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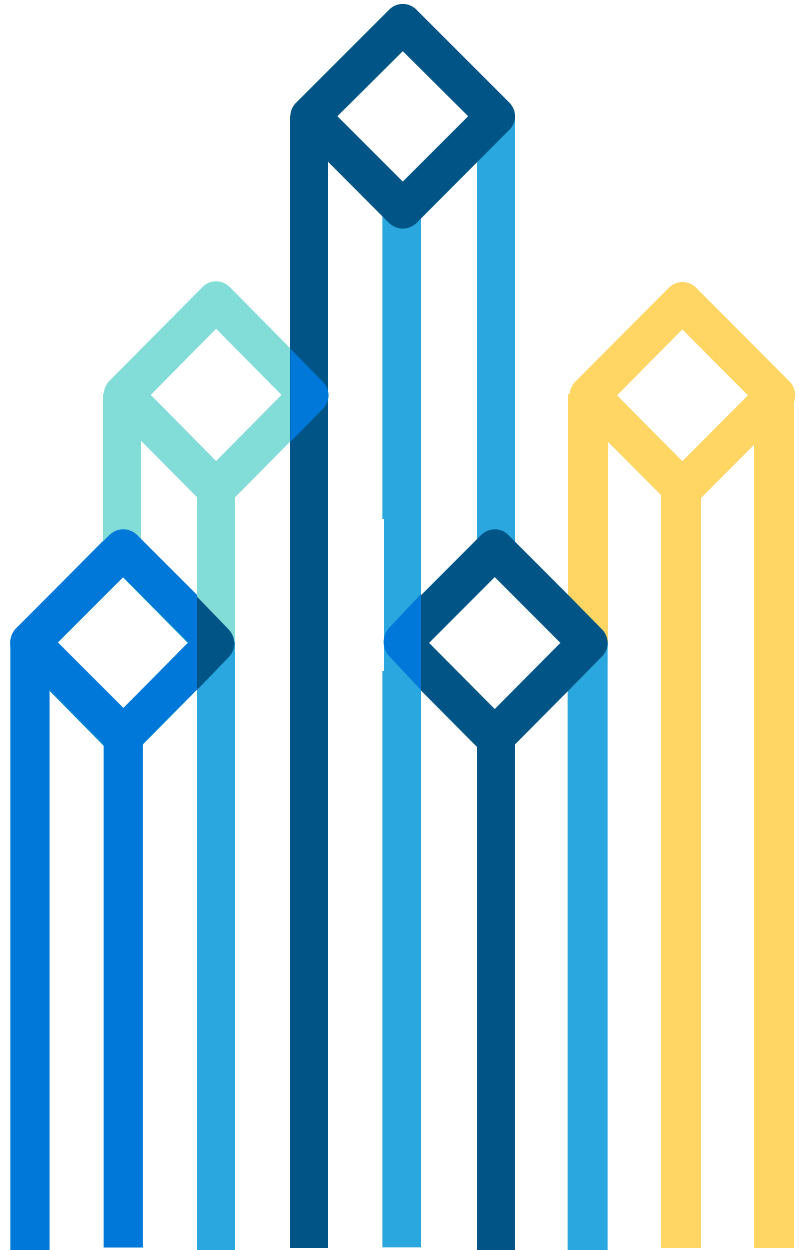

Apache HBase: Overview and Use Cases

Apekshit Sharma

About myself

Apekshit Sharma

- Software Engineer, Cloudera
  - Ex-Software Engineer, Google
- Apache HBase contributor
- Performance improvements, replication, build infra, etc

Contents

- Motivation
- Apache HBase data model
- Overview of Architecture
- Few usage patterns

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Motivation

Bigtable: A Distributed Storage System for Structured Data

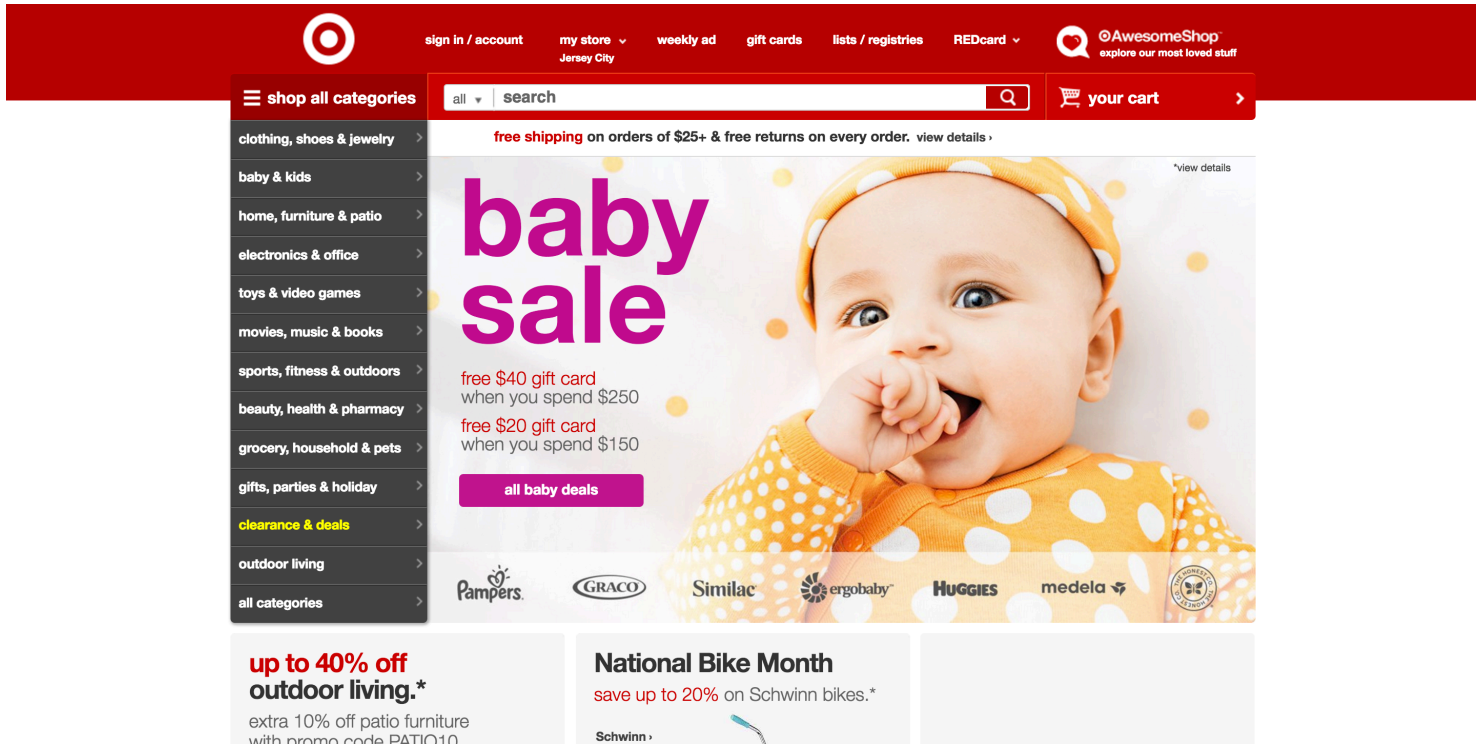
Fay Chang, Jeffrey Dean, Sanjay Ghemawat, Wilson C. Hsieh, Deborah A. Wallach
Mike Burrows, Tushar Chandra, Andrew Fikes, Robert E. Gruber

{fay,jeff,sanjay,wilsonh,kerr,m3b,tushar,fikes,gruber}@google.com

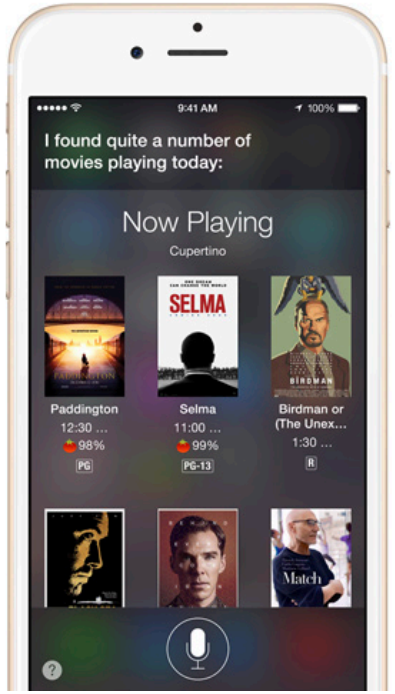
Google, Inc.

Motivation

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

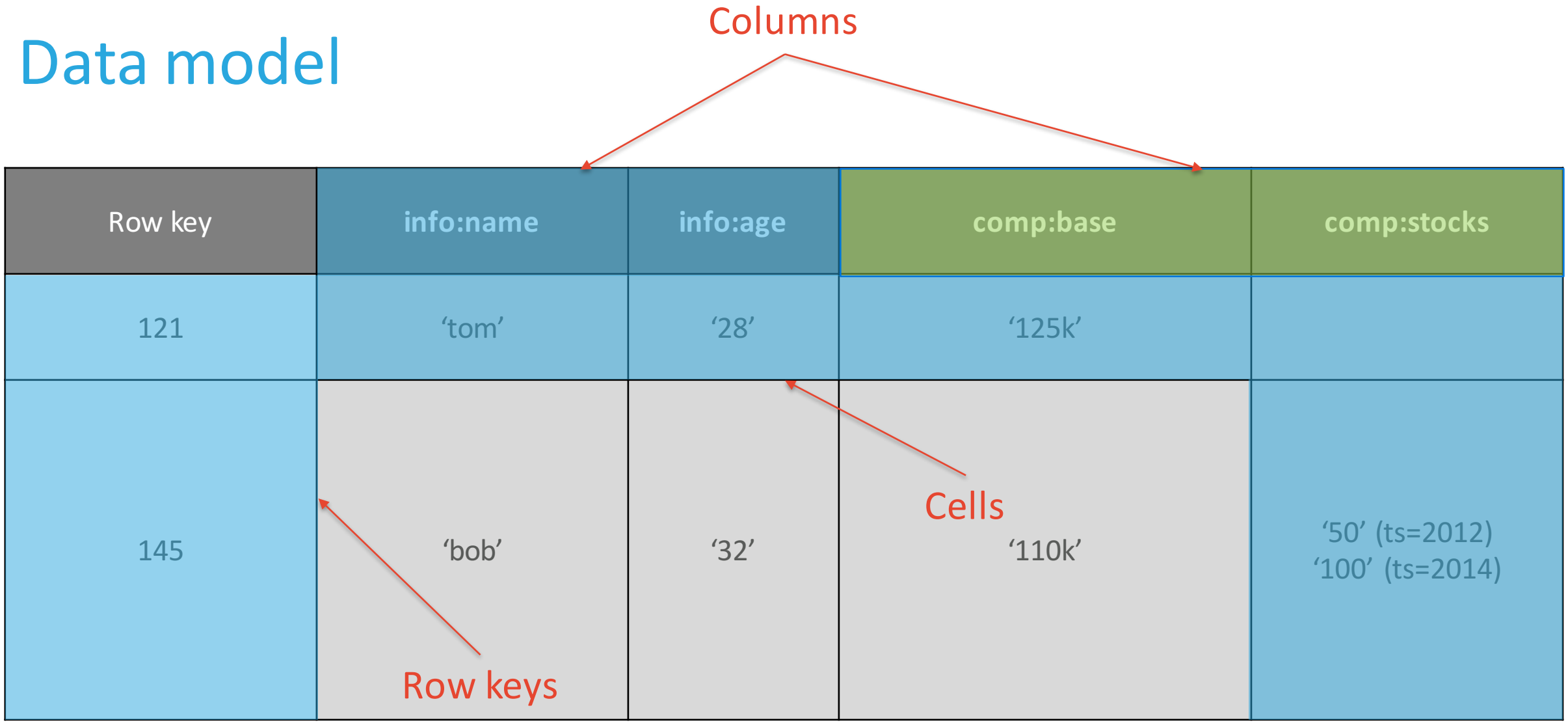


"What movies are playing today?"



- Open Source
- Horizontally Scalable
- Consistent
- Random access, low latency
- Built on top of HDFS

Data model



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Data model

- Sorted rows : supports billions of rows
- Columns : Supports millions of columns
- Cell : intersection of row and column.
  - Can have multiple values (which are time-stamped)
  - Can be empty. No storage/processing overheads

HBase Architecture

Unique id	Name	price	weight	store1	store2	store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
“3000000”	almonds	$9.99	8 Oz	Yes	No	Yes
“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes

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HBase Architecture

Unique id	Name	price	weight	store1	store2	store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
“3000000”	almonds	$9.99	8 Oz	Yes	No	Yes
“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes
“4000000”	new	$34.63	16 Oz	No	Yes	Yes

HBase Architecture

Unique id	Name	price	weight	store1	store2	store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
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“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes
“4000000”	foo	$34.63	16 Oz	No	Yes	Yes
“5000000”	bar	$22.54	16 Oz	Yes	Yes	Yes

HBase Architecture

Unique id	Name	price	weight	store1	store2	store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
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“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes
“4000000”	foo	$34.63	16 Oz	No	Yes	Yes
“5000000”	bar	$22.54	16 Oz	Yes	Yes	Yes
“9000000”	new1	$2.5	16 Oz	Yes	Yes	Yes
“7000000”	new2	$6.4	16 Oz	Yes	Yes	Yes
“2000000”	new3	$6.4	16 Oz	Yes	Yes	Yes

HBase Architecture | Regions

[“”, “5000000”)

Row Key	Name	brand	price	weight	store1	store2	store3
“1000000”	snickers	xxx	$9.99	4 Oz	Yes	Yes	Yes
“2000000”	new3	xxx	$6.4	16 Oz	Yes	Yes	Yes
“3000000”	almonds	xxx	$9.99	8 Oz	Yes	No	Yes
“4000000”	foo	xxx	$34.63	16 Oz	No	Yes	Yes

[“5000000”, “”)

Row Key	Name	brand	price	weight	store1	store2	store3
“5000000”	bar	xxx	$22.54	16 Oz	Yes	Yes	Yes
“7000000”	new2	xxx	$6.4	16 Oz	Yes	Yes	Yes
“8000000”	coke	xxx	$9.99	16 Oz	Yes	Yes	Yes
“9000000”	new1	xxx	$2.5	16 Oz	Yes	Yes	Yes

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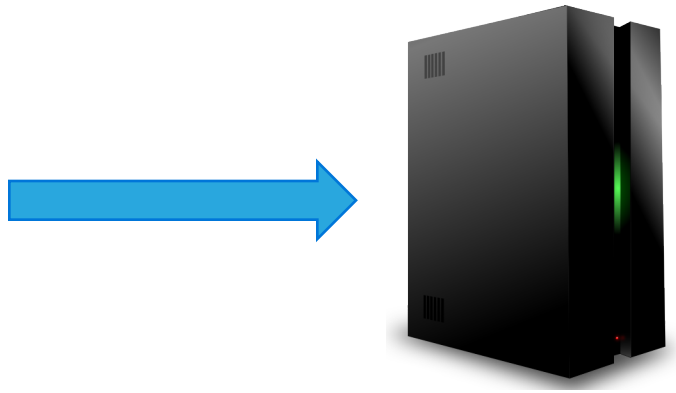
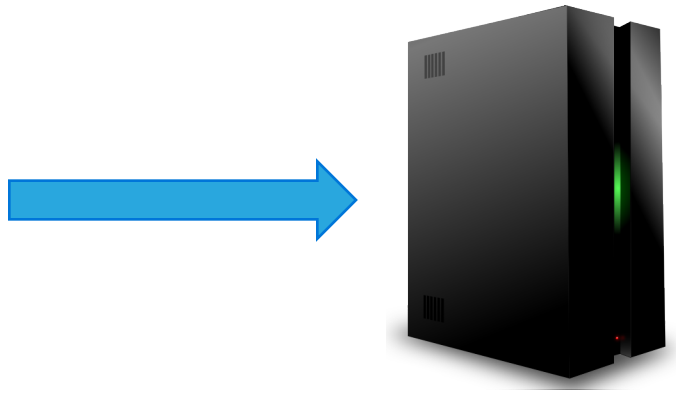
HBase Architecture | RegionServer

Row Key	Name	price	weight	….
“1000000”	snickers	$9.99	4 Oz	….
“2000000”	new3	$6.4	16 Oz	….
“3000000”	almonds	$9.99	8 Oz	….
“4000000”	foo	$34.63	16 Oz	….



Server 12

Row Key	Name	price	weight	….
“5000000”	bar	$22.54	16 Oz	….
“7000000”	new2	$6.4	16 Oz	….
“8000000”	coke	$9.99	16 Oz	….
“9000000”	new1	$2.5	16 Oz	….



Server 7

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HBase Architecture | Regions

- **Horizontal split** of tables
- Regions are served by RegionServers
- Automatically (based on configurations). Can be done manually too.

HBase Architecture

Row Key	Name	price	weight	store1	store2	store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
“2000000”	new3	$6.4	16 Oz	Yes	Yes	Yes
“3000000”	almonds	$9.99	8 Oz	Yes	No	Yes
“4000000”	foo	$34.63	16 Oz	No	Yes	Yes
“5000000”	bar	$22.54	16 Oz	Yes	Yes	Yes
“7000000”	new2	$6.4	16 Oz	Yes	Yes	Yes
“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes
“9000000”	new1	$2.5	16 Oz	Yes	Yes	Yes

HBase Architecture | Column family

Row Key	info: name	info: price	info: weight	availability: store1	availability: store2	availability: store3
“1000000”	snickers	$9.99	4 Oz	Yes	Yes	Yes
“2000000”	new3	$6.4	16 Oz	Yes	Yes	Yes
“3000000”	almonds	$9.99	8 Oz	Yes	No	Yes
“4000000”	foo	$34.63	16 Oz	No	Yes	Yes
“5000000”	bar	$22.54	16 Oz	Yes	Yes	Yes
“7000000”	new2	$6.4	16 Oz	Yes	Yes	Yes
“8000000”	coke	$9.99	16 Oz	Yes	Yes	Yes
“9000000”	new1	$2.5	16 Oz	Yes	Yes	Yes

HBase Architecture | Column family

- You can also see it as **vertical splits**
- Data stored in separate files
- Tune performance
  - In-memory
  - Compression
  - Version retention policies
  - Cache priority
- Needs to be specified by the user

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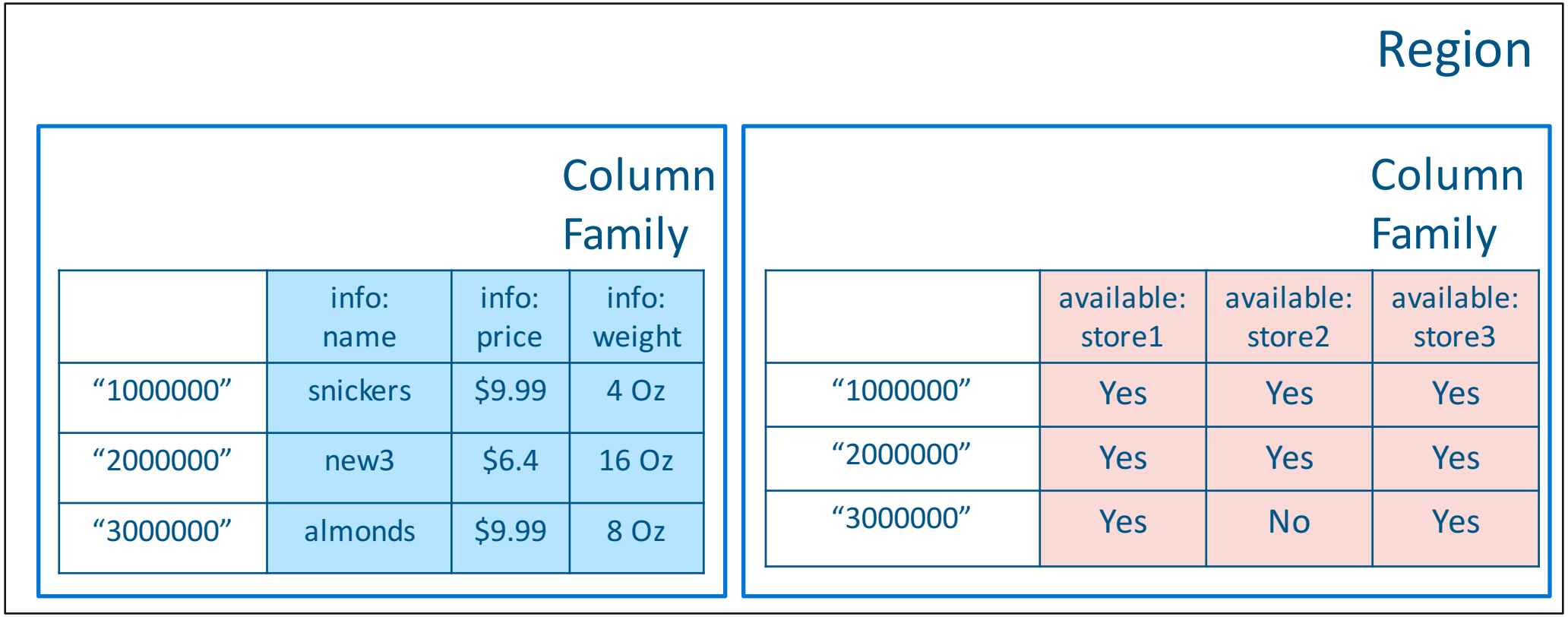
HBase Architecture

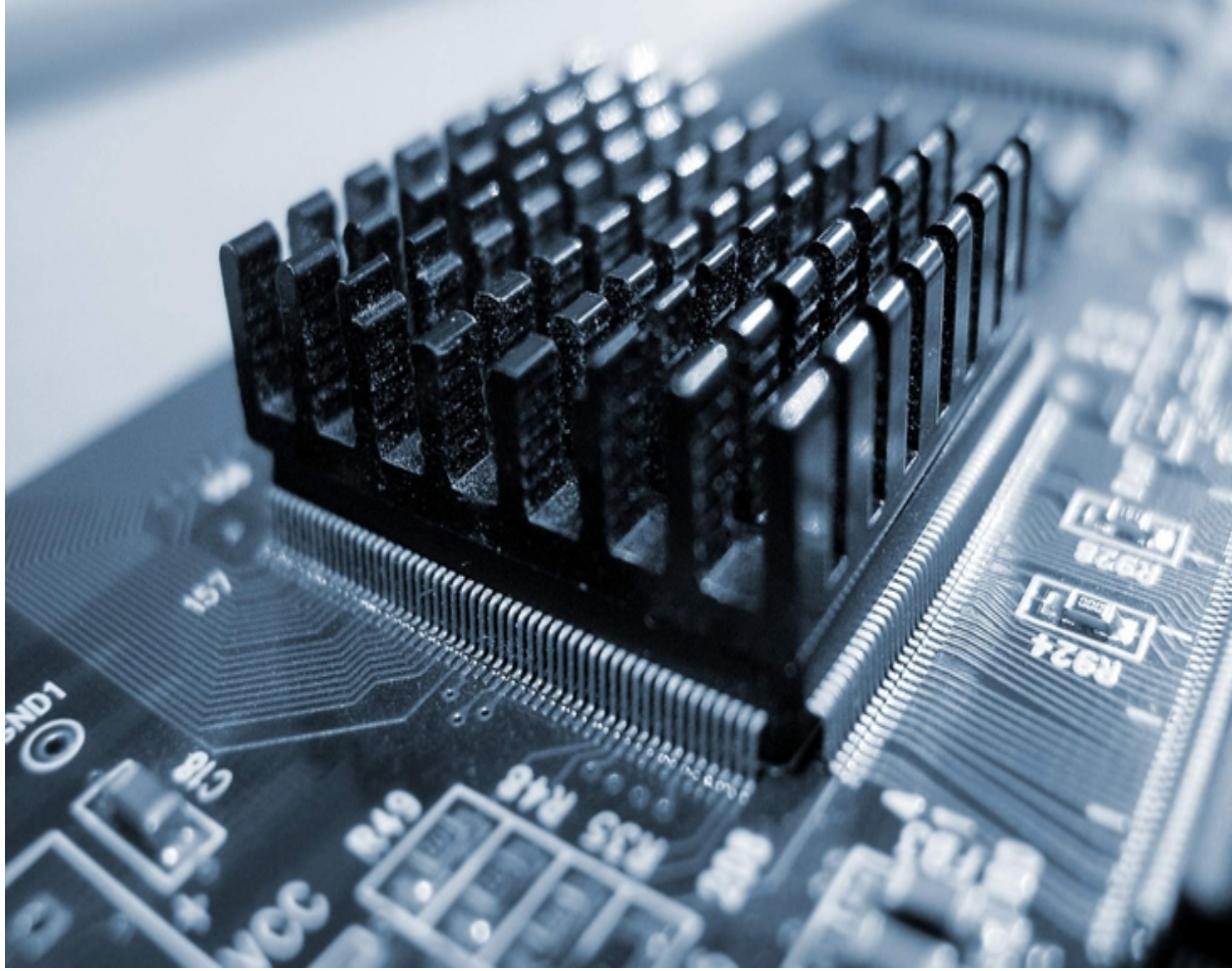


	info: name	info: price	info: weight
“1000000”	snickers	$9.99	4 Oz
“2000000”	new3	$6.4	16 Oz
“3000000”	almonds	$9.99	8 Oz

	available: store1	available: store2	available: store3
“1000000”	Yes	Yes	Yes
“2000000”	Yes	Yes	Yes
“3000000”	Yes	No	Yes

Enough of Architecture

Lets move to use patterns



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Apache HBase "Nascar" Slide

Apache HBase “Nascar” Slide

Apache HBase "Nascar" Slide

Apache HBase "Nascar" Slide

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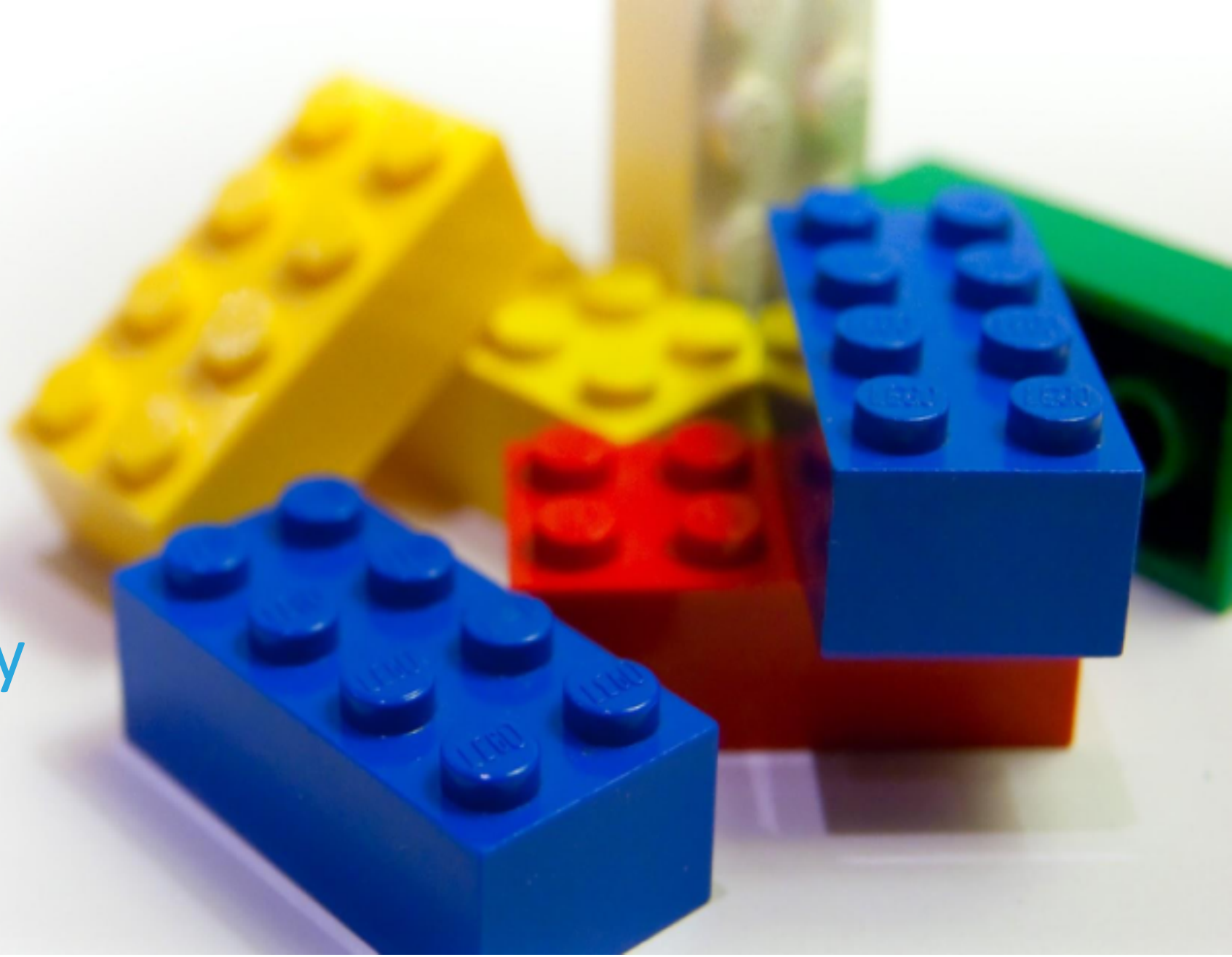
What have we learned from so many users?

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

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

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Entity centric data

Users

Accounts

Location

Clicks and Metrics

- 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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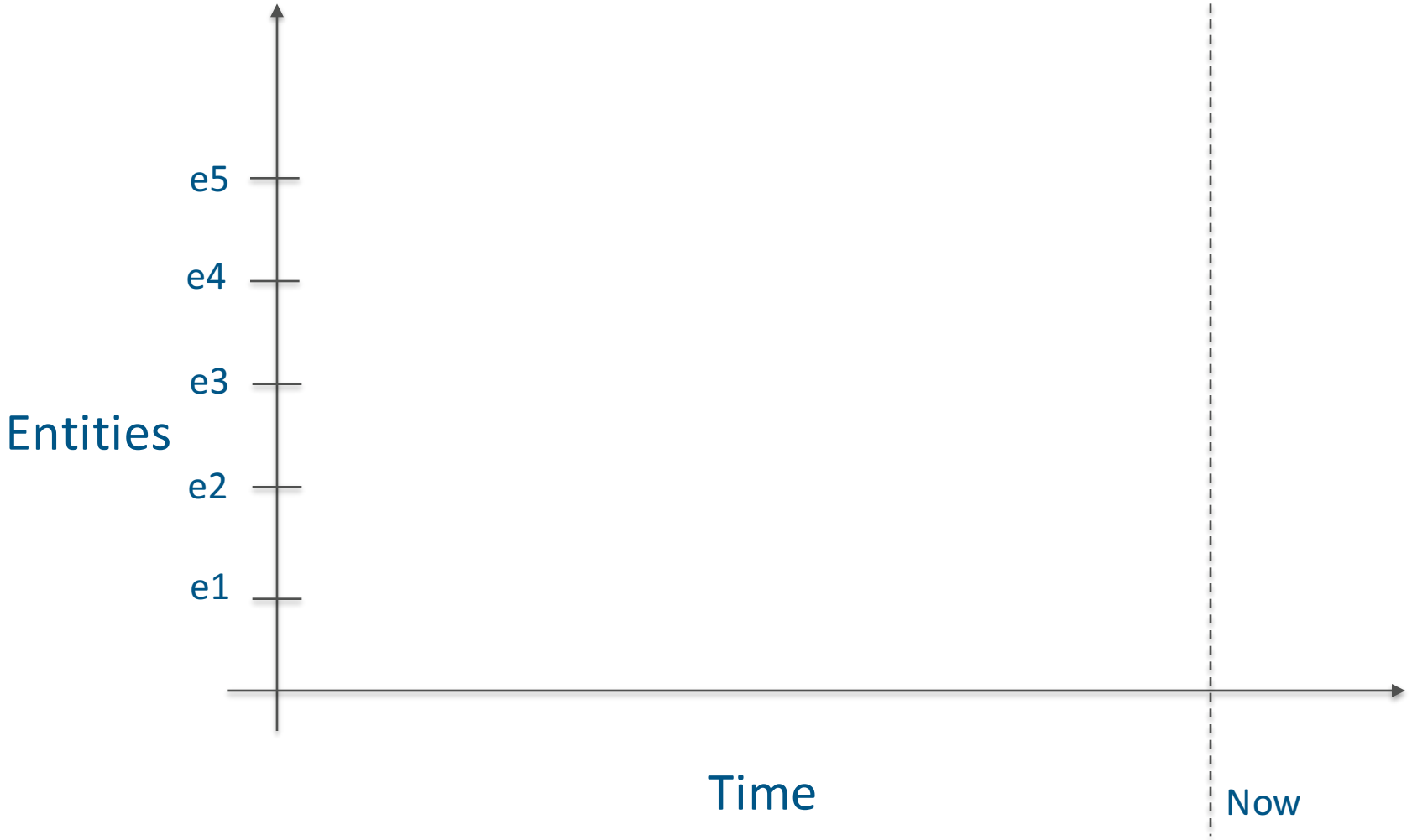

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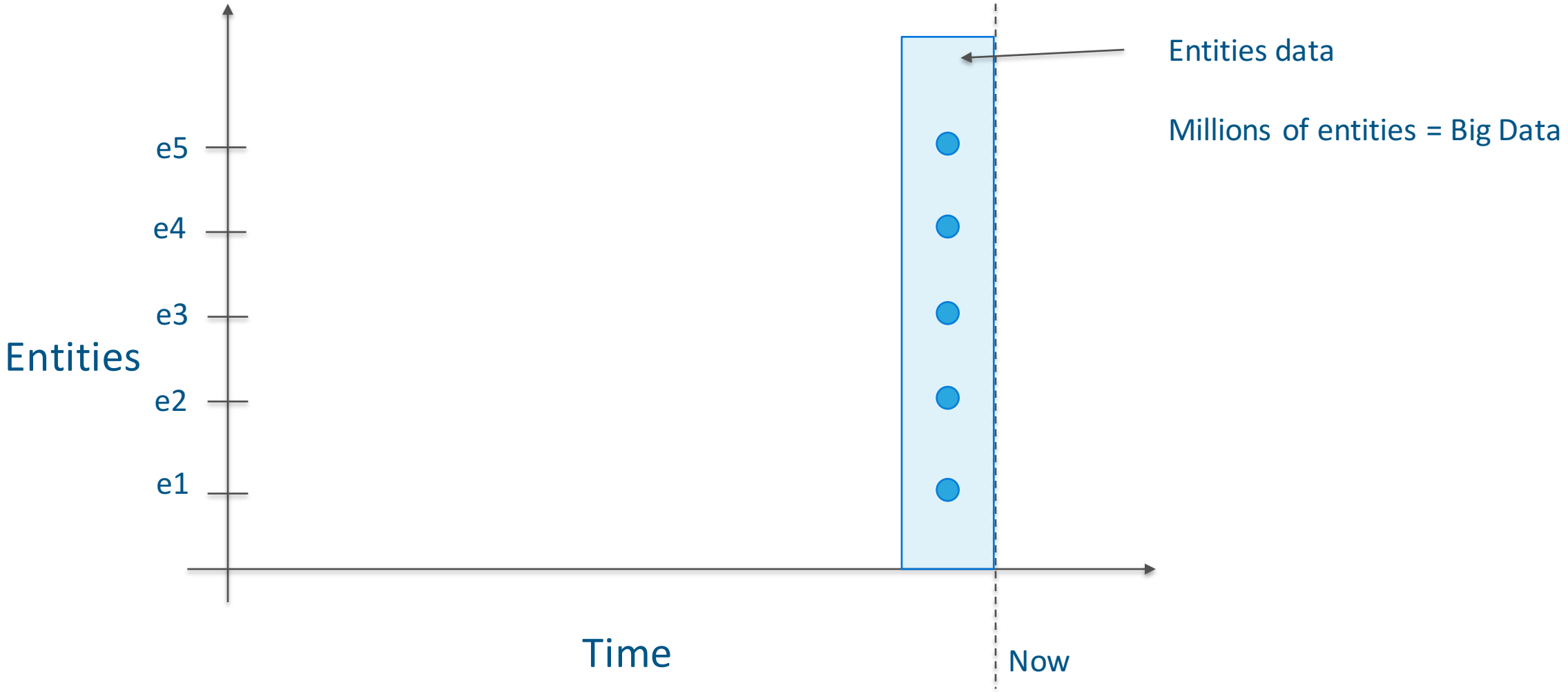
Entities data



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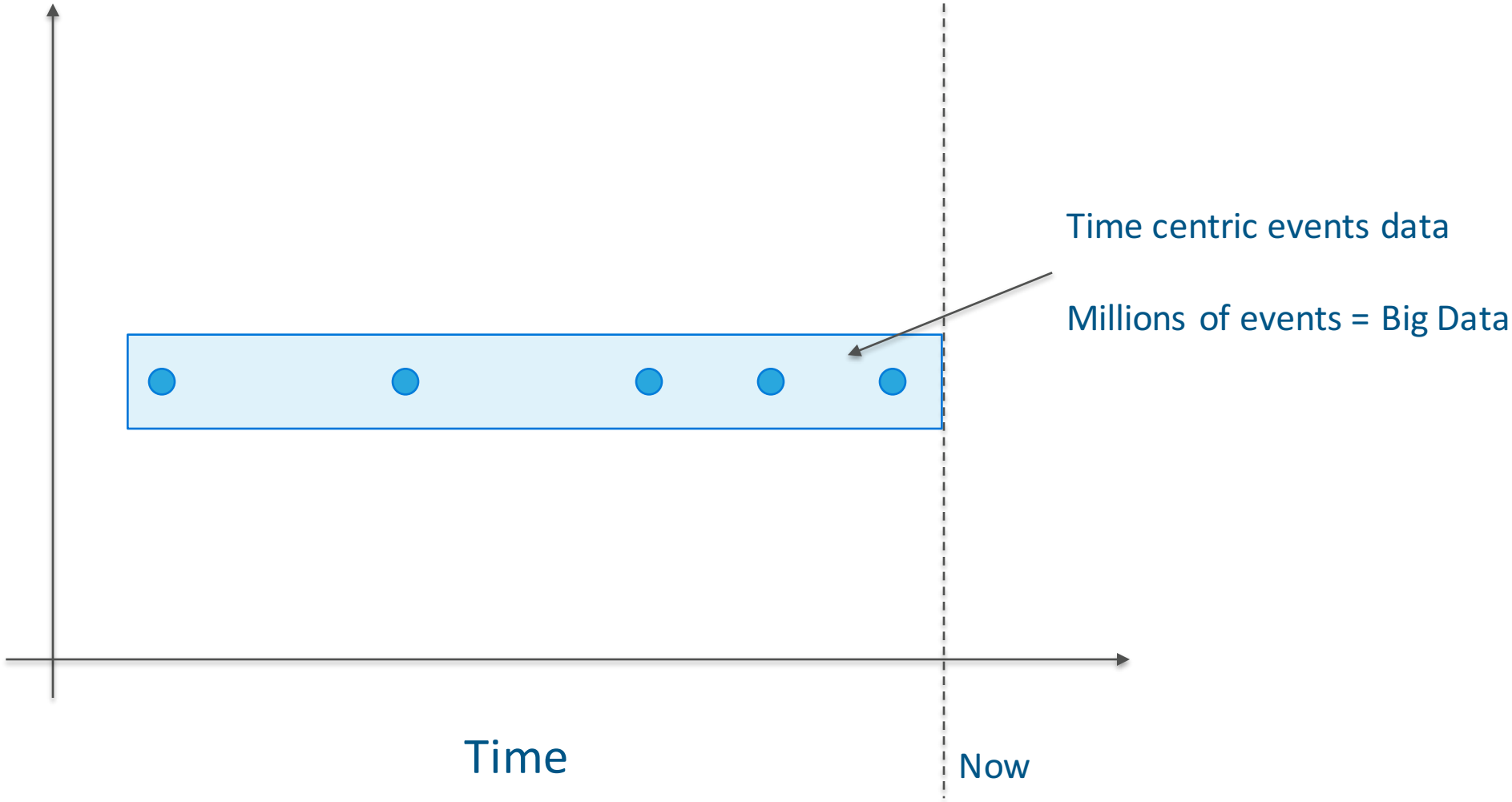
Time-centric events data



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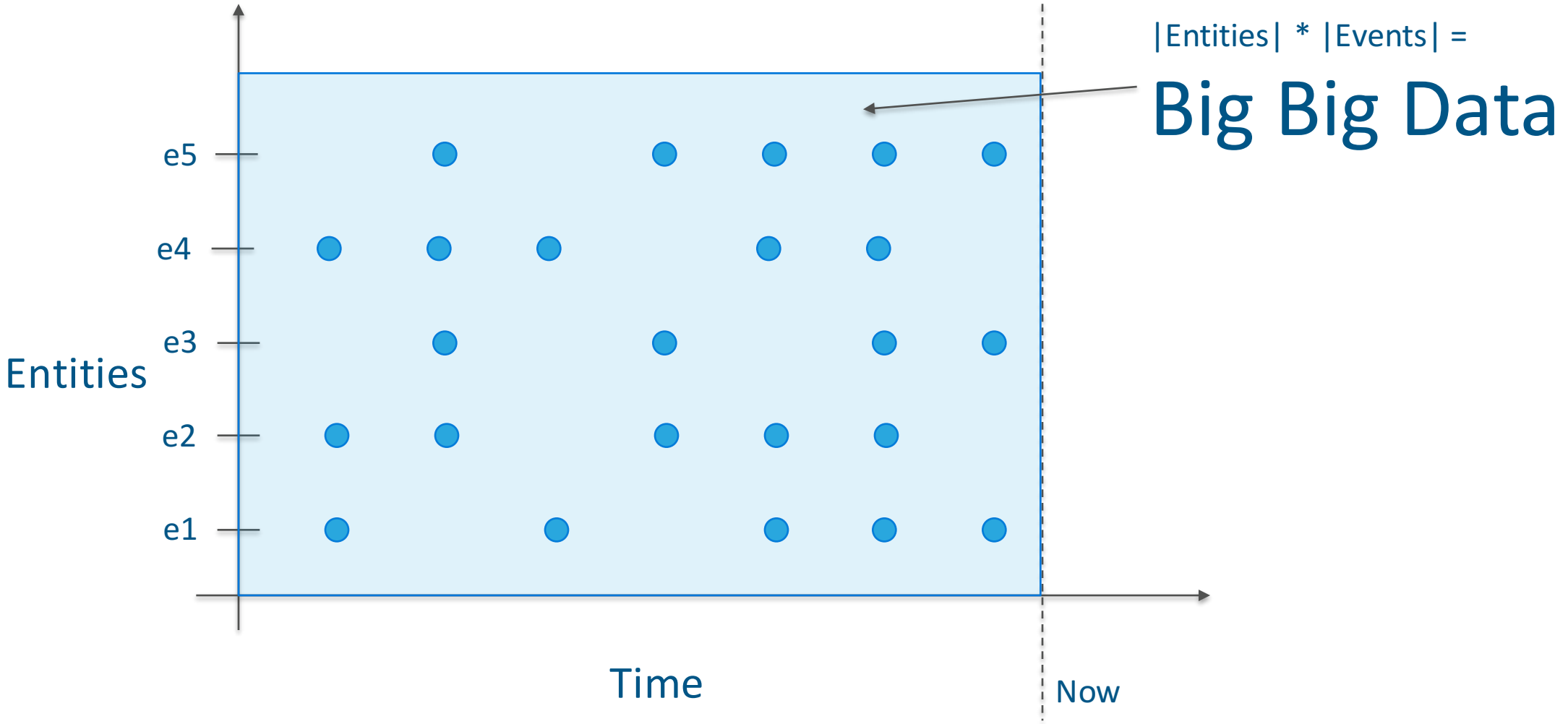
Time-centric events about Entities



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What questions do you ask?

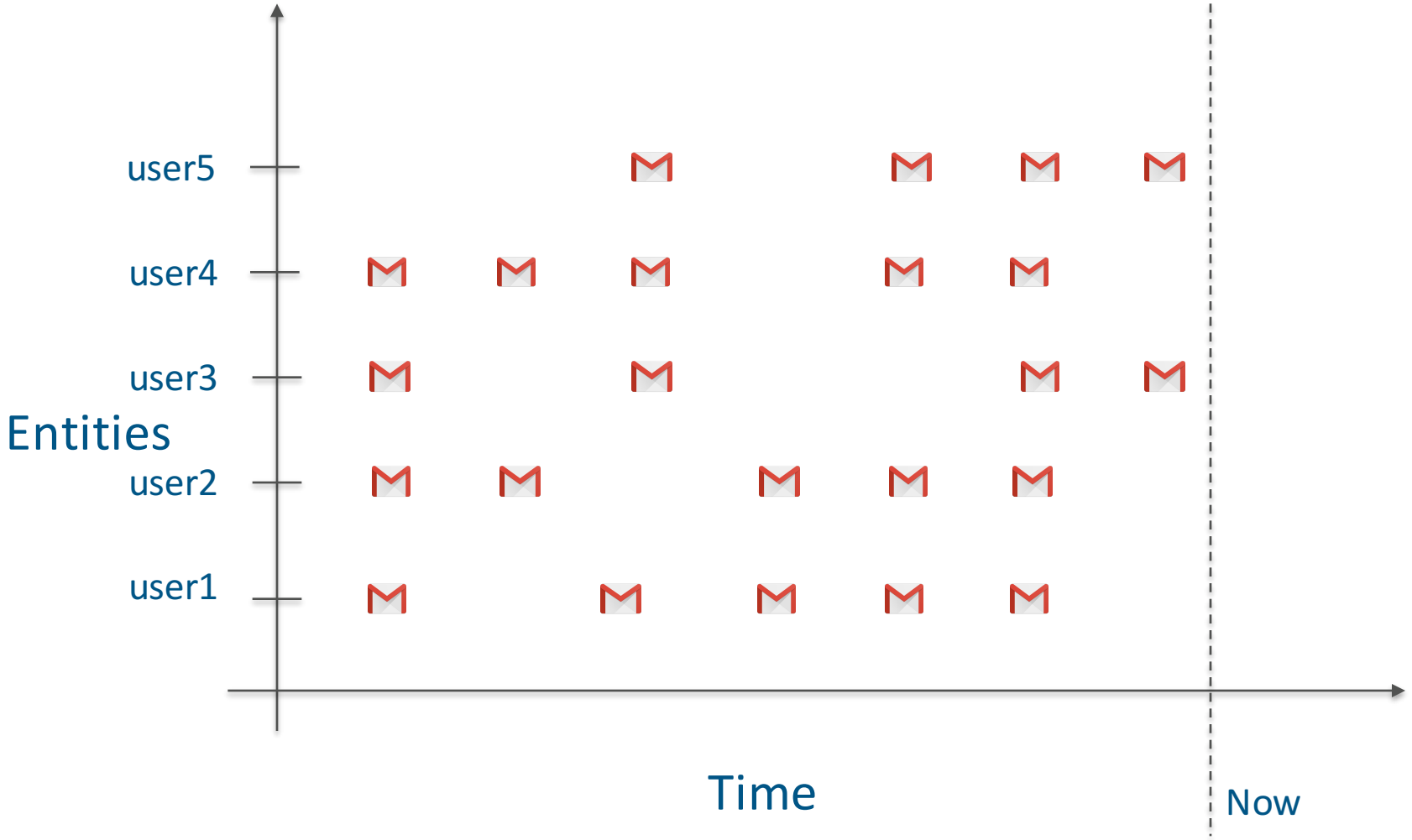
- Do you focus in on entity first?

OR

- Do you focus in on time ranges first?

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

Let’s say you start your own e-mail service….



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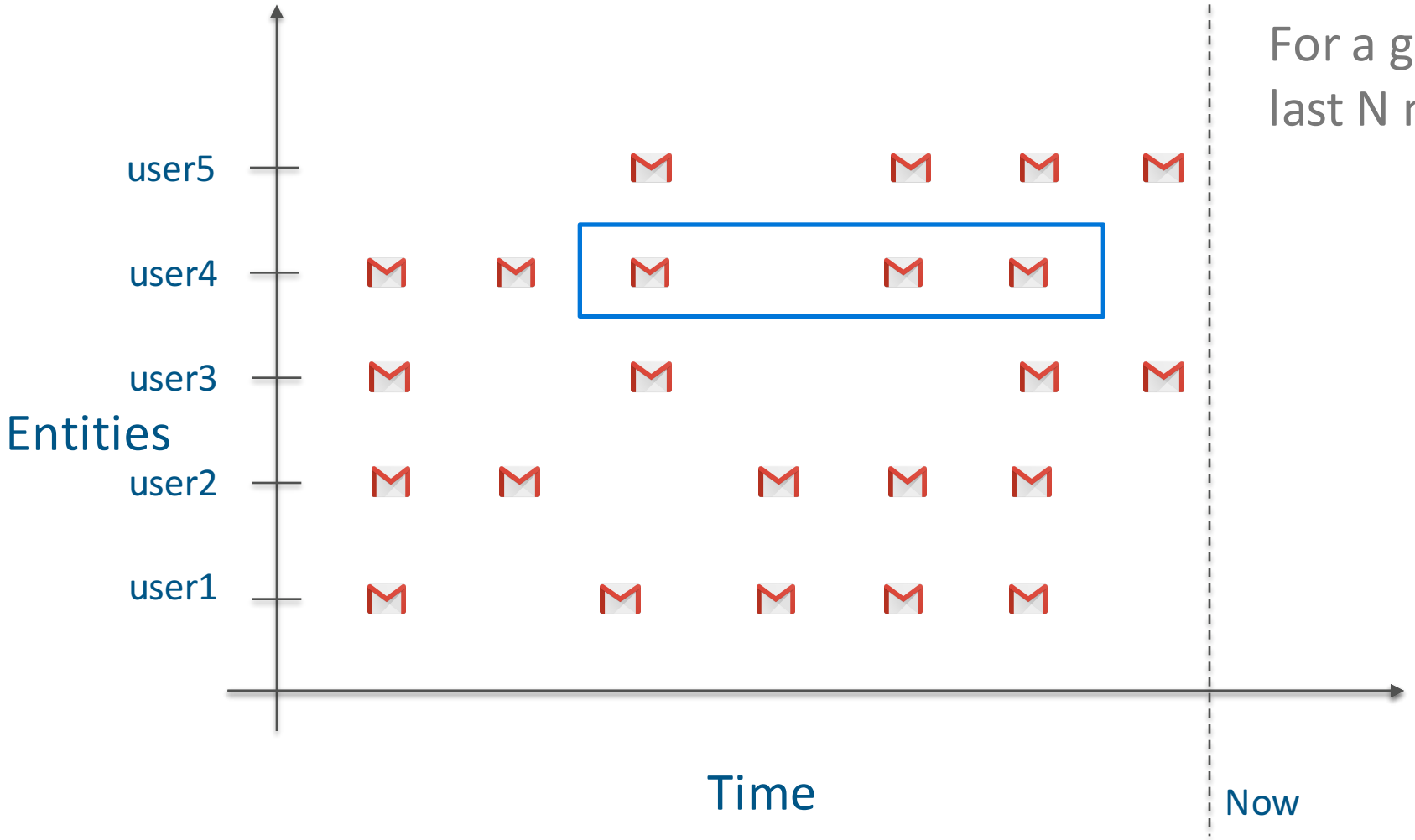
Entity first questions…



For a give user, show last N messages.

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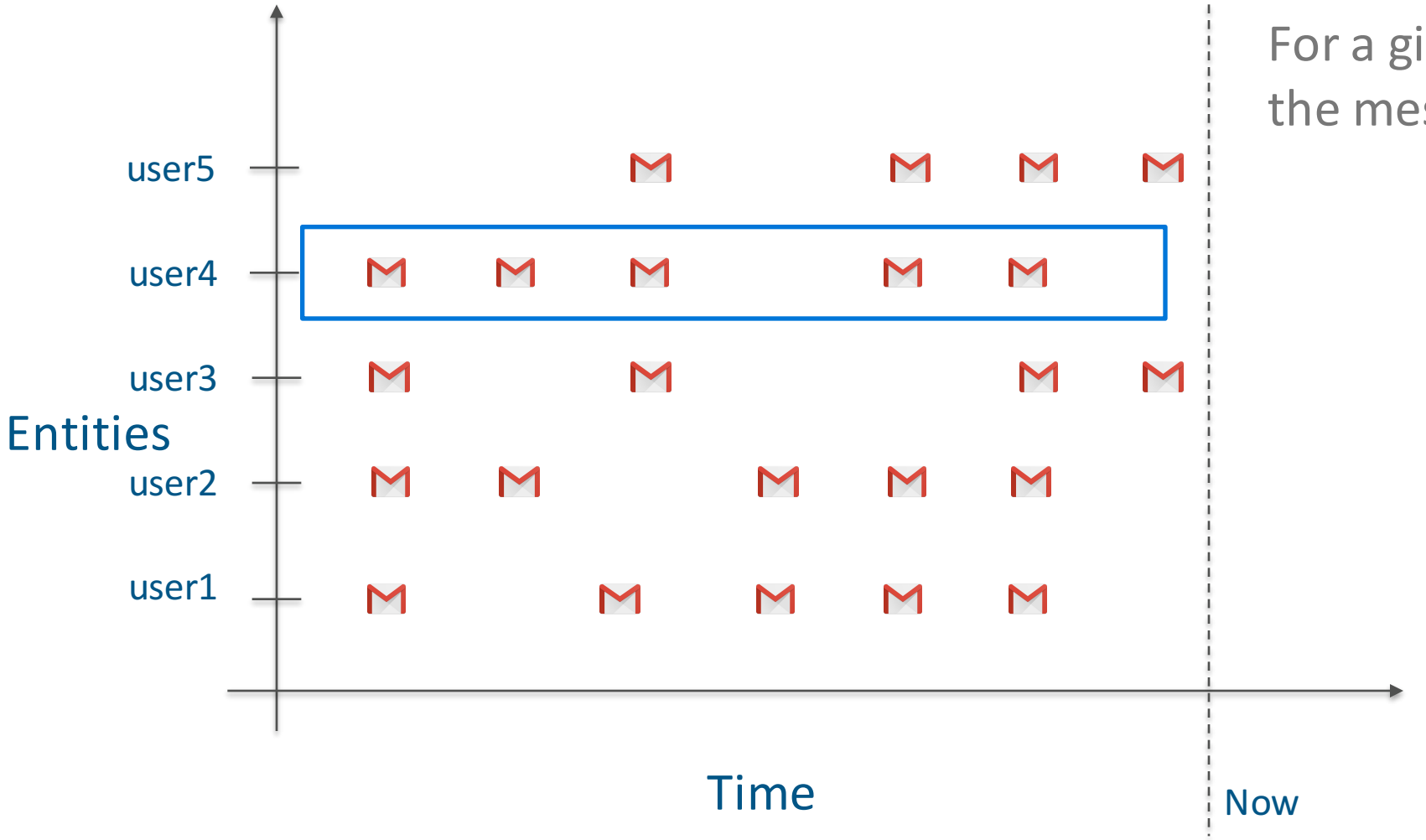
Entity first questions…



For a give user, show all the messages.

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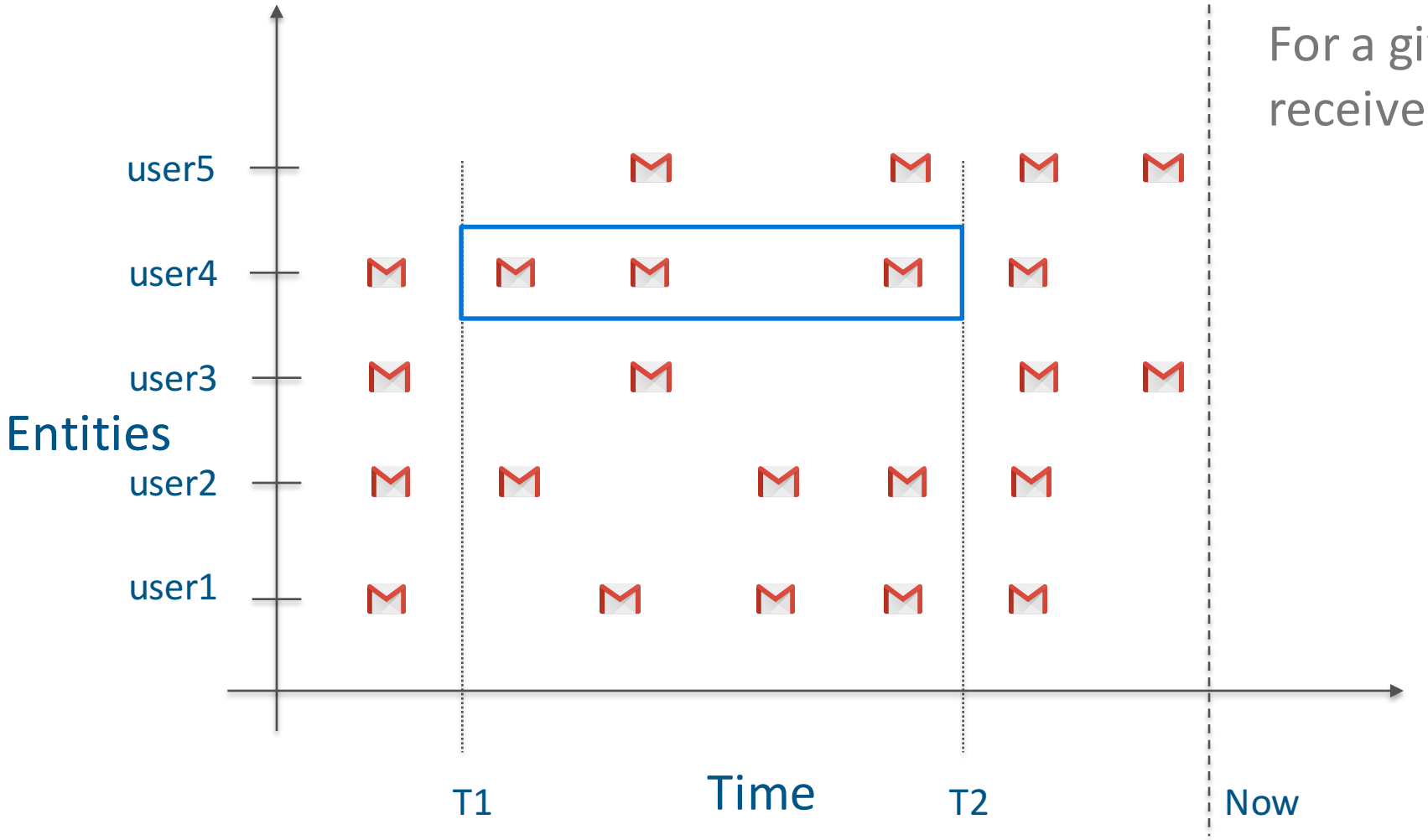
Entity first questions…



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

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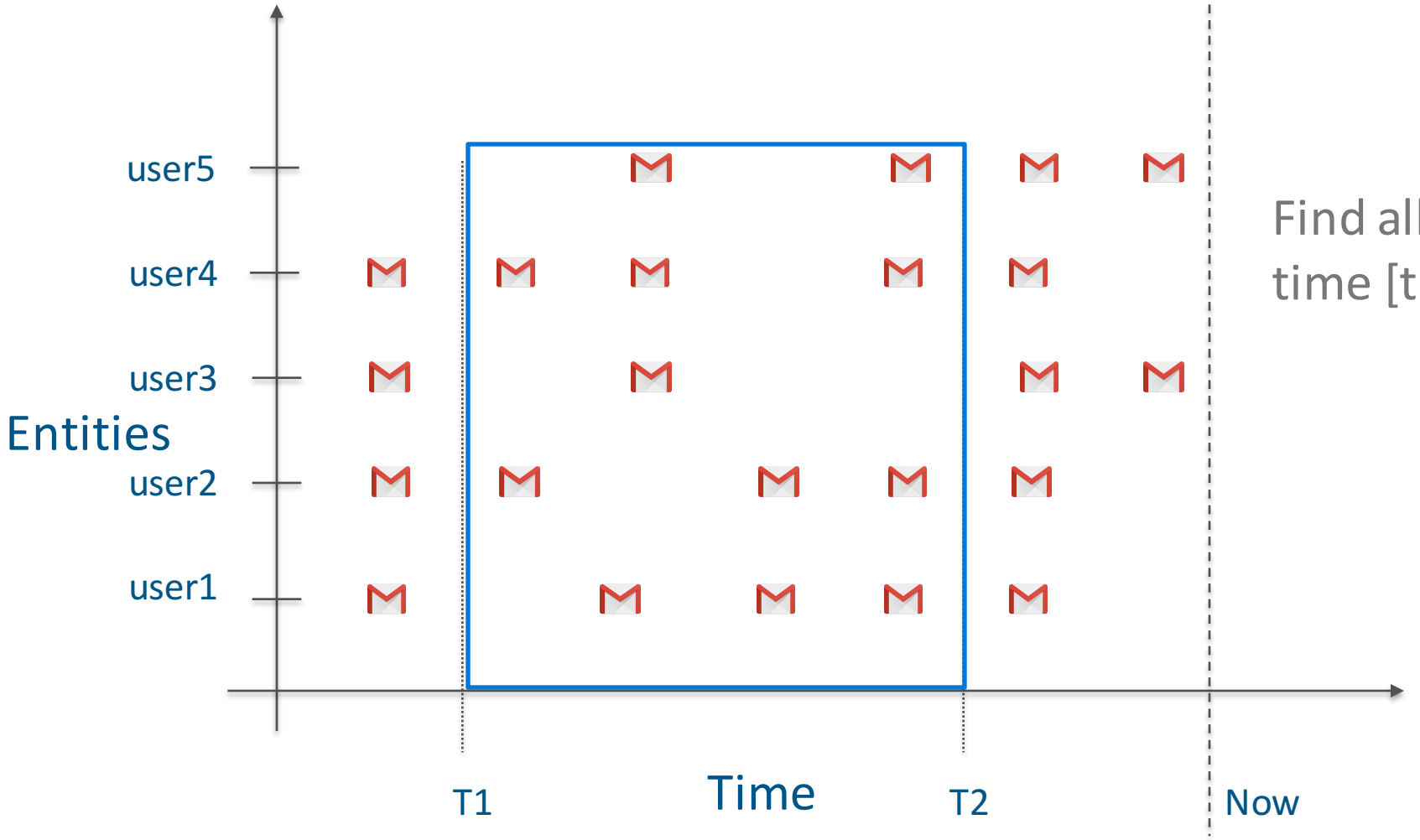
Time centric event first questions…



Find all messages between time [t1, t2].

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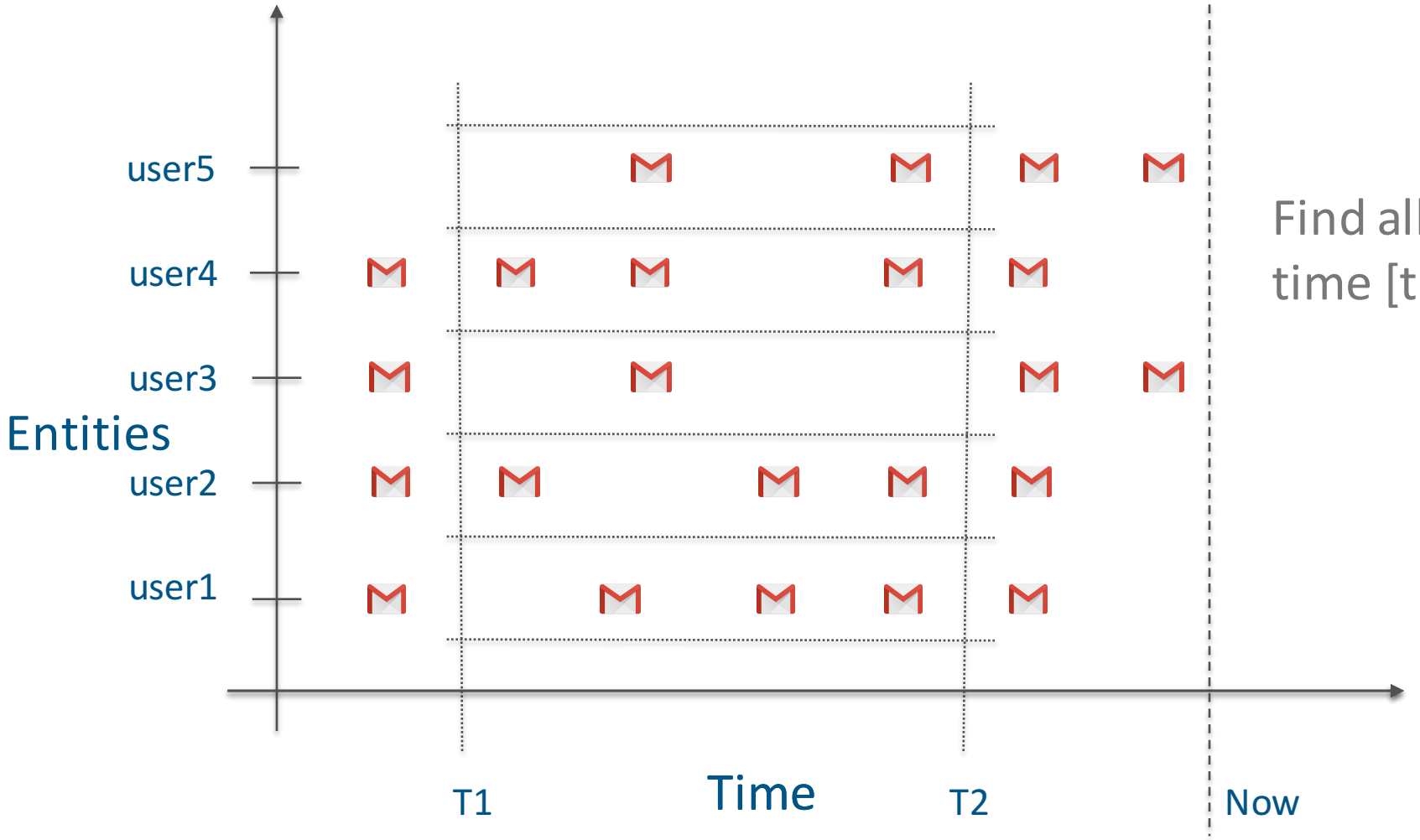
Time centric event first questions…



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

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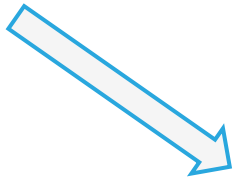
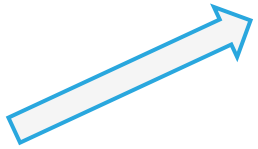
How does the data get in and out of HBase?

Getting data in...

Put, Incr, Append





Bulk Import

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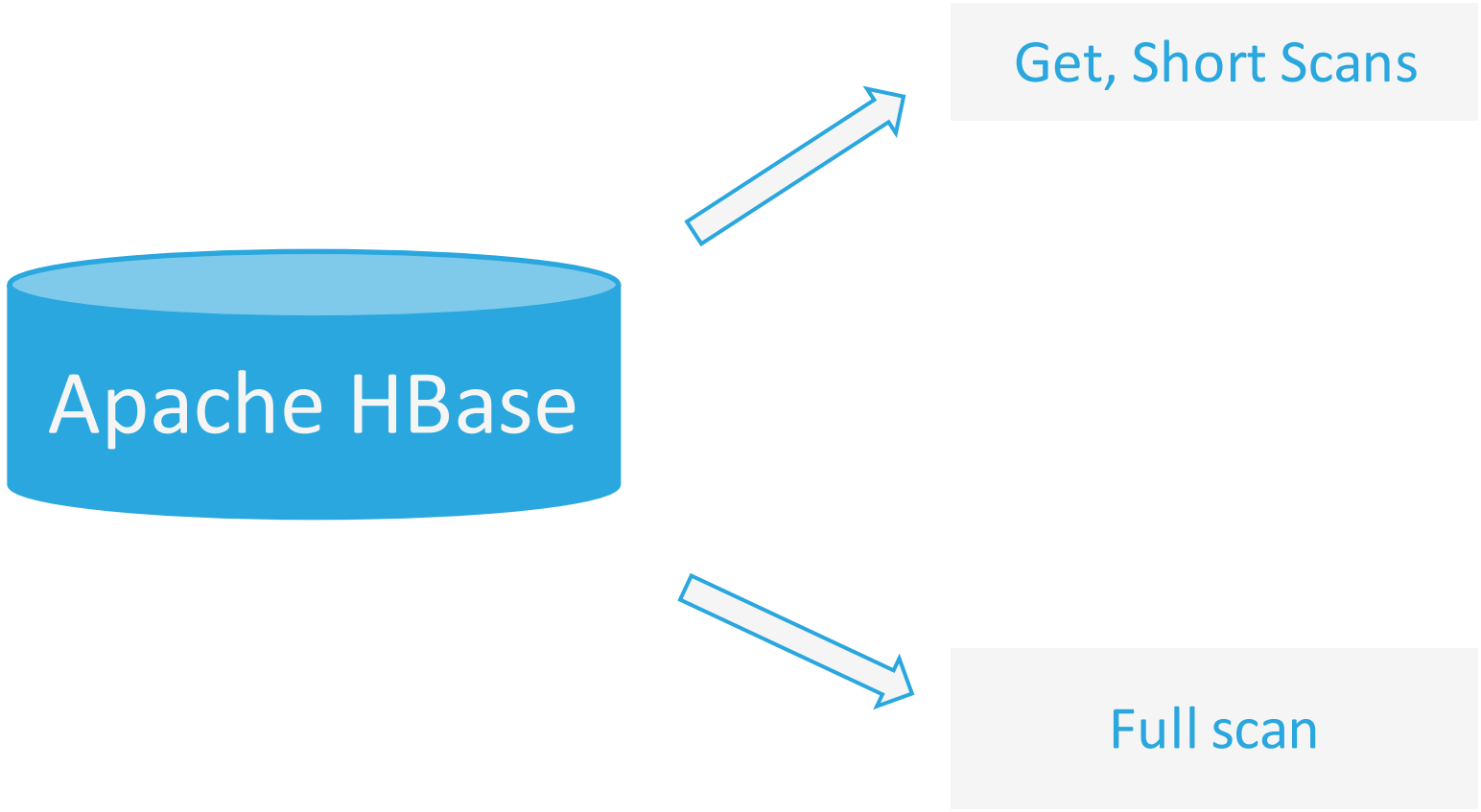
Getting data out...



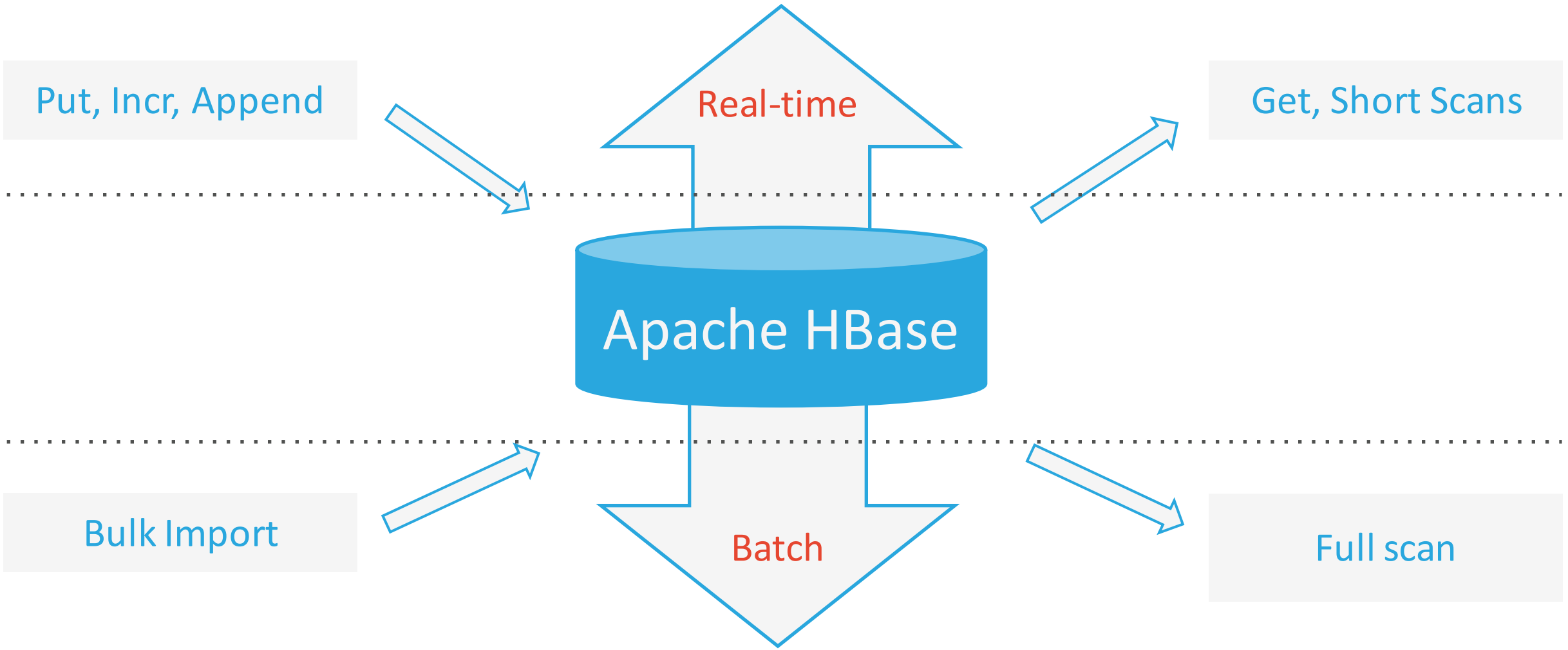
So, what’s the best way?

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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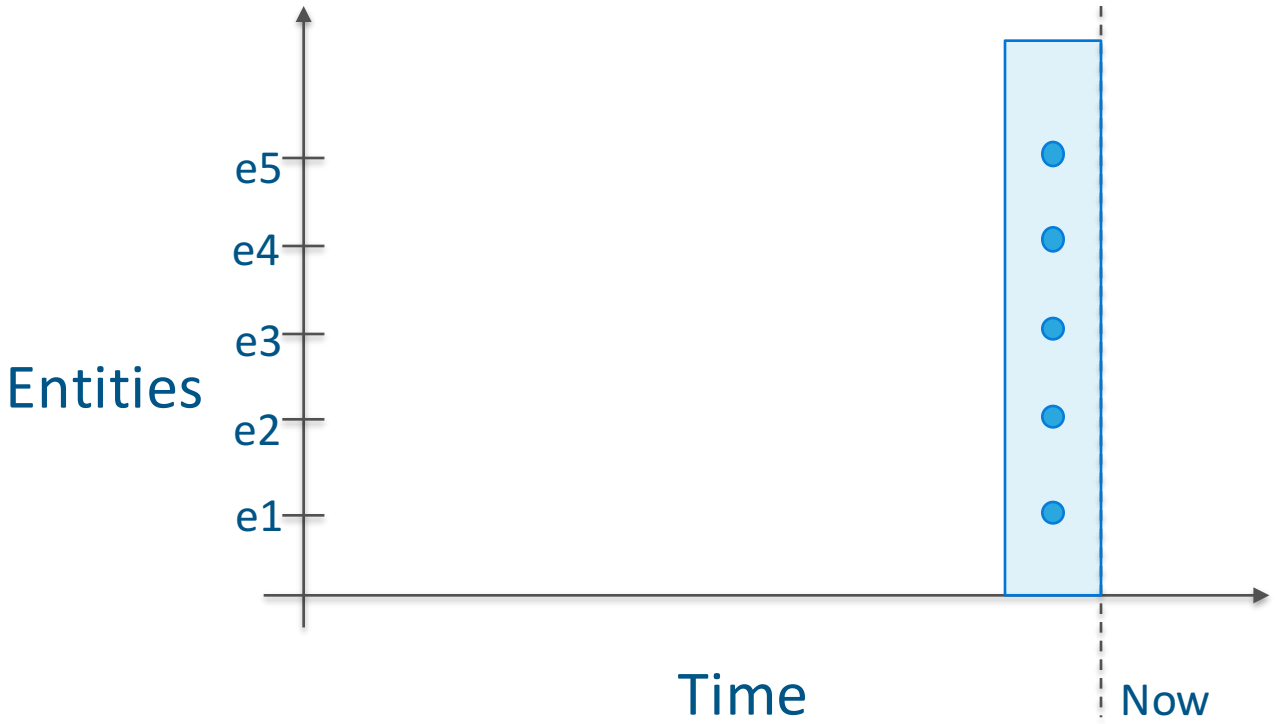
Simple Entities

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



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Simple Entities : Schema

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

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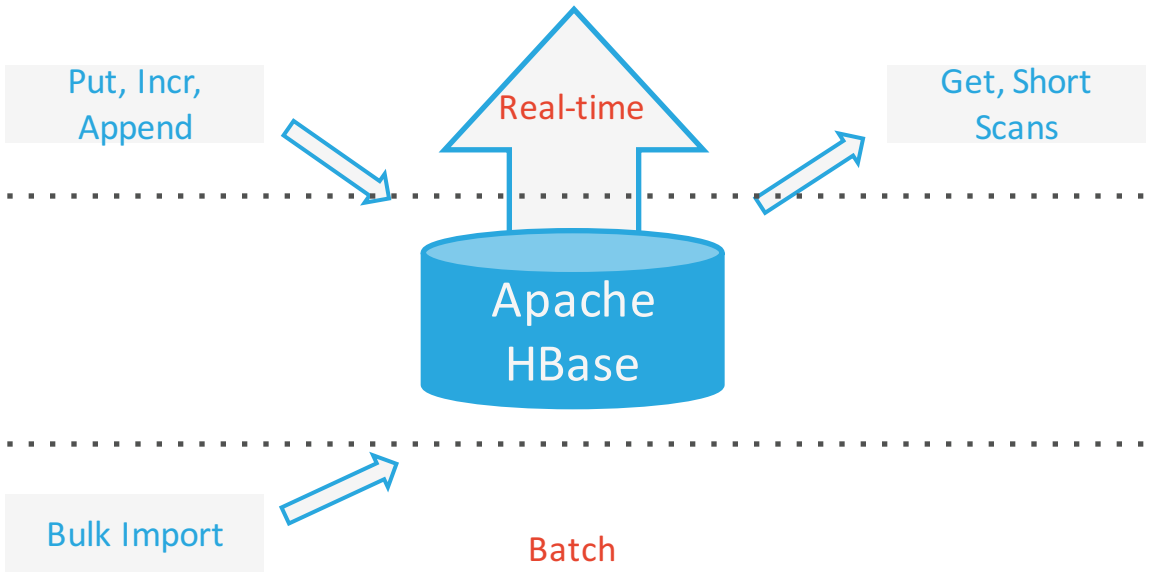
Simple Entities : Example

OCLC : Online Computer Library Center

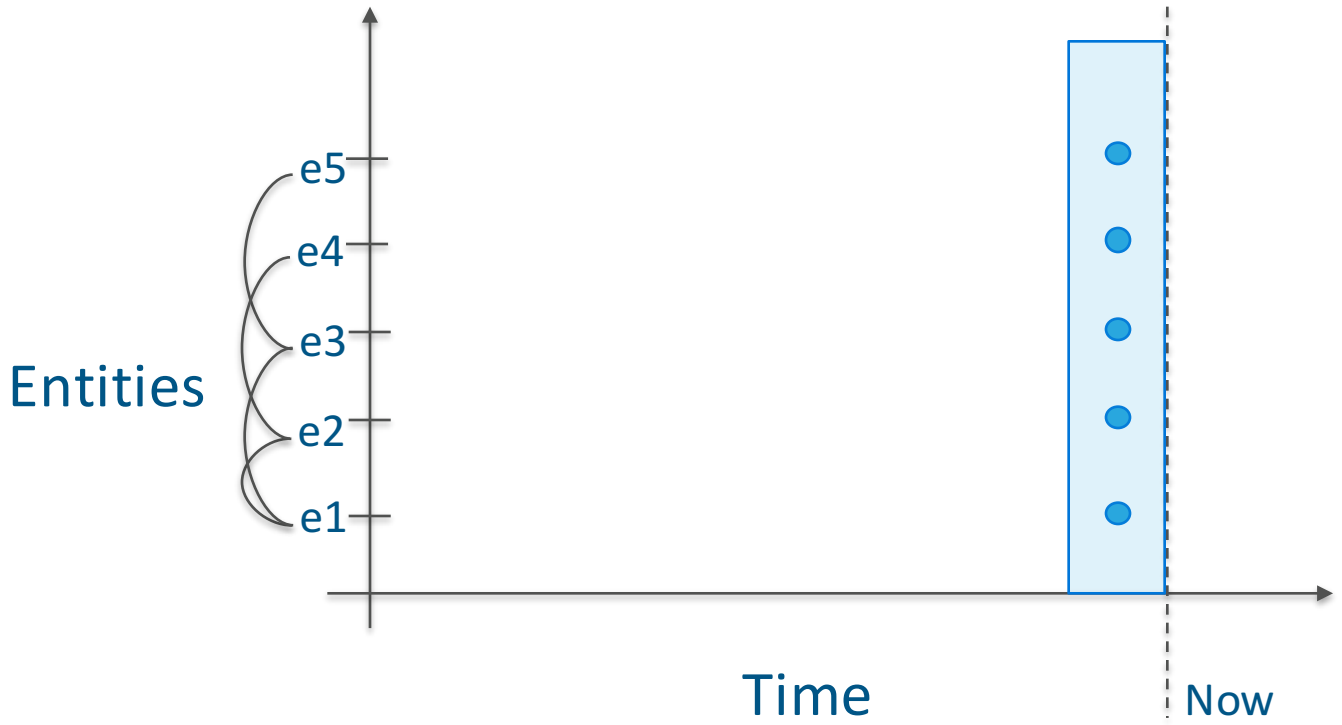
Workloads:

- 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



Linked Entities (Graph Data)

- Entity are linked to form a graph



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Linked Entities (Graph Data) : Schema

- One row per Node (Entity)
- Row key => Node ID (Entity ID)
- One Column Family to store edges =>

  “Relationship:OtherNodeID”
- Value => Meta data about relationship
- Second column family to store other information about node

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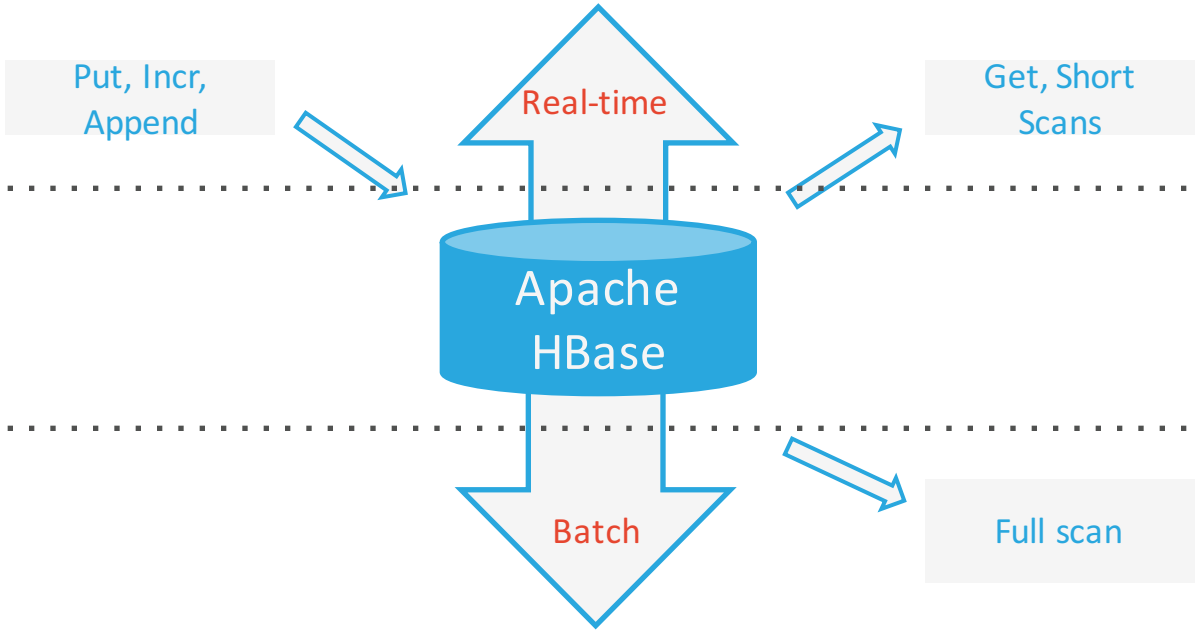
Linked Entities (Graph Data) : Example

Social Network (Facebook)

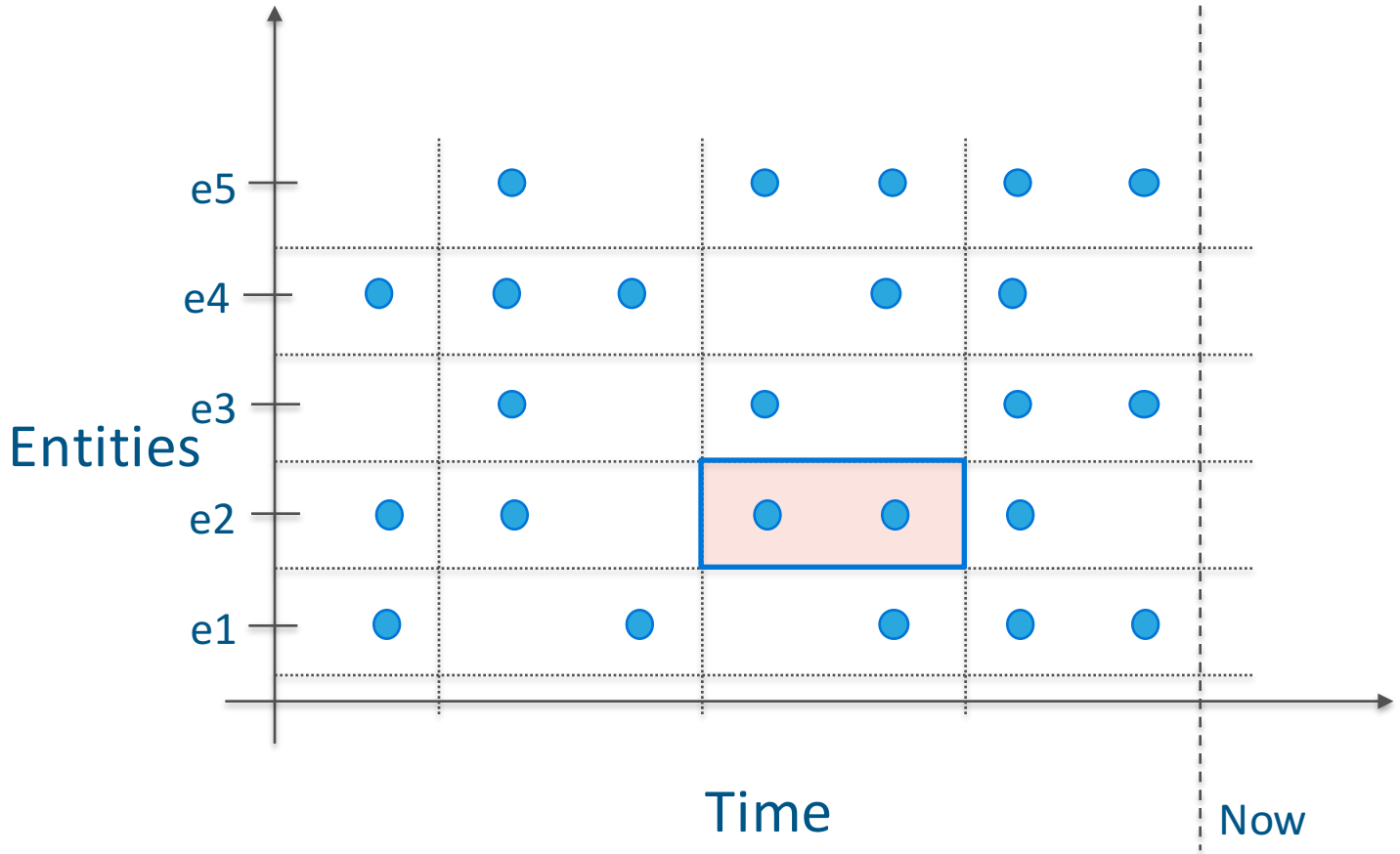
Workloads:

- 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



Time-coupled entities

- Events about entities
- **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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HBase is great!

But there are some use cases which are better off without it...

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

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
- Schema
  - Row key: timestamp
  - Monotonically increasing row key
  - Column qualifiers: properties with data or counters
- Example
  - Machine logs organized **by timestamp** (causes write hot-spotting)

That’s all folks!

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Questions ?

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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