Big Data Pipelines with Scala

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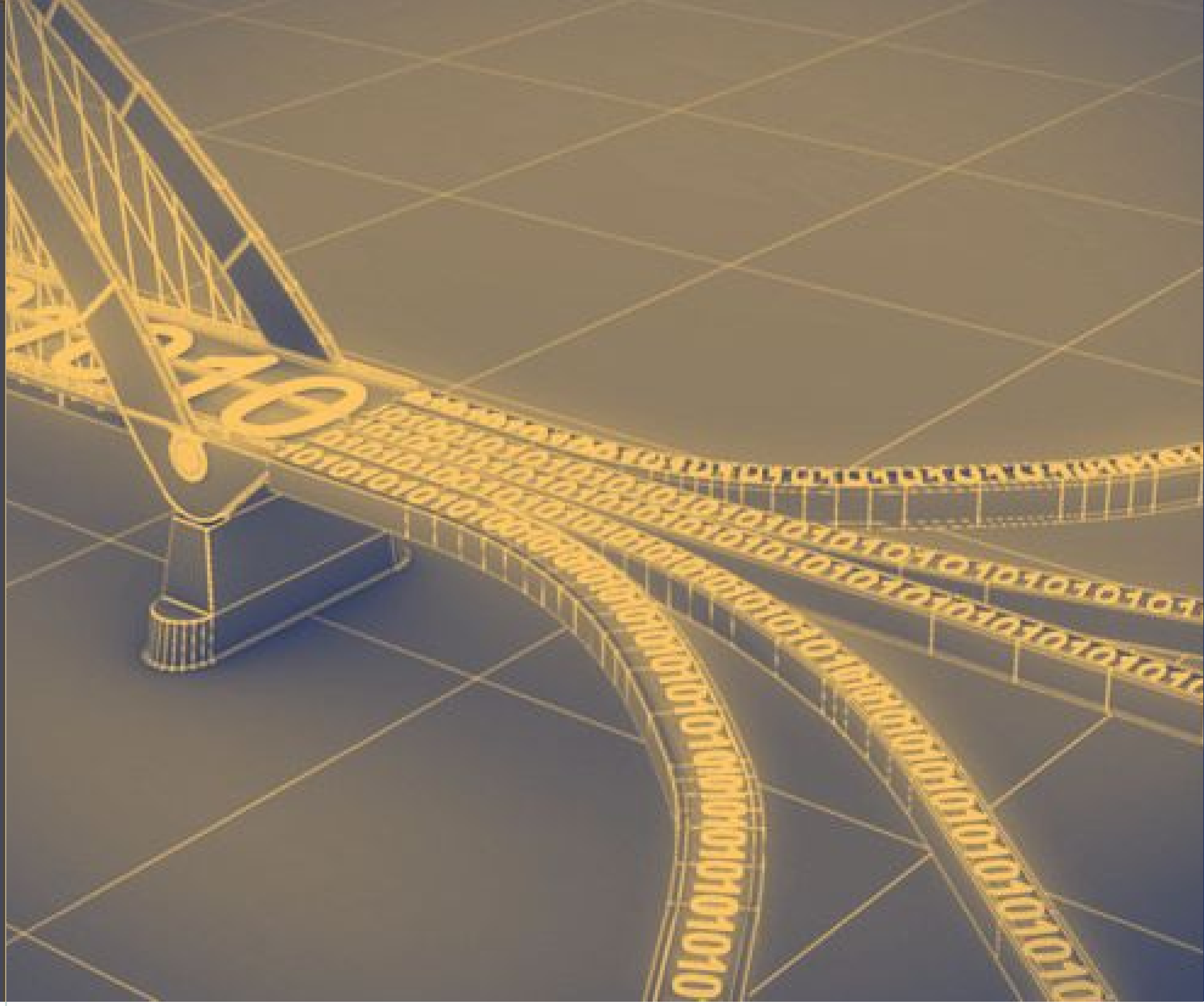
lambdaconf-2017-bigdata

Who am I?

- DATA @ Spotify
- ♥ Functional Programming and ~~Cofree~~ Coffee
- In Scala since 2012

We are hiring!

DATA



Unit 01

Batch Pipelines and Big Data

Unit 02

Functional Programming and Big Data

Unit 03

From Batch to Streaming

Fast Facts

- 100M+ Active Users
- 50M+ Subscribers
- 30M+ Songs
- 2B+ Playlists

[1] https://press.spotify.com/us/about/

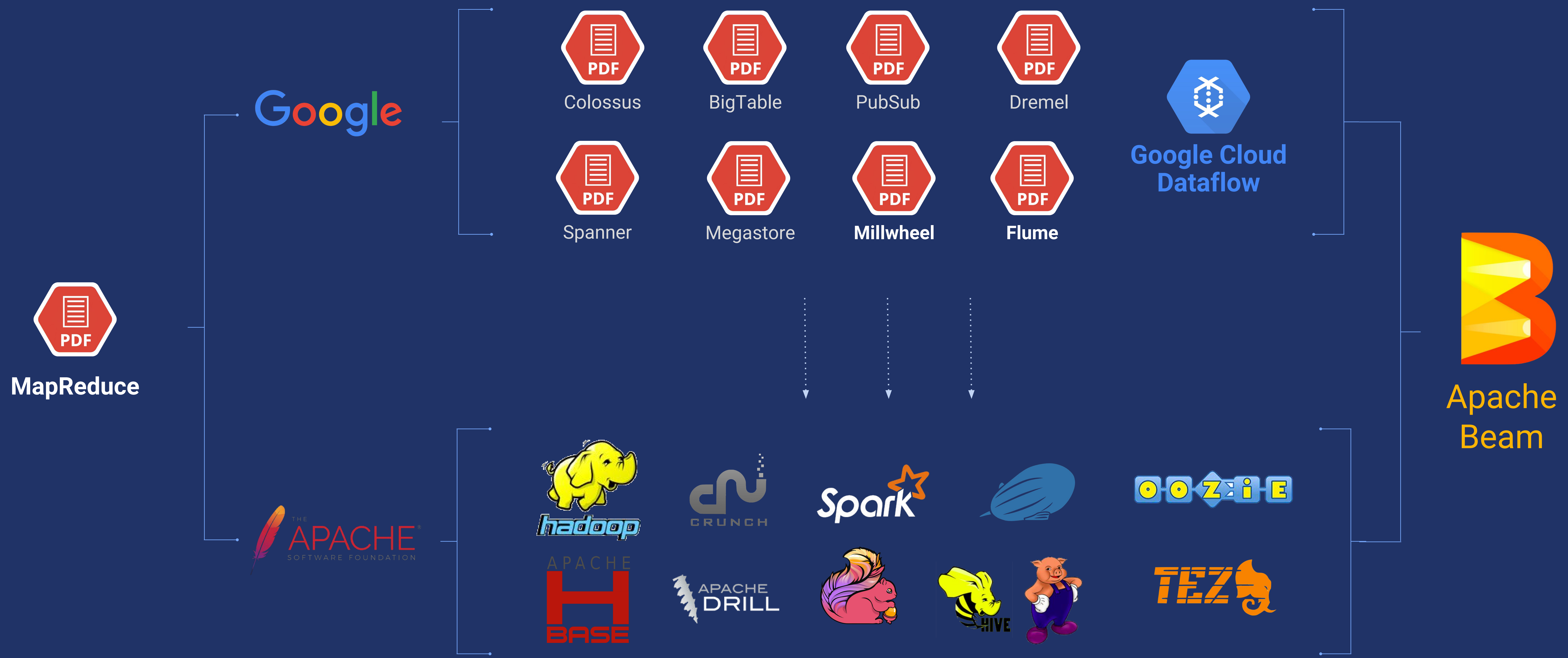
Hadoop@Spotify

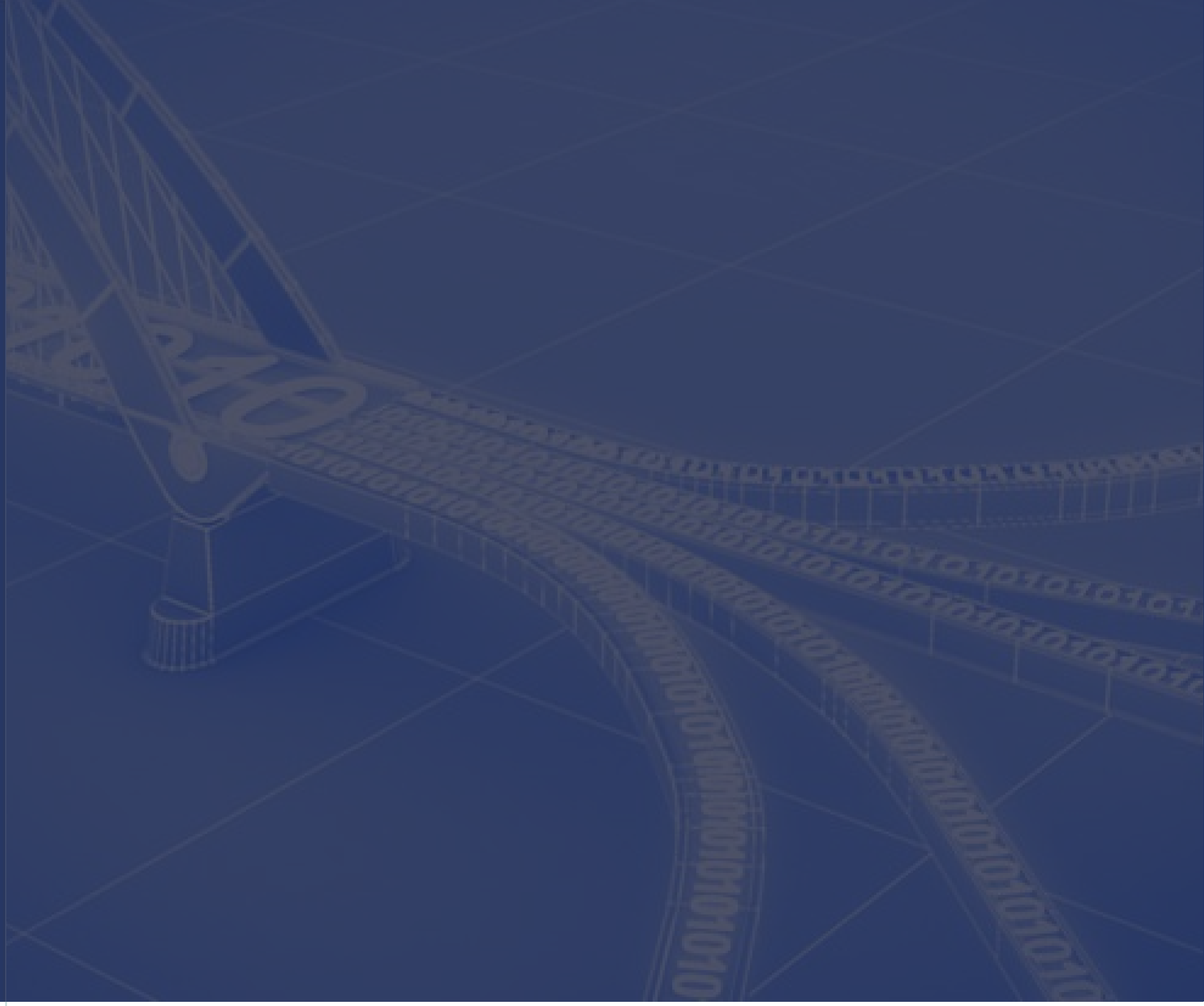
Hadoop@Spotify

- On-Premise
- 2,500 nodes
- 100 PB Disk
- 100 TB RAM
- 100B+ events per day
- 20K+ jobs per day

Moving to Google Cloud

The Evolution of Big Data Ecosystem





Unit 01

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MapReduce: Batch Processing

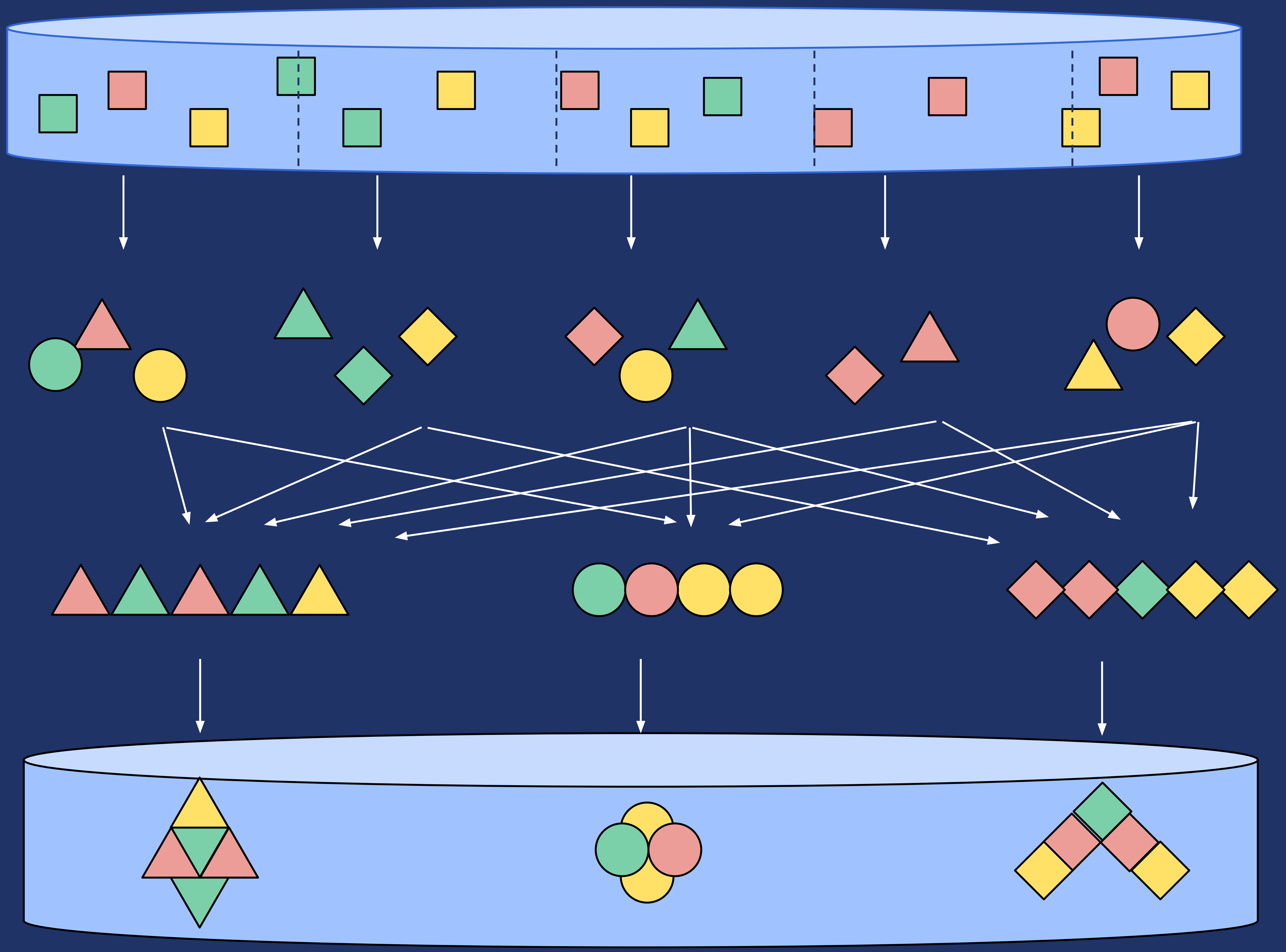
(Prepare)

Map

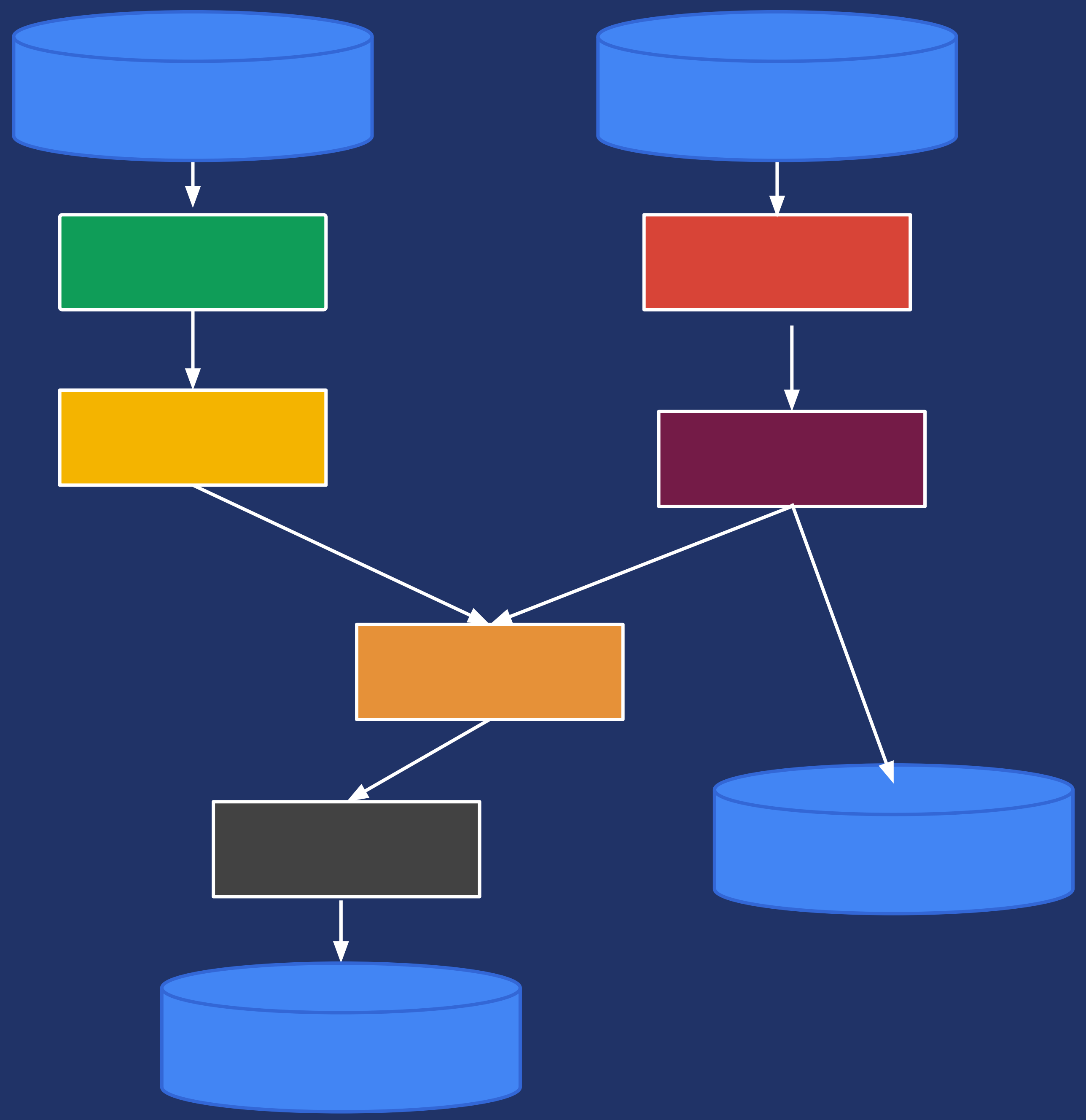
(Shuffle)

Reduce

(Produce)



Apache Beam



- High Level API
- User provides DAG of computations to be performed
- SDK available for Java and Python
- Runs on
  - Google Dataflow
  - Apache Spark
  - Apache Apex
  - Apache Flink

Scio

Latin /ˈʃi.o/, [ˈʃiː.o]

Verb: I can, know, understand, have knowledge.

```scala
case class TrackCount(trackId: TrackId, plays: Long)

case class PlayTrack(userId: UserId, trackId: TrackId)

playTracks
  .map(track => (track.trackId, 1L))
  .reduceByKey(_ + _)
  .map { case (trackId, plays) => TrackCount(trackId, plays) }
```

```scala
trait SCollection[A] {
  def map[B](f: A => B): SCollection[B]
  def flatMap[B](f: A => Iterable[B]): SCollection[B]
  def filter(f: A => Boolean): SCollection[A]
}

implicit class PairSCollectionOps[K, V](
  self: SCollection[(K, V)]) {

  def reduceByKey(f: (V, V) => V): SCollection[(K, V)]
  def sum(implicit V: Semigroup[V]): SCollection[(K, V)]
}
```

Unit 01.

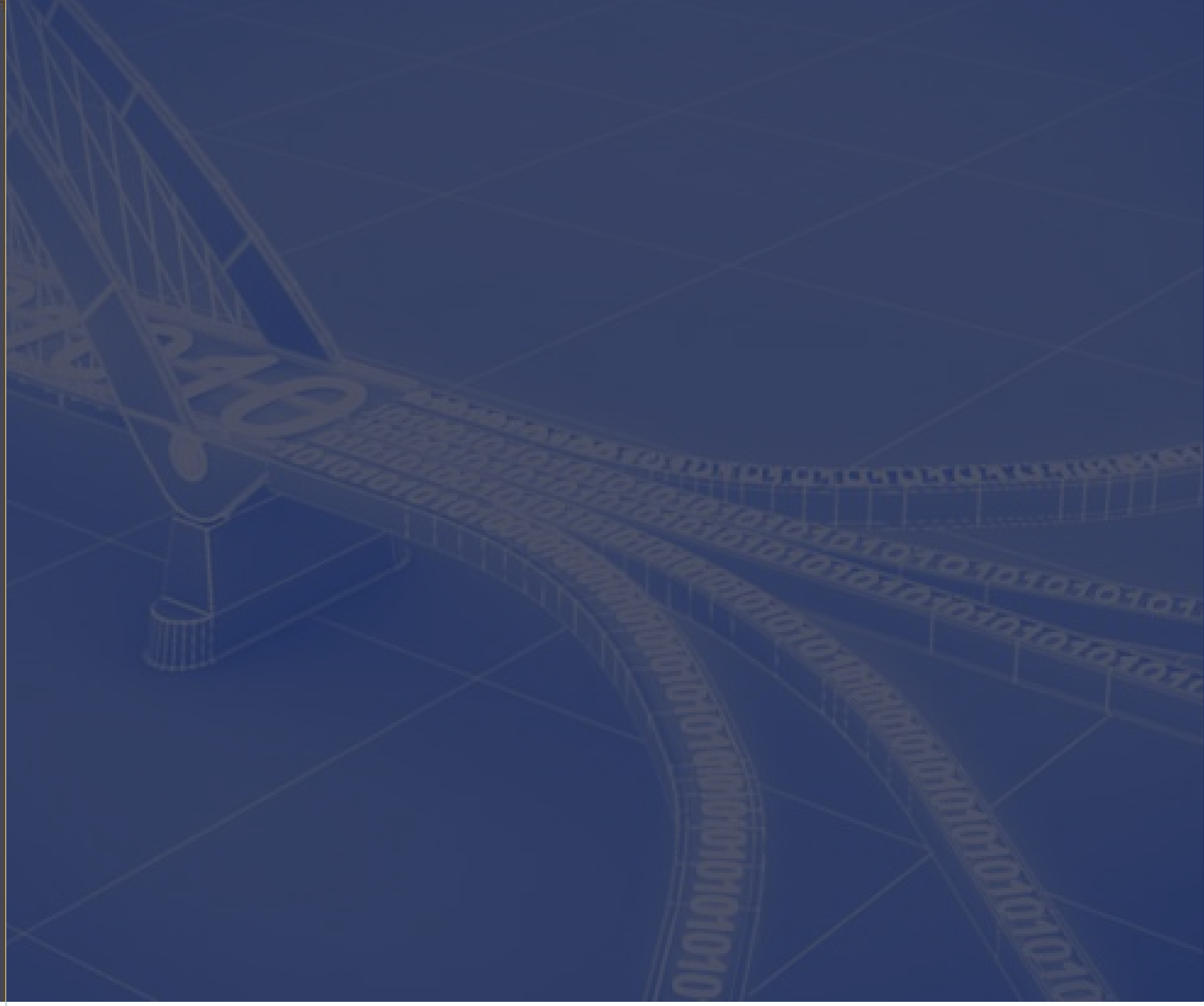
1. open sbt and run pipeline

```
$ ./sbt shell

> unit-1
> test-unit-1
> avro-read in/play_track/
> avro-read out/play_count/
```

2. output total content hours per user

3. output top n users by content hours



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Immutable Data

```
case class TrackCount(trackId: TrackId, plays: Long)

case class PlayTrack(userId: UserId, trackId: TrackId)

playTracks
  .map(track => (track.trackId, 1L))
  .reduceByKey(_ + _)
  .map { case (trackId, plays) => TrackCount(trackId, plays) }
```

Second-Order Functions

```
case class TrackCount(trackId: TrackId, plays: Long)

case class PlayTrack(userId: UserId, trackId: TrackId)

playTracks
  .map(track => (track.trackId, 1L))
  .reduceByKey(_ + _)
  .map { case (trackId, plays) => TrackCount(trackId, plays) }
```

First-Class Functions and Lambdas

```
case class TrackCount(trackId: TrackId, plays: Long)

case class PlayTrack(userId: UserId, trackId: TrackId)

playTracks
  .map(track => (track.trackId, 1L))
  .reduceByKey(_ + _)
  .map { case (trackId, plays) => TrackCount(trackId, plays) }
```

Pattern-Matching

```
case class TrackCount(trackId: TrackId, plays: Long)

case class PlayTrack(userId: UserId, trackId: TrackId)

playTracks
  .map(track => (track.trackId, 1L))
  .reduceByKey(_ + _)
  .map { case (trackId, plays) => TrackCount(trackId, plays) }
```

Composition

```
def contentHours(playTracks: SCollection[PlayTrack]):
  SCollection[ContentHours] = …

def topUsers(n: Int, playTracks: SCollection[PlayTrack]):
  SCollection[ContentHours] = {

  contentHours(playTracks)
    .top(n)(Ordering.by(_.msPlayedSum))
    .flatMap(x => x)
}
```

Unit 02.

What Can Go Wrong

Problem: Skewed Data

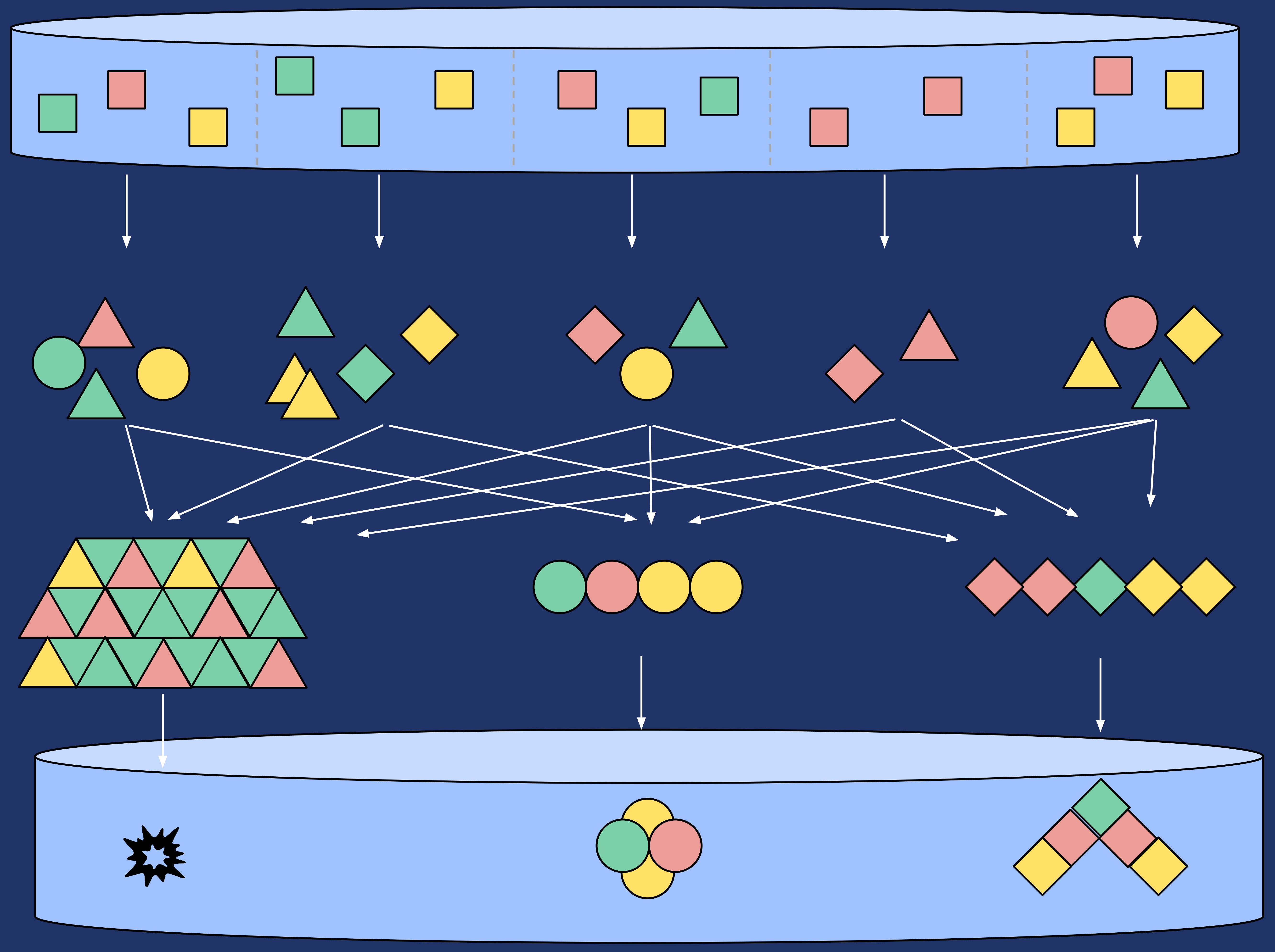
(Prepare)

Map

(Shuffle)

Reduce

(Produce)



Hot Key Fanout

```
def withHotKeyFanout(hotKeyFanout: K => Int):
  SCollectionWithHotKeyFanout[K, V]
```

- adds intermediate step to reduce skewed keys
- `hotKeyFanout` determines number of nodes

Hash Join

```
def hashJoin[W](that: SCollection[(K, W)]):
  SCollection[(K, (V, W))]
```

- replicates that to all workers
- right side should be tiny and fit into memory

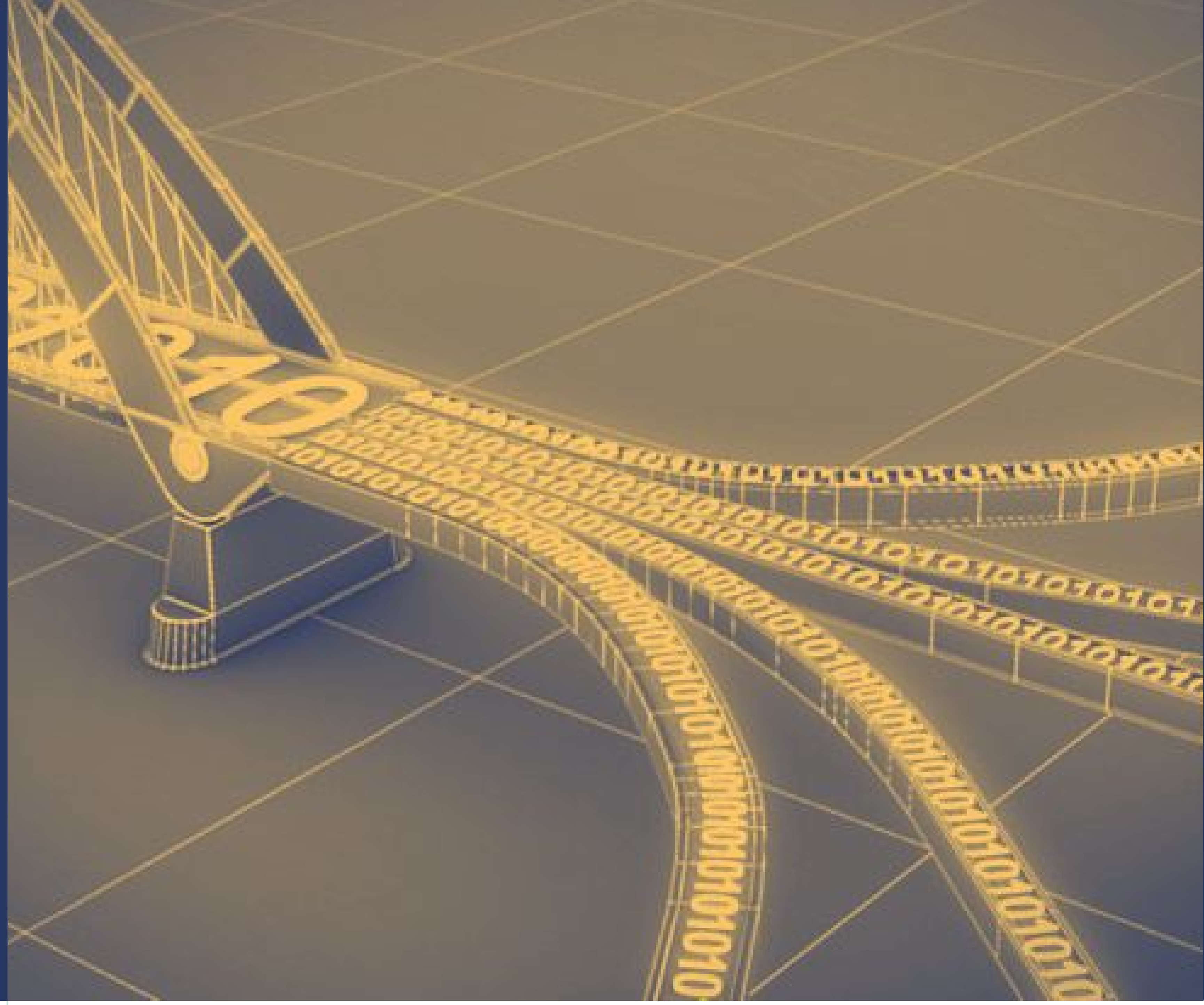
Skewed Join

```
def skewedJoin[W](that: SCollection[(K, W)]):
  SCollection[(K, (V, W))]
```

- adds intermediate step with hashJoin of hot keys
- uses Count-Min-Sketch to find hot keys

Testing your Code

See ./src/test/scala/us.lambdaconf/
4_tests.scala



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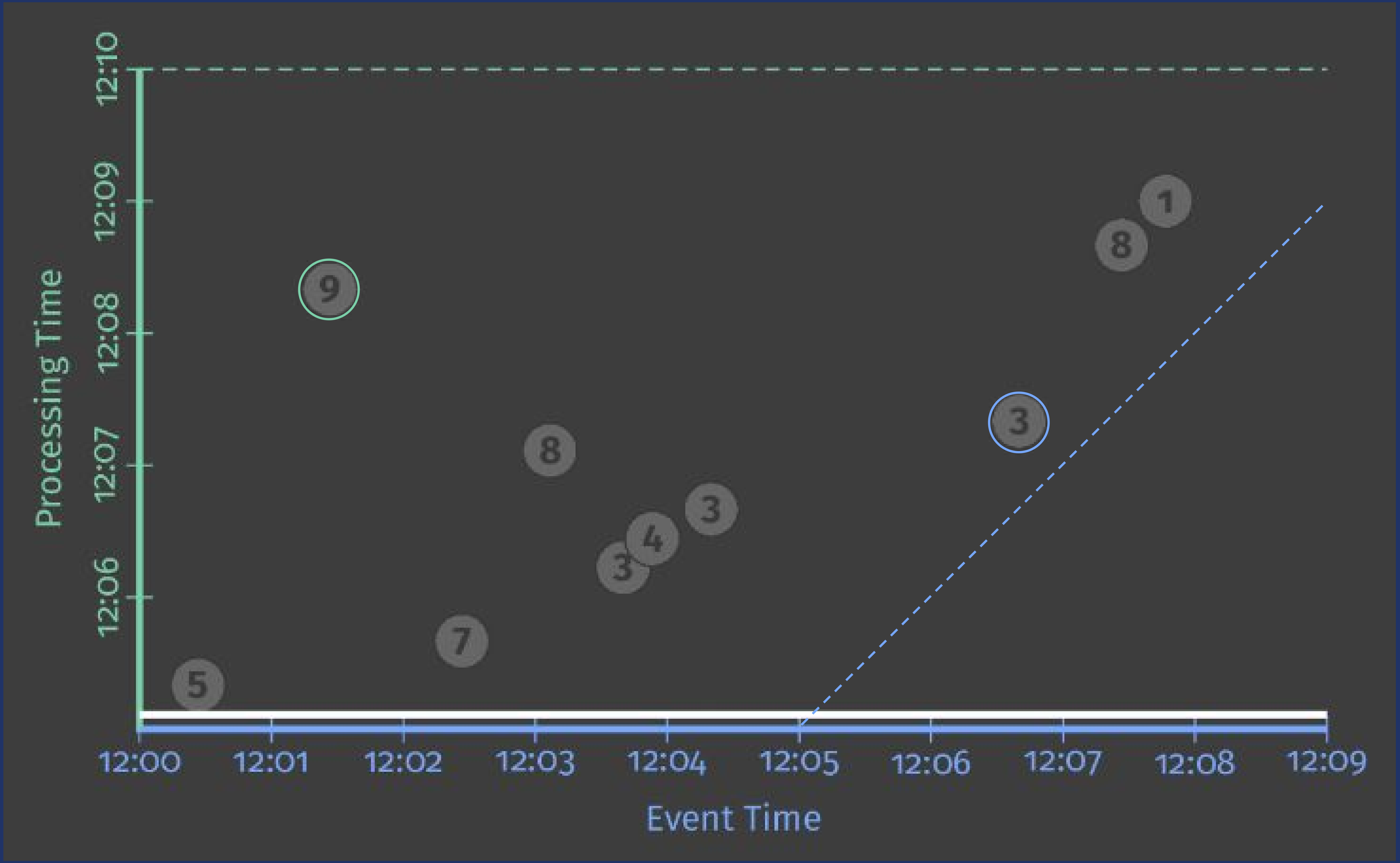
From Batch to Streaming

Event Time vs. Processing Time



What are you computing?

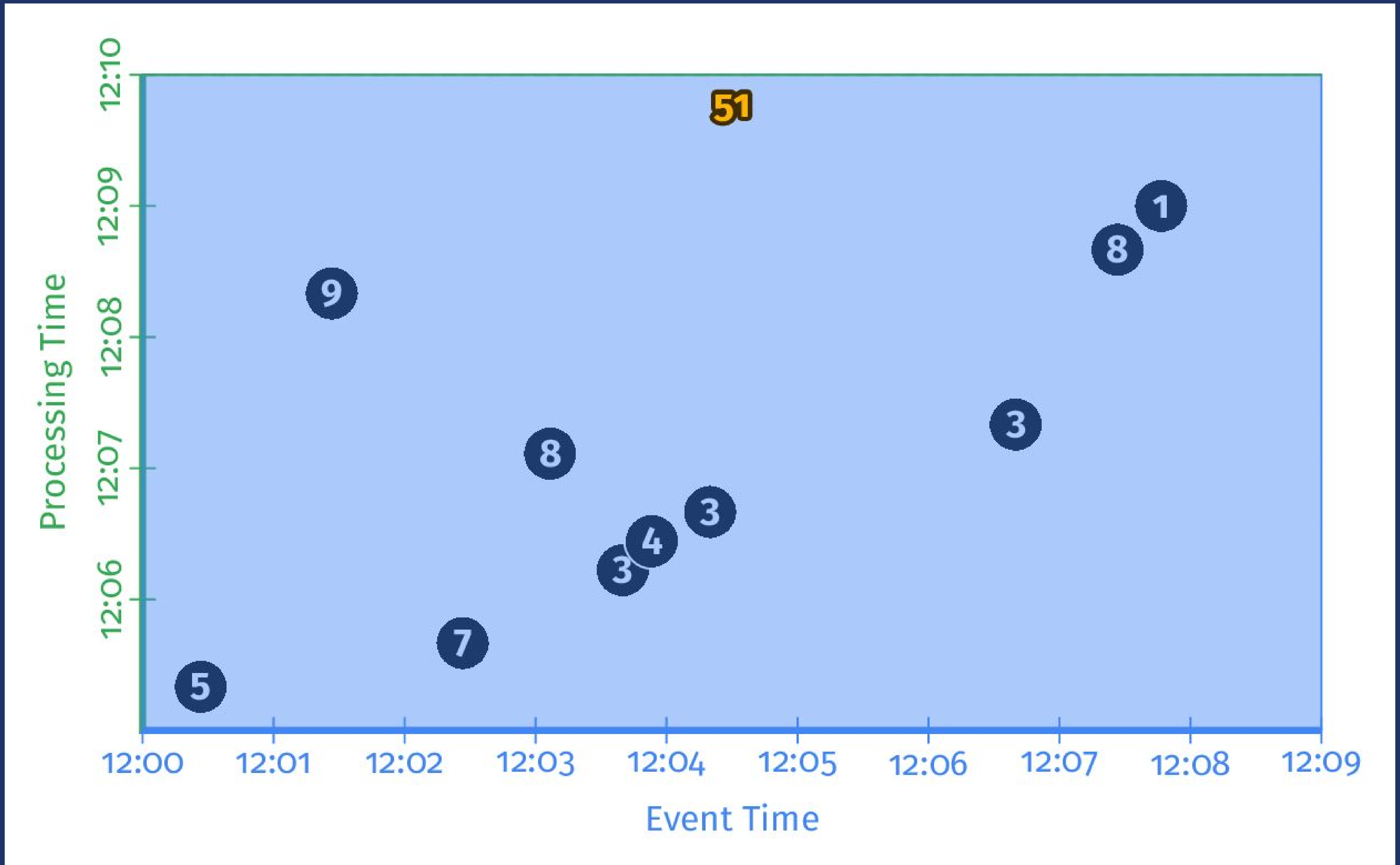
Where in event time?

When in processing time?

How do refinements relate?

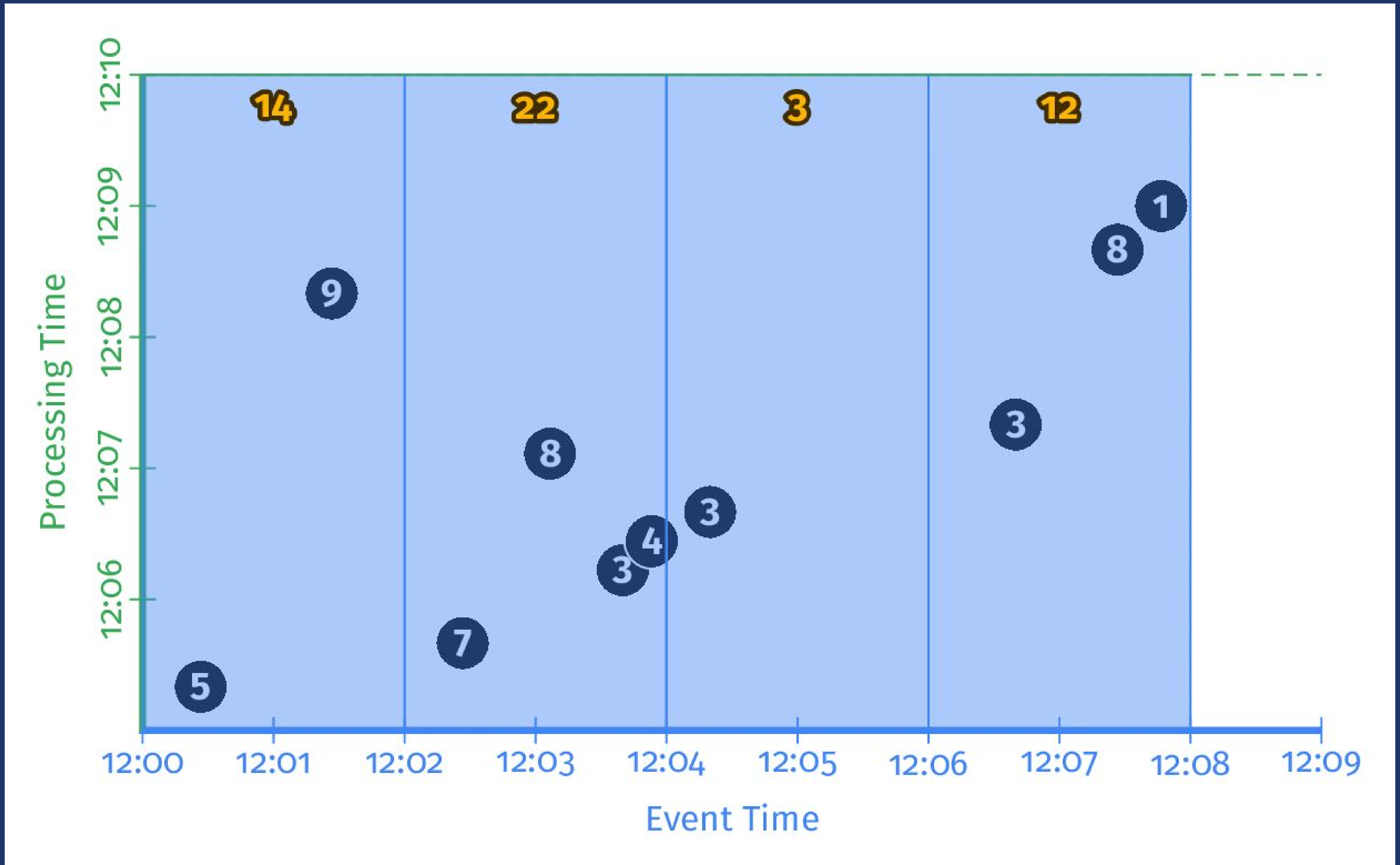
The Beam Model: What is Being Computed?

```
playTracks
  .map(_.msPlayed)
  .sum
```



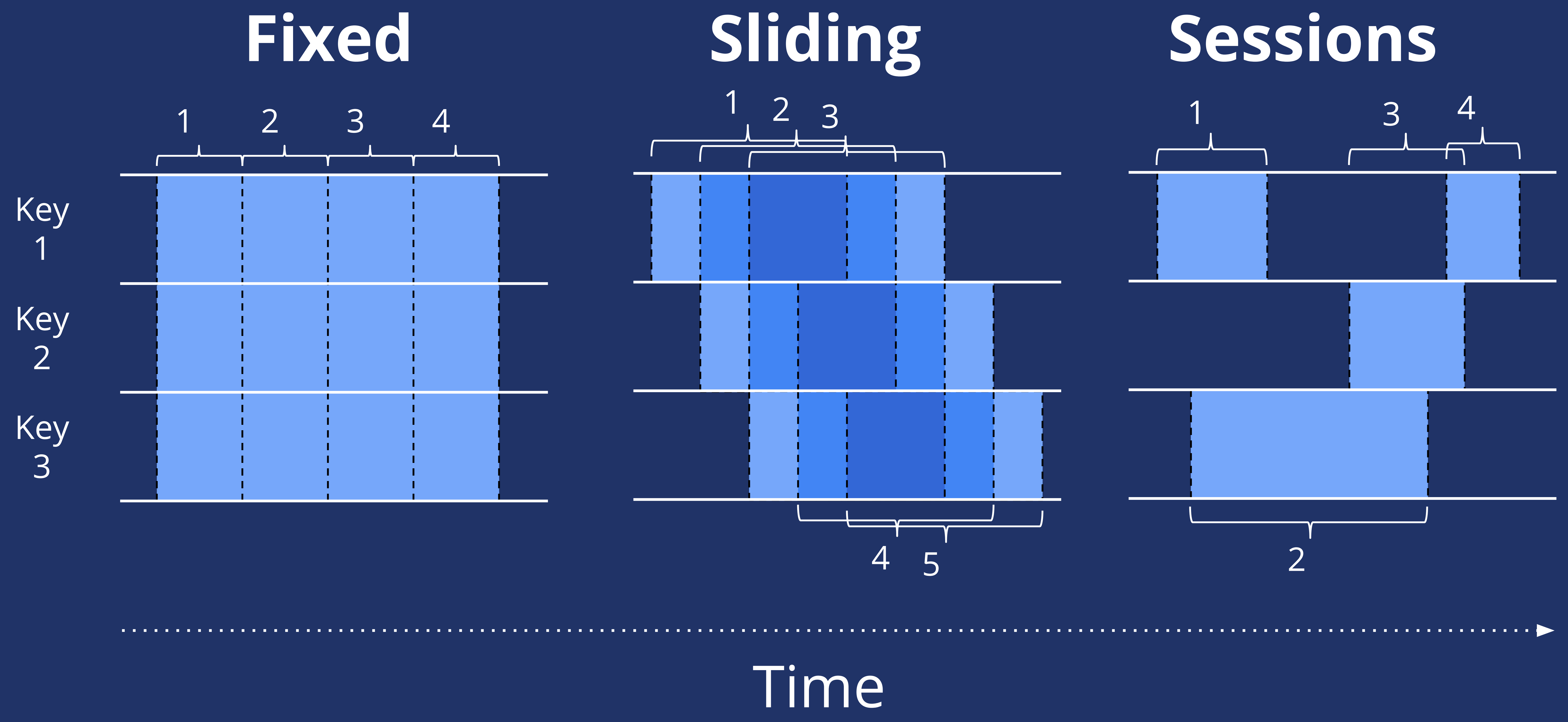
The Beam Model: Where in Event Time?

```
playTracks
  .map(_.msPlayed)
  .withFixedWindows(minutes(2))
  .sum
```



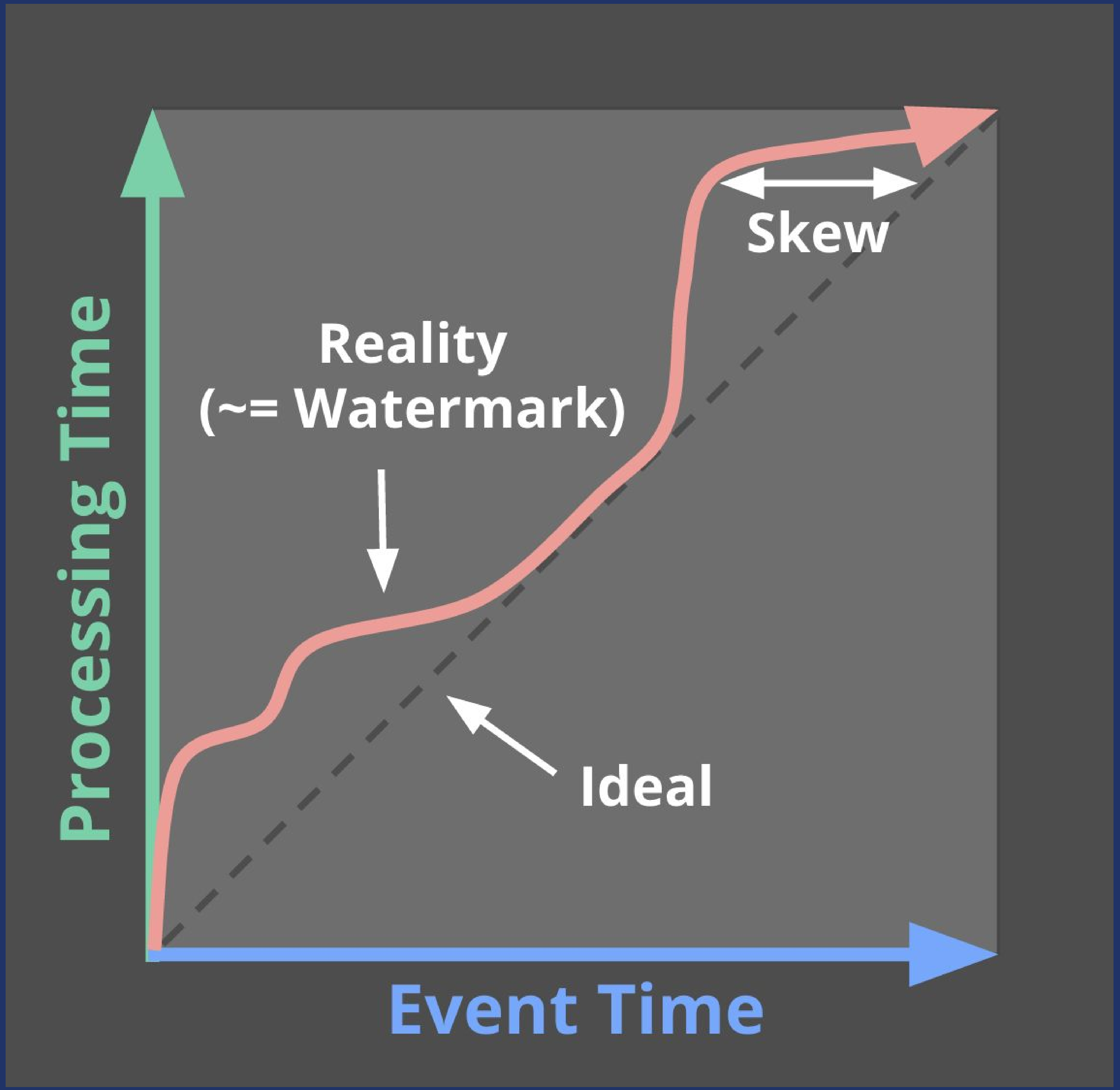
Where in event time?

Windowing divides data into event-time-based finite chunks.



Often required when doing aggregations over unbounded data.

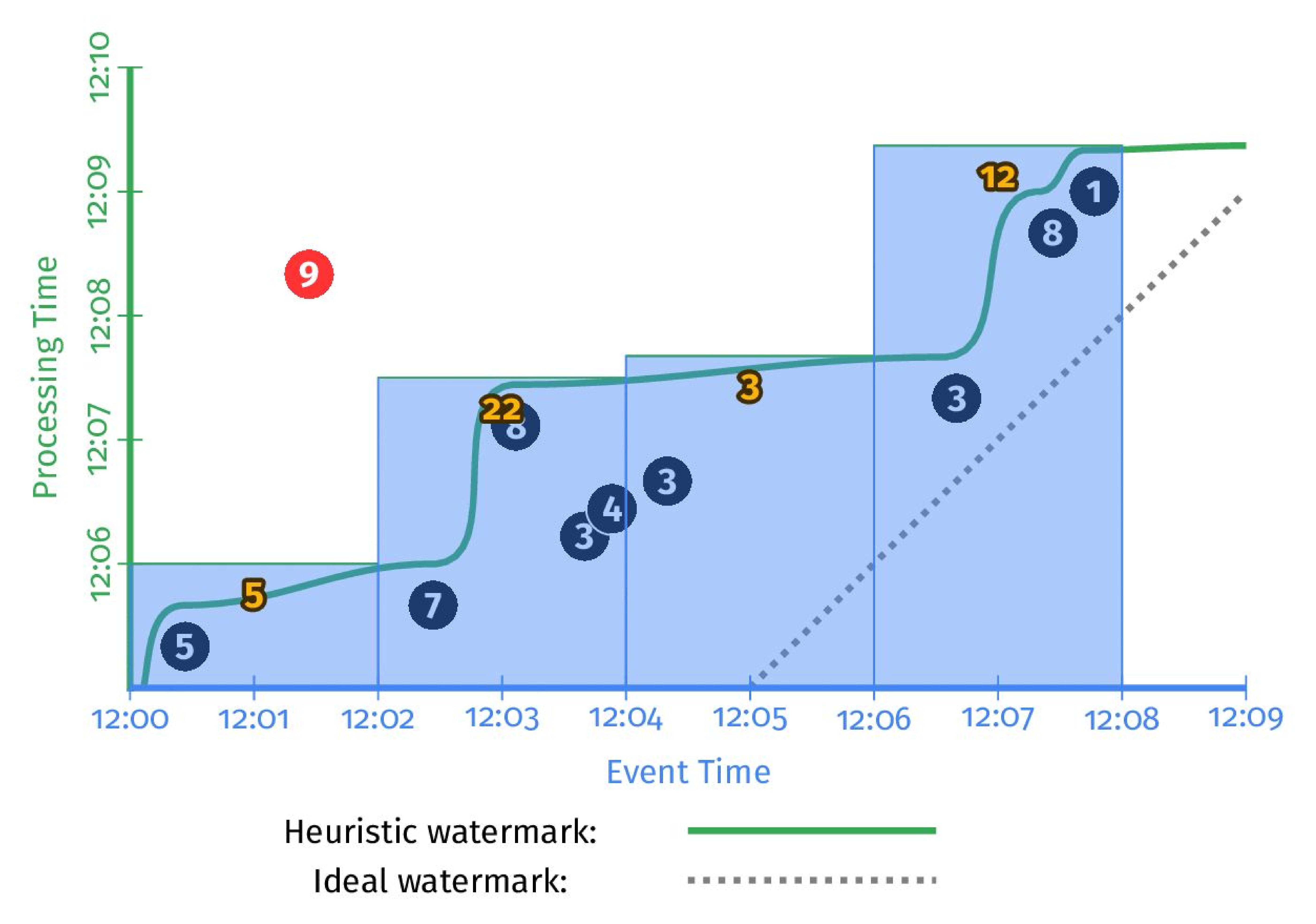
When in processing time?



- Triggers control when results are emitted.
- Triggers are often relative to the watermark.

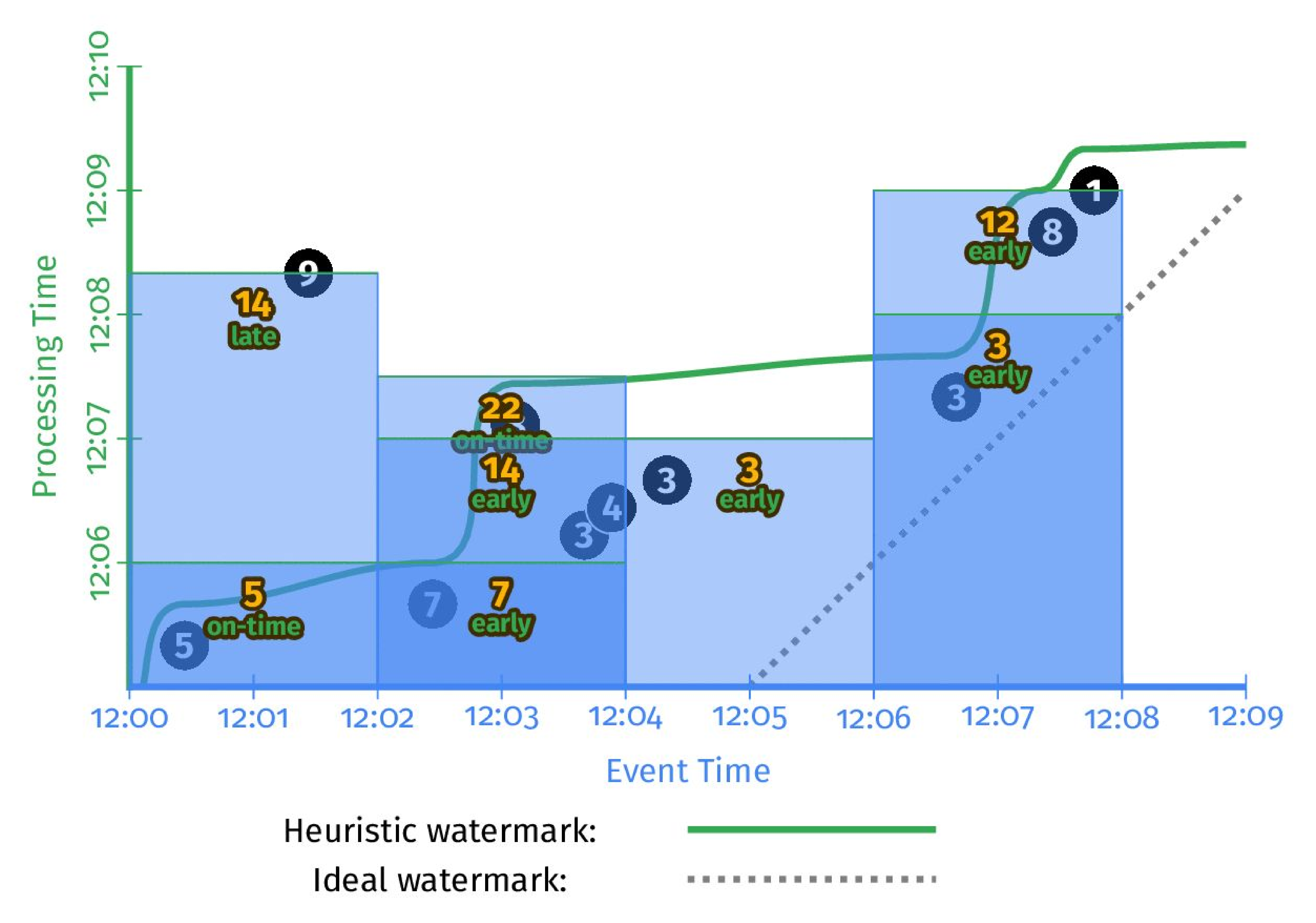
The Beam Model: When in Processing Time?

```
val trigger =
 AfterWatermark.pastEndOfWindow()

val options = WindowOptions(trigger)

playTracks
 .map(_.msPlayed)
 .withFixedWindows(
   duration = minutes(2),
   options = options)
 .sum
```

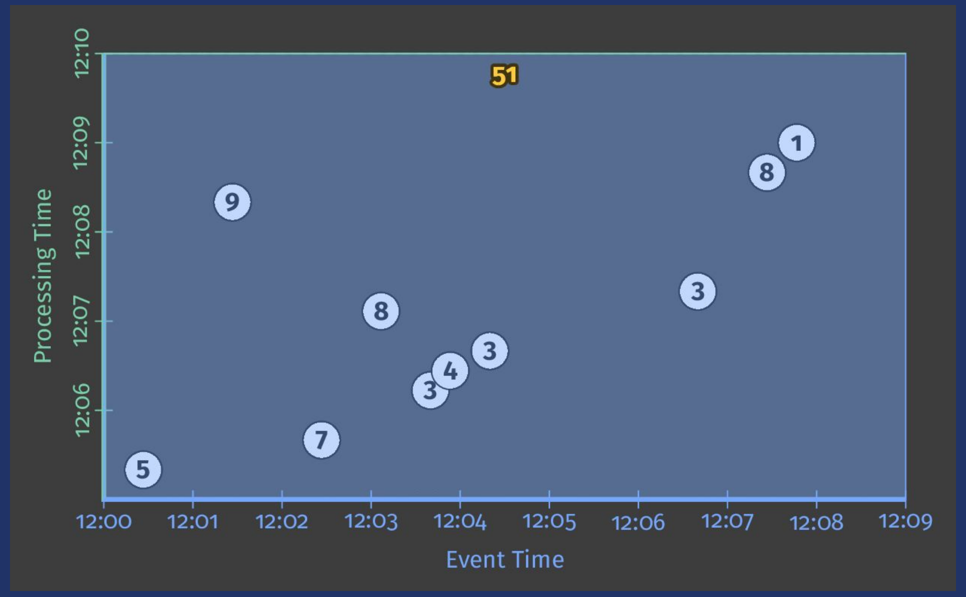


The Beam Model: How do Refinements Relate?

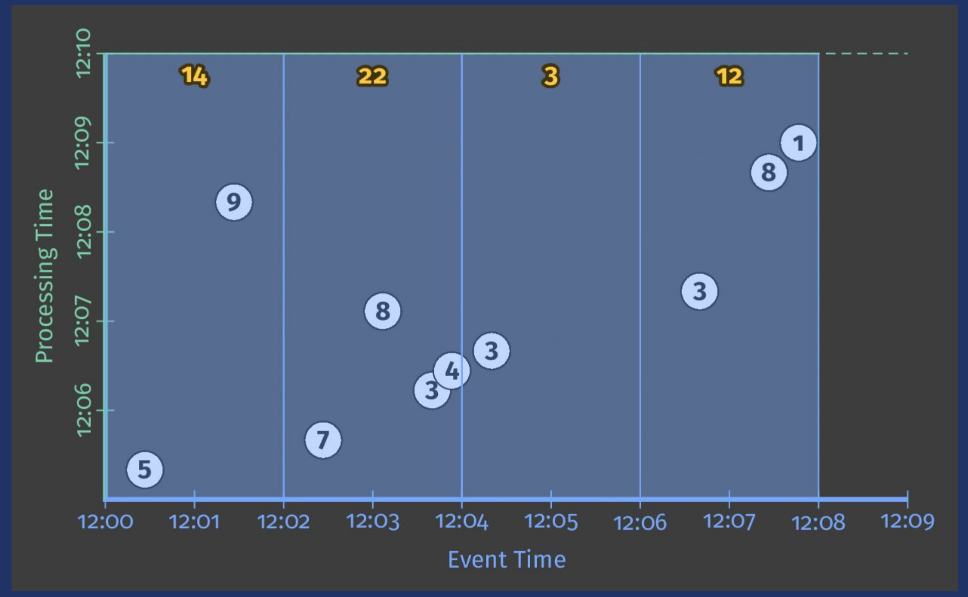
```
val trigger = AfterEach.inOrder(
 Repeatedly.forever(
   AfterProcessingTime
     .pastFirstElementInPane()
     .plusDelayOf(minutes(1))
 ).orFinally(
   AfterWatermark.pastEndOfWindow()),
 Repeatedly.forever(
   AfterPane
     .elementCountAtLeast(1)))

val options = WindowOptions(
 trigger = trigger,
 allowedLateness = days(1),
 accumulationMode =
   ACCUMULATING_FIRED_PANES)
```



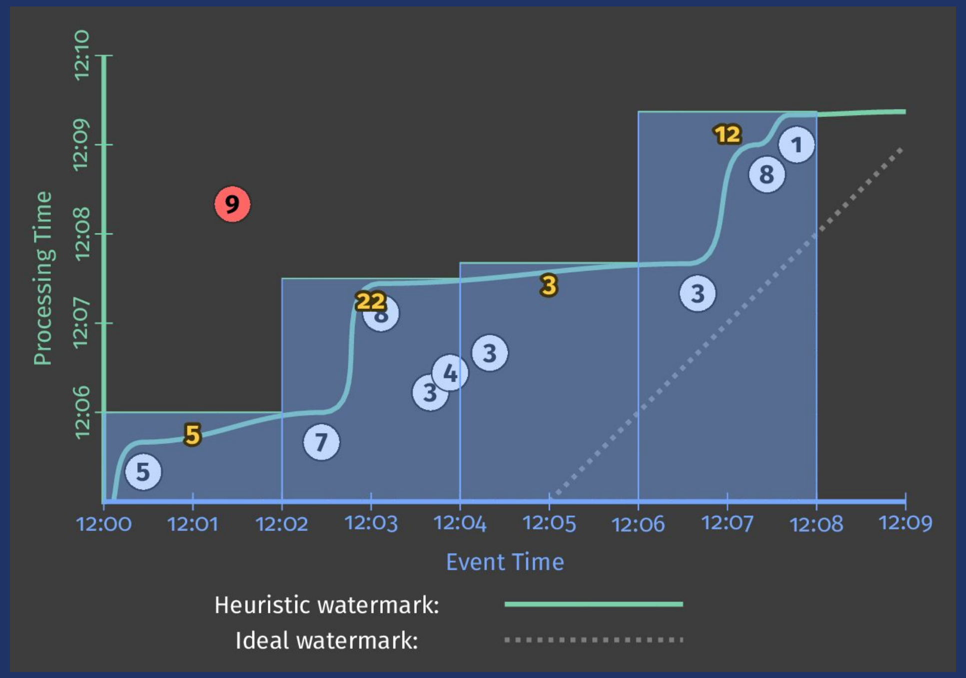
Customizing What When Where How



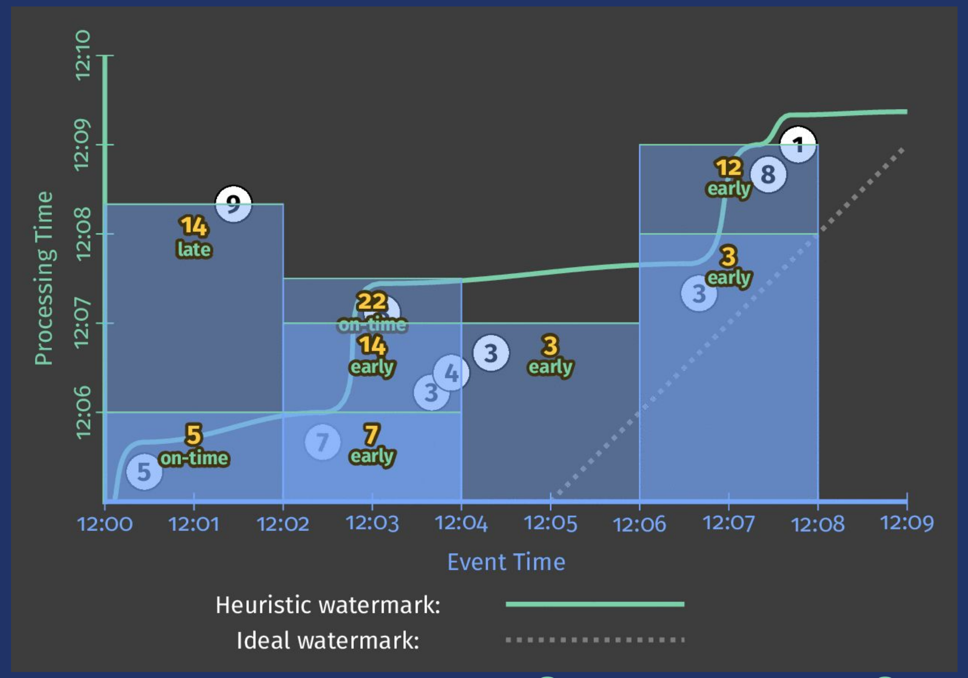
1.Classic Batch



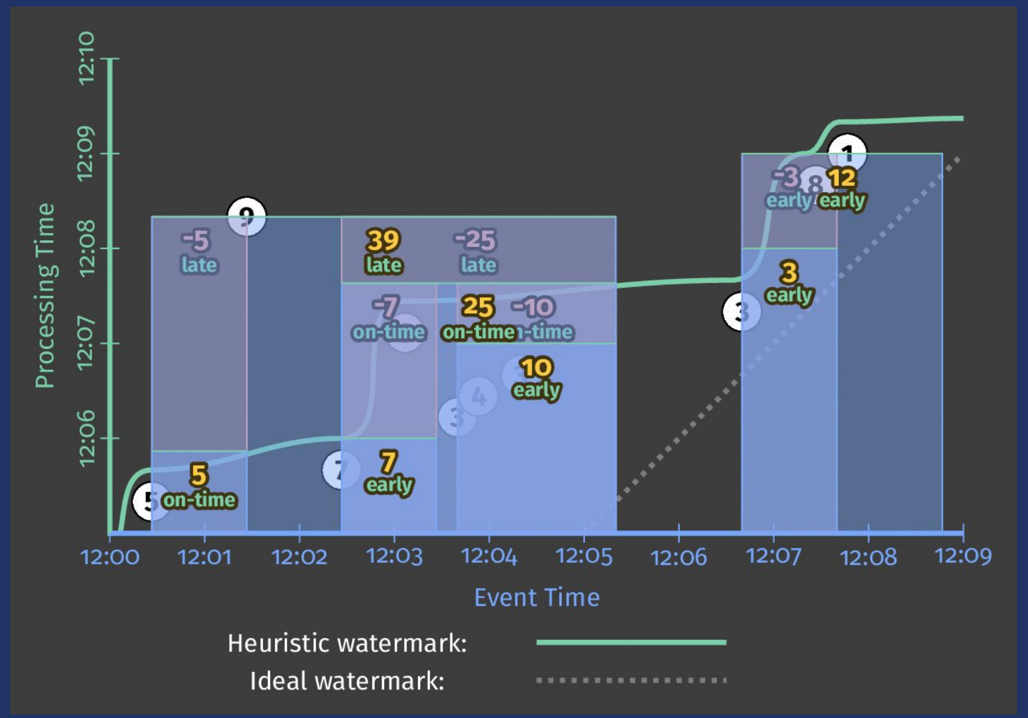
2. Batch with Fixed Windows



3. Streaming



4. Streaming with Speculative + Late Data



5. Streaming With Retractions

Unit 03.

1. override windowing options, set accumulation strategy for late events

2. drop events late more than 1 day

3. accumulate late events iff batch has more than 3 elements

4. wait for one hour for last event before closing the window

Learn More!

- github.com/spotify/scio
- beam.apache.org

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