Apache Cassandra Advanced

Need : New Era of data – Big Data

Big data involves data that

1) is high **velocity** in nature;
2) combines structured, semi-structured, and unstructured data - **variety**;
3) can include enormous **volumes**; and
4) typically involves complexity in data distribution and synchronization.

The massive scale, high performance, and never-go-down nature of these applications has forged a new set of technologies that have replaced the legacy RDBMS with NoSQL database like Cassandra

The Architecture of Cassandra

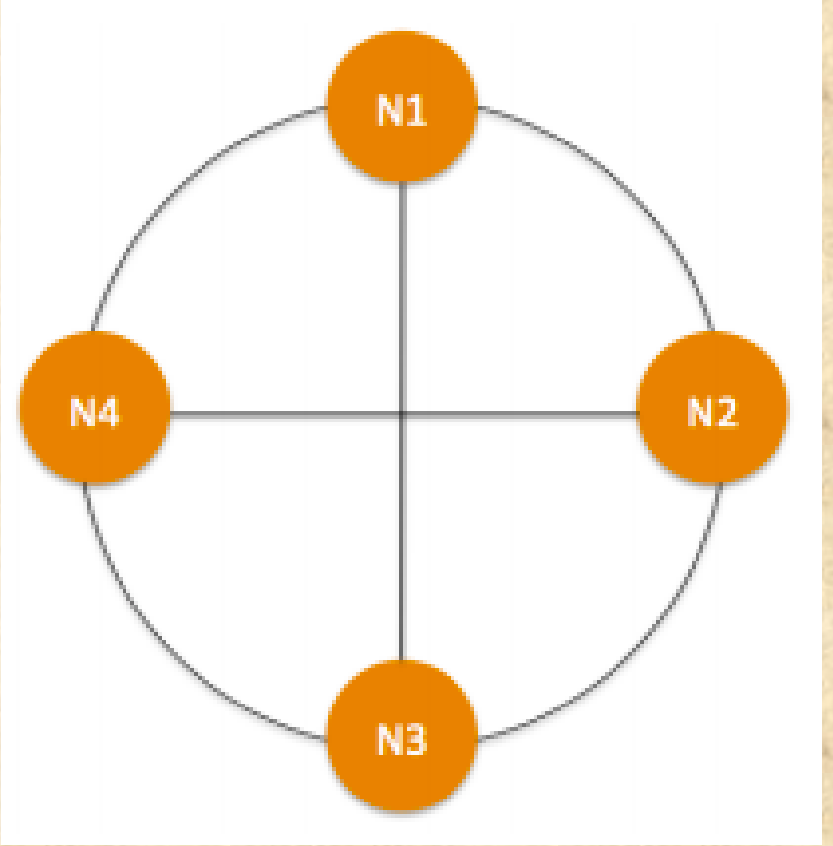
- Set of nodes
- peer-to-peer distributed architecture
- all nodes are the same; there is no concept of a master node
- with all nodes communicating with each other via a ***gossip protocol***
- capable of handling petabytes of information and thousands of concurrent users/operations per second (across multiple data centers)
- no single point of failure, true 24x7 availability

Gossip protocol

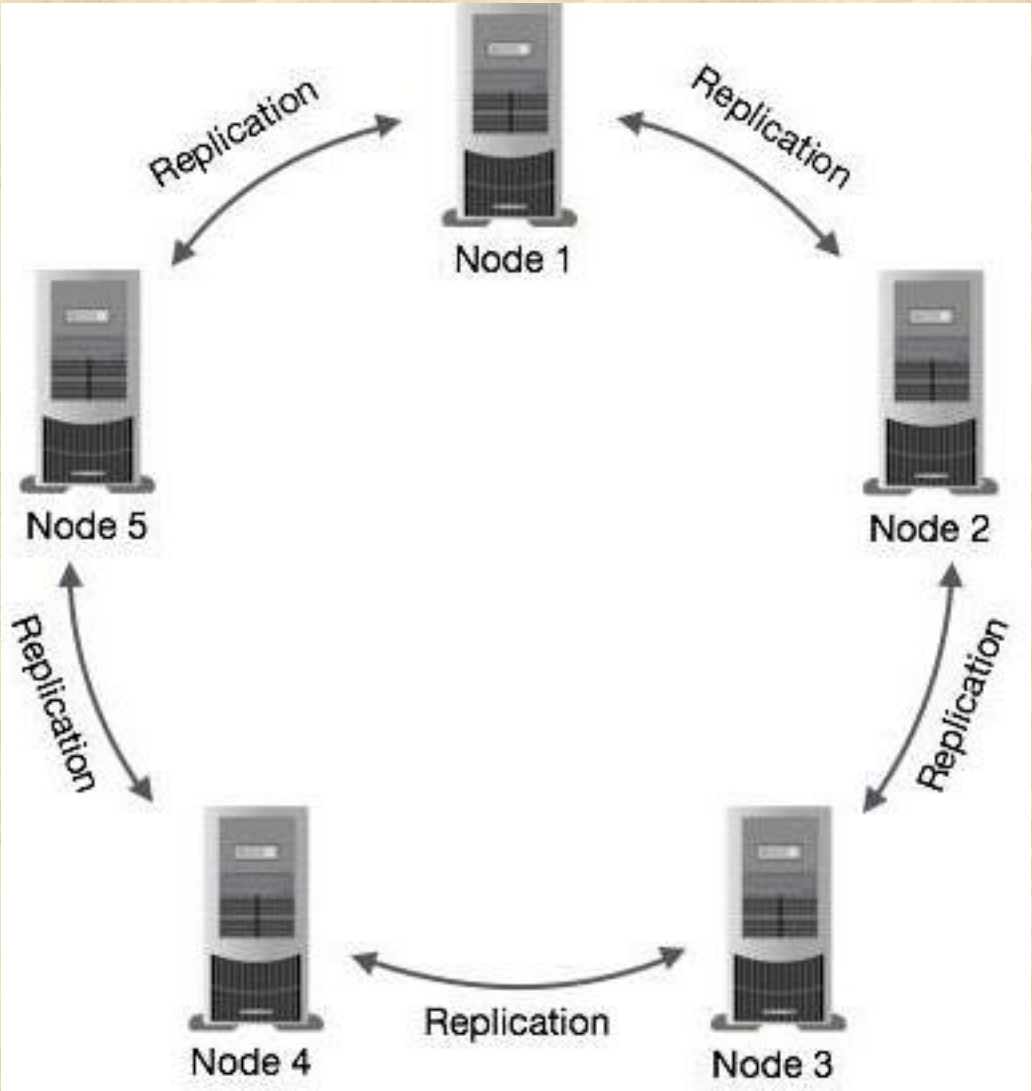
- It is similar to real-world gossip, where a node (say B) tells a few of its peers in the cluster what it knows about the state of a node (say A).
- Those nodes tell a few other nodes about A,
- and over a period of time, all the nodes know about A.

Distributing and Replicating Data

- Automatic data distribution across all nodes that participate in a “ring” or database cluster.
- Data is transparently partitioned across all nodes
  - Randomized (default)
  - ordered fashion
- Easy user-defined replication – “replication factor” parameter in keyspace creation

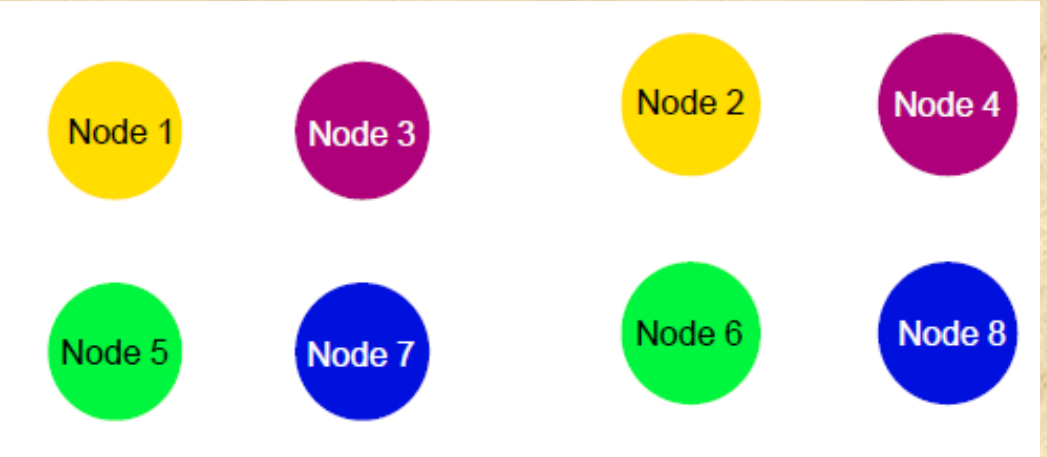


Replication

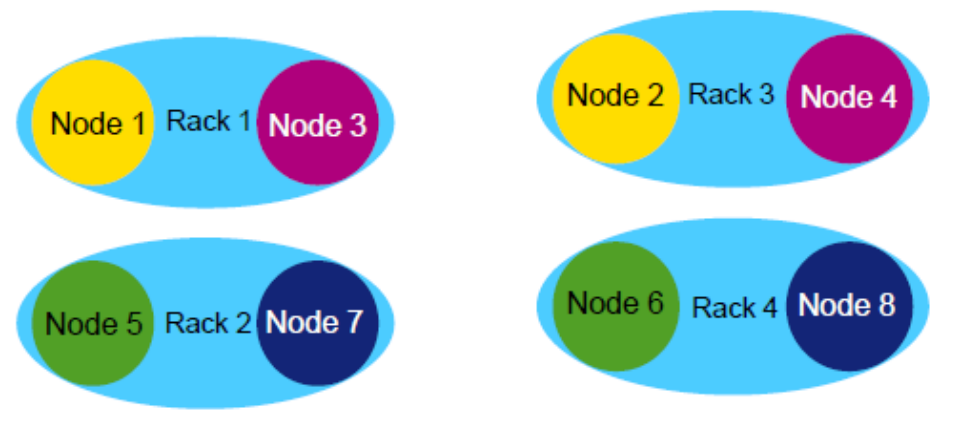


Architecture …

- One Node : Single Cassandra instance

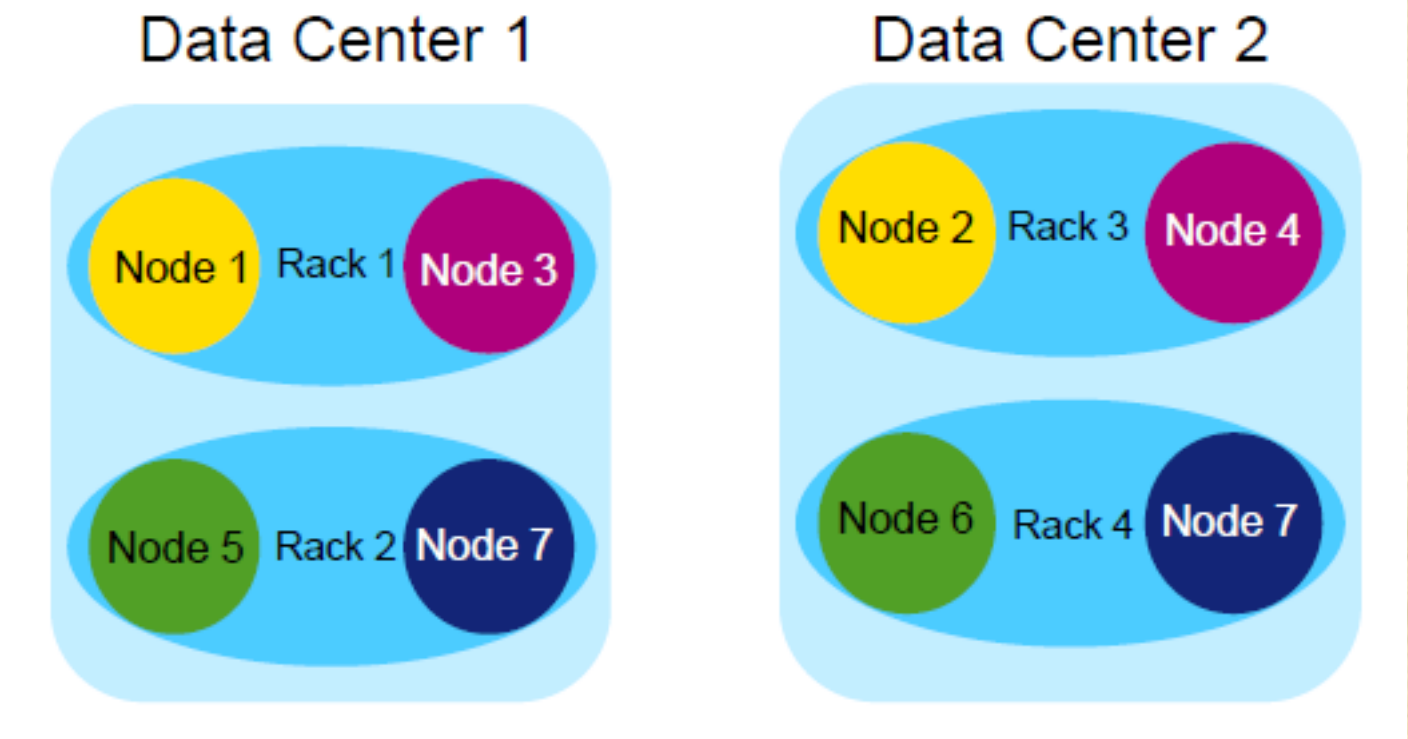


- Rack : Logical set of nodes

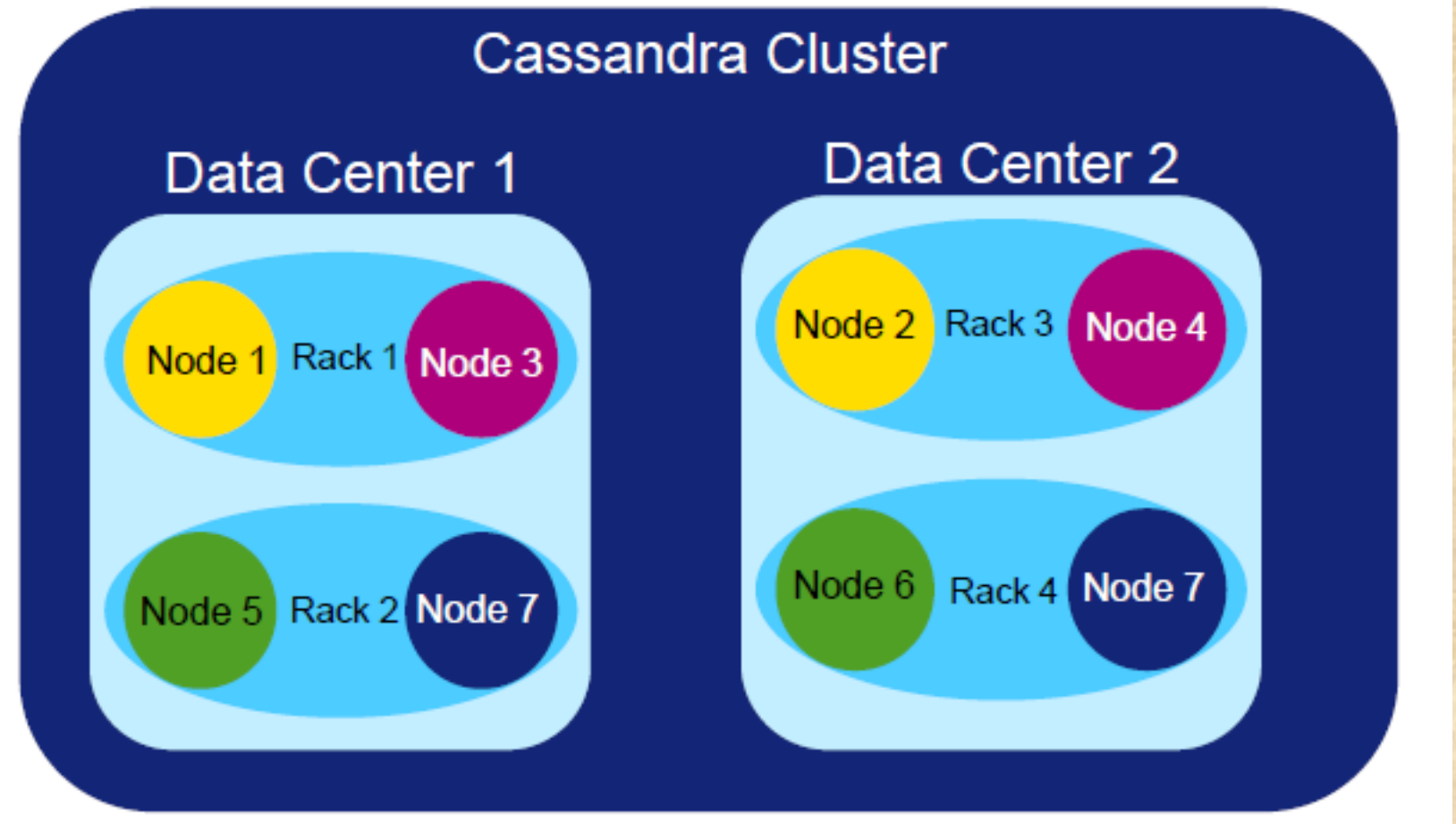


Architecture …

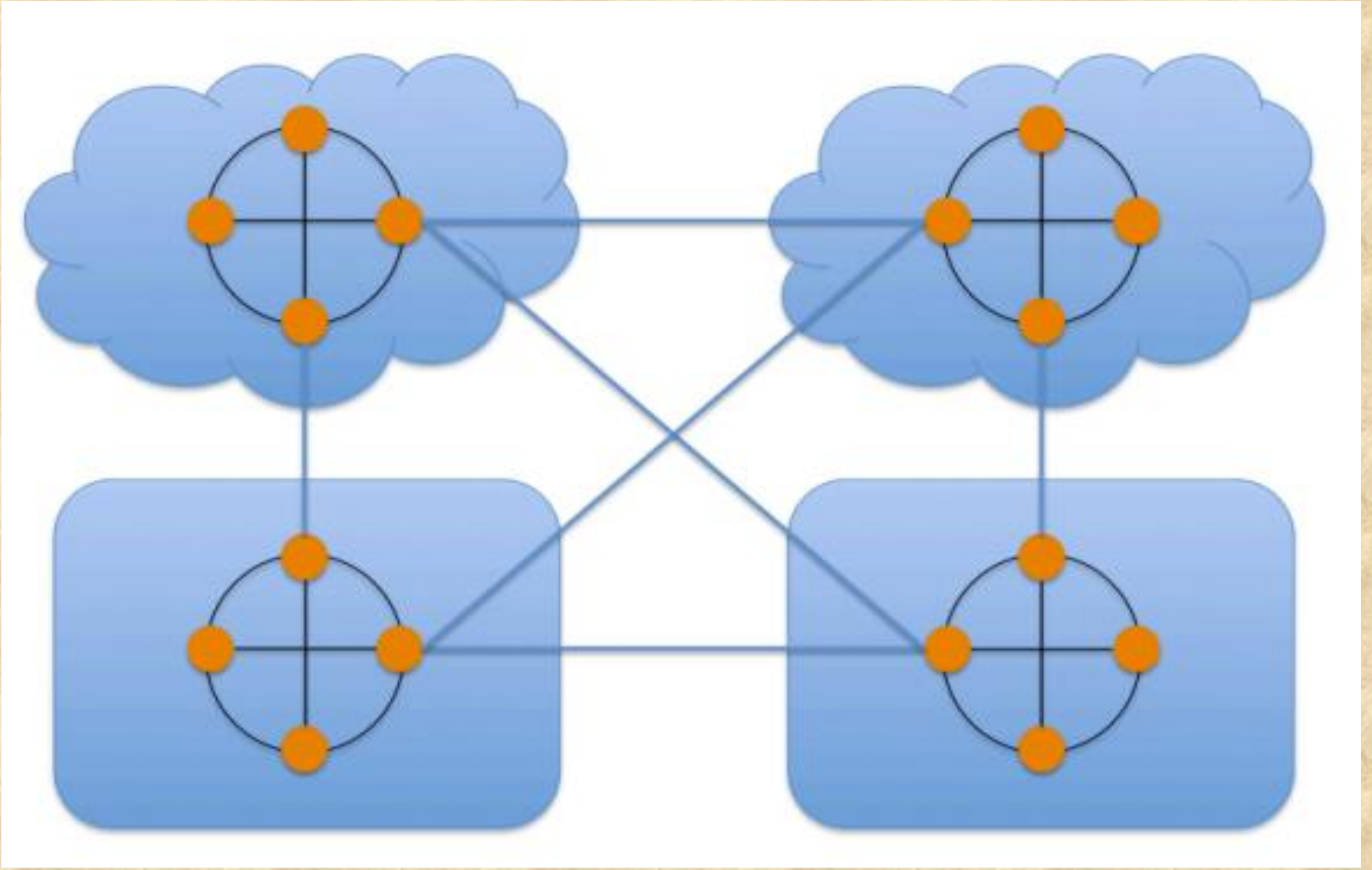
- Data Center : Logical set of Racks



Architecture …



Multi-Data Center and Cloud Support

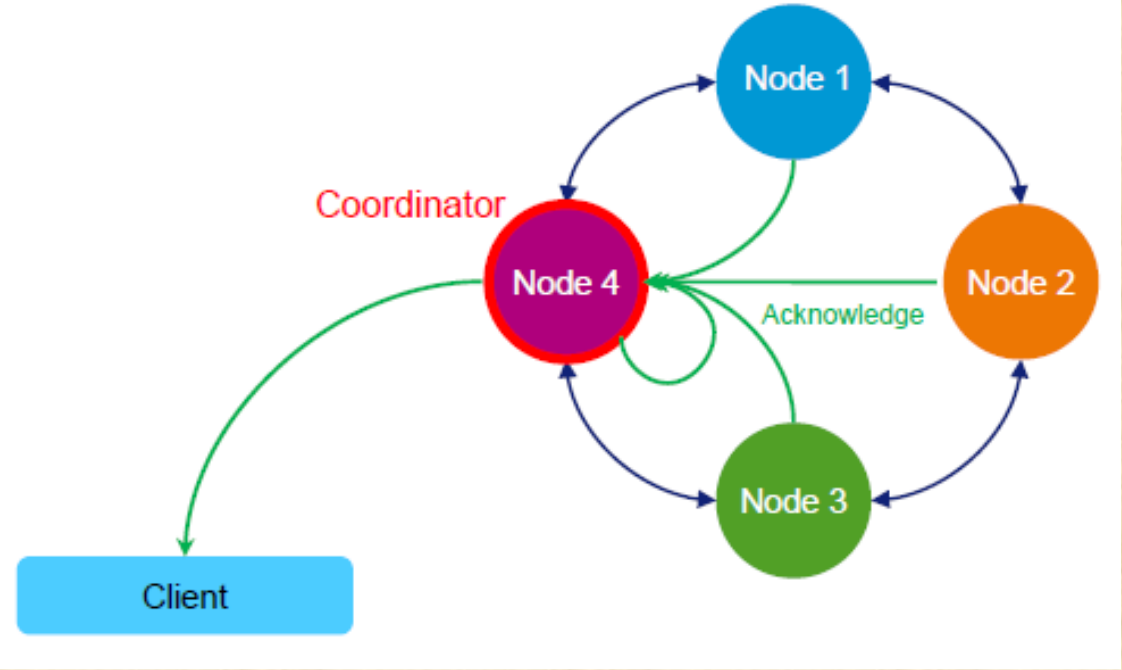


Reading and Writing Data

- true "**location independent**" architecture
- any node in a Cassandra cluster may be read or written to – ***true read/write-anywhere design***.
- it is first written to a **commit log**
- also to ***memtable***
- flushed to a disk structure called an ***sstable***
- user may requests data from any node, Cassandra engine assembled it from other nodes.

Request Coordination

- **Coordinator** : the node chosen by the client to receive a particular read or write request to its cluster.

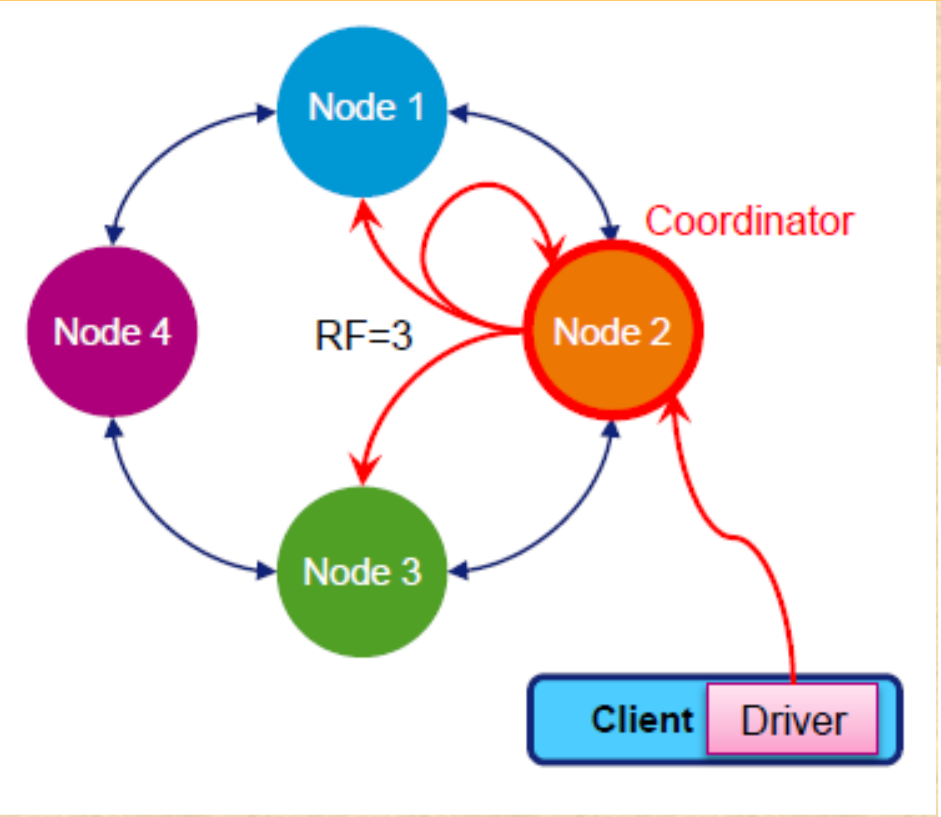


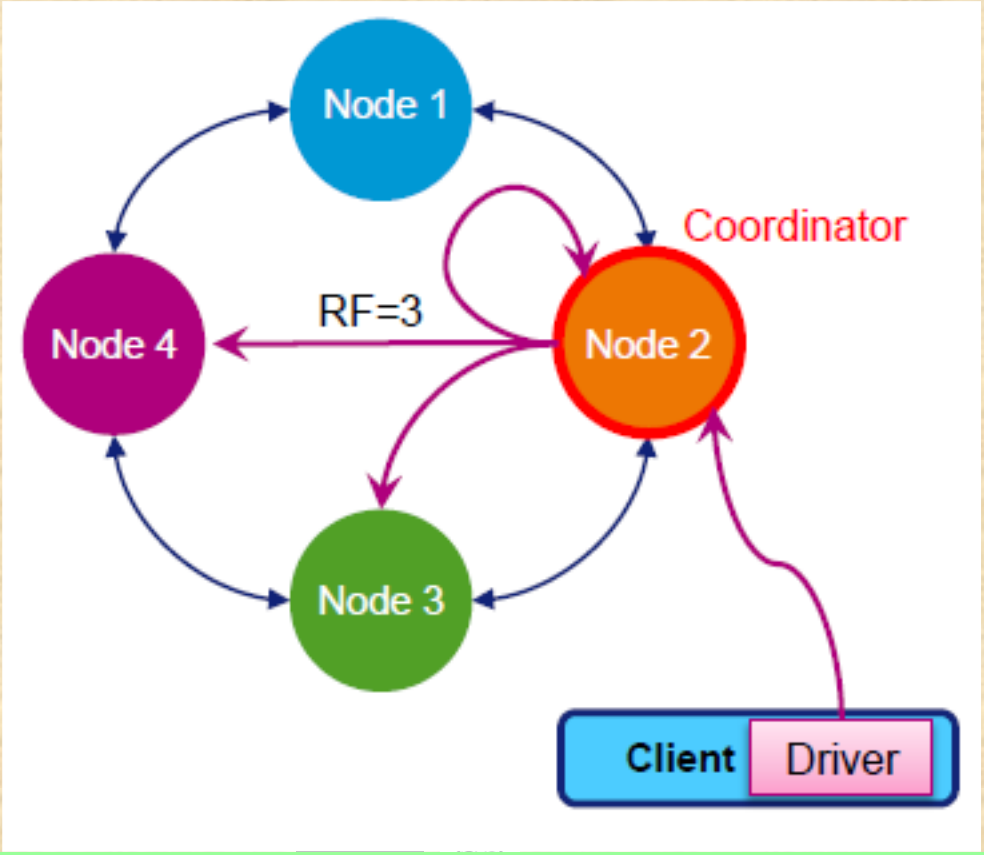
- Any node can coordinate any request
- Each client request may be coordinated by a different node

Replication of Data

- The **coordinator** manages the **replication process**
- **Replication Factor (RF)** : onto how many nodes should a write be copied
- The write will occur on the nodes responsible for that partition
- 1 ≤ **RF** ≤ (#nodes in cluster)
- Every write is time-stamped

Replication of Data





Transactions in Cassandra

- Cassandra is not a transactional database – no ACID.
- It uses "**AID**" - **A**tomic, **I**solated and **D**urable
- Cassandra offers ***tunable*** data **consistency** across a database cluster
- Developer or administrator can decide exactly how strong *(e.g., all nodes must respond)* or eventual *(e.g.,just one node responds, with others being updated eventually)* they want data consistency to be.

Consistency : Quorum Algorithm

- **The coordinator applies the Consistency Level (CL)**
- **Consistency Level (CL): Number of nodes which must acknowledge a request**
- **Examples of CL :** ONE , TWO , THREE , ANY , ALL (Not recommended)
- **QUORUM** = (RF/2 + 1)
- CL = QUORUM
- **CL may vary for each request**
- **On success, the coordinator notifies the client**

Cassandra : Application use cases

- Real-time, big data workloads
- Time series data management
- High-velocity device data consumption and analysis
- Media streaming management (e.g., music, movies)
- Social media (i.e., unstructured data) input and analysis
- Online web retail (e.g., shopping carts, user transactions)
- Real-time data analytics
- Online gaming (e.g., real-time messaging)
- Software as a Service (SaaS) applications that utilize web services
- Online portals (e.g., healthcare provider/patient interactions)
- Most write-intensive systems

Time series database example

- Cassandra is an excellent fit for time series data.
- Examples of TSDB use cases:
  - Ratings, recent purchases, and shopping cart
  - Session data, event streams, and click streams
  - Sensor data, application, and performance metrics
  - Velocities or windowed queries for a specific time period

Installation : Cassandra Clustering

- Install Cassandra on each node.
- Choose a name for the cluster.
- Get the IP address of each node.
- For each node, do the following configuration
- Go to ***conf*** folder in the ***apache-cassandra*** home directory.
- Open ***cassandra.yaml*** file in notepad and edit
- listen_address: <ip addres of node>
- rpc_address: <ip addres of node>
- - seeds: “<comma-delimited list of the IP address of each node in the cluster>"

Installation …

- The communication of Cassandra nodes mainly revolves around 2 ports which are :
  I. 7000 – TCP port for commands and data.
  II. 9042 – TCP port for the native transport server ***cqlsh***.
- Configure these ports on each node in the cluster
- Use ***nodetool status*** to see the status of cluster

```
anmols@anmols-15-3568:/opt/Applications/apache-cassandra-3.10$ ./bin/nodetool status
Datacenter: datacenter1
=======================
Status=Up/Down
|/ State=Normal/Leaving/Joining/Moving
--  Address        Load       Tokens       Owns (effective)  Host ID                               Rack
UN  192.168.2.122  7.28 MiB   256          49.4%             19fe4145-d49b-4009-b5d2-93c205452da0  rack1
UN  192.168.2.101  529.85 KiB  256          50.6%             74f9b27e-be87-411b-bae2-99ae1a657d7d  rack1
```

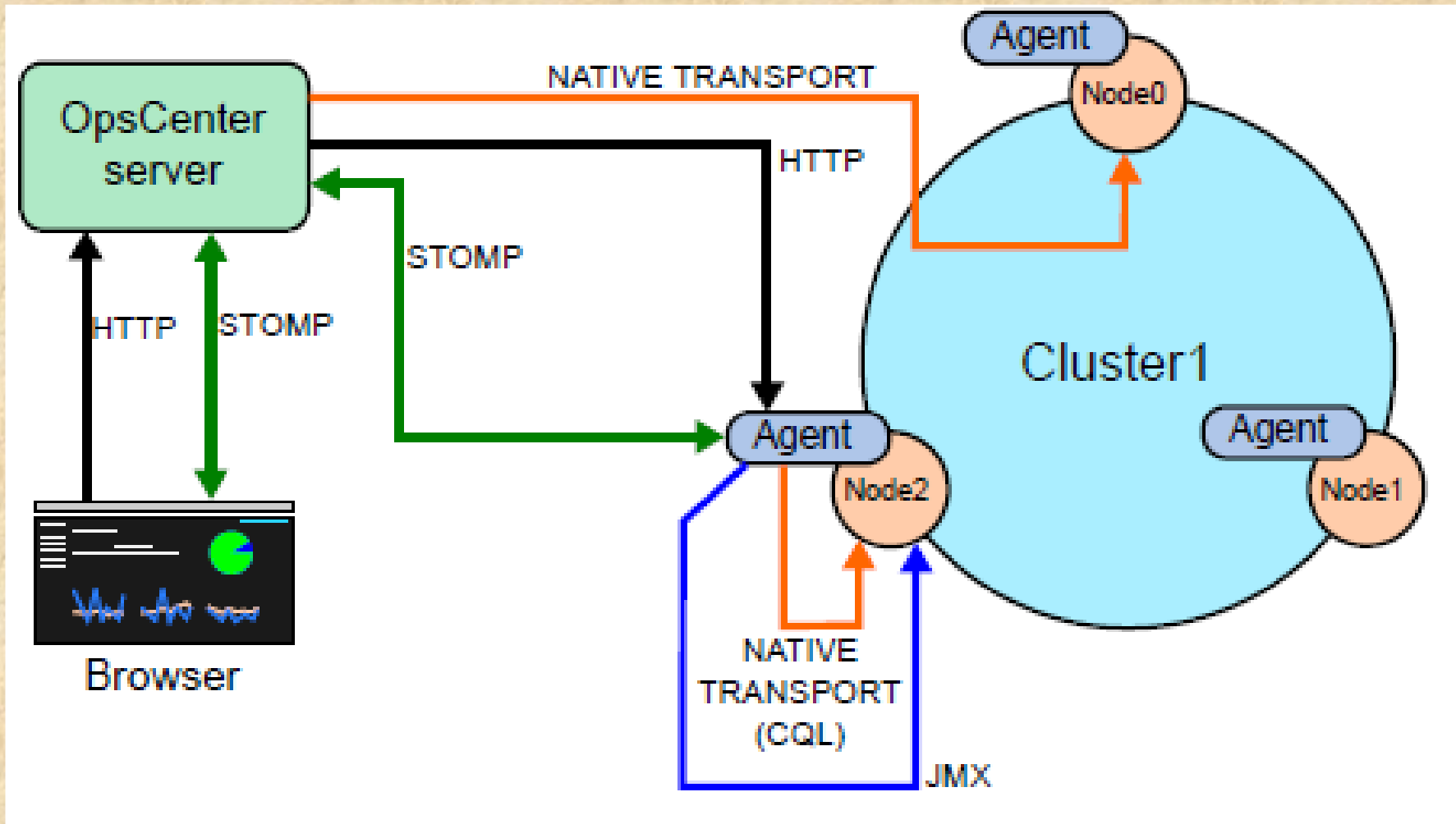
- Cluster is now ready to use.

DataStax OpsCenter

- DataStax OpsCenter is a visual management and monitoring solution for Apache Cassandra and DataStax Enterprise.
- It simplifies administration tasks such as:
  - Adding and expanding clusters
  - Configuring nodes
  - Viewing performance metrics
  - Rectifying issues
  - Monitoring the health of your clusters on the dashboard
- Available as open source Cassandra and DataStax Enterprise.

OpsCenter architecture overview

The agents use Java Management Extensions (JMX) to monitor and manage each node.



How to access OpsCenter ?
Web-based user interface

- **Open the browser**
- **URL : http://hostname:8888**
- **e.g. : http://10.4.1.101:8888**