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Facebook ODS

Real-time monitoring system built on HBase

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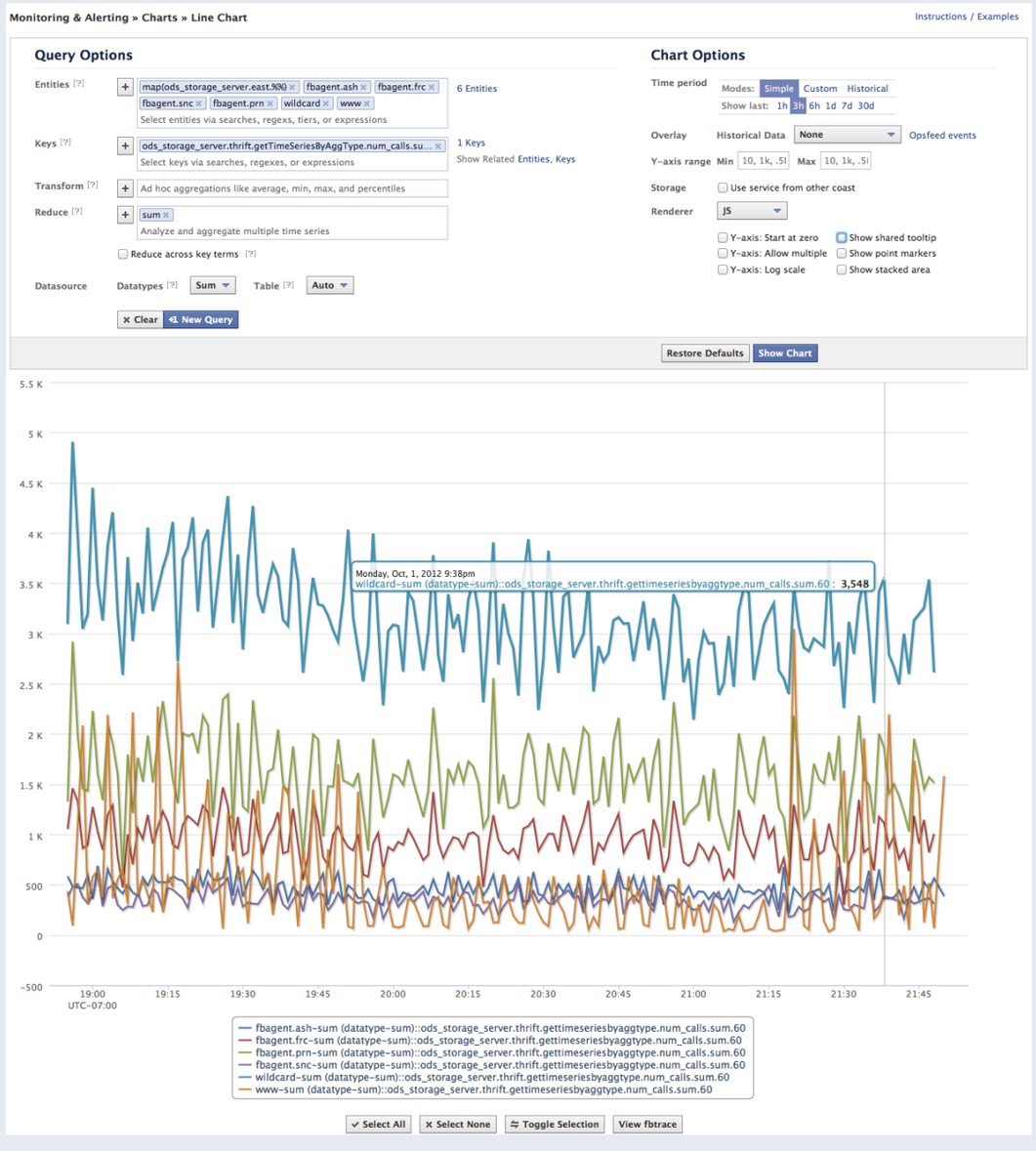
Agenda

1. Introduction (Vinod)
2. Architecture (Vinod)
3. Pitfalls (Charles)
4. Failover (Charles)
5. HBase performance tuning (Liyin)

Introduction

ODS

- Time series data for real-time monitoring and trends
- Collects metrics from each server
- Aggregates in useful ways
- Detects and alerts on anomalies
- 2.5 B data points written per minute, 16 k reads per minute



Motivation

Troubles with the old MySQL-based system

- Unavailability on hardware failures
- MySQL table size limitations
- Sharding scheme created hotspots
- Data growth manageability headaches

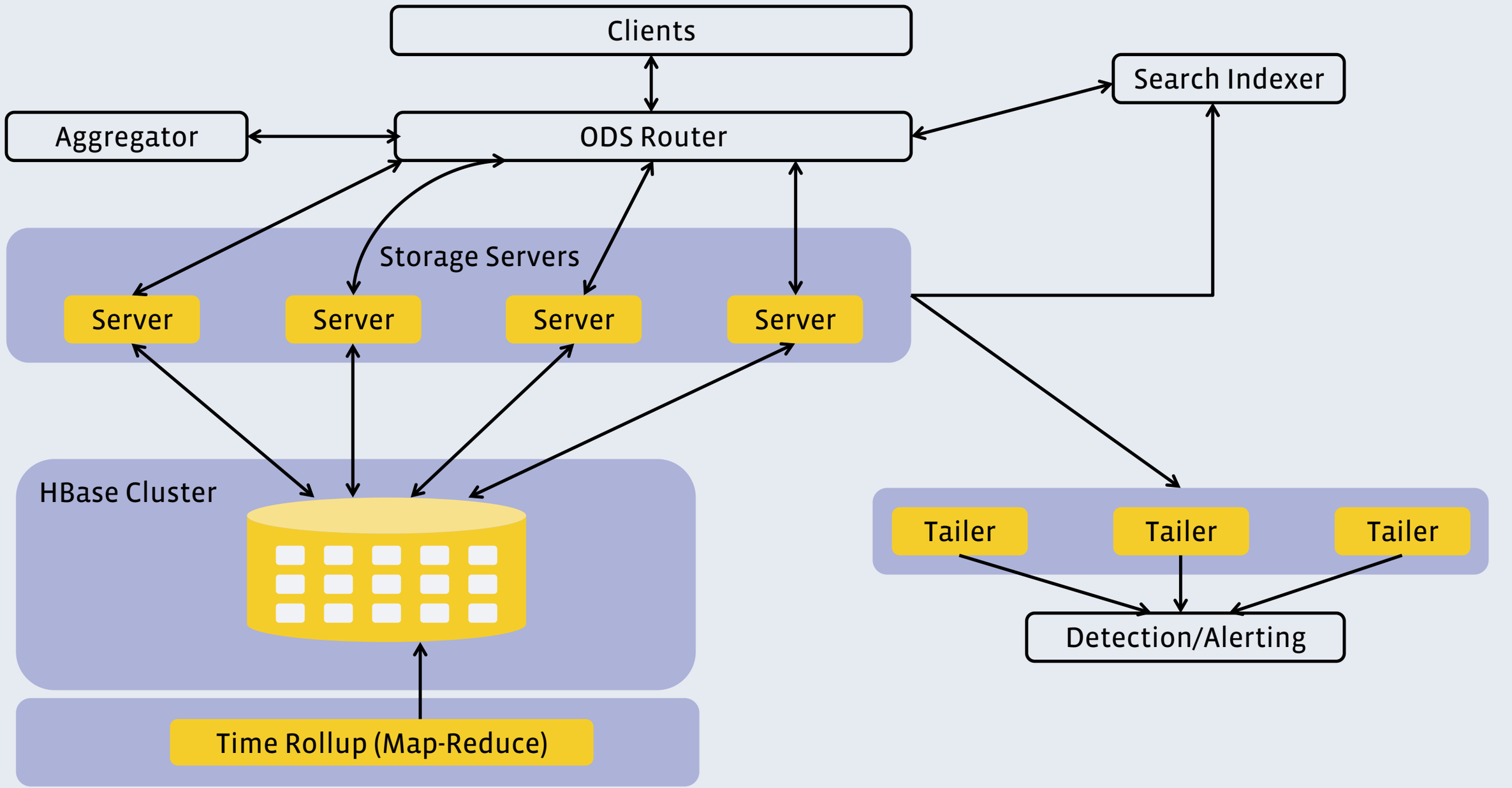
Motivation

Why HBase?

- Optimized for append-heavy, light read workloads
- Inherent sharding, connection handling, failure recovery
- Map-Reduce a natural fit for time rollups
- Strong in-house engineering and operational support
- Prototype provided promising results even when unoptimized

Architecture

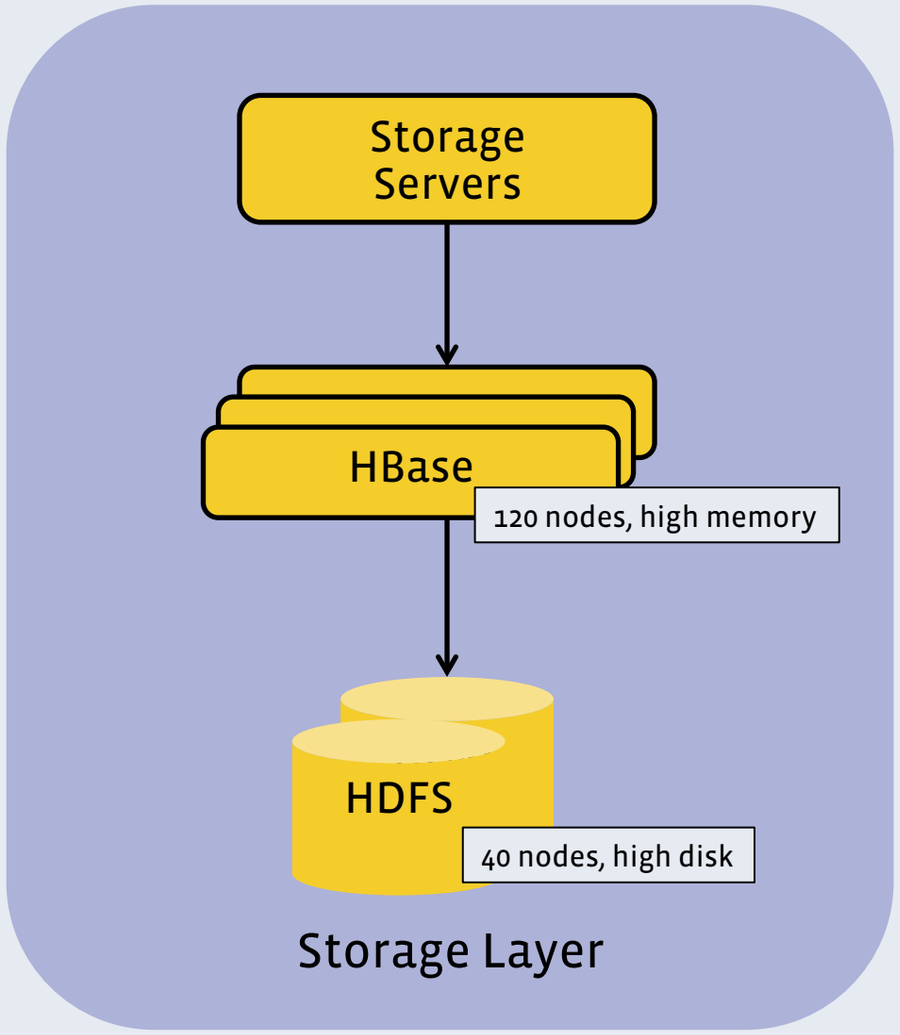
New Architecture Overview



Split cluster experiment

- ODS uses very little disk
- More memory allows for more cached data
- Limited server types
- What about running HBase and HDFS separately?
- In theory, can scale memory or disk separately as needed

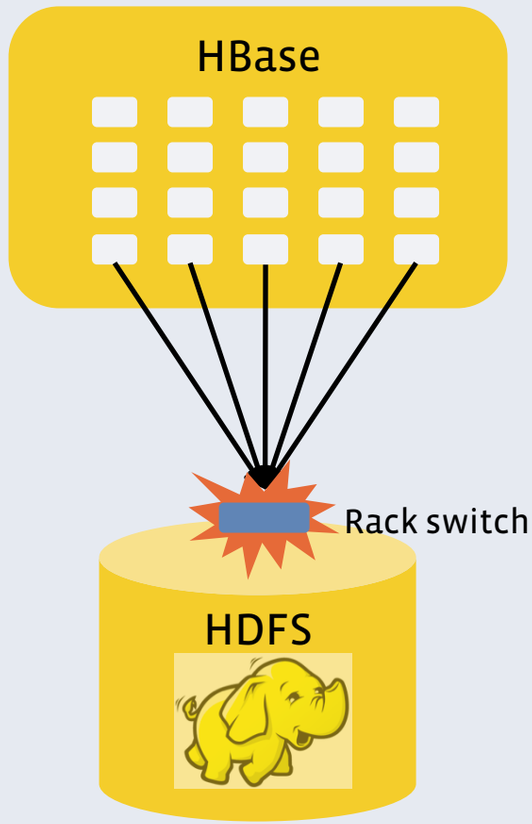
Capacity Engineers, Users like this.



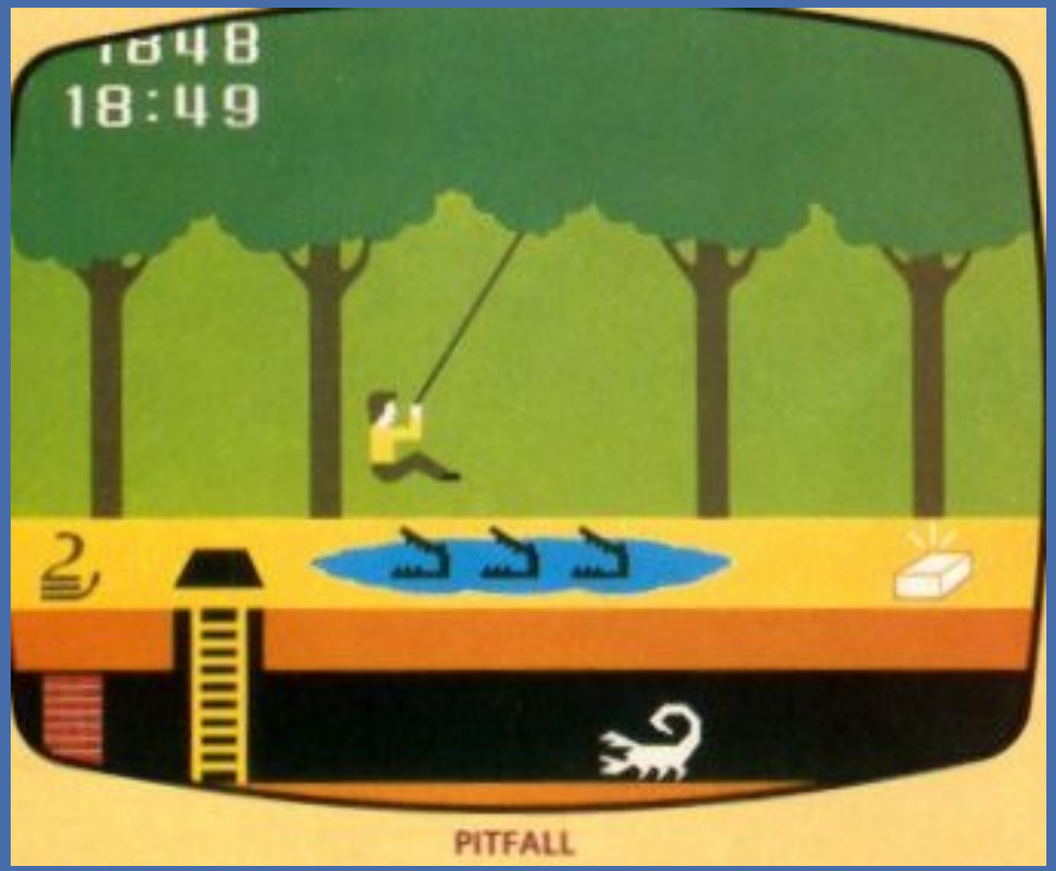
Split cluster experiment

So what went wrong?

- Locality, locality, locality!
- Map-Reduce jobs overload HDFS rack switches
- Compactions, cluster maintenance all overload HDFS rack switches
- Operational overhead
- Fell back to co-locating HBase/ HDFS



Pitfalls

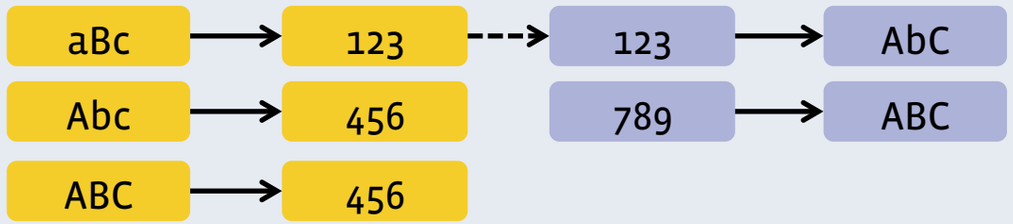


Design: Schema & Migration

Migration: Notes

- Bulkload is **fast** and you'll need it.
  - We migrated about **6** times.
  - No rewriting data, just **moves** (make backups with distcp)
  - Region **splits** must match.
    - Before reviving, run major **compaction**.
- Can not **rename** tables.
- Our process: copy SQL tables to HDFS -> MR -> **bulkload**

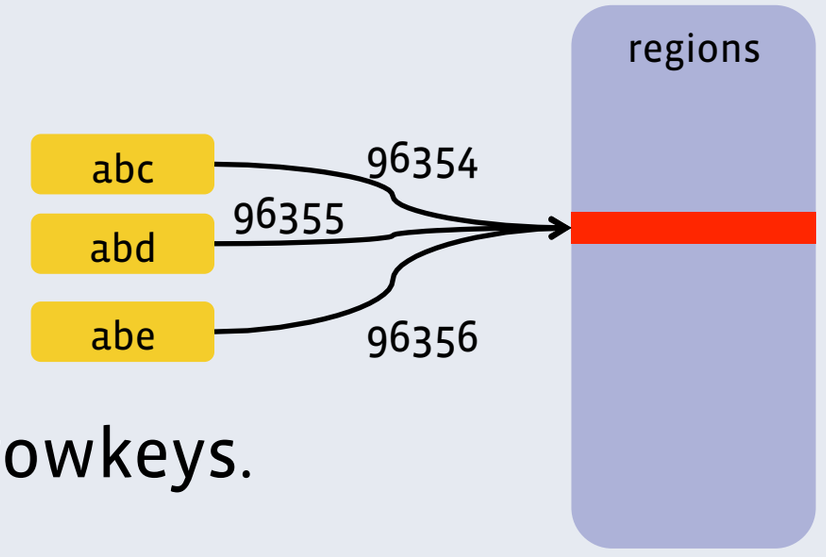
Migration: Lowercase



- You'll want tools:
  - To generate a **smaller** dataset for testing against.
  - To produce **text** output, for checking results

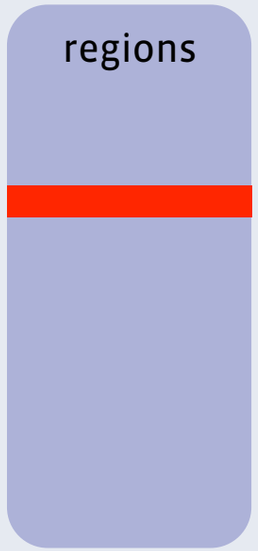
Migration: Hashes

- Found hotspots.
  - Running MR would **kill one** RS at a time
  - Watch your puts() per RS for balance
  - Cause: bad rowkey hashing
- Java's default hashCode() is bad for HBase rowkeys.
  - Poor spread
  - Went with **murmur**: balance of speed and effectiveness.
- **Beware**: Migrating a bad rowkey is **very** different from column data
  - It was a lot of work to cut-over live, and to minimize downtime.



Migration: Endnotes

- Numeric rowkey problems:
  - Avoid writing monotonically increasing sequence-ids
  - Beware of other "sequential" data types:
    - IP addrs, dates, hostnames, etc…
  - Natural strings
    - Combine data **and hash**: "apple" is bad but "f5ac8127:apple" isn't
    - NoSQL: Ok to have redundant info (especially with compression)
- When deletes **don't** delete: versions/timestamps
  - When you delete the last cell, and reveal an older version.



Practice: Threads & Memory

Threads & Memory

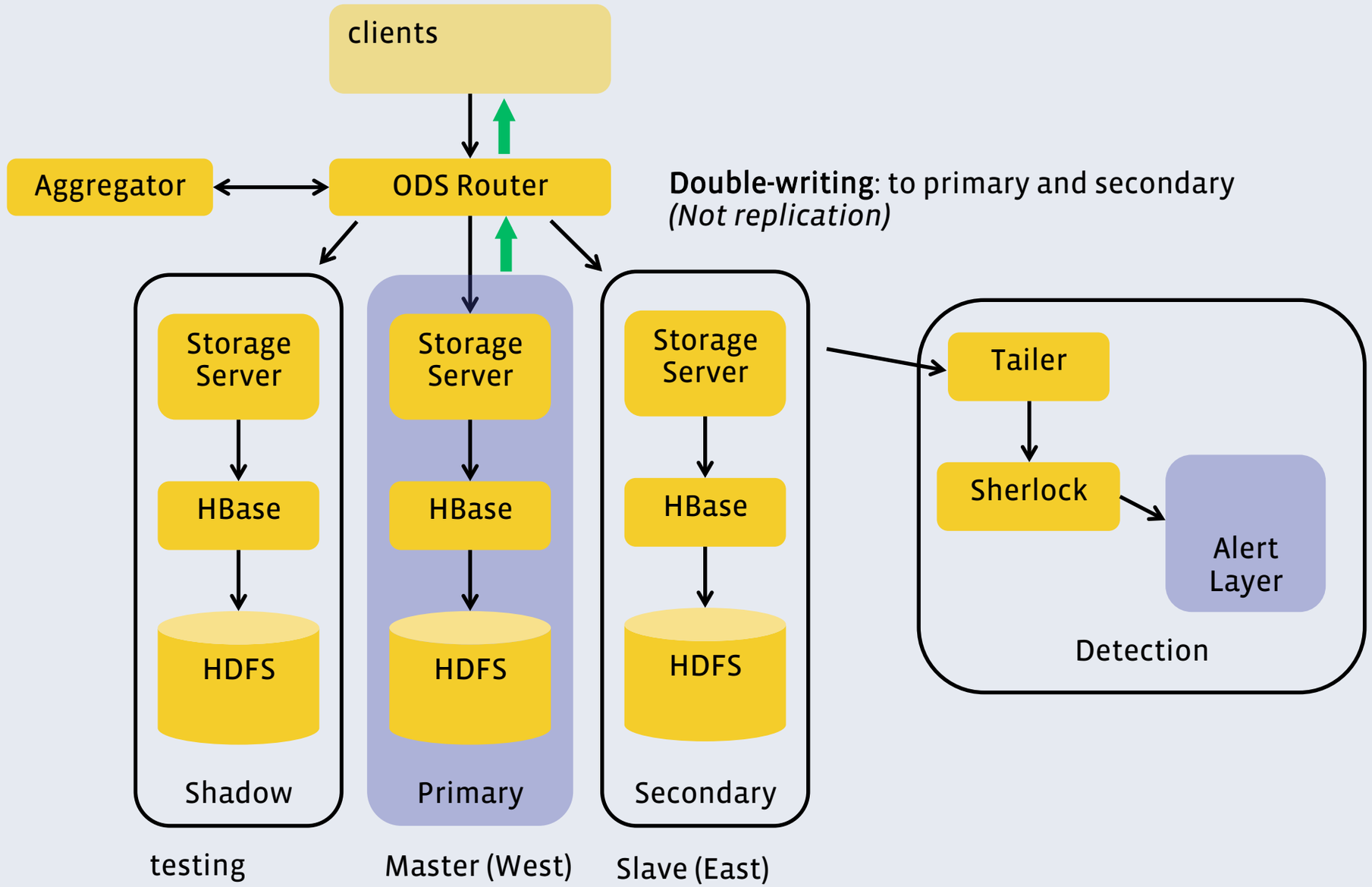
- You have **more** threads than you think (we had >28K)
  - 9 tables, 100 RS, 32 htable objects in a pool
- Limit the HTables with **HTablePool**.
  - We **wrote** a new pool on top of HTablePool.
    - Went from 28K -> 400 @idle & 1400 (typical)
- Limit stack size (-Xss128k)
- Memory “Leaks”
  - -XX:MaxDirectMemorySize=256m

Ops: Failover

Failover: Why do you need it?

- Unavoidable outages
  - When HDFS **file formats change**, you need conversion time.
  - Namenodes die and bringing up the secondary is **manual**.
  - **Rollback**: New software pushes sometimes trigger unexpected performance dips.

Failover:


clients
Aggregator
ODS Router
Double-writing: to primary and secondary
(Not replication)
Storage Server
HBase
HDFS
Shadow
Storage Server
HBase
HDFS
Primary
Storage Server
HBase
HDFS
Secondary
testing
Master (West)
Slave (East)
Tailer
Sherlock
Alert Layer
Detection

Failover: The Reality

- **Easy** -> all the time
- Having a Failover cluster has **saved** us many times. E.g.
  - Region servers **bouncing** up and down (still heartbeating)
  - HDFS can have various failures
  - **MR** can bring down the cluster
  - Rack failures survive, but **kill** performance

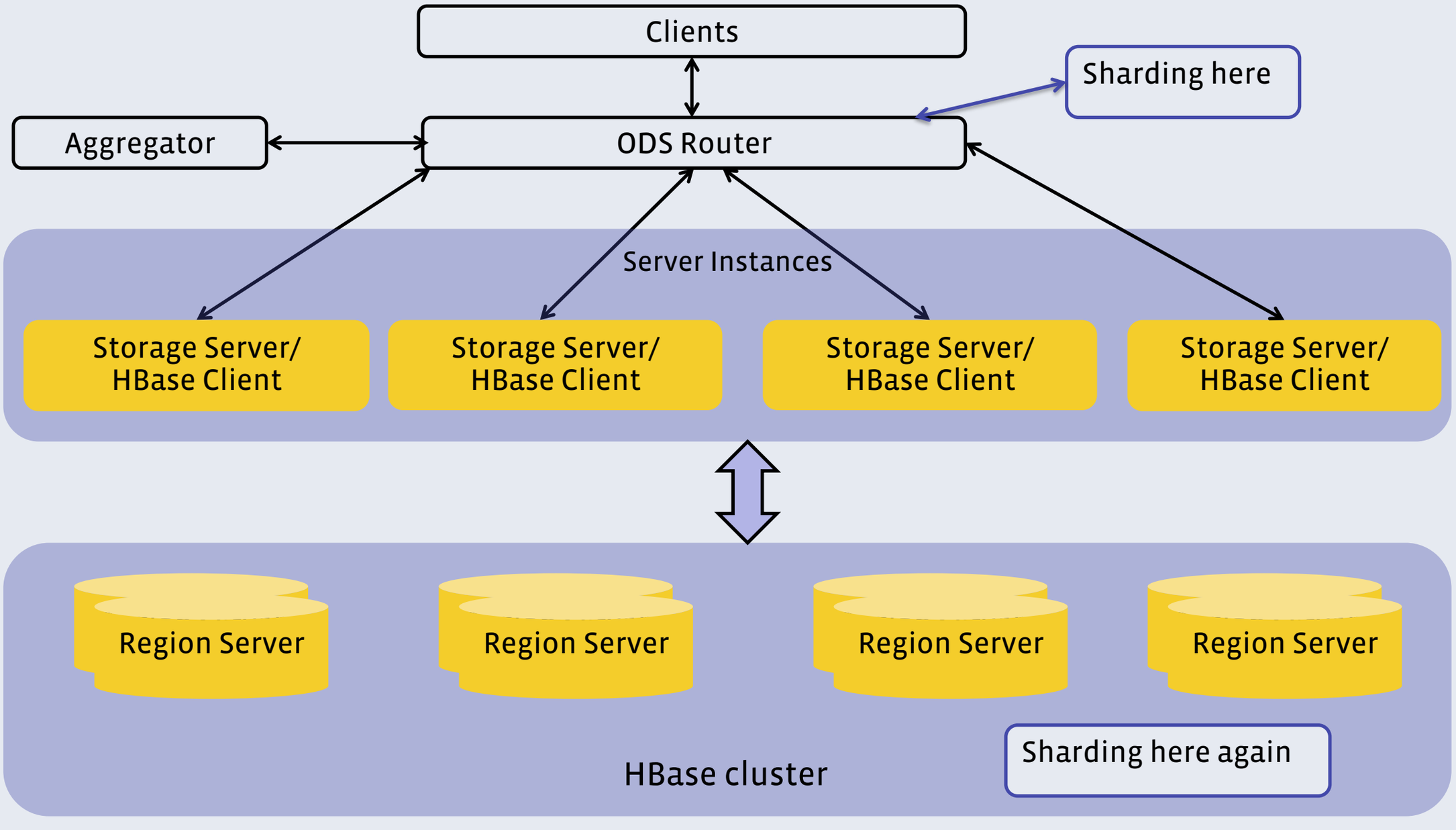
Failover: Benefits

- Upgrades can be “canary” **tested** on the secondary cluster.
- Upgrade problems are never experienced by **users**.
- We can **failover first**, then investigate problems.
- You have a **live** backup in a Disaster Event.
- Some **MR** can be run on the secondary cluster.
- **Backups** can run on the secondary cluster.
- You can compare both sides to help **debug** many issues.

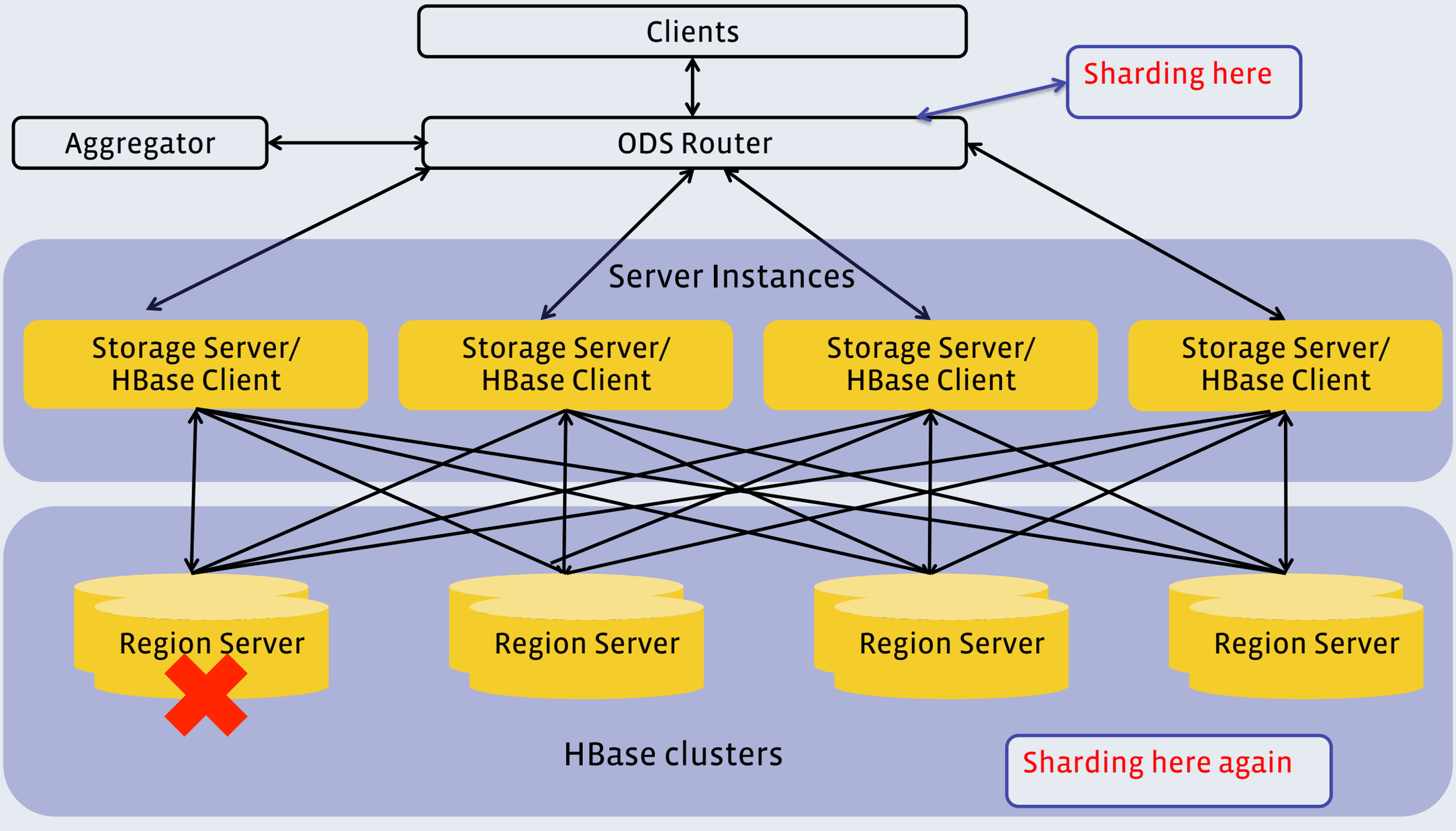
Lessons for HBase Performance Tuning

Takeaway I: Shard the application traffic as similar as HBase shards the row key space.

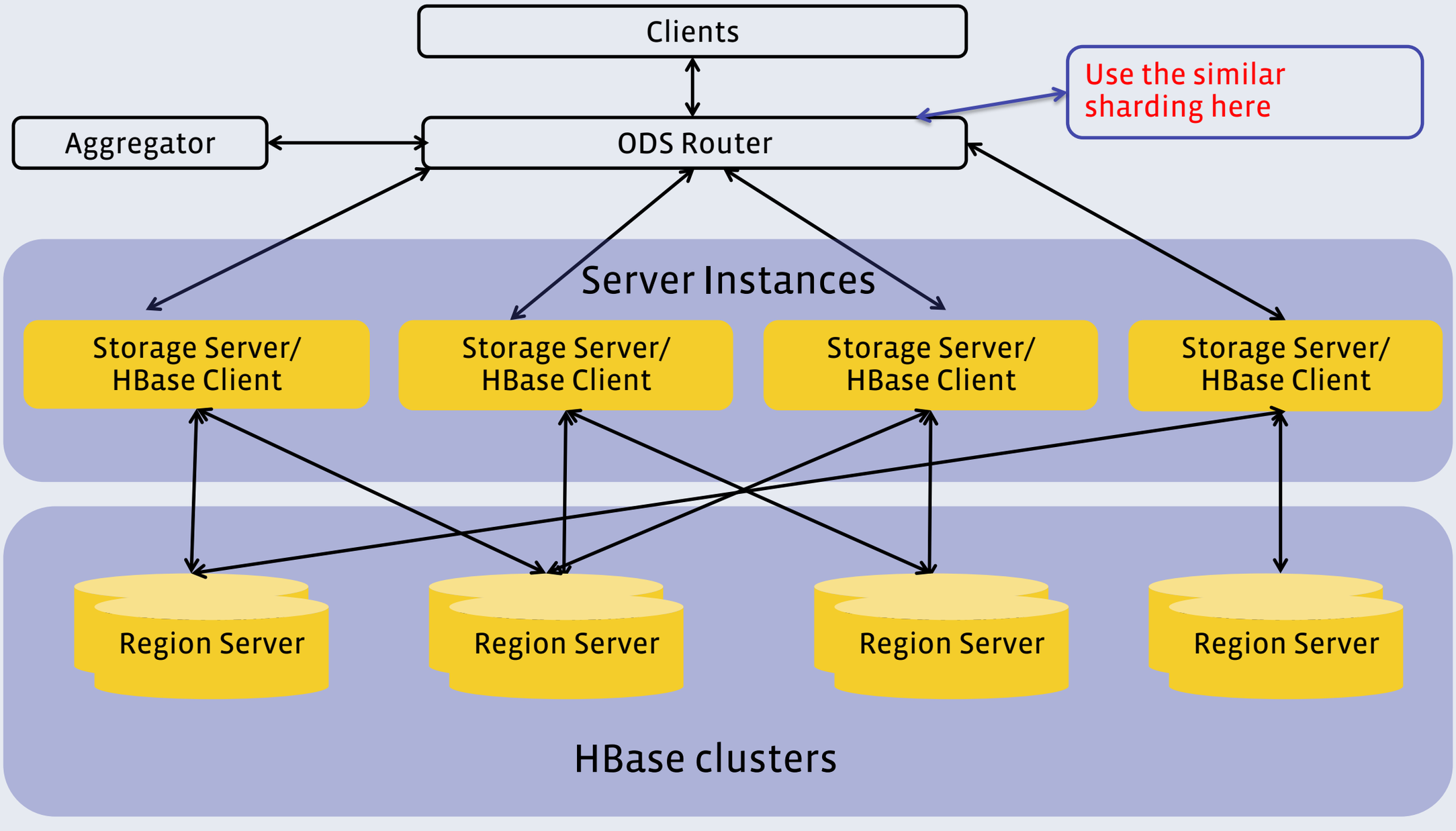
Sharding Overview



Sharding Overview

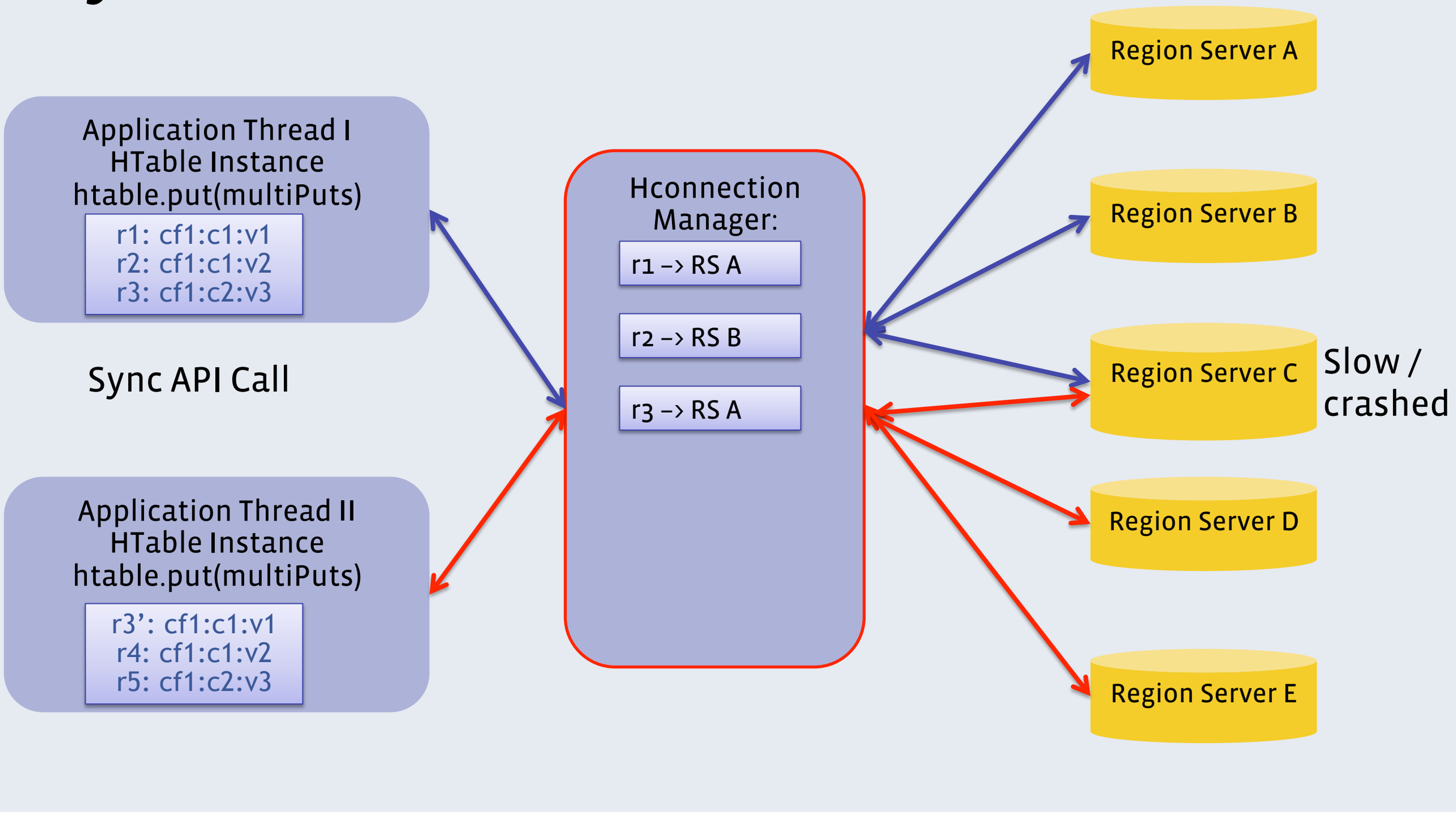


Sharding Overview

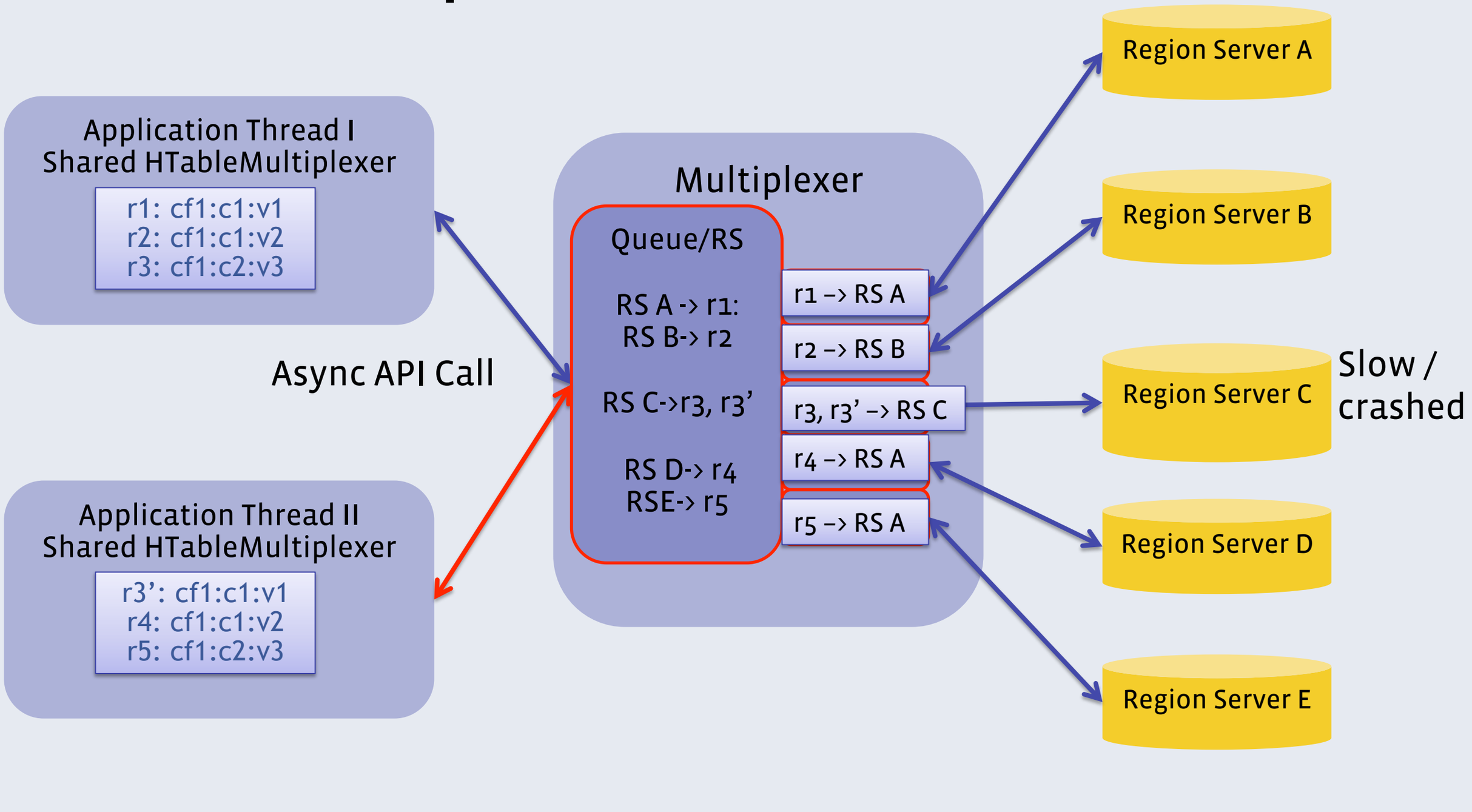


Takeaway II: Use the async put API provided by HTableMultiplexer to improve the write throughput

Sync MultiPut

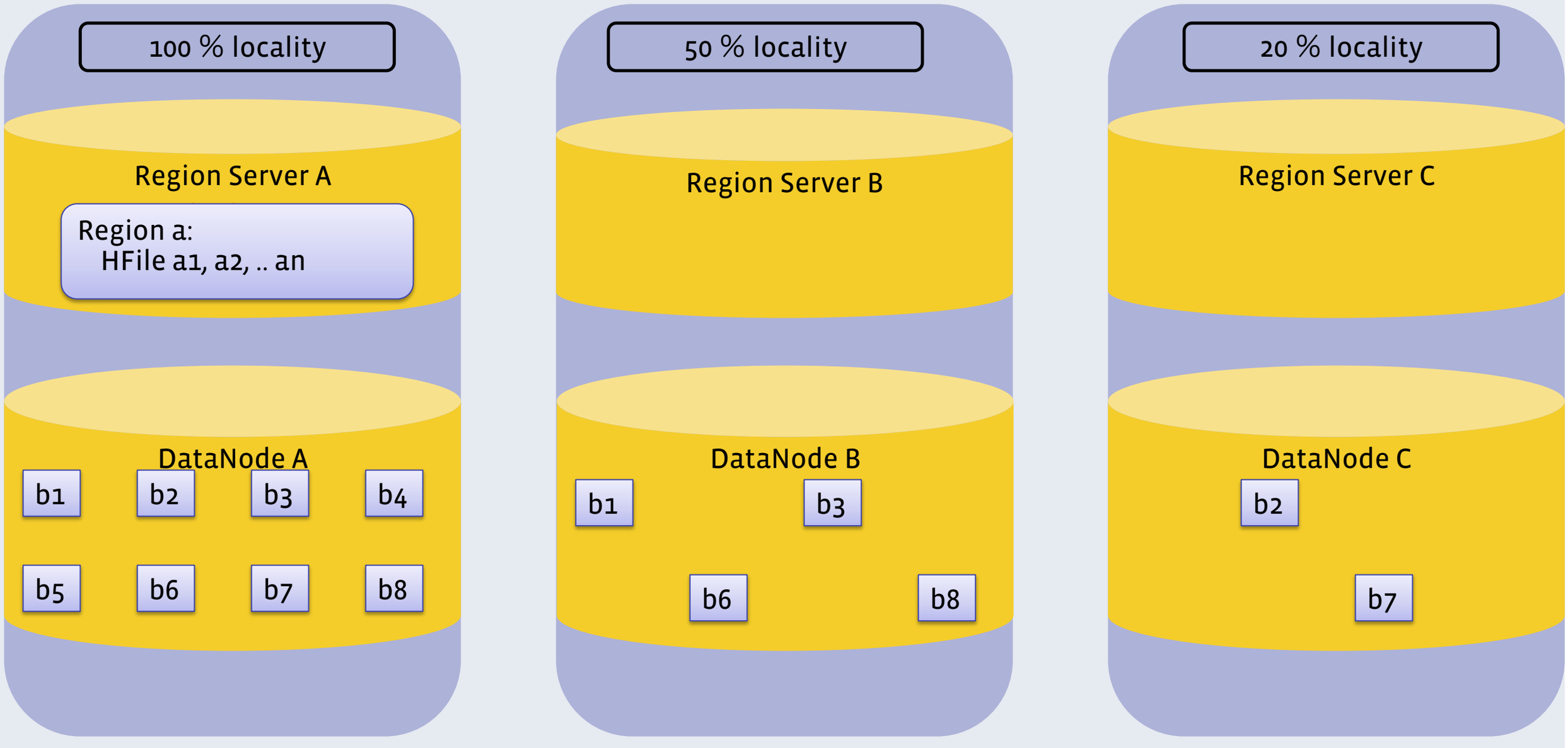


HTableMultiplexer



Takeaway III: Enhance the block placement to retain the data locality during the region movement

Locality drops when region moves

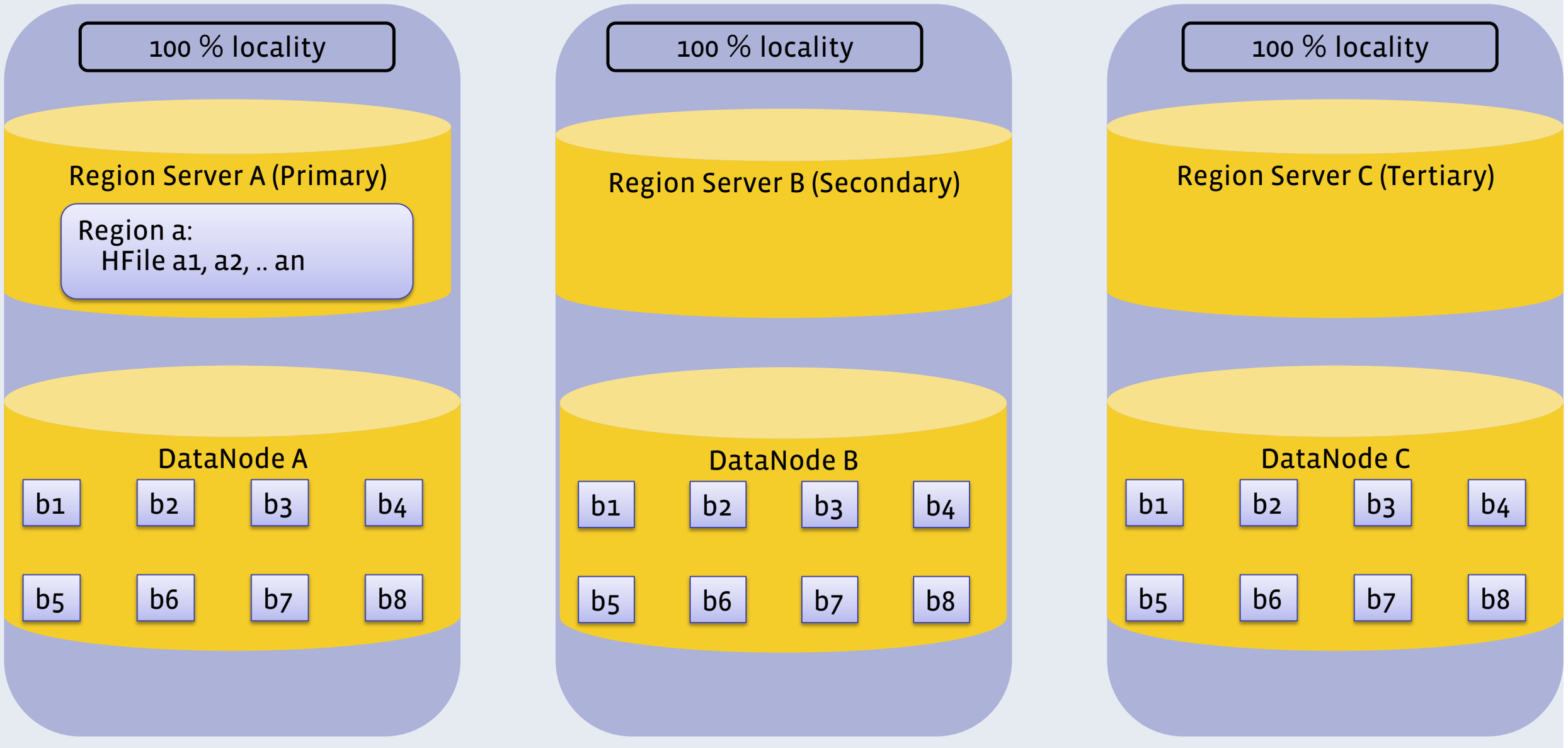


Locality-Based Region Placement

- Assignment Plan

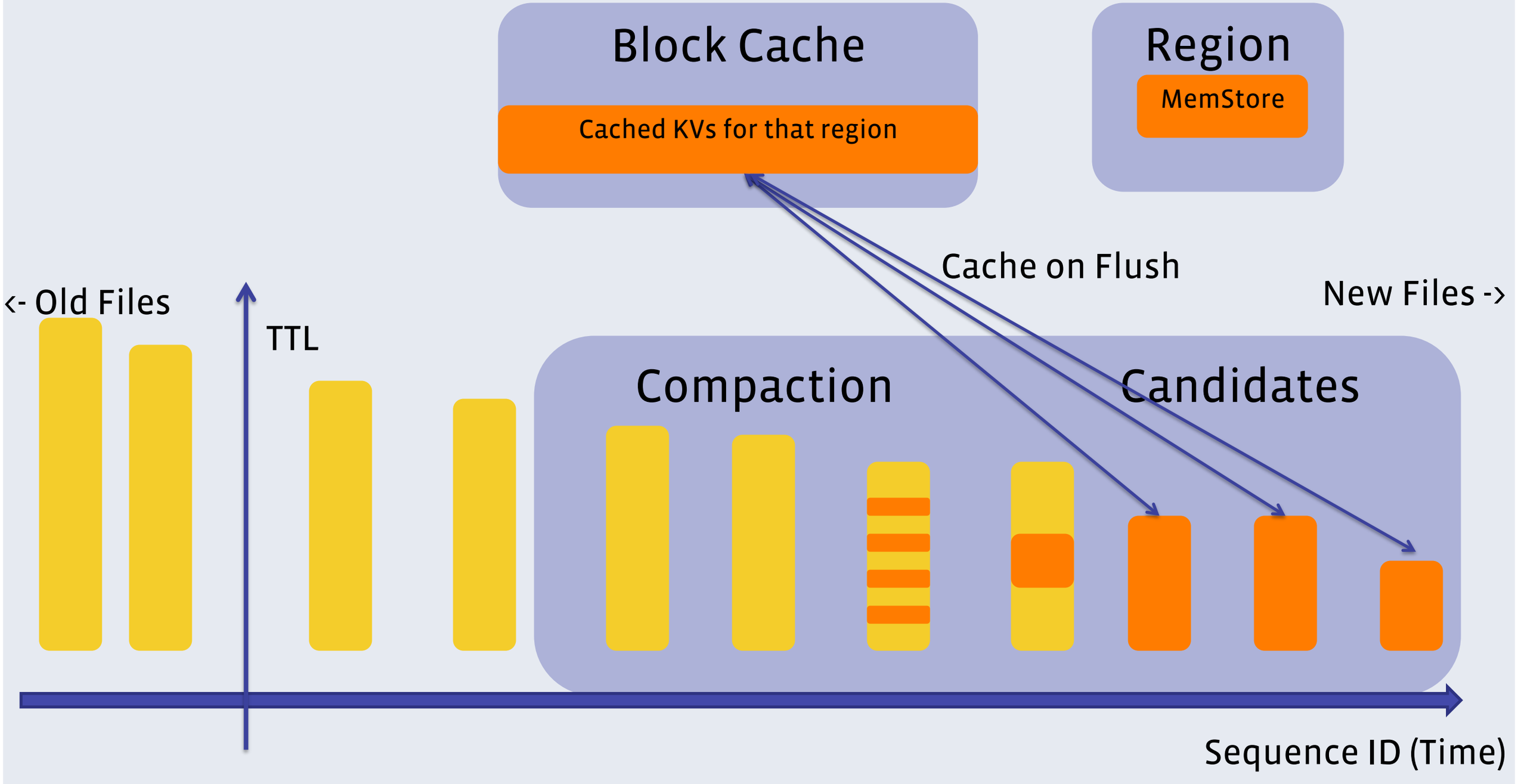
- Region Placement -> Block Placement
- Region -> Primary RS, Secondary RS, Tertiary RS
- Region will be failed over among these 3 locations
- All the blocks belonging to that region allocated on these 3 locations
- The plan is calculated offline and stored in the META table
- Easy to refresh or customize the plan
- Master executes the assignment plan

Goal: retain the locality during the region movement

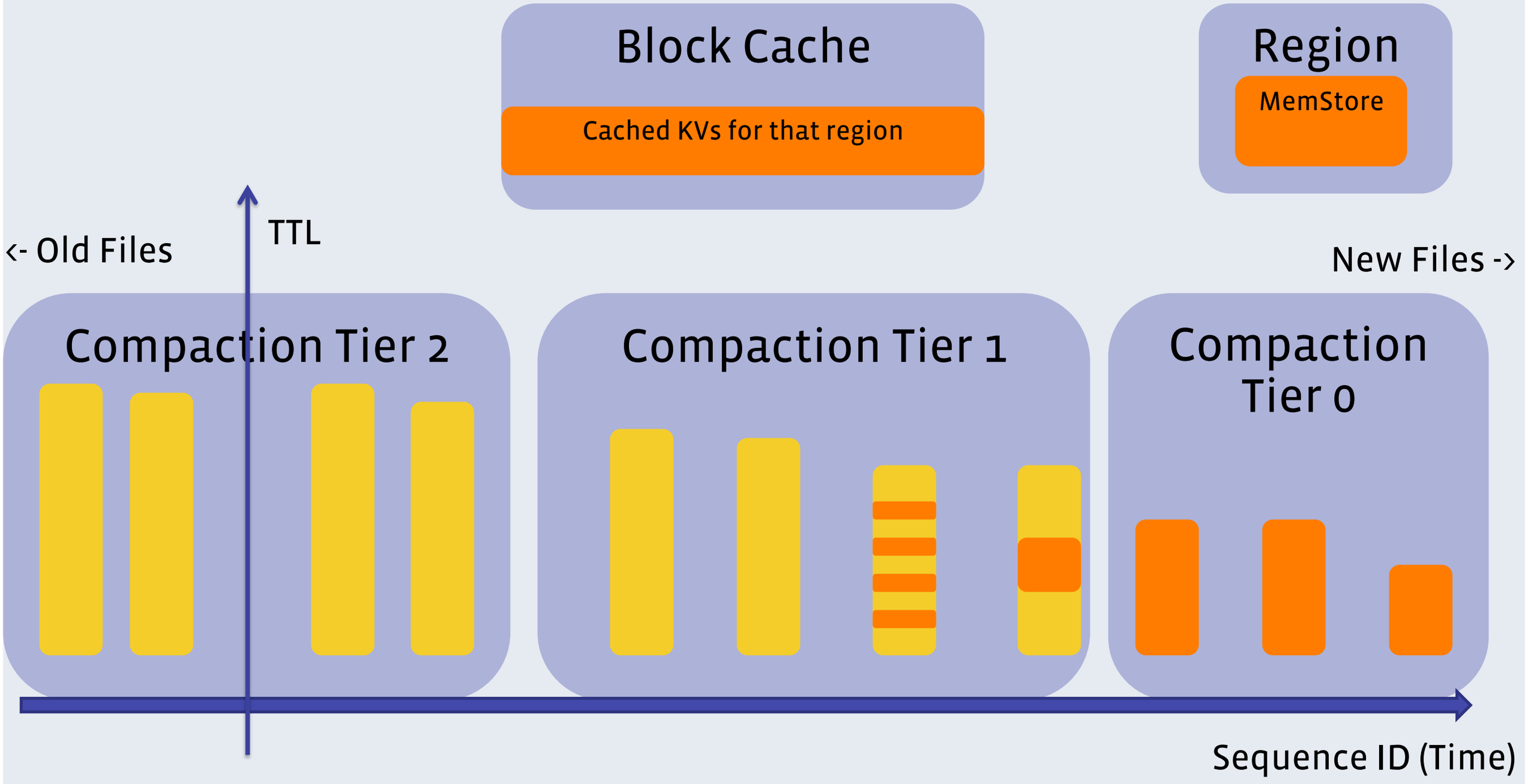


Takeaway IV: Keep the hot recent data live in the block cache

Compaction invalidates the block cache



Tier based compaction (HBase-6371)



Takeaways

1. Shard the application traffic similar to HBase
2. Use async puts from HTable Multiplexer
3. Place regions based on locality
4. Keep hot, recent data live in the block cache

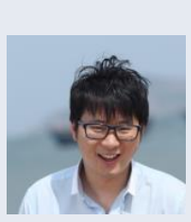
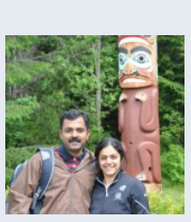
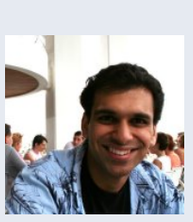
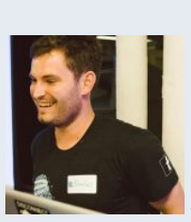
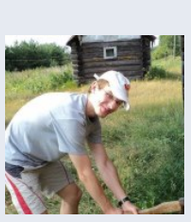
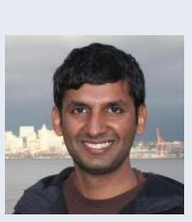
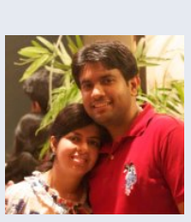
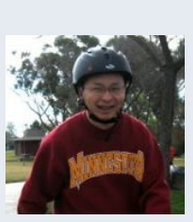
Acknowledgements

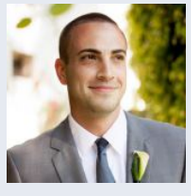
ODS



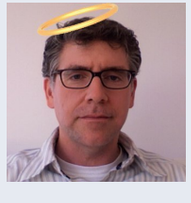
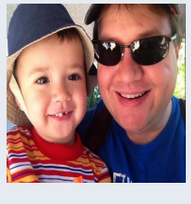
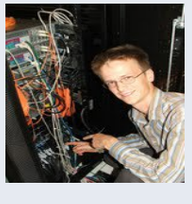



HBase Engineering




HBase Production Engineering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