Performance Prediction of Data-Rebalancing Actions in Sharded NoSQL Clusters

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Research Background / Problem Statement

- We consider **Data Rebalancing** as a **high priority activity** not a background task. Data are rapidly spreading to newly added nodes.
- **Case Study:** Operation **MoveChunk** in a sharded MongoDB NoSQL Cluster

1. Rapid scale-out

Modern services face sudden **load demands**. When a new node is added, data must redistribute to it **at full speed** so processing capacity grows with demand.

2. Why is it feasible?

- Low-overhead **RDMA networking**
- **SSD storage**

Make high-throughput chunk migration practical

3. The Core Problem

How many **simultaneous senders** maximize throughput to the new node?

- **Too few:** node underutilized, rebalancing too slow.
- **Too many:** throughput collapse from contention.

Hard to change live in MongoDB

Key Contributions of this Work

- **Queueing-Network Model:** A closed QN model of MongoDB's MoveChunk chunk-migration process, capturing parallelism across multiple donors.
- **Event-handling lifecycle:** detailed transaction lifecycle between donors (senders) & recipients.
- **Real-measurements parameters:** system parameterized from a real MongoDB v4.0 cluster (RDMA, no throttling) NIC = 31.25, SATA = 0.94, SSD = 4.69 chunks/s.
- **Pre-deployment prediction:** JMT / JSIM simulations (~40k samples, 99% CI) predict end-to-end latency and throughput vs. donor count before any deployment.

Key Results

- Throughput saturates fast
- Optimal number of Donors is **3 (SSD)** : **9.39** chunks/s aggregate, **0.32** s end-to-end latency
- More donors add contention, not throughput

Find Out More!

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QR code to poster

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