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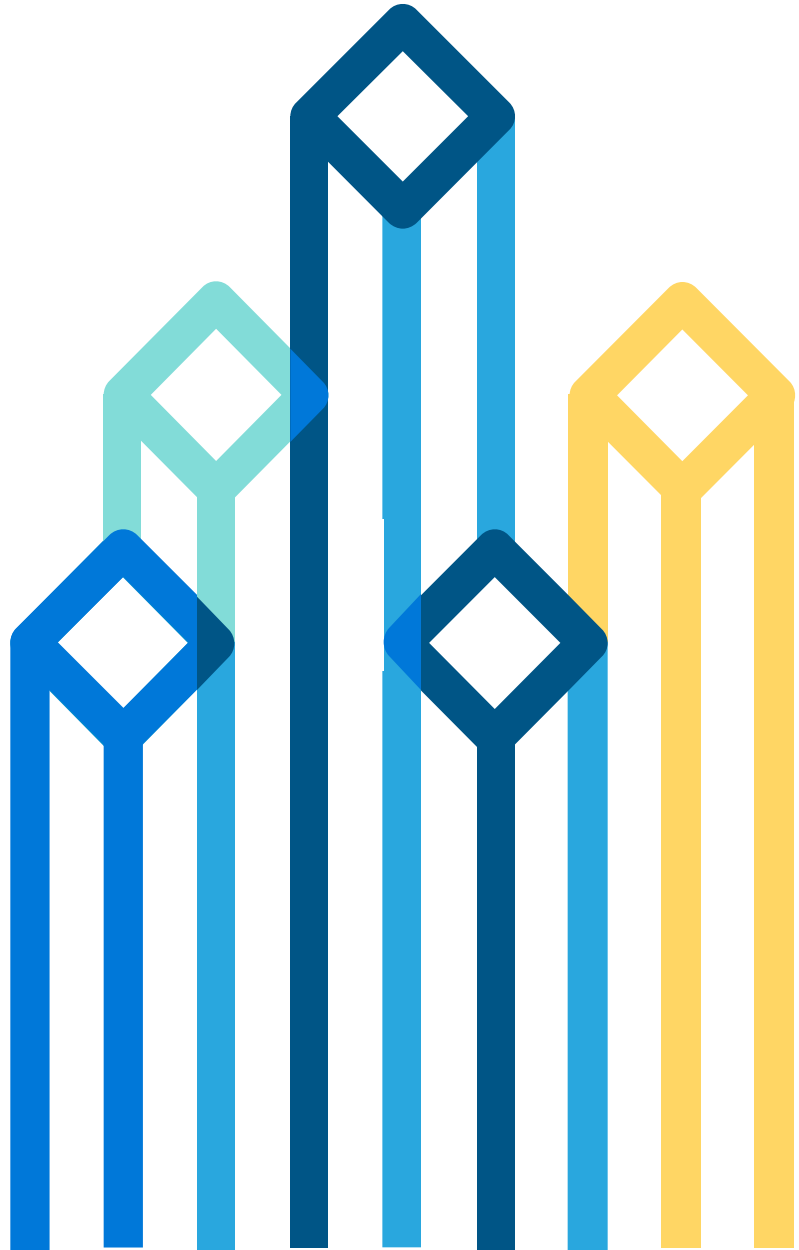

Apache HBase: Overview, Hands-On, and Use Cases

Apekshit Sharma

Dima Spivak

Who we are

Apekshit Sharma

- Distributed Software Engineer, Cloudera
  - Software Engineer, Google
- Apache HBase contributor
- Performance improvements and configuration framework

Dima Spivak (@dimaspivak)

- Distributed Software Engineer, Cloudera
  - Research Assistant (Physics), University of Minnesota
- Apache HBase contributor
- Test frameworks and automation

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Contents

- Motivation
- Introduction to Apache HBase
  - Data model
- Hands-On: Installation, HBase shell
- Break
- A slightly more in-depth introduction to Apache HBase
  - Apache Hadoop
  - System internals
  - APIs
- Break

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Contents

- Industry use cases & patterns
- Augmenting HBase
  - OpenTSDB
  - Apache Phoenix

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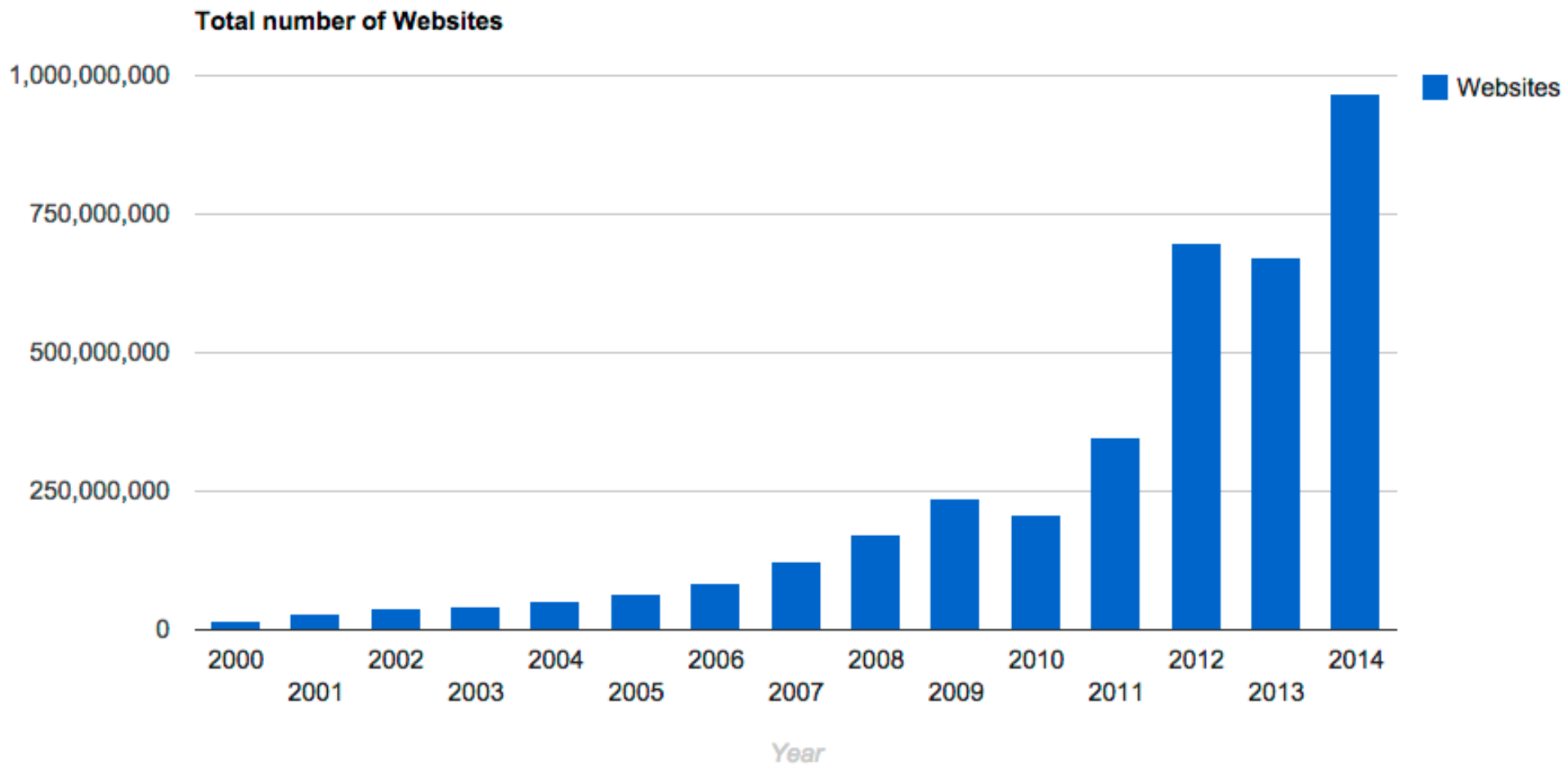
Motivation



http://www.internetlivestats.com/total-number-of-websites/

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Motivation

"We've known it for a long time: the web is big."

– Jesse Alpert & Nissan Hajaj, Google

http://googleblog.blogspot.com/2008/07/we-knew-web-was-big.html

Motivation

- Indexing the internet has challenges:
  - Scale
    - Volume
    - Rate
  - Diversity of content
    - URLs
    - High-resolution images
    - Video
  - Access

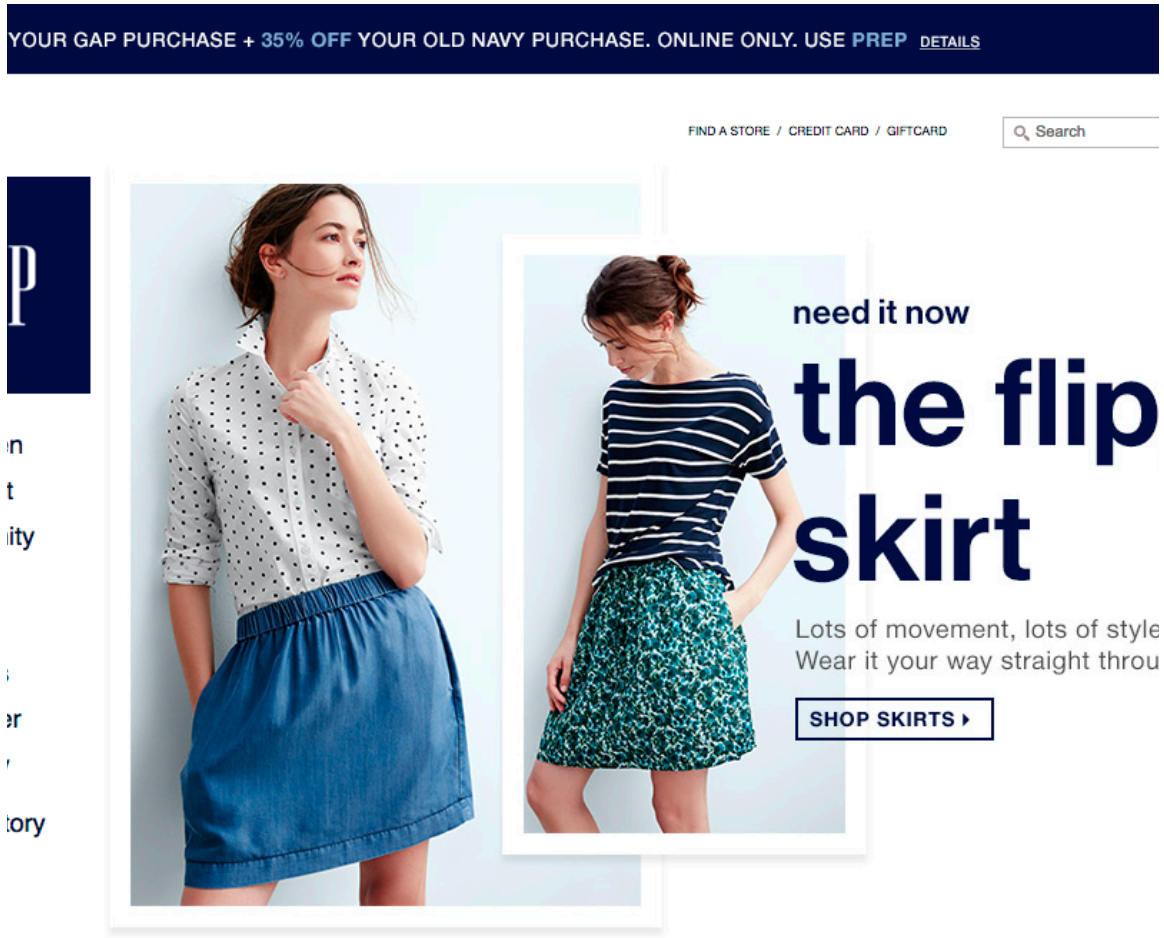
Motivation

Bigtable: A Distributed Storage System for Structured Data

Fay Chang, Jeffrey Dean, Sanjay Ghemawat, Wilson C. Hsieh, Deborah A. Wallach
Mike Burrows, Tushar Chandra, Andrew Fikes, Robert E. Gruber
{fay,jeff,sanjay,wilsonh,kerr,m3b,tushar,fikes,gruber}@google.com
Google, Inc.

Motivation

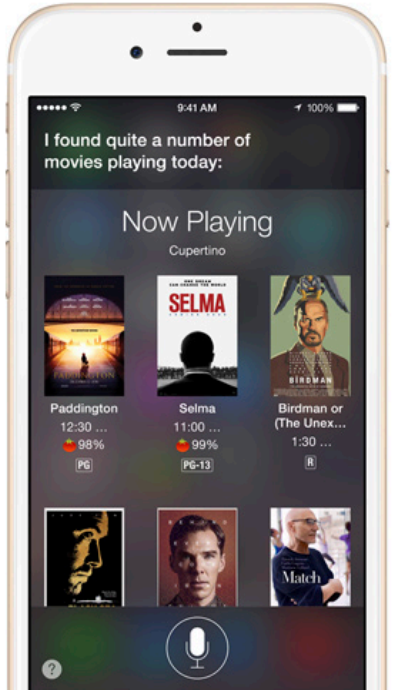
- What if you're not trying to index the internet?



Motivation

- Data for analytical processing
- User-facing real-time platforms

"What movies are playing today?"



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Introduction to Apache HBase

- "Apache HBase™ is the Hadoop database, a distributed, scalable, big data store."

  http://hbase.apache.org/

Introduction to Apache HBase

- Apache HBase is an open source, horizontally scalable, consistent, random access, low latency data store built on top of Apache Hadoop.

Apache HBase is open source

- Apache 2.0 License
- A community project with committers and contributors from diverse organizations
  - Cloudera, Facebook, Salesforce.com, Huawei, TrendMicro, eBay, HortonWorks, Intel, Twitter, …
- Code license means anyone can modify and use the code.

Apache HBase is horizontally scalable

- Adding more servers linearly increases performance and capacity
  - Storage capacity
  - Input/output operations
- Store and access data on commodity servers

- Largest cluster: > 3000 nodes, > 100 PB
- Average cluster: 10-40 nodes, 100-400TB

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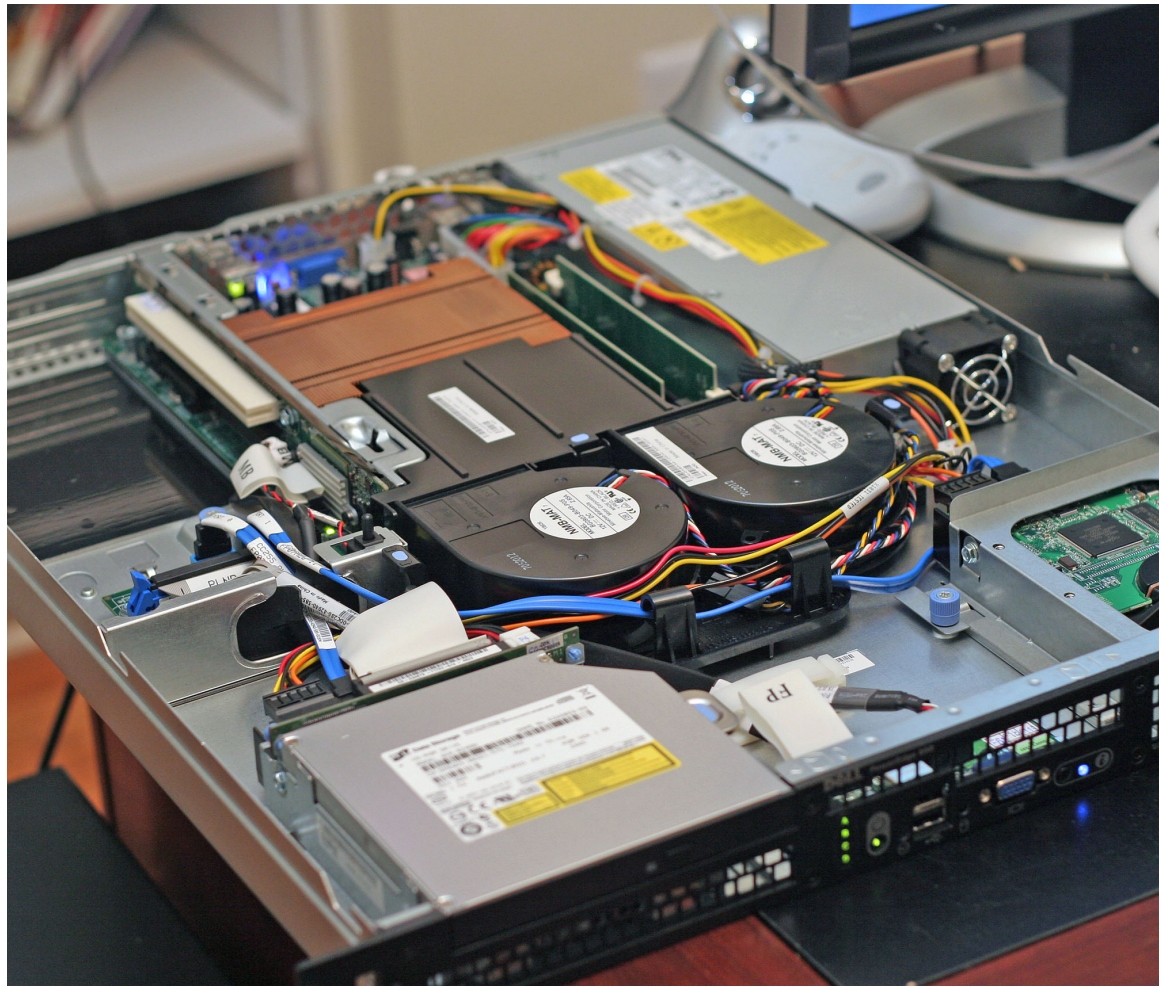
Apache HBase is horizontally scalable

- Commodity servers (crica 2015)
  - 12-24 2-4TB hard disks
  - 2 octa-core CPUs, 2-3 GHz
  - 64 - 512 GBs of RAM
  - 10 Gbps ethernet
  - $5,000 - $10,000 / machine



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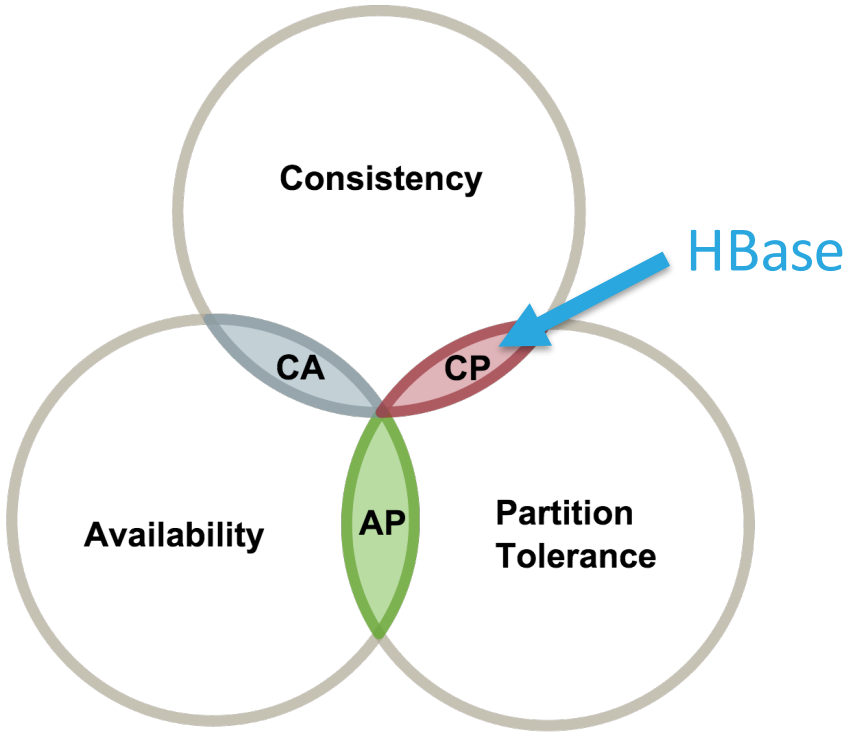
Apache HBase is consistent

- Brewer's theorem
  - Consistency
  - Availability
  - Partition tolerance



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Data model

- Data is stored… in a big table
  - Sorted map datastore
- Tables consist of sorted rows, each of which has a primary row key
- Each row has a set of columns
- A column is specified as a column family and column qualifier pair
- A given cell (row, column family:column qualifier) can have different time-stamped values

Data model

Row key	info:height	info:state	roles:hadoop	roles:hbase
cutting	‘9ft’	‘CA’	‘Founder’	
todd	‘5ft7’	‘CA’	‘PMC’ (ts=2011) ‘Committer’ (ts=2010)	‘Committer’

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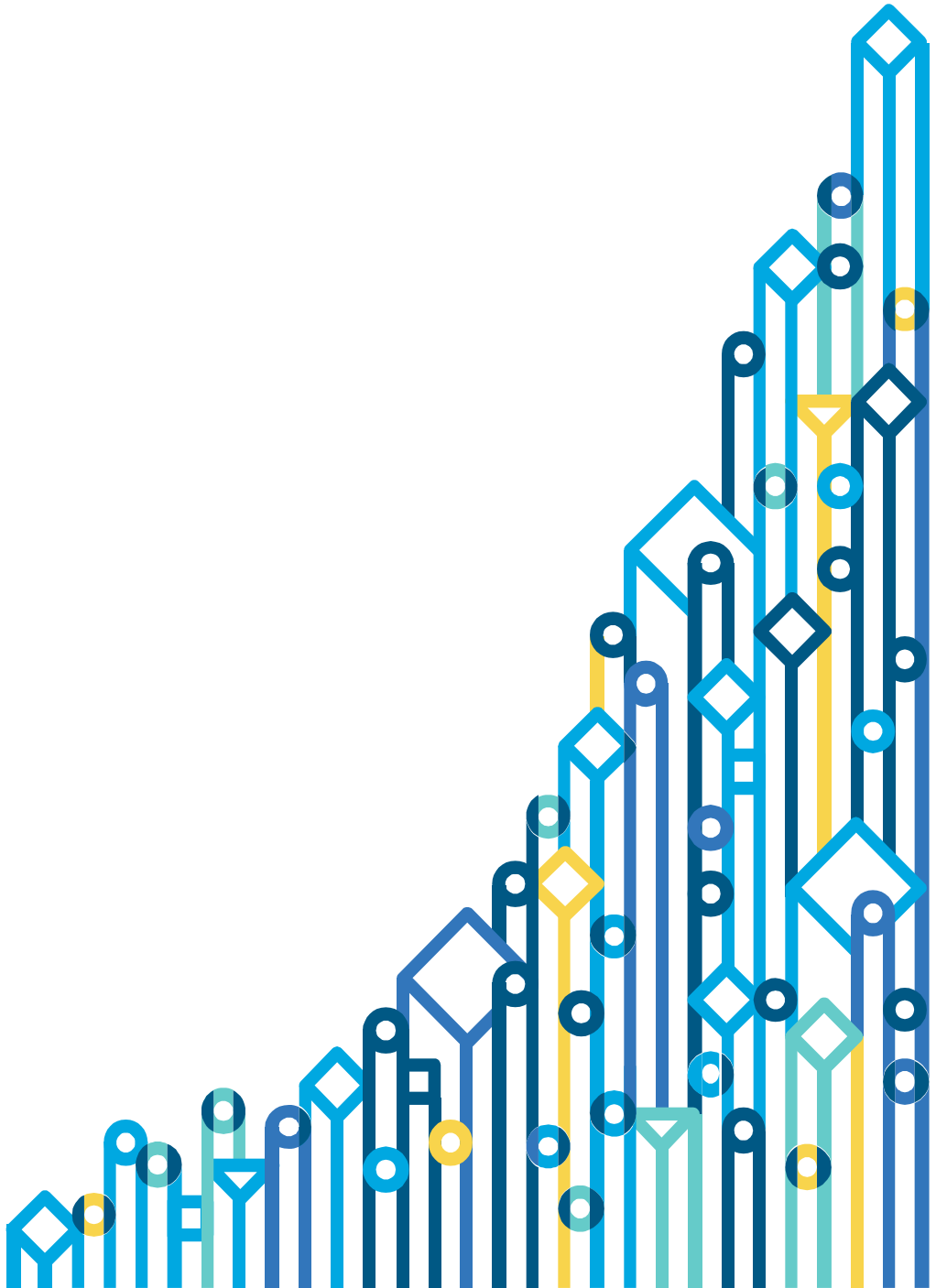

Hands On

Apache HBase installation

The HBase shell

http://pastebin.com/nMkZeq5S

Whats up for the next 1 hour?

Understanding basic architecture of

HDFS
(Apache Hadoop)

APACHE HBASE

And, more Hands-On with Apache HBase.

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Break

Understanding basic architecture of

Hadoop (HDFS)

Apache Hadoop

open source

commodity servers

horizontally scalable

highly fault-tolerant

massive processing power

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2 Core Components

Apache Hadoop

HDFS
(Hadoop Distributed File System)

MapReduce + YARN

History

The Google File System

Sanjay Ghemawat, Howard Gobioff, and Shun-Tak Leung

Google*

2003

GFS

- distributed file system
- commodity servers
- horizontally scalable
- highly fault-tolerant
- proprietary

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HDFS

- distributed file system
- commodity servers
- horizontally scalable
- highly fault-tolerant
- open source

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HDFS API

- File
  - Open, Close, Read, Write, Move, etc
- Directories
  - Create, Delete, etc
- Permissions
  - Owners, Groups, rwx permissions

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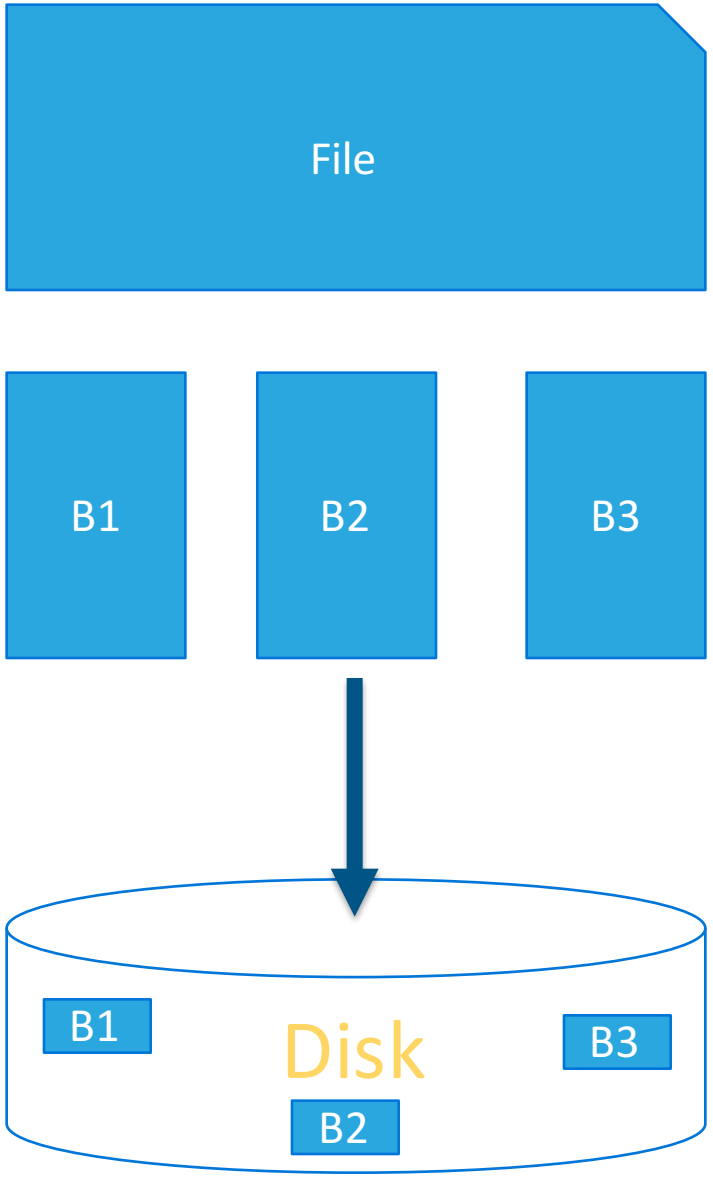
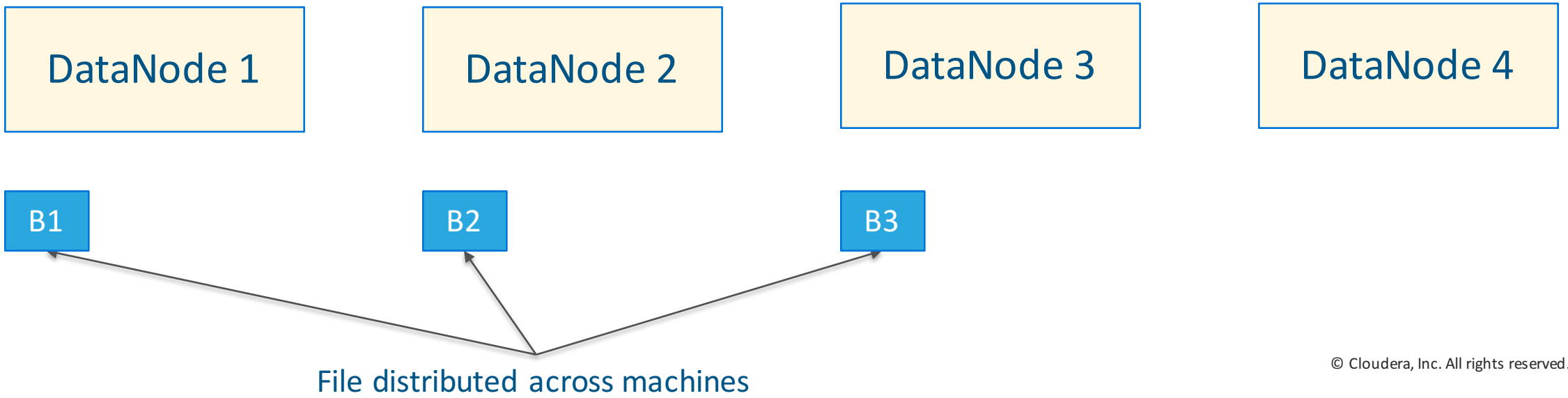
Basic Architecture of HDFS

Local file system

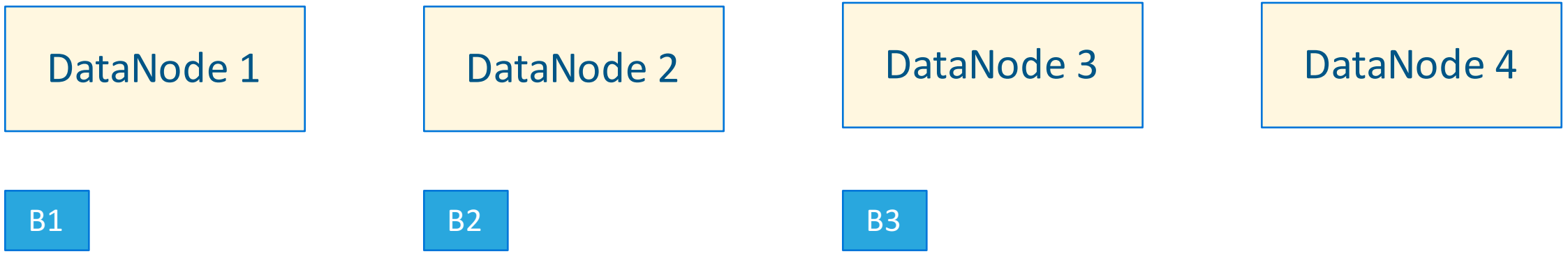
File system will split the file into blocks



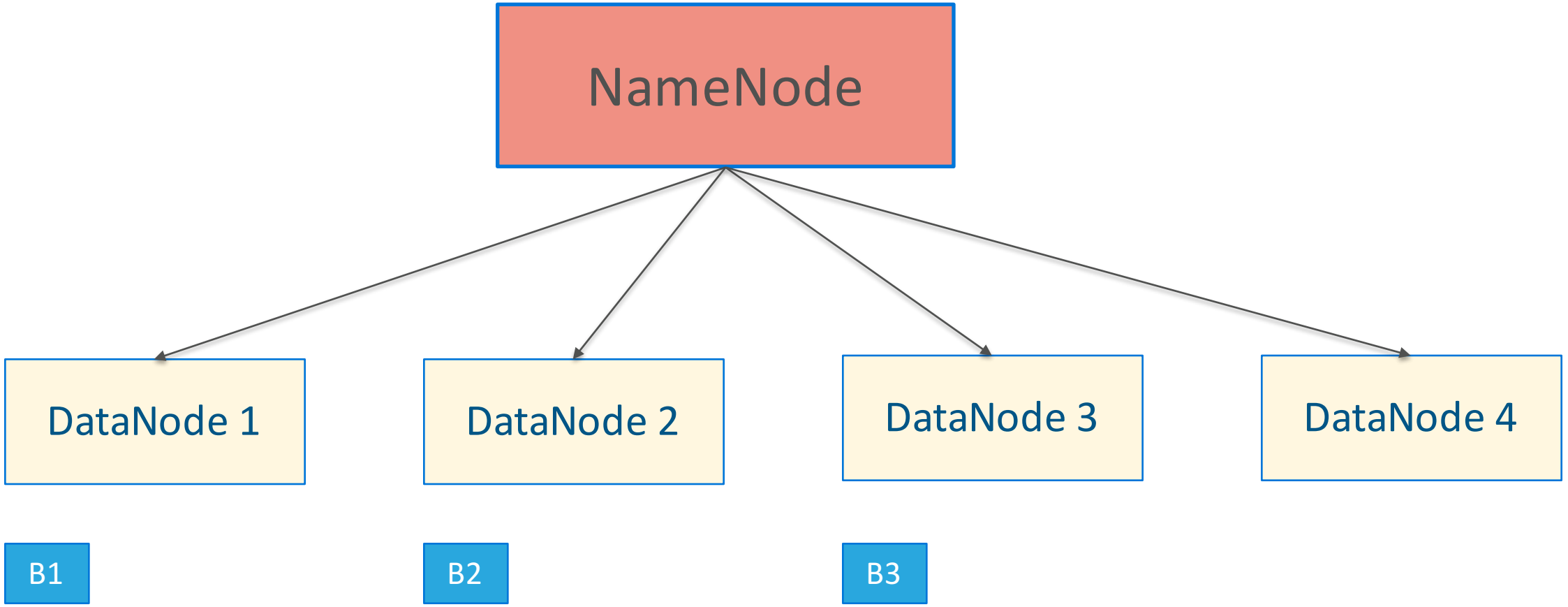
HDFS



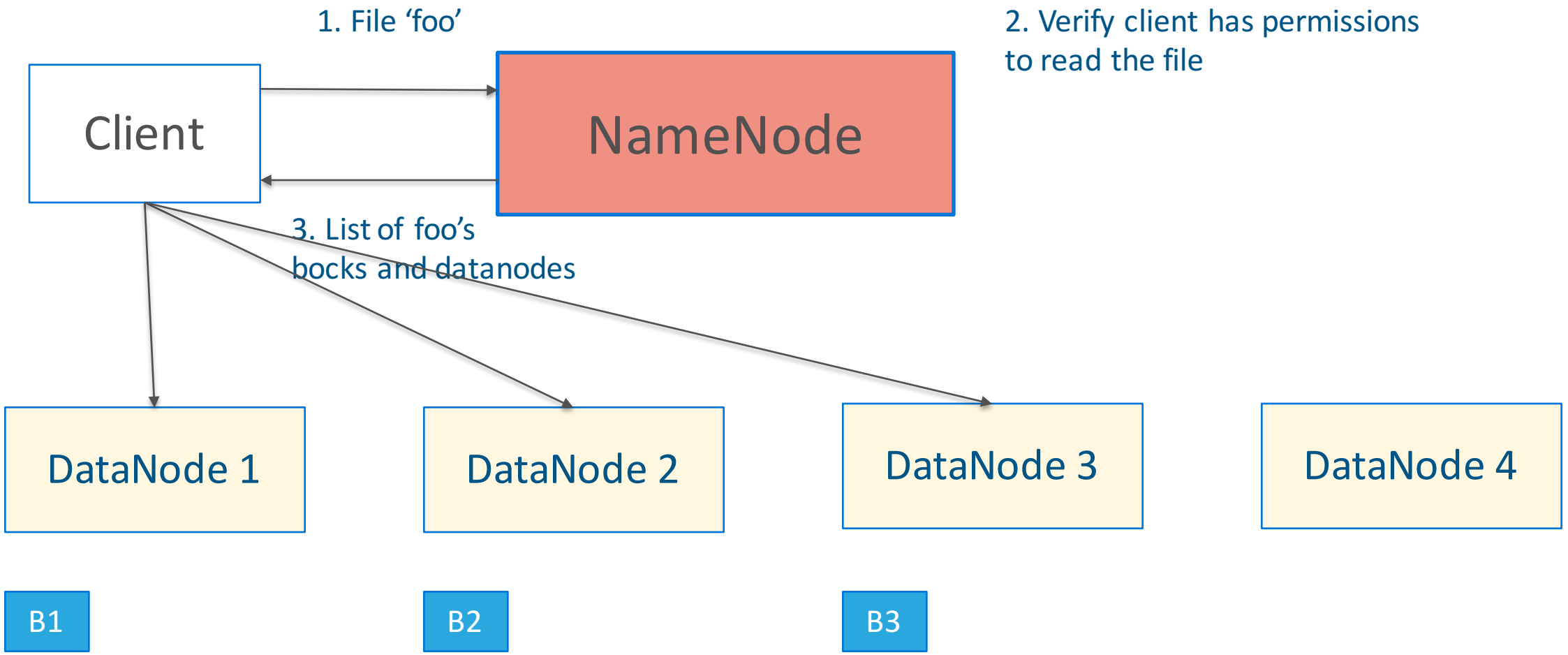
HDFS DataNode



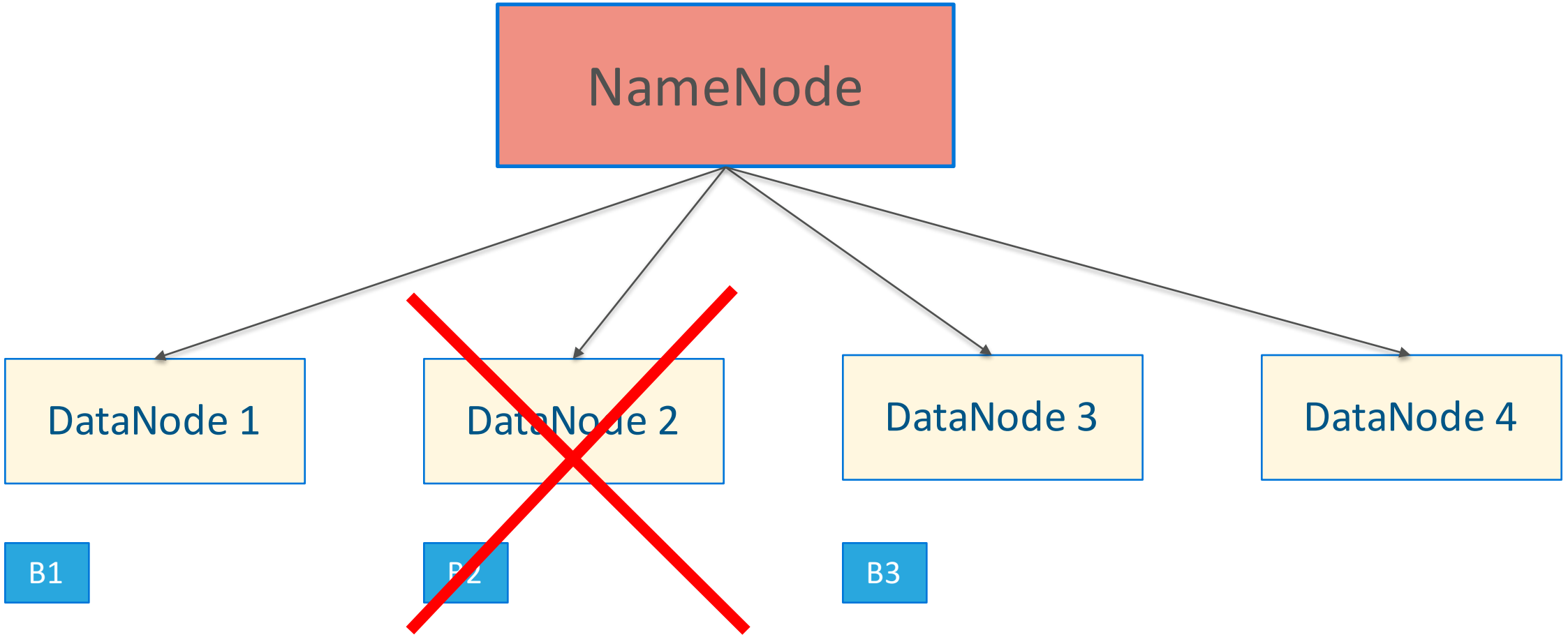
HDFS NameNode



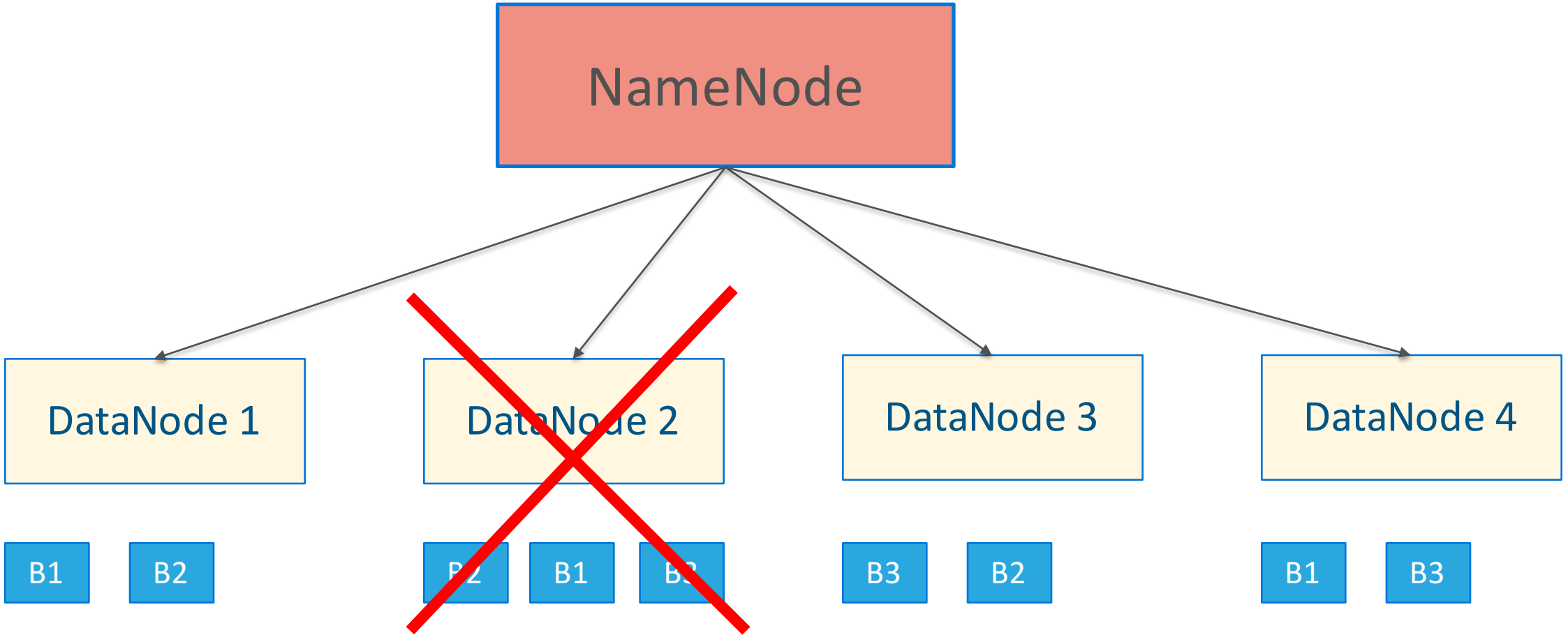
HDFS Reading a file



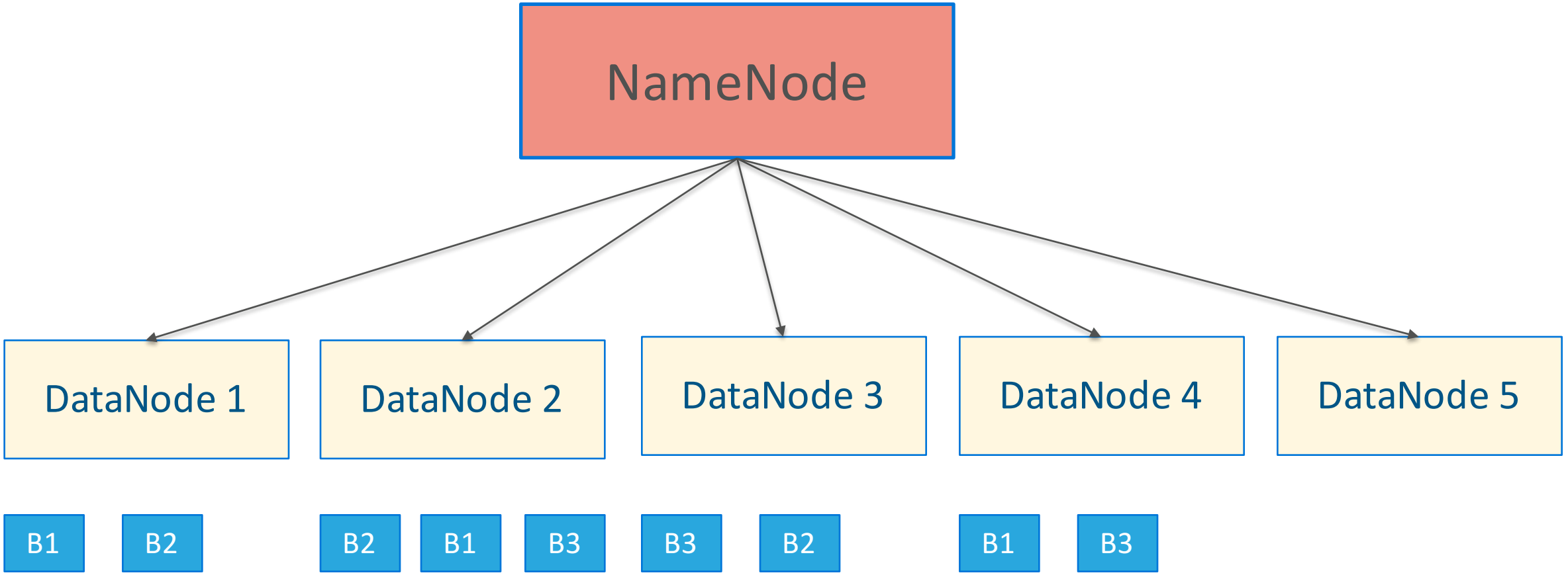
HDFS Fault tolerance



HDFS Redundancy



HDFS Horizontal Scalability



Let’s look at some existing HDFS systems...

- ## Yahoo! HDFS Clusters

  40k+ servers, 100k+ CPUs, 450PB data

- ## Facebook HDFS Cluster

  15TB new data per day

  1200+ machines, 30PB in one cluster

- *Lots* of 5-40 node clusters at companies *without* petabytes of data (web, retail, finance, telecom, research, government)

But…. there are restrictions!

It’s not a magic wand!

Files are **append only**

- Access Model : Write-once-read-many
- Can not change existing contents

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Not designed for small files

- Block sizes are in MB (default 128MB)
  - Designed for typical GBs / TBs of file sizes
  - Normal files system have 4kb block size!

Summary

HDFS is a great distributed file system!

- Store massive data
- Scalable
- High throughput
- Fault tolerance

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MapReduce

- Distributed processing framework
- Commodity machines
- Fault tolerance

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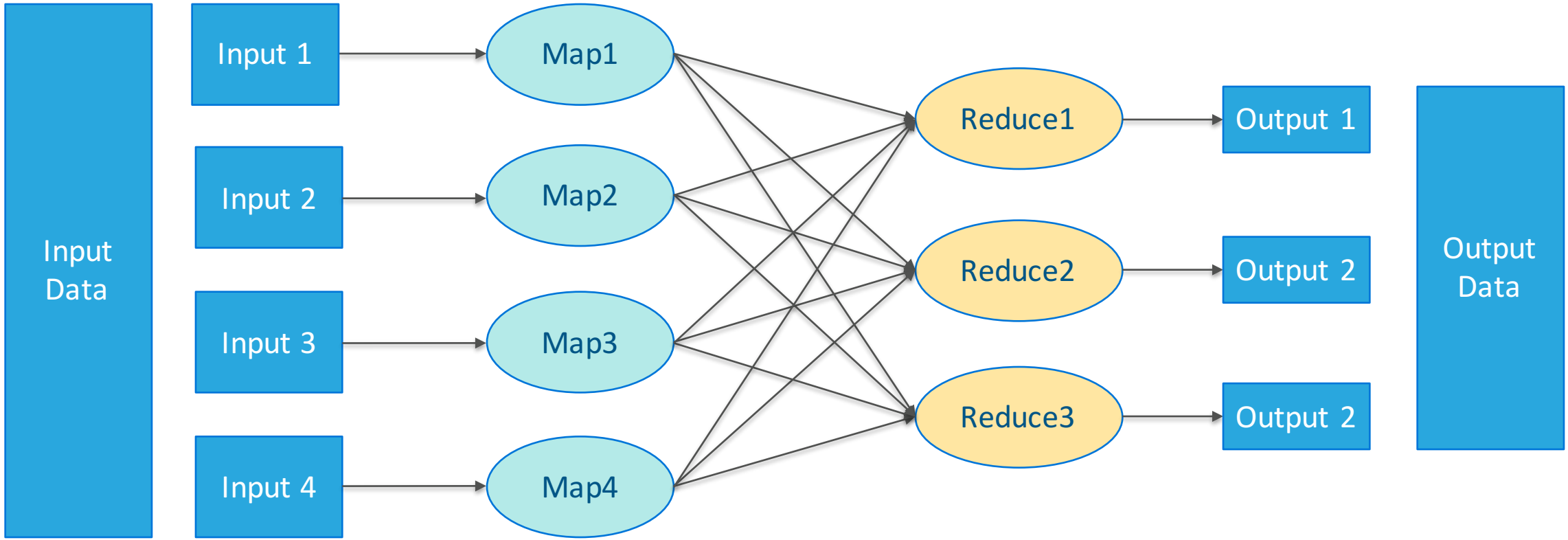
MapReduce



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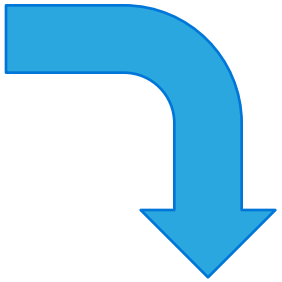
HBase Architecture

Name	Weight	UPC	Price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98



	info:weight	info:upc	info:price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98

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HBase Architecture

	info:weight	info:upc	info:price
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HBase Architecture

	info:weight	info:upc	info:price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98
A New Product	4 Oz	xxxxxxxx	$9.99

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HBase Architecture

	info:weight	info:upc	info:price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98
A New Product	4 Oz	xxxxxxxx	$9.99
Yet Another New Product	8 Oz	xxxxxxxx	$19.99

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HBase Architecture

	info:weight	info:upc	info:price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98
A New Product	4 Oz	xxxxxxxx	$9.99
Yet Another New Product	8 Oz	xxxxxxxx	$19.99
Four More Products (1)	16 Oz	xxxxxxxx	$9.99
Four More Products (2)	16 Oz	xxxxxxxx	$9.99
Four More Products (3)	16 Oz	xxxxxxxx	$9.99
Four More Products (4)	16 Oz	xxxxxxxx	$9.99

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HBase Architecture | Regions

- Tables are chopped up into regions (split).
- A region is only served by a single “region server” at a time.
- RegionServer can serve multiple regions.

HBase Architecture | Regions

	info:weight	info:upc	info:price
A New Product	4 Oz	xxxxxxxx	$9.99
Four More Products (1)	16 Oz	xxxxxxxx	$9.99
Four More Products (2)	16 Oz	xxxxxxxx	$9.99
Four More Products (3)	16 Oz	xxxxxxxx	$9.99
Four More Products (4)	16 Oz	xxxxxxxx	$9.99

Served by RegionServer on machine 2

	info:weight	info:upc	info:price
Prego Tomato Sauce	67 Oz	xxxxxxxx	$4.97
Trumoo Lowfat Chocolate Milk	128 Oz	xxxxxxxx	$2.99
Gatorade Lemon-Lime	64 Oz	xxxxxxxx	$3.98
Yet Another New Product	8 Oz	xxxxxxxx	$19.99

Served by RegionServer on machine 3

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HBase Architecture | Regions

	info:price	info:upc	info:weight
A New Product	$9.99	xxxxxxxx	4 Oz
Four More Products (1)	$9.99	xxxxxxxx	16 Oz
Four More Products (2)	$9.99	xxxxxxxx	16 Oz
Four More Products (3)	$9.99	xxxxxxxx	16 Oz
Four More Products (4)	$9.99	xxxxxxxx	16 Oz

Served by RegionServer on machine 2

	info:price	info:upc	info:weight
Gatorade Lemon-Lime	$3.98	xxxxxxxx	64 Oz
Prego Tomato Sauce	$4.97	xxxxxxxx	67 Oz
Trumoo Lowfat Chocolate Milk	$2.99	xxxxxxxx	128 Oz
Yet Another New Product	$19.99	xxxxxxxx	8 Oz

Served by RegionServer on machine 3

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HBase Architecture

	info:price	info:upc	info:weight	available:store1	available:store2	available:store3
A New Product	$9.99	xxxxxxxx	4 Oz	Yes	Yes	Yes
Four More Products (1)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	Yes
Four More Products (2)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	No
Four More Products (3)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	No
Four More Products (4)	$9.99	xxxxxxxx	16 Oz	No	No	No

	info:price	info:upc	info:weight	available:store1	available:store2	available:store3
Gatorade Lemon-Lime	$3.98	xxxxxxxx	64 Oz	Yes	Yes	Yes
Prego Tomato Sauce	$4.97	xxxxxxxx	67 Oz	Yes	No	Yes
Trumoo Lowfat Chocolate Milk	$2.99	xxxxxxxx	128 Oz	No	No	Yes
Yet Another New Product	$19.99	xxxxxxxx	8 Oz	Yes	Yes	Yes

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HBase Architecture

	info:price	info:upc	info:weight	available:store1	available:store2	available:store3
A New Product	$9.99	xxxxxxxx	4 Oz	Yes	Yes	Yes
Four More Products (1)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	Yes
Four More Products (2)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	No
Four More Products (3)	$9.99	xxxxxxxx	16 Oz	Yes	Yes	No
Four More Products (4)	$9.99	xxxxxxxx	16 Oz	No	No	No

	info:price	info:upc	info:weight	available:store1	available:store2	available:store3
Gatorade Lemon-Lime	$3.98	xxxxxxxx	64 Oz	Yes	Yes	Yes
Prego Tomato Sauce	$4.97	xxxxxxxx	67 Oz	Yes	No	Yes
Trumoo Lowfat Chocolate Milk	$2.99	xxxxxxxx	128 Oz	No	No	Yes
Yet Another New Product	$19.99	xxxxxxxx	8 Oz	Yes	Yes	Yes

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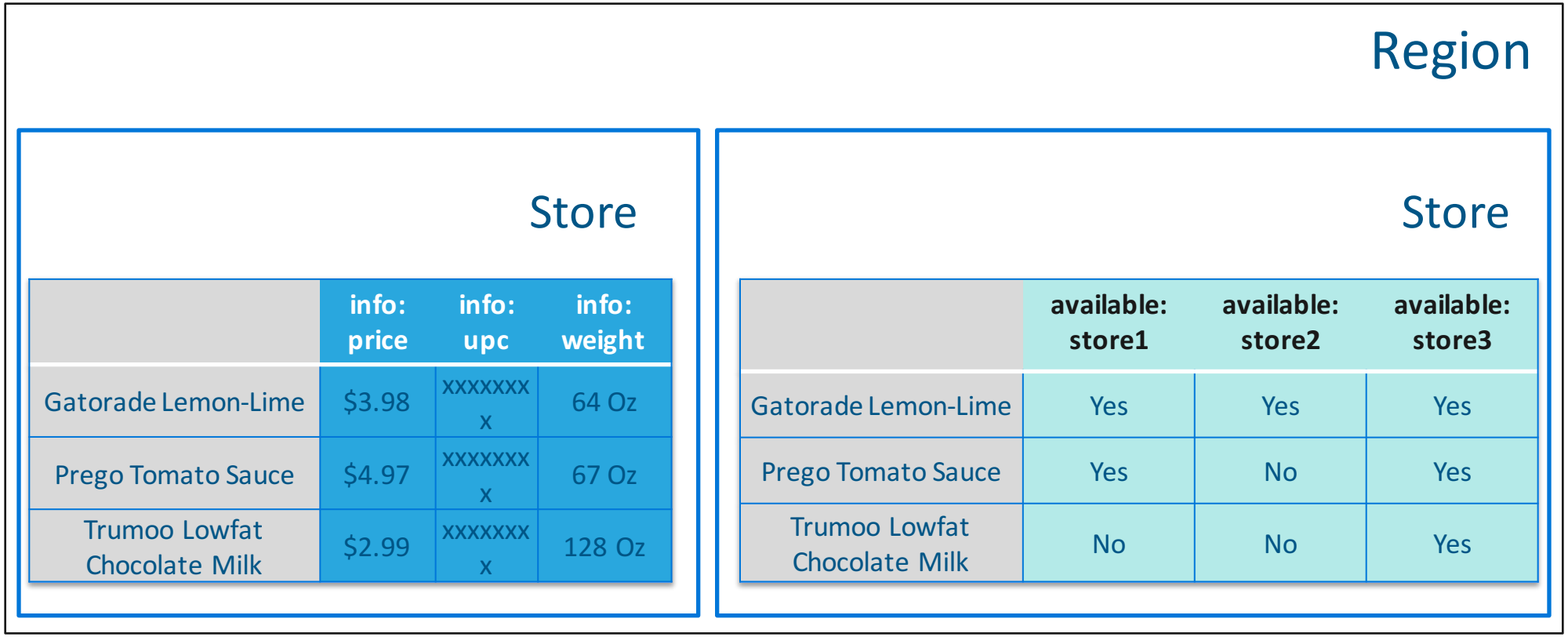
HBase Architecture | Column family

- A column family is a set of related columns.
  - Group sets of columns that have similar access patterns.
- Tune read performance.
  - Compression
  - Version retention policies
  - Cache priority

HBase Architecture



	info: price	info: upc	info: weight
Gatorade Lemon-Lime	$3.98	xxxxxxx x	64 Oz
Prego Tomato Sauce	$4.97	xxxxxxx x	67 Oz
Trumoo Lowfat Chocolate Milk	$2.99	xxxxxxx x	128 Oz

	available: store1	available: store2	available: store3
Gatorade Lemon-Lime	Yes	Yes	Yes
Prego Tomato Sauce	Yes	No	Yes
Trumoo Lowfat Chocolate Milk	No	No	Yes

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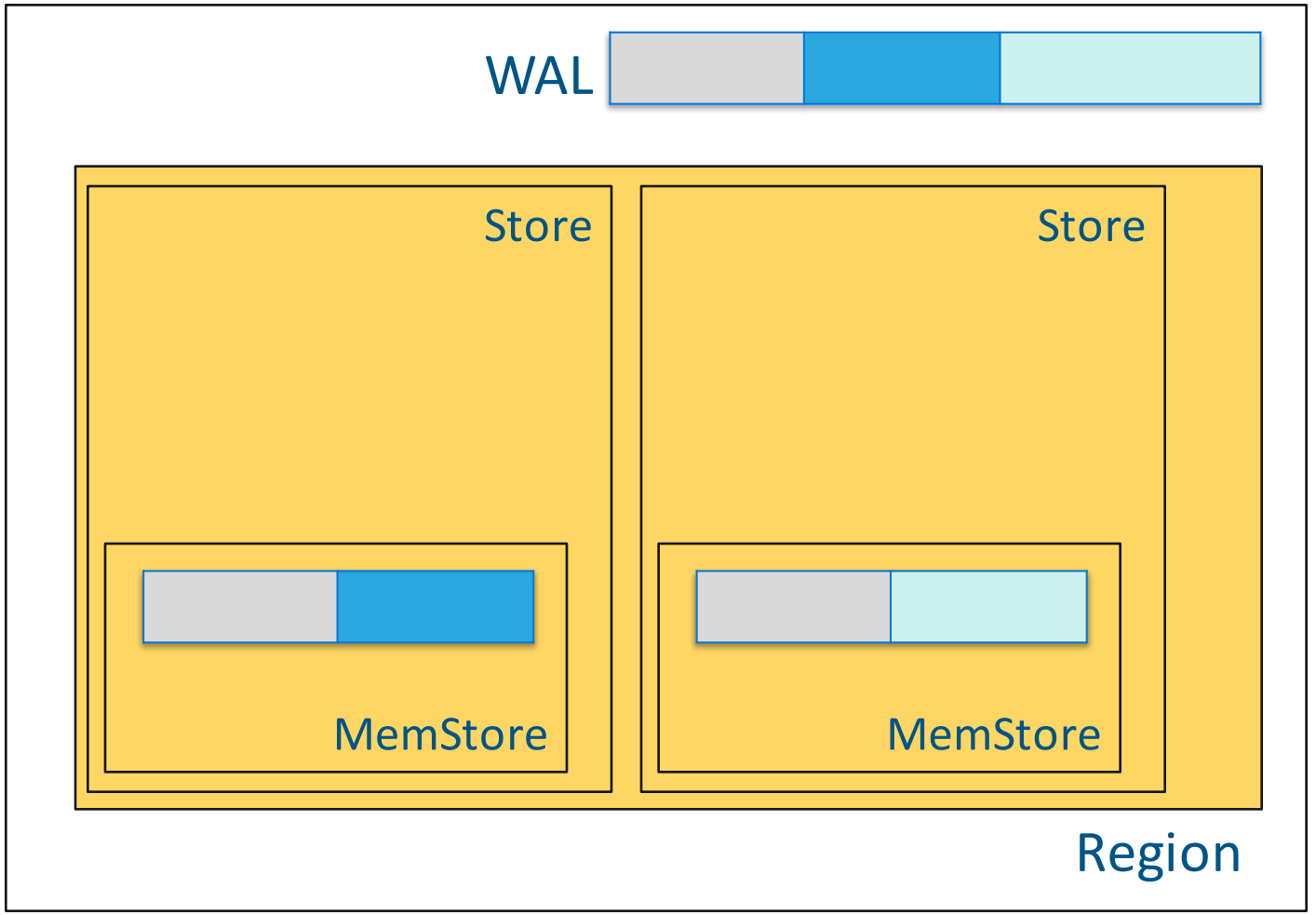
HBase Architecture | Write Path

1. Client creates a row to put.
2. Client checks with meta* for which RegionServer hosts this row.
3. Row is written into write-ahead log (WAL).
4. Row is written to MemStore.

HBase Architecture | Write Path

HBase Architecture | Write Path

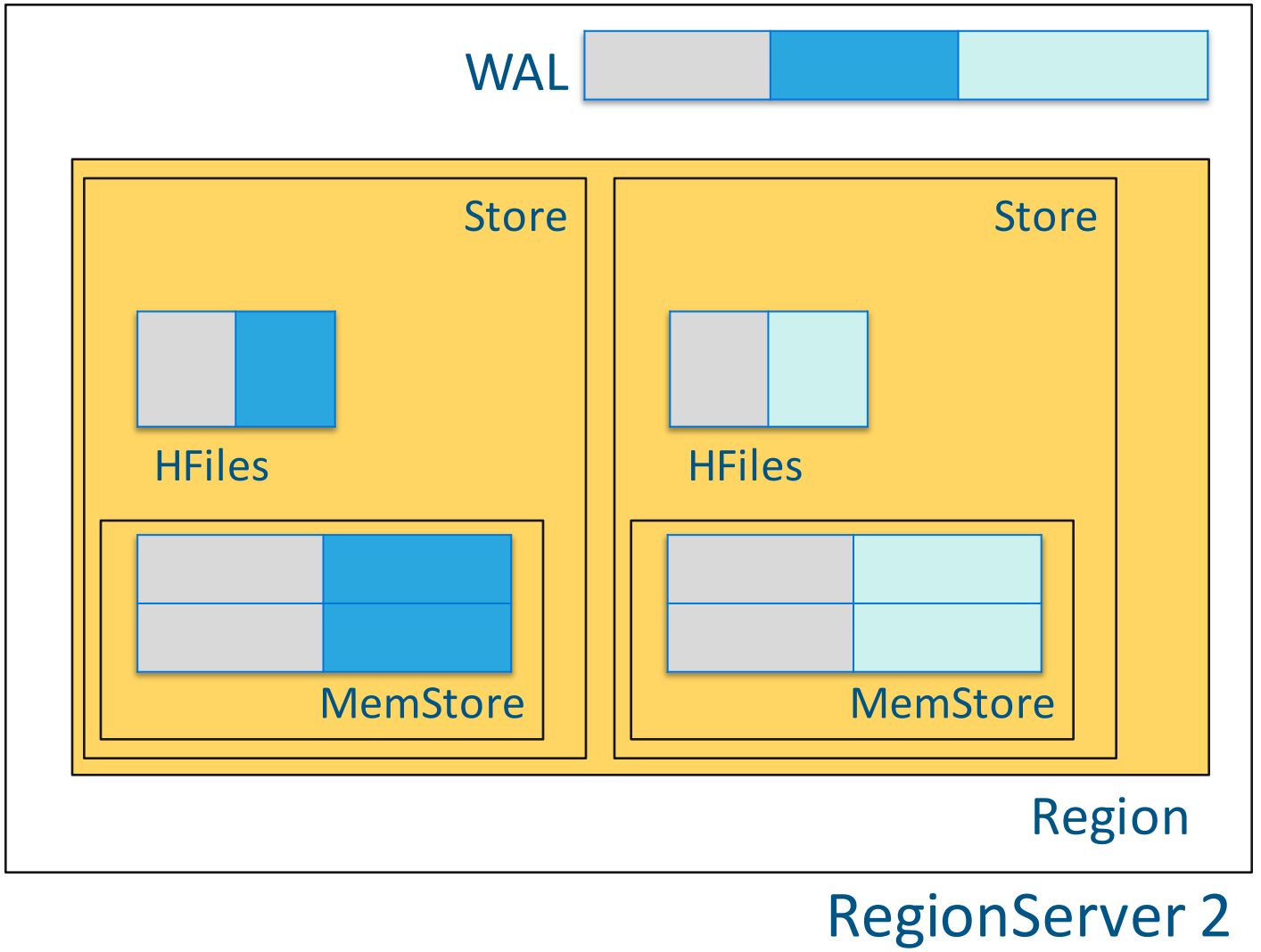


Put

HBase Architecture | Write Path

- When MemStore gets full or a flush is triggered, contents of MemStore are flushed to disk.
  - HFiles are created.

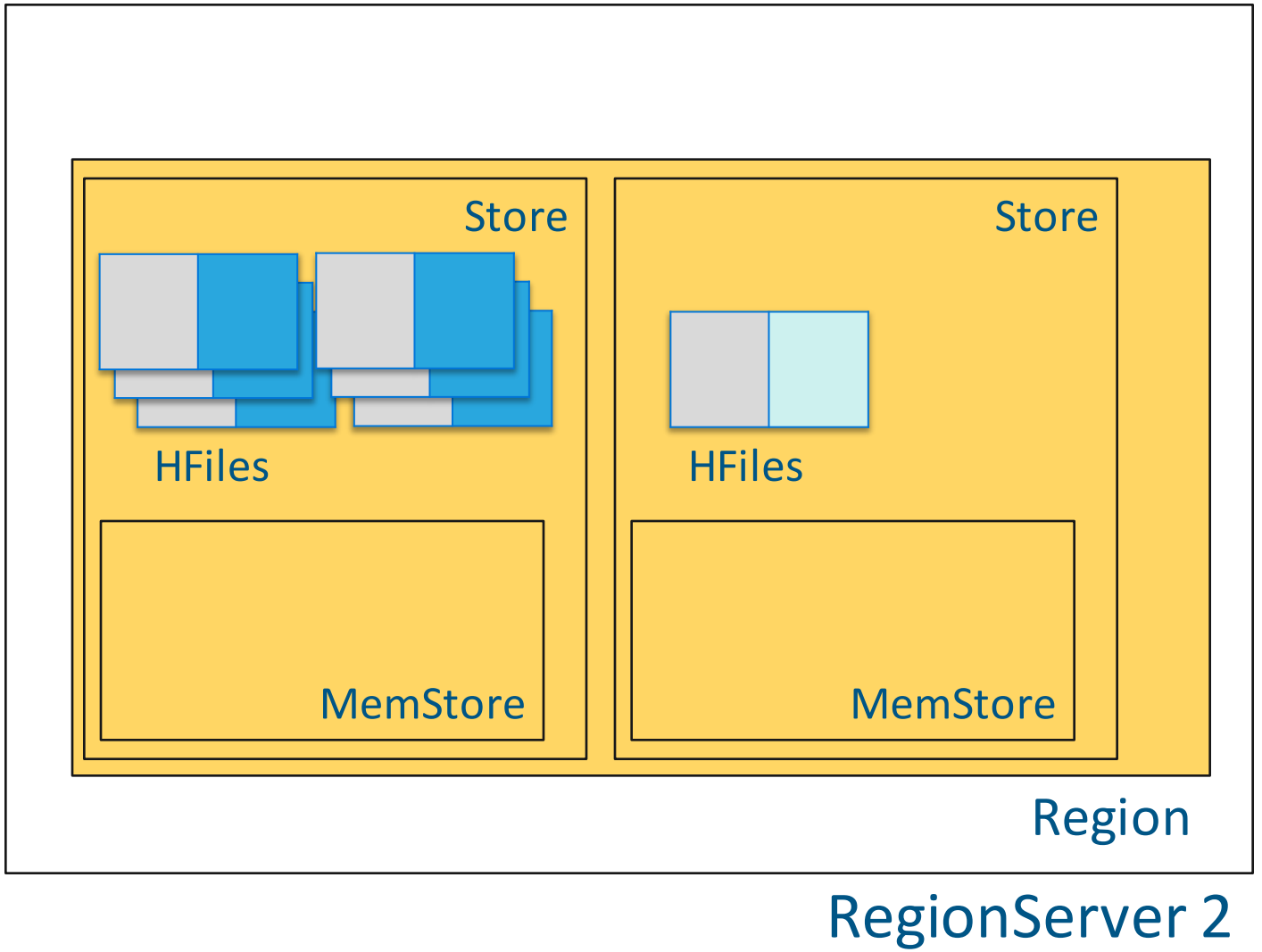
HBase Architecture | Write Path



HBase Architecture | Write Path

- Each subsequent write repeats this process.
  - Write to WAL.
  - Write to MemStore.
  - Flush when MemStore fills or a flush is triggered.
  - Create HFiles.
- Lots of HFiles in a Region mean lots of disk seeks on read.
  - Might be better to combine (compact) HFiles.

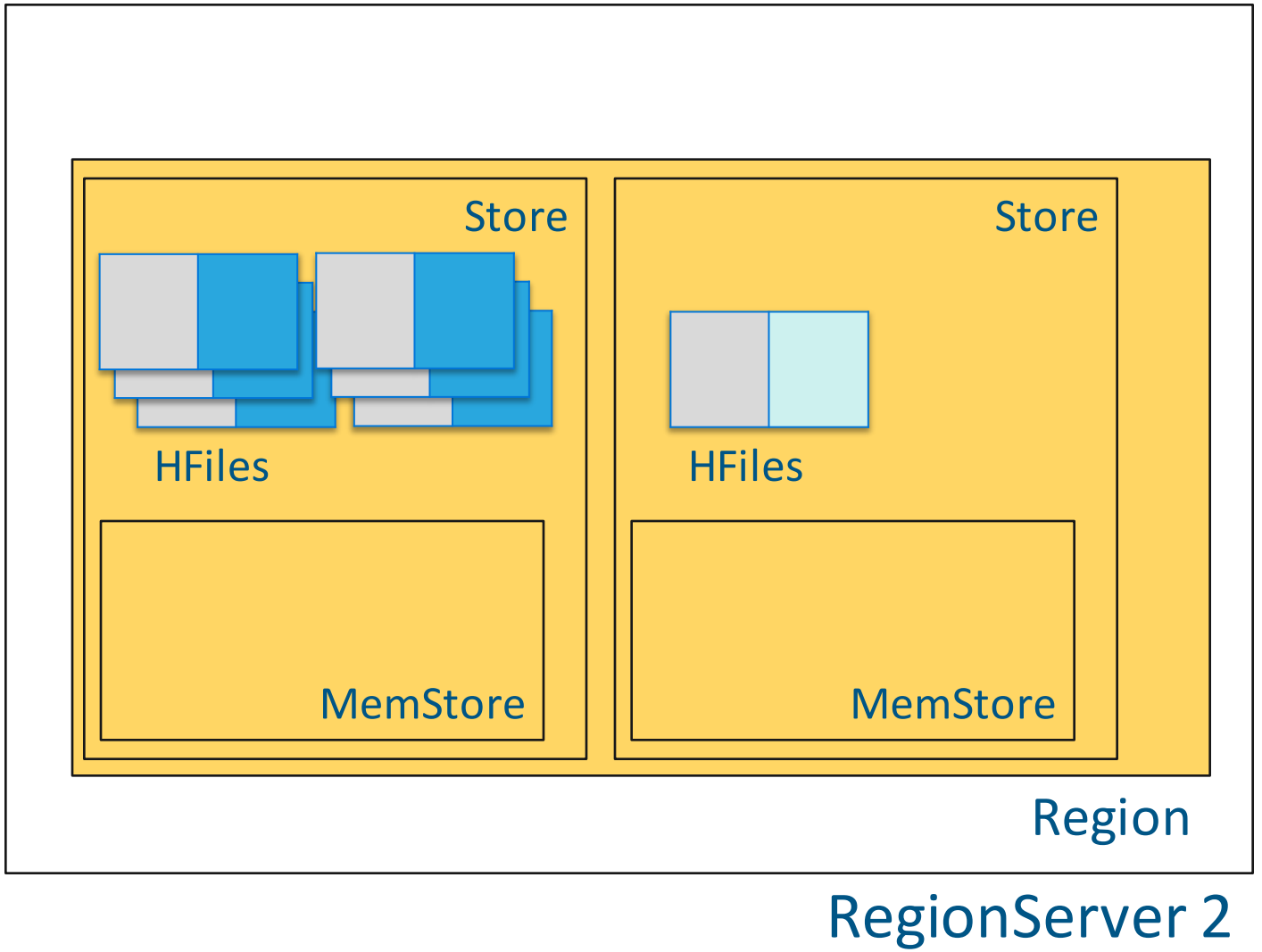
HBase Architecture



HBase Architecture | Compactions

- Minor compactions
  - Merge some HFiles (in a given Store).
- Major compactions
  - Merge all HFiles (in a given Store).
  - Take care of other HBase housekeeping tasks.

HBase Architecture | Compaction



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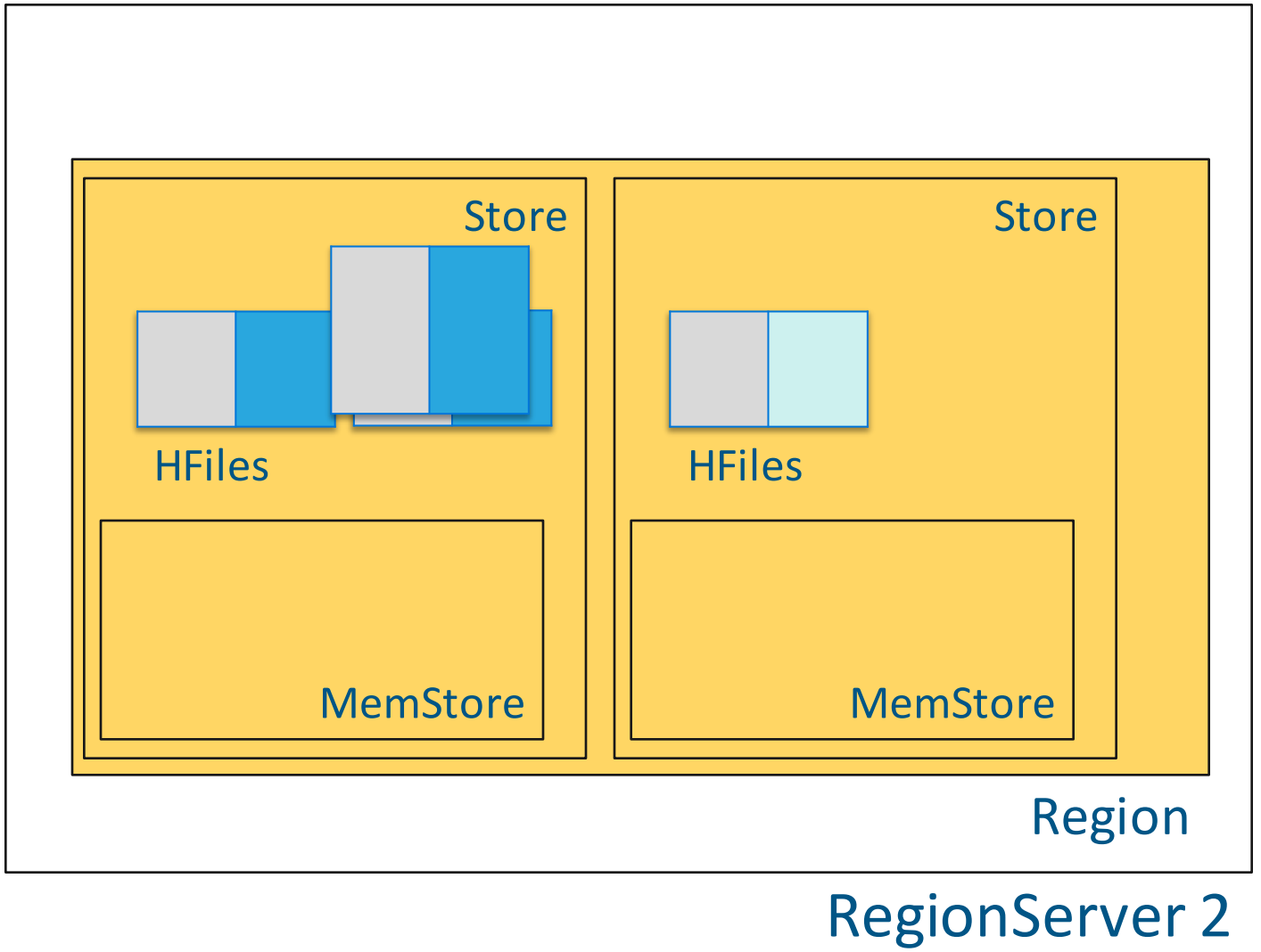
HBase Architecture | Minor compaction



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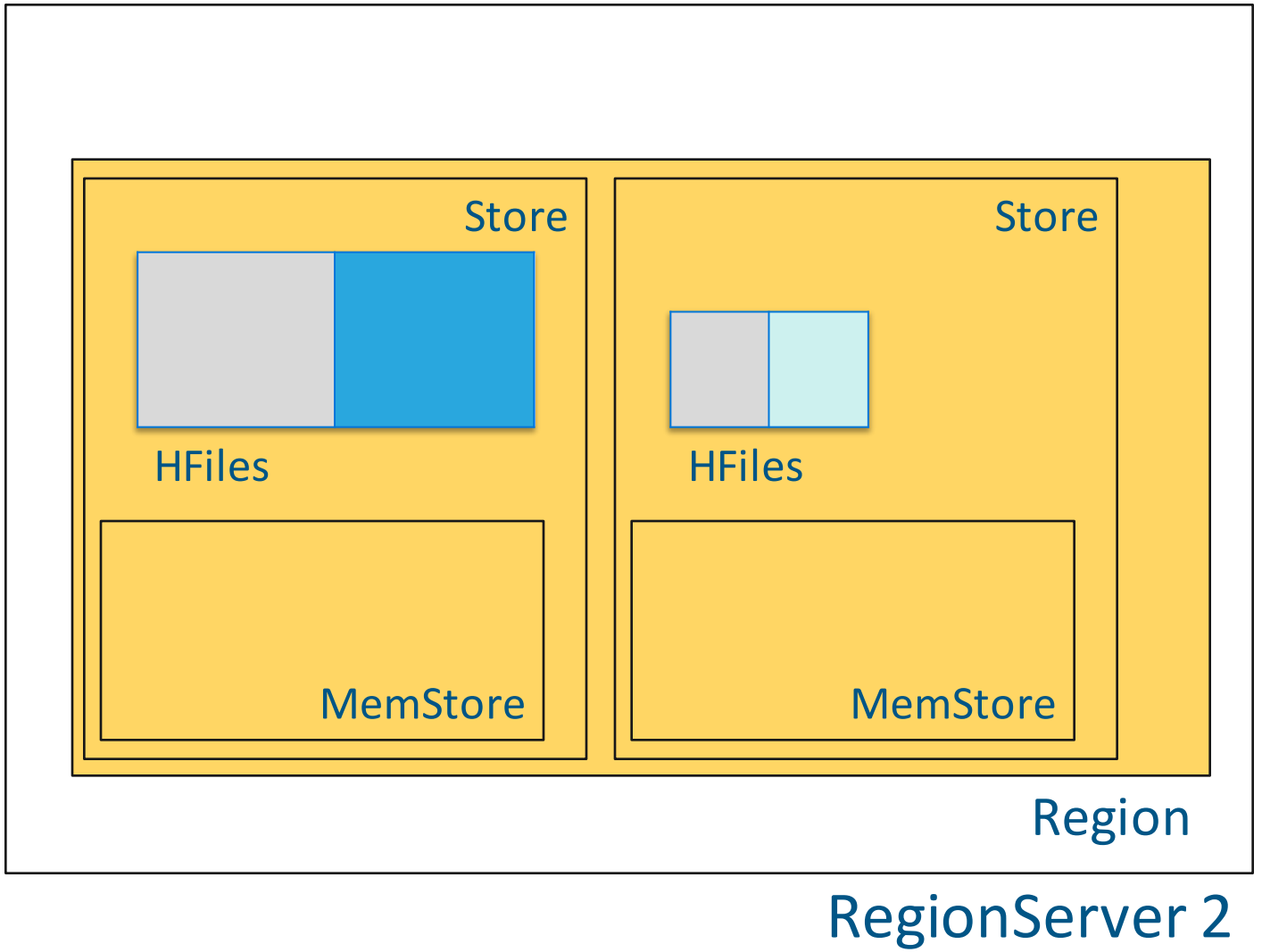
HBase Architecture | Major compaction



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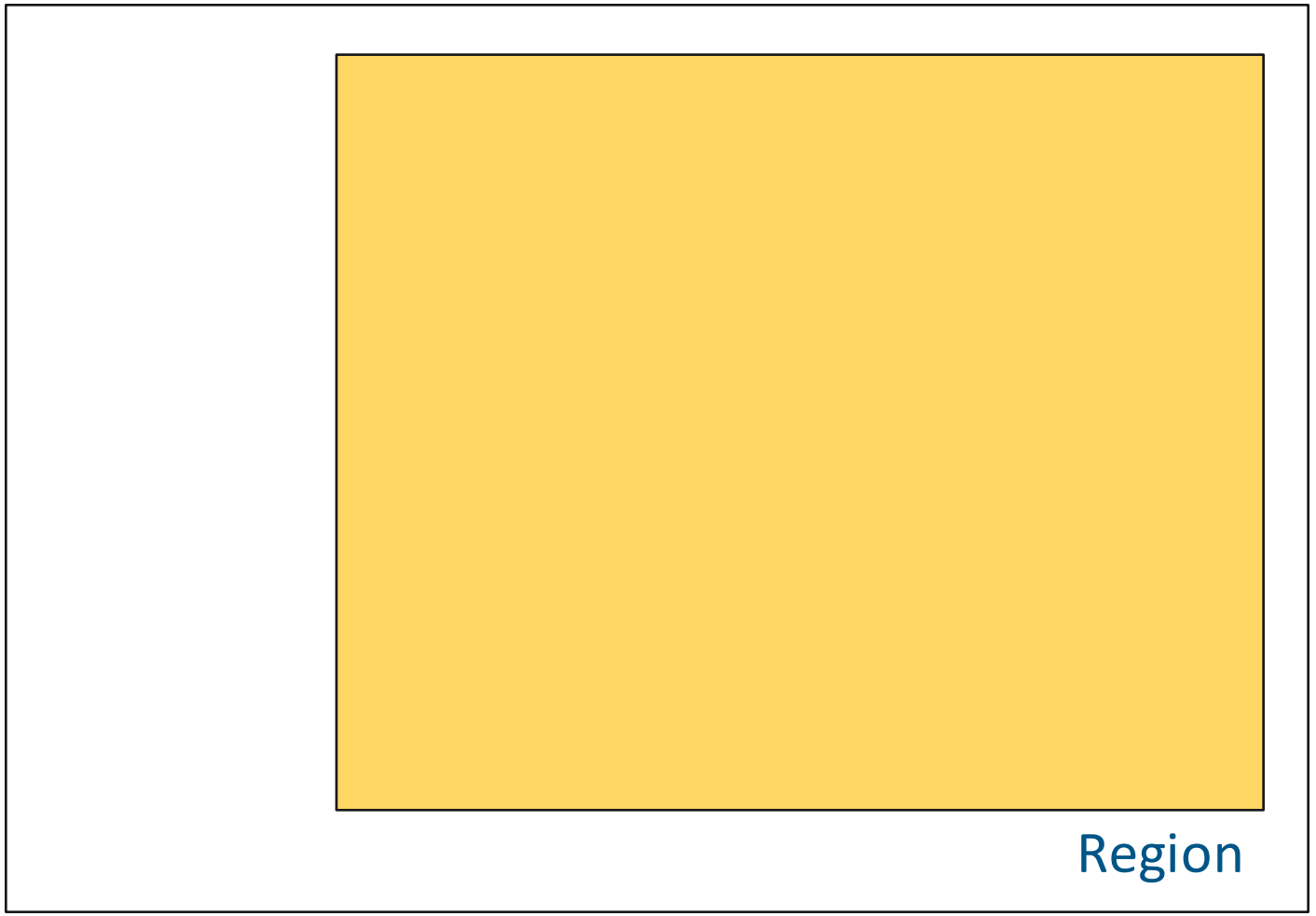
HBase Architecture | Compactions

- Minor compactions
  - Controlled by policy (pluggable).
- Major compactions
  - Automatic (by time) or manually triggered.
  - Tend to be run during off-peak times.

HBase Architecture | Splits

- Eventually, Regions become imbalanced.
  - Some grow to be huge, others remain small.
  - Leads to disparate load across RegionServers.
- In these cases, HBase can split a Region into two.
- Each Region is then available to be moved to a different RegionServer, if necessary.

HBase Architecture | Splits



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HBase Architecture | Splits

RegionServer 3: Yeah! Pick me!

Master: RegionServer 2 is really busy… Maybe another RegionServer can handle one of its Regions?

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HBase Architecture | APIs

- Conventional write path can be accessed through multiple APIs:
  - Java API
    - Most full-featured.
  - REST API
    - Easily accessible.
  - Thrift API
    - Support for many languages (e.g. C, C++, Perl, Ruby, Python).

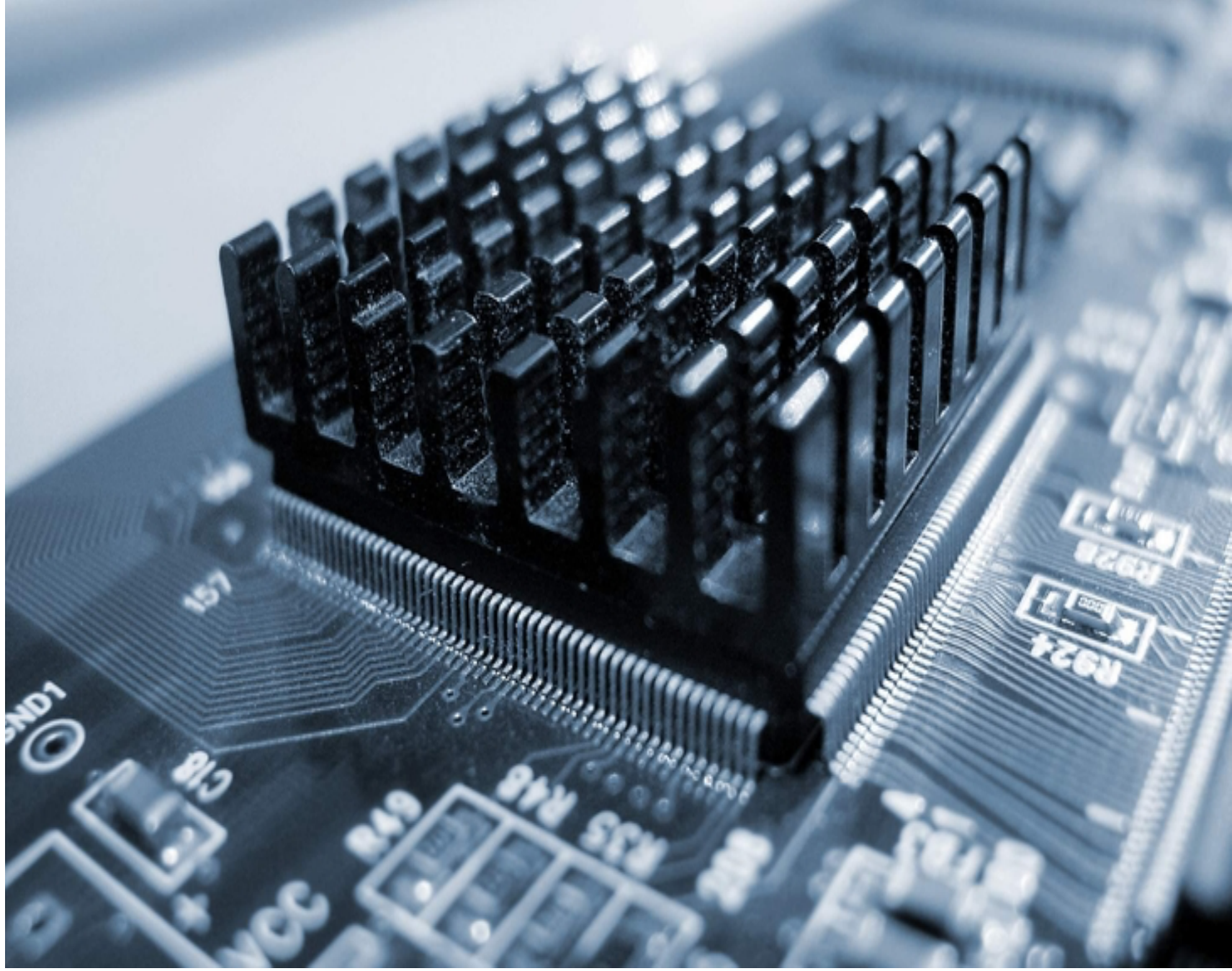
HBase Architecture | APIs

- This write path is durable, but if you're importing a lot of data, it can be problematic…
  - Every put goes into WAL, which means disk seeks. Lots of puts mean lots of disk seeks.
  - Lots of data into MemStores means lots of flushing to disk.
  - Lots of flushing to disk might mean lots of compactions.

HBase Architecture | Bulk Loading

- Bypass conventional write path.
  - Extract data from source.
  - Transform data into HFiles (done with MapReduce job) directly.
  - Tell RegionServers to serve these HFiles.

Enough of Architecture



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What's up next, Doc?

- Break
- What have we learned from the users
- How can **you** benefit from that information

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Break

Apache HBase "Nascar" Slide

Apache HBase “Nascar” Slide

Apache HBase “Nascar” Slide

Apache HBase "Nascar" Slide

Apache HBase "Nascar" Slide

Apache HBase "Nascar" Slide

Apache HBase "Nascar" Slide

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What have we learned from all these users?

There are some patterns which repeat often.

Just like a lego block, maybe you can fit one directly in your system!

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Know your ...

Data

- Entity Data
- Time-centric Event Data

Use of data

- Operational
- Analytical

How it goes in and out

- Real-time vs Batch
- Random vs Sequential

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Know your data ...

There are primarily two kinds of big data workloads. They have different storage requirements.

- Entity centric data
- Time centric event data

Entity centric data

Users

Accounts

Location

Clicks and Metrics

Sensor Data

- Scales up with # of entities
- Billions of distinct entities

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Time centric event data

Stock Ticker Data

Monitoring applications

Periodic Sensor Data

- Time-series data points over a period
- Scales up due to finer grained intervals, retention policies, and the passage of time

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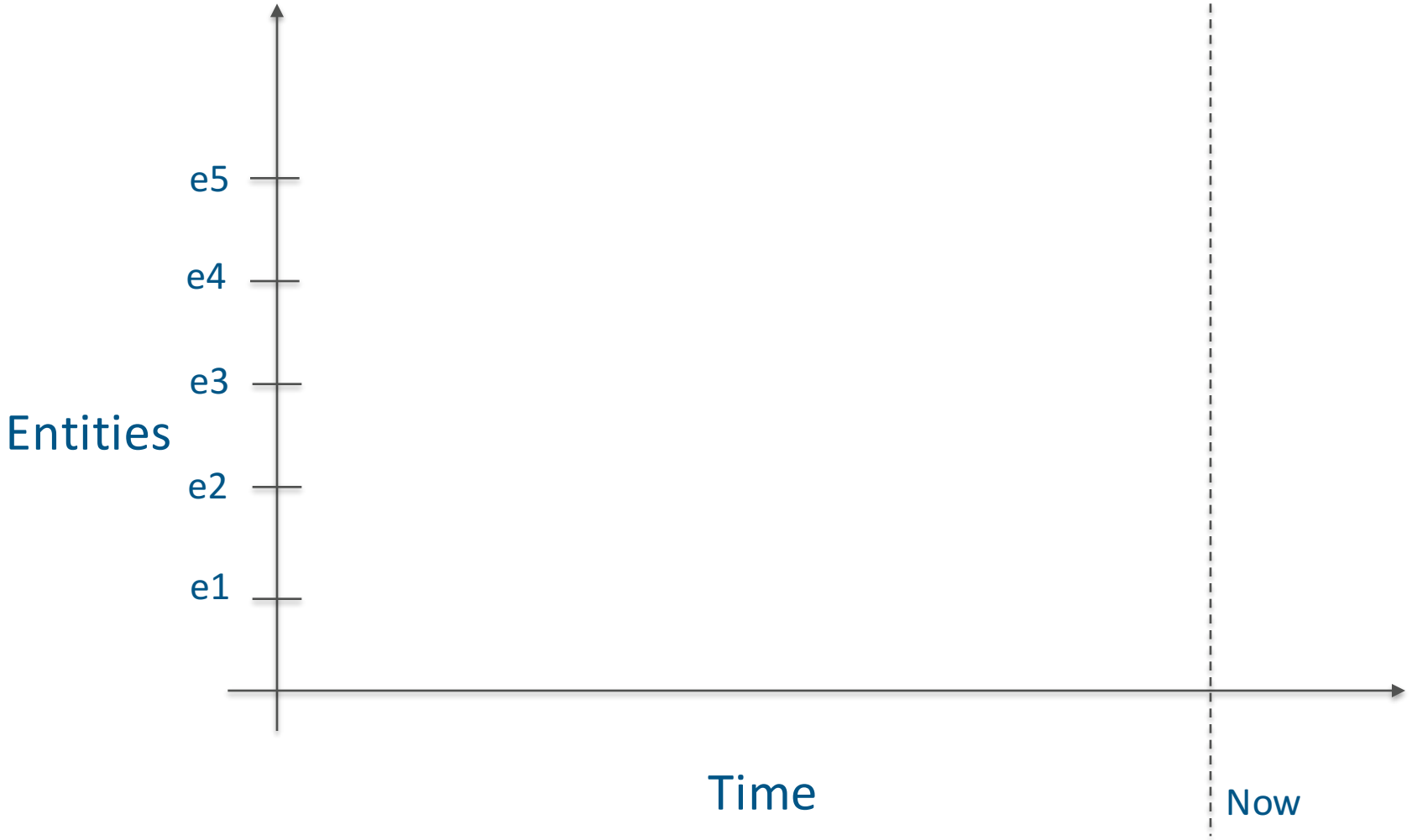

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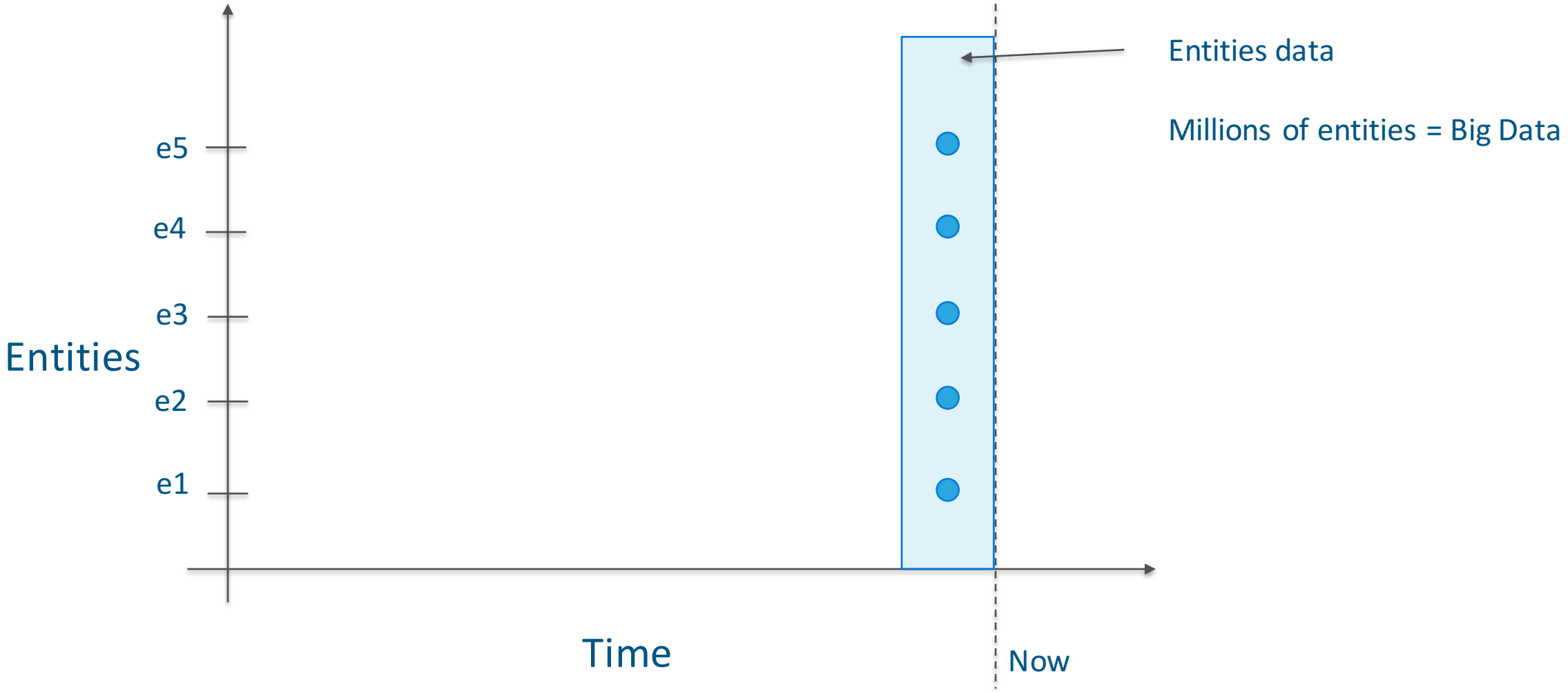
Entities data



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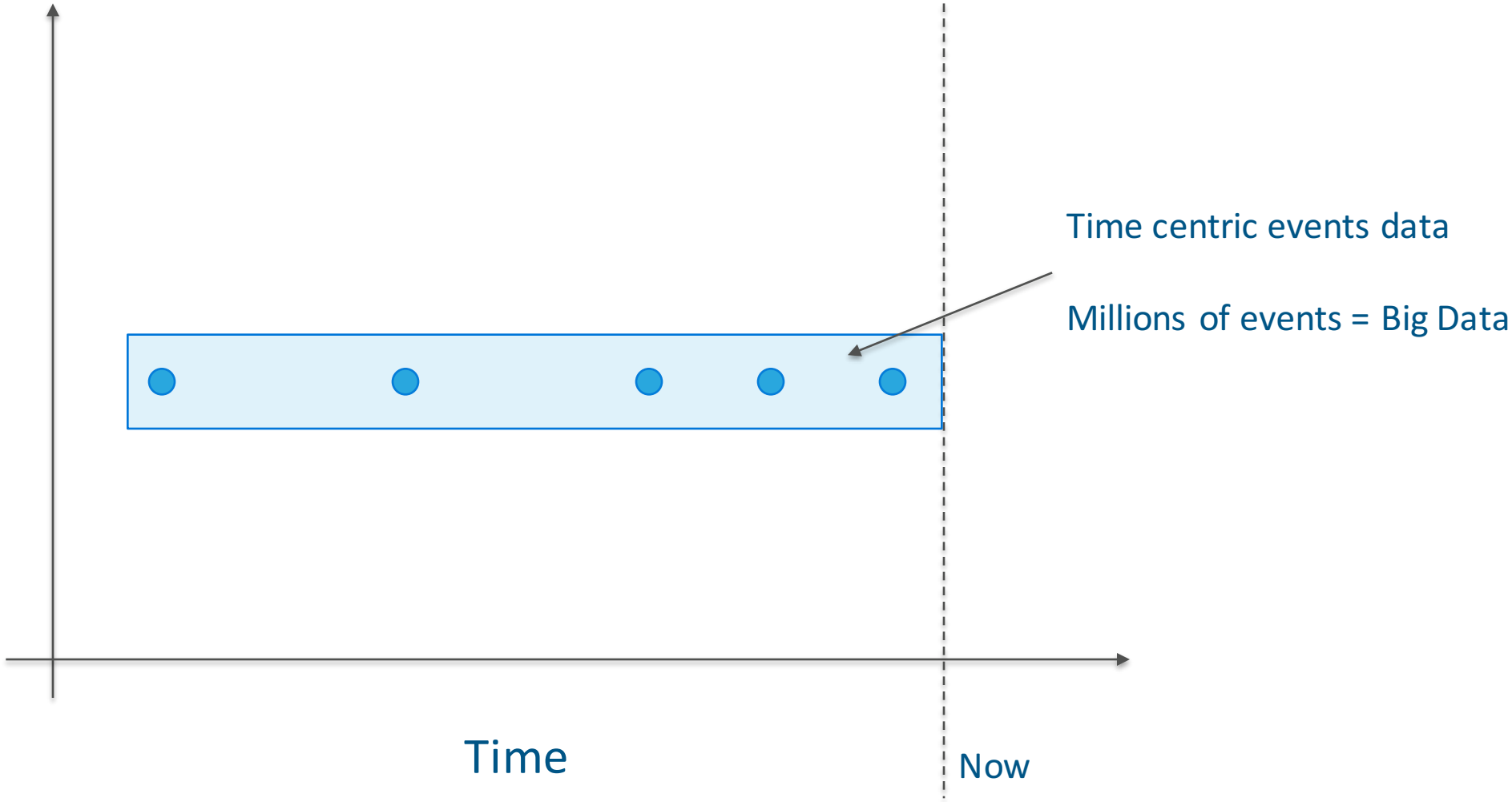
Time-centric events data



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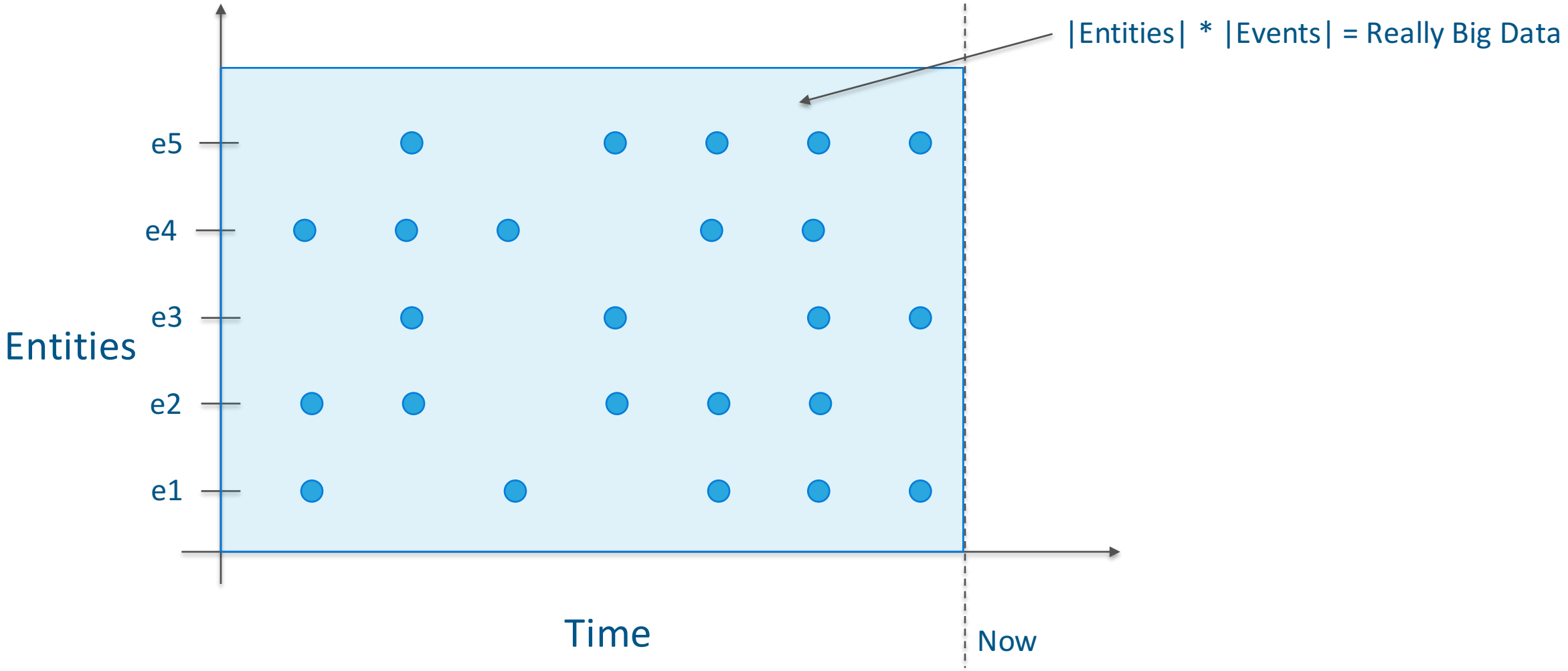
Time-centric events about Entities



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What questions do you ask?

- Do you focus in on entity first?

OR

- Do you focus in on time ranges first?

- Your answer will help you determine where and how to store your data.

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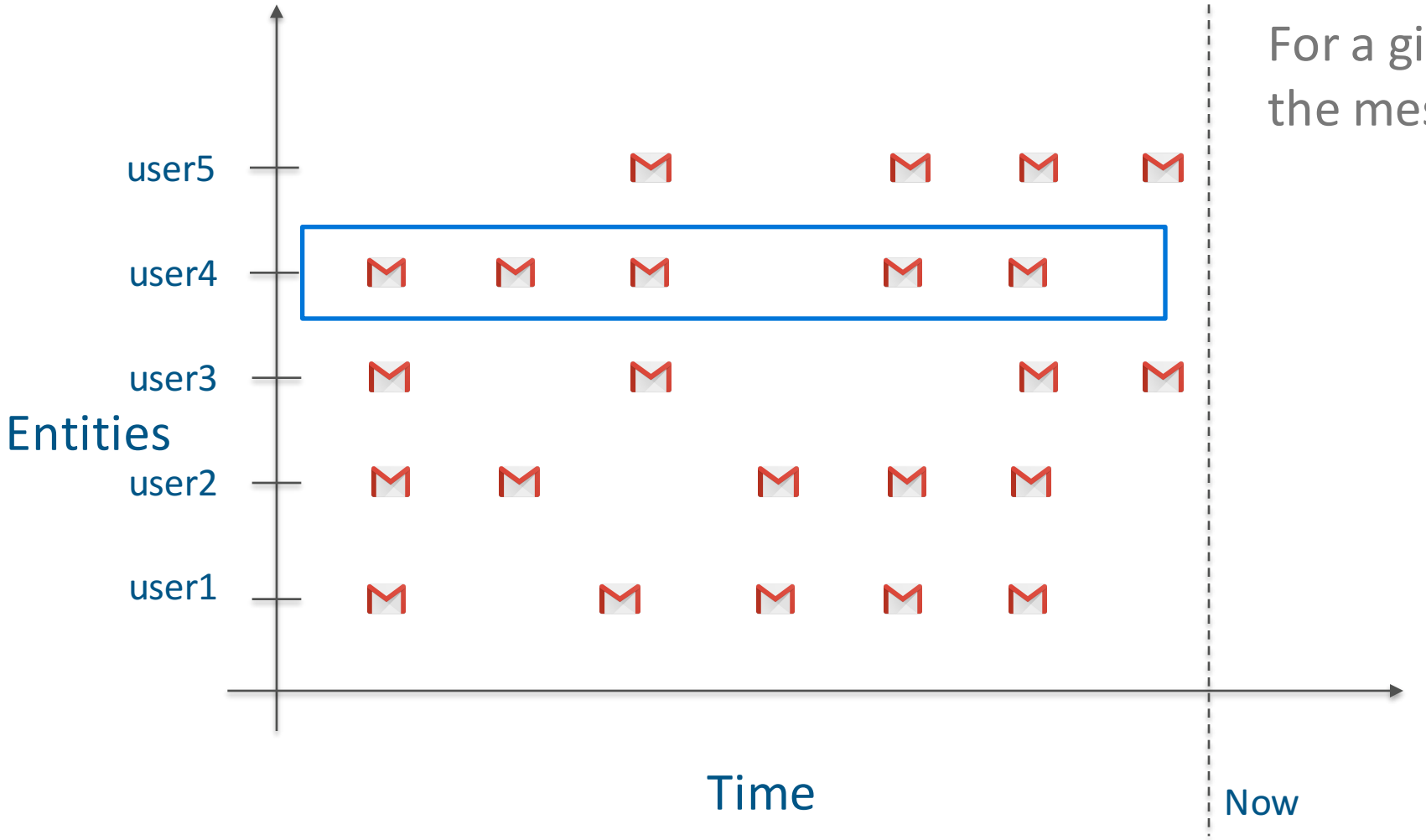
Entity first questions…



For a give user, show all the messages.

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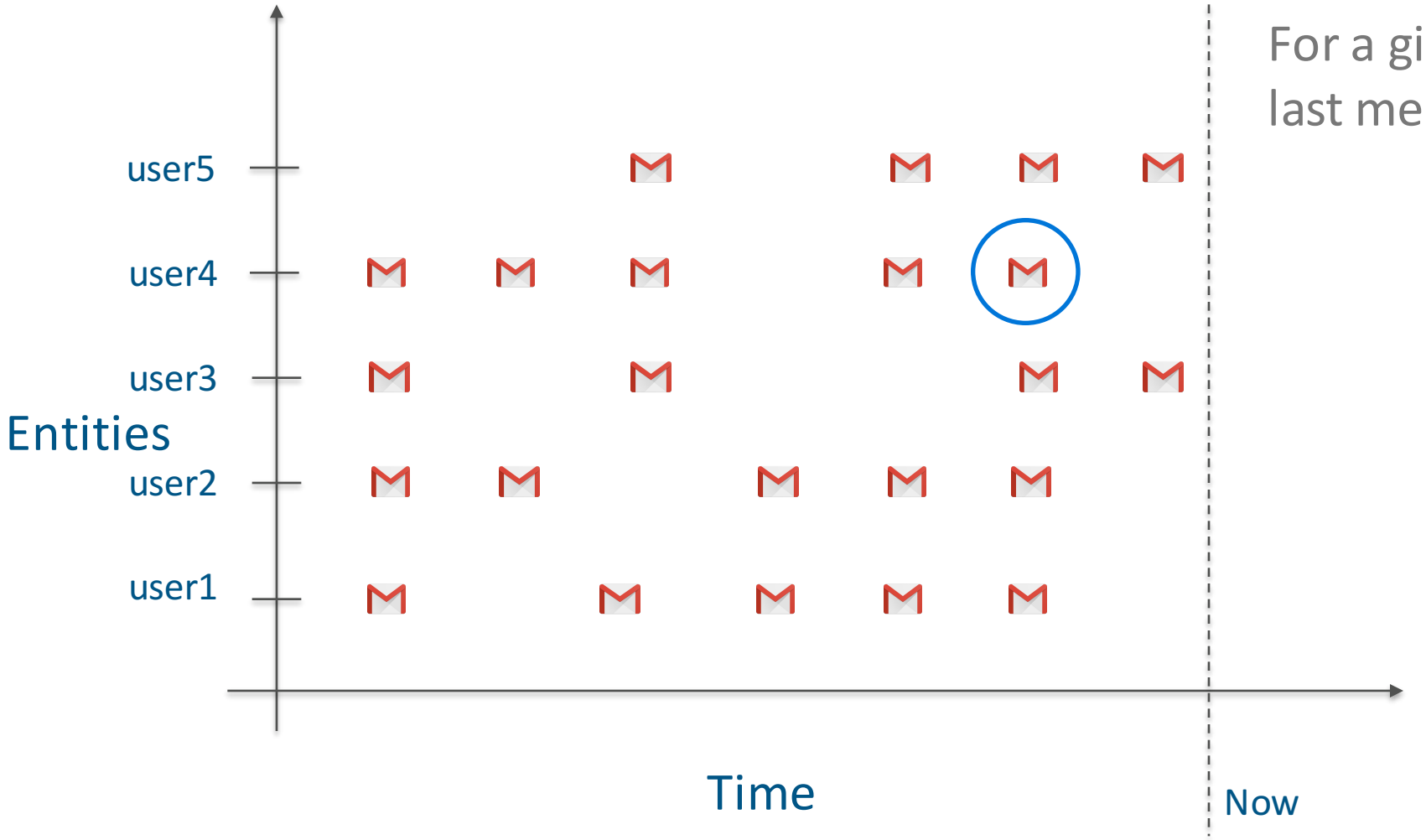
Entity first questions…



For a given user, show the last message.

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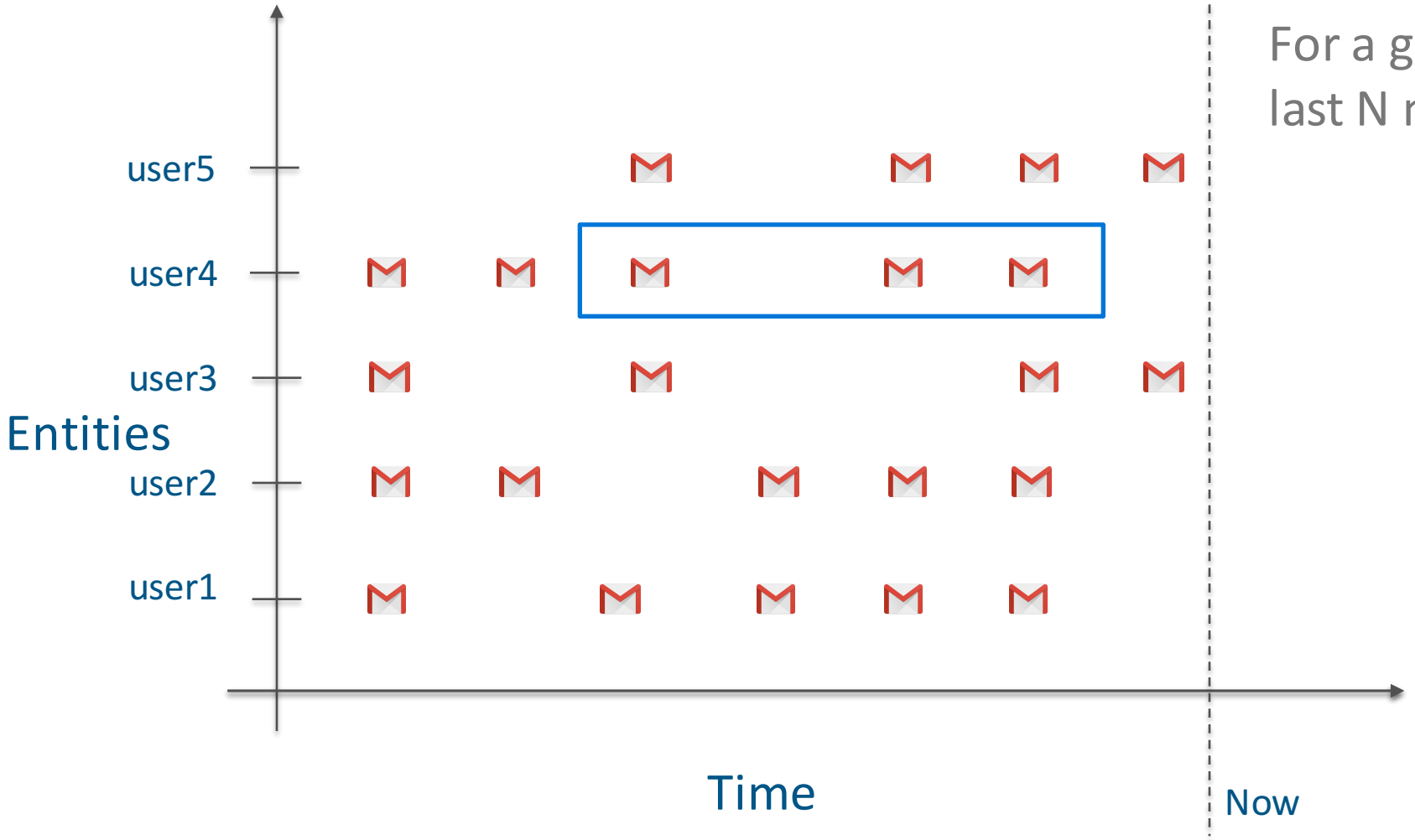
Entity first questions…



For a give user, show last N messages.

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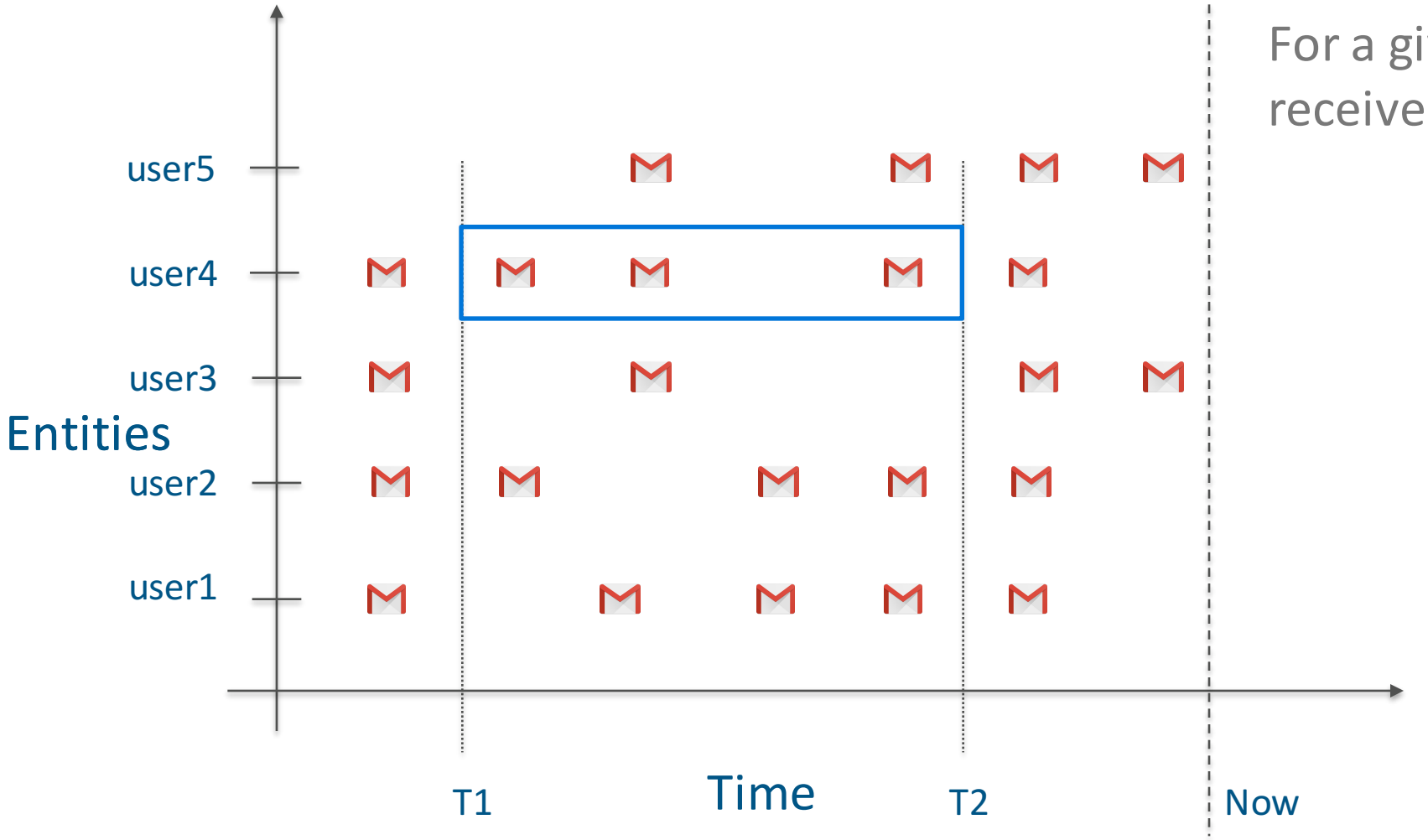
Entity first questions…



For a give user, show all messages received between time [t1, t2].

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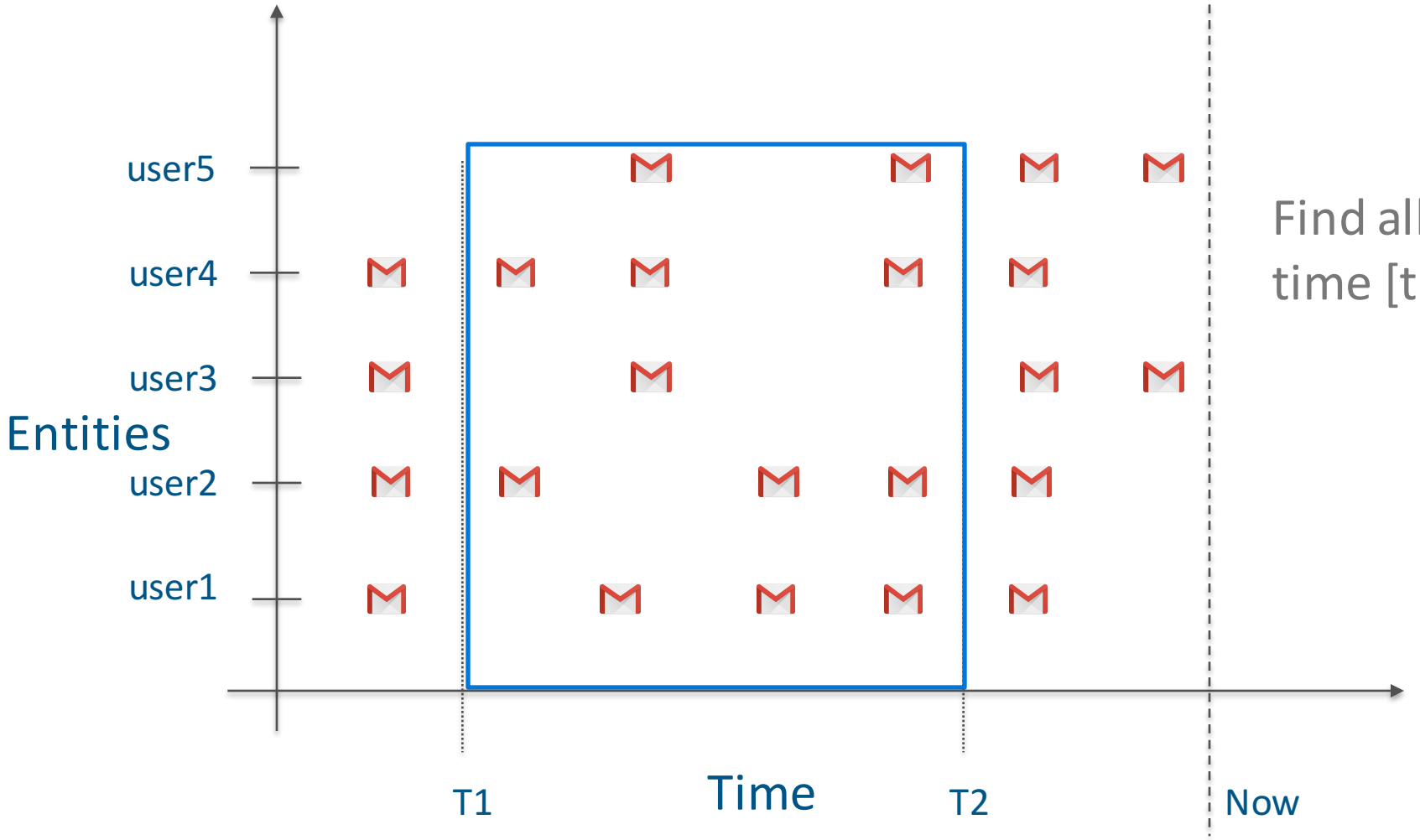
Time centric event first questions…



Find all messages between time [t1, t2].

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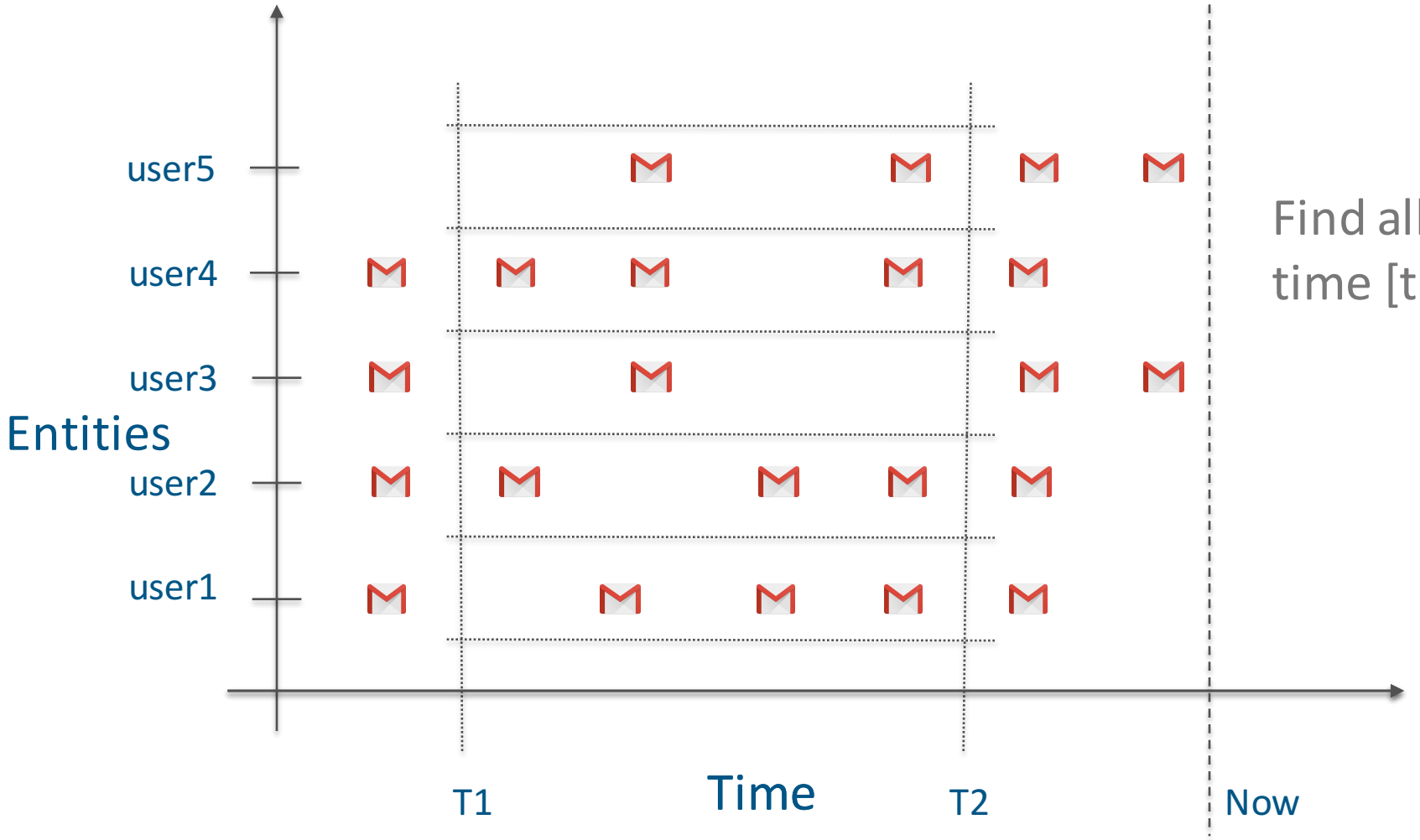
Time centric event first questions…



Find all messages between time [t1, t2] **for all users.**

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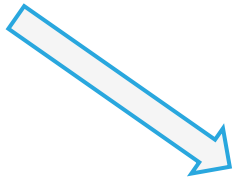
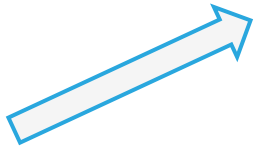
How does the data get in and out of HBase?

Getting data in...

Put, Incr, Append





Bulk Import

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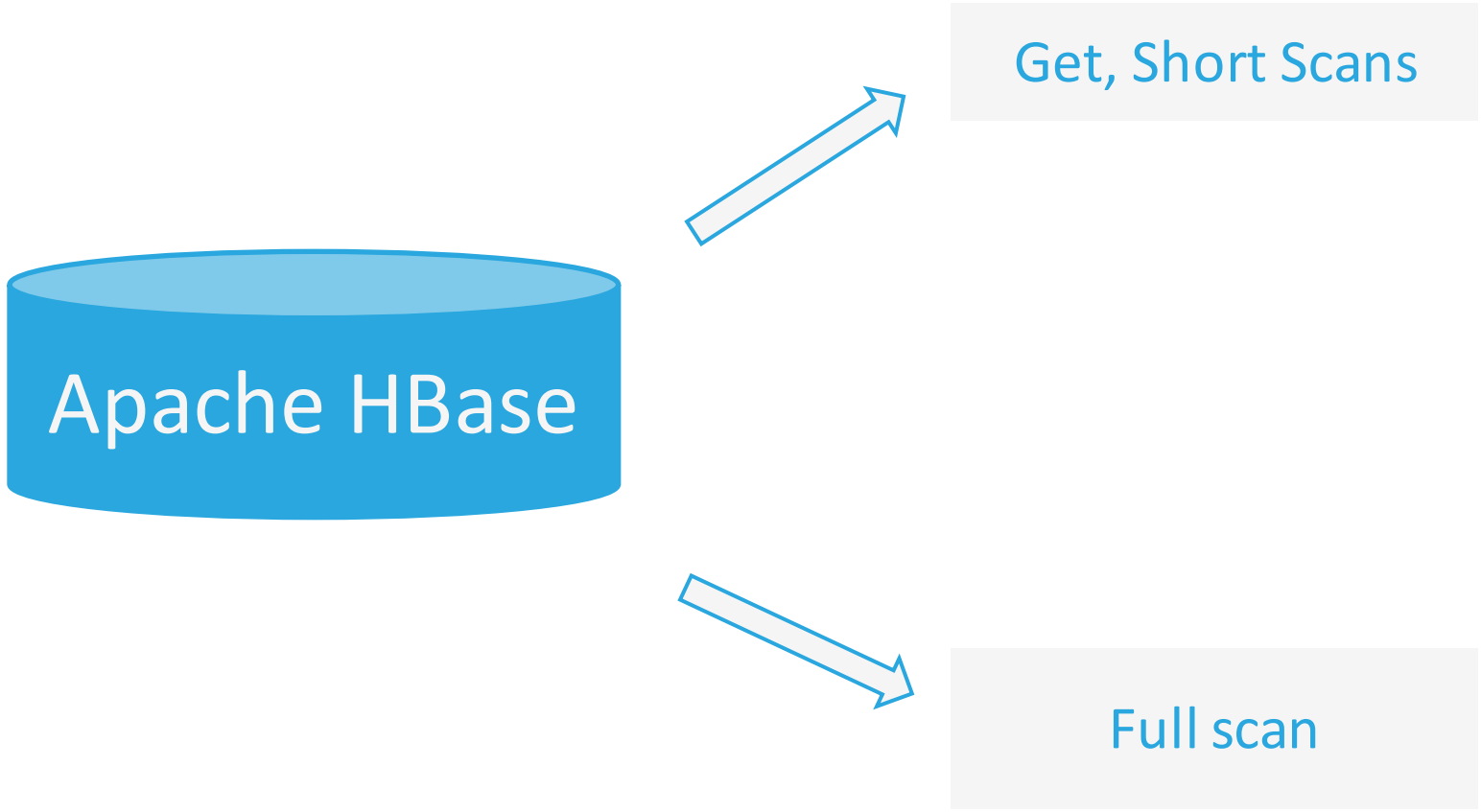
Getting data out...



So, what's the best way?

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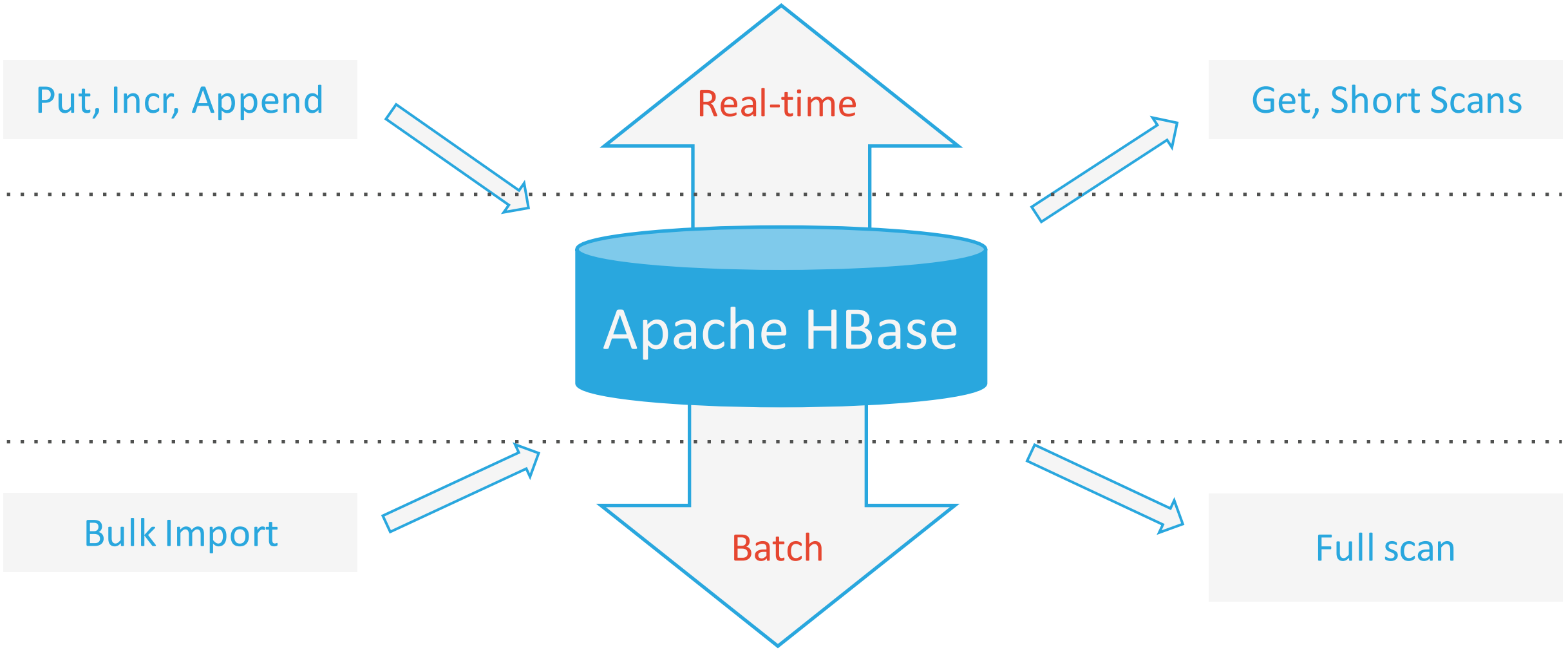
Depends on your use case

Bottom-line: Disk I/O takes times.

- Limited disk read-write heads in a cluster

- Use the I/O bandwidth of your cluster efficiently



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Let’s dive into use case ...

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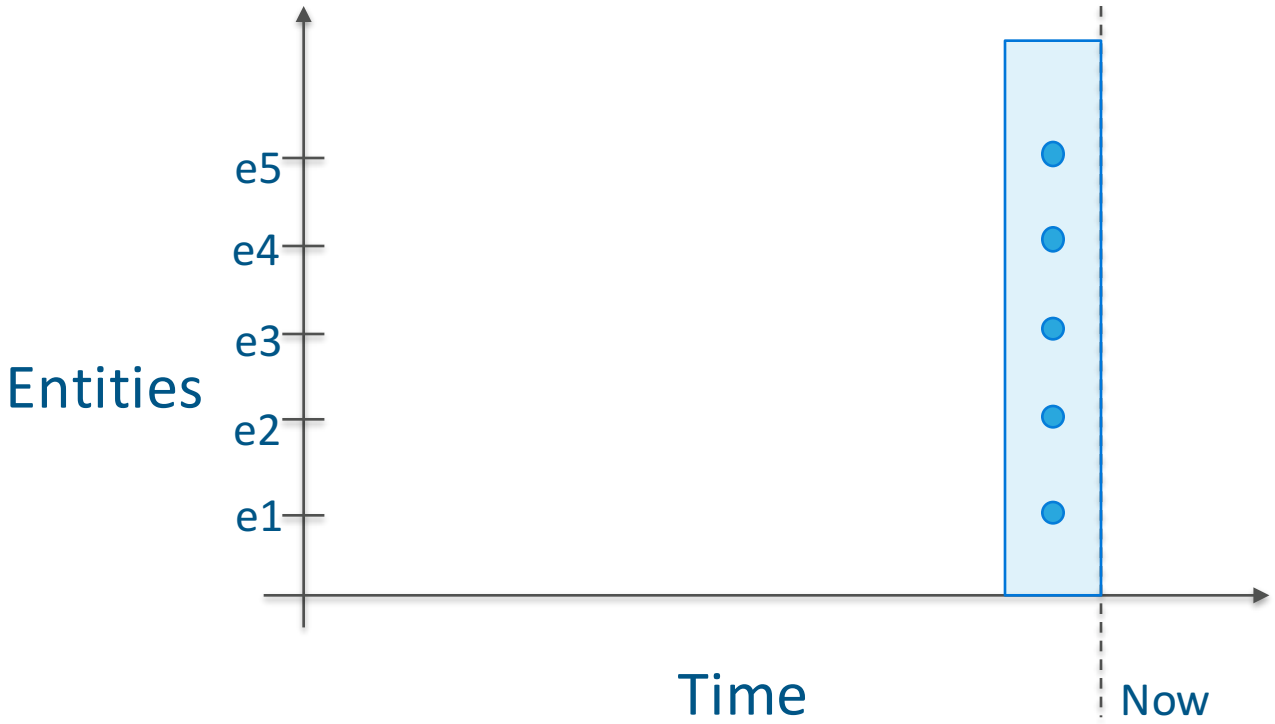
Simple Entities

- Purely entity data, no relation between entities
  - Often from many different sources
  - Could be a well-done de-normalized RDBMS port



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Simple Entities : Schema

- Row per entity
- Row key => entity ID, or hash of entity ID
- Column => Property / field, possibly timestamp

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Simple Entities : Example

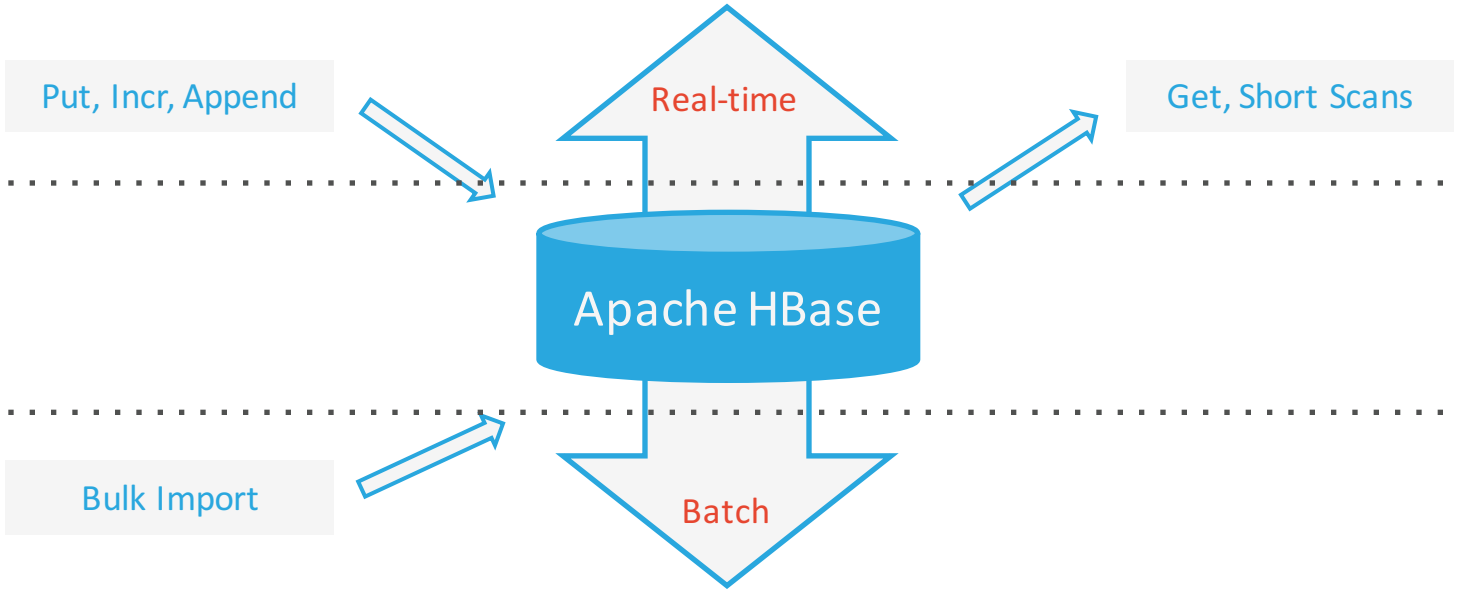
OCLC : Online Computer Library Center 

Workloads:

- Lookup books → Real time read
- Add new book one at a time, update information about existing books, issue books → Real-time write
- New library joins the group, import its data → Batch write

Simple Entities : Access Pattern

- Access Patterns
  - Writes : Batch / Real-time
  - Reads: Real-time



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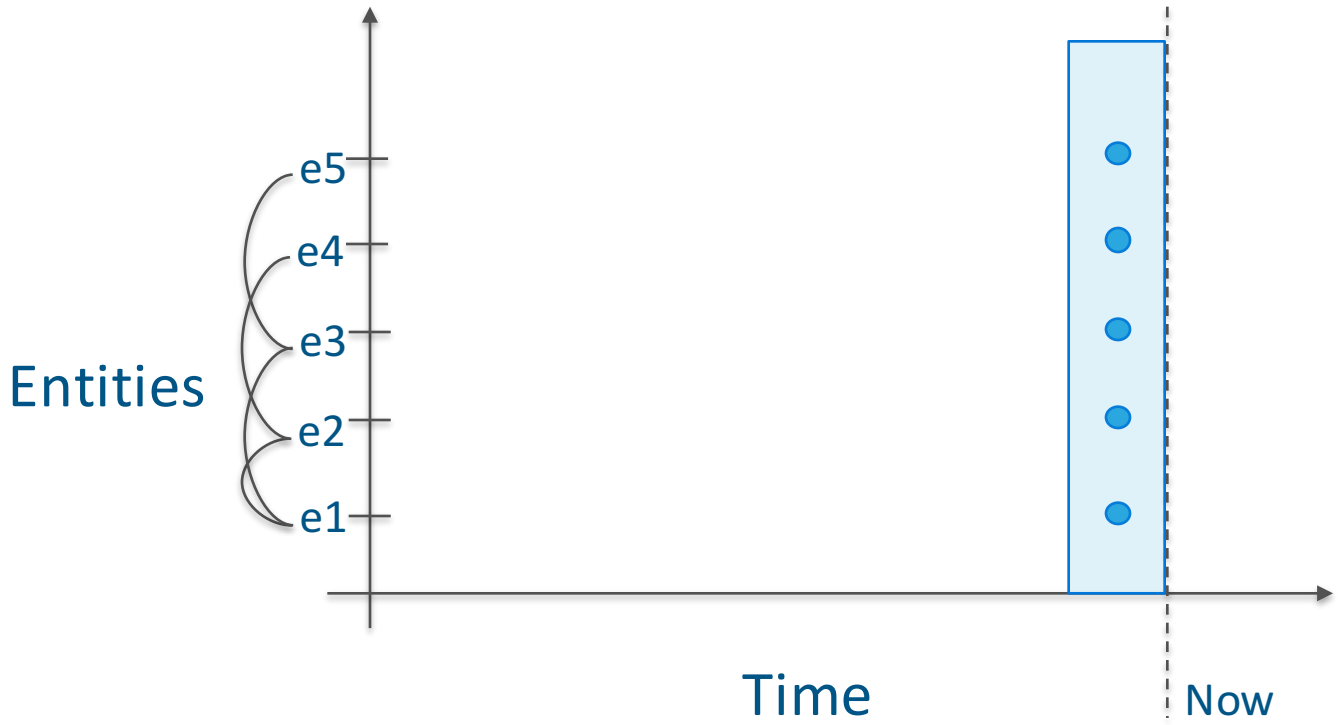
Linked Entities (Graph Data)

- Entity are linked to form a graph



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Linked Entities (Graph Data) : Schema

- Row per Node (Entity)
- Row key => Node ID (Entity ID)
- Column => “Relationship:OtherNodeID”
- Value => Meta data about relationship

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Linked Entities (Graph Data) : Example

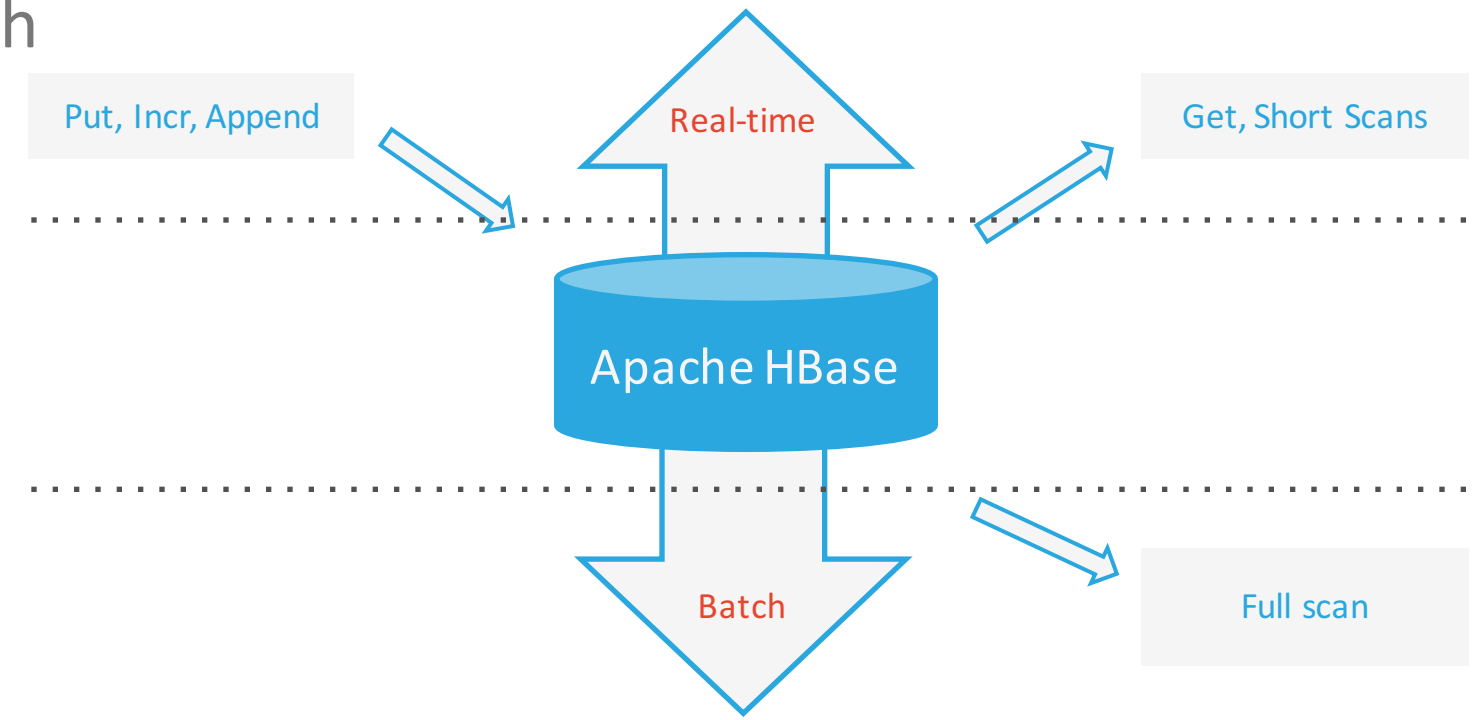
Social Network (Facebook)

Workloads:

- Get any info about a user → Real time read
- Update any info about a user → Real time write
- Limited graph analysis (based on immediate friends) → Batch read

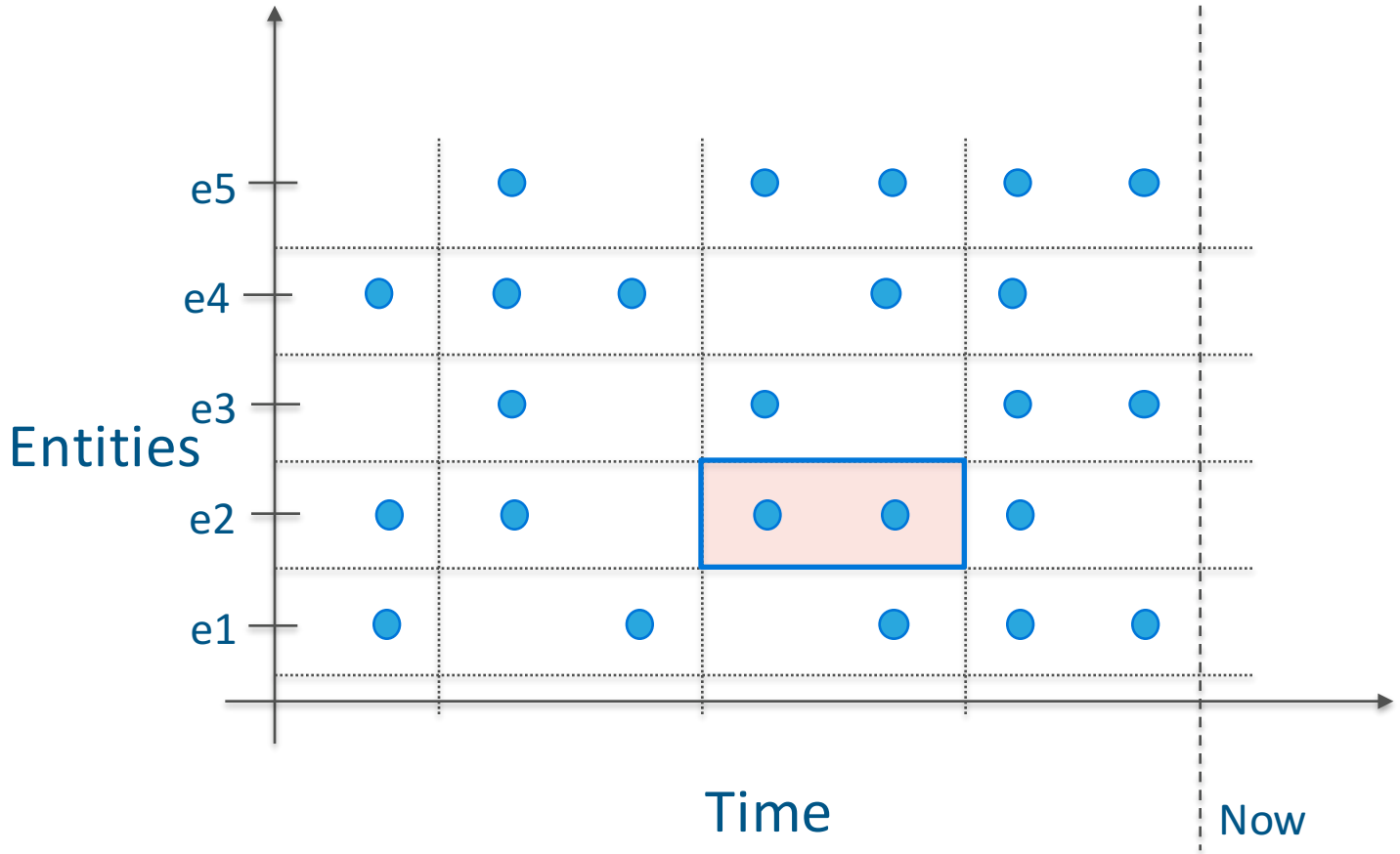
Linked Entities (Graph Data) : Access Pattern

- Access Patterns
  - Reads: Real-time or Batch
  - Writes: Real-time



Time-coupled entities

- Events about entities in time centric
- **Focus on entities first**



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Time-coupled entities : Schema

- Row = Entity's events in a time slice
- Row key = Entity ID + (time / k)
- Column Qualifier = timestamp

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Time-coupled entities: Example

Messaging service

Primary Workload

- Sending a message, update metadata (read, star, move, delete) →

  Real-time write

- Reading a message, get last N messages → Real-time read

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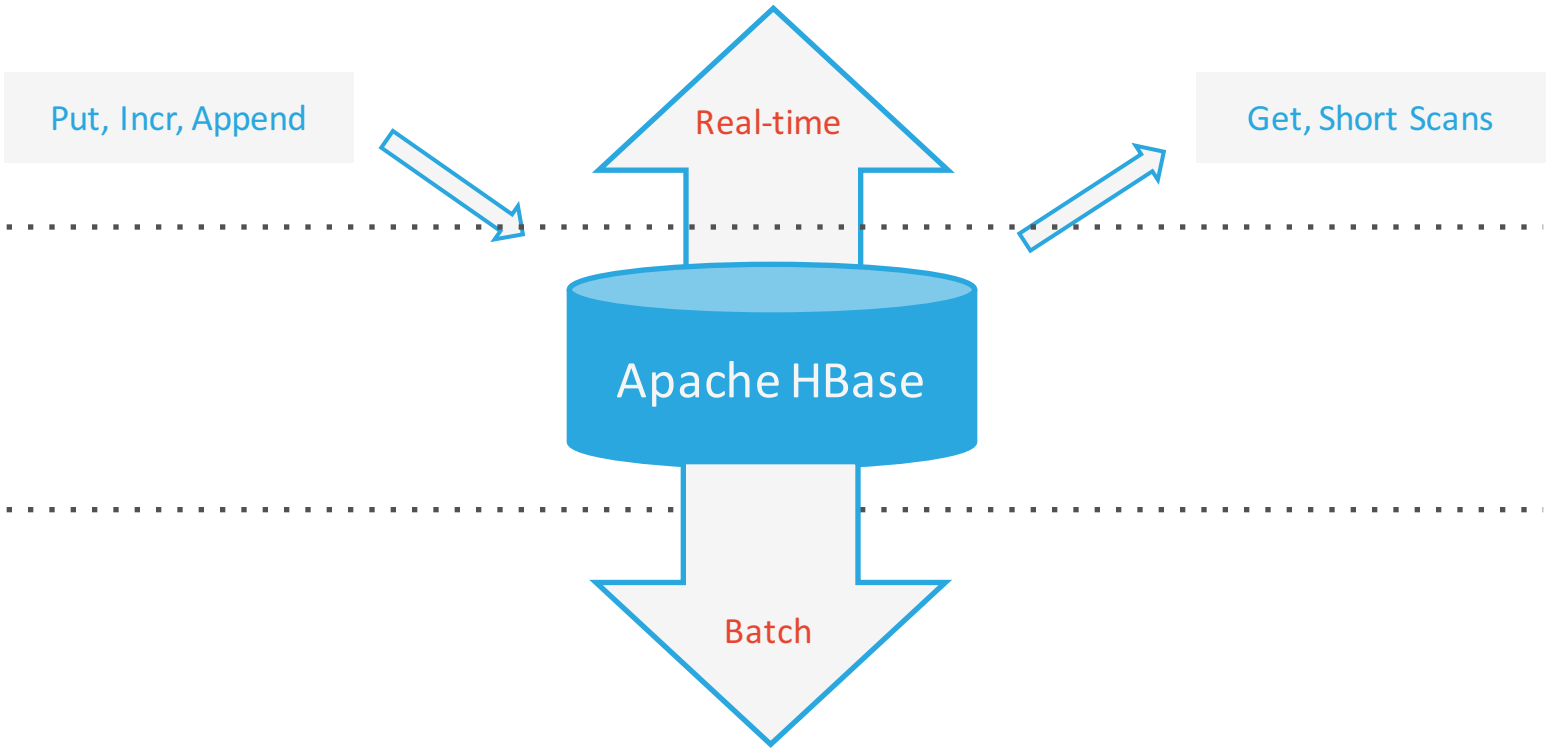
Time-coupled entities : Access Pattern

- Access Pattern
  - Writes: Real-time
  - Reads: Real-time



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HBase is great!

But not for everything ...

Current HBase weak spots

- HBase architecture can handle a lot
  - Engineering tradeoffs optimize for some use cases
  - HBase can still do things it is not optimal for
  - Other systems are fundamentally more efficient for some workloads
- Just because it is not good today, doesn't mean it can't be better tomorrow!

A not so good use case: Large Blob Store

- Saving large objects >50 MB per cell
- Examples
  - Raw video storage in HBase
- Problems:
  - **Write amplification** when re-optimizing data for read (compactions on large unchanging data)
- New: Medium Object (MOB) supported (lots of 100KB-10MB cells)

Another not good use case: Analytic archive

- Store data chronologically, time as primary index
  - Row key = timestamp
  - Real time writes
  - Column-centric aggregations over all rows
- Schema
  - Row key: timestamp
  - Column qualifiers: properties with data or counters
- Example
  - Machine logs organized **by timestamp** (causes write hot-spotting)

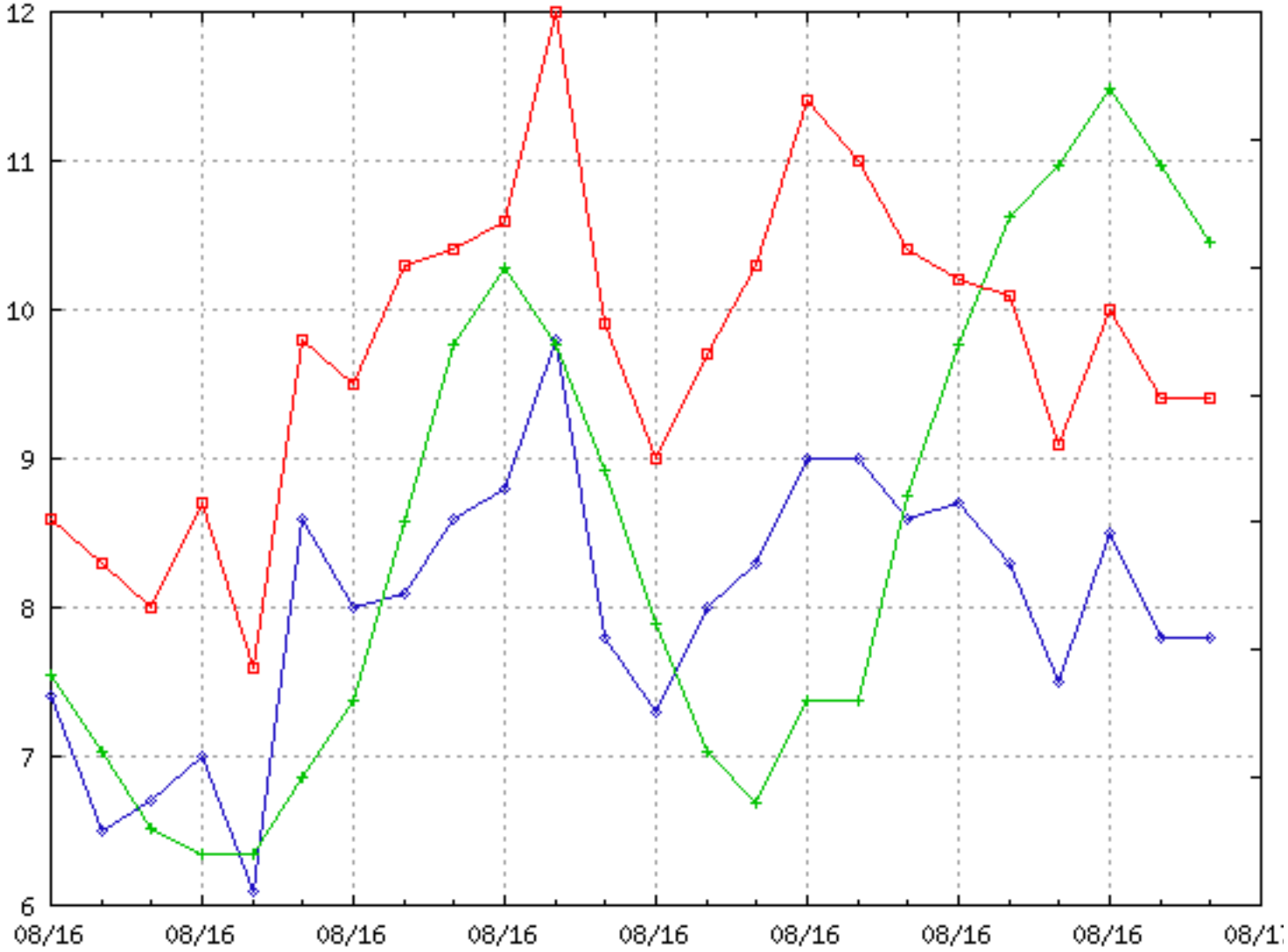
Summary

- HBase is used widely across industry
- Few patterns learnt from these users
- Understanding
  - Data : Entity and time-centric events
  - Questions you ask from your data
  - How does data gets in and out
- When not to use HBase

Scalable time series database

Time-Series

Data points for entities over time



OpenTSDB

- Store trillions of data points
- Millisecond precision
- Keep raw data forever
- Scales to millions of writes per sec
- Generate graphs from GUI

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OpenTSDB

- Store trillions of data points
- Millisecond precision
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- Generate graphs from GUI

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OpenTSDB : Use Cases

- System Monitoring
  - Servers
  - Network
- Sensor Data
- Stock market data

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OpenTSDB : Example

OVH

- Large cloud/hosting provider
- Monitor everything: networking, temperature, voltage, application performance, resource utilization, customer-facing metrics, etc.
- 35 servers, 100k writes/s, 25TB raw data

Yahoo!

- Monitoring application performance and statistics
- 15 servers, 280k writes/s

Source: http://www.slideshare.net/HBaseCon/ecosystem-session-6

OpenTSDB : Datapoints

- In OpenTSDB, there are
  - Metric
  - Timestamp
  - Value
  - Tags (key-value pairs) : to identify the entity

OpenTSDB : Datapoints example

- E.g. 10 servers handling requests web requets
- Metric: num_requests_per_second
- Tags: “host=web-server-1”, “host=web-server-2”, and so on

- Example data points
  - num_requests_per_second 1439828251 50 host=web-server-1
  - num_requests_per_second 1439828251 72 host=web-server-2
  - num_requests_per_second 1439828252 30 host=web-server-3
  - …so on

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OpenTSDB : How it works

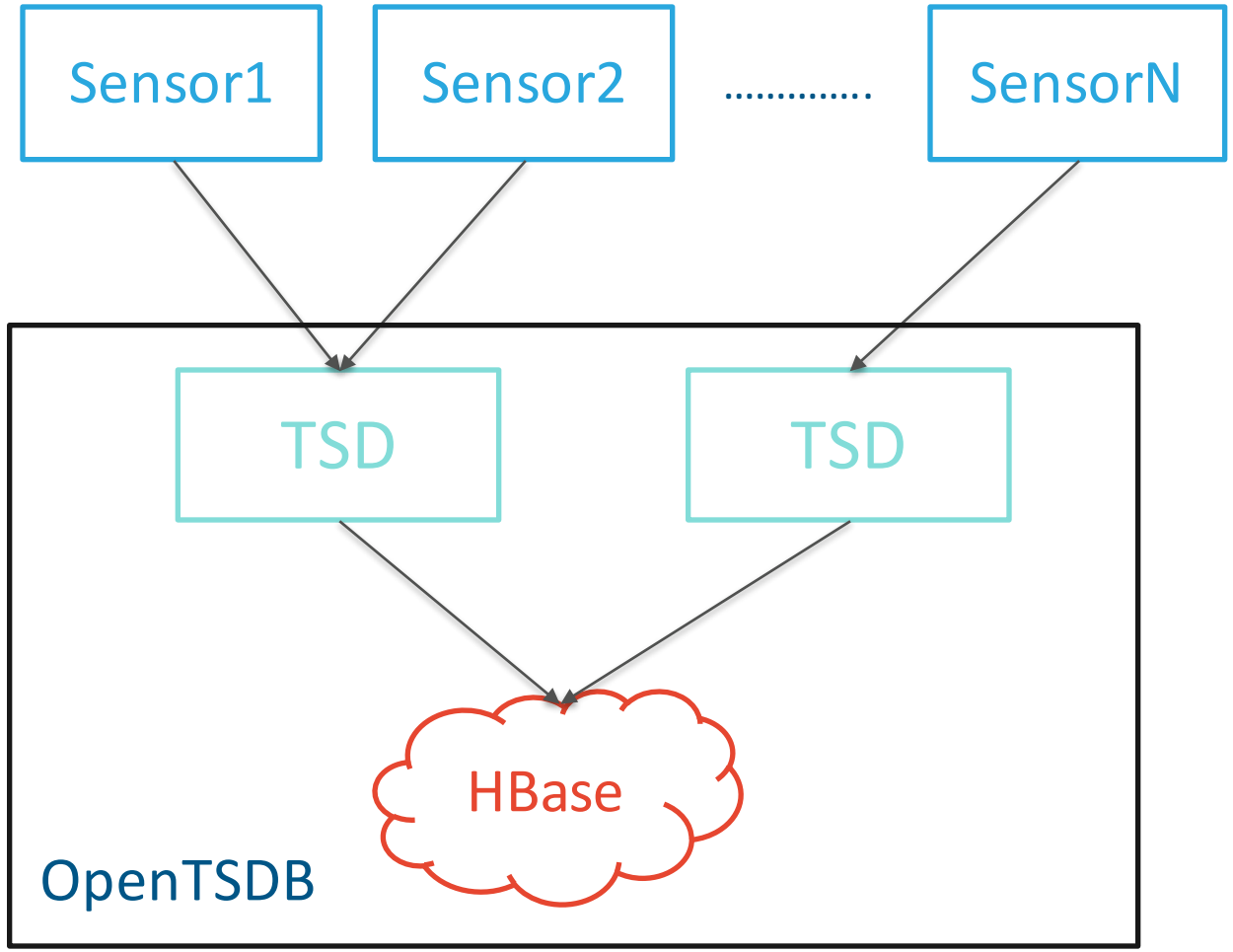

Image source: http://opentsdb.net/overview.html

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OpenTSDB : Writing data

- Telnet
  - put <metric> <timestamp> <value> <tagk1=tagv1[tagk2=tagv2 ...tagkN=tagvN]>
  - Example: put num_requests_per_second 1439828251 50 host=web-server-1

- HTTP API
  - <host>:<port>/api/put
  - JSON objects containing data points

- Bulk Import
  - Using ‘import’ CLI utility

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OpenTSDB : Reading data

- OpenTSDB GUI
  - Select metrics and tags to generate graphs

- HTTP API
  - <host>:<port>/api/query

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OpenTSDB : Storing data – row key

- Row key is a concatenation of metric, timestamp and tags
  - num_requests_per_second1439827200host=web-server-1

- Since data is stored in sorted order, chunking happens in this order
  1. Metric
     - Enables fast scan of all time series for a metric
  2. Time
     - Normalized on 1 hour boundaries
     - All data points for an hour are stored in a single row
  3. Tags

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OpenTSDB : Storing data – column

- Offset from timestamp in row key
- Example
  - num_requests_per_second 1439828251 50 host=web-server-1
  - num_requests_per_second 1439828251 72 host=web-server-2
  - num_requests_per_second 1439828252 30 host=web-server-3

Row key	Data:1051	Data:1052
num_requests_per_second1439827200host=web-server-1	50	
num_requests_per_second1439827200host=web-server-2	72	
num_requests_per_second1439827200host=web-server-3		30

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OpenTSDB : GUI

TSD Time Series Database

Graph | Stats | Logs | Version

From 2014/09/28-10:00:00 To (now) Autoreload WxH: 835x400

2014/09/28-22:30:00

transfer_time +

Metric: curl.transfer_time Rate Rate Ctr Right Axis

Tags node ams1 Rate Ctr Max:

x host www.akamai.com Rate Ctr Reset:

Aggregator: avg

Downsample avg 1m

Axes | Key | Style

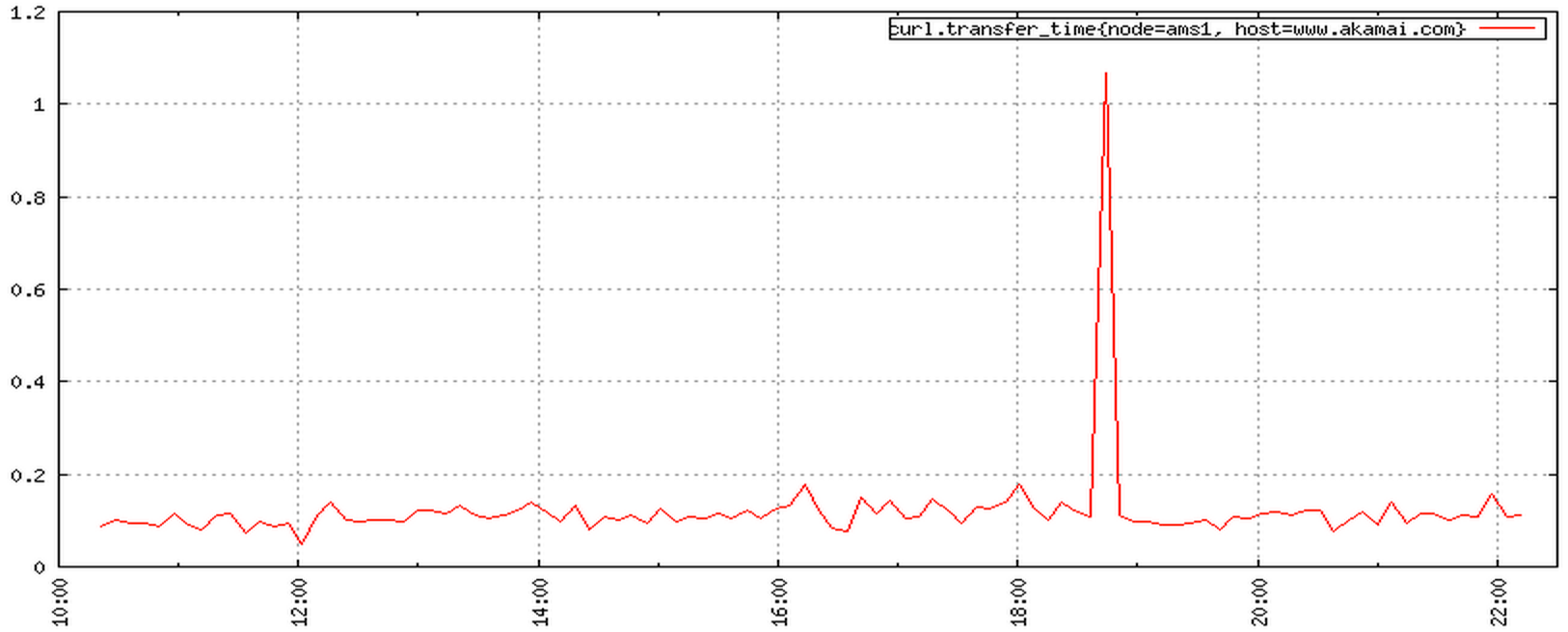
Key location:

Horizontal layout

Box

No key (overrides others)

5656 points retrieved, 655 points plotted in 46ms.



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- High performance relational database layer over HBase for low-latency applications
- JDBC API

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Phoenix : Use Case

Scalability of HBase

+

SQL interface access

Phoenix

- Provides typed access to data
- Provides secondary indexes
- Compiles SQL queries to native HBase scans
- Executes scans parallely
- Directly uses HBase API, server-side hooks and custom filters
- Brings computation to the data
  - Pushes where clause to server-side filter
  - Executes aggregate queries using server-side hooks

That’s it folks!

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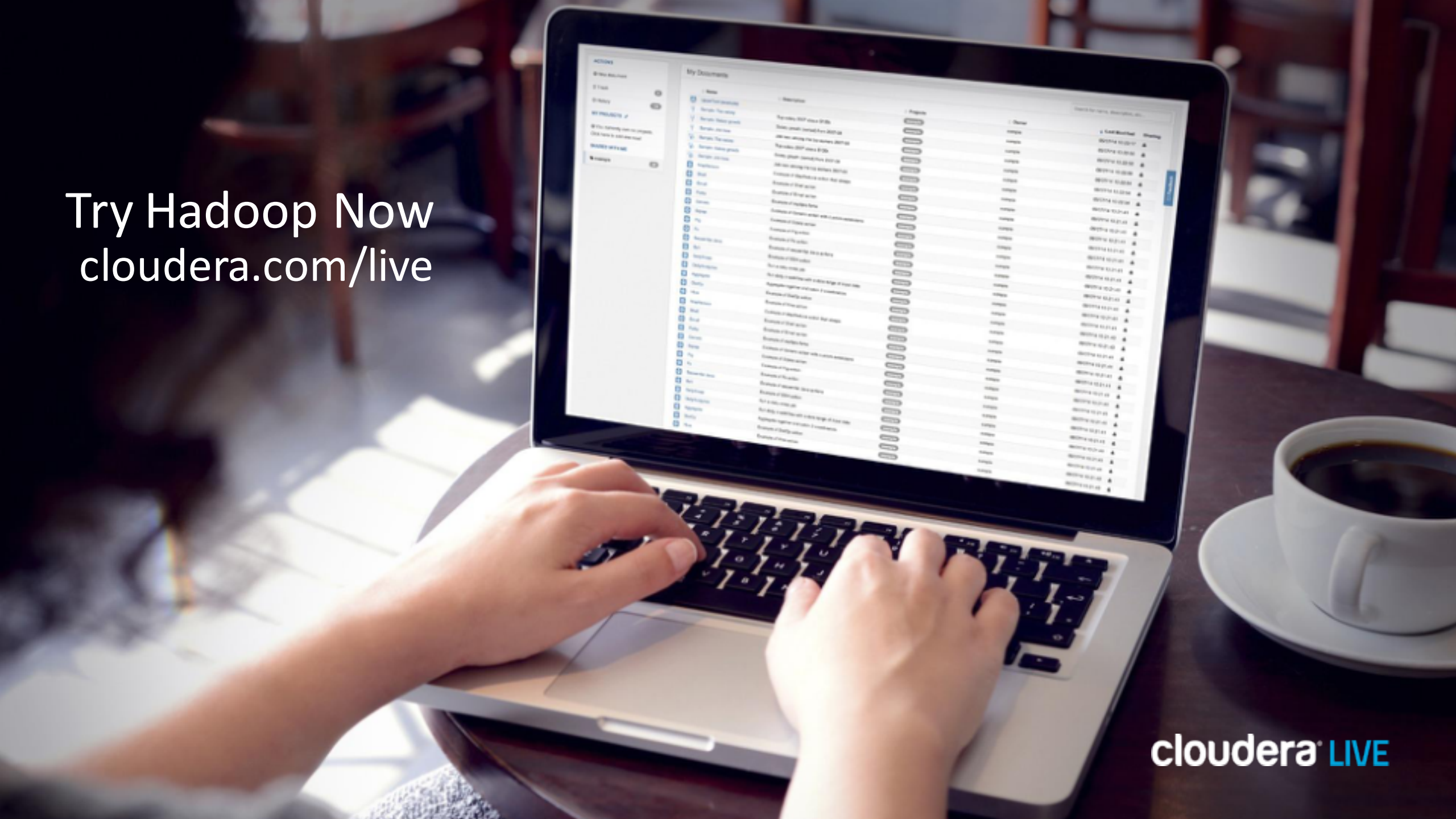
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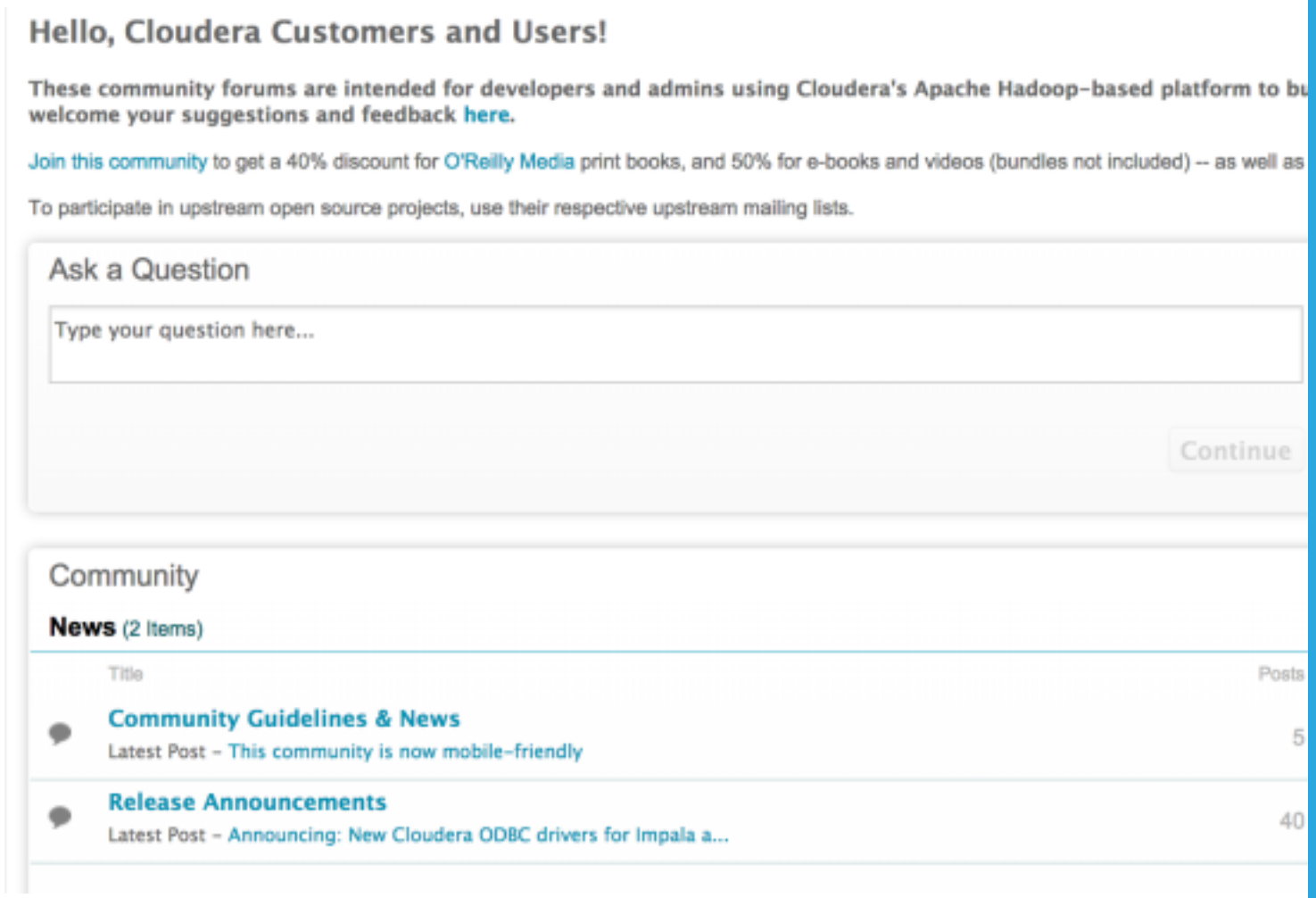

Get community help or provide feedback

cloudera.com/community

Sources

- A Survey of HBase Application Archetypes
  - Lars George, Jon Hsieh
  - http://www.slideshare.net/HBaseCon/case-studies-session-7
- OpenTSDB 2.0
  - Benoit Sigoure, Chris Larsen
  - http://www.slideshare.net/HBaseCon/ecosystem-session-6
- Hadoop and HBase: Motivations, Use cases and Trade-offs
  - Jon Hsieh
- Phoenix
  - https://phoenix.apache.org

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Questions ?

