Consistent Hashing :

Dynamic Load distribution
and
Load balancing

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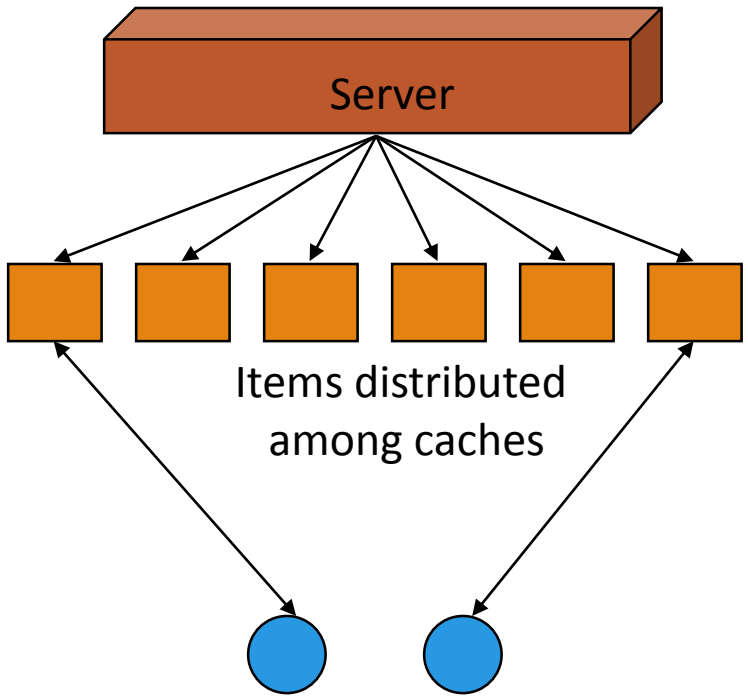
Motivation case study: Web caching



Known fact: caching for improving efficiency of data delivery over internet

Single cache – problems:

- Cache size limit
- Single Point Of Failure
- Swamped by user requests

Solution : Hashing based Distributed Web Cache servers

- Cache server ***s = Hash(URL)***
- User get content from cache server ***S***

Problems:

- ***What if node joins/ fails ?***
- ***What if different view?***

Solution : Consistent hashing

Key features

- Dynamic Load distribution
- Better Scalability
- Efficient Resource utilization
- Efficient Data retrieval
- Improving Performance
- Parition Tolerance

Research Applications

- Design for **Bigdata storage and efficient retrieval** using NoSQL Database over cloud
  - E.g.. Cassendra [2], Amazon's Dynamo[3]
- **Cloud storage mgt.:** Data placement strategy in Cloud computing[7]
- **Virtual Partition Consistent Hashing (VPCH) :** Balancing reducer load in map-reduce [8]
- ***UbiCrawler****: One of best* Distributed Web Crawler [5]
- **Distributed Real – time storage :** Fast, timely storage for IoT applications[6]
  - E.g. Transport monitoring for traffic management system

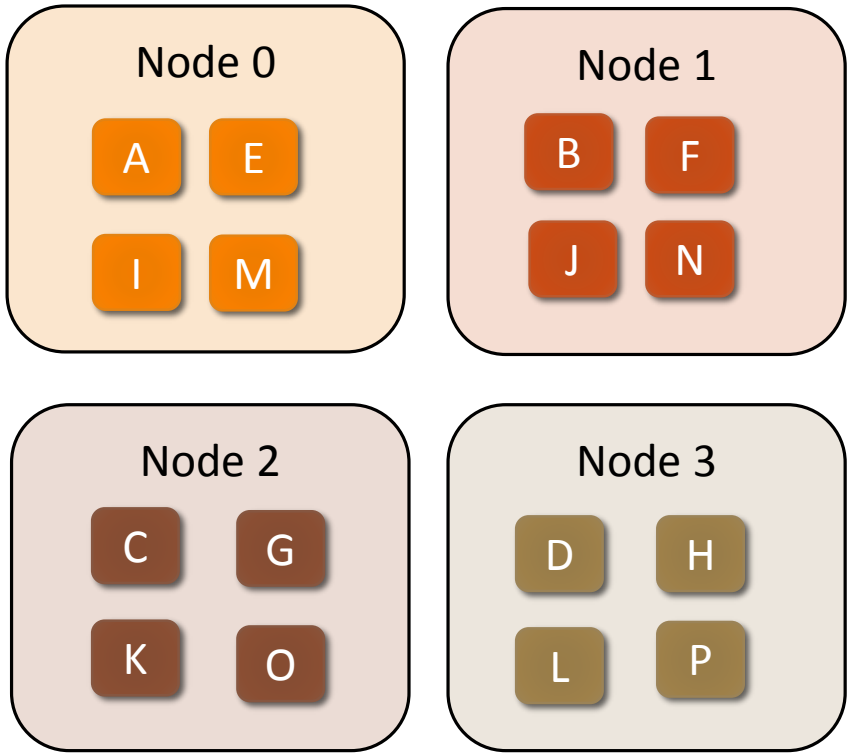
Other Applications:

Task: distribute items into buckets

- Data to memory locations
- Files to disks
- Tasks to processors
- Web pages to caches (our motivation)

Goal: balanced distribution

Background: Basic Hashing



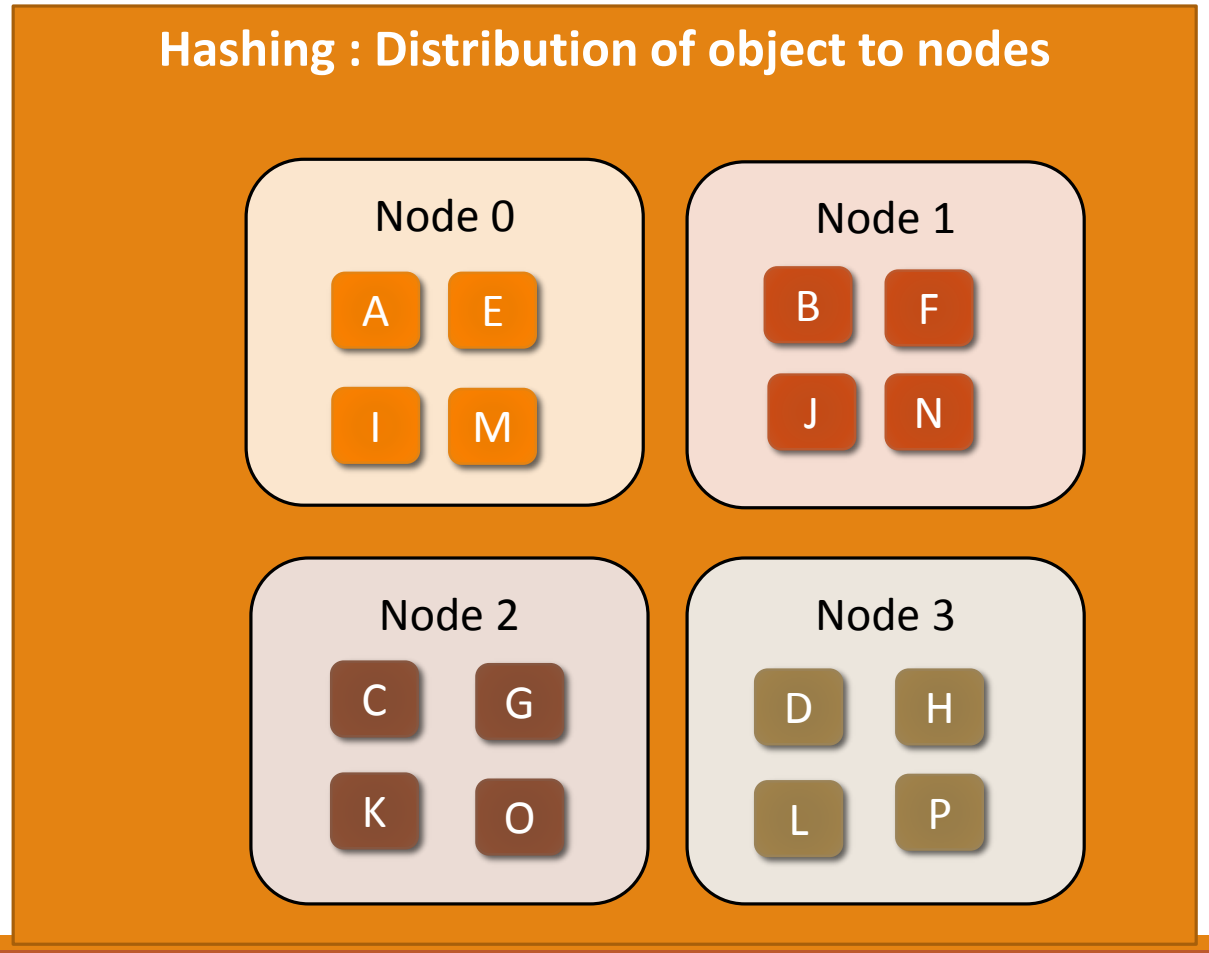
to distribute objects among cache servers

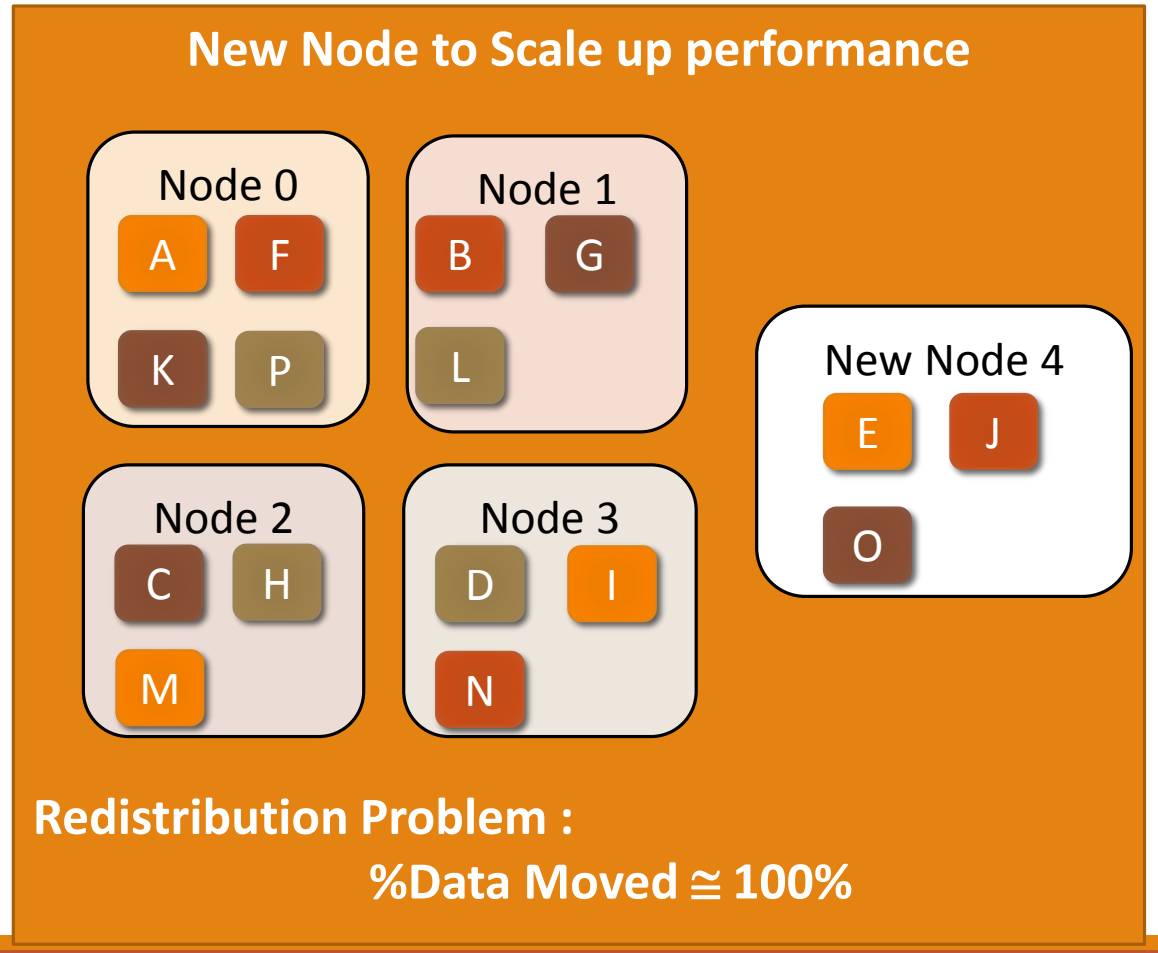
Goal of Hashing in Distributed System :

- **Balanced** distribution
- **Smoothness**: Little impact on buckets on
  - Adding a bucket (for scalability)
  - Remove a bucket (Node Failure)
- **Light Load :** on each Node
- **Spread** : small set of object that may hold an object

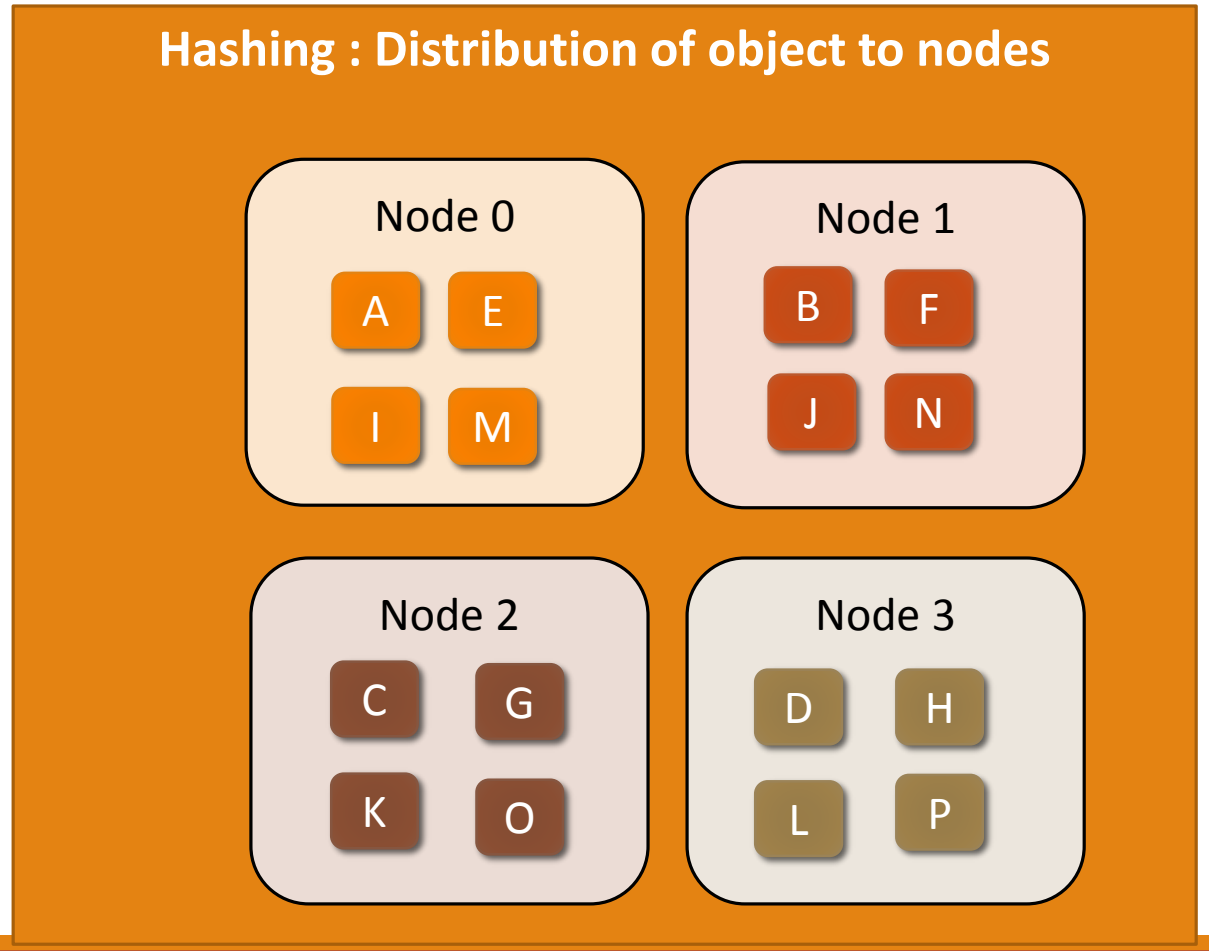
Simple Hash Function Location = Hash(Key) % # Nodes

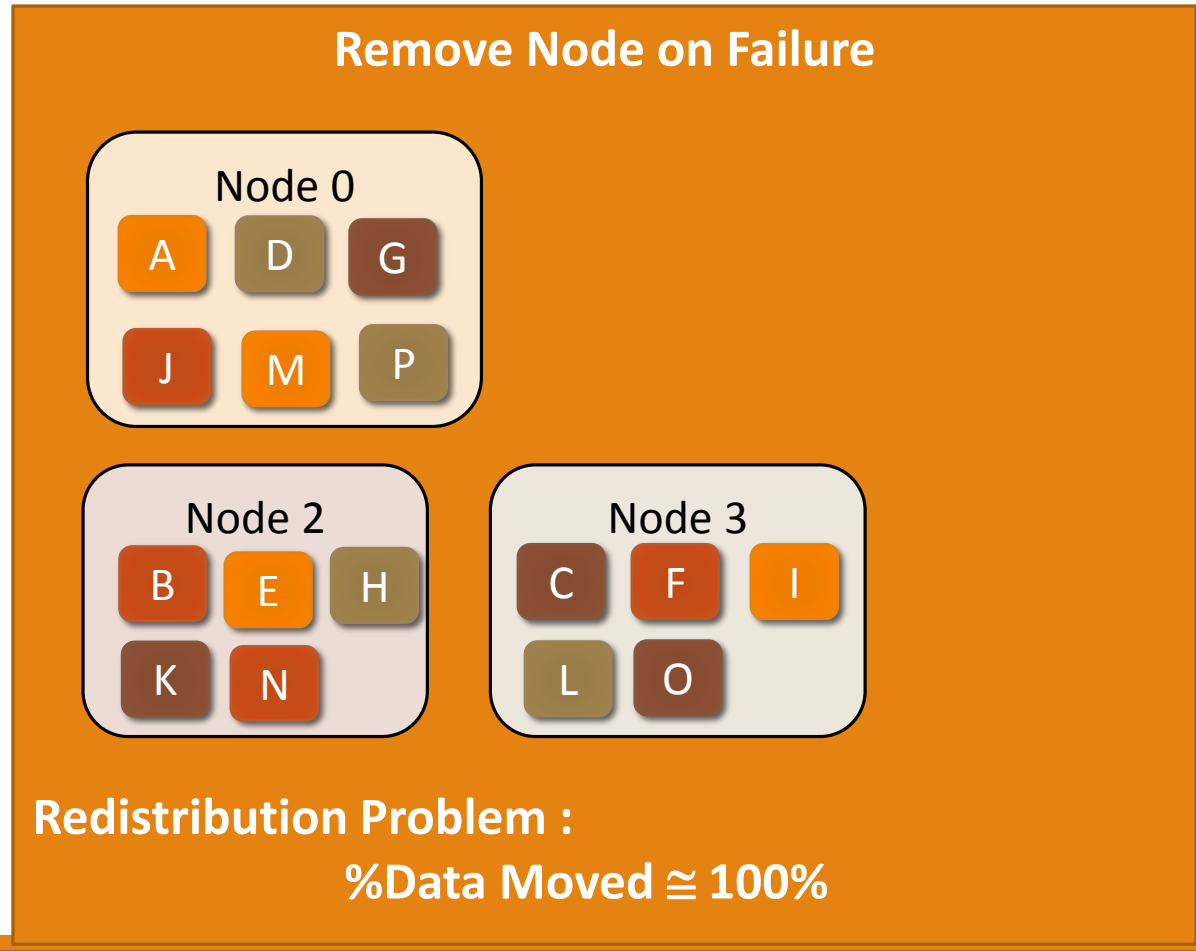
Hashing problem : Add/Remove node





Hashing problem : Add/Remove node

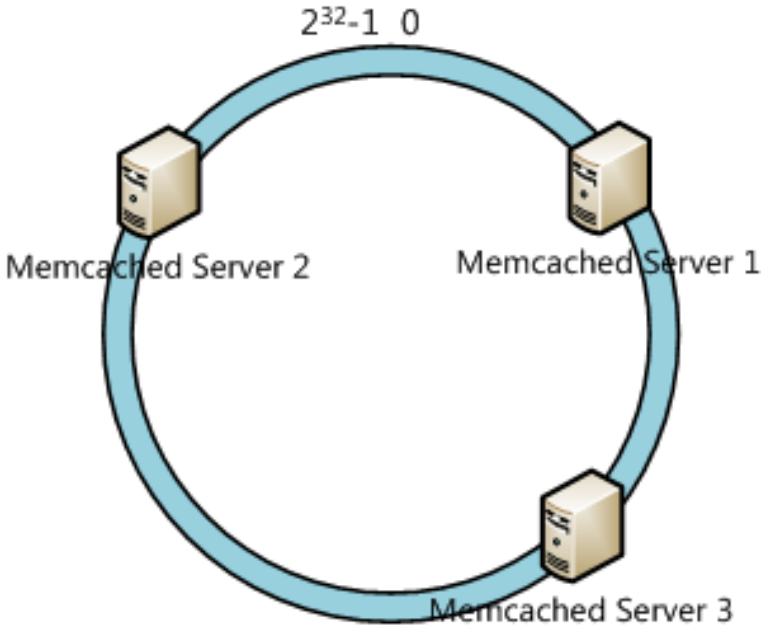




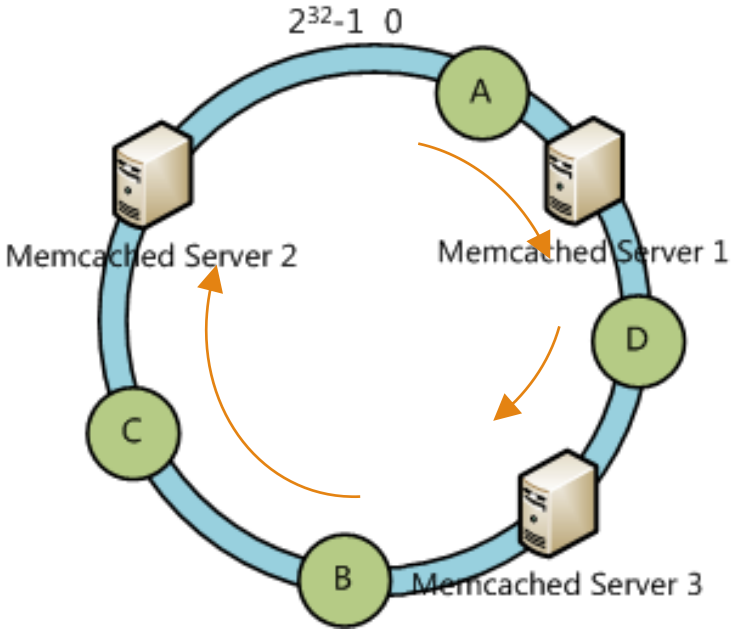
Consistent Hashing

Introduced by Karger et al.[1]

Consistent (same) hashing function for Cache (node) and data objects

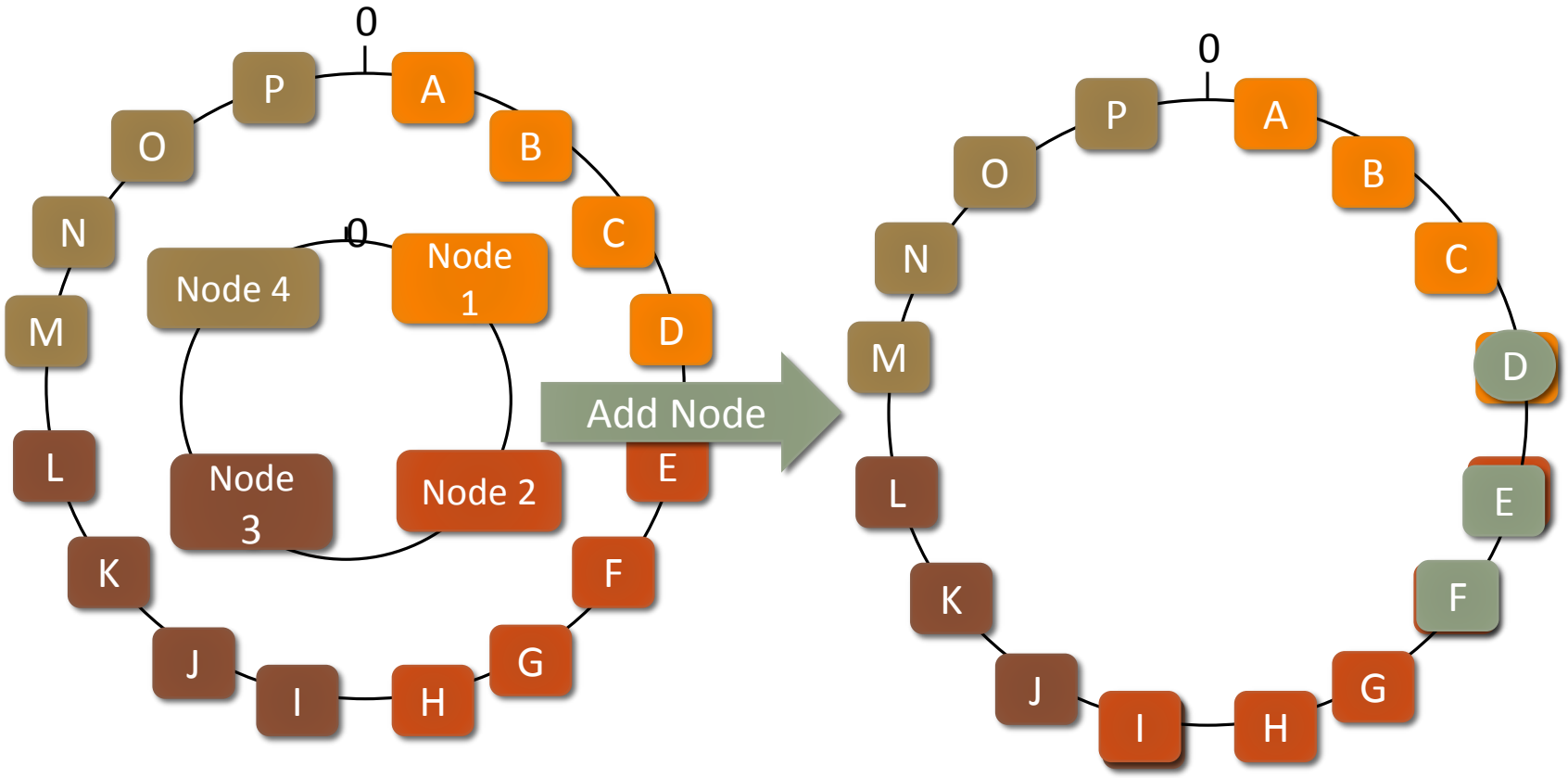


Hash server : i.e. Hash(IP)



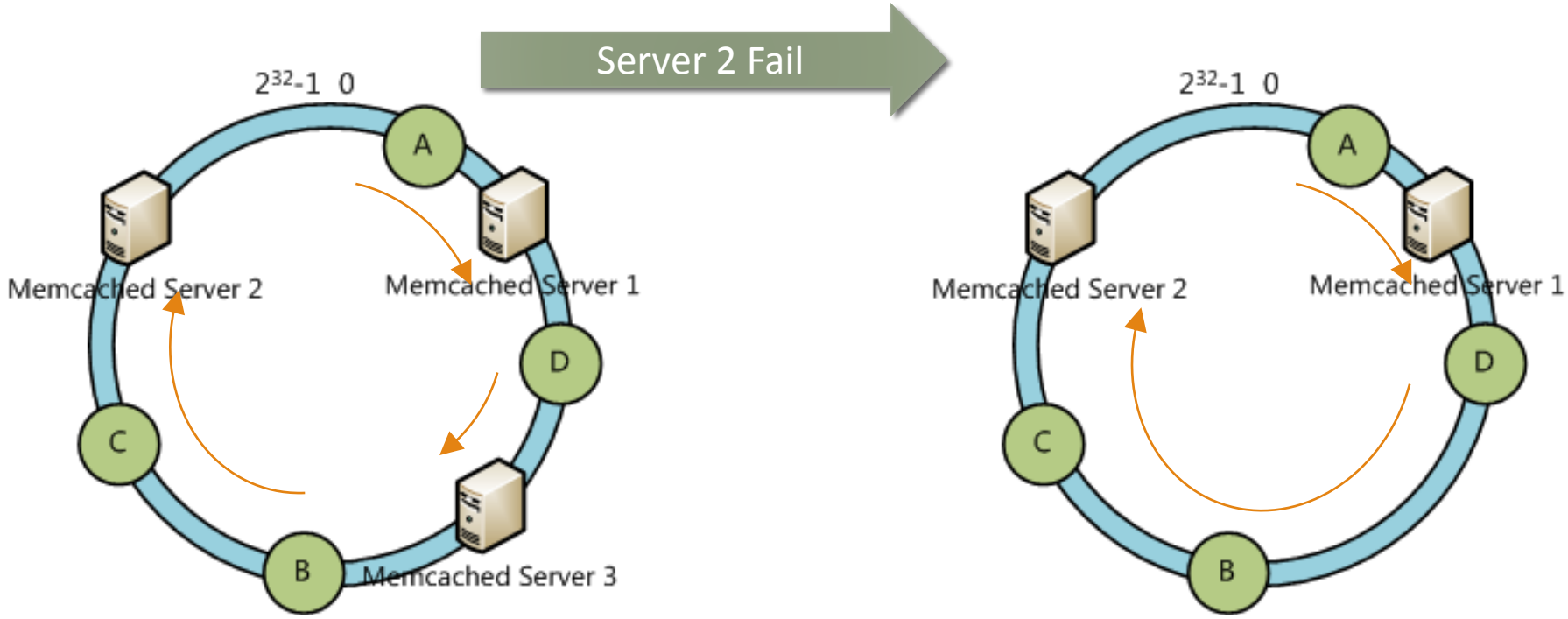
Hash objects: i.e. Hash(o) % servers

Redistribution on Joining of new node/Back up of failed node



Redistribution = % Data Moved = 100 * **1 / N** i.e. 1/5 * (16) = 3

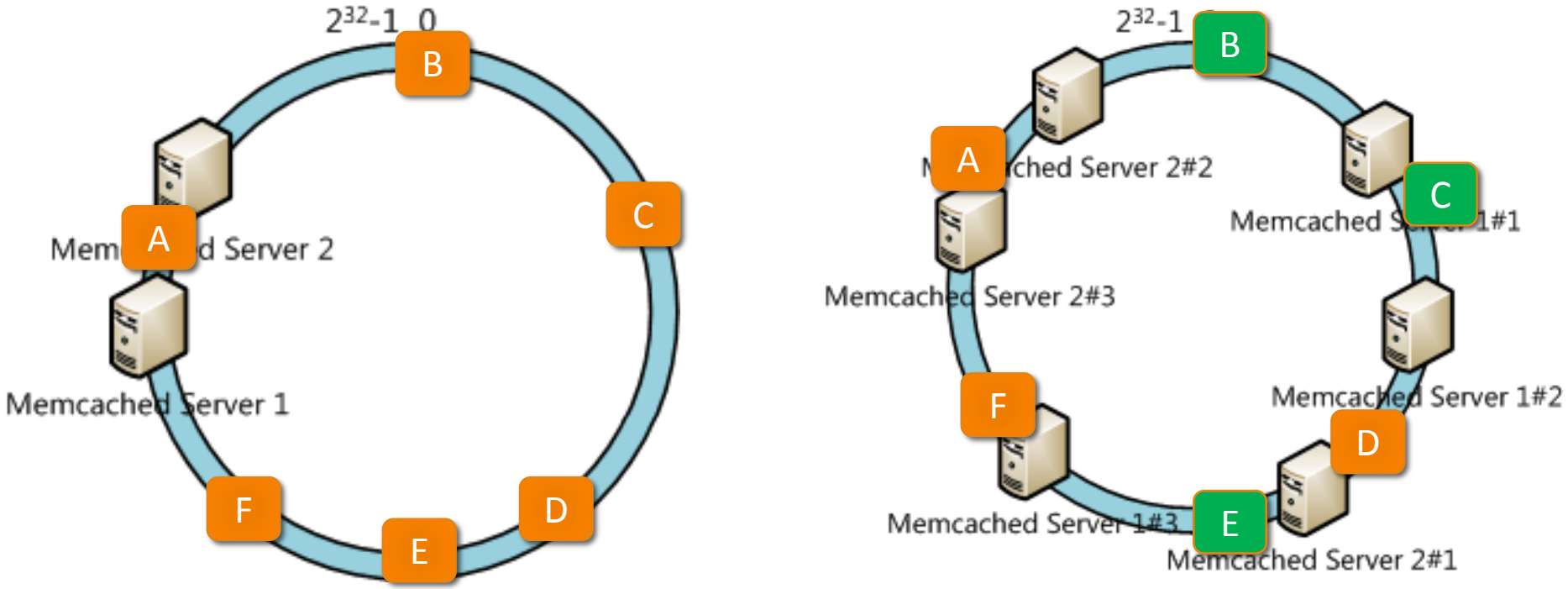
Consistent Hashing: Redistribution on a server down



Challenge : Balanced Distribution

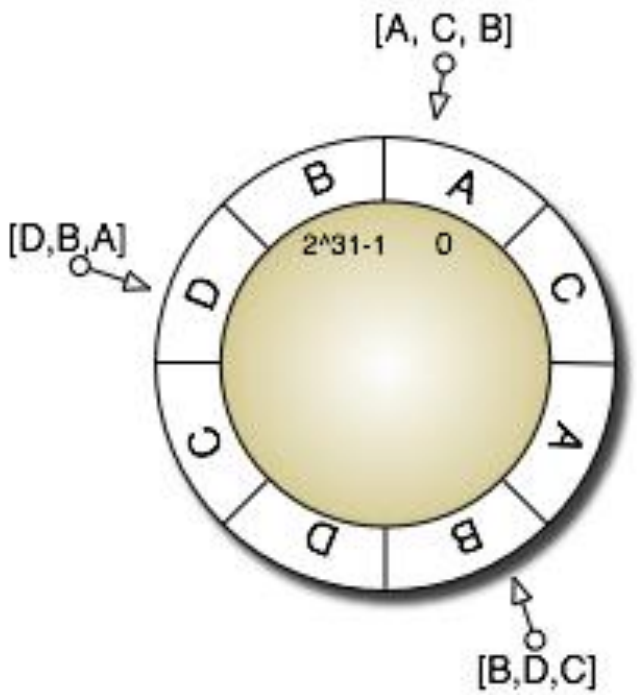
for efficient resource utilization and performance

Solution : Use Virtual Node for better balancing



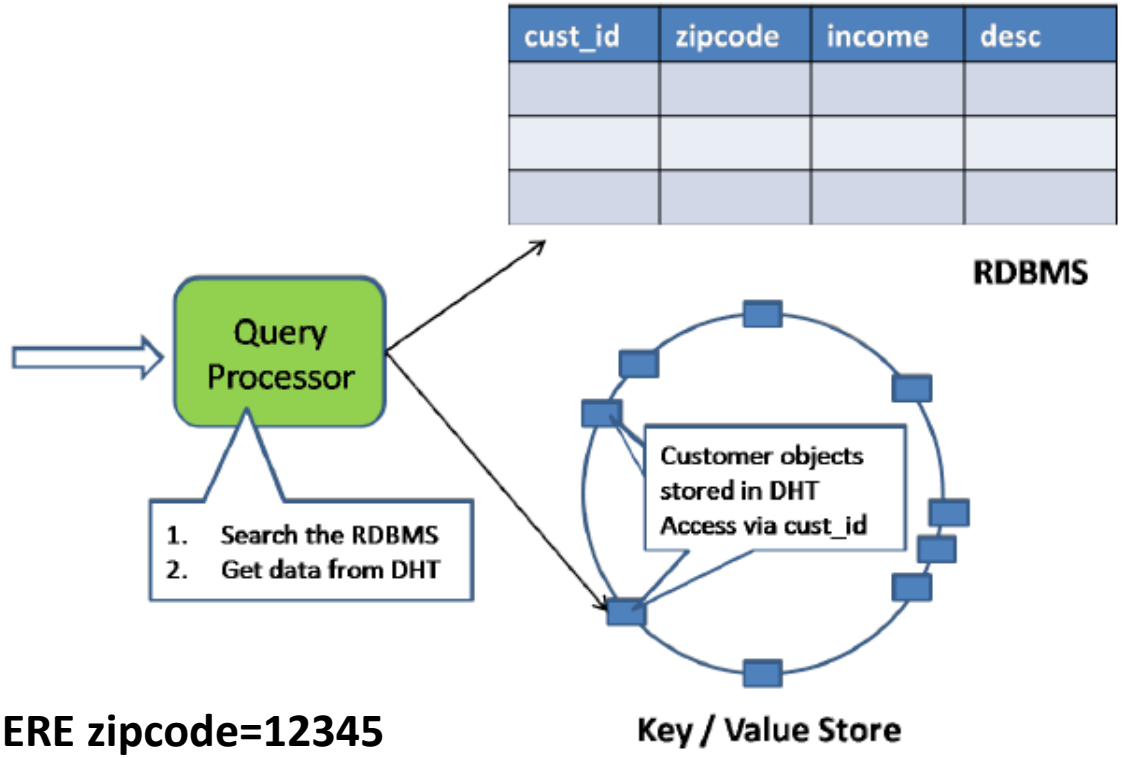
Challenge : Fault / Partition tolerance

Solution : Use Virtual Node for replica of object to nearer nodes



Challenge in designing Query model :
Data access by variety of predicates

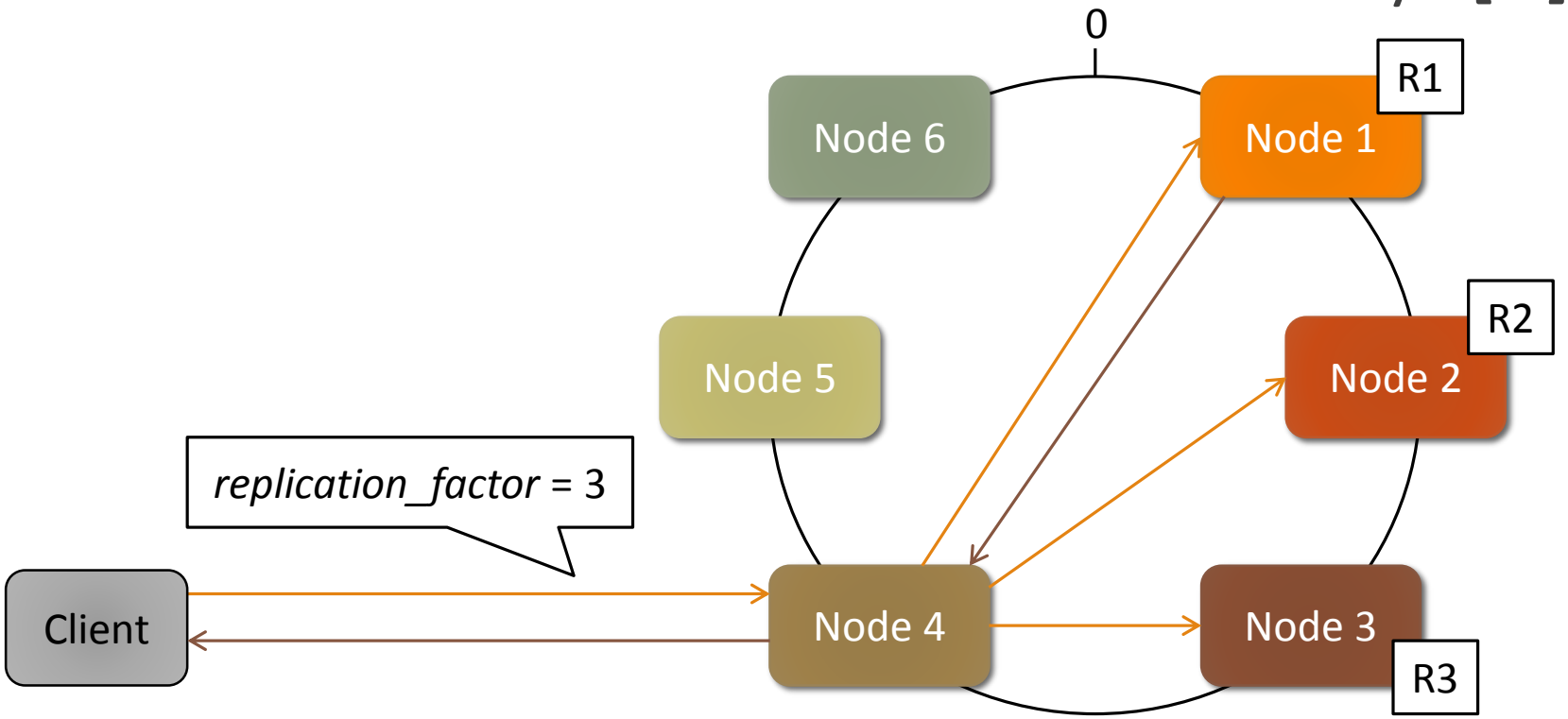
Solution : Use Key mapping for predicate attributes[4]



SELECT * FROM CUSTOMER WHERE zipcode=12345

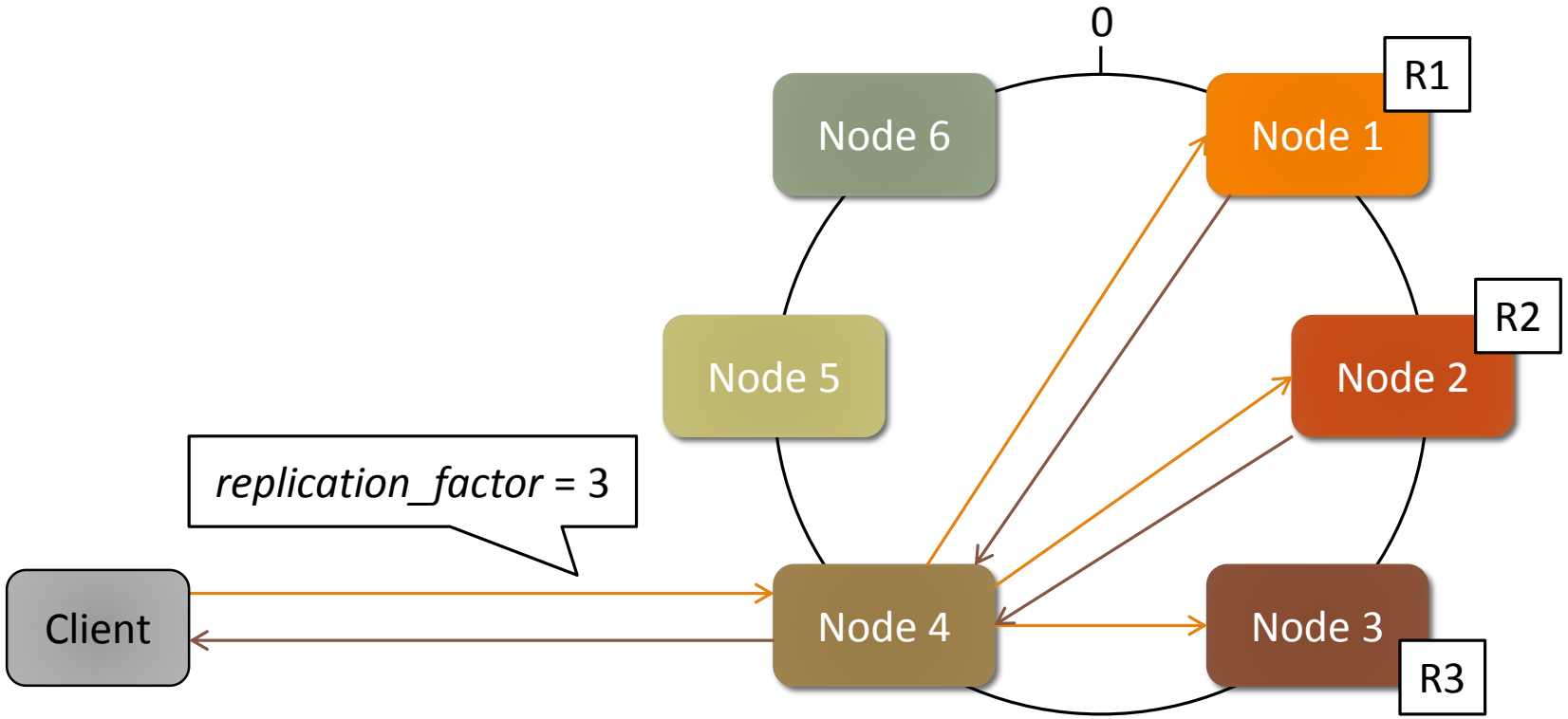
Challenge : Consistency

Cassandra solution: Tuneable consistency [3]



INSERT INTO table (column1, …) VALUES (value1, …) USING CONSISTENCY ONE

Challenge : Consistency
Cassandra solution: Tuneable consistency [3]



INSERT INTO table (column1, …) VALUES (value1, …) USING CONSISTENCY QUORUM

Challenges :

Deciding Hash function parameters (ie. URL, IP, website size, structure of site[5])

Parameters for Virtual node configuration for heterogeneous nodes (Power, memory capacity, disk capacity)

Configuring number of virtual nodes as per Energy Efficiency algorithm[9]

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Thank You