
cassandra
cassandra
cassandra
cassandra
cassandra
cassandra
Gossip Protocol

SUNBEAM

Thank you!