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Realtime Apache Hadoop at Facebook

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Agenda

1. Why Apache Hadoop and HBase?
2. Quick Introduction to Apache HBase
3. Applications of HBase at Facebook

Why Hadoop and HBase?

For *Realtime* Data?

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Problems with existing stack

- MySQL is stable, but…
  - Not inherently distributed
  - Table size limits
  - Inflexible schema
- Hadoop is scalable, but…
  - MapReduce is slow and difficult
  - Does not support random writes
  - Poor support for random reads

Specialized solutions

- High-throughput, persistent key-value
  - Tokyo Cabinet
- Large scale data warehousing
  - Hive/Hadoop
- Photo Store
  - Haystack
- Custom C++ servers for lots of other stuff

What do we need in a data store?

- Requirements for Facebook Messages
  - Massive datasets, with large subsets of cold data
  - Elasticity and high availability
  - Strong consistency within a datacenter
  - Fault isolation
- Some non-requirements
  - Network partitions within a single datacenter
  - Active-active serving from multiple datacenters

HBase satisfied our requirements

- In early 2010, engineers at FB compared DBs
  - Apache Cassandra, Apache HBase, Sharded MySQL
- Compared performance, scalability, and features
  - HBase gave excellent write performance, good reads
  - HBase already included many nice-to-have features
    - Atomic read-modify-write operations
    - Multiple shards per server
    - Bulk importing
    - MapReduce

HBase uses HDFS

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

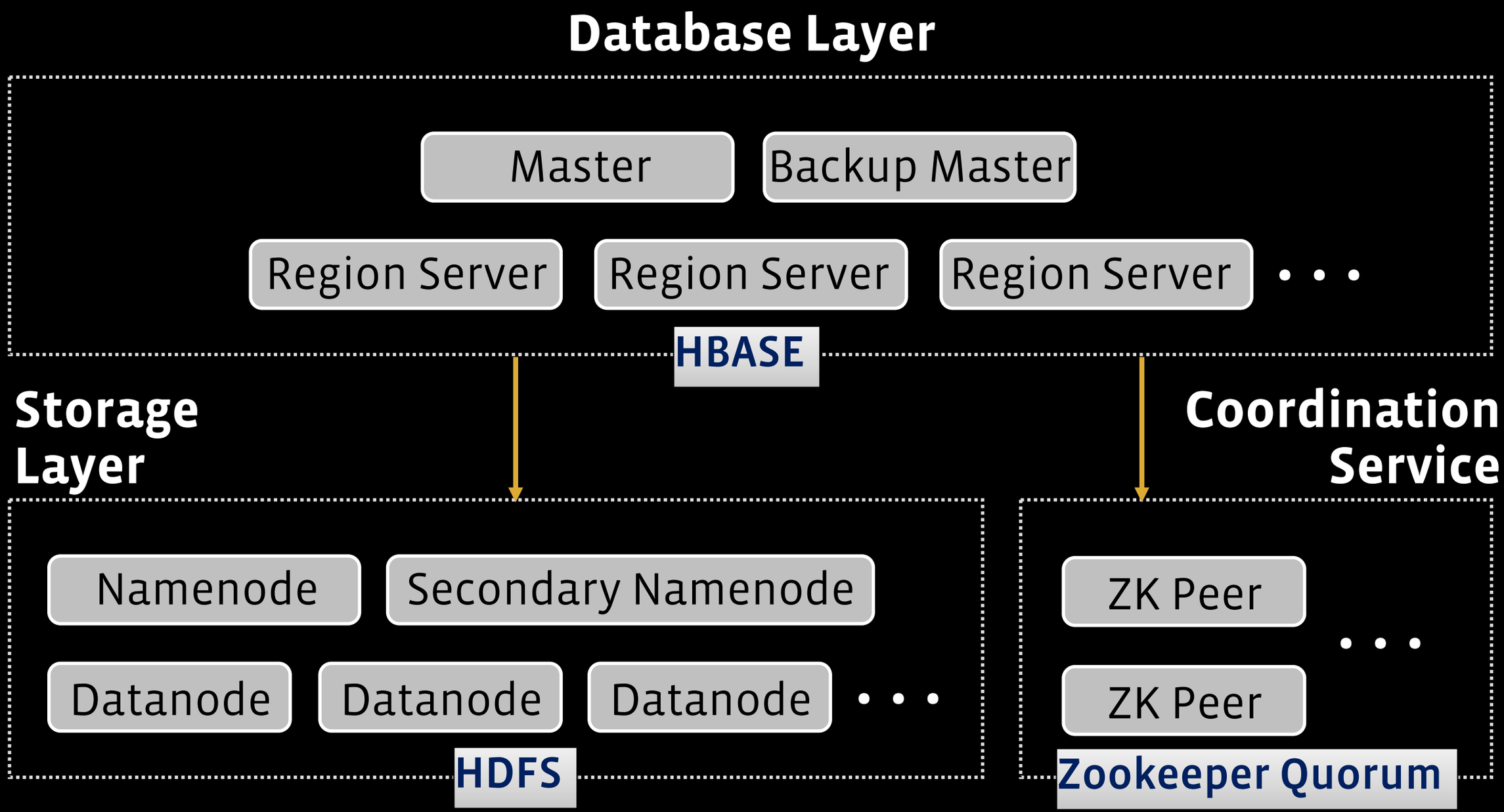
- Fault toleranceScalabilityChecksums fix corruptionsMapReduce
- Fault isolation of disksHDFS battle tested at petabyte scale at Facebook

Lots of existing operational experience

Apache HBase

- Originally part of Hadoop
  - HBase adds random read/write access to HDFS
- Required some Hadoop changes for FB usage
  - File appends
  - HA NameNode
  - Read optimizations
- Plus ZooKeeper!

HBase System Overview



HBase in a nutshell

- Sorted and column-oriented
- High write throughputHorizontal scalability Automatic failoverRegions sharded dynamically

Applications of HBase at Facebook

Use Case 1

Titan

(Facebook Messages)

The New Facebook Messages

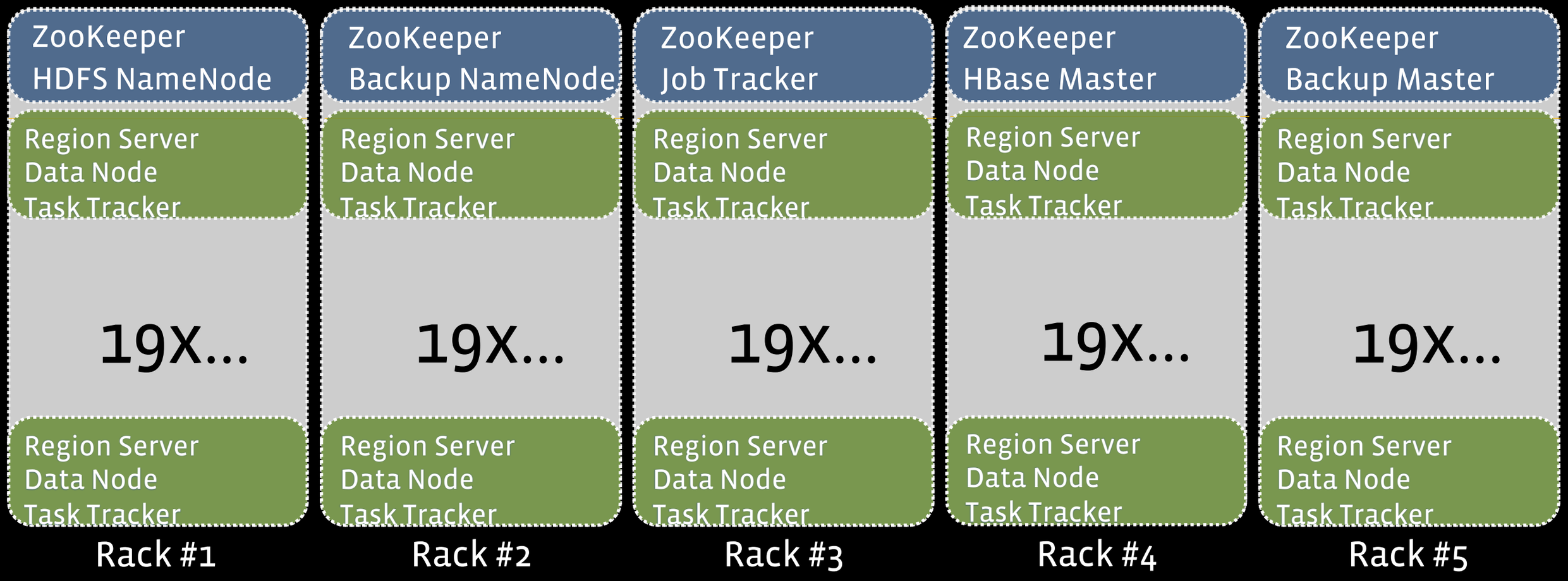
Messages **IM/Chat** **email** **SMS**

Facebook Messaging

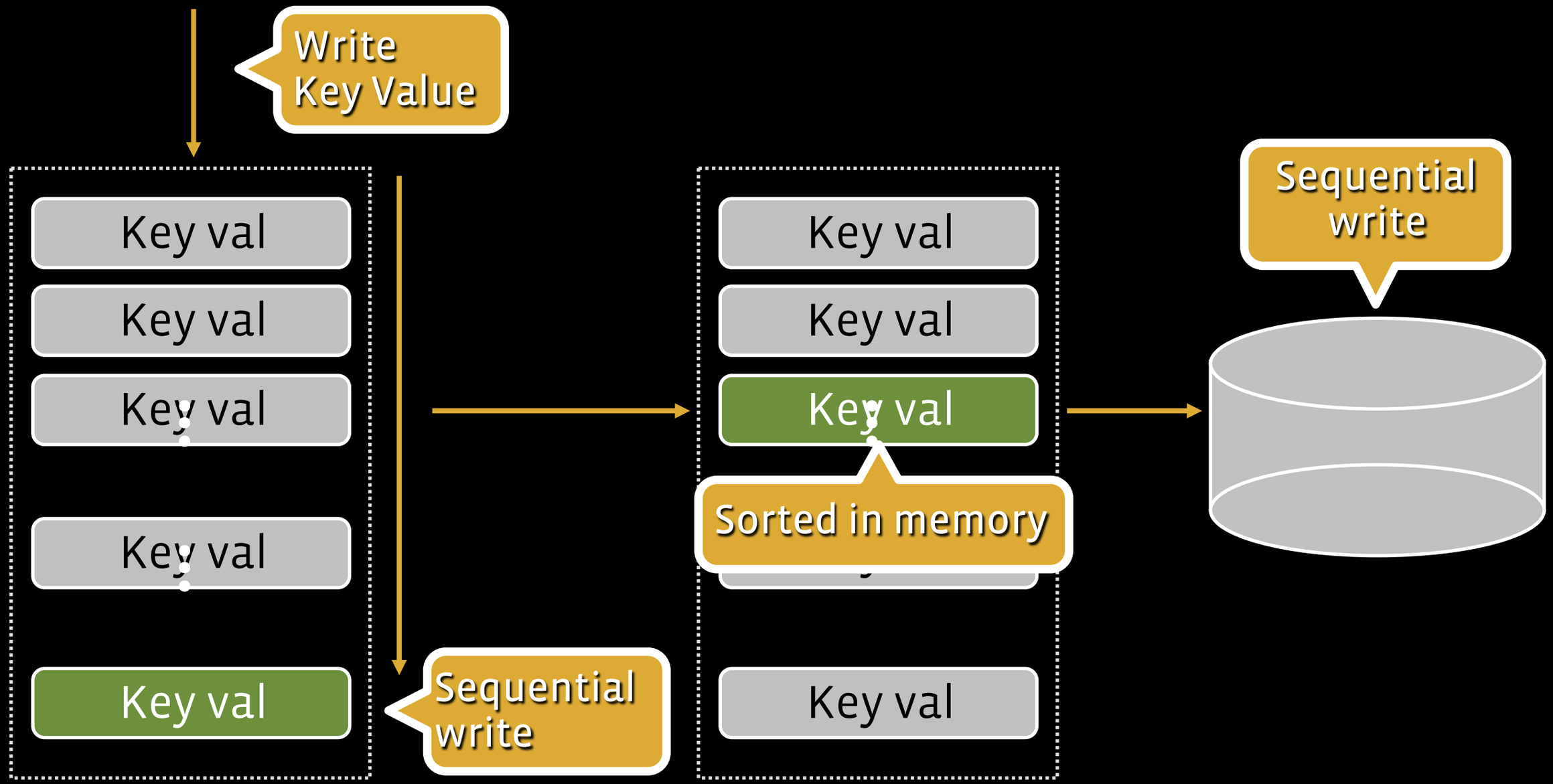
- **High write throughput** Every message, instant message, SMS, and e-mail Search indexes for all of the above
  - Denormalized schema
- **A product at massive scale on day one**
  - 6k messages a second
  - 50k instant messages a second
  - 300TB data growth/month compressed

Typical Cell Layout

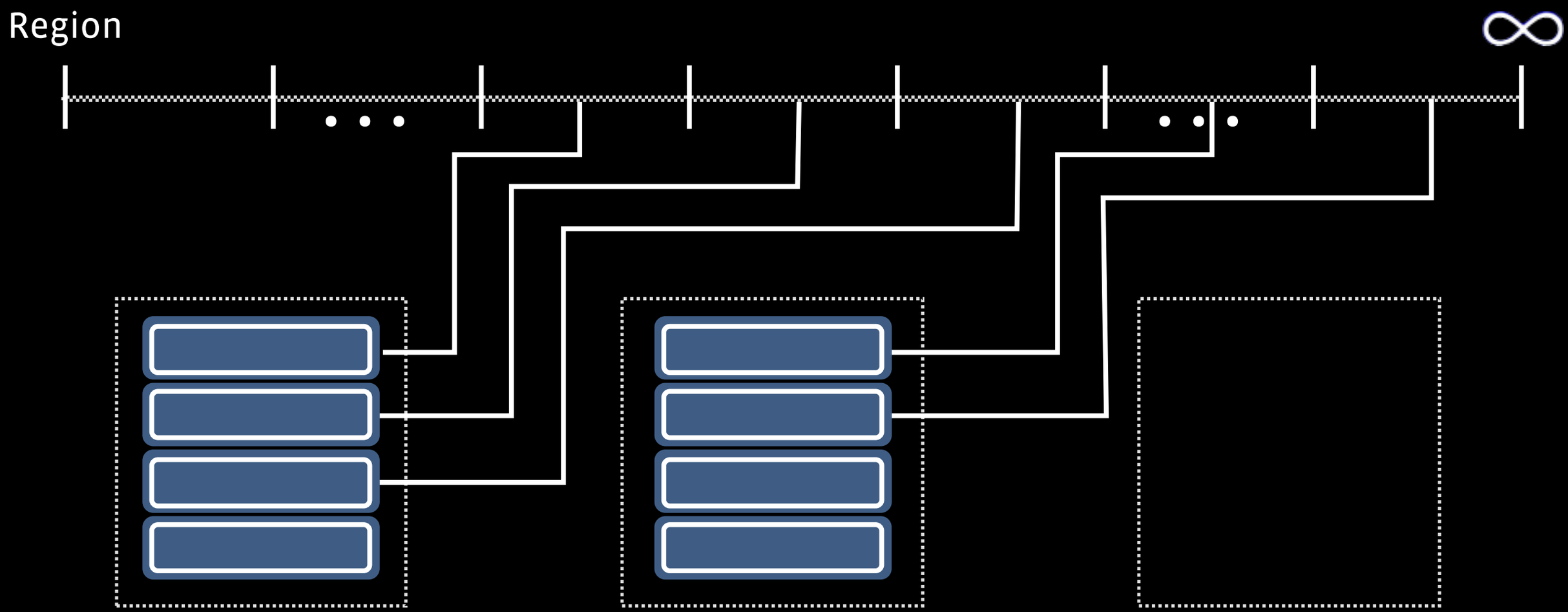
- Multiple cells for messaging
- 20 servers/rack; 5 or more racks per cluster
- Controllers (master/Zookeeper) spread across racks



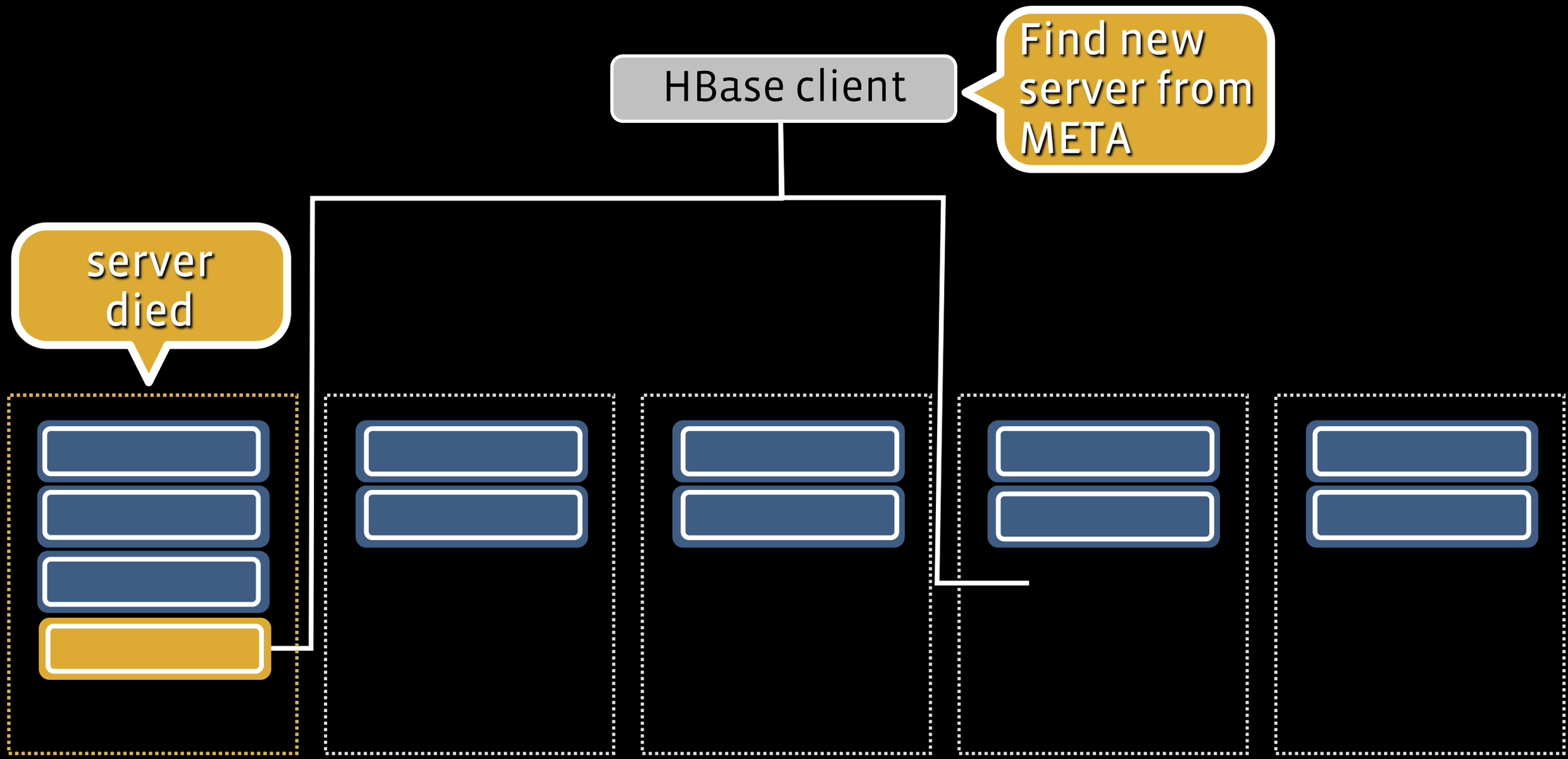
High Write Throughput



Horizontal Scalability



Automatic Failover



No physical data copy because data is in HDFS

Use Case 2

Puma

(Facebook Insights)

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Puma

- Realtime Data Pipeline
  - Utilize existing log aggregation pipeline (Scribe-HDFS)
  - Extend low-latency capabilities of HDFS (Sync+PTail)
  - High-throughput writes (HBase)

- Support for Realtime Aggregation
  - Utilize HBase atomic increments to maintain roll-ups
  - Complex HBase schemas for unique-user calculations
  - Store checkpoint information directly in HBase

Puma as Realtime MapReduce

- Map phase with PTail
  - Divide the input log stream into N shards
  - First version only supported random bucketing
  - Now supports application-level bucketing
- Reduce phase with HBase
  - Every row+column in HBase is an output key
  - Aggregate key counts using atomic counters
  - Can also maintain per-key lists or other structures

Puma for Facebook Insights

- Realtime URL/Domain Insights
  - Domain owners can see deep analytics for their site
  - Clicks, Likes, Shares, Comments, Impressions
  - Detailed demographic breakdowns (anonymized)
  - Top URLs calculated per-domain and globally

- Massive Throughput
  - Billions of URLs
  - > 1 Million counter increments per second

Day | Week | Month | 05/08/2011 - 06/06/2011 | Export

Site Engagement

[redacted] Total Actions?

118x

Distribution on Facebook

[redacted] Total Impressions?

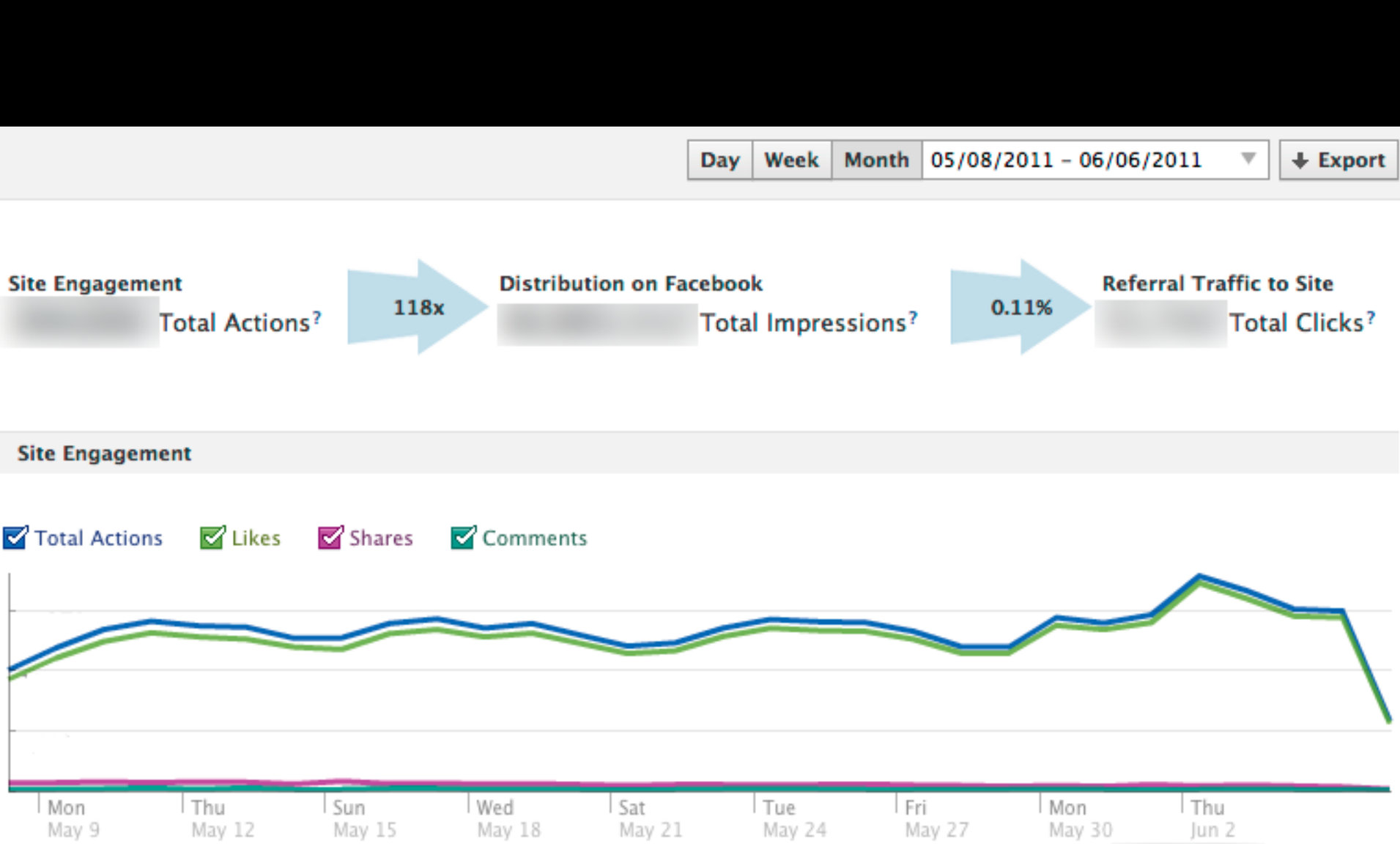
0.11%

Referral Traffic to Site

[redacted] Total Clicks?

Site Engagement

Total Actions | Likes | Shares | Comments



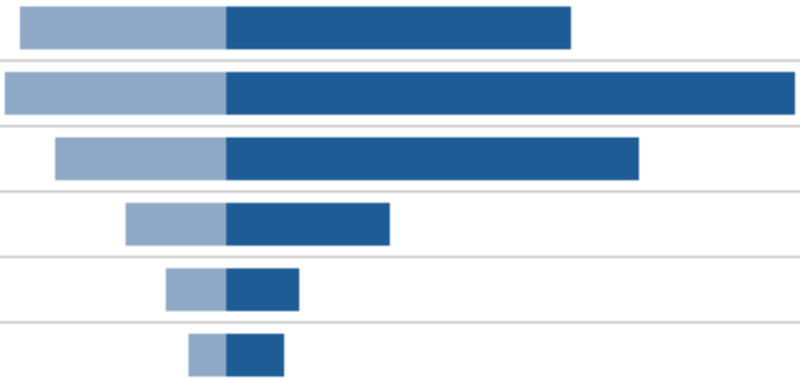
[redacted] Total Actions?

[redacted] Likes?

Shares?

Comments?

Age	Female (31%)	Male (62%)
13–17	7.9%	13%
18–24	8.5%	22%
25–34	6.6%	16%
35–44	3.9%	6.3%
45–54	2.3%	2.8%
55+	1.5%	2.3%



Language	
English (US)	(34%)
Spanish	(12%)
Arabic	(6.1%)
Turkish	(6%)
English (UK)	(5.3%)
French (France)	(5.2%)
Spanish (Spain)	(4.6%)
Indonesian	(3.9%)
Italian	(3.7%)
German	(2.7%)
Portuguese (Brazil)	(2.6%)
Thai	(1.2%)
Russian	(0.96%)
Polish	(0.91%)
More	

Country	
United States	(13%)
Turkey	(5.9%)
Philippines	(5%)
Indonesia	(4.5%)
India	(4.4%)
Mexico	(4.3%)
Egypt	(4.1%)
Italy	(3.8%)
Brazil	(2.7%)
Argentina	(2.7%)
Germany	(2.6%)
Malaysia	(2.6%)
United Kingdom	(2.3%)
Spain	(1.8%)
More	

Use Case 3

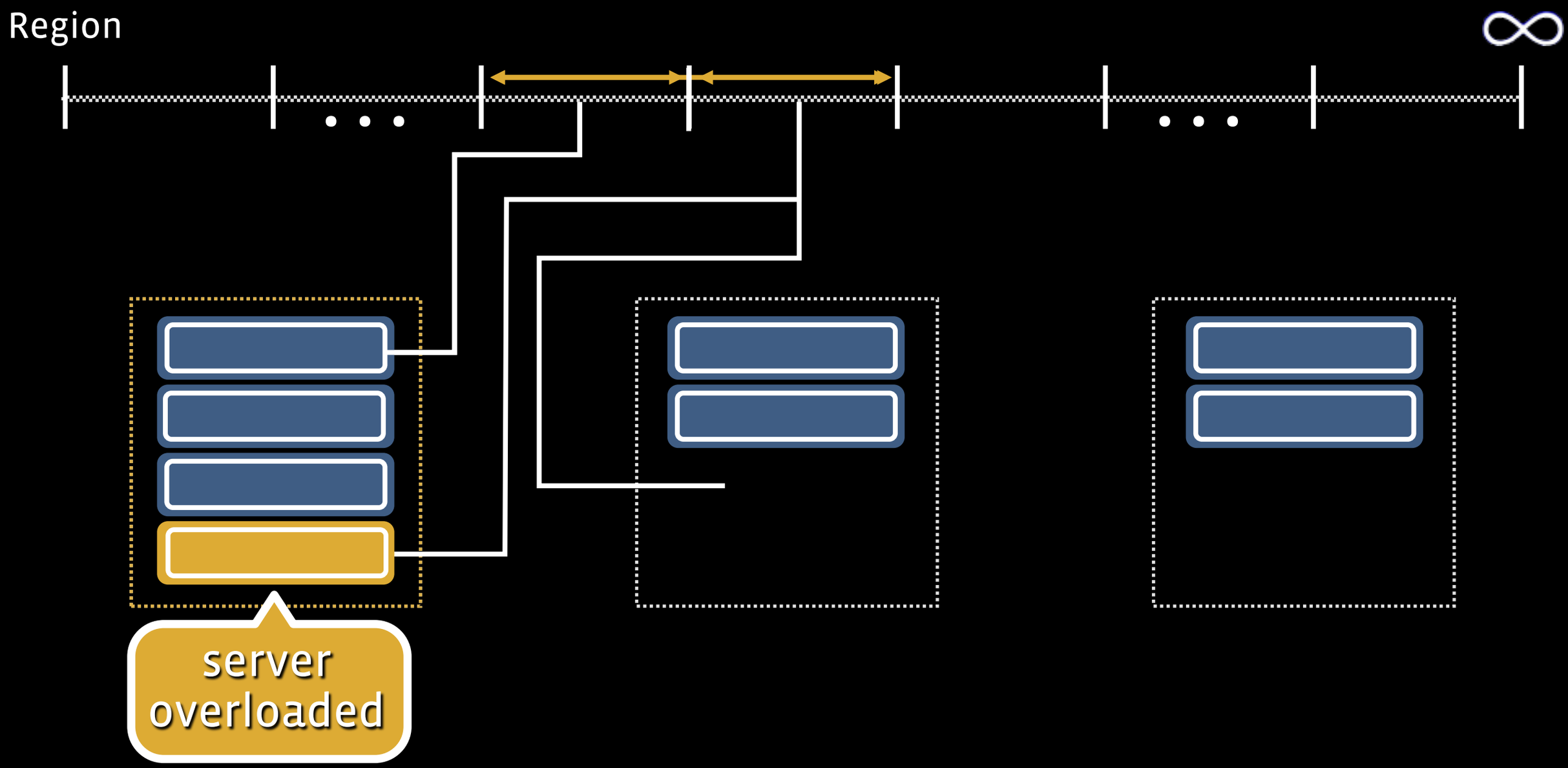
ODS

(Facebook Internal Metrics)

ODS

- **Operational Data Store**
  - System metrics (CPU, Memory, IO, Network)
  - Application metrics (Web, DB, Caches)
  - Facebook metrics (Usage, Revenue)
    - Easily graph this data over time
    - Supports complex aggregation, transformations, etc.
- **Difficult to scale with MySQL**
  - Millions of unique time-series with billions of points
  - Irregular data growth patterns

Dynamic sharding of regions



Future of HBase at Facebook

User and Graph Data in HBase

HBase for the important stuff

- Looking at HBase to augment MySQL
  - Only single row ACID from MySQL is used
  - DBs are always fronted by an in-memory cache
  - HBase is great at storing dictionaries and lists
- Database tier size determined by IOPS
  - HBase does only sequential writes
  - Lower IOPs translate to lower cost
  - Larger tables on denser, cheaper, commodity nodes

Conclusion

- Facebook investing in Realtime Hadoop/HBase
  - Work of a large team of Facebook engineers
  - Close collaboration with open source developers
- Much more detail in Realtime Hadoop paper
  - Technical details about changes to Hadoop and HBase
  - Operational experiences in production

Questions?

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