# **MongoDB System Architecture Overview**

## **1. Data Centers Overview**

Shoreview, Oxmoor, and Silas are the three data centers in which our MongoDB system is deployed. Each data center is designed to support the critical infrastructure components, including shards, config servers, and query routers, providing geographic distribution for improved redundancy and reduced latency.

## **2. Cluster Configuration**

The MongoDB cluster consists of 5 nodes, distributed across the three data centers. This configuration allows for a resilient system with data replication across multiple locations, ensuring high availability and enabling automatic failover in the event of a node or data center failure.

## **3. Shard Configuration**

The cluster comprises 10 shards, with each shard containing 5 nodes. The node distribution per shard is as follows:  
 - Shoreview: 2 nodes (1 primary, 1 secondary)  
 - Oxmoor: 2 secondary nodes  
 - Silas: 1 secondary node  
The placement of the primary node in Shoreview ensures that all write operations are centralized, simplifying the write flow and reducing complexity during primary elections.

## **3.1 Hardware Configuration per Shard**

Each shard is provisioned with the following hardware specifications:  
 - 16 CPUs  
 - 256GB RAM  
This powerful hardware configuration ensures that the shards can handle high volumes of read and write requests, effectively supporting the demands of large-scale transactional workloads.

## **4. Config Server Replica Set**

A 5-node Config Server Replica Set is deployed to maintain the cluster's metadata and configuration settings, including information about data distribution and shard states. The node placement for the Config Server Replica Set is as follows:  
 - Shoreview: 2 nodes  
 - Oxmoor: 2 nodes  
 - Silas: 1 node  
The distributed setup of config servers provides fault tolerance and ensures that metadata is replicated across different locations, enabling consistent operations throughout the cluster.

## **4.1 Hardware Configuration per Config Server**

The hardware configuration for each config server is as follows:  
 - 4 CPUs  
 - 16GB RAM  
This hardware setup is optimized for managing metadata with minimal resource requirements while ensuring quick access and synchronization of cluster configurations.

## **5. Query Routing with Mongos Instances**

The MongoDB architecture uses 15 Mongos instances (query routers) to facilitate communication between applications and the sharded cluster. These query routers are distributed evenly across the three data centers:  
 - Shoreview: 5 Mongos instances  
 - Oxmoor: 5 Mongos instances  
 - Silas: 5 Mongos instances  
The distributed Mongos instances ensure that queries are effectively routed to the appropriate shards, providing load balancing and optimizing query performance based on geographic location.

## **5.1 Hardware Configuration per Mongos/Query Router**

Each Mongos instance is equipped with the following hardware:  
 - 8 CPUs  
 - 32GB RAM  
This configuration supports the efficient handling of incoming client requests, with ample processing power to manage the routing of queries to the correct shards, thereby reducing latency and avoiding bottlenecks.

## **6. Primary Node Placement and Data Synchronization**

The primary node for each shard is consistently placed in the Shoreview data center. Centralizing the primary nodes in Shoreview allows for a streamlined write flow to a single data center, thereby reducing the complexity of write coordination and ensuring a predictable write latency. Secondary nodes are distributed across Shoreview, Oxmoor, and Silas, which allows the system to maintain a replicated copy of data across multiple locations, ensuring data redundancy and enabling automatic failover in case of any failure.

## **7. High Availability and Fault Tolerance**

The distribution of nodes across three geographically distinct data centers enhances the system's fault tolerance. In the event of a failure at one data center, the remaining data centers can maintain the cluster’s availability. The replica set architecture for each shard provides redundancy, as secondary nodes can be promoted to primary in the case of node failure, ensuring that the database remains available for read and write operations.

## **8. Performance and Scalability Considerations**

The 16 CPUs and 256GB RAM per shard ensure high throughput for both read and write operations. This powerful setup is capable of handling intensive workloads, supporting large-scale applications with minimal latency. The 8 CPUs and 32GB RAM per Mongos instance ensure that the routing layer does not become a performance bottleneck, providing efficient load balancing for incoming requests. The config server replica set is optimized with 4 CPUs and 16GB RAM per node, balancing resource usage while providing reliable metadata management.

## **9. Security and Data Management**

Security features such as encryption in transit and access control mechanisms are implemented across all components to safeguard data during transmission between shards, config servers, and query routers. The architecture also allows for role-based access control (RBAC) to manage access levels across different parts of the cluster, ensuring that only authorized personnel have access to critical operations.

## **10. Backup and Disaster Recovery**

Backup solutions are implemented to cover all nodes in each data center, allowing for point-in-time recovery and ensuring data is not lost during incidents. Disaster recovery plans are established by utilizing secondary nodes across multiple data centers, which enables failover to other locations and prevents downtime during unexpected outages.

## **11. Summary**

This MongoDB architecture leverages a geographically distributed approach across three data centers—Shoreview, Oxmoor, and Silas—to achieve high availability, resilience, and optimized performance. With 10 shards and a 5-node Config Server Replica Set, the cluster is designed for scalability and fault tolerance. The careful placement of primary and secondary nodes across data centers ensures efficient data synchronization, while the distributed Mongos instances provide effective load balancing and query routing.  
  
The combination of robust hardware configurations, strategic placement of primary nodes, and the use of a distributed query routing layer provides a system that can efficiently handle high-volume transactional workloads and maintain continuous operational integrity, even in the face of data center-level failures.