facebook

Facebook Messages & HBase

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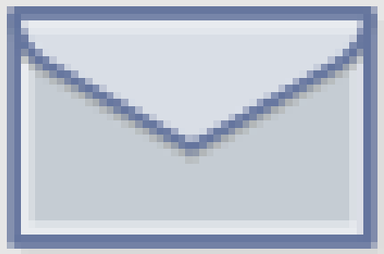
Talk Outline

- About Facebook Messages
- Intro to HBase
- Why HBase
- HBase Contributions
- MySQL -> HBase Migration
- Future Plans
- Q&A

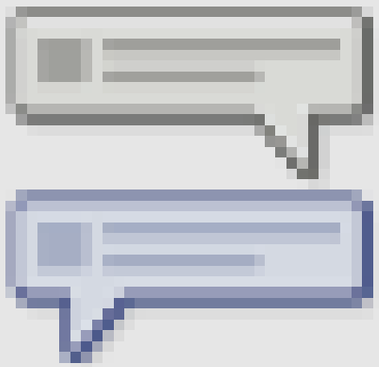
Facebook Messages

The New Facebook Messages

Messages

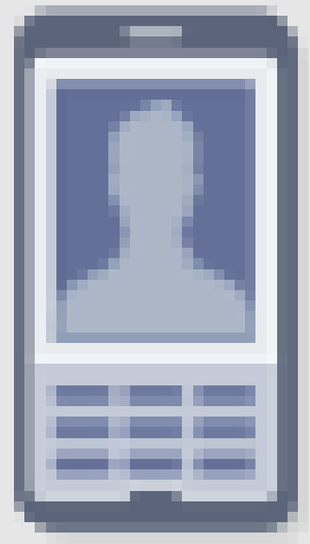


Chats



Emails

SMS

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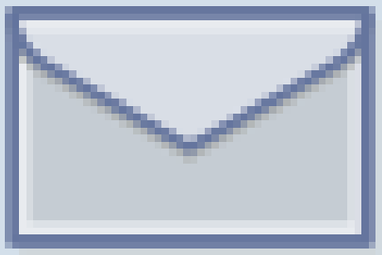
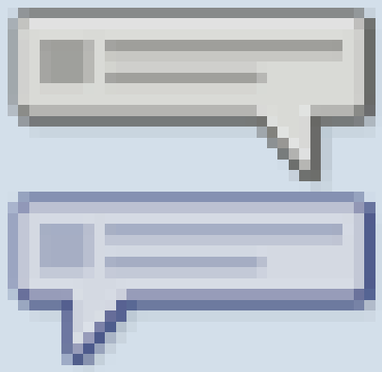
Search
Home
Profile
Account
Andrew Bosworth
Edit My Profile
News Feed
Messages 1
Other
Events
Friends
Groups Team
Groups Engineering 1
Engineering Spea...
More
Photos
Quikvote
More
Friends on Chat
Messages
+ New Message
Search Messages
James Wang, Dave Troiano
remember that time i made prime rib roast?
33 minutes ago
Will Bailey
k I'll follow up with him
2 hours ago
Ben Chiaramonte
like the song
2 hours ago
Kenny Lau
anything should push you
2 hours ago
Ross Bayer
whatsup?
3 hours ago
Mark Zuckerberg
> and I'll dig into the engineering side more
6 hours ago
Eric Antonow
pretty bad - you win this round
17 hours ago
Pat Kinsel
... and i thought you called yourself a Visio fan for life.
22 hours ago
Katie Zacarian
"people respect him"
Yesterday

Monthly data volume prior to launch



15B x 1,024 bytes = 14TB



120B x 100 bytes = 11TB

Messaging Data

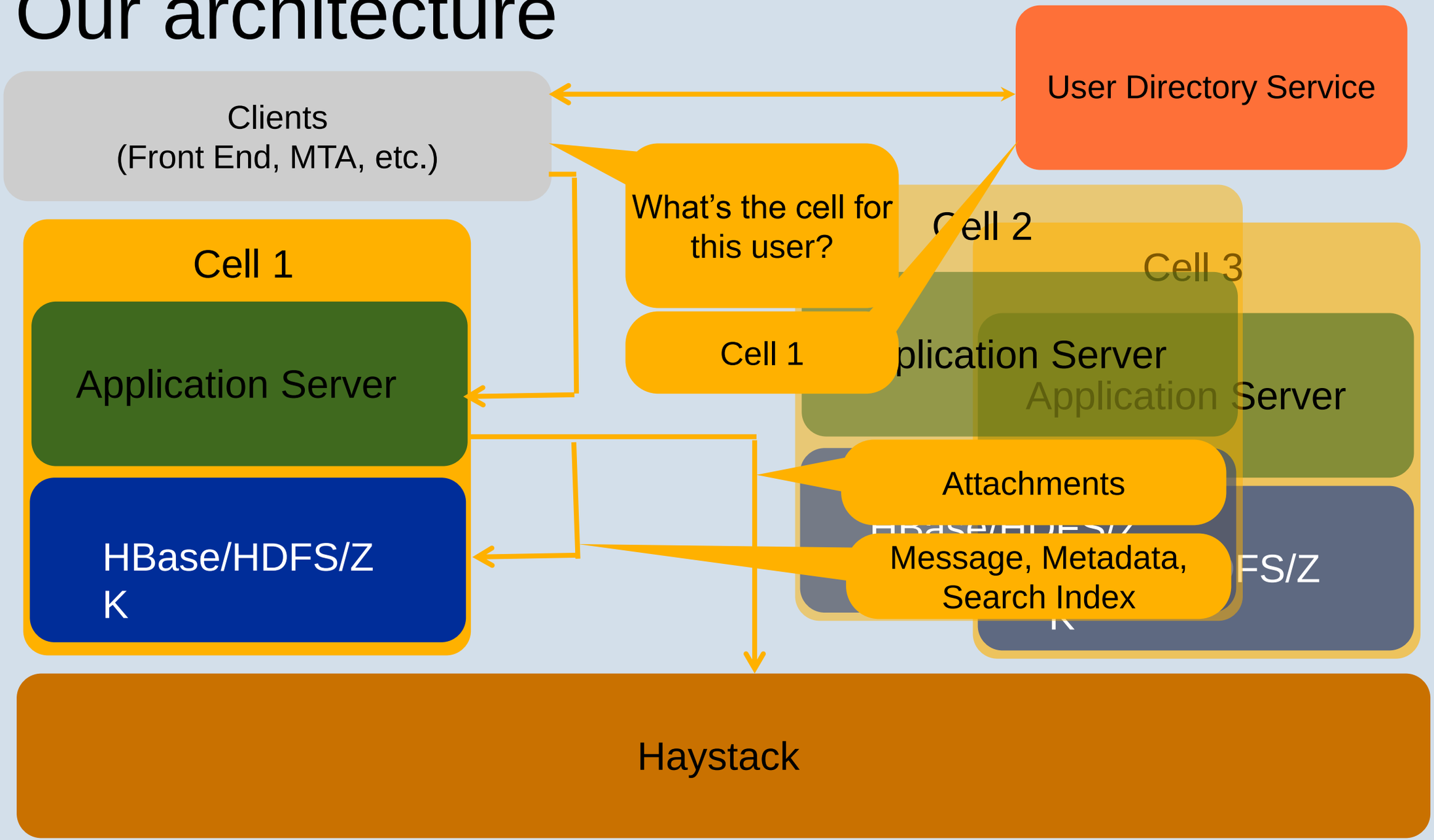
- Small/medium sized data  HBase
  - Message metadata & indices
  - Search index
  - Small message bodies

- Attachments and large messages  Haystack
  - Used for our existing photo/video store

Open Source Stack

- Memcached --> App Server Cache
- ZooKeeper --> Small Data Coordination Service
- HBase --> Database Storage Engine
- HDFS --> Distributed FileSystem
- Hadoop --> Asynchronous Map-Reduce Jobs

Our architecture



About HBase

HBase in a nutshell

- distributed, large-scale data store
- efficient at random reads/writes
- initially modeled after Google’s BigTable
- open source project (Apache)

When to use HBase?

- storing large amounts of data
- need high write throughput
- need efficient random access within large data sets
- need to scale gracefully with data
- for structured and semi-structured data
- don’t need full RDMS capabilities (cross table transactions, joins, etc.)

HBase Data Model

- An HBase table is:
  - a sparse , three-dimensional array of cells, indexed by:

    RowKey, ColumnKey, Timestamp/Version
  - sharded into *regions* along an ordered RowKey space
- Within each region:
  - Data is grouped into column families
  - Sort order within each column family:

    Row Key (asc), Column Key (asc), Timestamp (desc)

Example: Inbox Search

- Schema
  - Key: RowKey: userid, Column: word, Version: MessageID
  - Value: Auxillary info (like offset of word in message)

- Data is stored sorted by <userid, word, messageID>:

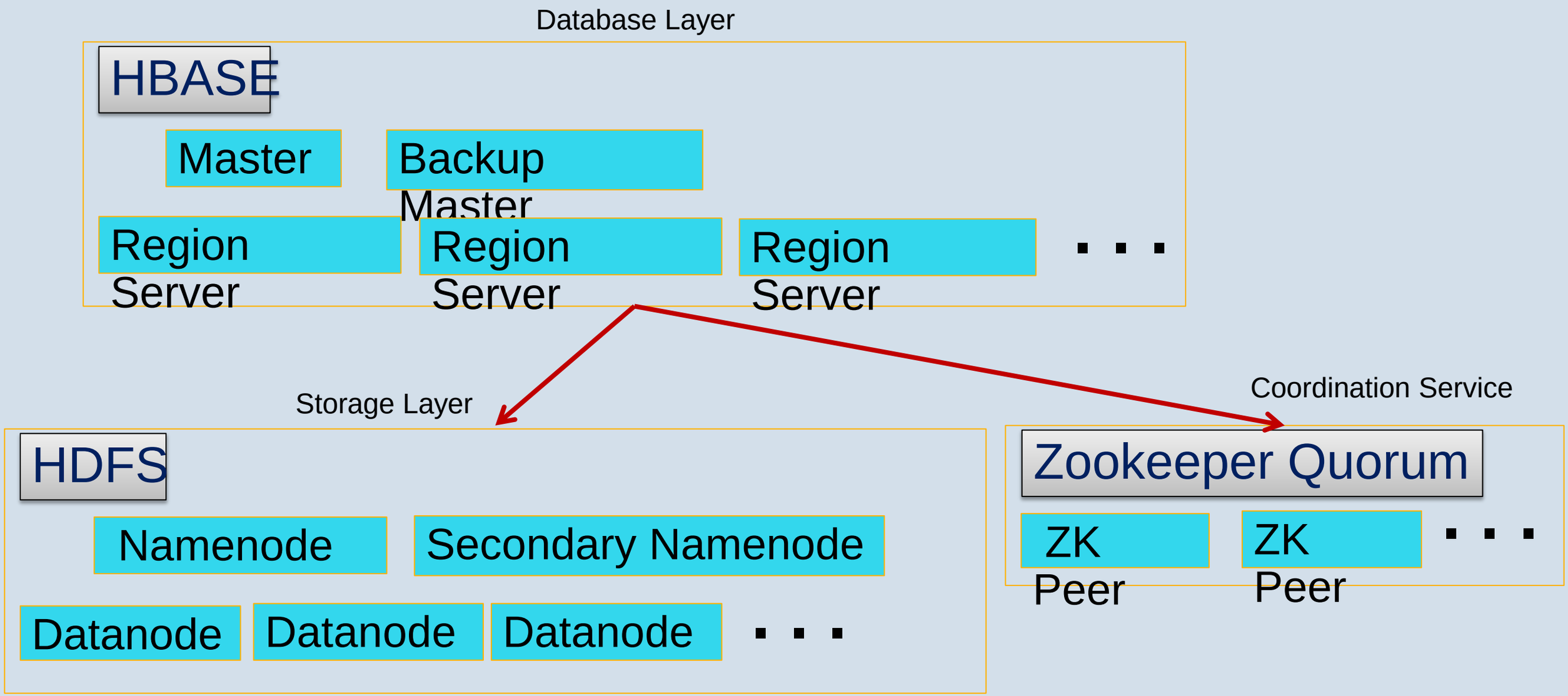
User1:hi:17->offset1
User1:hi:16->offset2
User1:hello:16->offset3
User1:hello:2->offset4
...
User2:....
User2:...
...

Can efficiently handle queries like:

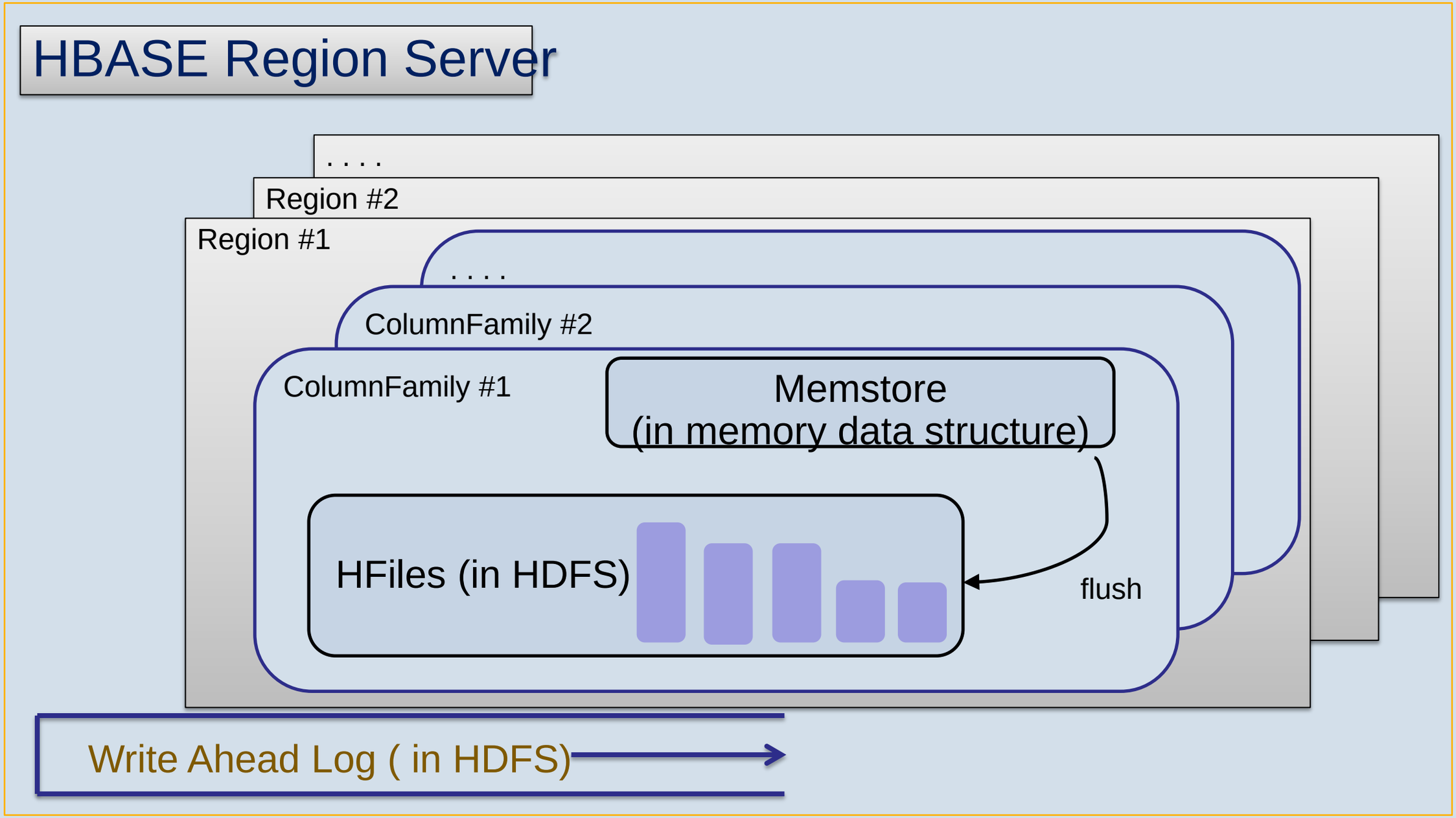
- Get top N messageIDs for a specific user & word

- Typeahead query: for a given user, get words that match a prefix

HBase System Overview



HBase Overview



HBase Overview

- Very good at random reads/writes
- Write path
  - Sequential write/sync to commit log
  - update memstore
- Read path
  - Lookup memstore & persistent HFiles
  - HFile data is sorted and has a block index for efficient retrieval
- Background chores
  - Flushes (memstore -> HFile)
  - Compactions (group of HFiles merged into one)

Why HBase?

Performance is great, but what else…

Horizontal scalability

- HBase & HDFS are elastic by design
- Multiple table shards (regions) per physical server
- On node additions
  - Load balancer automatically reassigns shards from overloaded nodes to new nodes
  - Because filesystem underneath is itself distributed, data for reassigned regions is instantly servable from the new nodes.
- Regions can be *dynamically* split into smaller regions.
  - Pre-sharding is not necessary
  - Splits are near instantaneous!

Automatic Failover

- Node failures automatically detected by HBase Master
- Regions on failed node are distributed evenly among surviving nodes.
  - Multiple regions/server model avoids need for *substantial* overprovisioning
- HBase Master failover
  - 1 active, rest standby
  - When active master fails, a standby automatically takes over

HBase uses HDFS

We get the benefits of HDFS as a storage system for free

- Fault tolerance (block level replication for redundancy)
- Scalability
- End-to-end checksums to detect and recover from corruptions
- Map Reduce for large scale data processing
- HDFS already battle tested inside Facebook
  - running petabyte scale clusters
  - lot of in-house development and operational experience

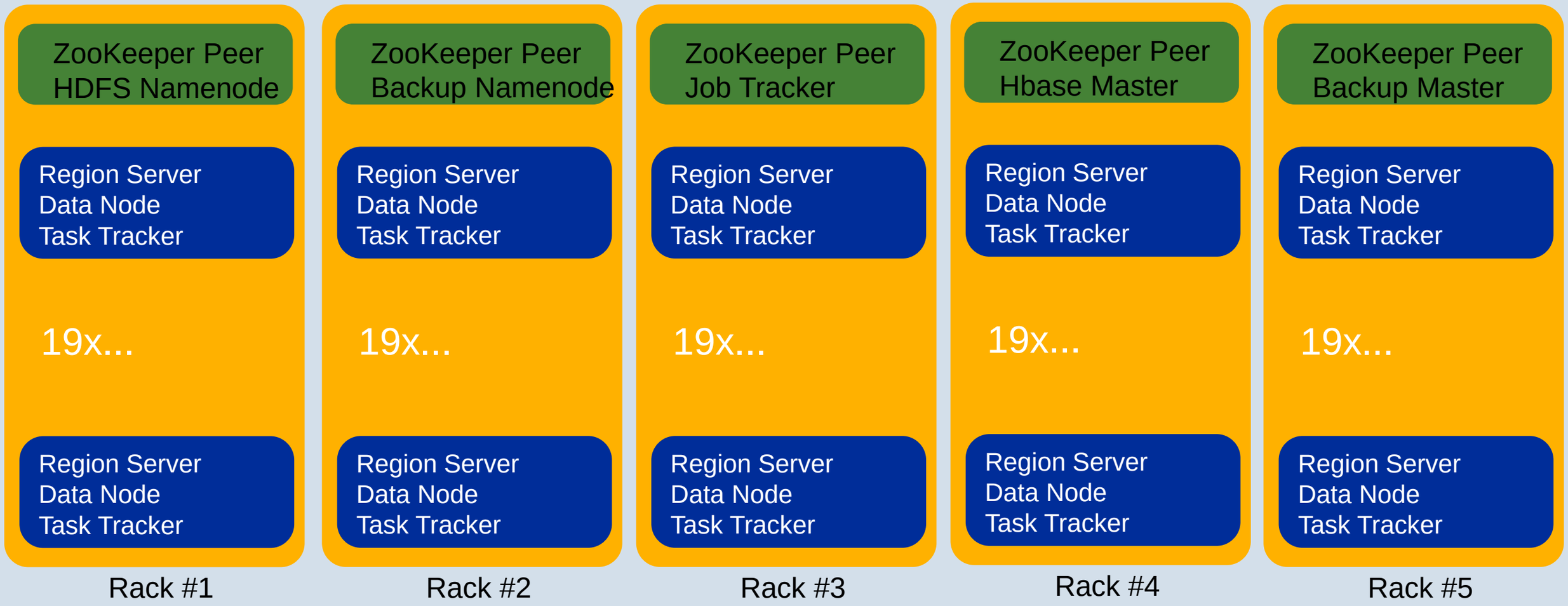
Simpler Consistency Model

- HBase's strong consistency model
  - simpler for a wide variety of applications to deal with
  - client gets same answer no matter which replica data is read from

- Eventual consistency: tricky for applications fronted by a cache
  - replicas may heal *eventually* during failures
  - but stale data could remain stuck in cache

Typical Cluster Layout

- Multiple clusters/cells for messaging
  - 20 servers/rack; 5 or more racks per cluster
- Controllers (master/Zookeeper) spread across racks



HBase Enhancements

Goal: Zero Data Loss

Goal of Zero Data Loss/Correctness

- *sync* support added to hadoop-20 branch
  - for keeping transaction log (WAL) in HDFS
  - to guarantee durability of transactions
- Row-level ACID compliance
- Enhanced HDFS's Block Placement Policy:
  - Original: rack aware, but minimally constrained
  - Now: Placement of replicas constrained to configurable node groups
  - Result: Data loss probability reduced by orders of magnitude

Availability/Stability improvements

- HBase master rewrite- region assignments using ZK
- Rolling Restarts – doing software upgrades without a downtime
- Interrupt Compactions – prioritize availability over minor perf gains
- Timeouts on client-server RPCs
- Staggered major compaction to avoid compaction storms

Performance Improvements

- Compactions
  - critical for read performance
  - Improved compaction algo
  - delete/TTL/overwrite processing in minor compactions
- Read optimizations:
  - Seek optimizations for rows with large number of cells
  - Bloom filters to minimize HFile lookups
  - Timerange hints on HFiles (great for temporal data)
  - Improved handling of compressed HFiles

Operational Experiences

- Darklaunch:
  - shadow traffic on test clusters for continuous, at scale testing
  - experiment/tweak knobs
  - simulate failures, test rolling upgrades
- Constant (pre-sharding) region count & controlled rolling splits
- Administrative tools and monitoring
  - Alerts (HBCK, memory alerts, perf alerts, health alerts)
  - auto detecting/decommissioning misbehaving machines
  - Dashboards
- Application level backup/recovery pipeline

Working within the Apache community

- Growing with the community
  - Started with a stable, healthy project
  - In house expertise in both HDFS and HBase
  - Increasing community involvement
- Undertook massive feature improvements with community help
  - HDFS 0.20-append branch
  - HBase Master rewrite
- Continually interacting with the community to identify and fix issues
  - e.g., large responses (2GB RPC)

Data migration

Another place we used HBase heavily…

Move messaging data from MySQL to HBase

Move messaging data from MySQL to HBase

- In MySQL, inbox data was kept normalized
  - user's messages are stored across many different machines
- Migrating a user is basically one big join across tables spread over many different machines
- Multiple terabytes of data (for over 500M users)
  - Cannot pound 1000s of production UDBs to migrate users

How we migrated

- Periodically, get a full export of all the users' inbox data in MySQL
- And, use bulk loader to import the above into a *migration* HBase cluster
- To migrate users:
  - Since users may continue to receive messages during migration:
    - double-write (to old and new system) during the migration period
  - Get a list of all recent messages (since last MySQL export) for the user
    - Load new messages into the *migration* HBase cluster
    - Perform the join operations to generate the new data
    - Export it and upload into the final cluster

Future Plans

HBase Expands

Facebook Insights Goes Real-Time

- Recently launched real-time analytics for social plugins on top of HBase
- Publishers get real-time distribution/engagement metrics:
  - # of impressions, likes
  - analytics by
    - Domain, URL, demographics
    - Over various time periods (the last hour, day, all-time)
- Makes use of HBase capabilities like:
  - Efficient counters (read-modify-write increment operations)
  - TTL for purging old data

Future Work

It is still early days…!

- Namenode HA (AvatarNode)
- Fast hot-backups (Export/Import)
- Online schema & config changes
- Running HBase as a service (multi-tenancy)
- Features (like secondary indices, batching hybrid mutations)
- Cross-DC replication
- Lot more performance/availability improvements

Thanks! Questions?

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