

- 1 Bloom Filters
- 2 Quorum
- 3 Leader & Follower
- 4 Checksum
- 5 Heartbeat

Bloom Filter

member is present in the set ?

Username :

gladden-xumao

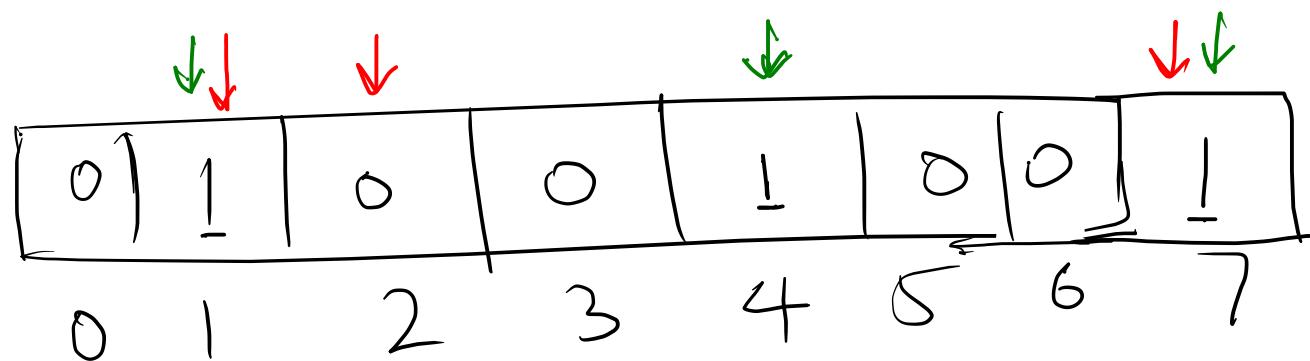
X username already exist
✓ username available

Next

Bloom filter

probabilistic data structure

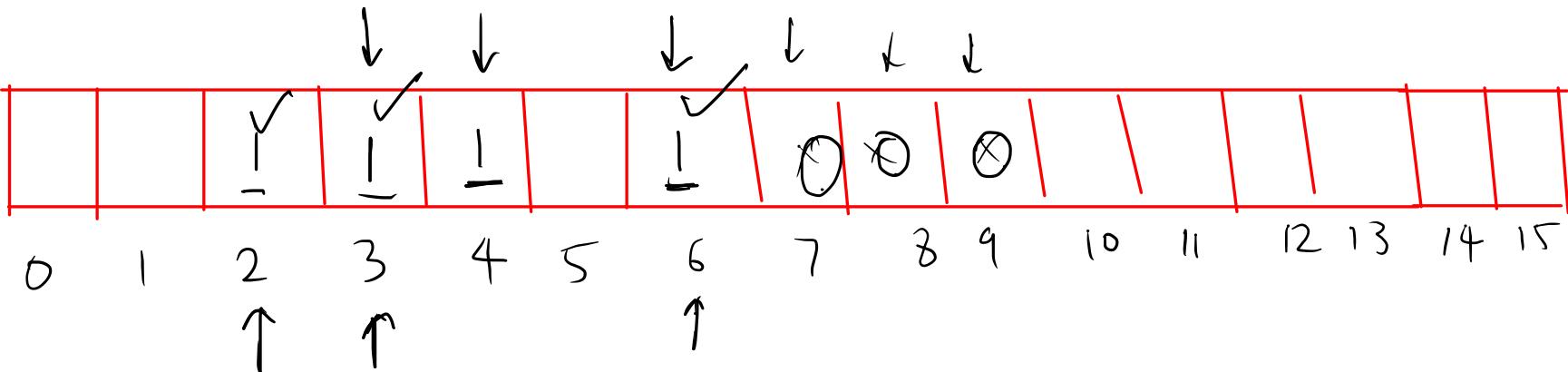
"bat" → 4 1 7



~~"bat"~~ → 4 1 7

~~"mat"~~ → 2 1 7

$$\left\{ \begin{array}{l} \text{adf} \\ \hline \text{bdf} \end{array} \right. \rightarrow \begin{array}{ccc} 2 & 4 & 6 \\ 3 & 4 & 6 \end{array}$$



$$\begin{array}{l} \text{a b f} \\ \hline \text{x y z} \end{array} \rightarrow \begin{array}{ccc} 2 & 3 & 6 \\ - & - & - \\ 7 & 8 & 9 \end{array}$$

Bloom Filter :

- False positives are possible
- False negatives are not possible

→ multiple layers of hash functions

$s = "pet"$

0	1	2	3	4	5	6	7
0	1	1	1	0	0	0	1

$$\begin{array}{l} hf_1(s) \rightarrow 3 \ 2 \ 7 \\ hf_2(s) \rightarrow 1 \ 2 \ 3 \\ hf_3(s) \rightarrow 4 \ 5 \ 6 \end{array}$$

$s = "cat"$

0	1	0	0	1	1	1	0
0	1	1	1	1	0	0	0

$$\begin{array}{l} hf_1(s) \rightarrow 1 \ 2 \ 7 \\ hf_2(s) \rightarrow 1 \ 2 \ 4 \\ hf_3(s) \rightarrow 4 \ 6 \ 1 \end{array}$$

"get" → 3 17, 4 13, 106

cat →

3 1 7

2 0 4

4 1 8

← mat

~~217~~

~~403~~

629

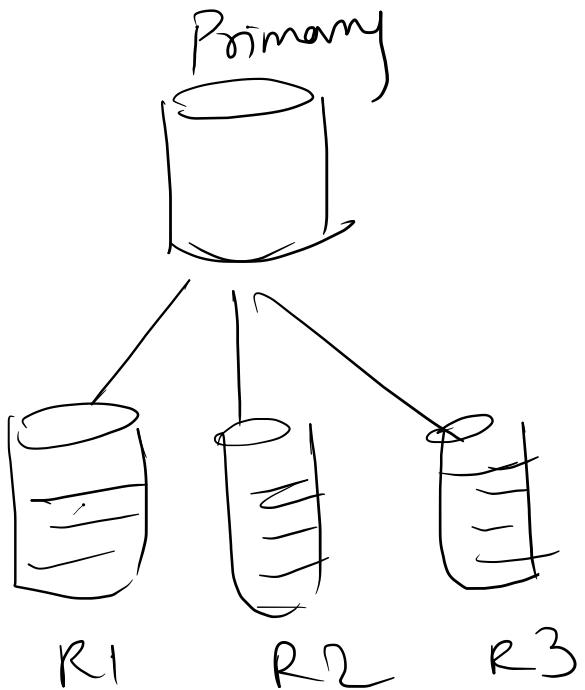
cat →

3 1 7 ✓

2 0 4 ✓

4 1 8 ✓

Quorum :



Replication :

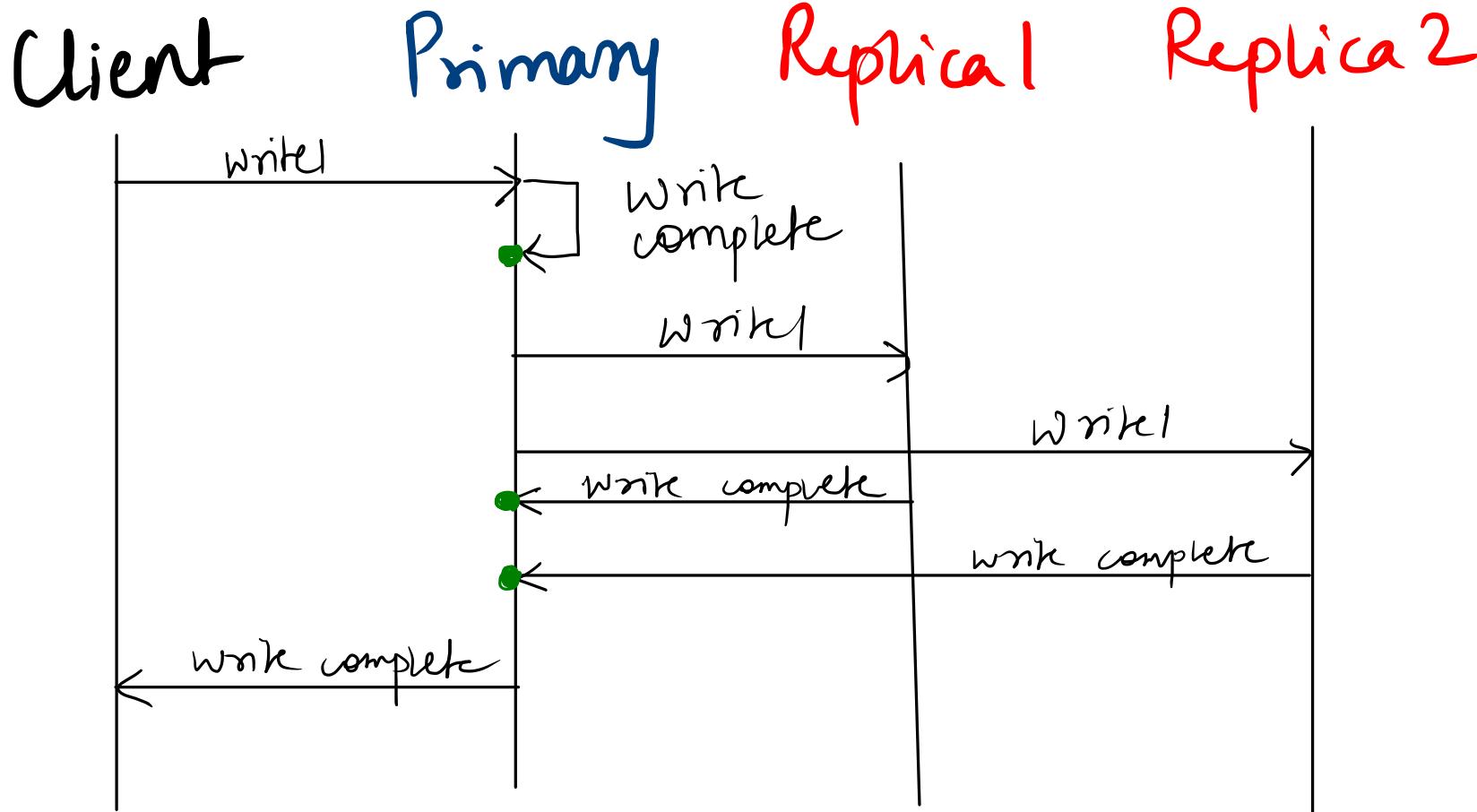
Data is copied throughout many servers to acquire higher availability & fault tolerance.

Synchronous Replication

→ Original node reports success to the user only when it has received acknowledgement from all replicas

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Problem in synchronous Replication

If any of the replica node fails to ack. due to some fault, the original node cannot respond to the client

Quorum as a Solution

→ Quorum in a distributed system is the minimal number of replicas on which an operation must be completed before claiming success.

Suppose, we have 3 replicas

Quorum number : 2



Number of Replicas = N

Quorum \Rightarrow $N/2 + 1$

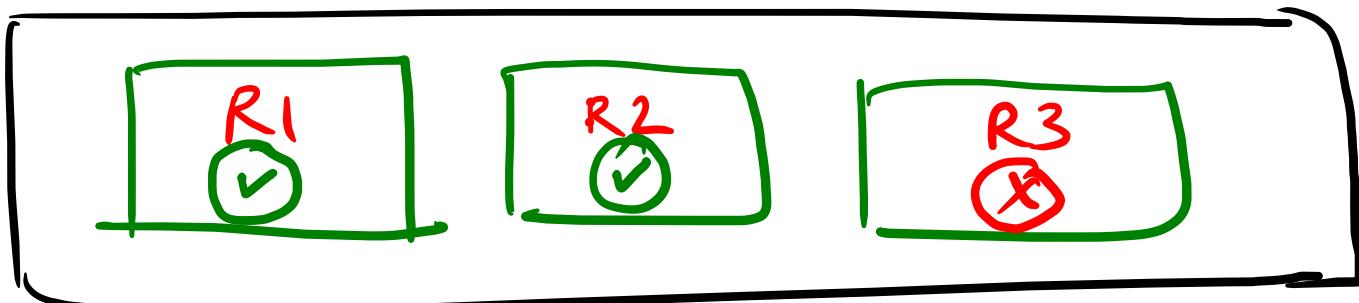
(majority \leftrightarrow more than 50%)

No. of Replicas = 5

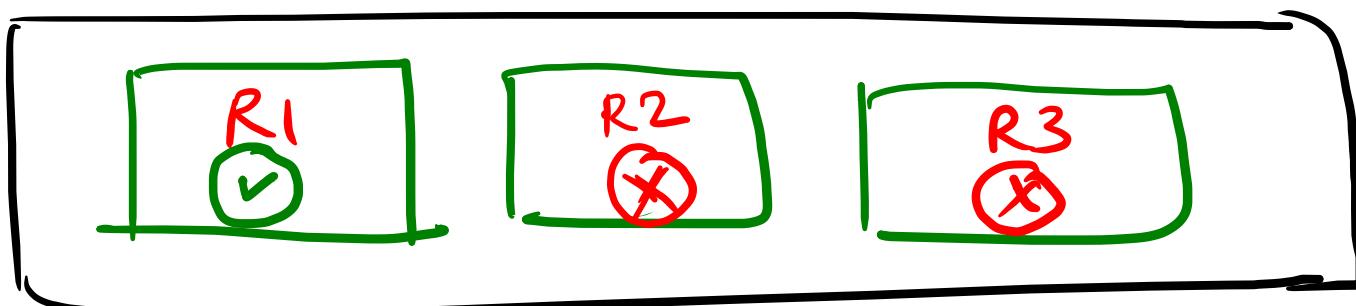
$$\text{quorum number} = \frac{N}{2} + 1 = \frac{5}{2} + 1 = 3$$

3 Node cluster, atleast 2 should be working.

5 Node cluster, atleast 3 should be working.



Cluster is working



Cluster Not working

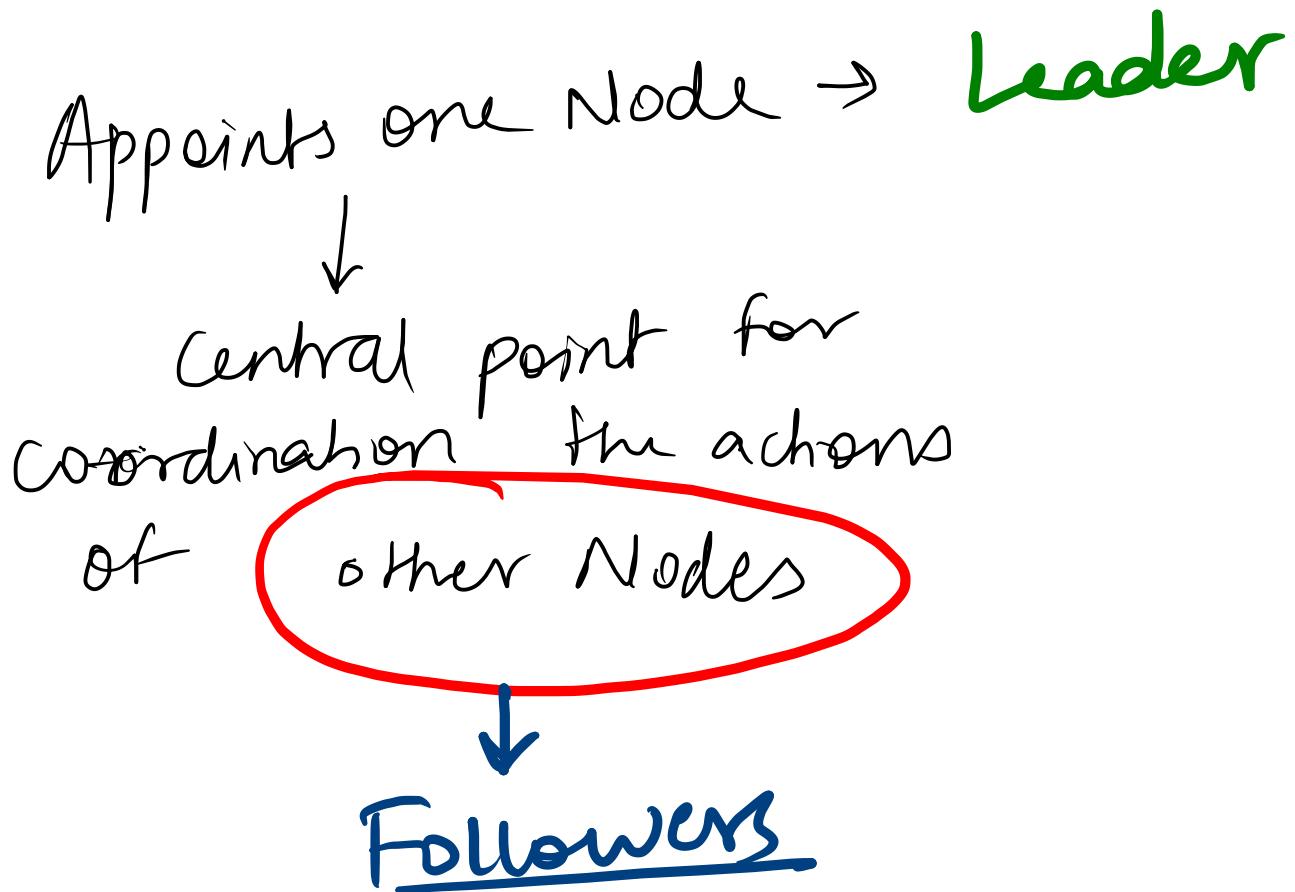
Replication Technique → multiple copies

Consistency between → quorum
replicas

Leader & Follower

→ ensures system continues to operate even if one or more server fails
(copies of the data should be stored on multiple servers)

Leader - Follower



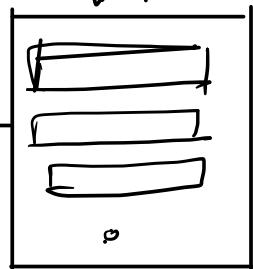
Central Decision-Making

- Leader →
 - handles client requests
 - delegates tasks to followers nodes
- Follower →
 - carry out the assigned task
 - provide feedback to leader.

Client



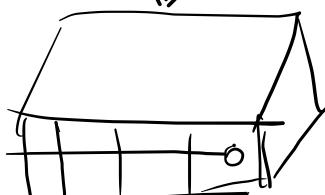
request response



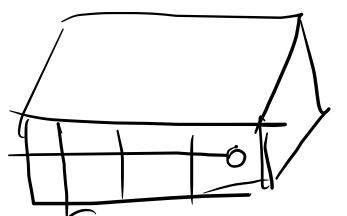
Leader

Replicate

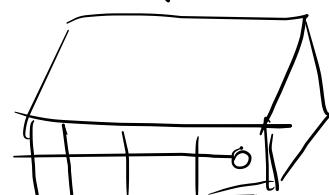
Replicate



Follower 1



Follower 2



Follower 3

Replicate

Failure of leader

In case leader fails, a follower can be appointed as the leader.

Checksum

- used to verify the integrity of data during transmission.
- a number is calculated from the data, and sent along with the data.

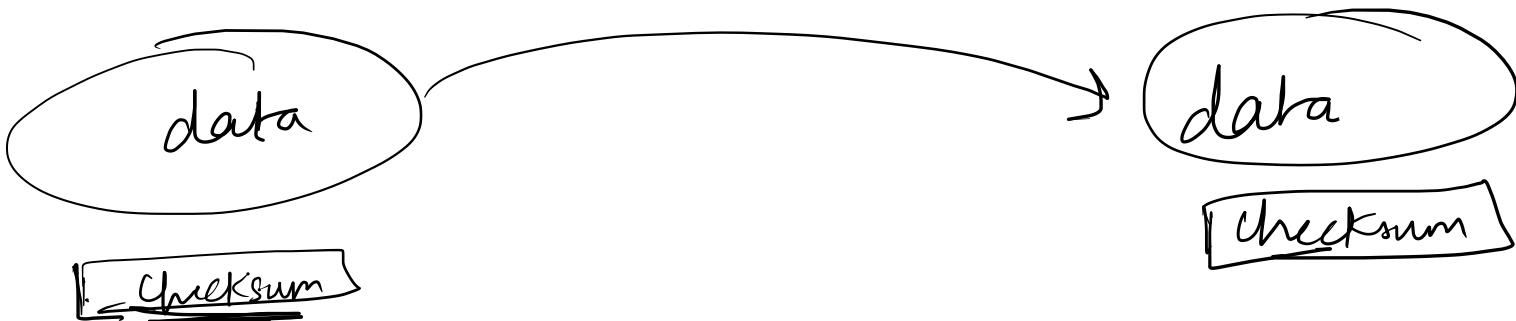
Checksum Algorithms:

SHA-1

SHA-2

MD5

CRC 32



Source

destination

Heartbeat :

A node in D-S regularly sends message indicating its healthy & active. If the node fails to send heartbeat messages, other nodes can assume, that node has failed.

Heartbeat

Signal that indicates node is alive.

