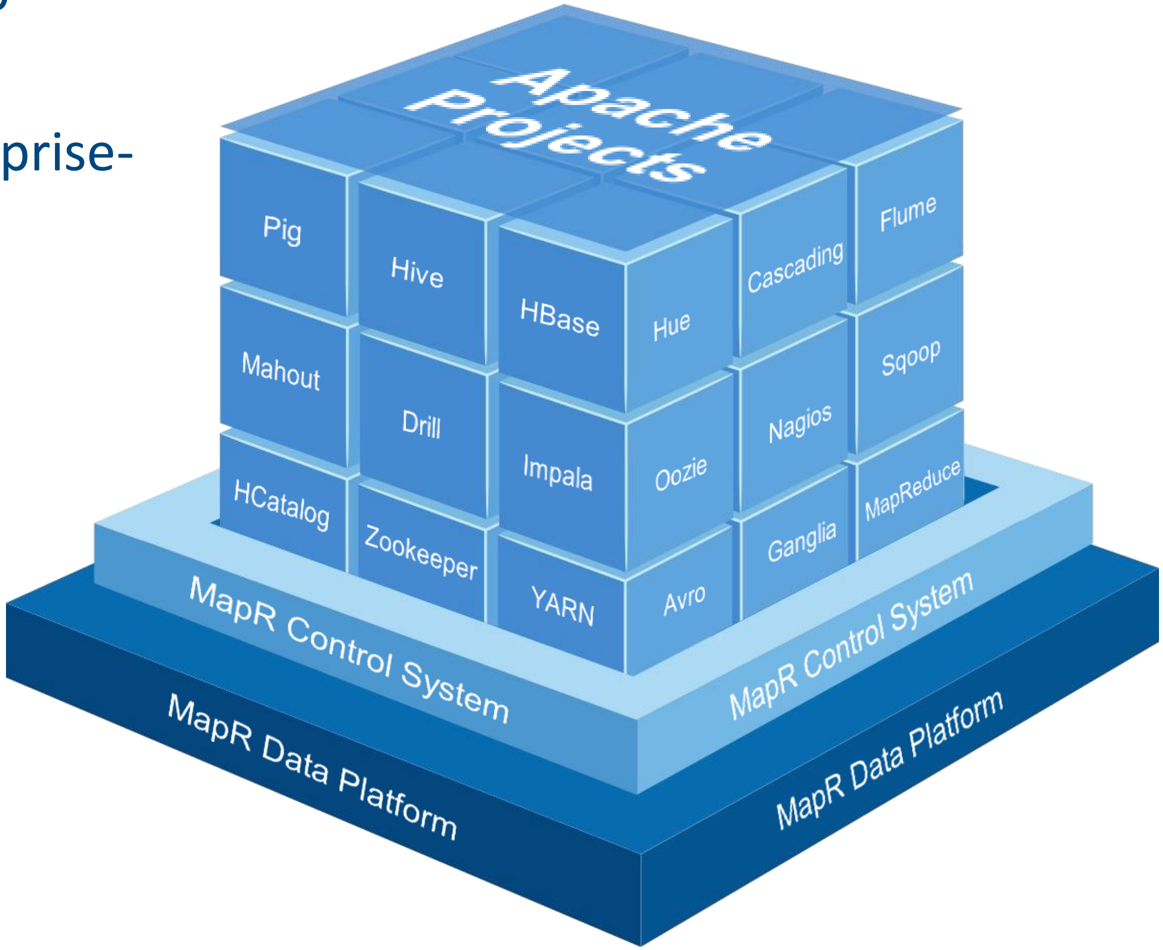
An Architectural Overview of MapR

M. C. Srivas, CTO/Founder

MapR Distribution for Apache Hadoop

- 100% Apache Hadoop
- With significant enterprise-grade enhancements
- Comprehensive management
- Industry-standard interfaces
- Higher performance



MapR: Lights Out Data Center Ready

Reliable Compute

Dependable Storage

- Automated stateful failover
- Automated re-replication
- Self-healing from HW and SW failures
- Load balancing
- Rolling upgrades
- No lost jobs or data
- 99999's of uptime

- Business continuity with snapshots and mirrors
- Recover to a point in time
- End-to-end check summing
- Strong consistency
- Built-in compression
- Mirror between two sites by RTO policy

MapR does MapReduce (fast)

TeraSort Record

1 TB in 54 seconds

1003 nodes

MinuteSort Record

1.5 TB in 59 seconds

2103 nodes

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MAPR TECHNOLOGIES Google

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300

The Cloud Leaders Pick MapR

Amazon EMR is the largest Hadoop provider in revenue and # of clusters

Google chose MapR to provide Hadoop on Google Compute Engine

Deploying OpenStack? MapR partnership with Canonical and Mirantis on OpenStack support.

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3. Do it fast
   - Instant-on … (1) and (2) must happen very, very fast
   - Without maintenance windows
     - No compactions (eg, Cassandra, Apache HBase)
     - No "anti-entropy" that periodically wipes out the cluster (eg, Cassandra)

Reliability With Commodity Hardware

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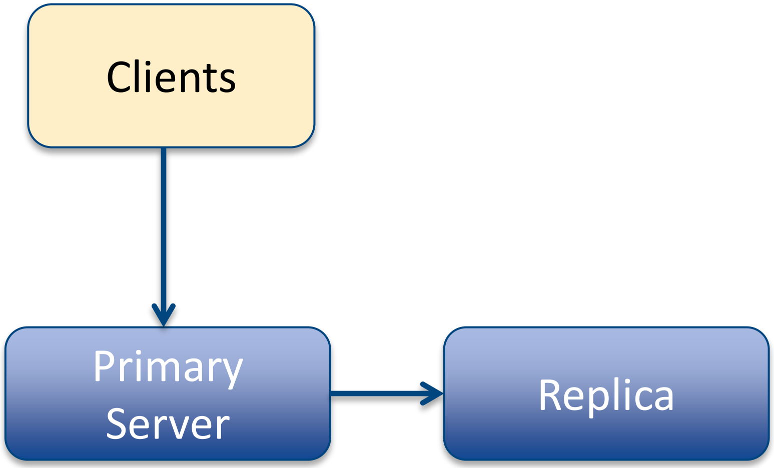
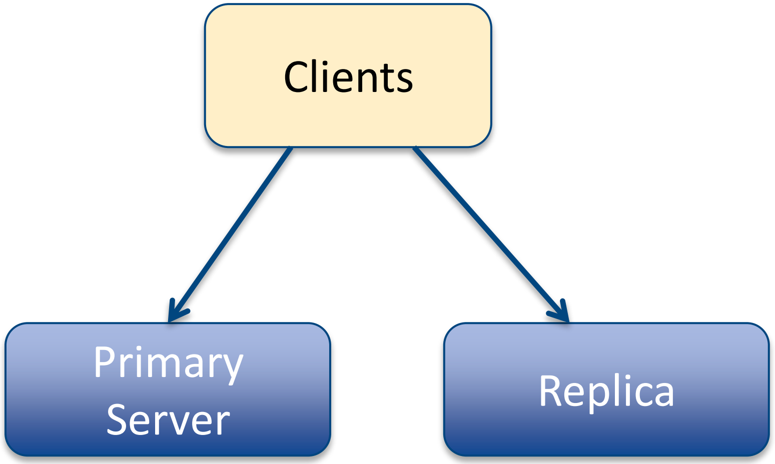
- No choice but to replicate for reliability

Reliability via Replication

- Replication is easy, right? All we have to do is send the same bits to the master and replica.



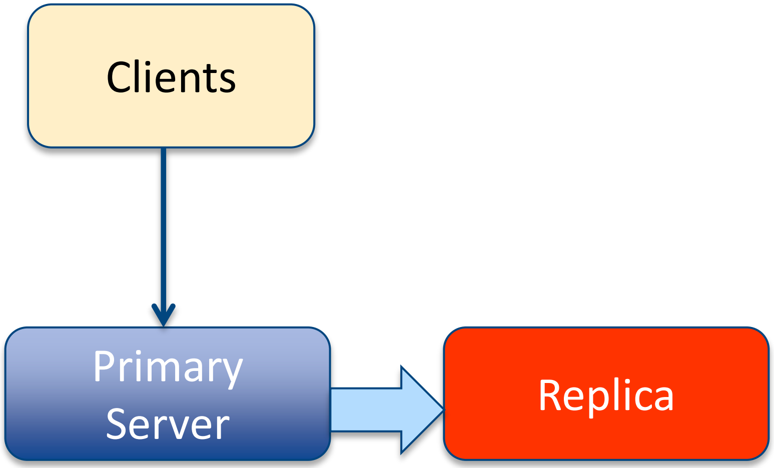
Normal replication, primary forwards



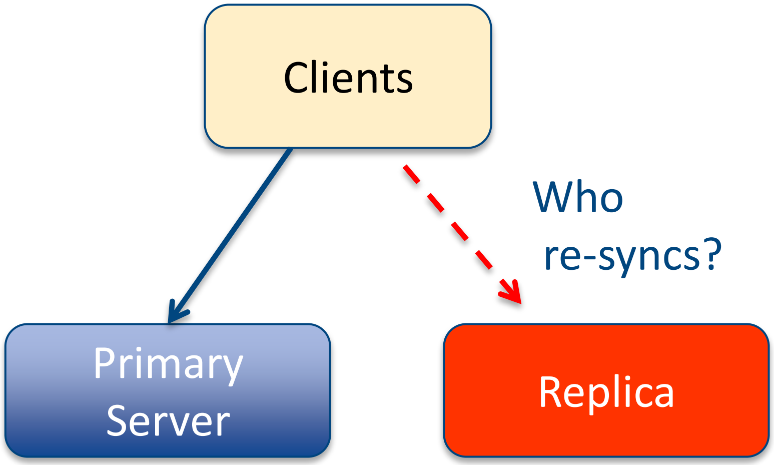
Cassandra-style replication

But crashes occur…

- When the replica comes back, it is stale
  - it must brought up-to-date
  - until then, exposed to failure



Primary re-syncs replica



Replica remains stale until "anti-entropy" process kicked off by administrator

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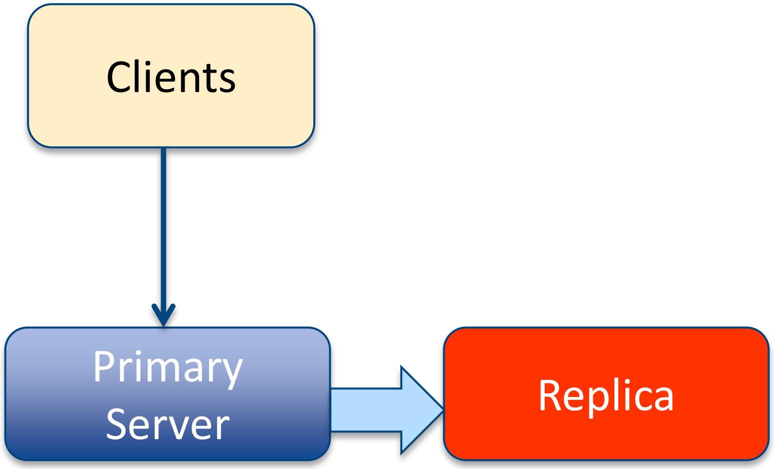
- HDFS therefore cannot do NFS, ever
  - No “close” in NFS … can lose data any time

This is the 21st century…

- To support normal apps, need full read/write support
- Let's return to issue: resync the replica when it comes back



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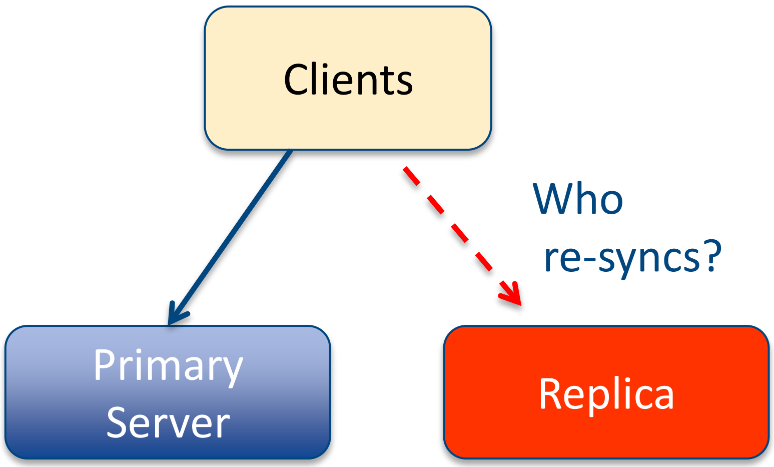

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- 24 TB / server
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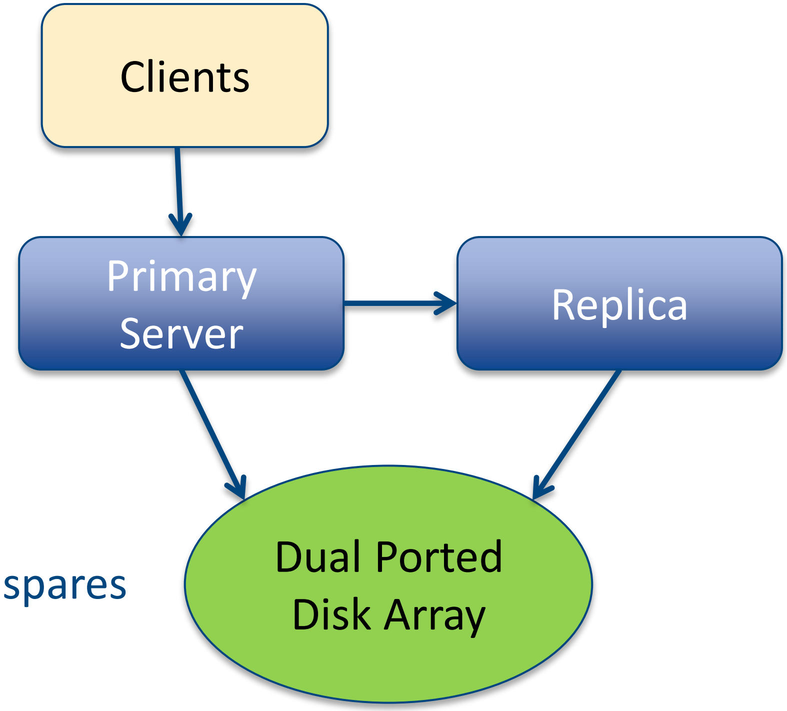
- What is your Mean Time To Data Loss (MTTDL)?
  - how long before a double disk failure?
  - a triple disk failure?

Traditional solutions

- Use dual-ported disk to side-step this problem



Servers use NVRAM

Raid-6 with idle spares

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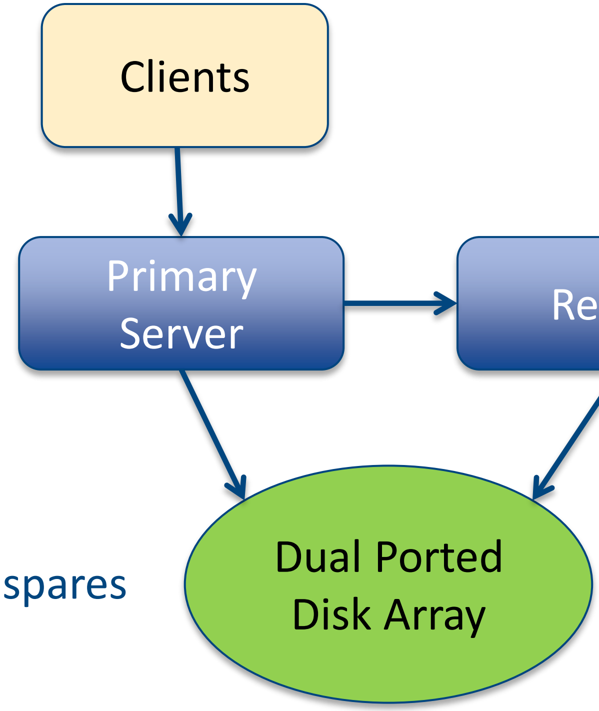

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COMMODITY HARDWARE

LARGE SCALE CLUSTERING

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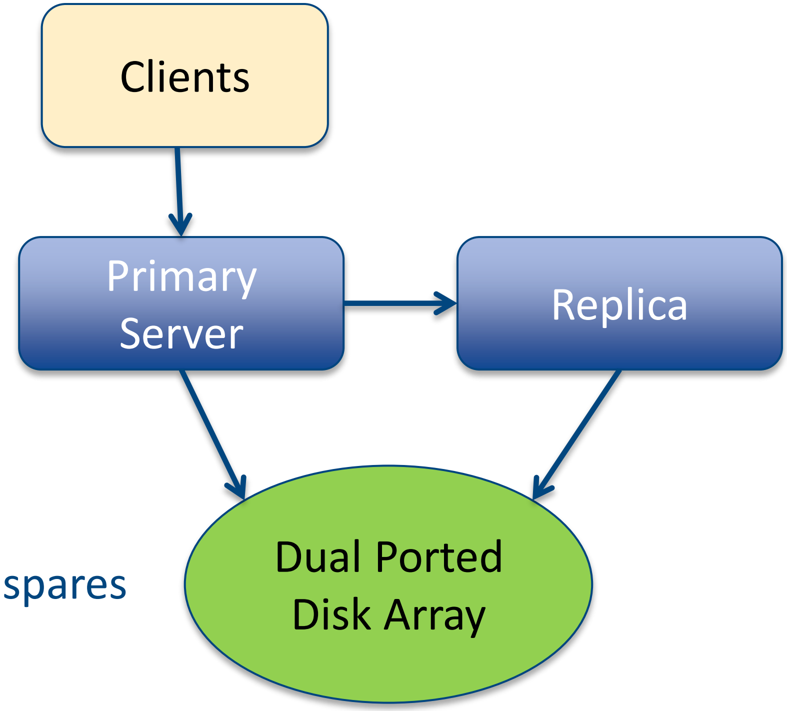

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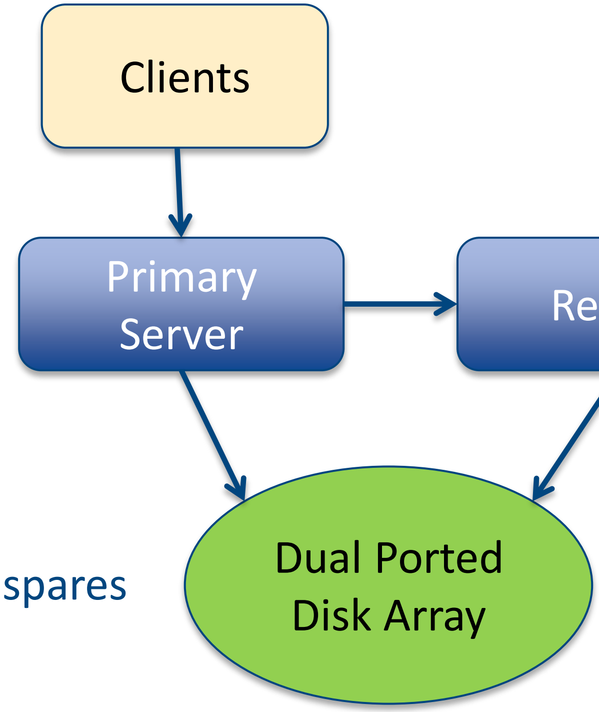

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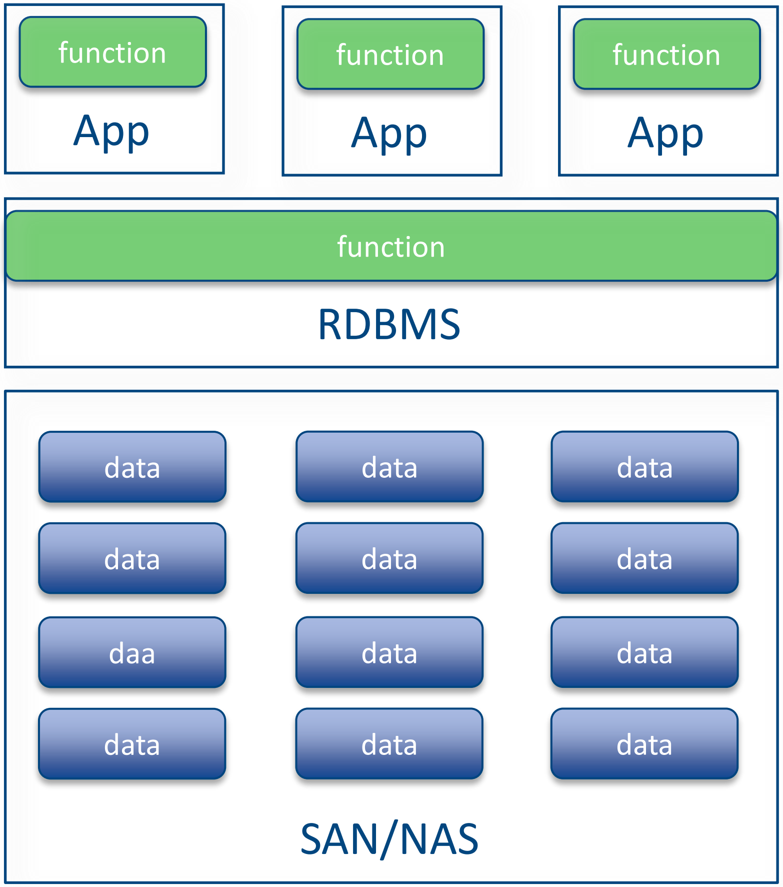
~~COMMODITY HARDWARE~~ ~~LARGE SCALE CLUSTERING~~

Large Purchase Contracts, 5-year spare-parts plan

Forget Performance?

Traditional Architecture



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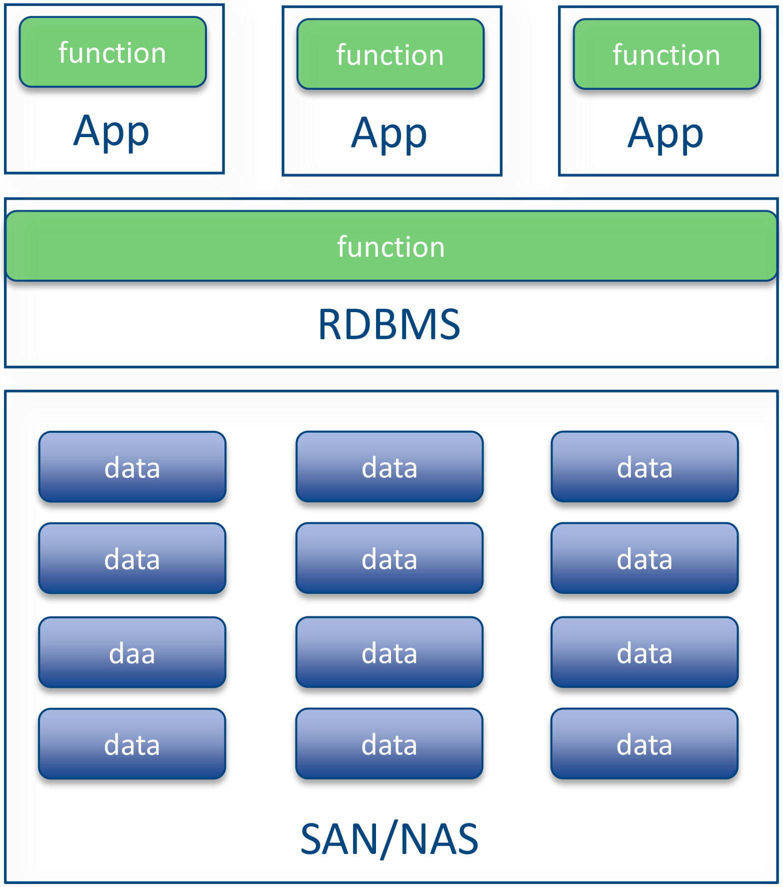
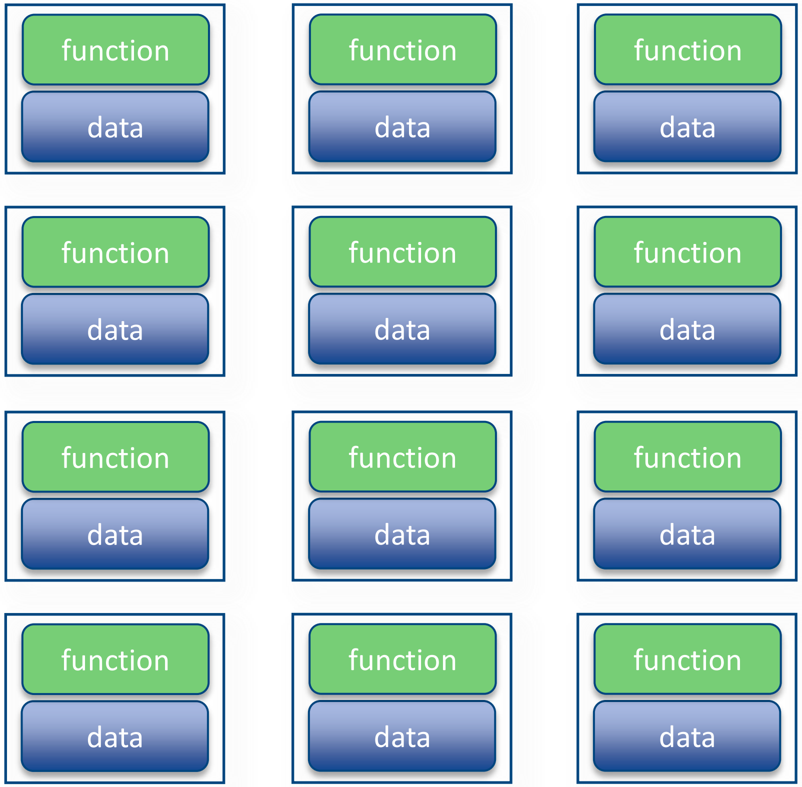


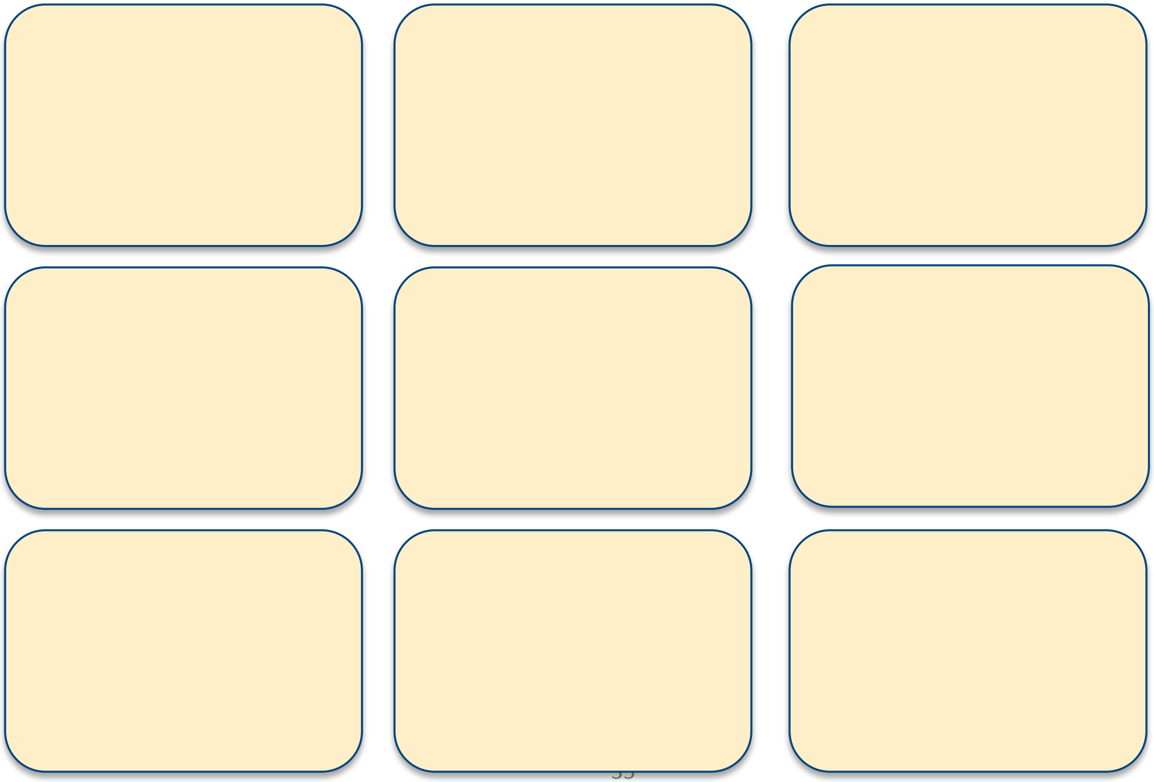
Hadoop



Geographically dispersed also?

What MapR does

- Chop the data on each node to 1000's of pieces
  - not millions of pieces, only 1000's
  - pieces are called ***containers*** ⬢



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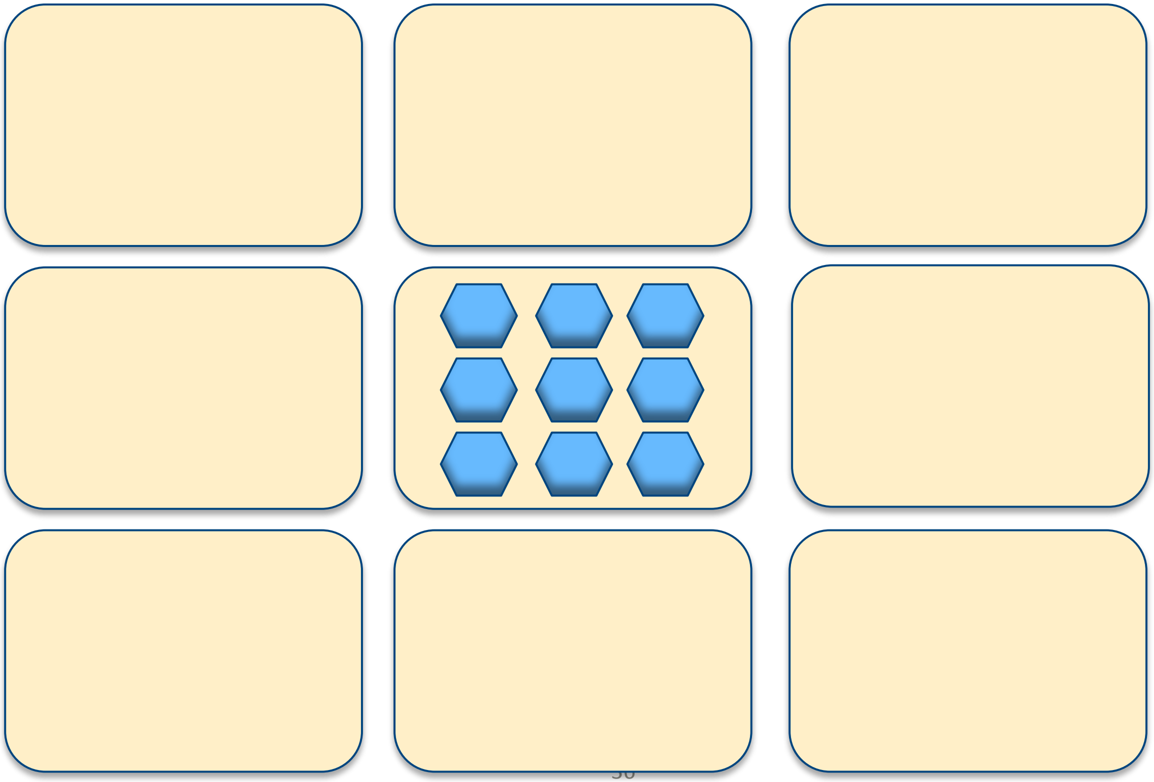

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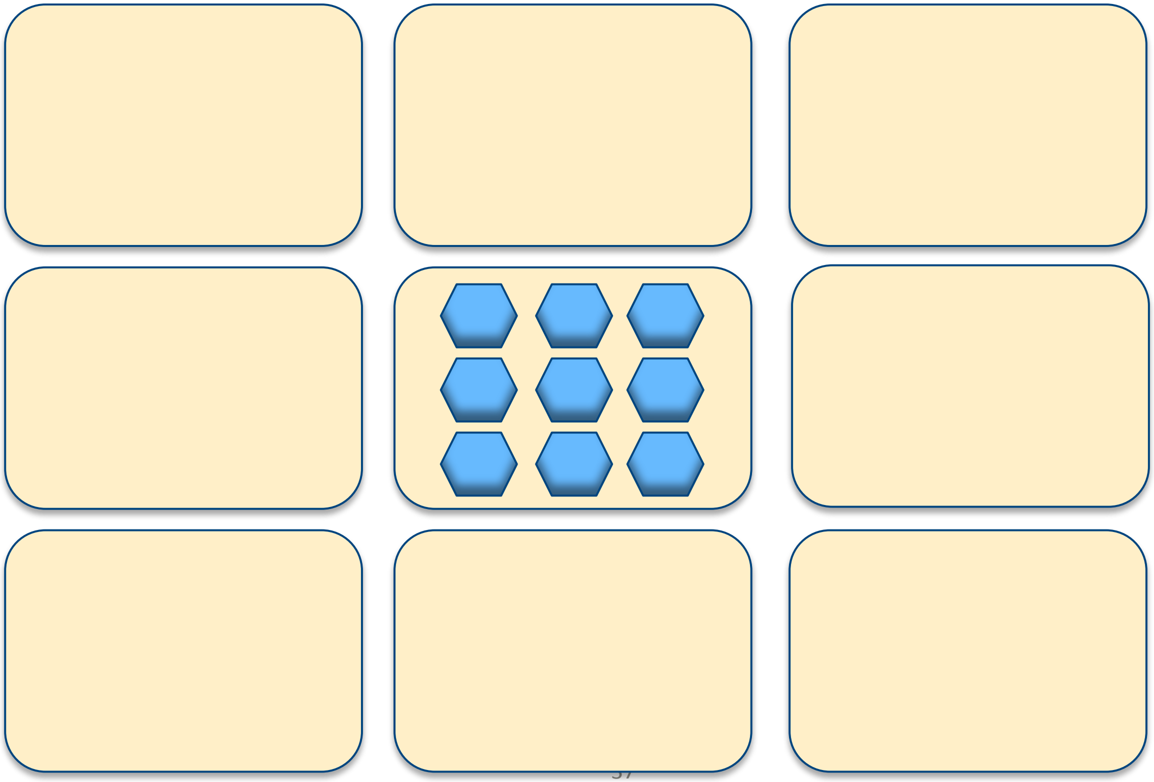

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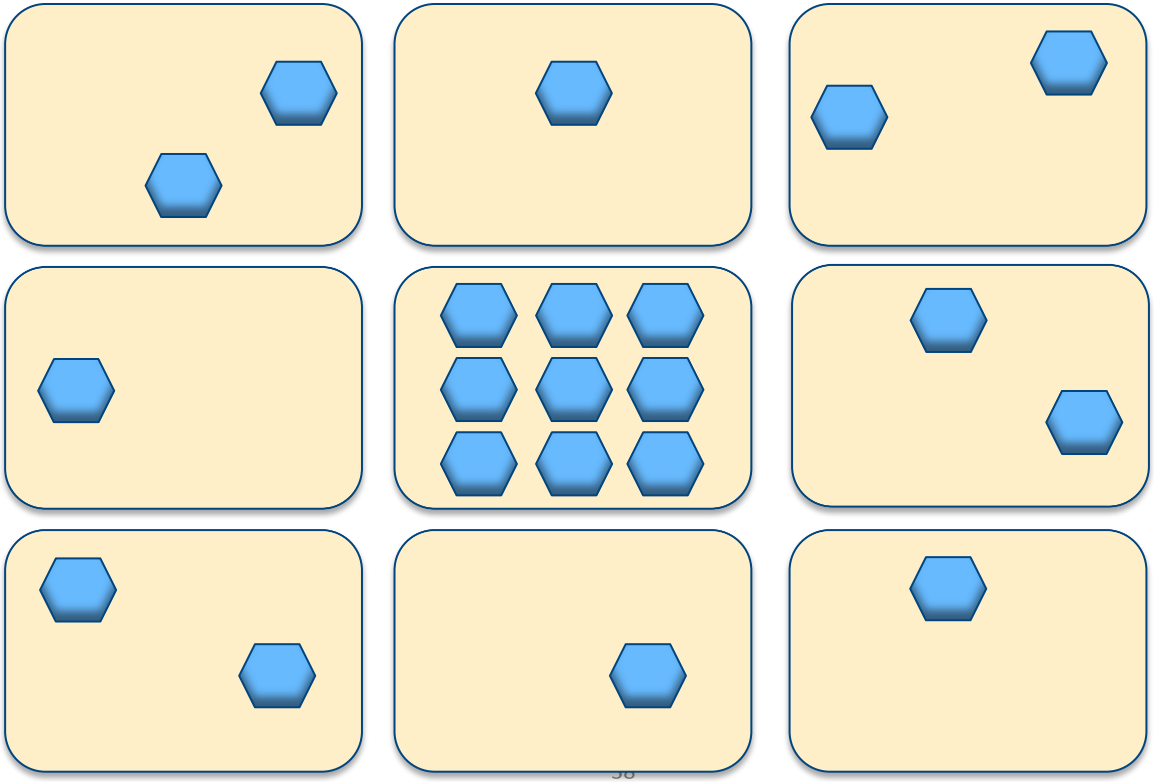
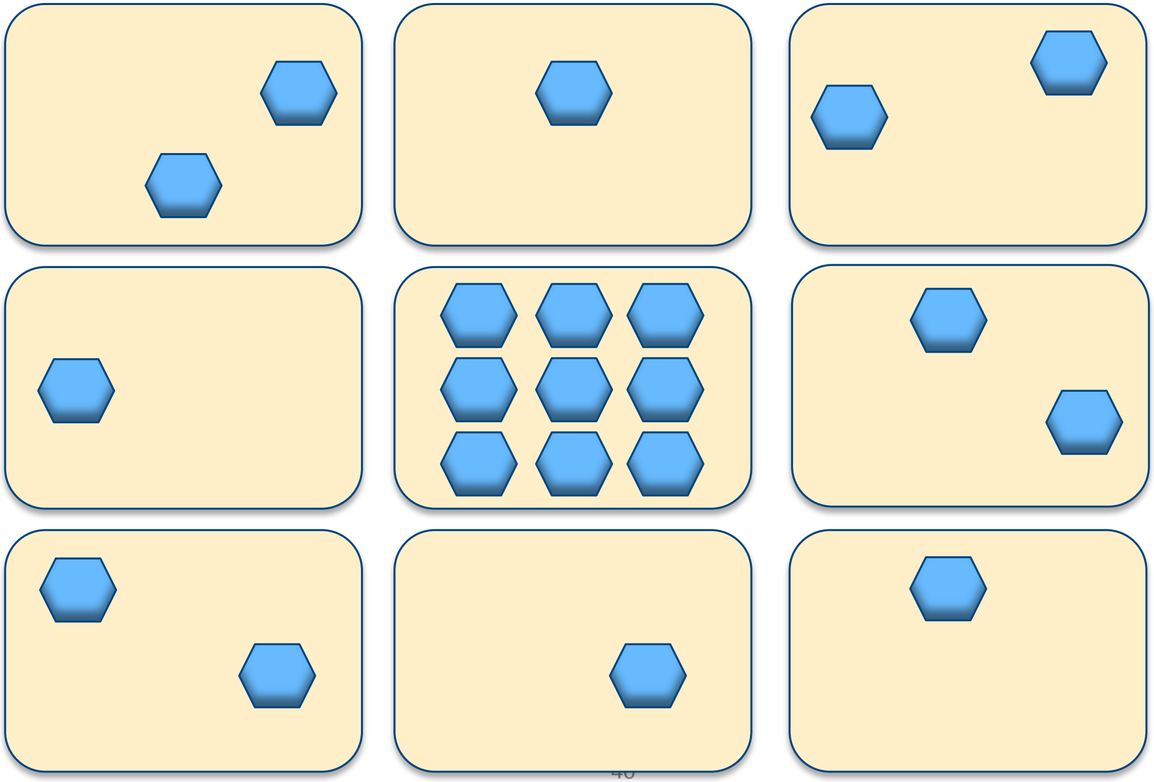


Why does it improve things?

MapR Replication Example

- 100-node cluster
- each node holds 1/100th of every node's data



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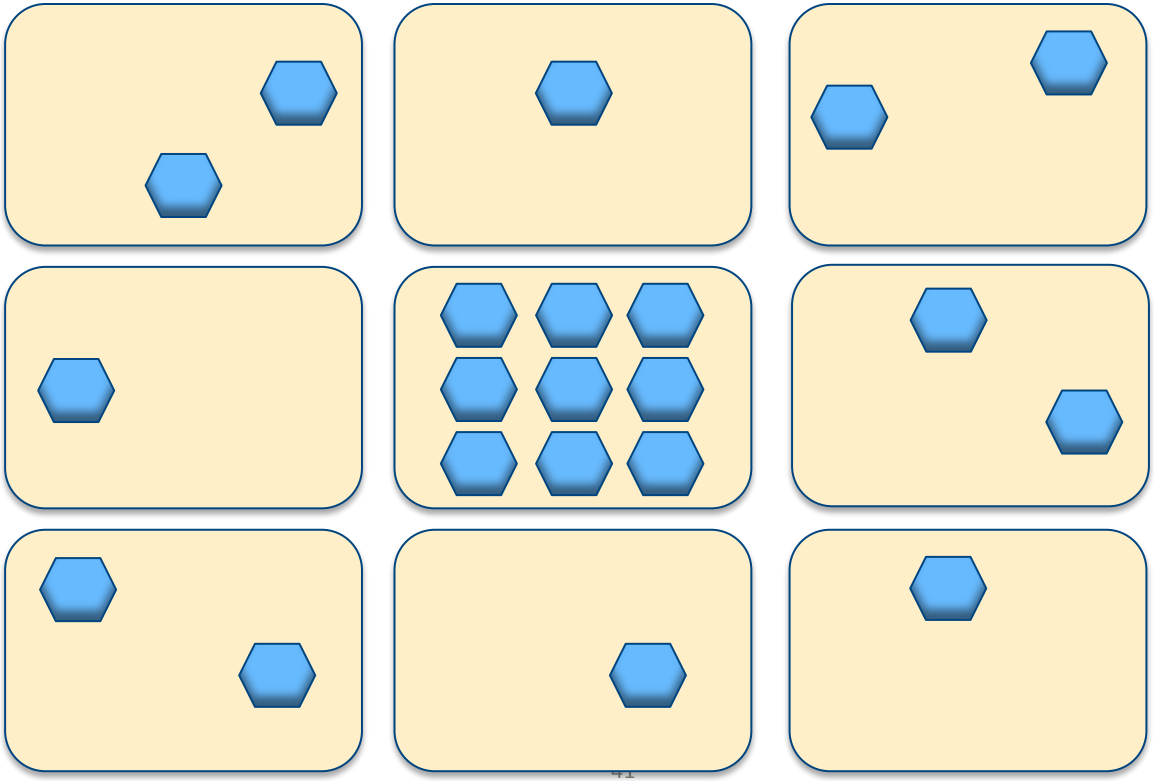

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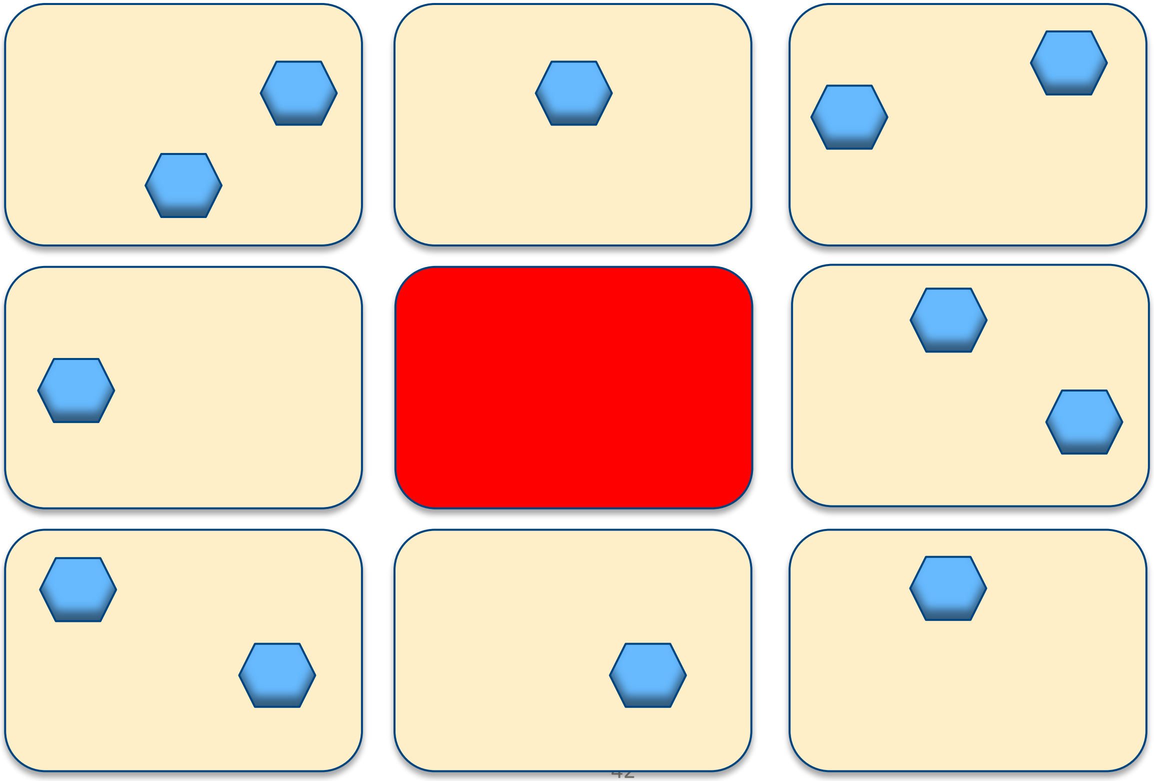

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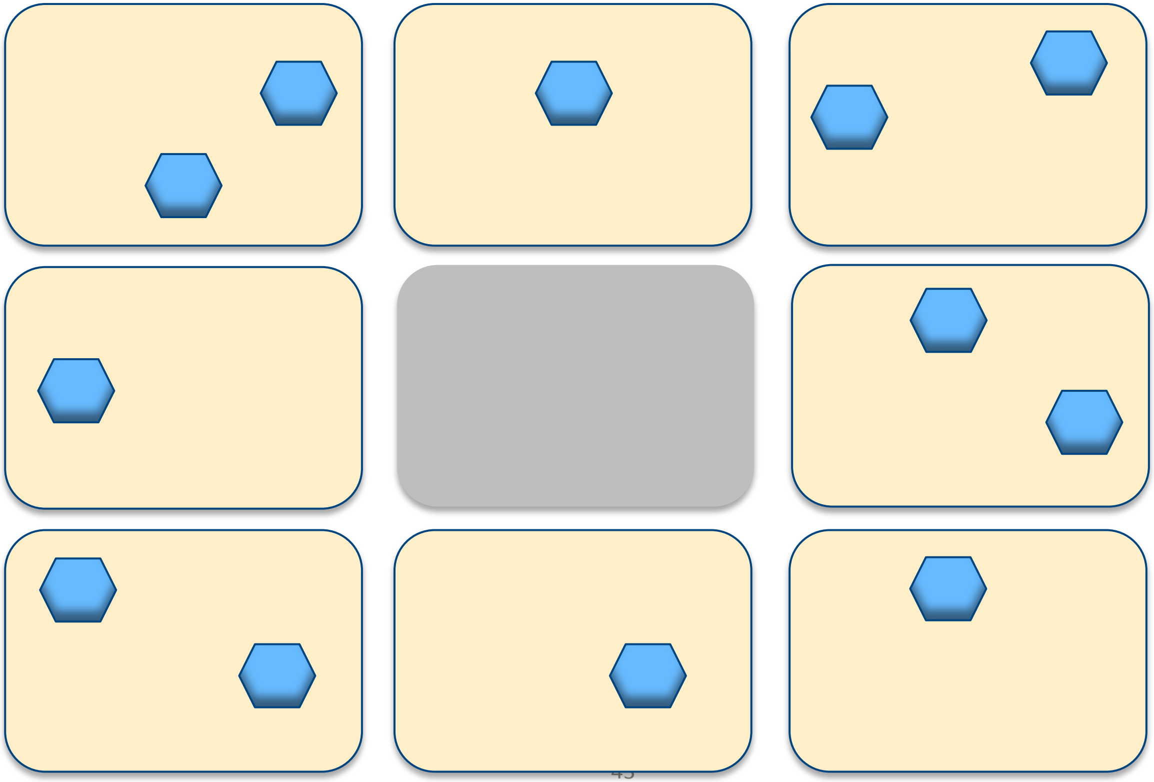

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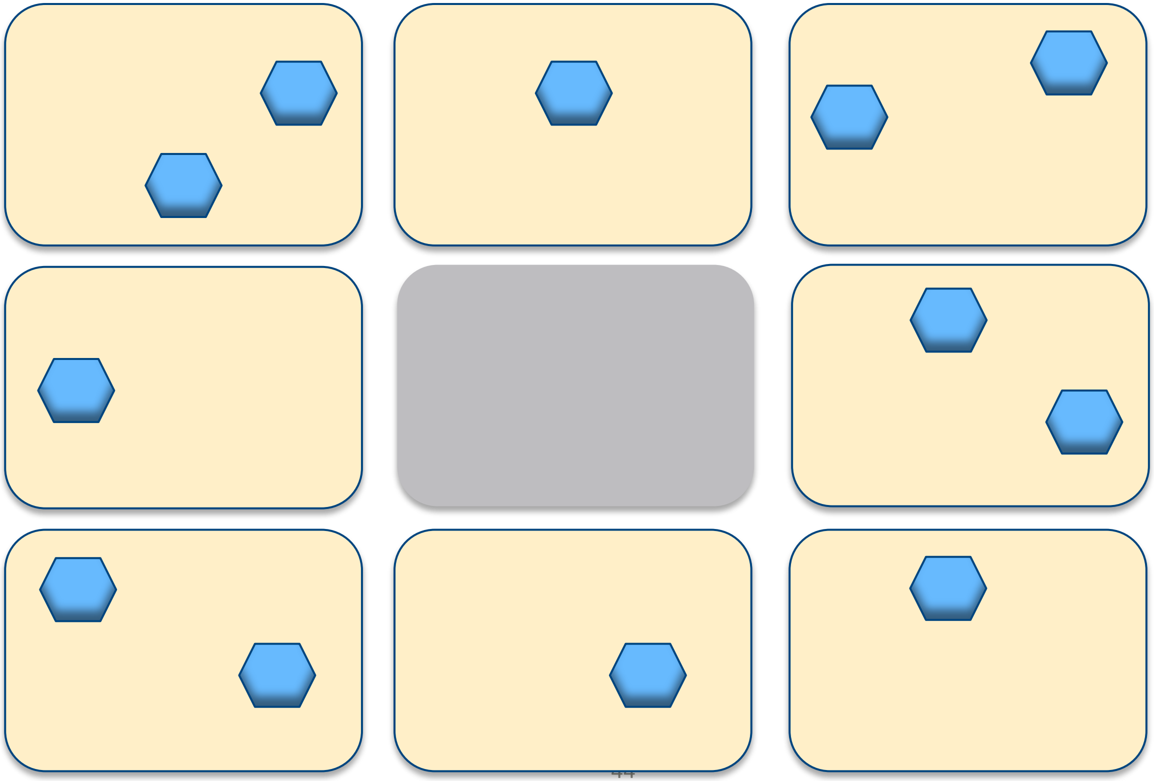

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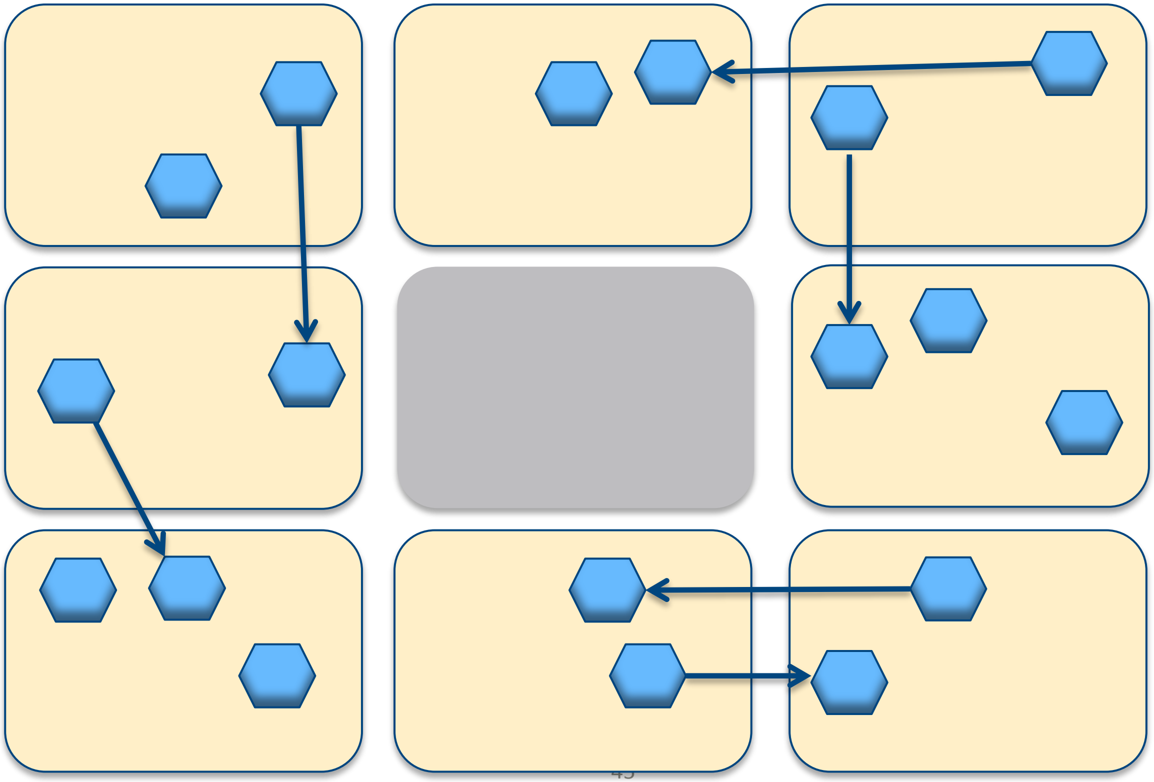

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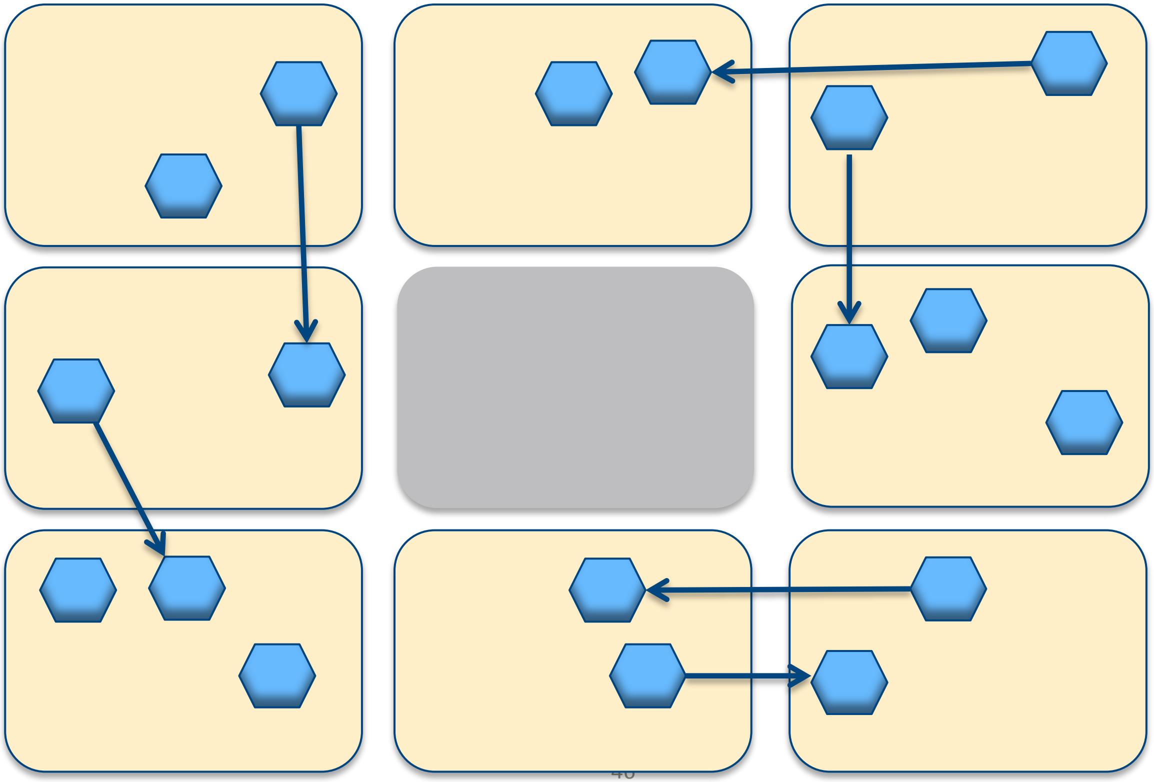

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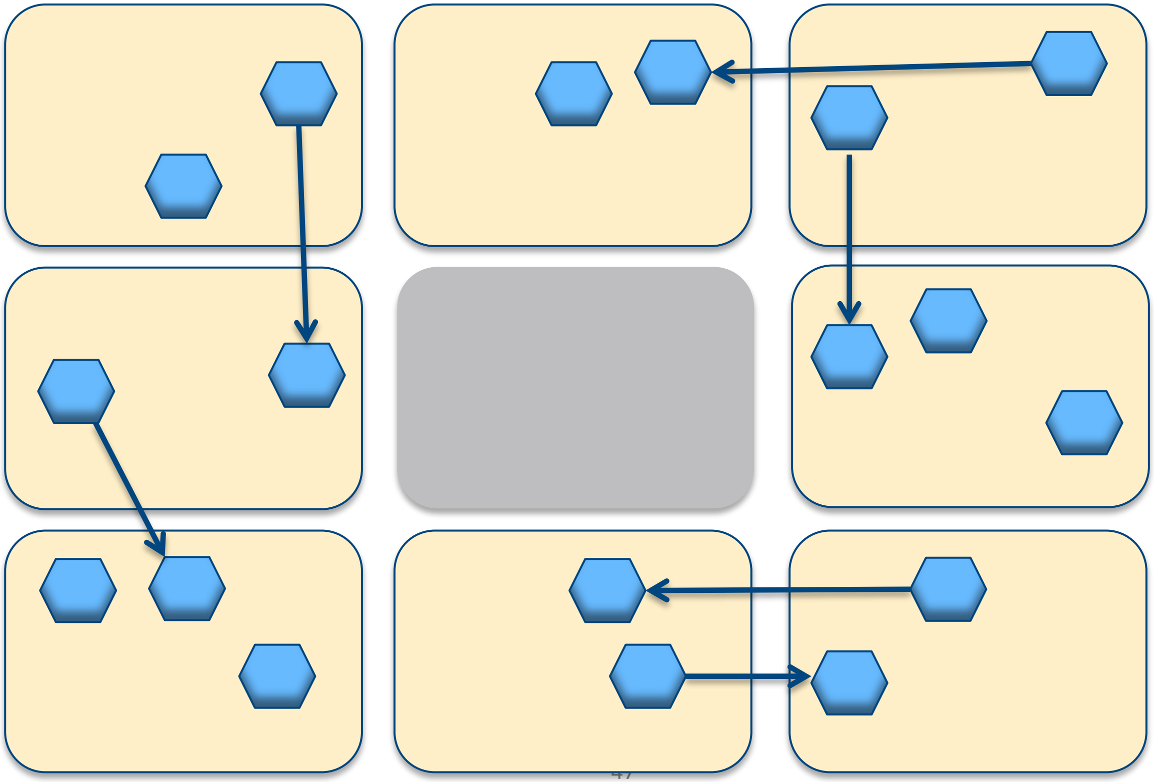

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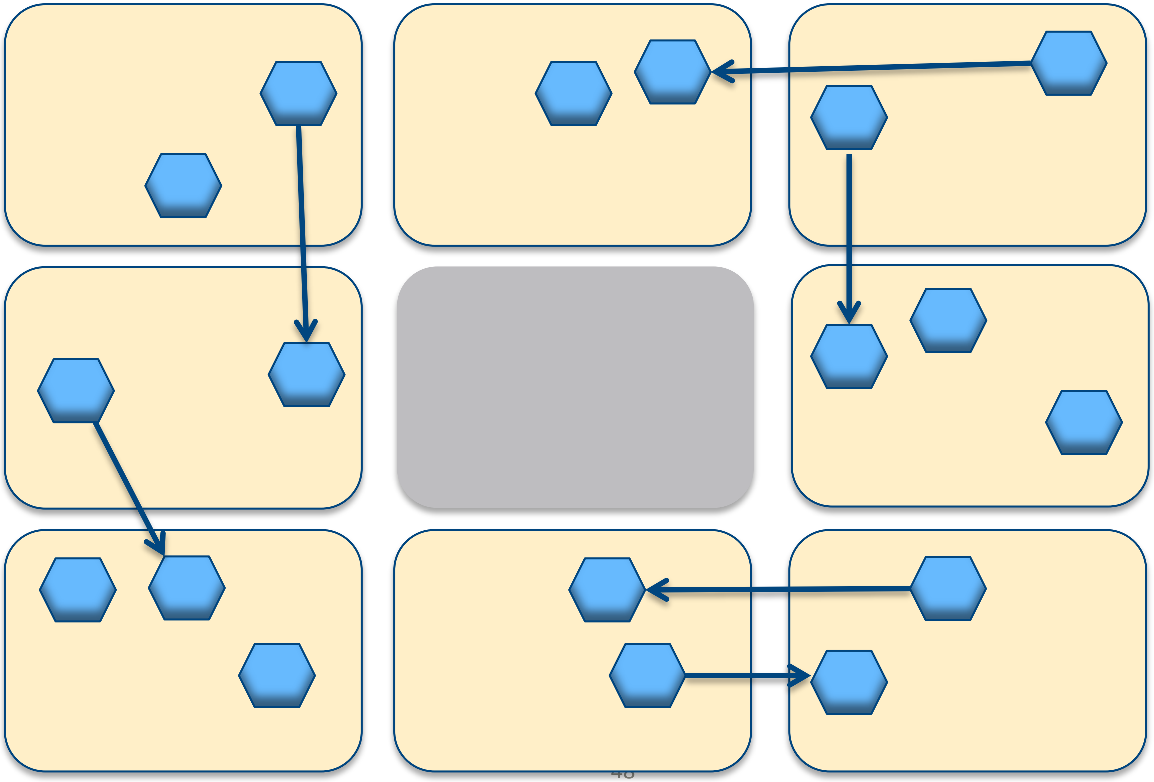

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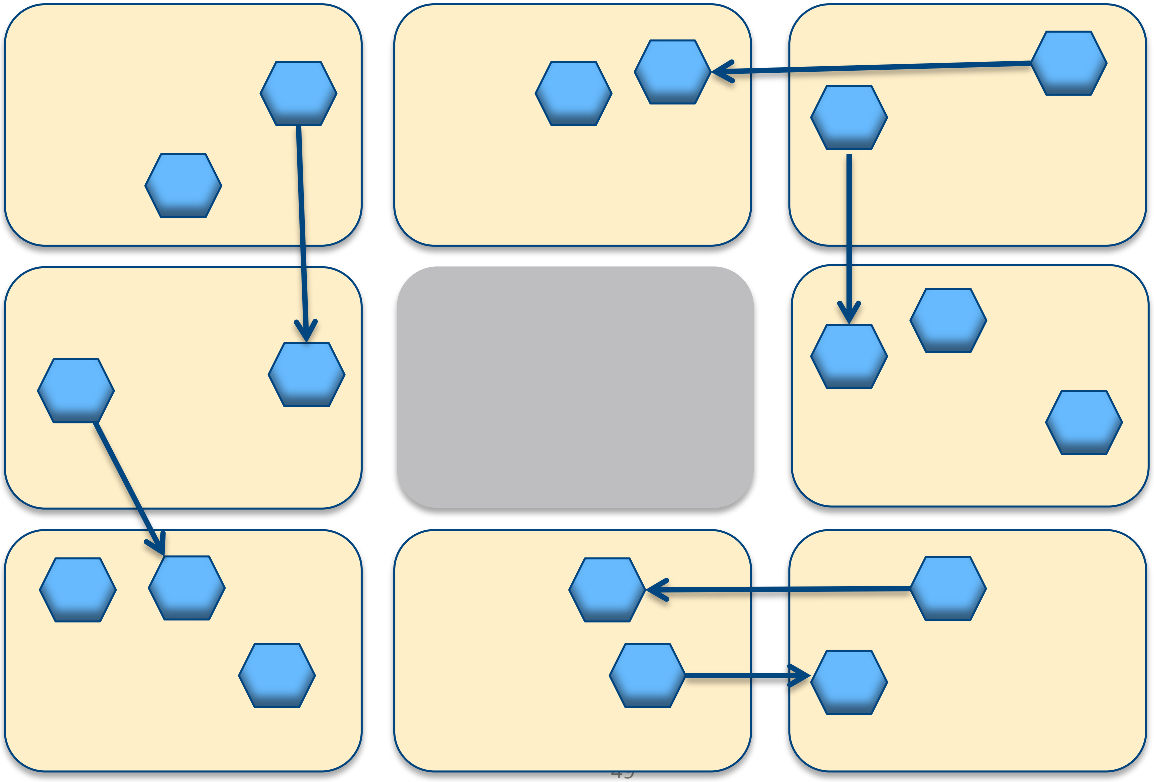

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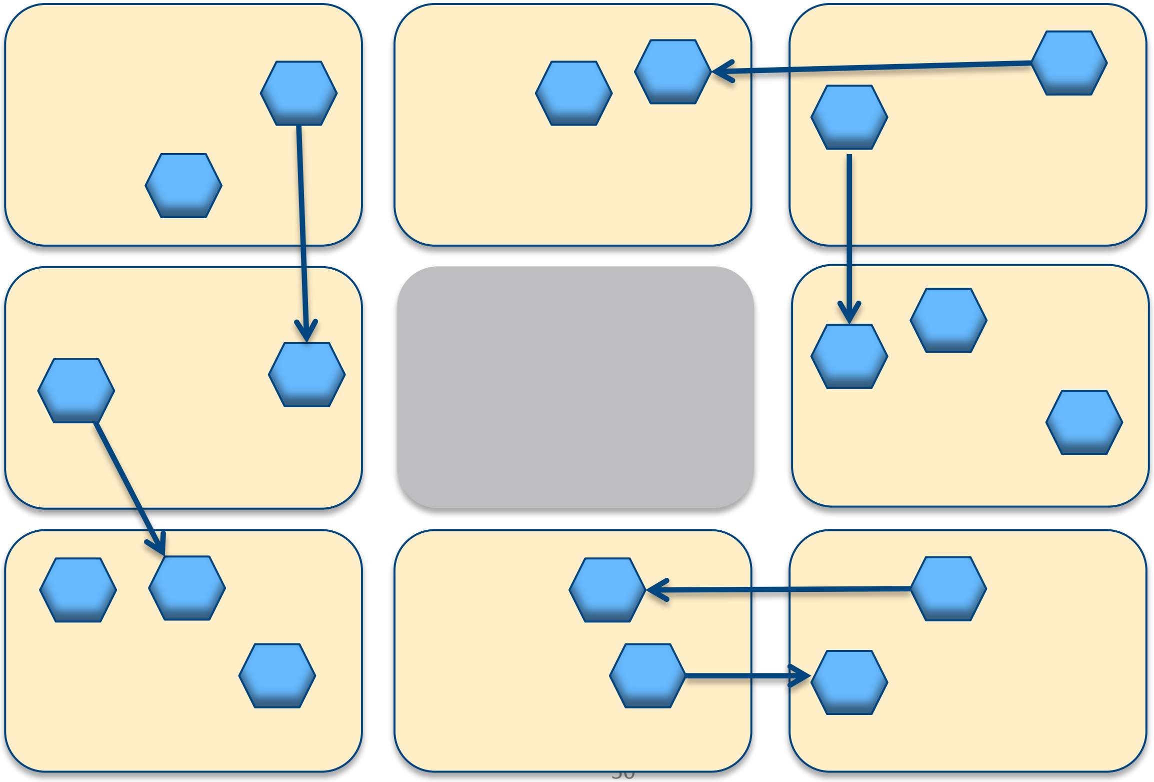
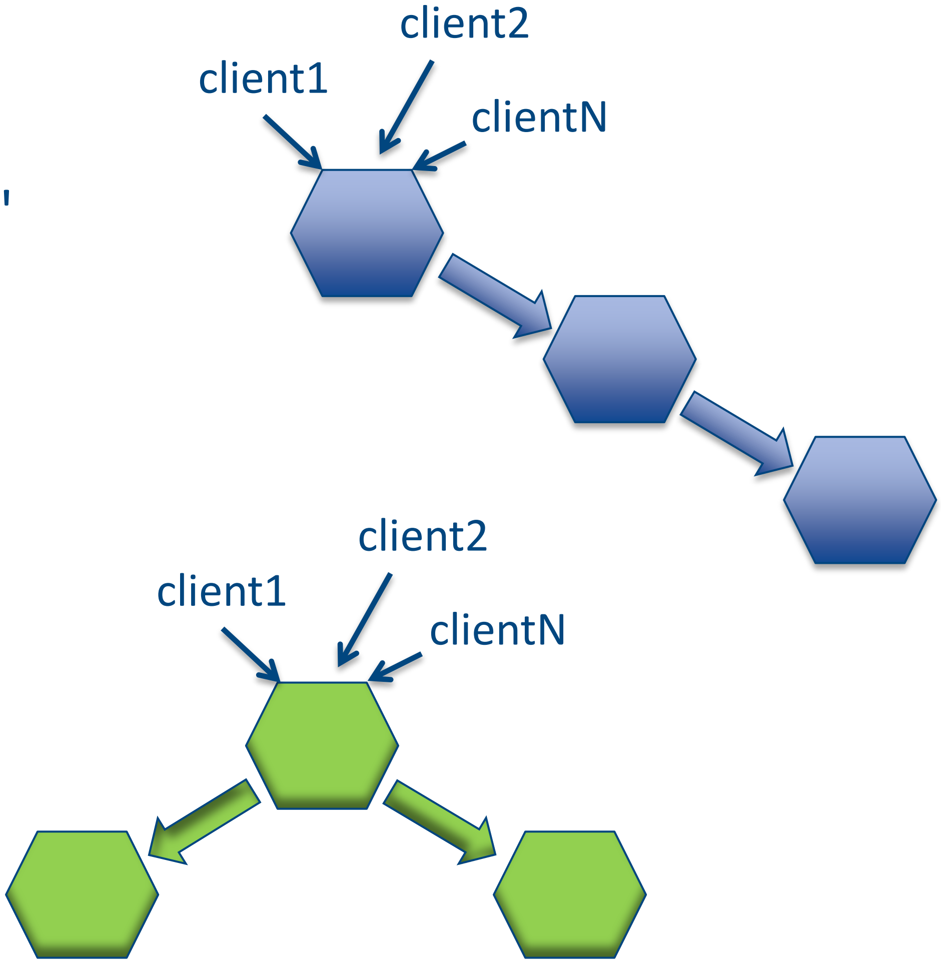
- **MTTDL is 100x better**



Why is this so difficult?

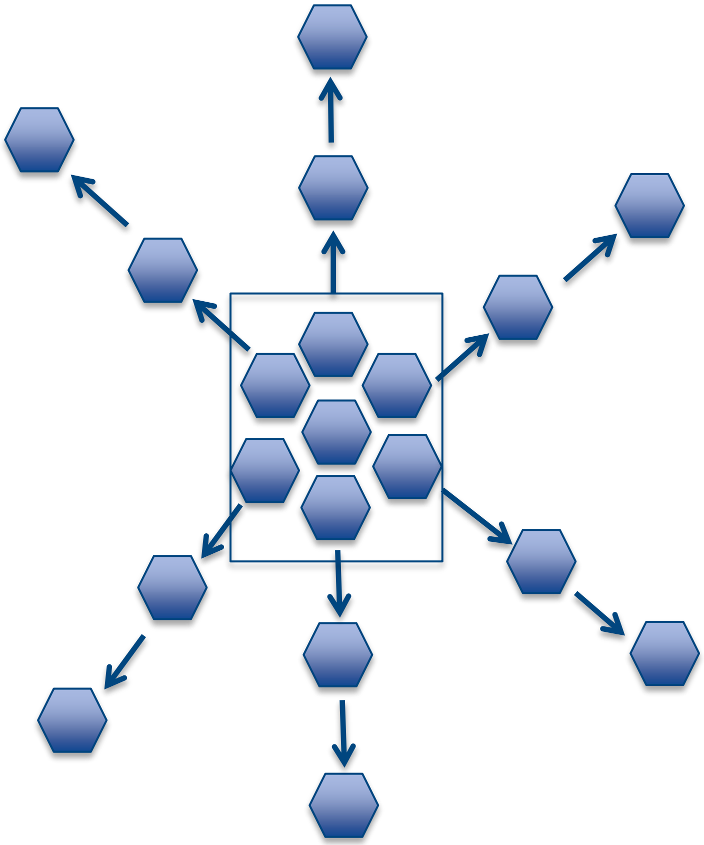
MapR's Read-write Replication

- Writes are synchronous
- Data is replicated in a "chain" fashion
  – utilizes full-duplex network
- Meta-data is replicated in a "star" manner
  – response time better



Container Balancing

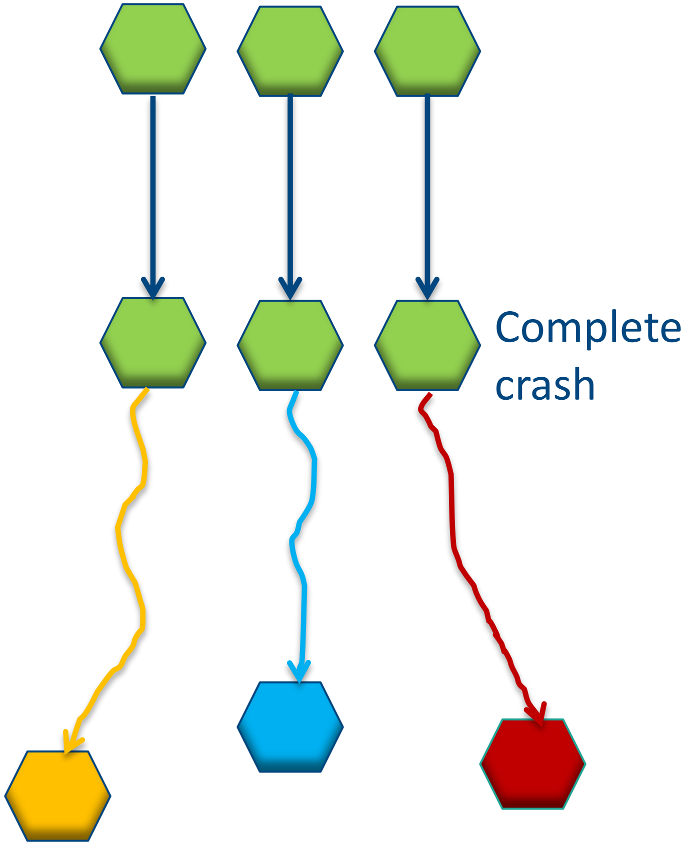
- Servers keep a bunch of containers "ready to go".
- Writes get distributed around the cluster.



- As data size increases, writes spread more, like dropping a pebble in a pond
- Larger pebbles spread the ripples farther
- Space balanced by moving idle containers

MapR Container Resync

- MapR is 100% random write
  - very tough problem
- On a complete crash, all replicas diverge from each other
- On recovery, which one should be master?

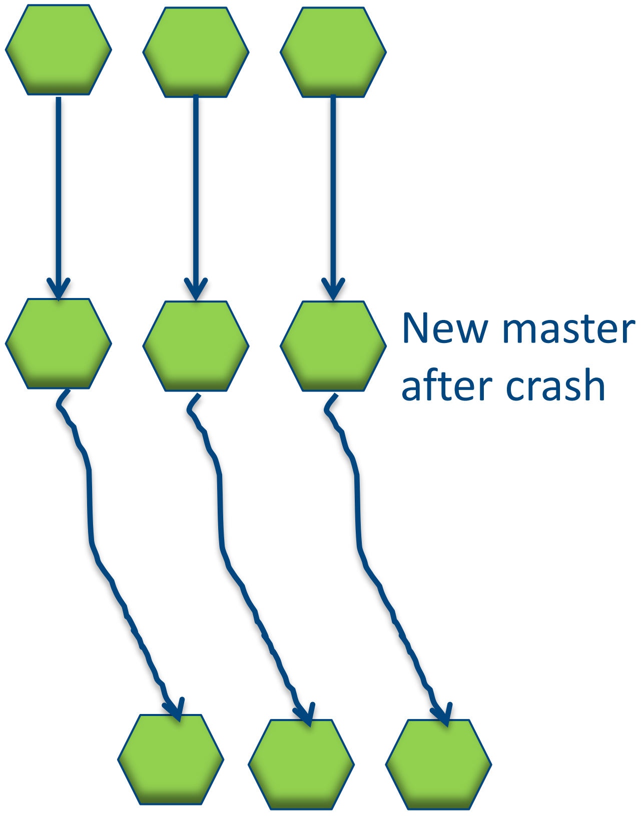


MapR Container Resync

- MapR can detect exactly where replicas diverged
  - even at 2000 MB/s update rate

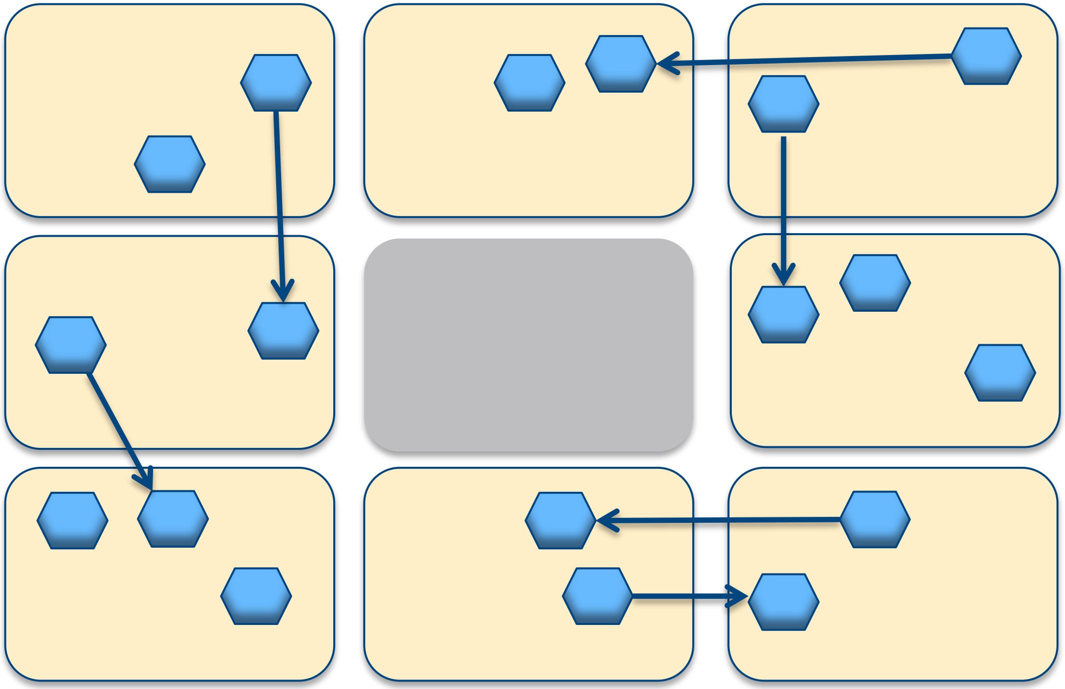
- Resync means
  - roll-back rest to divergence point
  - roll-forward to converge with chosen master

- Done while online
  - with very little impact on normal operations



MapR does Automatic Resync Throttling

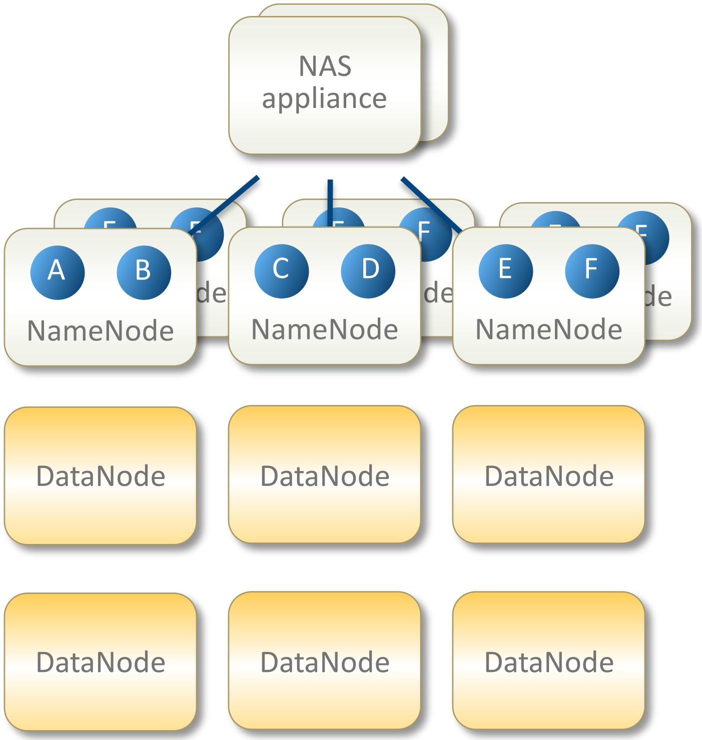
- Resync traffic is “secondary”
- Each node continuously measures RTT to all its peers
- More throttle to slower peers
  - Idle system runs at full speed
- All automatically



Where/how does MapR exploit this unique advantage?

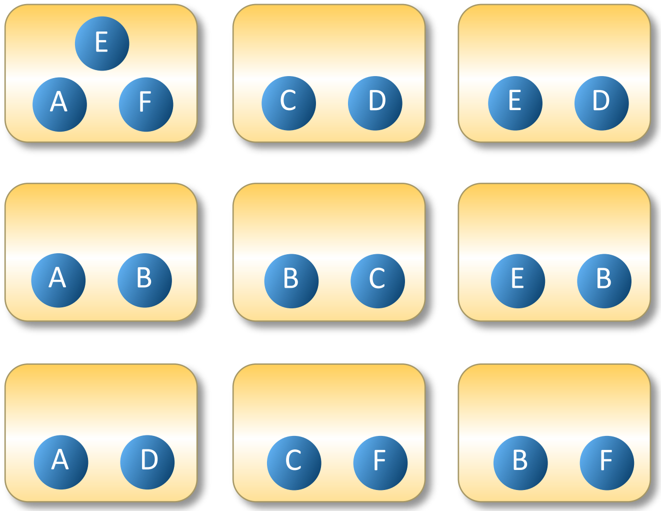
MapR's No-NameNode Architecture

HDFS Federation



- Multiple single points of failure
- Limited to 50-200 million files
- Performance bottleneck
- Commercial NAS required

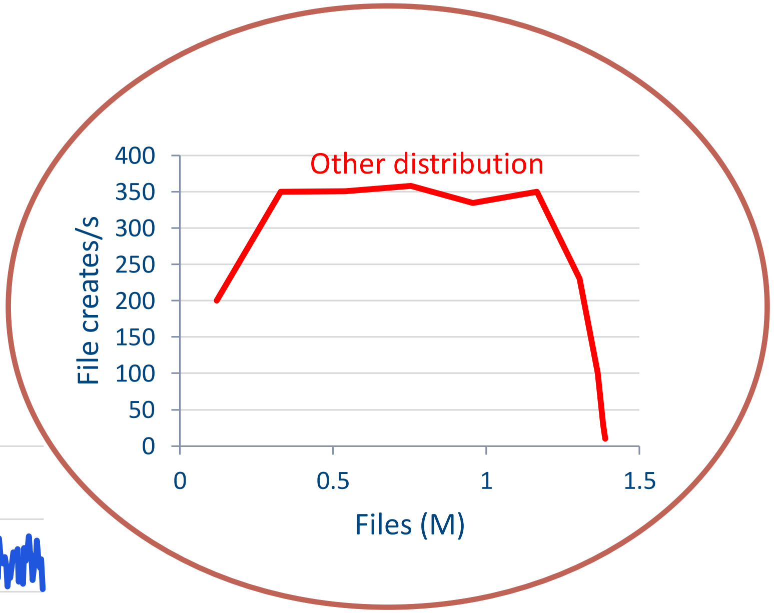
MapR (distributed metadata)

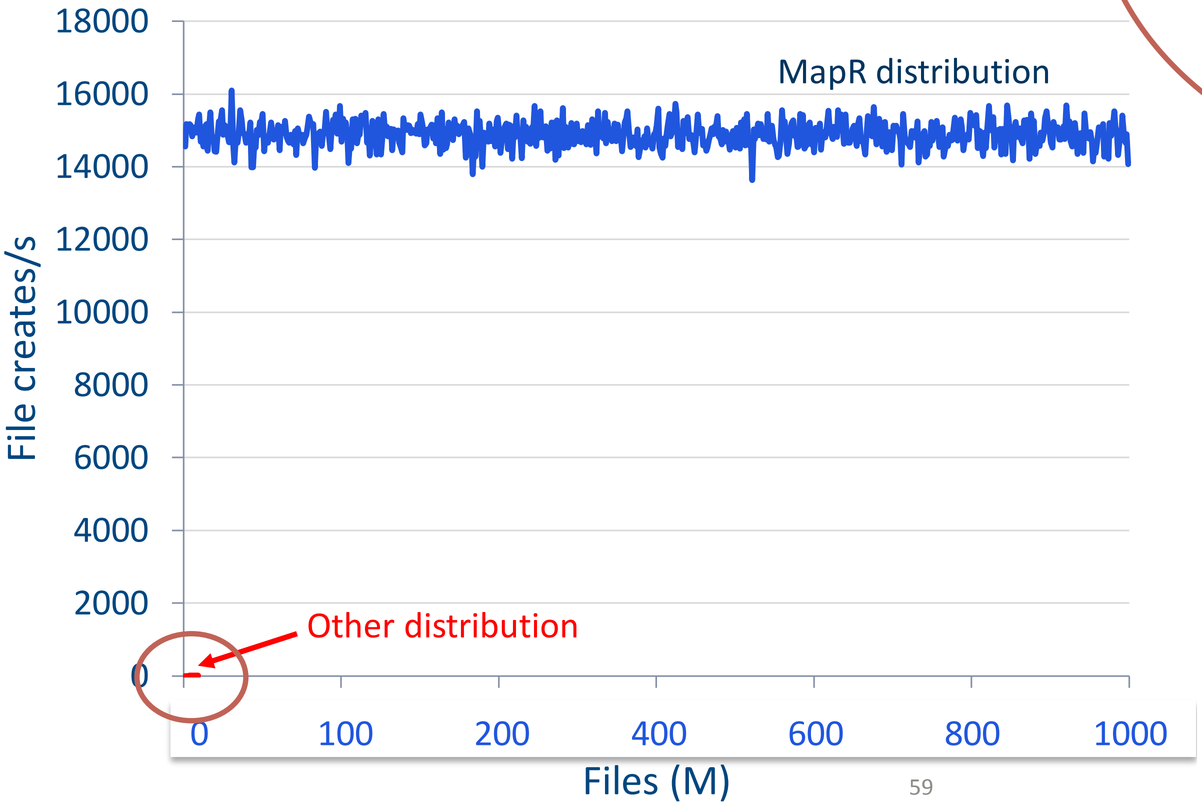


- HA w/ automatic failover
- Instant cluster restart
- Up to 1T files (> 5000x advantage)
- 10-20x higher performance
- 100% commodity hardware

Relative performance and scale

	MapR	Other	Advantage
Rate (creates/s)	14-16K	335-360	40x
Scale (files)	6B	1.3M	4615x



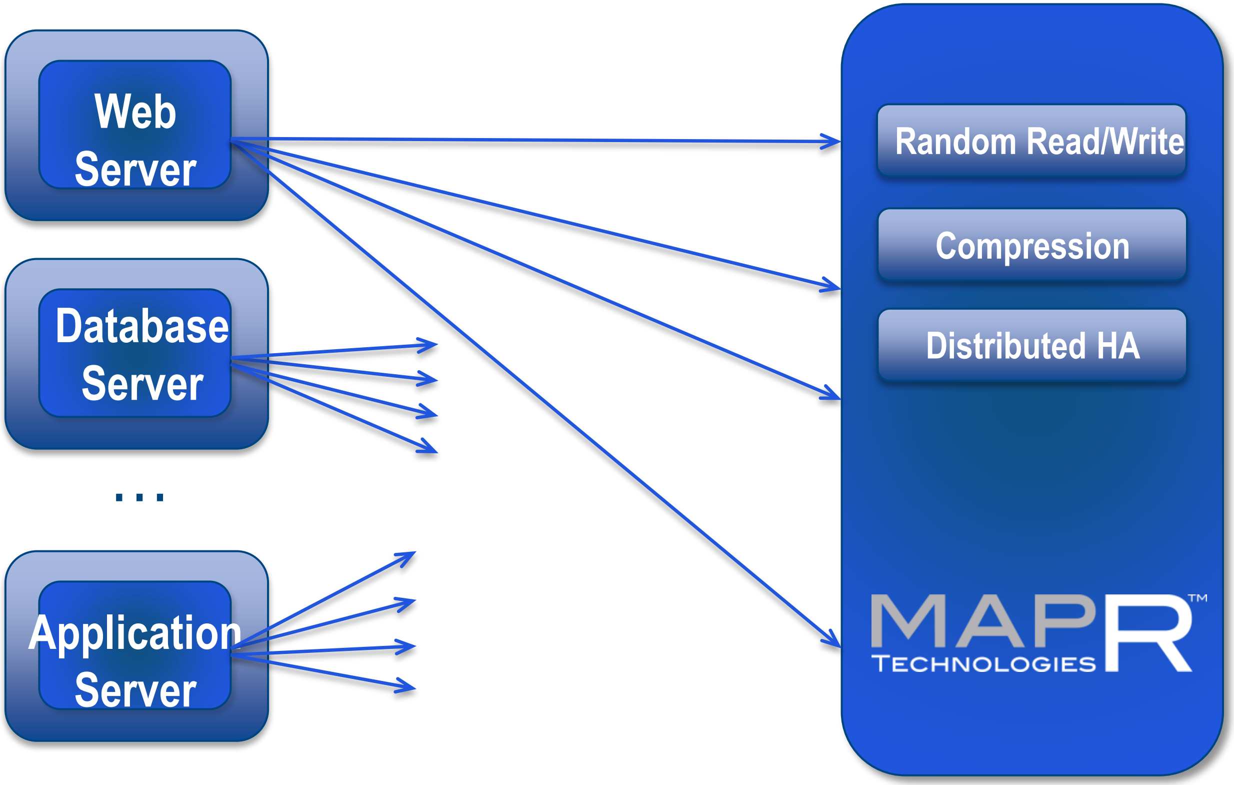


<u>Benchmark:</u> File creates (100B)

<u>Hardware</u>: 10 nodes, 2 x 4 cores, 24 GB RAM, 12 x 1 TB 7200 RPM

Where/how does MapR exploit this unique advantage?

MapR’s NFS allows Direct Deposit



Connectors not needed

No extra scripts or clusters to deploy and maintain

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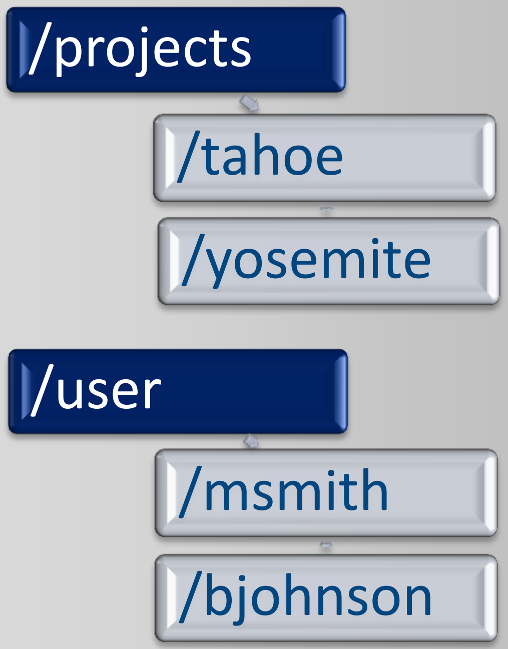
MapR Volumes



/projects

/tahoe

/yosemite

/user

/msmith

/bjohnson

100K volumes are OK, create as many as desired!

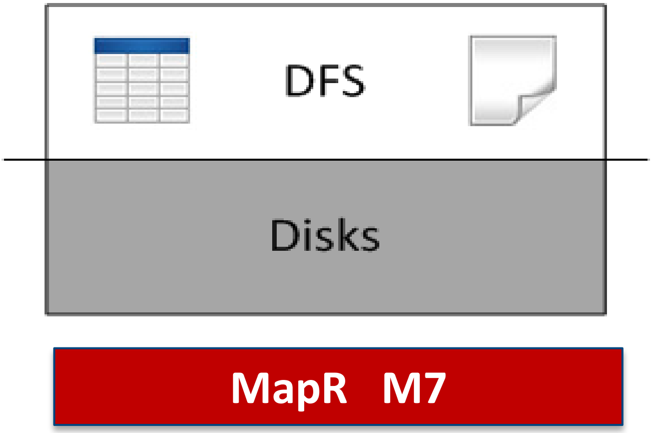
Volumes dramatically simplify the management of Big Data

- Replication factor
- Scheduled mirroring
- Scheduled snapshots
- Data placement control
- User access and tracking
- Administrative permissions

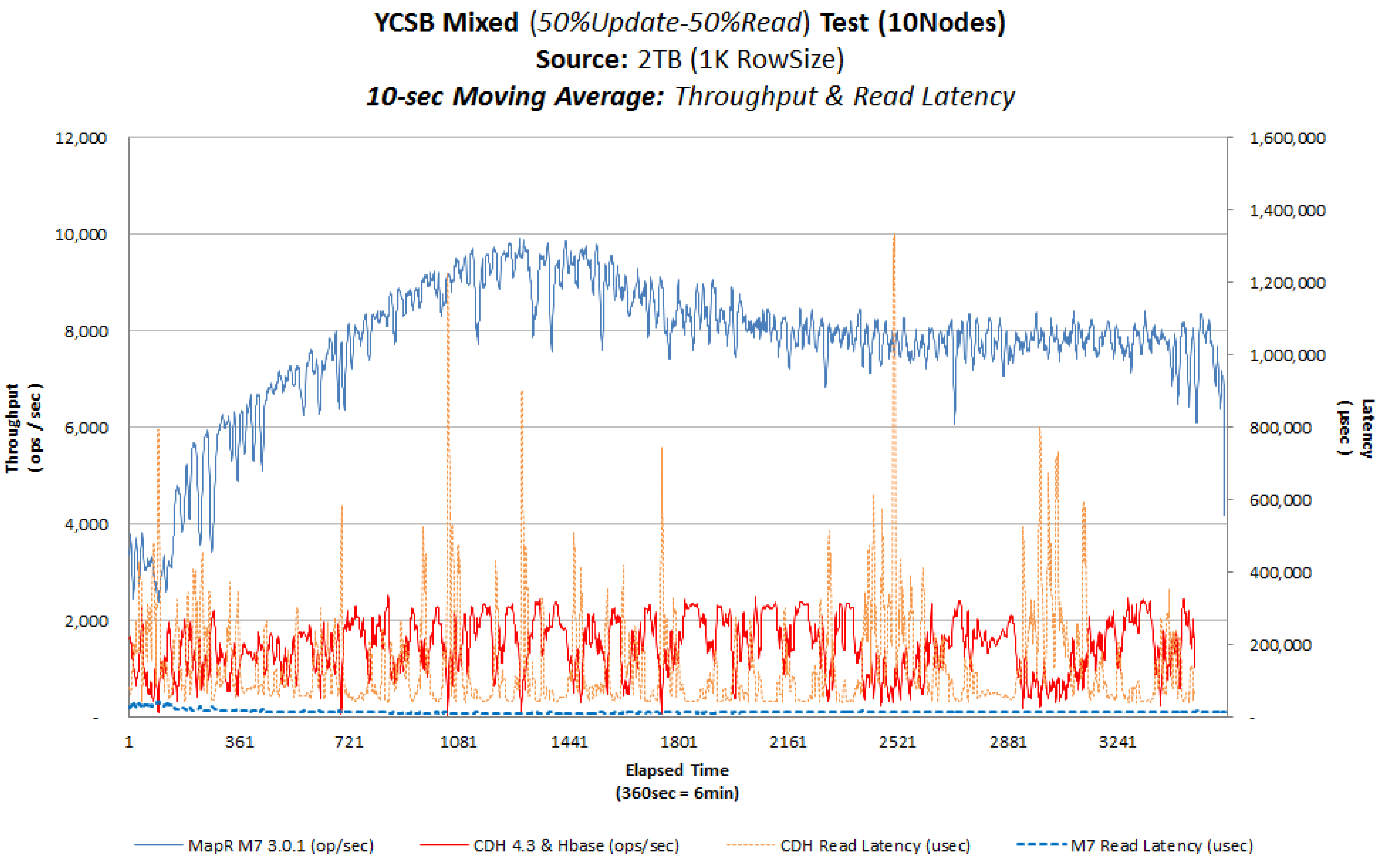
Where/how does MapR exploit this unique advantage?

M7 Tables

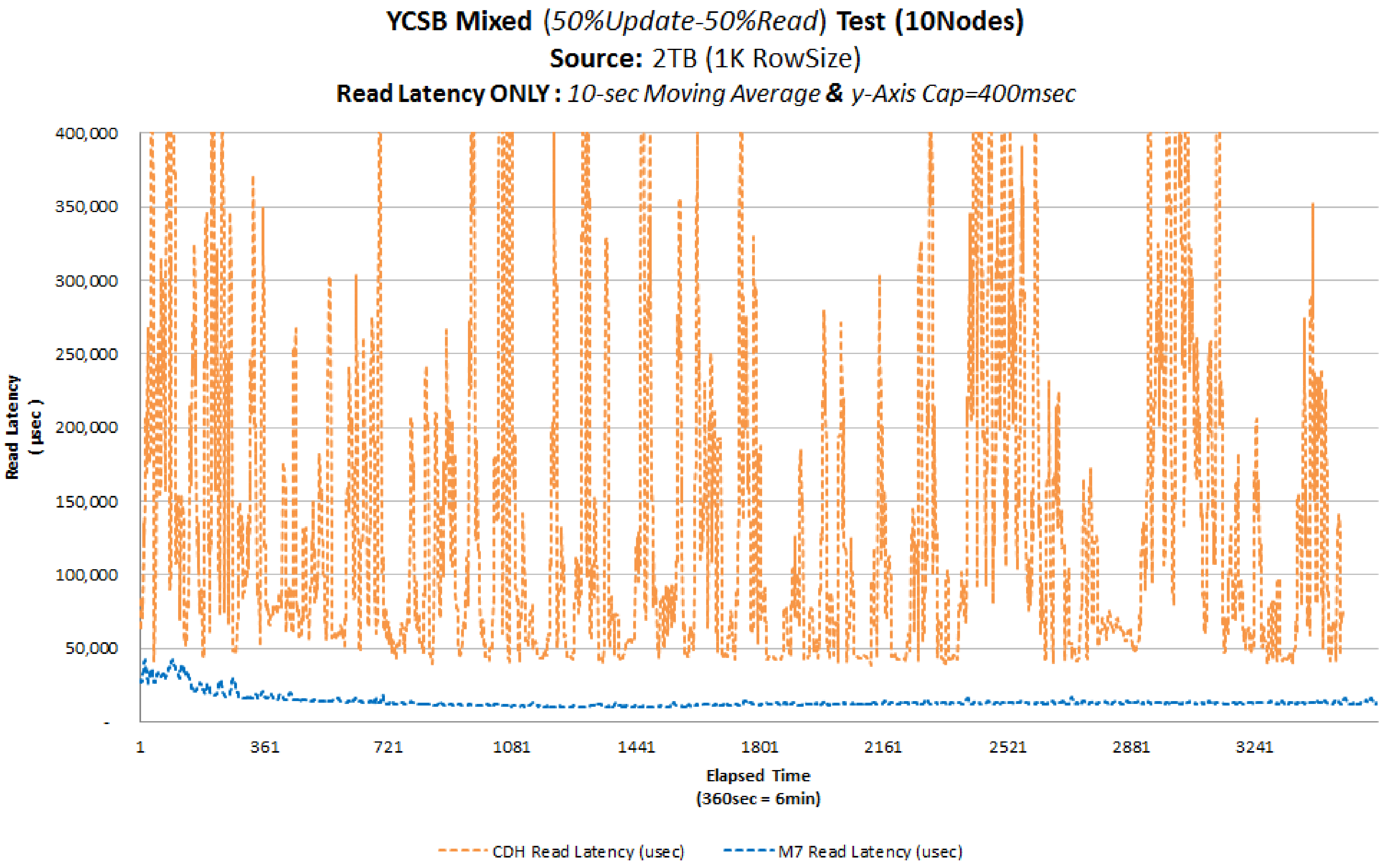
- M7 tables integrated into storage
  - always available on every node, zero admin
- Unlimited number of tables
  - Apache HBase is typically 10-20 tables (max 100)
- **No compactions**
- **Instant-On**
  - zero recovery time
- 5-10x better perf
- Consistent low latency
  - At 95%-ile and 99%-ile



M7 vs. CDH: 50-50 Mix (Reads)



M7 vs. CDH: 50-50 load (read latency)



Where/how does MapR exploit this unique advantage?

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- Allows pre-emption
  - MapR can pre-empt any job, without losing its progress
  - ExpressLane™ feature in MapR exploits it

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- That’s what we did!
- Only from MapR: HA for Impala, Hive, Oozie, Storm, MySQL, SOLR/Lucene, Kafka, …

MapR: Unlimited Scale

# files, # tables	trillions
# rows per table	trillions
# data	1-10 Exabytes
# nodes	10,000+

Build cluster brick by brick, one node at a time

- Use commodity hardware at rock-bottom prices
- Get enterprise-class reliability: instant-restart, snapshots, mirrors, no-single-point-of-failure, …
- Export via NFS, ODBC, Hadoop and other std protocols