Architectural Considerations for Hadoop Applications

Strata+Hadoop World, San Jose – February 18th, 2015

tiny.cloudera.com/app-arch-slides

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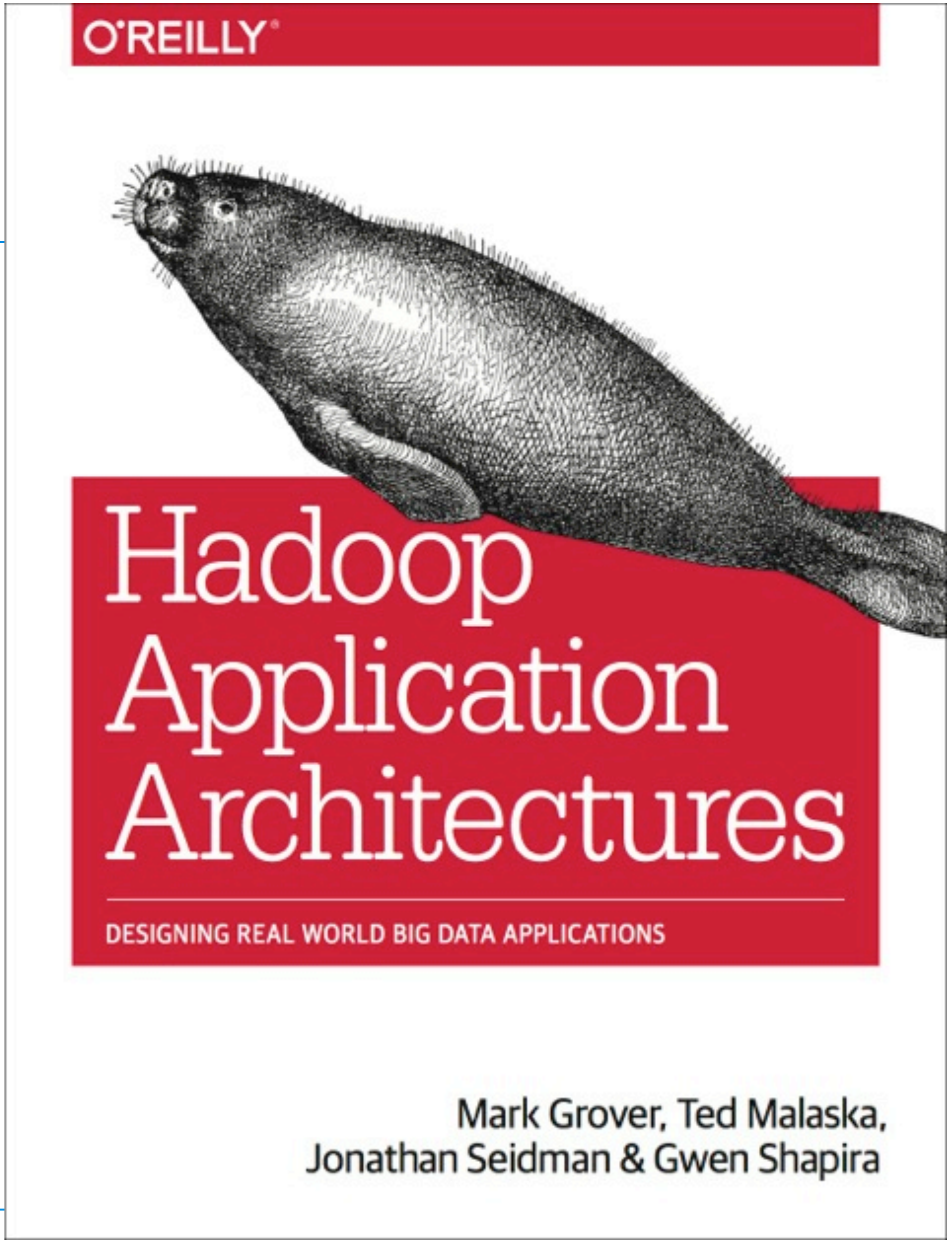
Gwen Shapira | @gwenshap

About the book

- @hadooparchbook
- hadooparchitecturebook.com
- github.com/hadooparchitecturebook
- slideshare.com/hadooparchbook



O'REILLY

Hadoop Application Architectures

DESIGNING REAL WORLD BIG DATA APPLICATIONS

Mark Grover, Ted Malaska,
Jonathan Seidman & Gwen Shapira

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About the presenters

Ted Malaska

- Principal Solutions Architect at Cloudera
- Previously, lead architect at FINRA
- Contributor to Apache Hadoop, HBase, Flume, Avro, Pig and Spark

Jonathan Seidman

- Senior Solutions Architect/Partner Enablement at Cloudera
- Previously, Technical Lead on the big data team at Orbitz Worldwide
- Co-founder of the Chicago Hadoop User Group and Chicago Big

About the presenters

Gwen Shapira

- Solutions Architect turned Software Engineer at Cloudera
- Committer on Apache Sqoop
- Contributor to Apache Flume and Apache Kafka

Mark Grover

- Software Engineer at Cloudera
- Committer on Apache Bigtop, PMC member on Apache Sentry (incubating)
- Contributor to Apache Hadoop, Spark, Hive, Sqoop, Pig and Flume

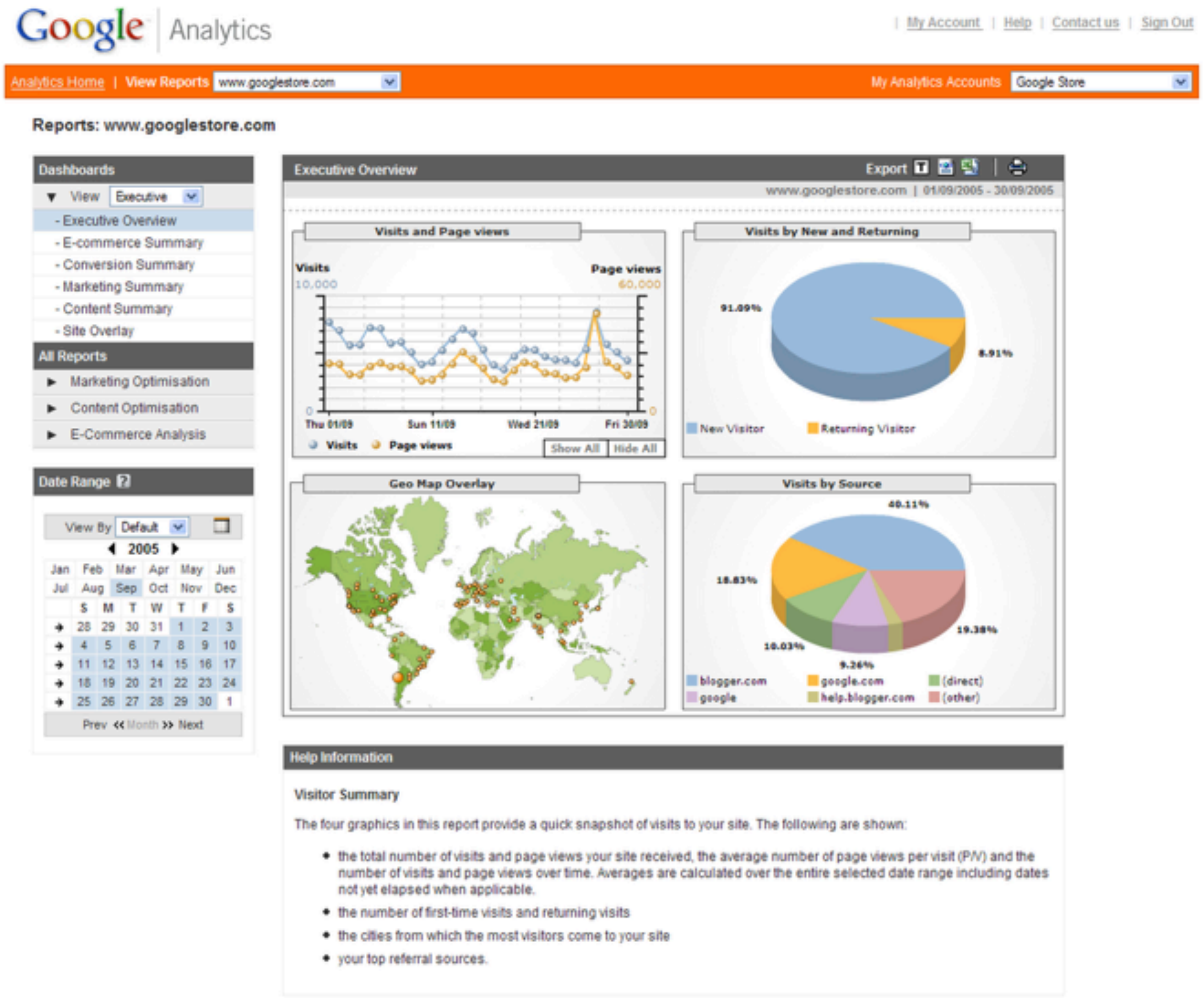
Logistics

- Break at 10:30-11:00 PM
- Questions at the end of each section

Case Study

Clickstream Analysis

Analytics



View Reports: www.googlestore.com

My Analytics Accounts: Google Store

Reports: www.googlestore.com

View: Executive

View By: Default

www.googlestore.com | 01/09/2005 - 30/09/2005

Help Information

Visitor Summary

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- the cities from which the most visitors come to your site
- your top referral sources.

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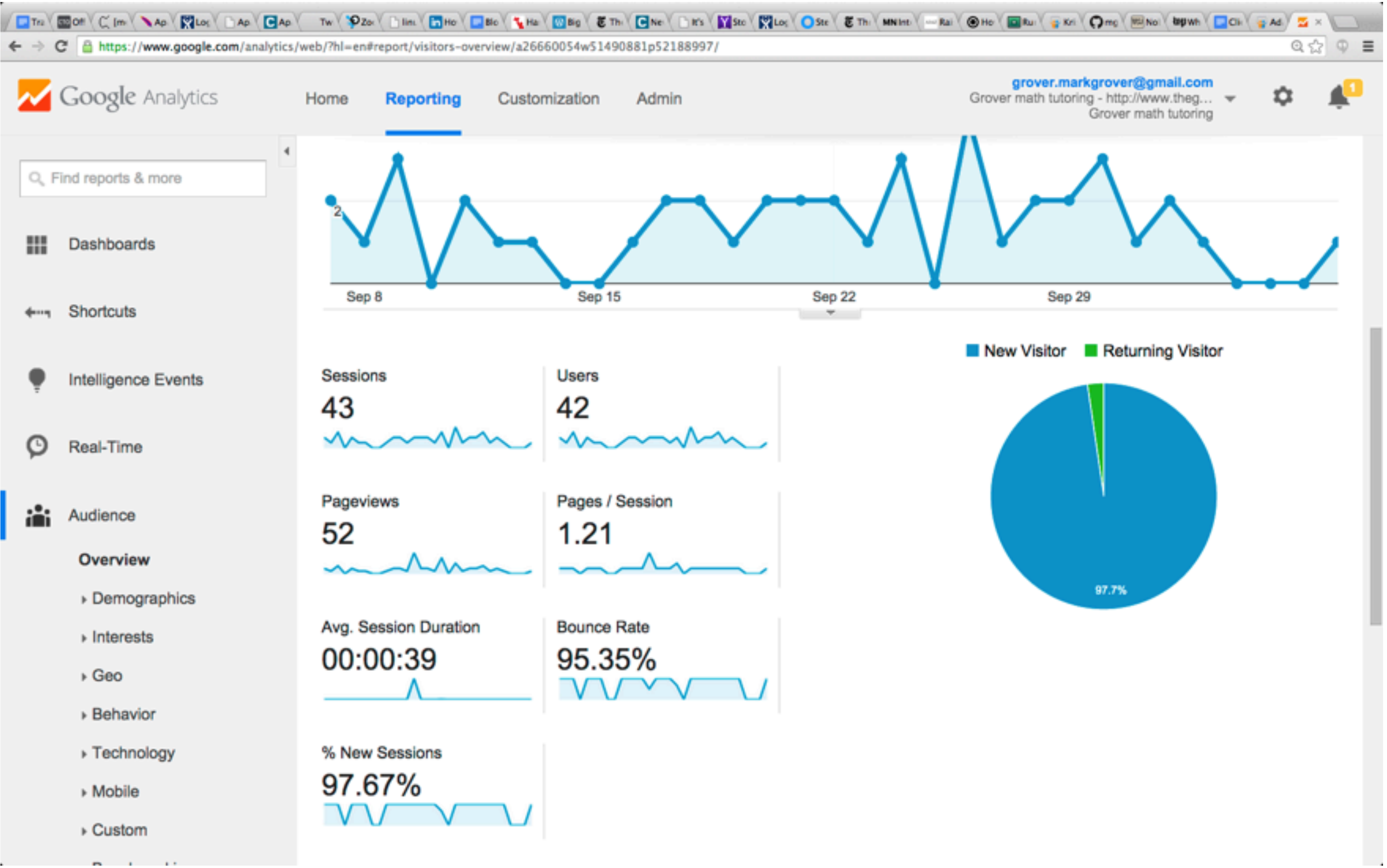


Sessions
43

Users
42

Pageviews
52

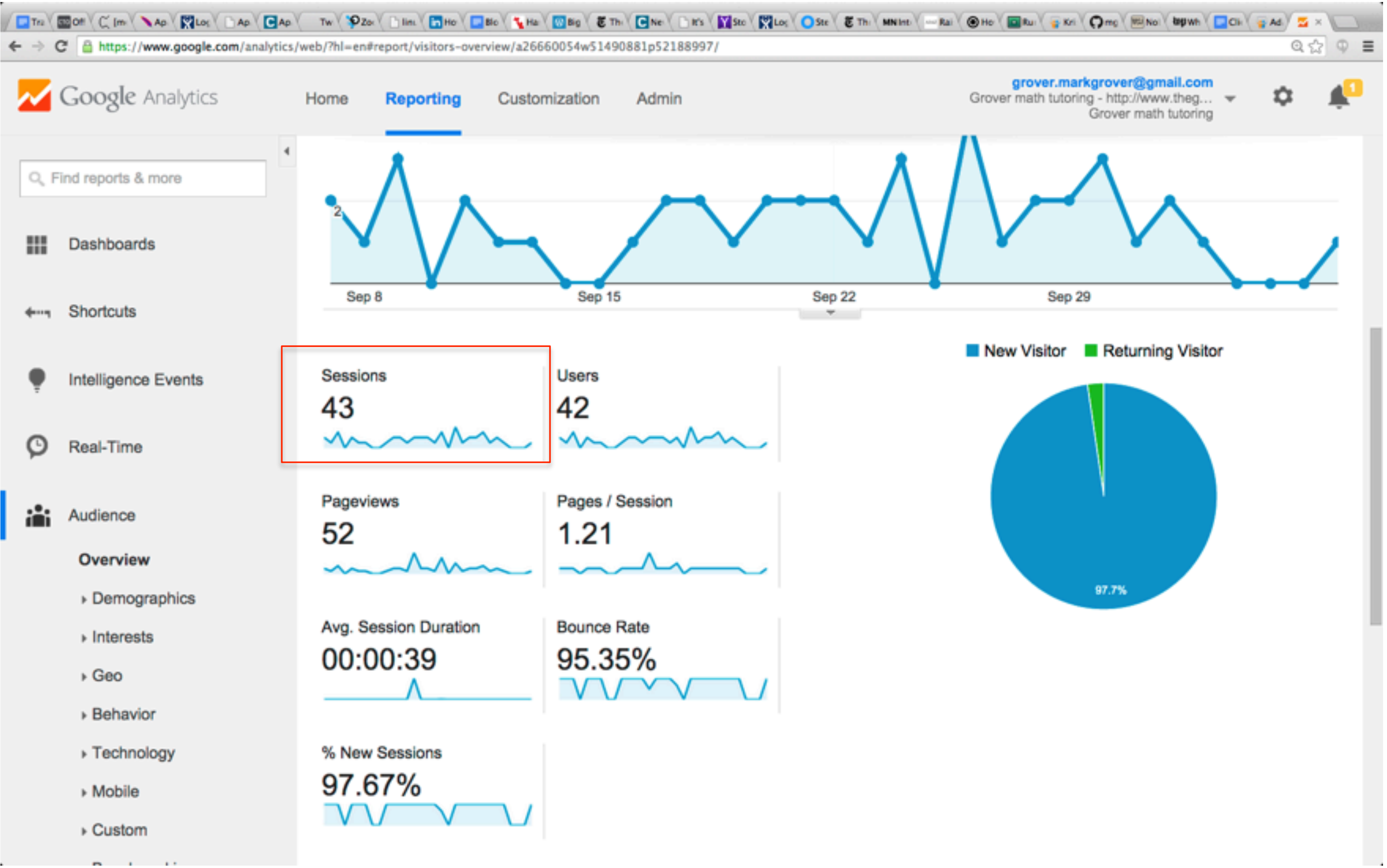
Pages / Session
1.21

Avg. Session Duration
00:00:39

Bounce Rate
95.35%

% New Sessions
97.67%

Analytics



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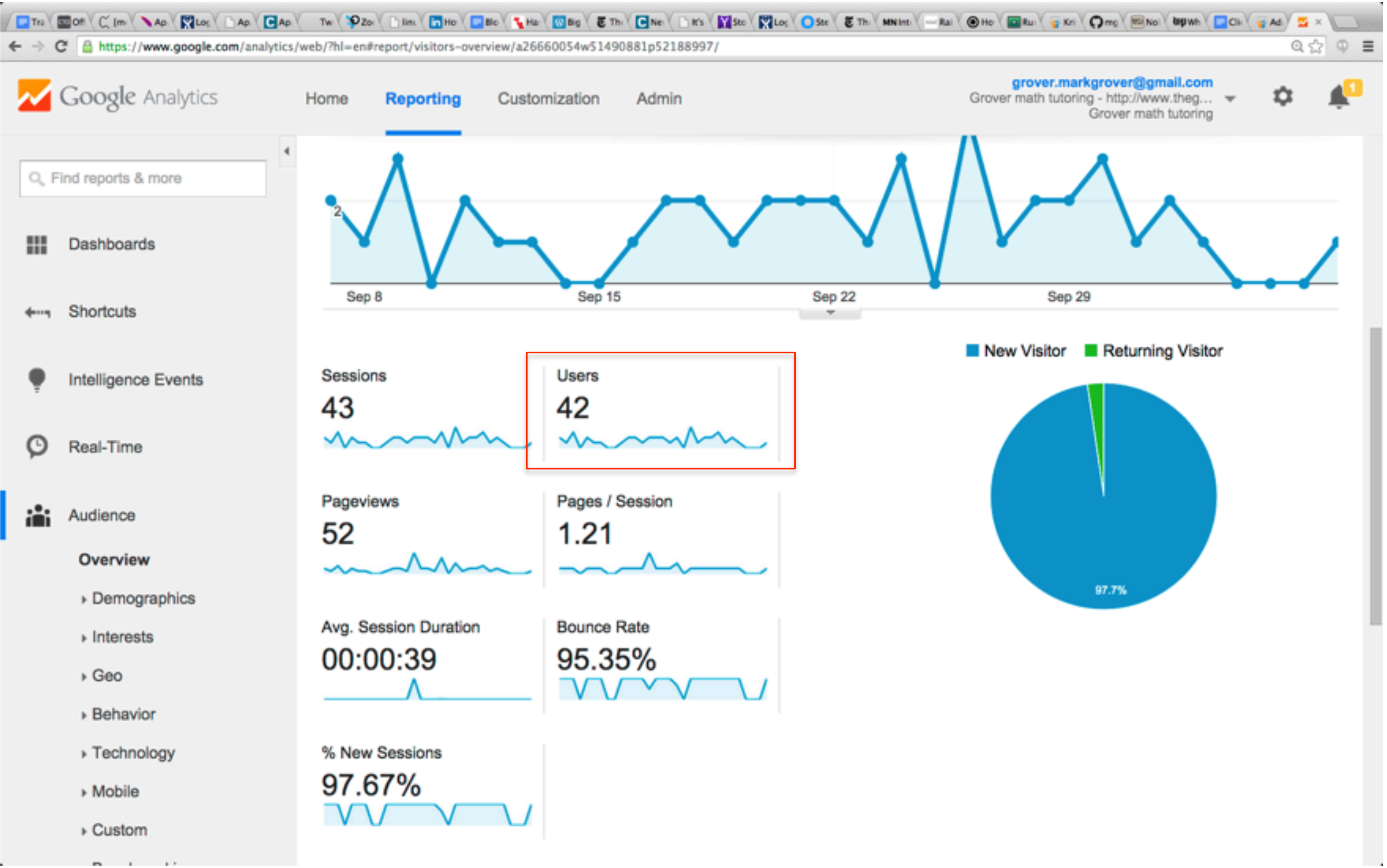

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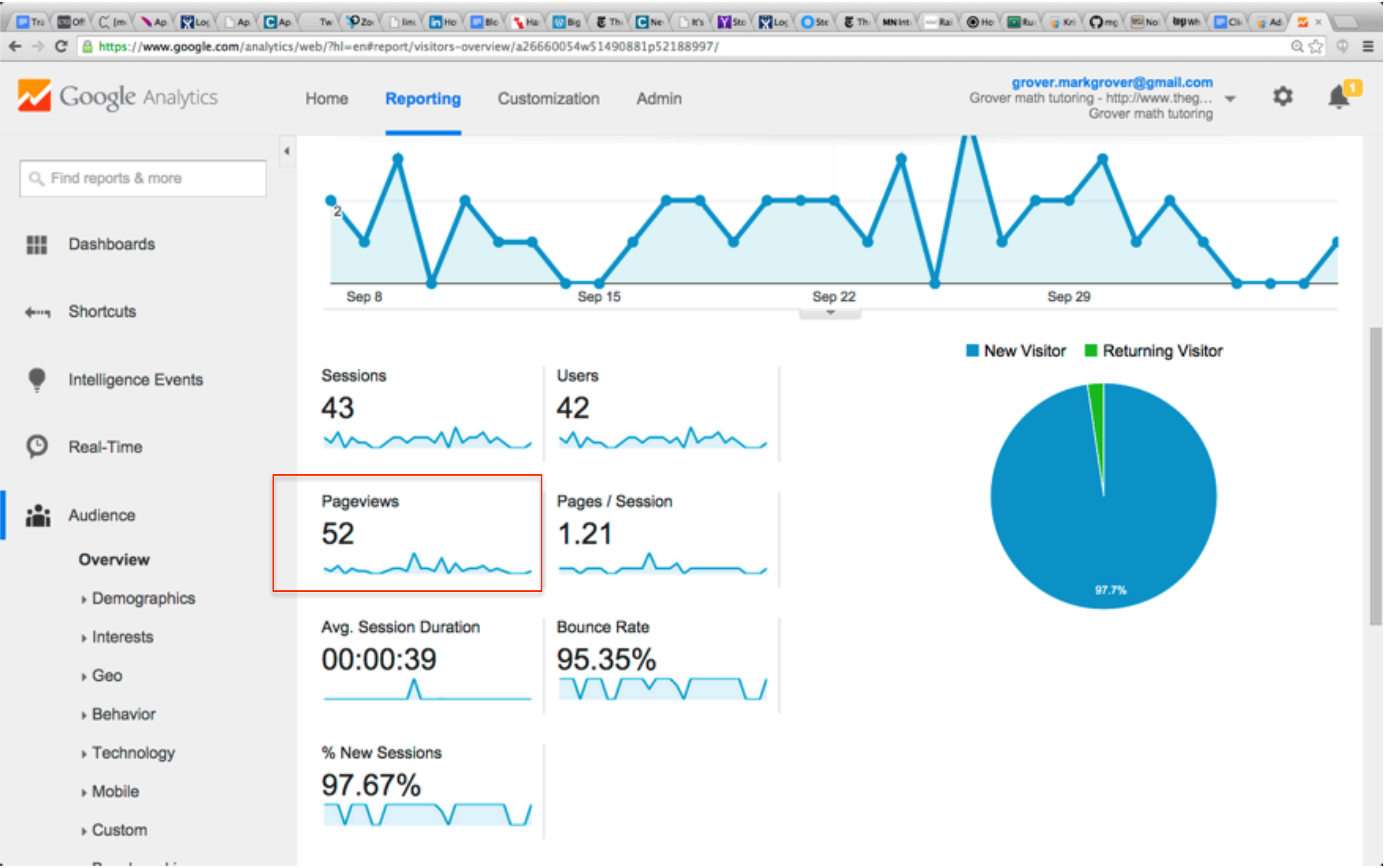

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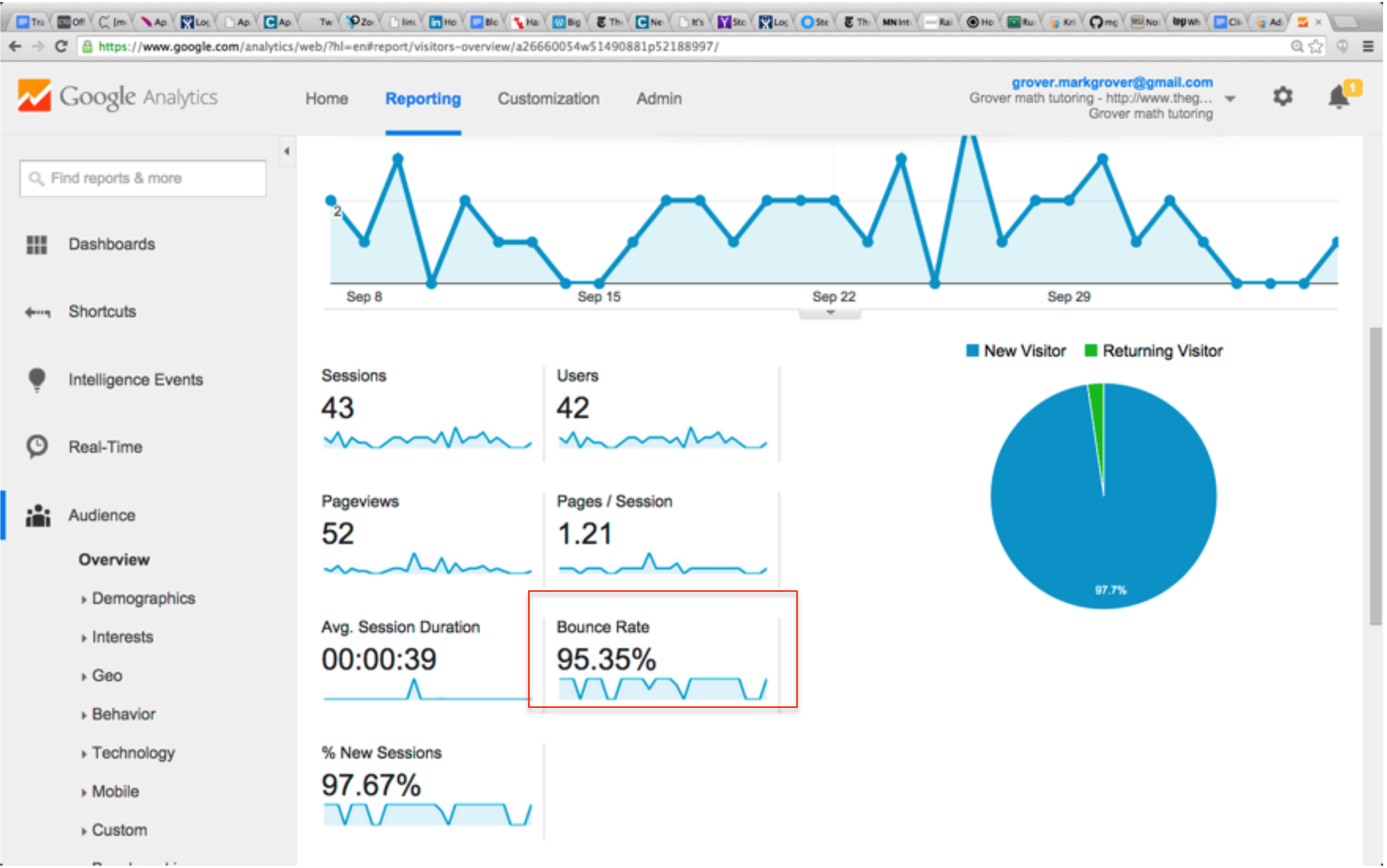

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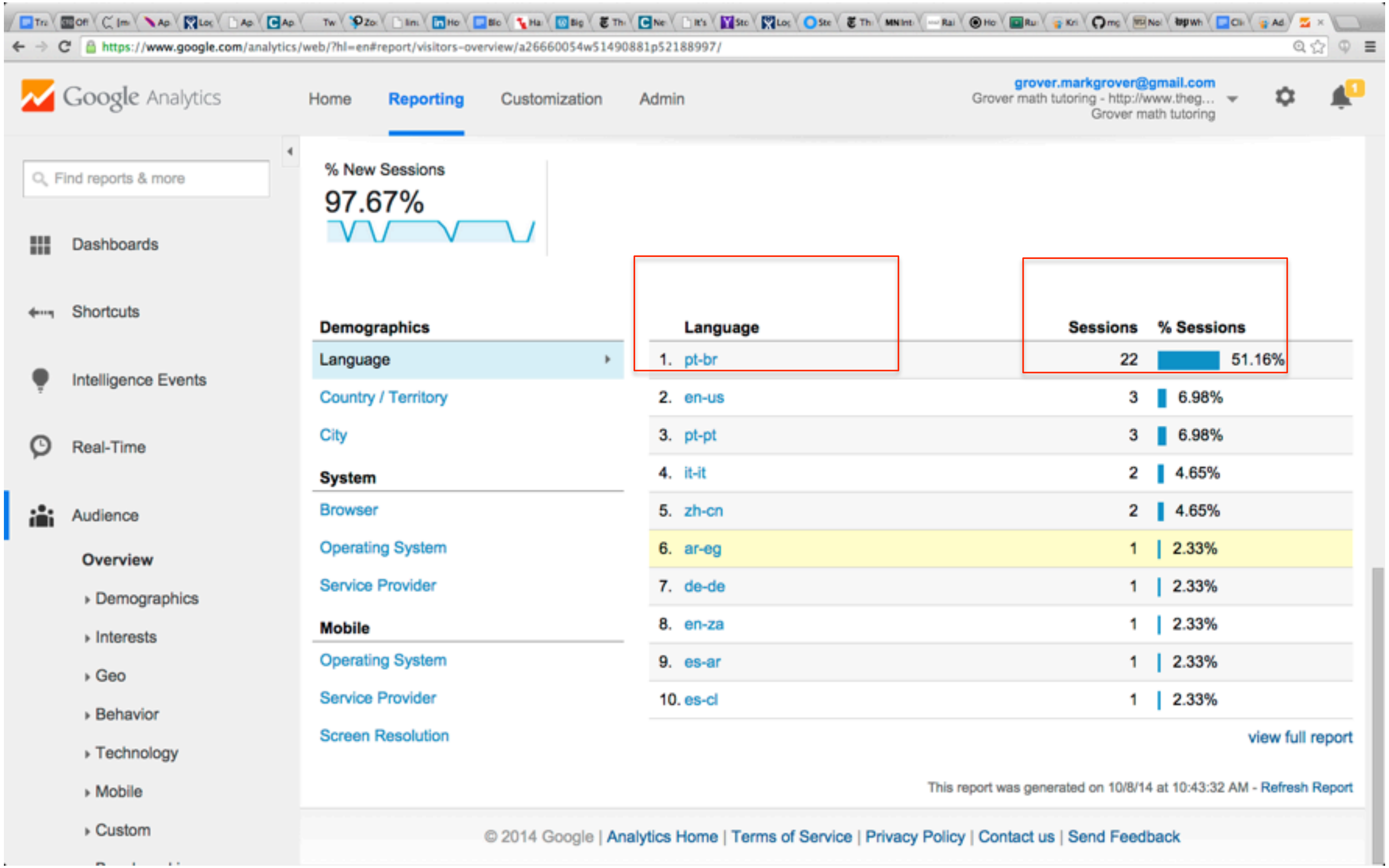

% New Sessions

97.67%

Demographics
- Language
- Country / Territory
- City

System
- Browser
- Operating System
- Service Provider

Mobile
- Operating System
- Service Provider
- Screen Resolution

	Language	Sessions	% Sessions
1.	pt-br	22	51.16%
2.	en-us	3	6.98%
3.	pt-pt	3	6.98%
4.	it-it	2	4.65%
5.	zh-cn	2	4.65%
6.	ar-eg	1	2.33%
7.	de-de	1	2.33%
8.	en-za	1	2.33%
9.	es-ar	1	2.33%
10.	es-cl	1	2.33%

view full report

This report was generated on 10/8/14 at 10:43:32 AM - Refresh Report

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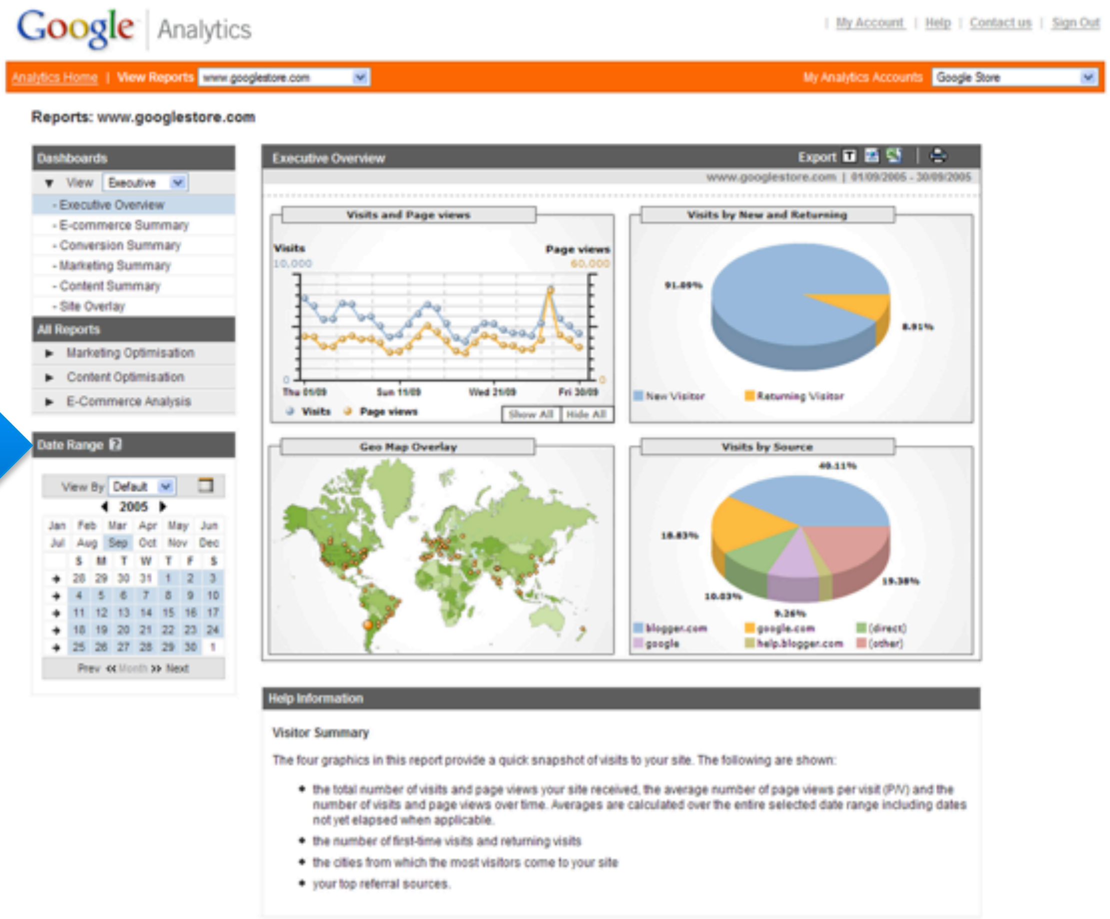
Web Logs – Combined Log Format

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0"
200 4463 "http://bestcyclingreviews.com/top_online_shops" "Mozilla/
5.0 (Macintosh; Intel Mac OS X 10_9_2) AppleWebKit/537.36 (KHTML,
like Gecko) Chrome/36.0.1944.0 Safari/537.36”
244.157.45.12 - - [17/Oct/2014:21:59:59 ] "GET /Store/cart.jsp?
productID=1023 HTTP/1.0" 200 3757 "http://www.casualcyclist.com"
"Mozilla/5.0 (Linux; U; Android 2.3.5; en-us; HTC Vision Build/
GRI40) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0 Mobile
Safari/533.1”
```

Clickstream Analytics

```
244.157.45.12 - - [17/Oct/
2014:21:08:30 ] "GET /seatposts
HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/
top_online_shops" "Mozilla/5.0
(Macintosh; Intel Mac OS X 10_9_2)
AppleWebKit/537.36 (KHTML, like
Gecko) Chrome/36.0.1944.0 Safari/
537.36”
```



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- your top referral sources.

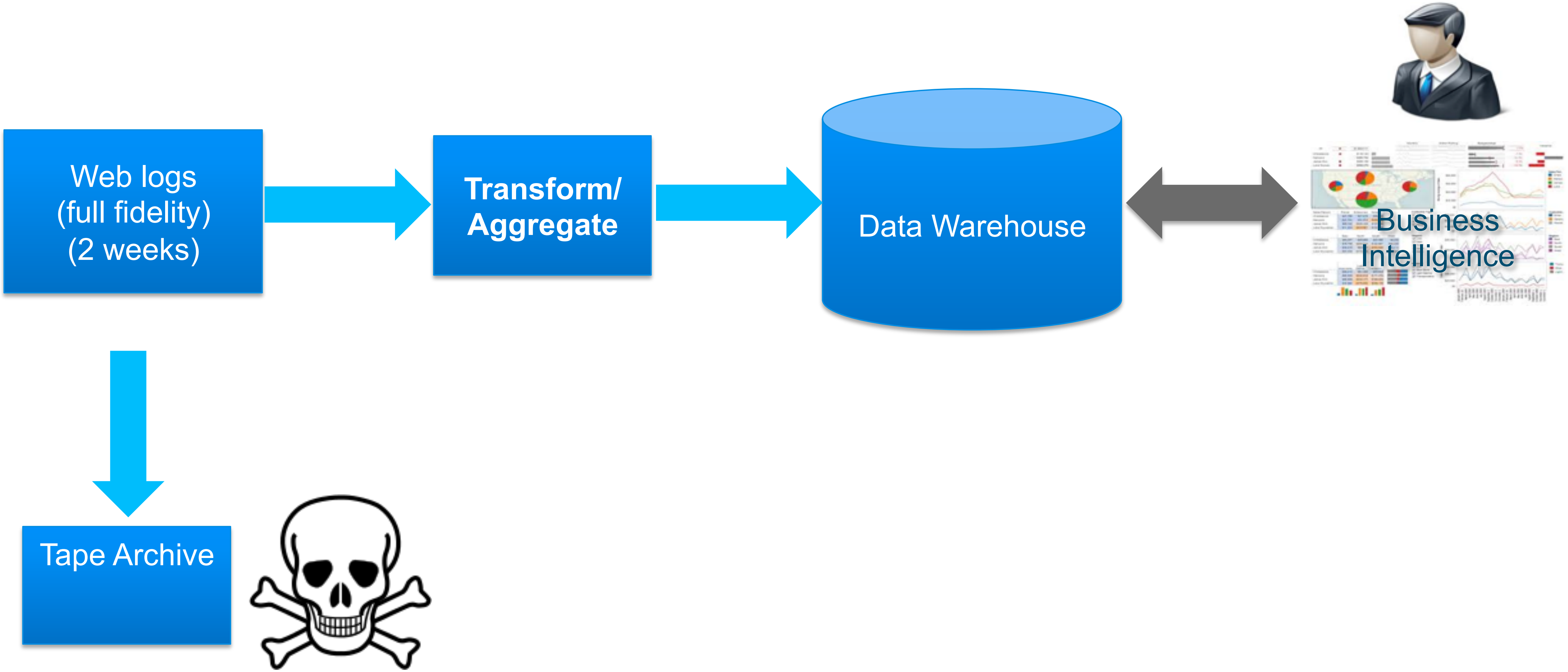
Similar use-cases

- Sensors – heart, agriculture, etc.
- Casinos – session of a person at a table

Pre-Hadoop Architecture

Clickstream Analysis

Click Stream Analysis (Before Hadoop)



Web logs (full fidelity) (2 weeks)

Transform/ Aggregate

Data Warehouse

Business Intelligence

Tape Archive

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Problems with Pre-Hadoop Architecture

- Full fidelity data is stored for small amount of time (~weeks).
- Older data is sent to tape, or even worse, deleted!
- Inflexible workflow - think of all aggregations beforehand

Effects of Pre-Hadoop Architecture

- Regenerating aggregates is expensive or worse, impossible
- Can’t correct bugs in the workflow/aggregation logic
- Can’t do experiments on existing data

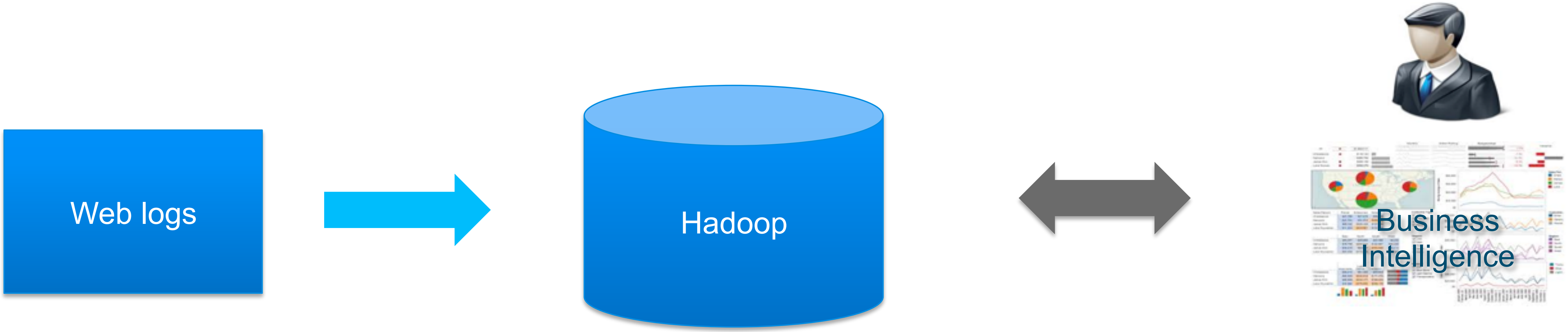
Why is Hadoop A Great Fit?

Clickstream Analysis

Why is Hadoop a great fit?

- Volume of clickstream data is huge
- Velocity at which it comes in is high
- Variety of data is diverse - semi-structured data
- Hadoop enables
  - active archival of data
  - Aggregation jobs
  - Querying the above aggregates or raw fidelity data

Click Stream Analysis (with Hadoop)



Web logs

Hadoop

Business Intelligence

Active archive (no tape)
Aggregation engine
Querying engine

Challenges of Hadoop Implementation

Challenges of Hadoop Implementation

APACHE
HBASE
sqoop
mahout
FLUME
AVRO
TM
hadoop
OOZIE
cascading
HIVE
ZOO
Spark

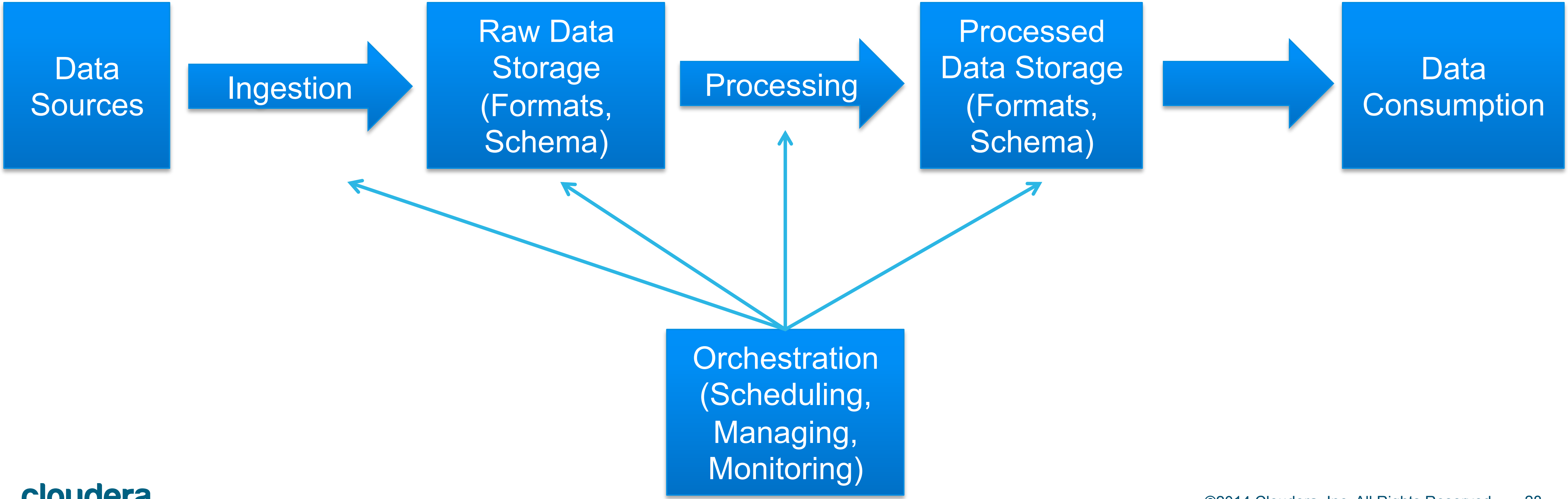
Other challenges - Architectural Considerations

- Storage managers?
  - HDFS? HBase?
- Data storage and modeling:
  - File formats? Compression? Schema design?
- Data movement
  - How do we actually get the data into Hadoop? How do we get it out?
- Metadata
  - How do we manage data about the data?
- Data access and processing
  - How will the data be accessed once in Hadoop? How can we transform it? How do we query it?
- Orchestration
  - How do we manage the workflow for all of this?

Case Study Requirements

Overview of Requirements

Overview of Requirements



Data Sources

Ingestion

Raw Data Storage (Formats, Schema)

Processing

Processed Data Storage (Formats, Schema)

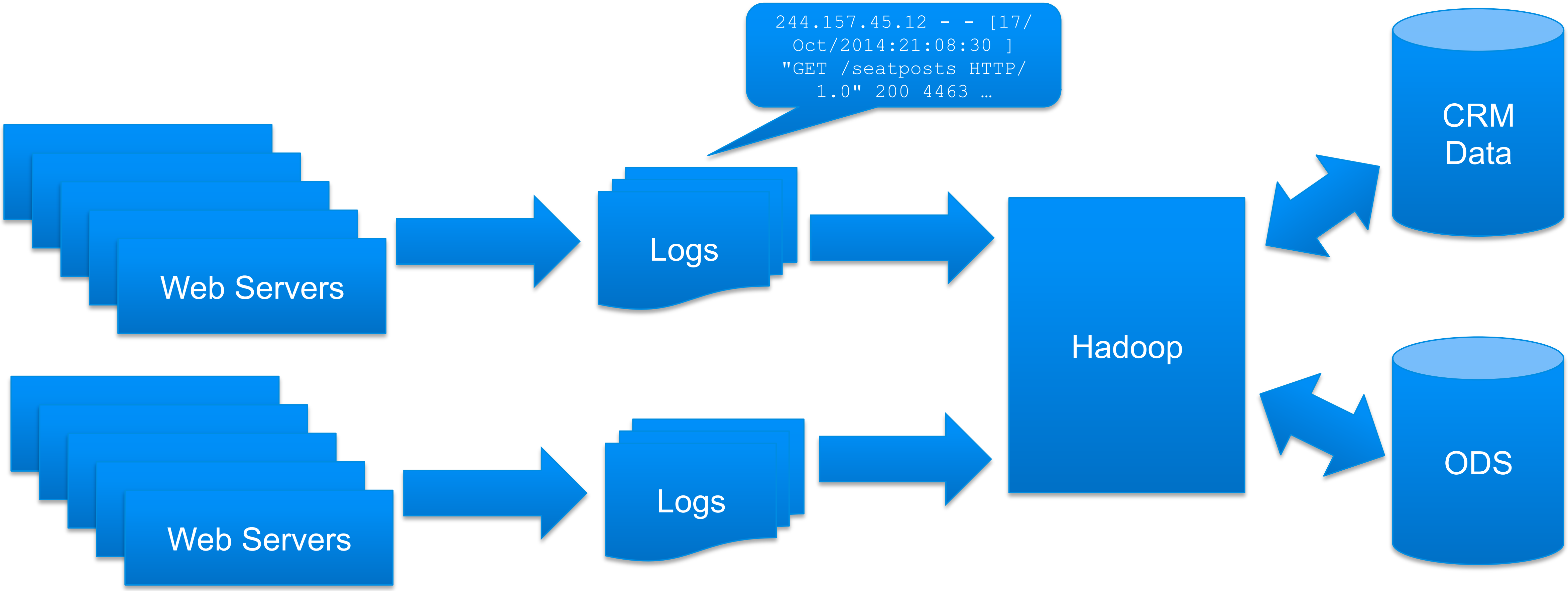
Data Consumption

Orchestration (Scheduling, Managing, Monitoring)

Case Study Requirements

Data Ingestion

Data Ingestion Requirements



```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 …
```

Data Ingestion Requirements

- So we need to be able to support:
  - Reliable ingestion of large volumes of semi-structured event data arriving with high velocity (e.g. logs).
  - Timeliness of data availability – data needs to be available for processing to meet business service level agreements.
  - Periodic ingestion of data from relational data stores.

Case Study Requirements

Data Storage

Data Storage Requirements

Store all the data

Make the data accessible for processing

Compress the data

Case Study Requirements

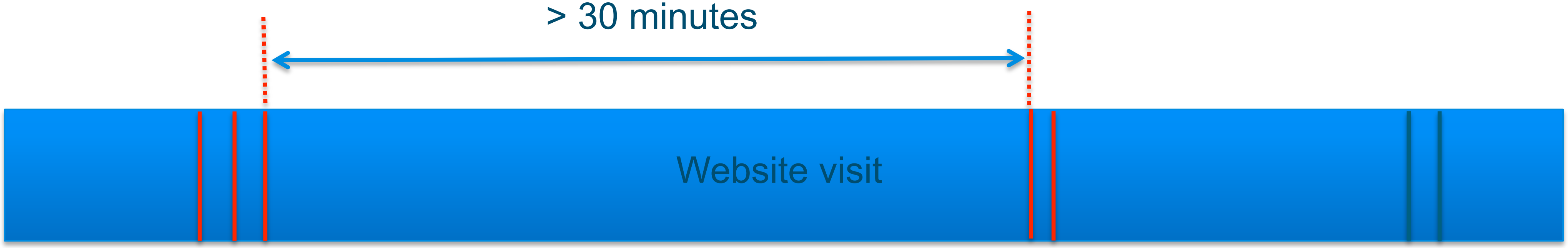
Data Processing

Processing requirements

Be able to answer questions like:

- What is my website’s bounce rate?
  - i.e. how many % of visitors don’t go past the landing page?
- Which marketing channels are leading to most sessions?
- Do attribution analysis
  - Which *channels* are responsible for most *conversions*?

Sessionization



> 30 minutes

Website visit

Visitor 1
Session 1

Visitor 1
Session 2

Visitor 2
Session 1

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Case Study Requirements

Orchestration

Orchestration is simple

We just need to execute actions

One after another

Actually,

we also need to handle errors

And user notifications

….

And…

- Re-start workflows after errors
- Reuse of actions in multiple workflows
- Complex workflows with decision points
- Trigger actions based on events
- Tracking metadata
- Integration with enterprise software
- Data lifecycle
- Data quality control
- Reports

OK, maybe we need a product
To help us do all that

Architectural Considerations

Data Modeling

Data Modeling Considerations

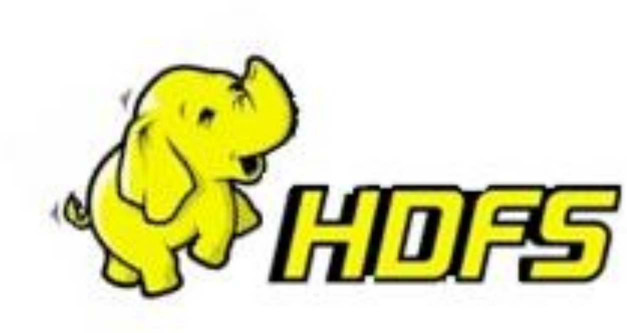
- We need to consider the following in our architecture:
  - Storage layer – HDFS? HBase? Etc.
  - File system schemas – how will we lay out the data?
  - File formats – what storage formats to use for our data, both raw and processed data?
  - Data compression formats?

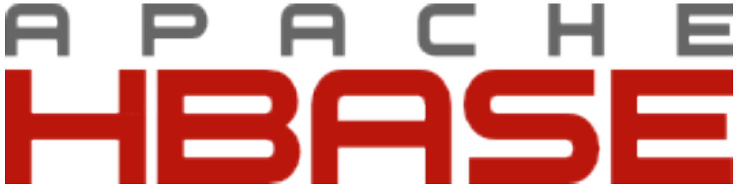
Architectural Considerations

Data Modeling – Storage Layer

Data Storage Layer Choices

- Two likely choices for raw data:





Data Storage Layer Choices

HDFS

- Stores data directly as files
- Fast scans
- Poor random reads/writes

APACHE HBASE

- Stores data as Hfiles on HDFS
- Slow scans
- Fast random reads/writes

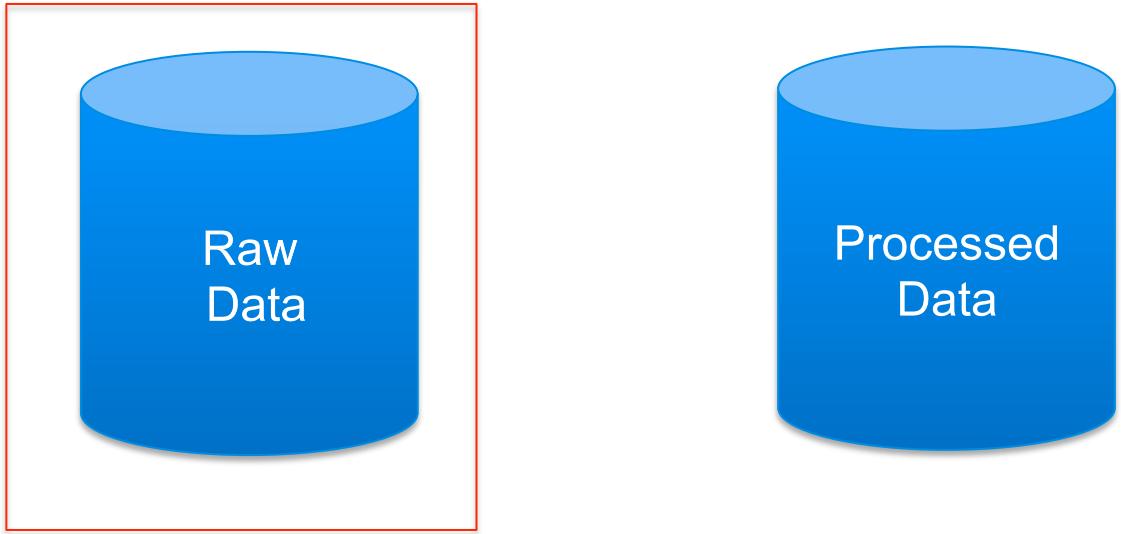
Data Storage – Storage Manager Considerations

- Incoming raw data:
  - Processing requirements call for batch transformations across multiple records – for example sessionization.
- Processed data:
  - Access to processed data will be via things like analytical queries – again requiring access to multiple records.
- We choose HDFS
  - Processing needs in this case served better by fast scans.

Architectural Considerations

Data Modeling – Raw Data Storage

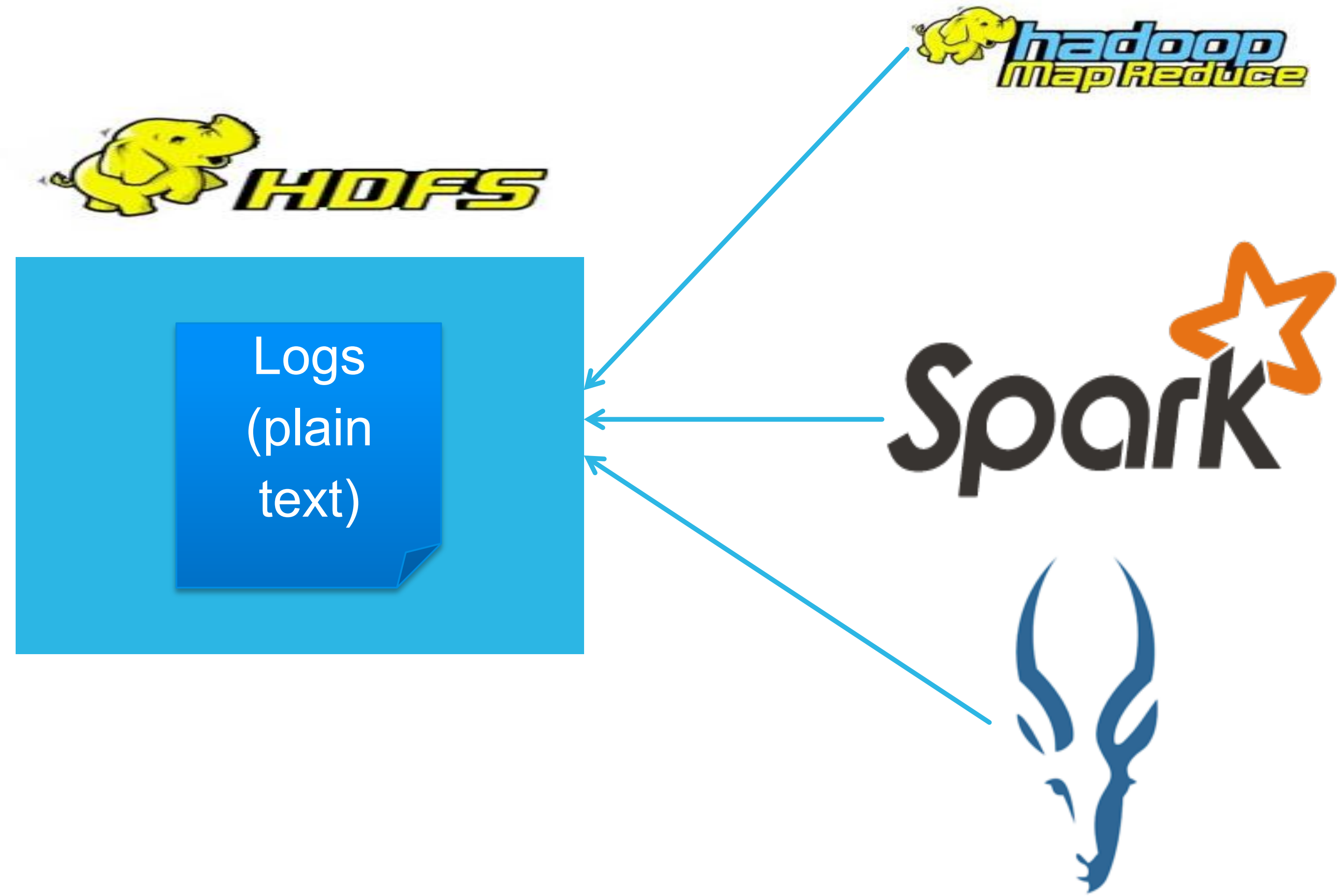
Storage Formats – Raw Data and Processed Data



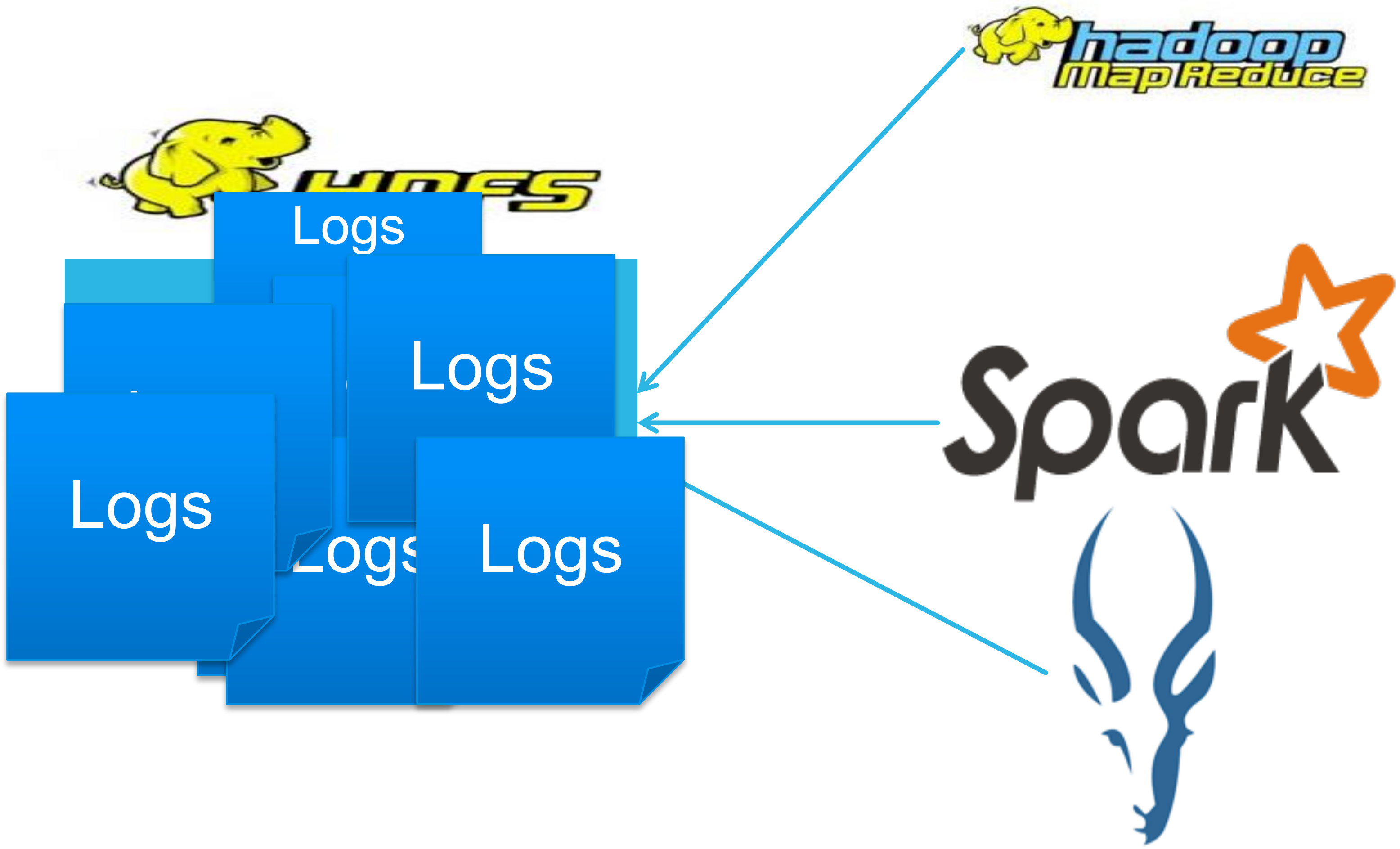
Raw Data

Processed Data

Data Storage – Format Considerations



Data Storage – Format Considerations



Data Storage – Compression

gzip

Well, maybe.
But not splittable.

lzop

Splittable. Getting better…

~~bzip2~~

Splittable, but no….

snappy

Hmmm….

Raw Data Storage – More About Snappy

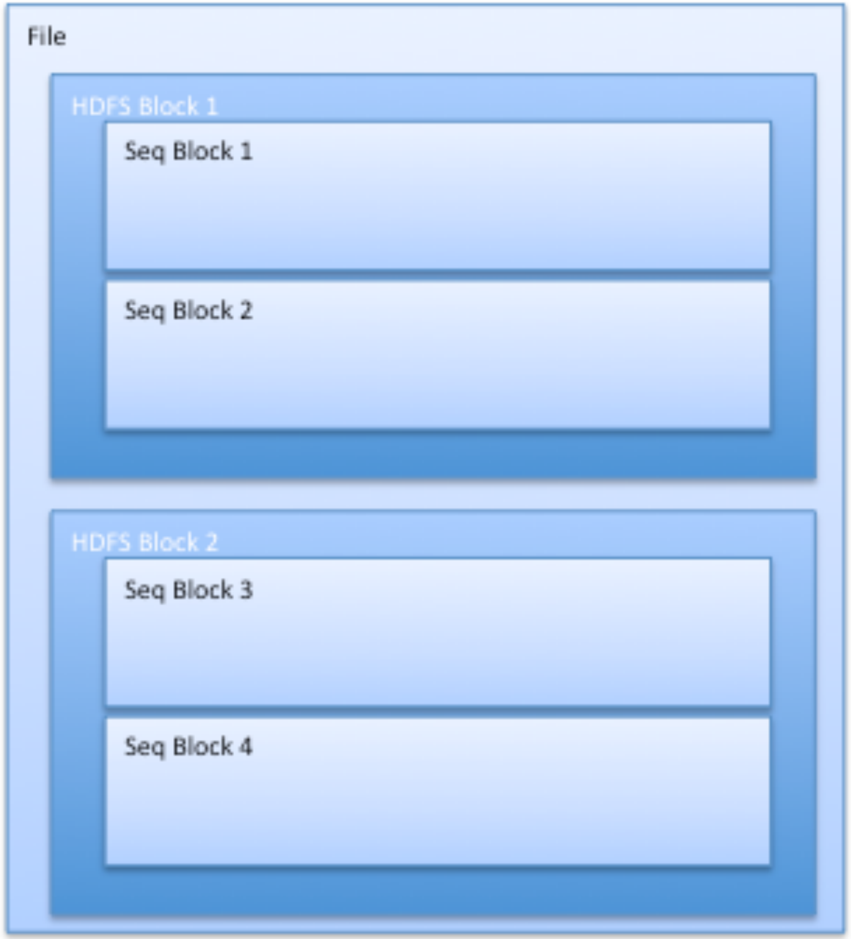
- Designed at Google to provide high compression speeds with reasonable compression.
- Not the highest compression, but provides very good performance for processing on Hadoop.
- Snappy is not splittable though, which brings us to…

Hadoop File Types

- Formats designed specifically to store and process data on Hadoop:
  - File based – SequenceFile
  - Serialization formats – Thrift, Protocol Buffers, Avro
  - Columnar formats – RCFile, ORC, Parquet

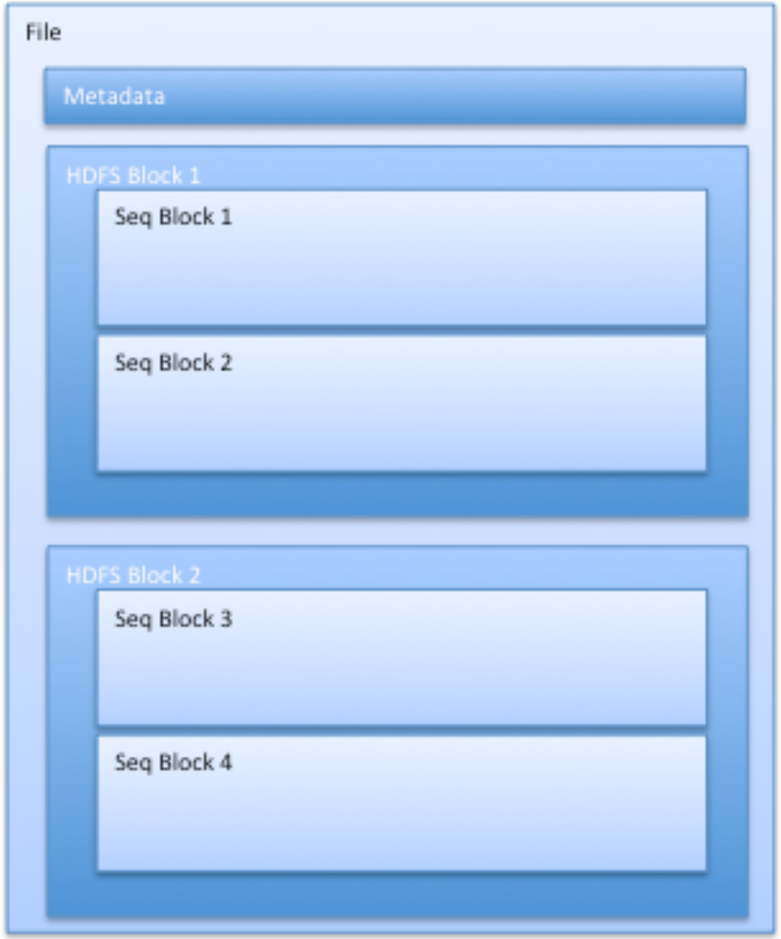
SequenceFile

- Stores records as binary key/value pairs.
- SequenceFile “blocks” can be compressed.
- This enables splittability with non-splittable compression.



Avro

- Kinda SequenceFile on Steroids.
- Self-documenting – stores schema in header.
- Provides very efficient storage.
- Supports splittable compression.



Our Format Recommendations for Raw Data…

- Avro with Snappy
  - Snappy provides optimized compression.
  - Avro provides compact storage, self-documenting files, and supports schema evolution.
  - Avro also provides better failure handling than other choices.
- SequenceFiles would also be a good choice, and are directly supported by ingestion tools in the ecosystem.
  - But only supports Java.

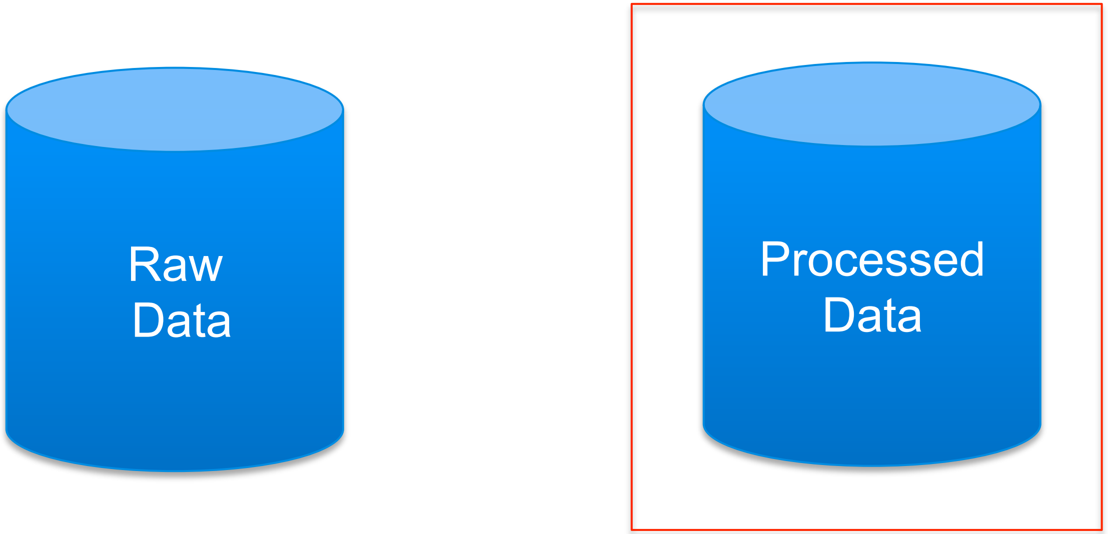
But Note…

- For simplicity, we'll use plain text for raw data in our example.

Architectural Considerations

Data Modeling – Processed Data Storage

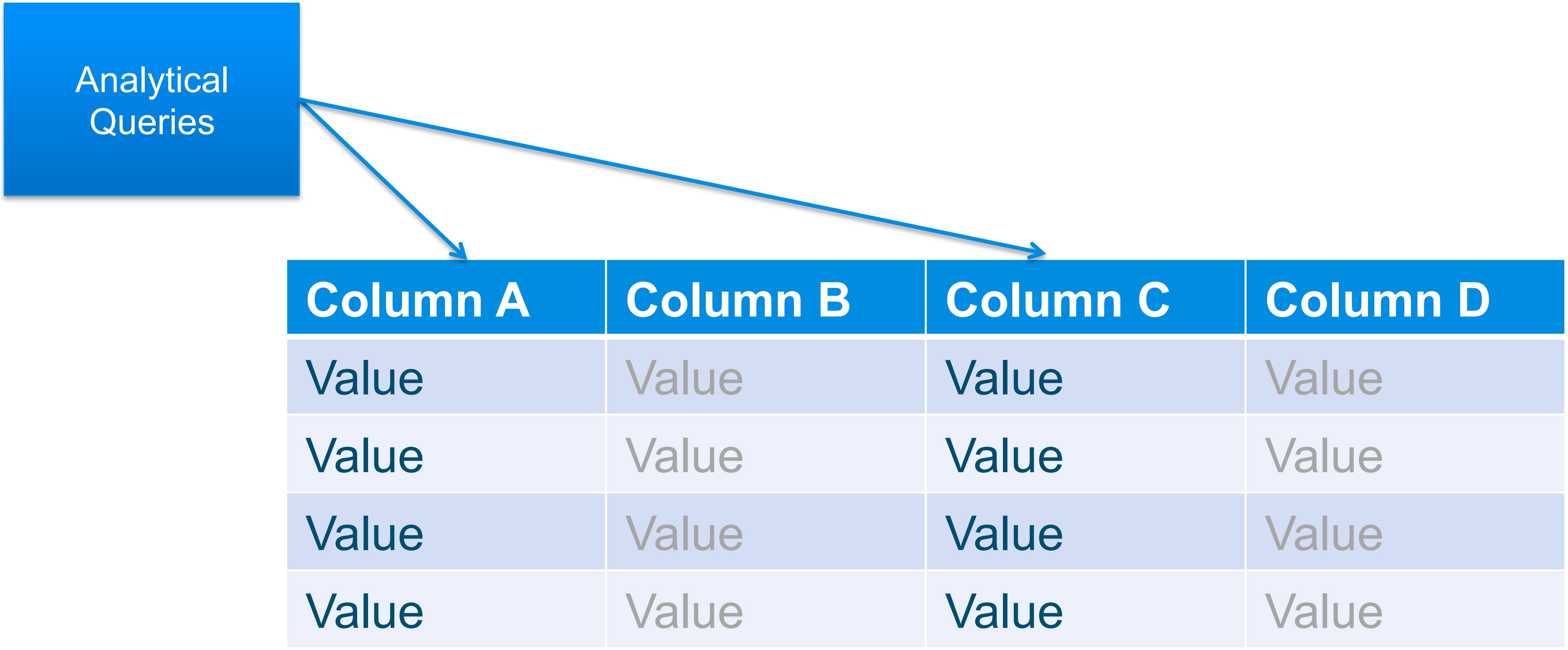
Storage Formats – Raw Data and Processed Data



Raw Data

Processed Data

Access to Processed Data

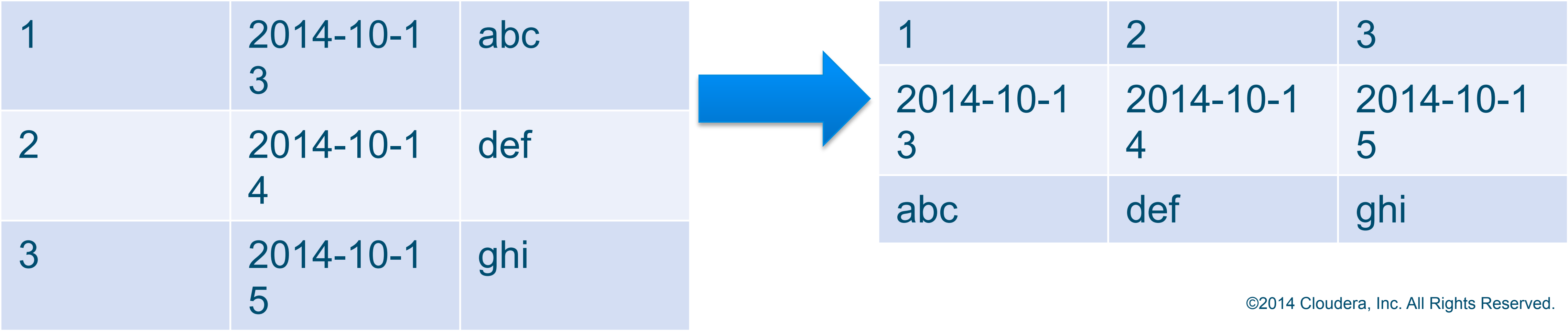


Analytical Queries

Column A	Column B	Column C	Column D
Value	Value	Value	Value
Value	Value	Value	Value
Value	Value	Value	Value
Value	Value	Value	Value

Columnar Formats

- Eliminates I/O for columns that are not part of a query.
- Works well for queries that access a subset of columns.
- Often provide better compression.
- These add up to dramatically improved performance for many queries.



1	2014-10-13	abc
2	2014-10-14	def
3	2014-10-15	ghi

1	2	3
2014-10-13	2014-10-14	2014-10-15
abc	def	ghi

Columnar Choices – RCFile

- Designed to provide efficient processing for Hive queries.
- Only supports Java.
- No Avro support.
- Limited compression support.
- Sub-optimal performance compared to newer columnar formats.

Columnar Choices – ORC

- A better RCFile.
- Also designed to provide efficient processing of Hive queries.
- Only supports Java.

Columnar Choices – Parquet

- Designed to provide efficient processing across Hadoop programming interfaces – MapReduce, Hive, Impala, Pig.
- Multiple language support – Java, C++
- Good object model support, including Avro.
- Broad vendor support.
- These features make Parquet a good choice for our processed data.

Architectural Considerations

Data Modeling – Schema Design

HDFS Schema Design – One Recommendation

/etl – Data in various stages of ETL workflow

/data – processed data to be shared data with the entire organization

/tmp – temp data from tools or shared between users

/user/<username> - User specific data, jars, conf files

/app – Everything but data: UDF jars, HQL files, Oozie workflows

Partitioning

- Split the dataset into smaller consumable chunks.
- Rudimentary form of “indexing”. Reduces I/O needed to process queries.

Partitioning

Un-partitioned HDFS directory structure

```
dataset
  file1.txt
  file2.txt
    …
  filen.txt
```

Partitioned HDFS directory structure

```
dataset
   col=val1/file.txt
   col=val2/file.txt
    …
   col=valn/file.txt
```

Partitioning considerations

- What column to partition by?
  - Don’t have too many partitions (<10,000)
  - Don’t have too many small files in the partitions
  - Good to have partition sizes at least ~1 GB, generally a multiple of block size.
- We’ll partition by *timestamp*. This applies to both our raw and processed data.

Partitioning For Our Case Study

- Raw dataset:
  - `/etl/BI/casualcyclist/clicks/rawlogs/year=2014/month=10/day=10`
- Processed dataset:
  - `/data/bikeshop/clickstream/year=2014/month=10/day=10`

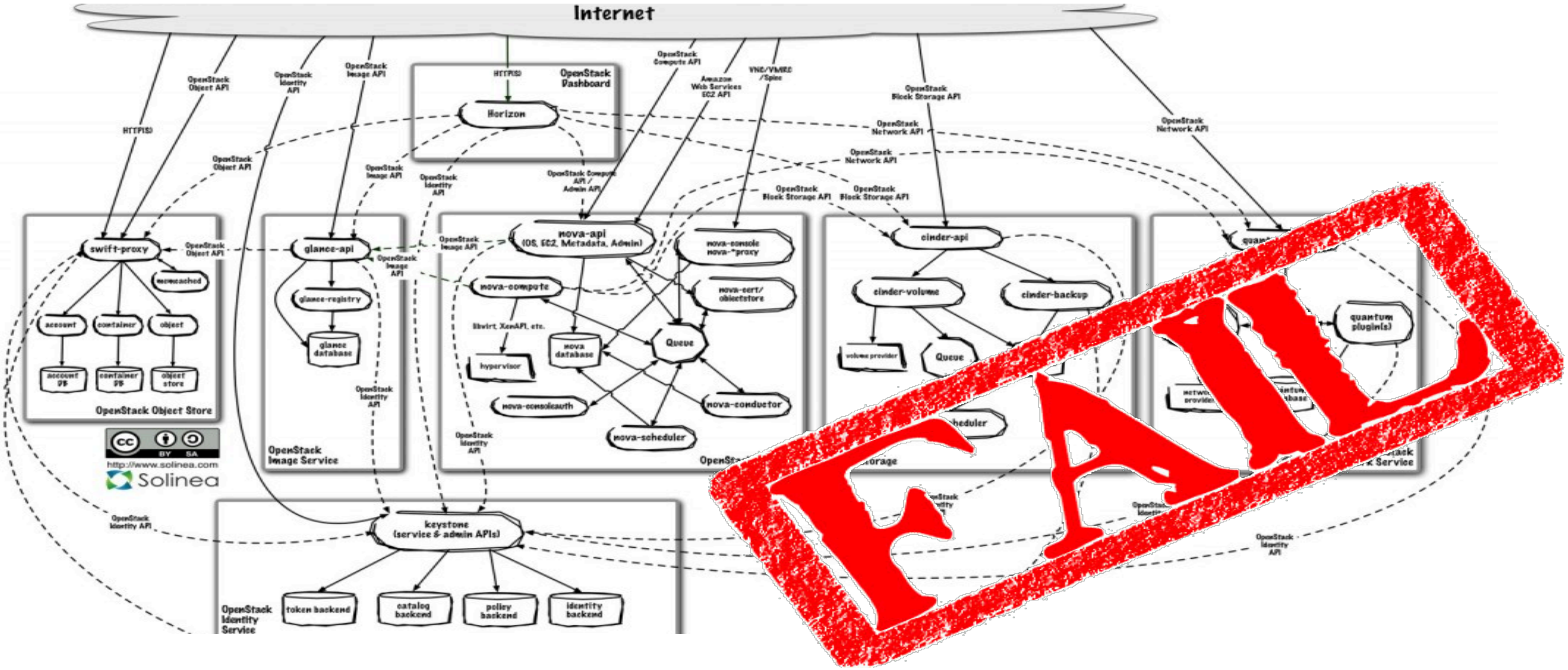
Architectural Considerations

Data Ingestion

Typical Clickstream data sources

- Omniture data on FTP
- Apps
- App Logs
- RDBMS

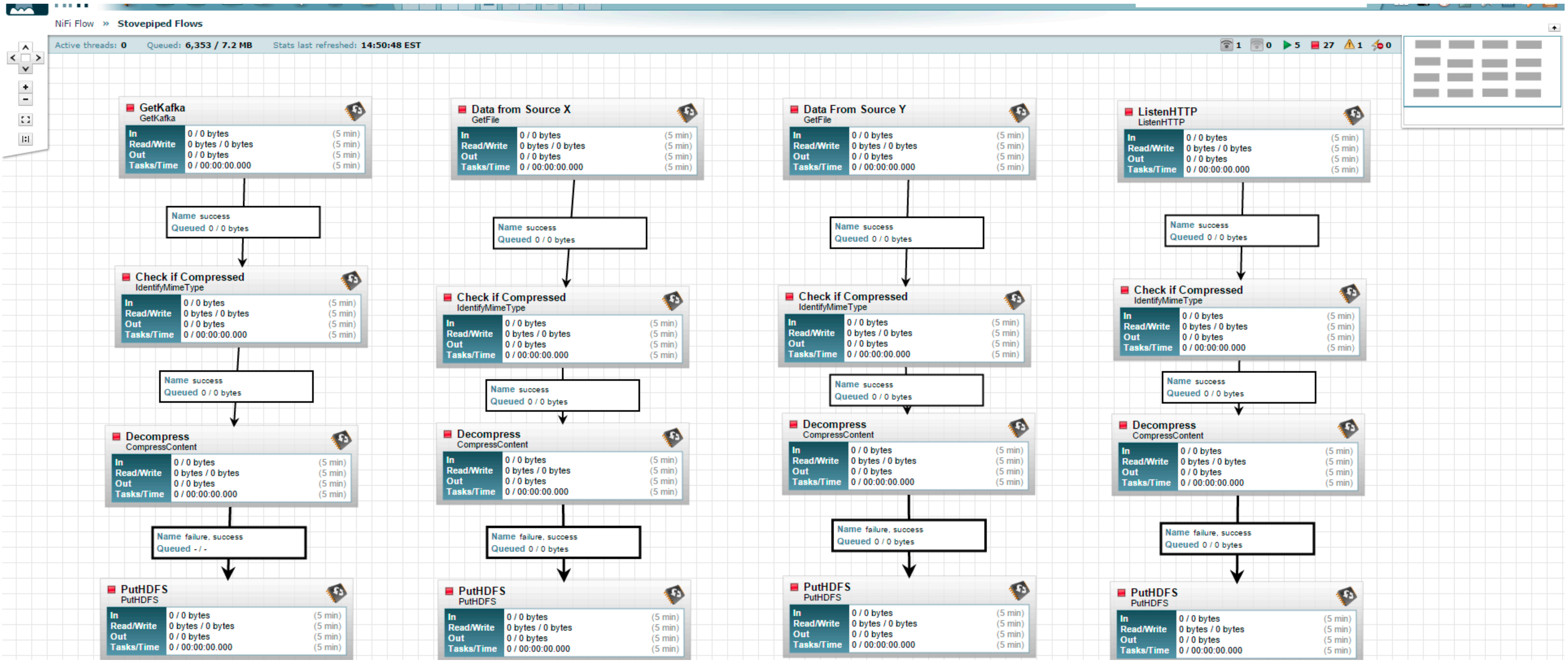
Getting Files from FTP



Don’t over-complicate things

```
curl ftp://myftpsite.com/sitecatalyst/
myreport_2014-10-05.tar.gz
--user name:password | hdfs -put - /etl/clickstream/raw/
sitecatalyst/myreport_2014-10-05.tar.gz
```

Apache NiFi



NiFi Flow » Stovepiped Flows

Active threads: 0 Queued: 6,353 / 7.2 MB Stats last refreshed: 14:50:48 EST

```
GetKafka
GetKafka
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Check if Compressed
IdentifyMimeType
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Decompress
CompressContent
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name failure, success
Queued - / -

PutHDFS
PutHDFS
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)
```

```
Data from Source X
GetFile
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Check if Compressed
IdentifyMimeType
In          0 / 0 bytes              (5 min)
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PutHDFS
PutHDFS
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)
```

```
Data From Source Y
GetFile
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Check if Compressed
IdentifyMimeType
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

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CompressContent
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name failure, success
Queued 0 / 0 bytes

PutHDFS
PutHDFS
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)
```

```
ListenHTTP
ListenHTTP
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Check if Compressed
IdentifyMimeType
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name success
Queued 0 / 0 bytes

Decompress
CompressContent
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)

Name failure, success
Queued 0 / 0 bytes

PutHDFS
PutHDFS
In          0 / 0 bytes              (5 min)
Read/Write  0 bytes / 0 bytes        (5 min)
Out         0 / 0 bytes              (5 min)
Tasks/Time  0 / 00:00:00.000         (5 min)
```

Event Streaming – Flume and Kafka

Reliable, distributed and highly available systems

That allow streaming events to Hadoop

Flume:

- Many available data collection sources
- Well integrated into Hadoop
- Supports file transformations
- Can implement complex topologies
- Very low latency
- No programming required

We use Flume when:

“We just want to grab data
from this directory
and write it to HDFS”

Kafka is:

- Very high-throughput publish-subscribe messaging
- Highly available
- Stores data and can replay
- Can support many consumers with no extra latency

Use Kafka When:

“Kafka is awesome.
We heard it cures cancer”

Actually, why choose?

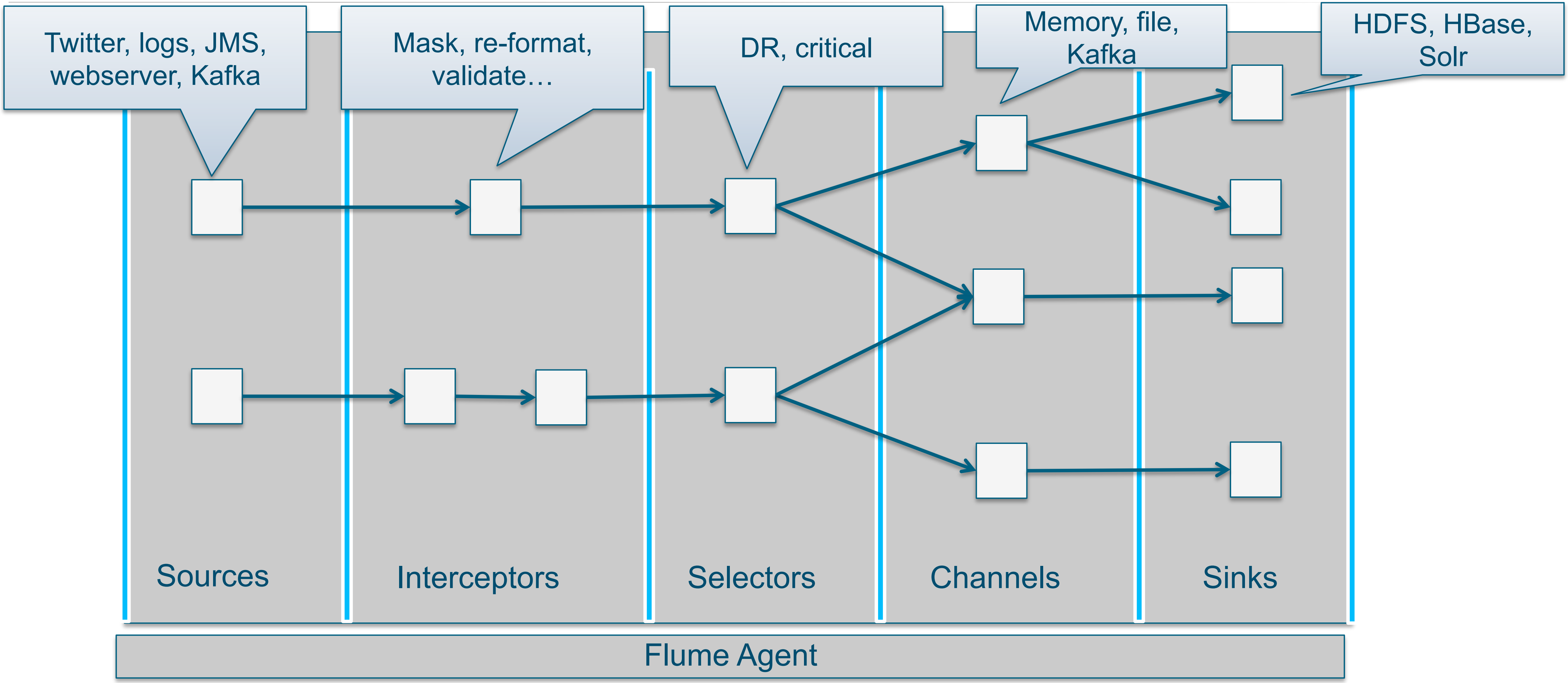
- Use Flume with a Kafka Source
- Allows to get data from Kafka,
  run some transformations
  write to HDFS, HBase or Solr

In Our Example…

- We want to ingest events from log files
- Flume’s Spooling Directory source fits
- With HDFS Sink

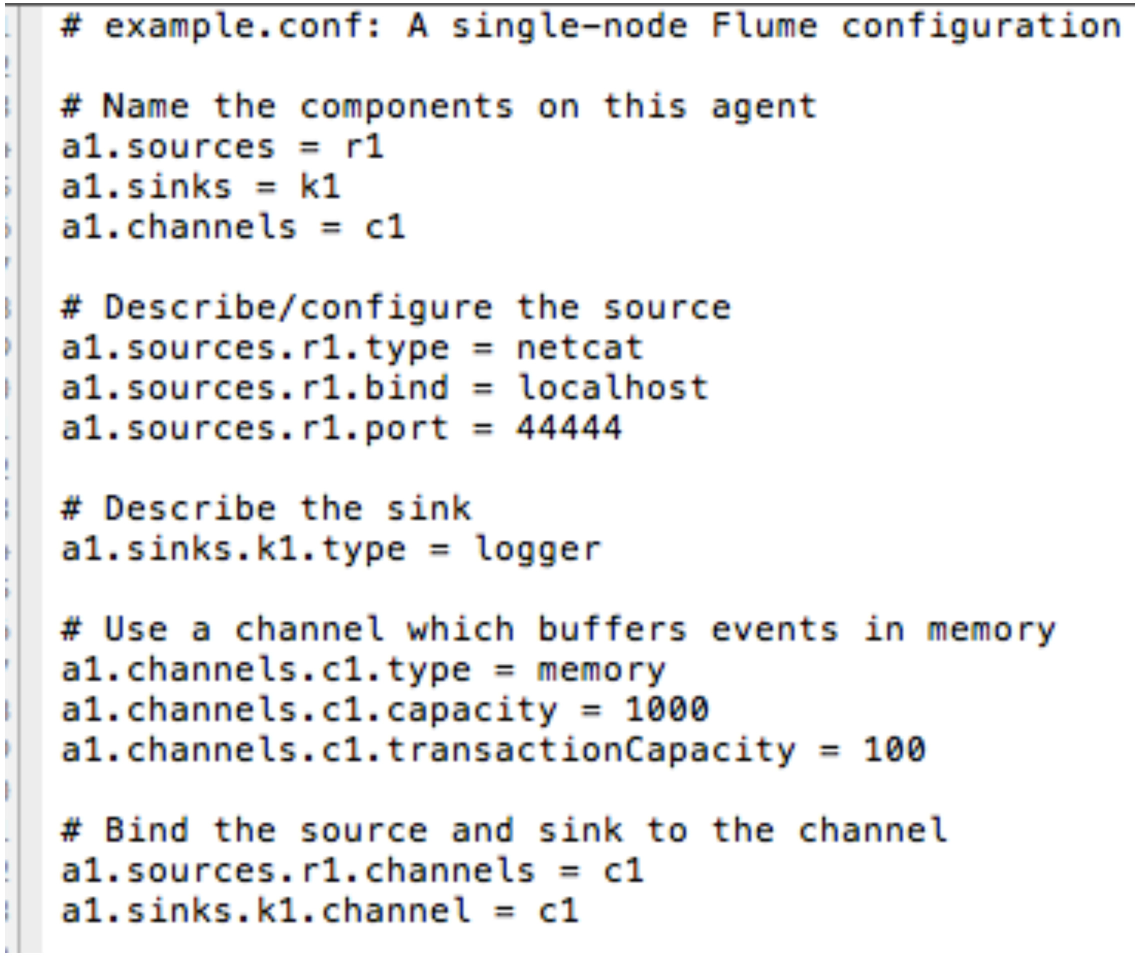
- We would have used Kafka if…
  - We wanted the data in non-Hadoop systems too

Short Intro to Flume



Configuration

- Declarative
  - No coding required.
  - Configuration specifies how components are wired together.



```
# example.conf: A single-node Flume configuration

# Name the components on this agent
a1.sources = r1
a1.sinks = k1
a1.channels = c1

# Describe/configure the source
a1.sources.r1.type = netcat
a1.sources.r1.bind = localhost
a1.sources.r1.port = 44444

# Describe the sink
a1.sinks.k1.type = logger

# Use a channel which buffers events in memory
a1.channels.c1.type = memory
a1.channels.c1.capacity = 1000
a1.channels.c1.transactionCapacity = 100

# Bind the source and sink to the channel
a1.sources.r1.channels = c1
a1.sinks.k1.channel = c1
```

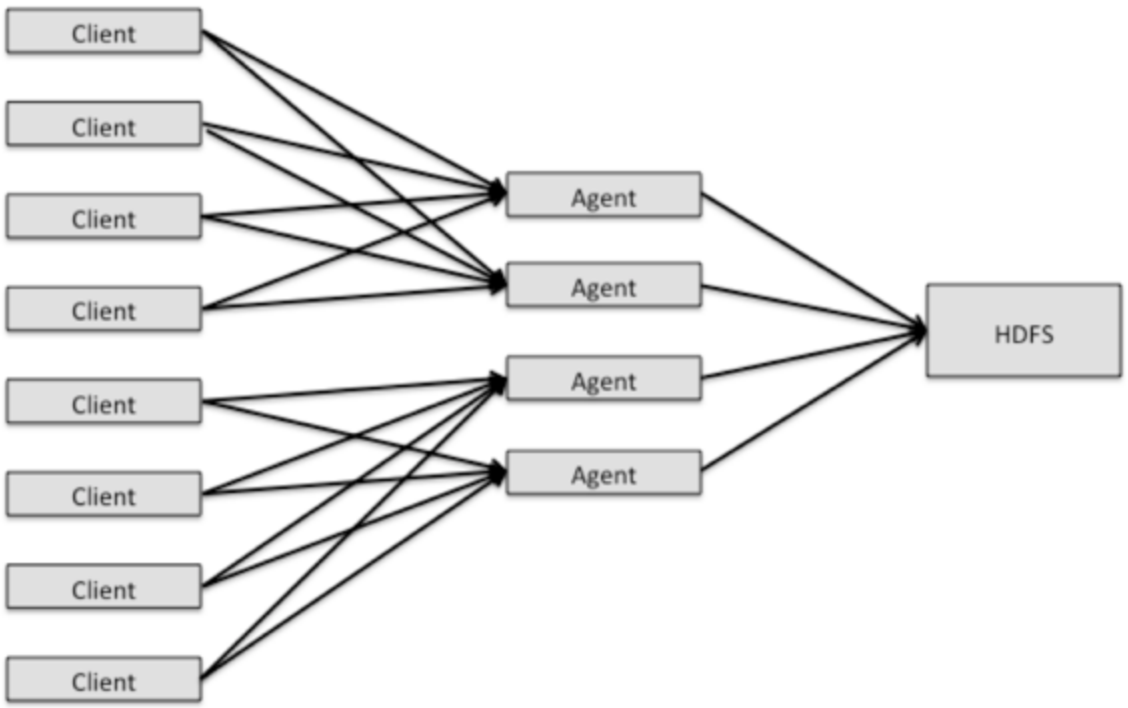
Interceptors

- Mask fields
- Validate information against external source
- Extract fields
- Modify data format
- Filter or split events

Any sufficiently complex configuration
Is indistinguishable from code

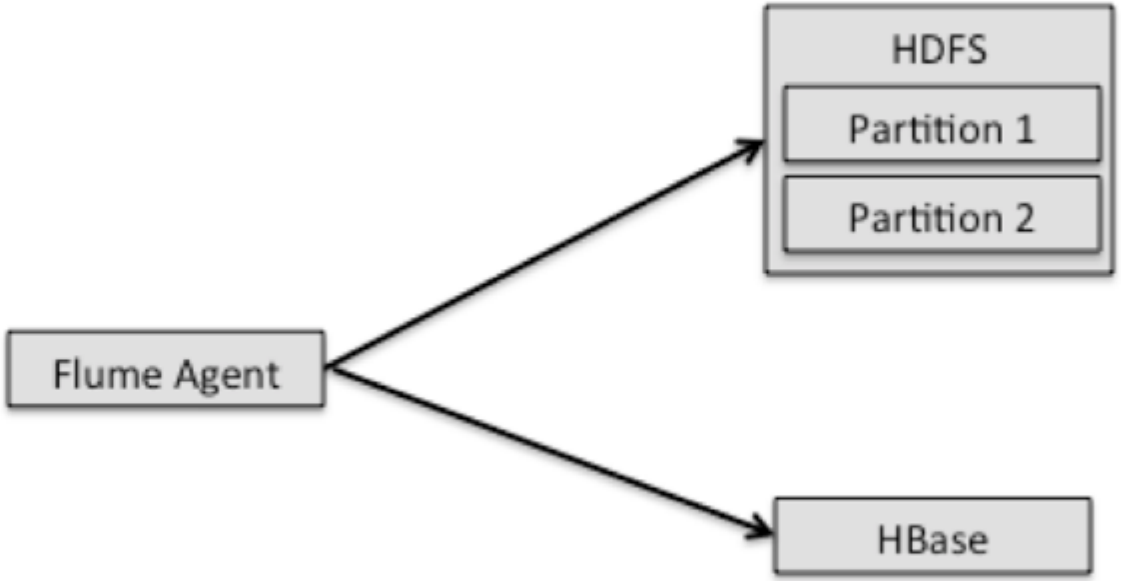
A Brief Discussion of Flume Patterns – Fan-in

- Flume agent runs on each of our servers.
- These client agents send data to multiple agents to provide reliability.
- Flume provides support for load balancing.

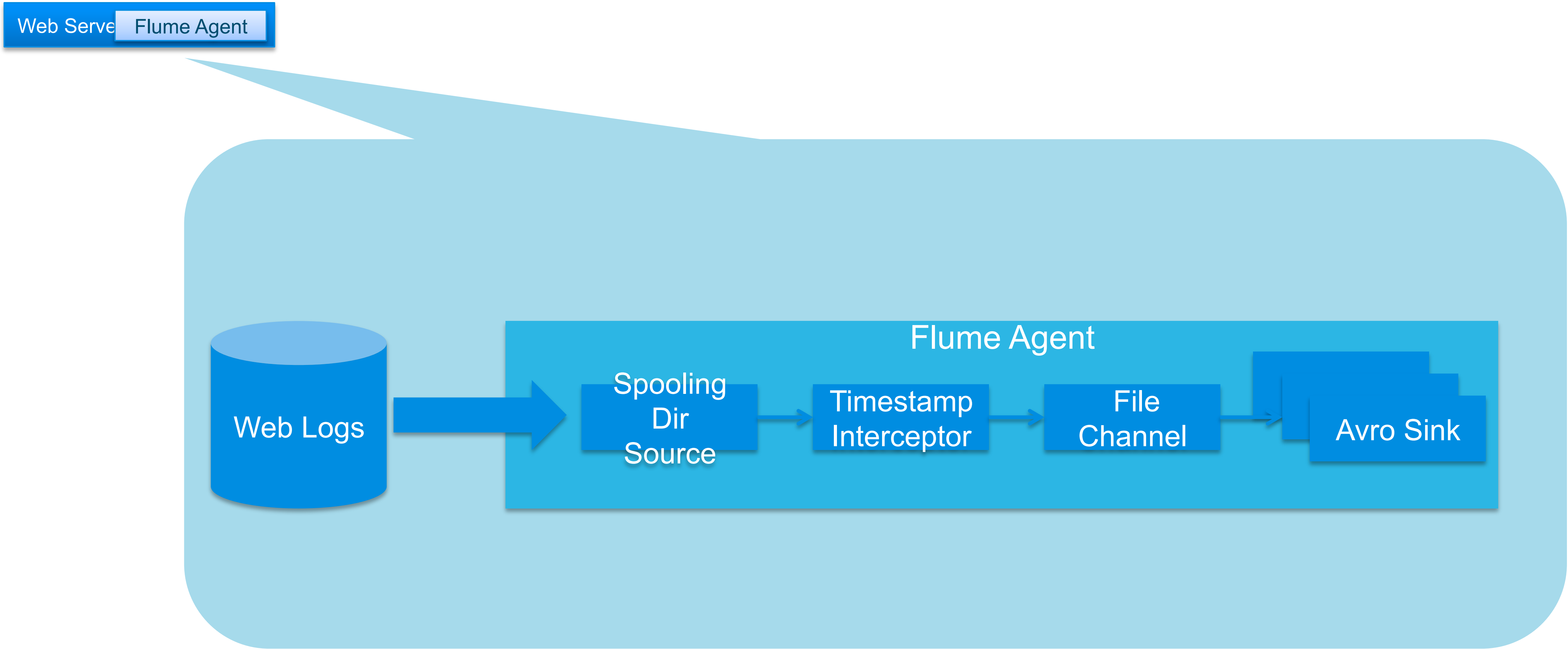


A Brief Discussion of Flume Patterns – Splitting

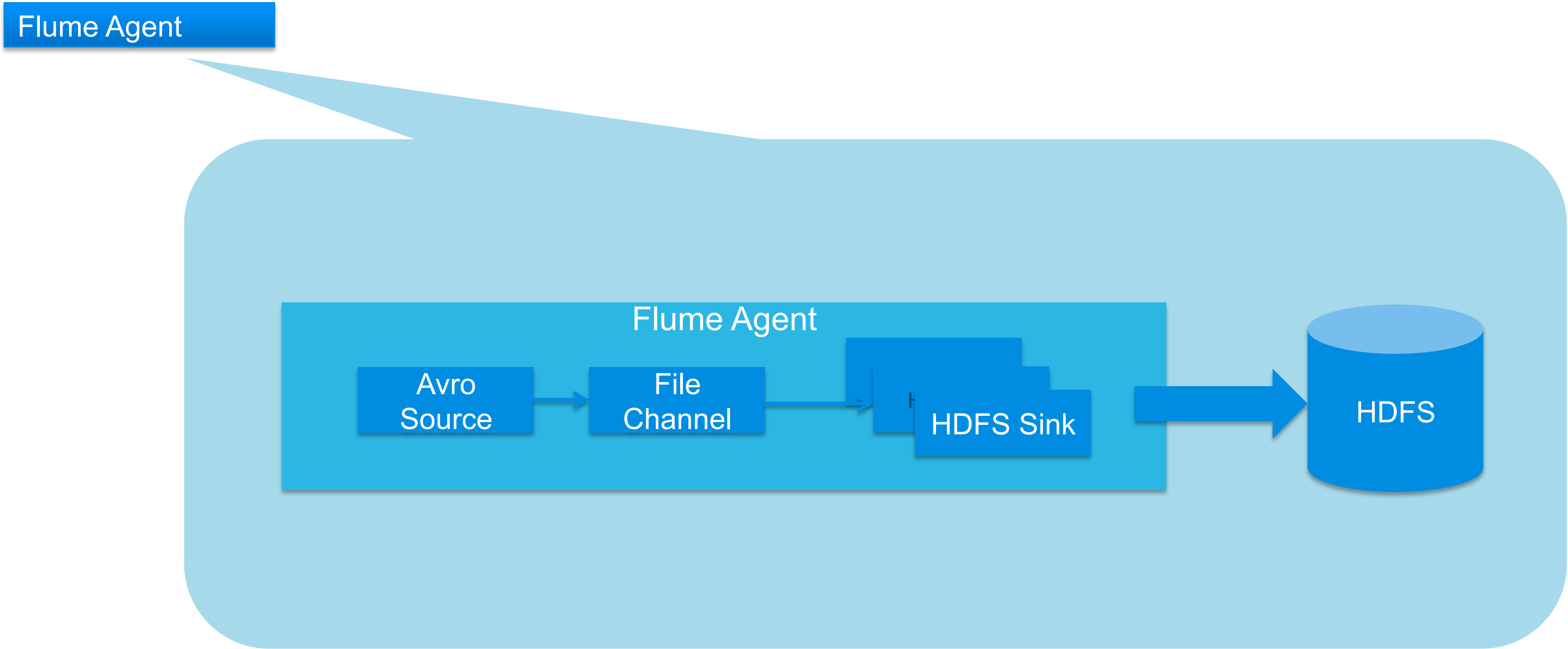
- Common need is to split data on ingest.
- For example:
  - Sending data to multiple clusters for DR.
  - To multiple destinations.
- Flume also supports partitioning, which is key to our implementation.



Flume Architecture – Client Tier



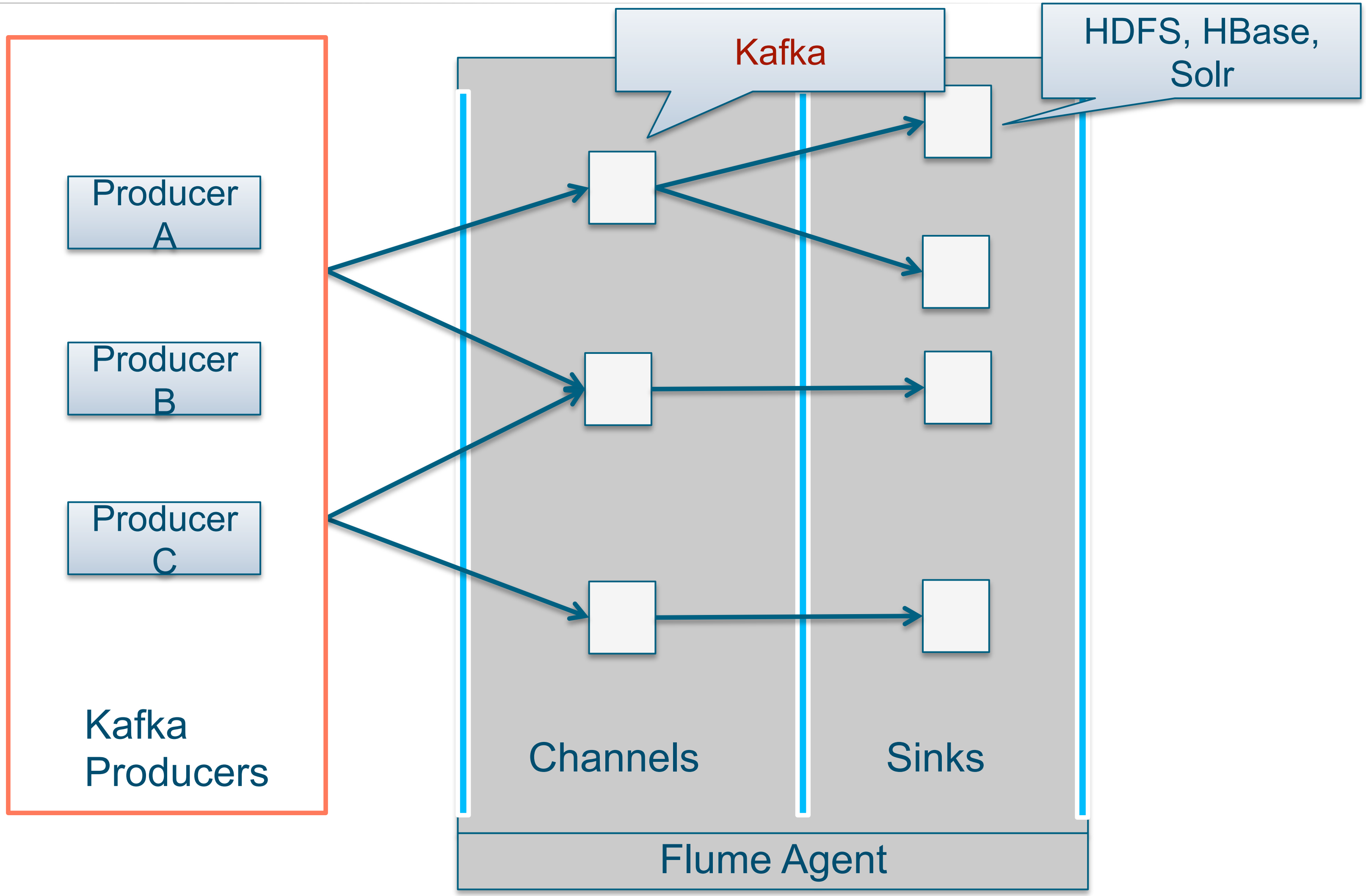
Flume Architecture – Collector Tier



What if…. We were to use Kafka?

- Add Kafka producer to our webapp
- Send clicks and searches as messages
- Flume can ingest events from Kafka
- We can add a second consumer for real-time processing in SparkStreaming
- Another consumer for alerting…
- And maybe a batch consumer too

The Kafka Channel



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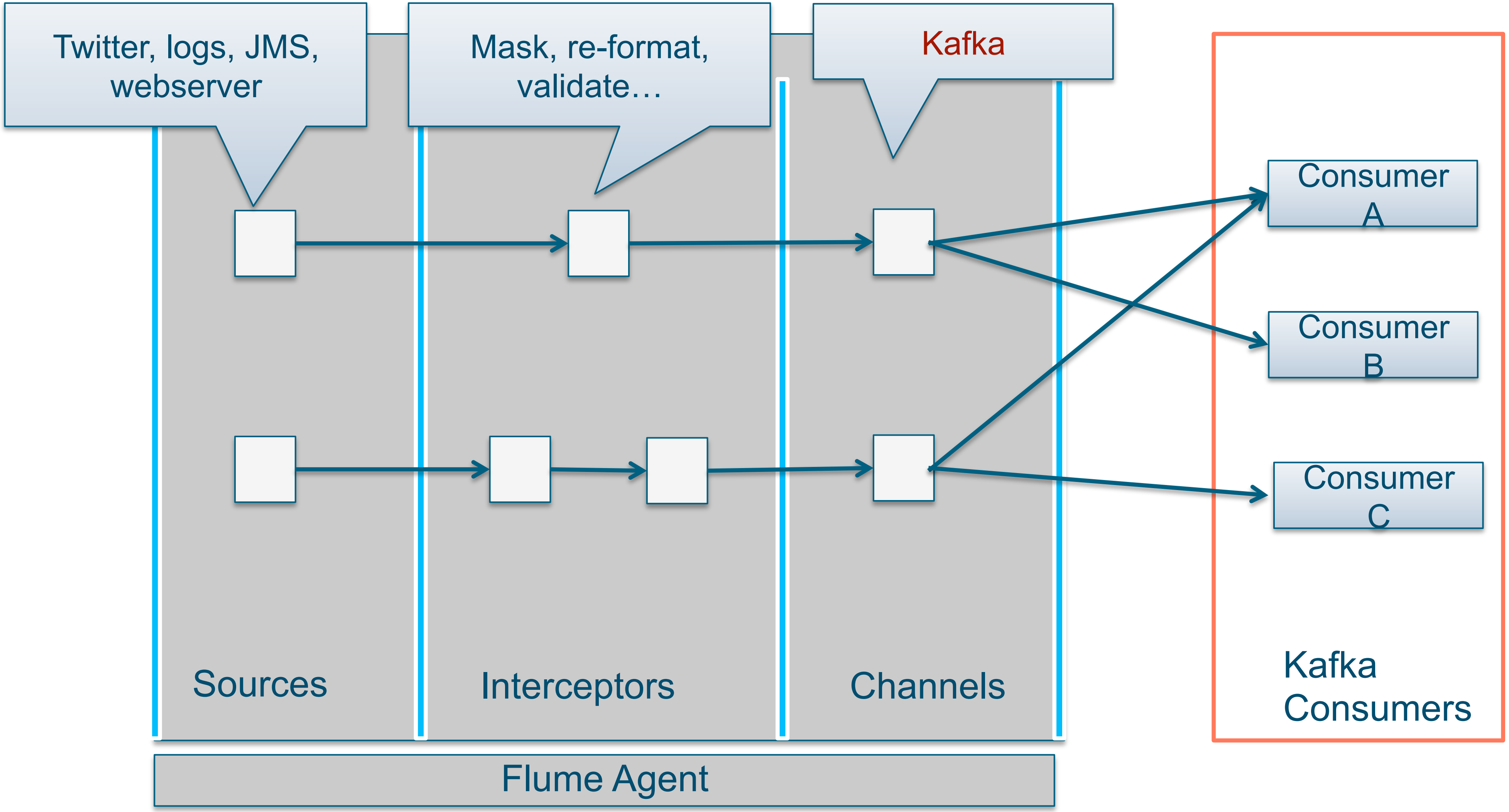
The Kafka Channel



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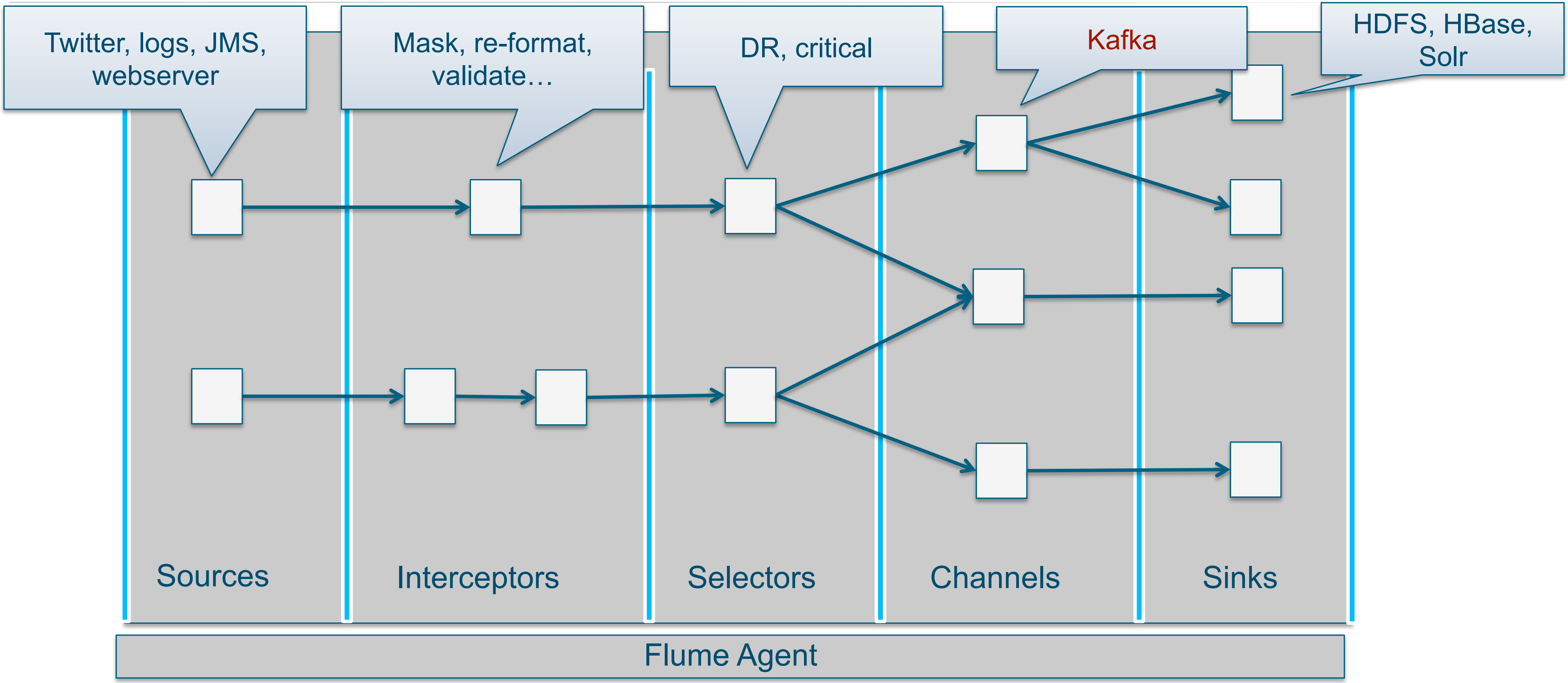
The Kafka Channel



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Architectural Considerations

Data Processing – Engines

tiny.cloudera.com/app-arch-slides

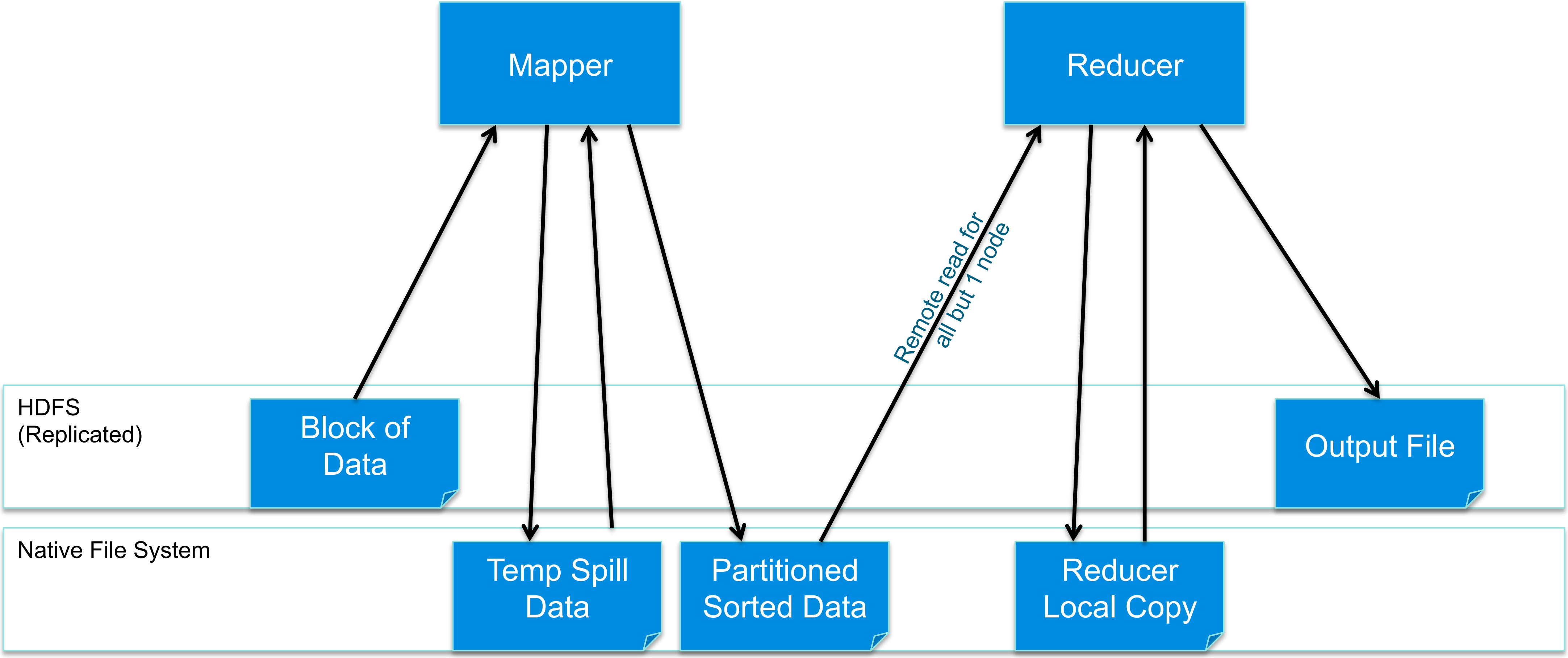
Processing Engines

- MapReduce
- Abstractions
- Spark
- Spark Streaming
- Impala

MapReduce

- Oldie but goody
- Restrictive Framework / Innovated Work Around
- Extreme Batch

MapReduce Basic High Level



MapReduce Innovation

- Mapper Memory Joins
- Reducer Memory Joins
- Buckets Sorted Joins
- Cross Task Communication
- Windowing
- And Much More

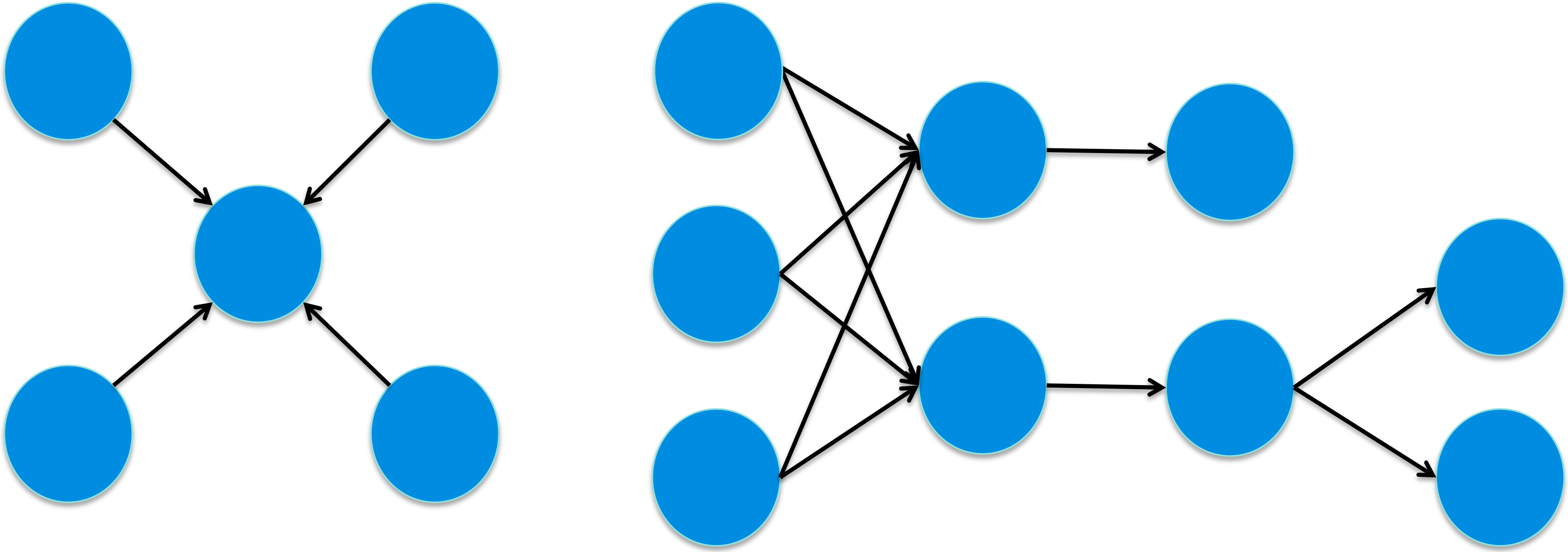
Abstractions

- SQL
  - Hive
- Script/Code
  - Pig: Pig Latin
  - Crunch: Java/Scala
  - Cascading: Java/Scala

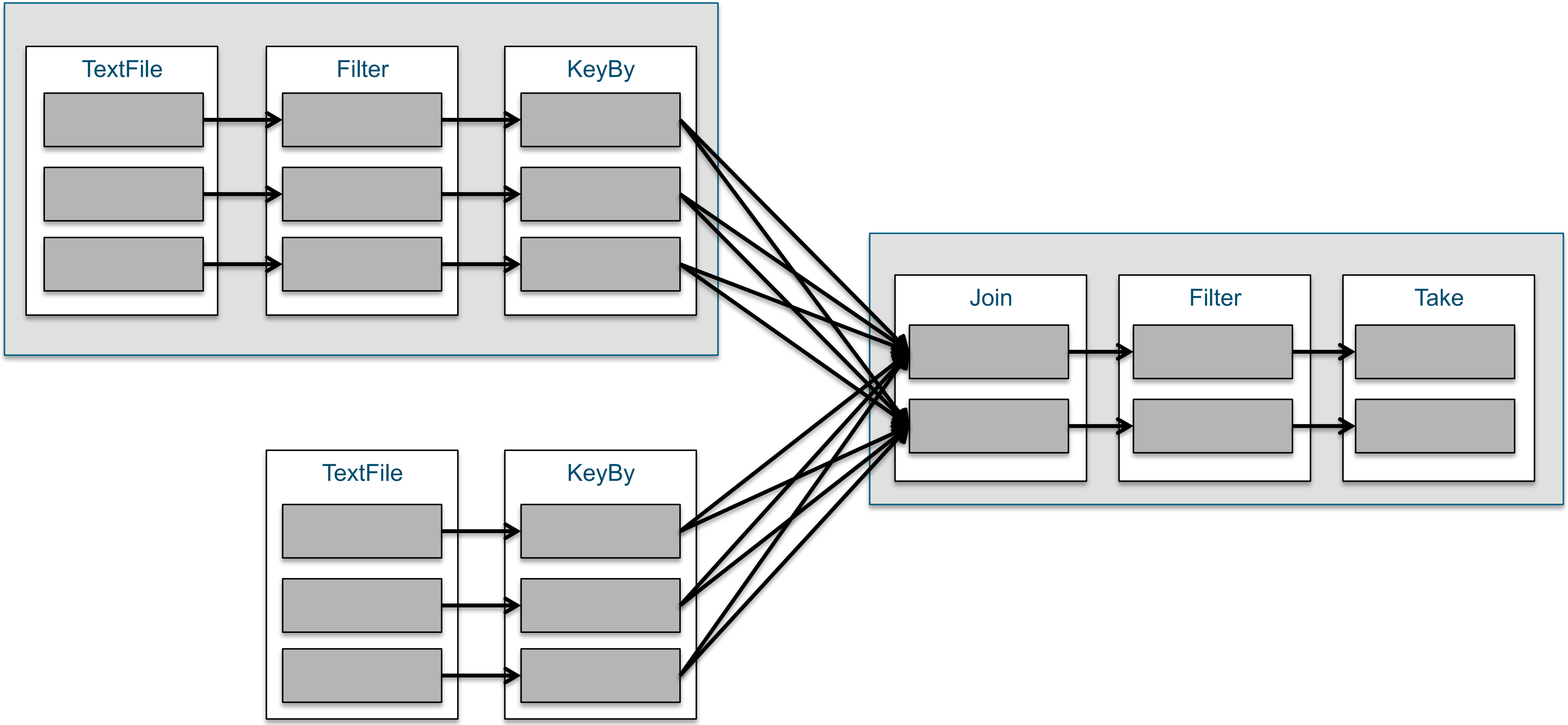
Spark

- The New Kid that isn’t that New Anymore
- Easily 10x less code
- Extremely Easy and Powerful API
- Very good for machine learning
- Scala, Java, and Python
- RDDs
- DAG Engine

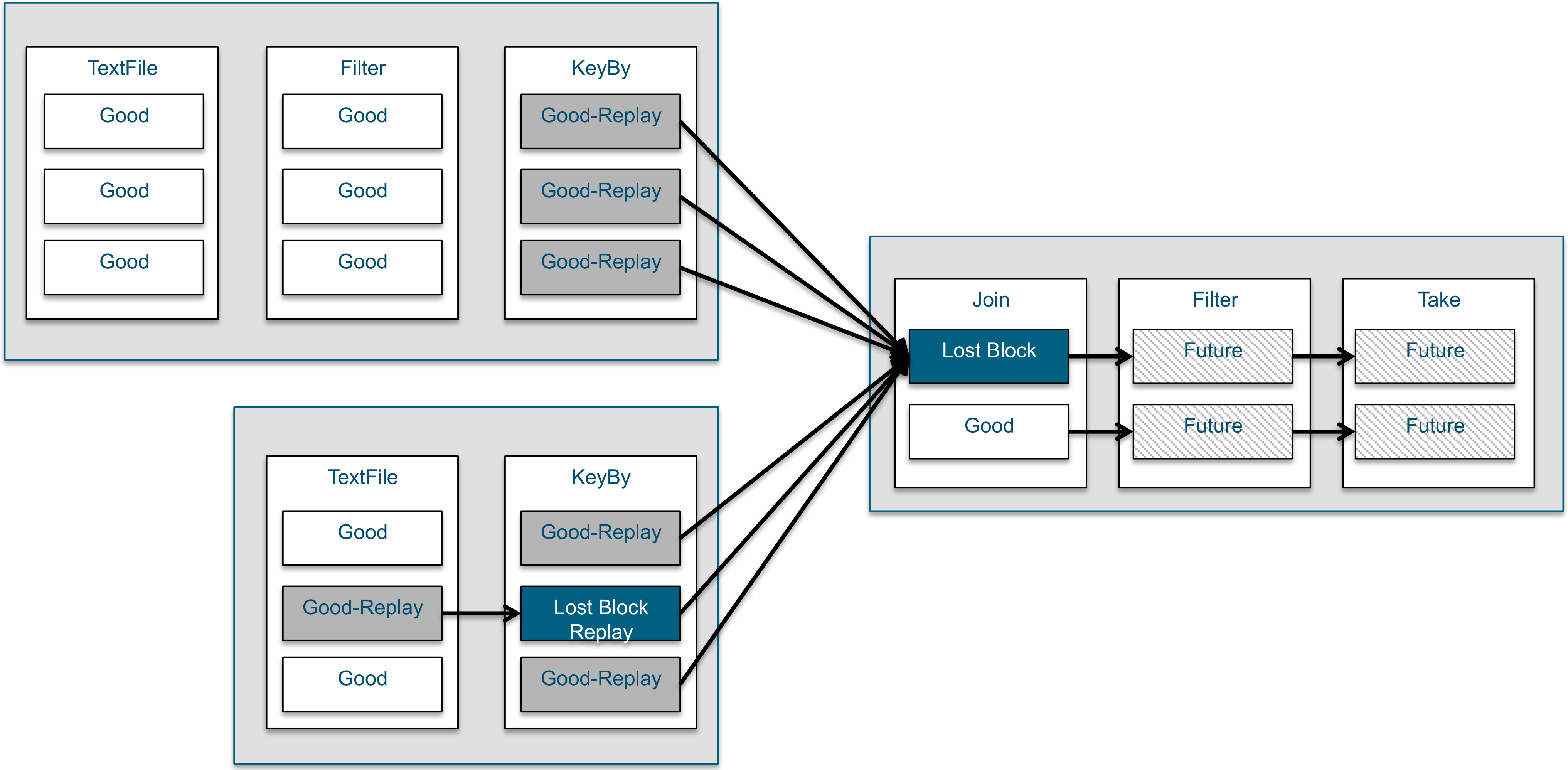
Spark - DAG



Spark - DAG



Spark - DAG



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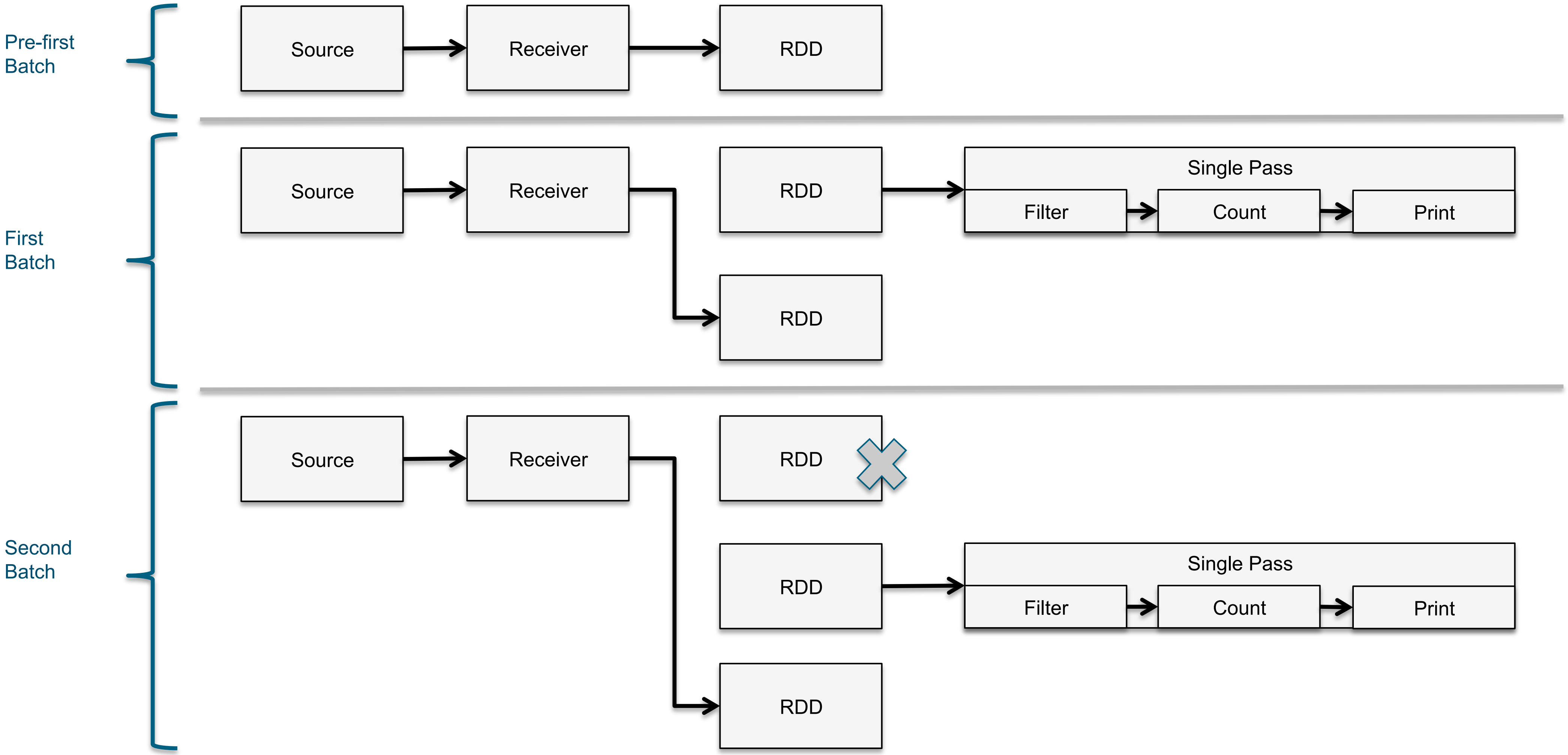
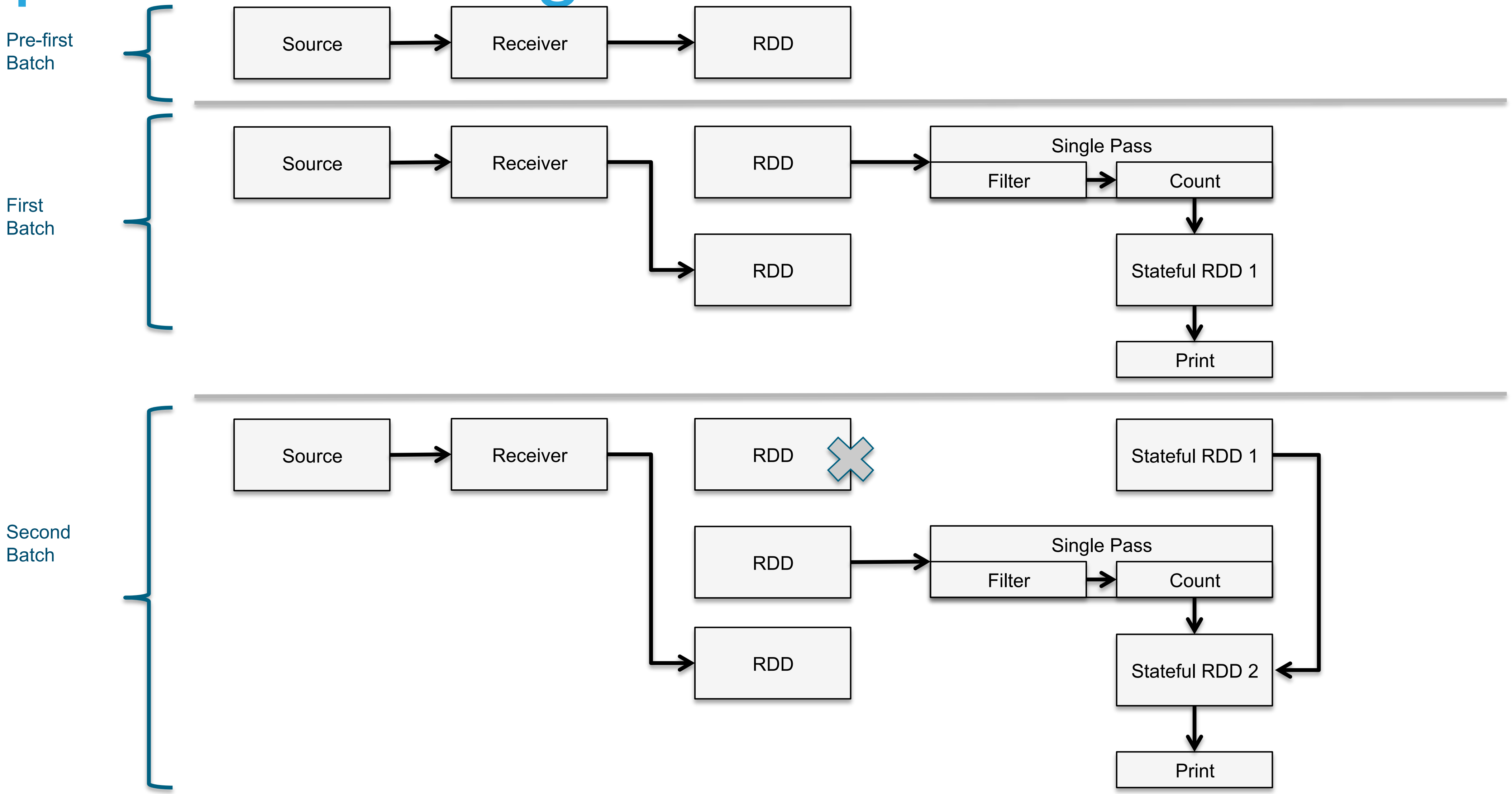
Spark Streaming

- Calling Spark in a Loop
- Extends RDDs with DStream
- Very Little Code Changes from ETL to Streaming

Spark Streaming



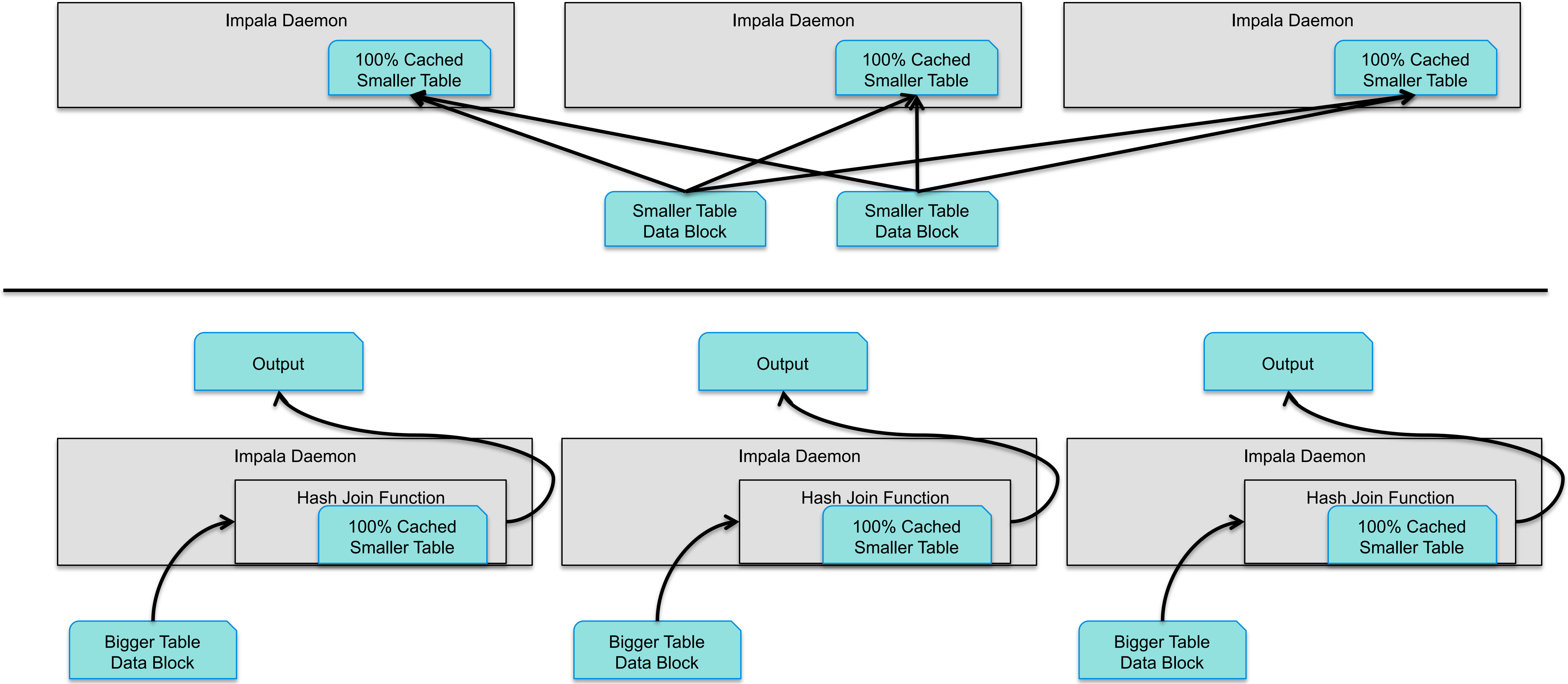
Spark Streaming



Impala

- MPP Style SQL Engine on top of Hadoop
- Very Fast
- High Concurrency
- Analytical windowing functions (C5.2).

Impala – Broadcast Join



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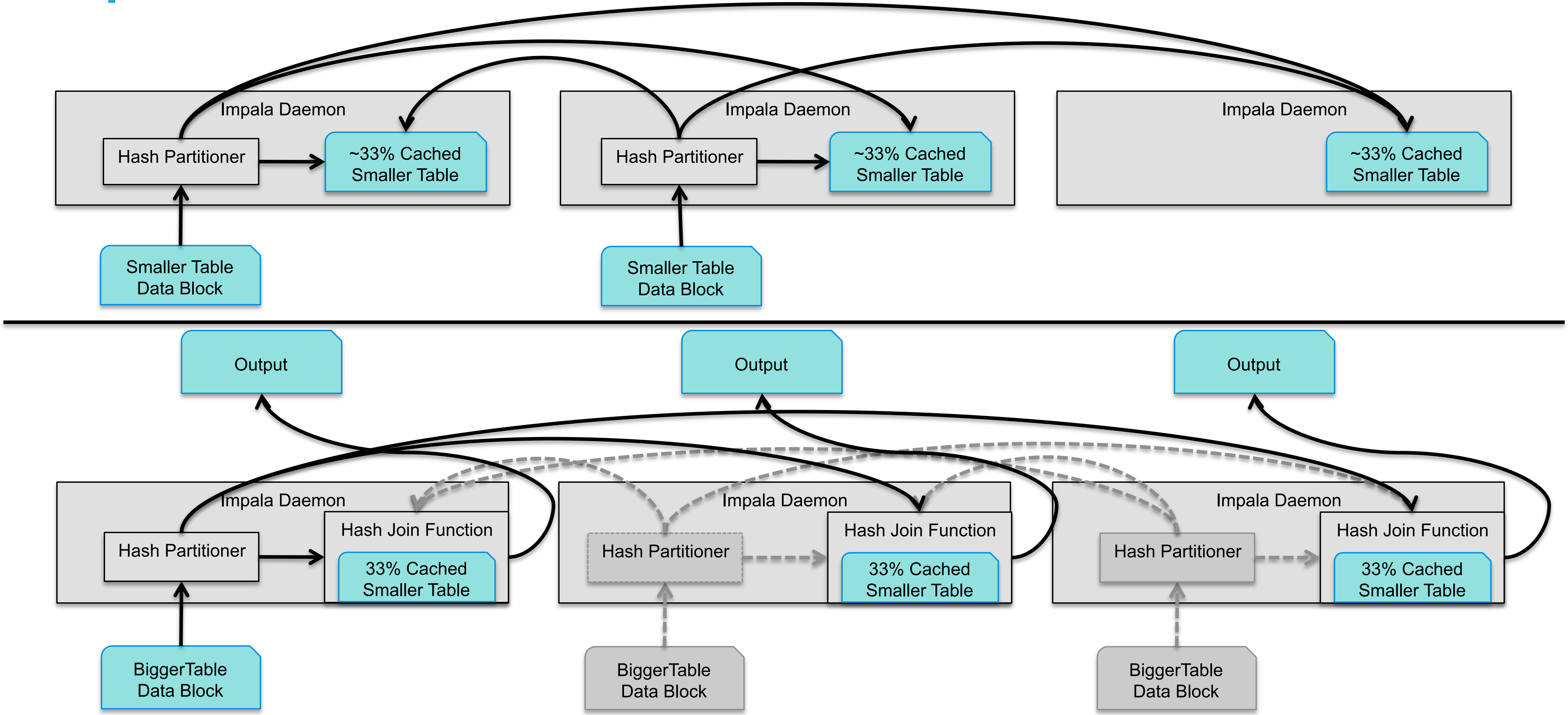
Impala – Partitioned Hash Join



Impala vs Hive

- Very different approaches and
- We may see convergence at some point
- But for now
  - Impala for speed
  - Hive for batch

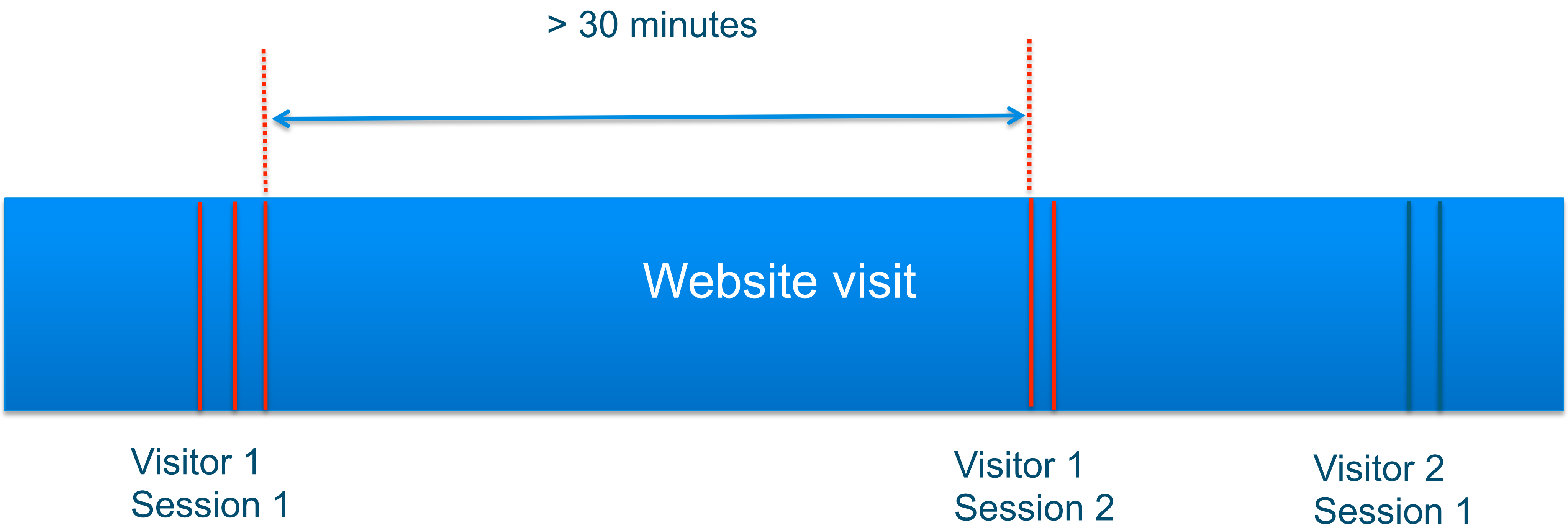
Architectural Considerations

Data Processing – Patterns and Recommendations

What processing needs to happen?

- Sessionization
- Filtering
- Deduplication
- BI / Discovery

Sessionization



Why sessionize?

Helps answers questions like:

- What is my website's bounce rate?
  - i.e. how many % of visitors don't go past the landing page?
- Which marketing channels (e.g. organic search, display ad, etc.) are leading to most sessions?
  - Which ones of those lead to most conversions (e.g. people buying things, signing up, etc.)
- Do attribution analysis – which *channels* are responsible for most *conversions*?

Sessionization

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X
10_9_2) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
244.157.45.12+1413580110
244.157.45.12 - - [17/Oct/2014:21:59:59 ] "GET /Store/cart.jsp?productID=1023 HTTP/
1.0" 200 3757 "http://www.casualcyclist.com" "Mozilla/5.0 (Linux; U; Android 2.3.5;
en-us; HTC Vision Build/GRI40) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0
Mobile Safari/533.1” 244.157.45.12+1413583199
```

How to Sessionize?

1. Given a list of clicks, determine which clicks came from the same user (Partitioning, ordering)
2. Given a particular user's clicks, determine if a given click is a part of a new session or a continuation of the previous session (Identifying session boundaries)

#1 – Which clicks are from same user?

- We can use:
  - IP address (`244.157.45.12`)
  - Cookies (`A9A3BECE0563982D`)
  - IP address (`244.157.45.12`) and user agent string (`(KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36"`)

#1 – Which clicks are from same user?

- We can use:
  - IP address (`244.157.45.12`)
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#1 – Which clicks are from same user?

```
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AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
244.157.45.12 - - [17/Oct/2014:21:59:59 ] "GET /Store/cart.jsp?productID=1023 HTTP/1.0"
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Vision Build/GRI40) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0 Mobile Safari/533.1”
```

#2 – Which clicks part of the same session?

> 30 mins apart = different sessions

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
244.157.45.12 - - [17/Oct/2014:21:59:59 ] "GET /Store/cart.jsp?productID=1023 HTTP/1.0"
200 3757 "http://www.casualcyclist.com" "Mozilla/5.0 (Linux; U; Android 2.3.5; en-us; HTC
Vision Build/GRI40) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0 Mobile Safari/533.1”
```

Sessionization engine recommendation

- We have sessionization code in MR and Spark on github. The complexity of the code varies, depends on the expertise in the organization.
- We choose MR
  - MR API is stable and widely known
  - No Spark + Oozie (orchestration engine) integration currently

Filtering – filter out incomplete records

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
~~244.157.45.12 - - [17/Oct/2014:21:59:59 ] "GET /Store/cart.jsp?productID=1023 HTTP/1.0"~~
~~200 3757 "http://www.casualcyclist.com" "Mozilla/5.0 (Linux; U…~~
```

Filtering – filter out records from bots/spiders

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
```

~~209.85.238.11 - - [17/Oct/2014:21:59:59] "GET /Store/cart.jsp?productID=1023 HTTP/1.0"~~
~~200 3757 "http://www.casualcyclist.com" "Mozilla/5.0 (Linux; U; Android 2.3.5; en-us; HTC~~
~~Vision Build/GRI40) AppleWebKit/533.1 (KHTML, like Gecko) Version/4.0 Mobile Safari/533.1”~~

Google spider IP address

Filtering recommendation

- Bot/Spider filtering can be done easily in any of the engines
- Incomplete records are harder to filter in schema systems like Hive, Impala, Pig, etc.
- Flume interceptors can also be used
- Pretty close choice between MR, Hive and Spark
- Can be done in Spark using rdd.filter()
- We can simply embed this in our MR sessionization job

Deduplication – remove duplicate records

```
244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://
bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”
~~244.157.45.12 - - [17/Oct/2014:21:08:30 ] "GET /seatposts HTTP/1.0" 200 4463 "http://~~
~~bestcyclingreviews.com/top_online_shops" "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2)~~
~~AppleWebKit/537.36 (KHTML, like Gecko) Chrome/36.0.1944.0 Safari/537.36”~~
```

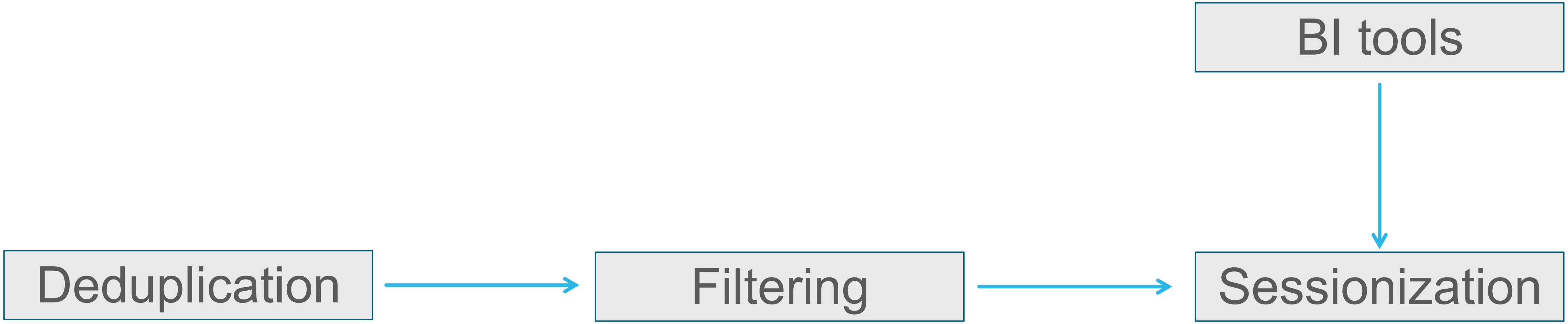
Deduplication recommendation

- Can be done in all engines.
- We already have a Hive table with all the columns, a simple DISTINCT query will perform deduplication
- reduce() in spark
- We use Pig

BI/Discovery engine recommendation

- Main requirements for this are:
  - Low latency
  - SQL interface (e.g. JDBC/ODBC)
  - Users don't know how to code
- We chose Impala
  - It's a SQL engine
  - Much faster than other engines
  - Provides standard JDBC/ODBC interfaces

End-to-end processing



Architectural Considerations

Orchestration

Orchestrating Clickstream

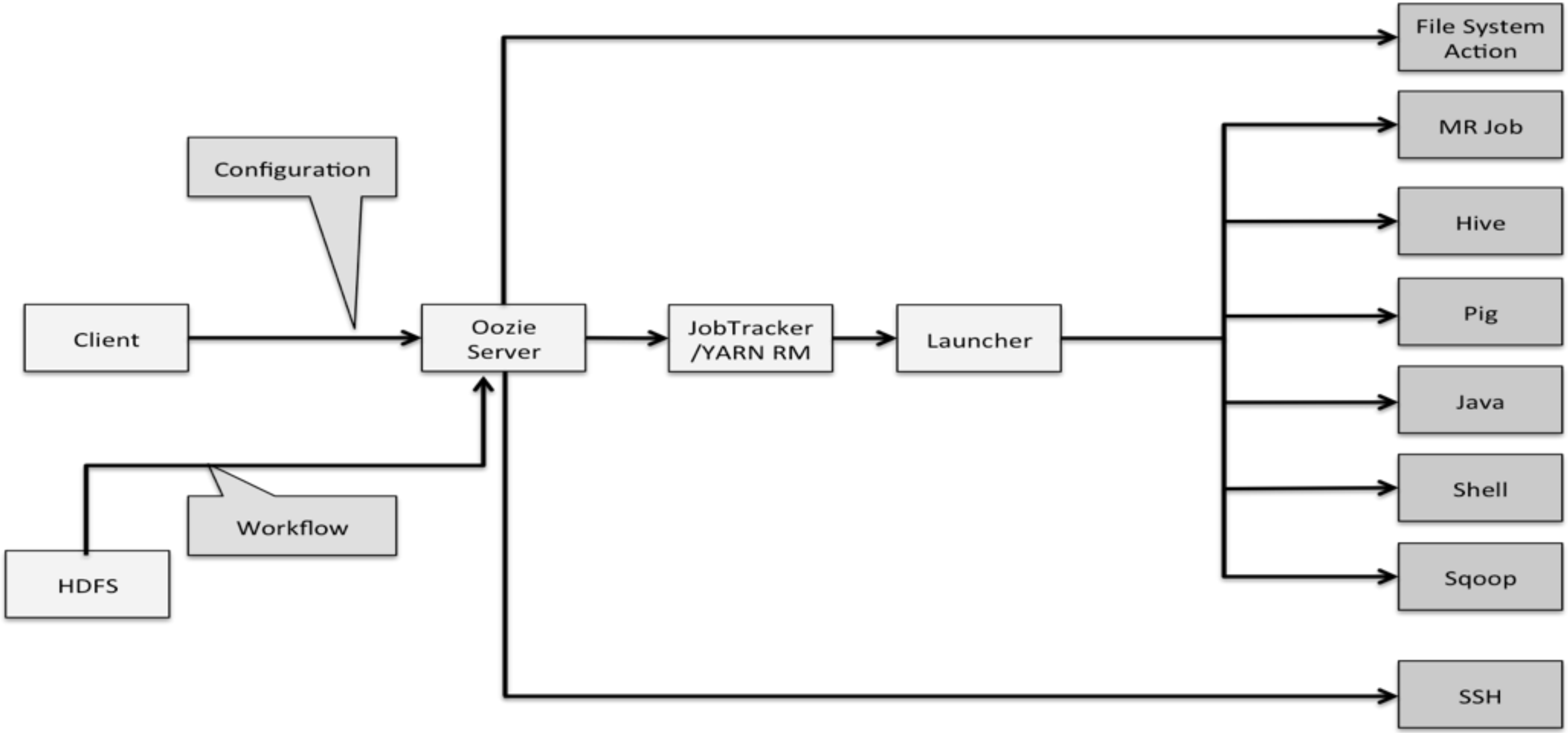
- Data arrives through Flume
- Triggers a processing event:
  - Sessionize
  - Enrich – Location, marketing channel…
  - Store as Parquet
- Each day we process events from the previous day

Choosing Right

- Workflow is fairly simple
- Need to trigger workflow based on data
- Be able to recover from errors
- Perhaps notify on the status
- And collect metrics for reporting

Oozie or Azkaban?

Oozie Architecture



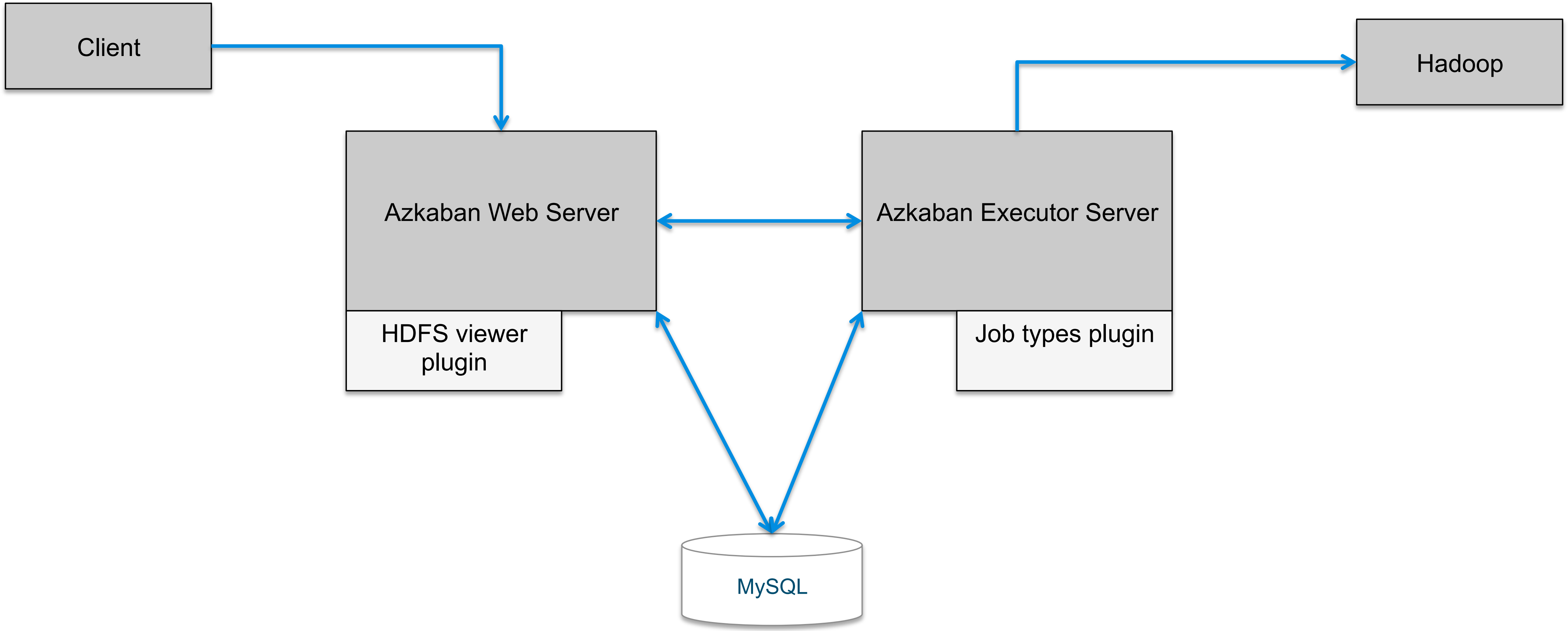
Oozie features

- Part of all major Hadoop distributions
- Hue integration
- Built -in actions – Hive, Sqoop, MapReduce, SSH
- Complex workflows with decisions
- Event and time based scheduling
- Notifications
- SLA Monitoring
- REST API

Oozie Drawbacks

- Overhead in launching jobs
- Steep learning curve
- XML Workflows

Azkaban Architecture



Azkaban features

- Simplicity
- Great UI – including pluggable visualizers
- Lots of plugins – Hive, Pig…
- Reporting plugin

Azkaban Limitations

- Doesn’t support workflow decisions
- Can’t represent data dependency

Choosing…

- Workflow is fairly simple
- Need to trigger workflow based on data
- Be able to recover from errors
- Perhaps notify on the status
- And collect metrics for reporting

Easier in Oozie

Choosing the right Orchestration Tool

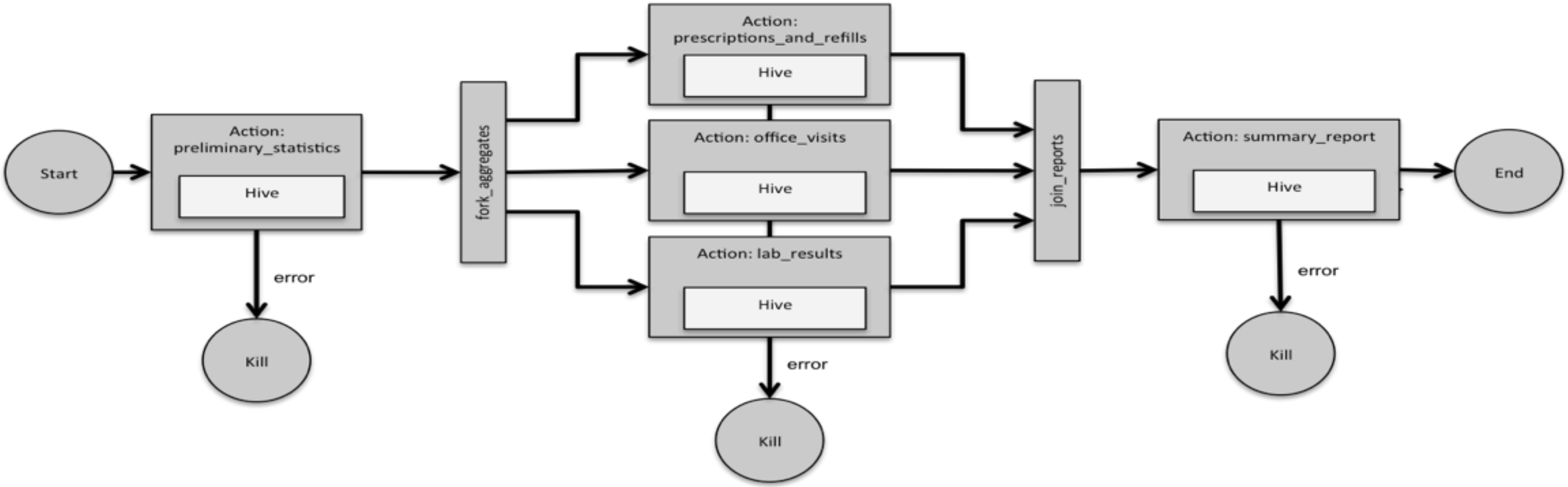
- Workflow is fairly simple
- Need to trigger workflow based on data
- Be able to recover from errors
- Perhaps notify on the status
- And collect metrics for reporting

Better in Azkaban

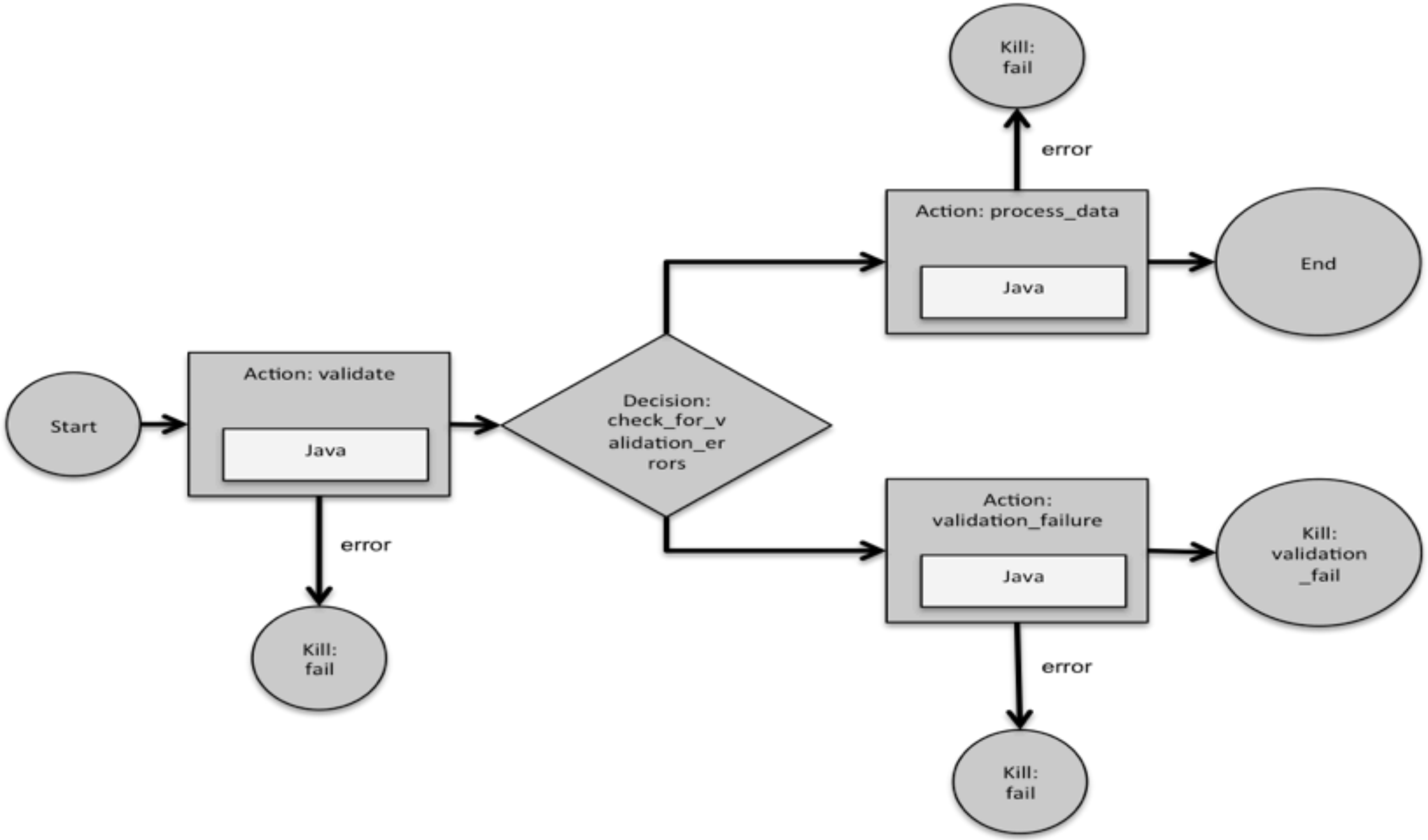
Important Decision Consideration!

The best orchestration tool
is the one you are an expert on

Orchestration Patterns – Fan Out



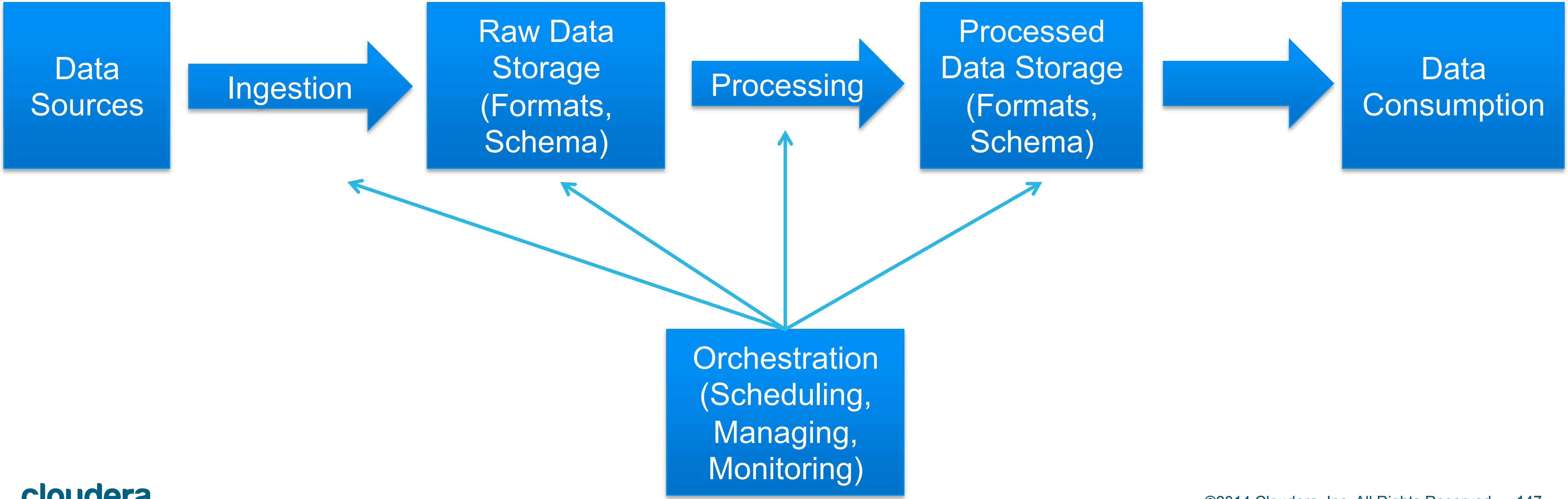
Capture & Decide Pattern



Putting It All Together

Final Architecture

Final Architecture – High Level Overview



Data Sources

Ingestion

Raw Data Storage (Formats, Schema)

Processing

Processed Data Storage (Formats, Schema)

Data Consumption

Orchestration (Scheduling, Managing, Monitoring)

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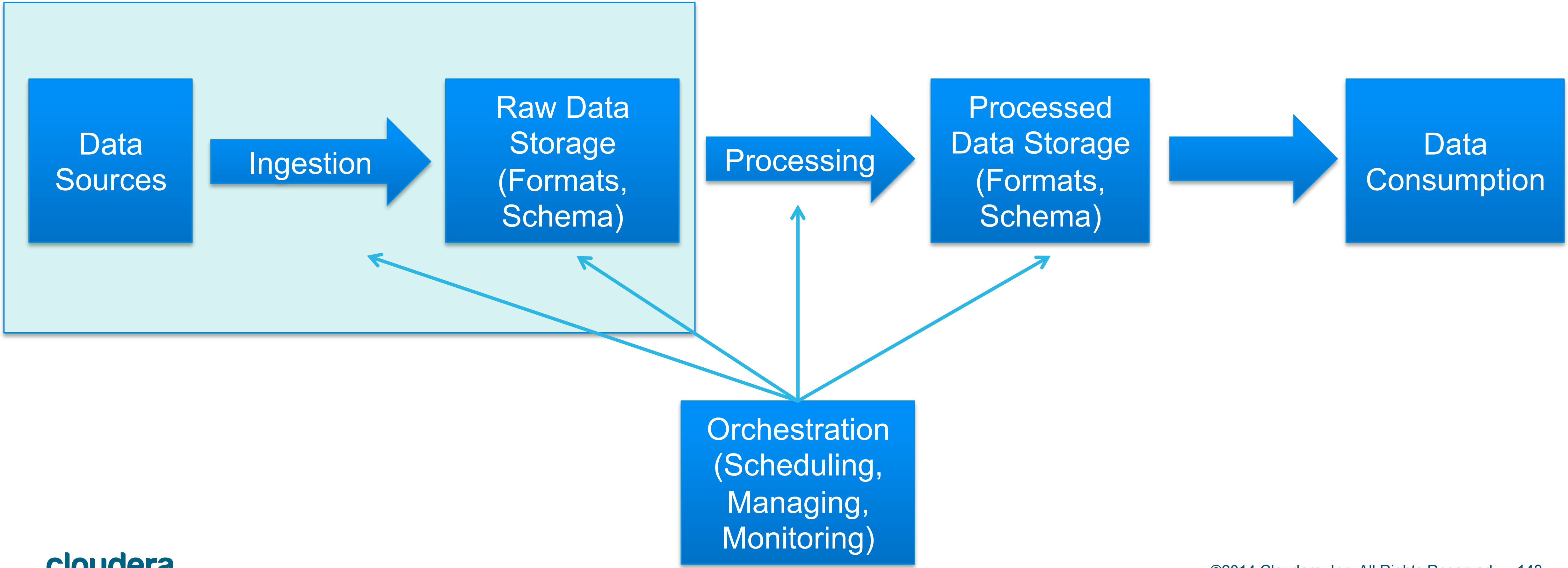
Final Architecture – High Level Overview



Data Sources

Ingestion

Raw Data Storage (Formats, Schema)

Processing

Processed Data Storage (Formats, Schema)

Data Consumption

Orchestration (Scheduling, Managing, Monitoring)

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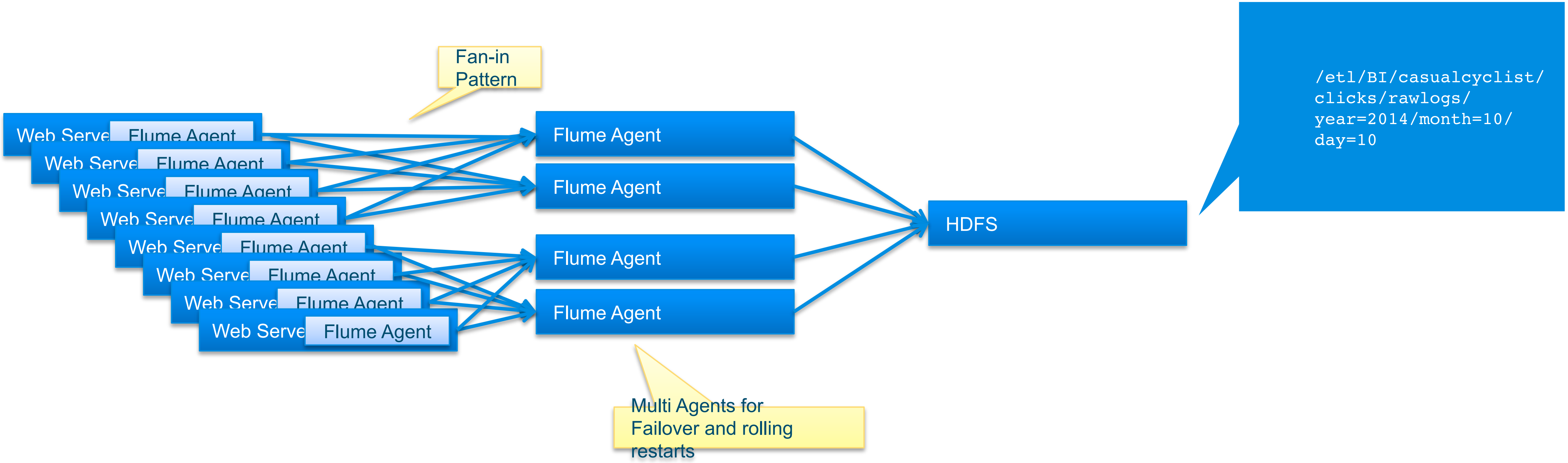
Final Architecture – Ingestion/Storage



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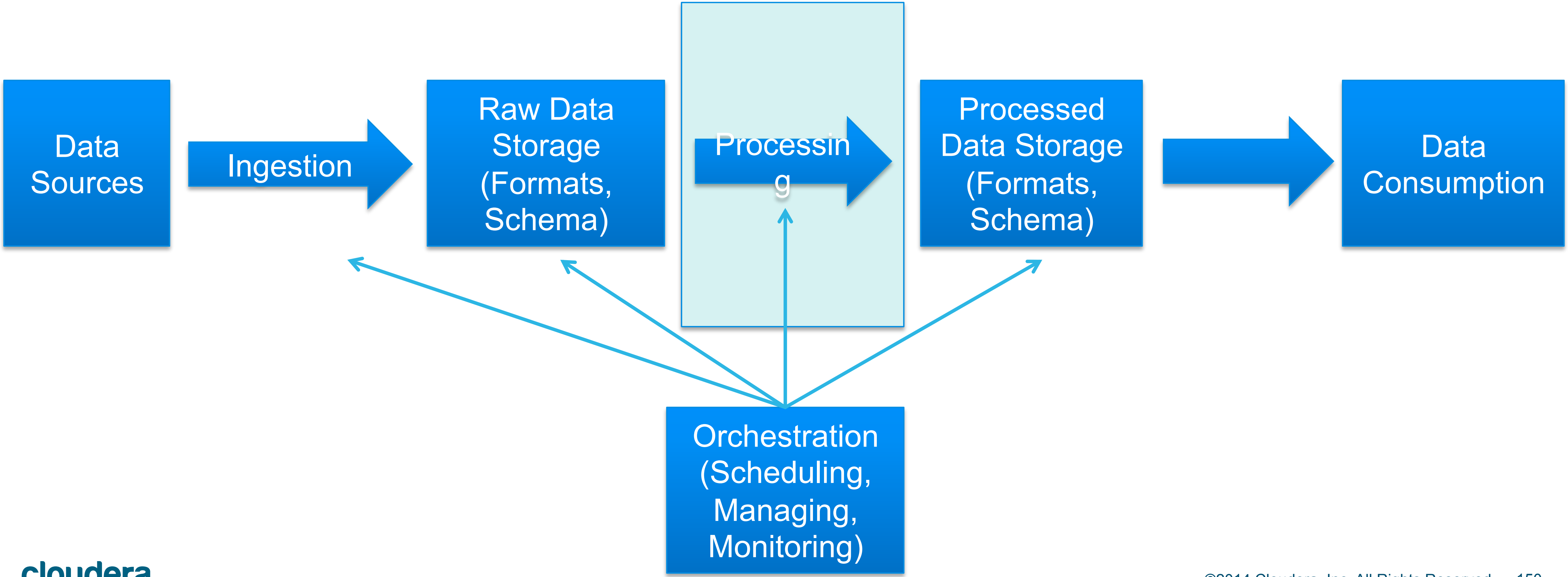
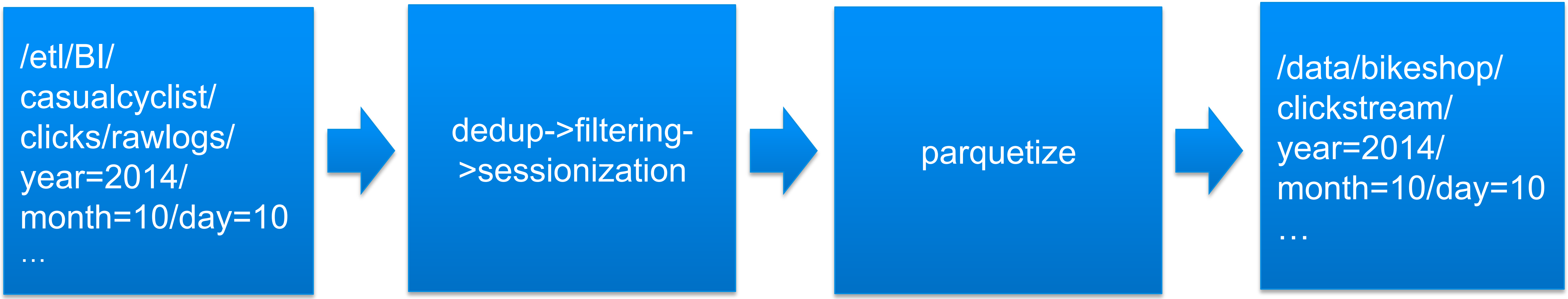
Final Architecture – High Level Overview


Data Sources
Ingestion
Raw Data Storage (Formats, Schema)
Processin g
Processed Data Storage (Formats, Schema)
Data Consumption
Orchestration (Scheduling, Managing, Monitoring)

Final Architecture – Processing and Storage



/etl/BI/casualcyclist/clicks/rawlogs/year=2014/month=10/day=10
…

dedup->filtering->sessionization

parquetize

/data/bikeshop/clickstream/year=2014/month=10/day=10
…

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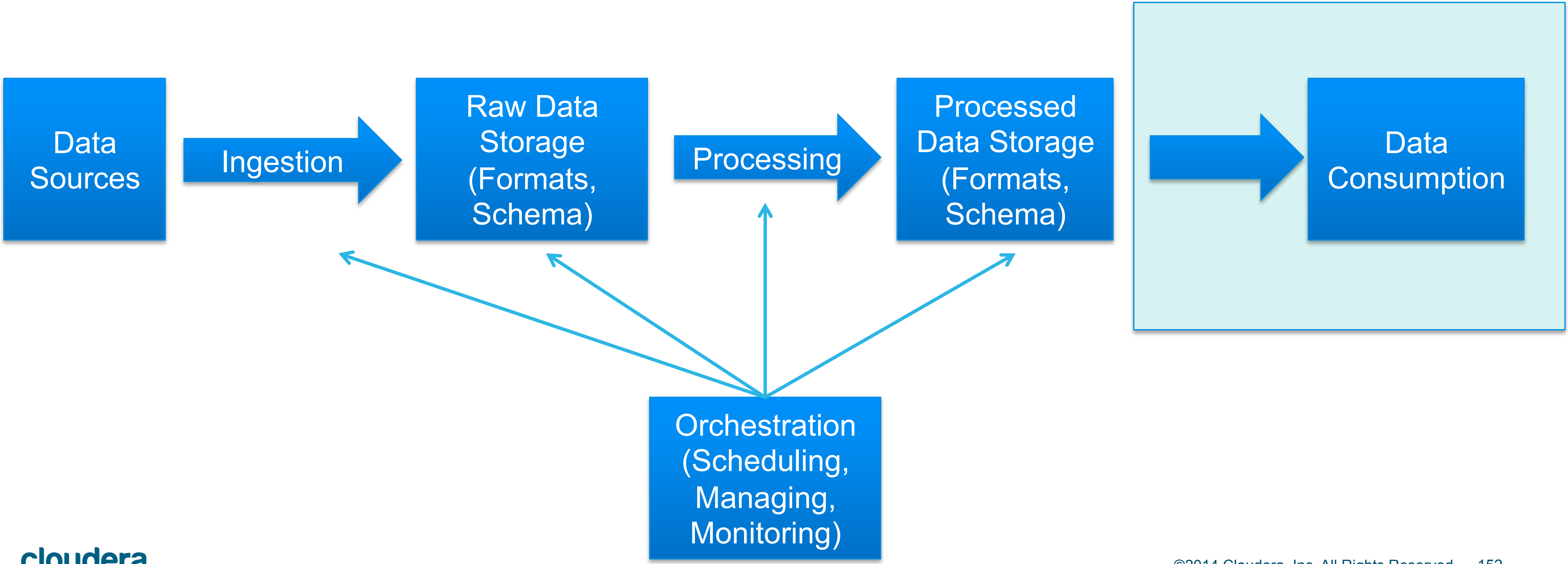
Final Architecture – High Level Overview



Data Sources

Ingestion

Raw Data Storage (Formats, Schema)

Processing

Processed Data Storage (Formats, Schema)

Data Consumption

Orchestration (Scheduling, Managing, Monitoring)

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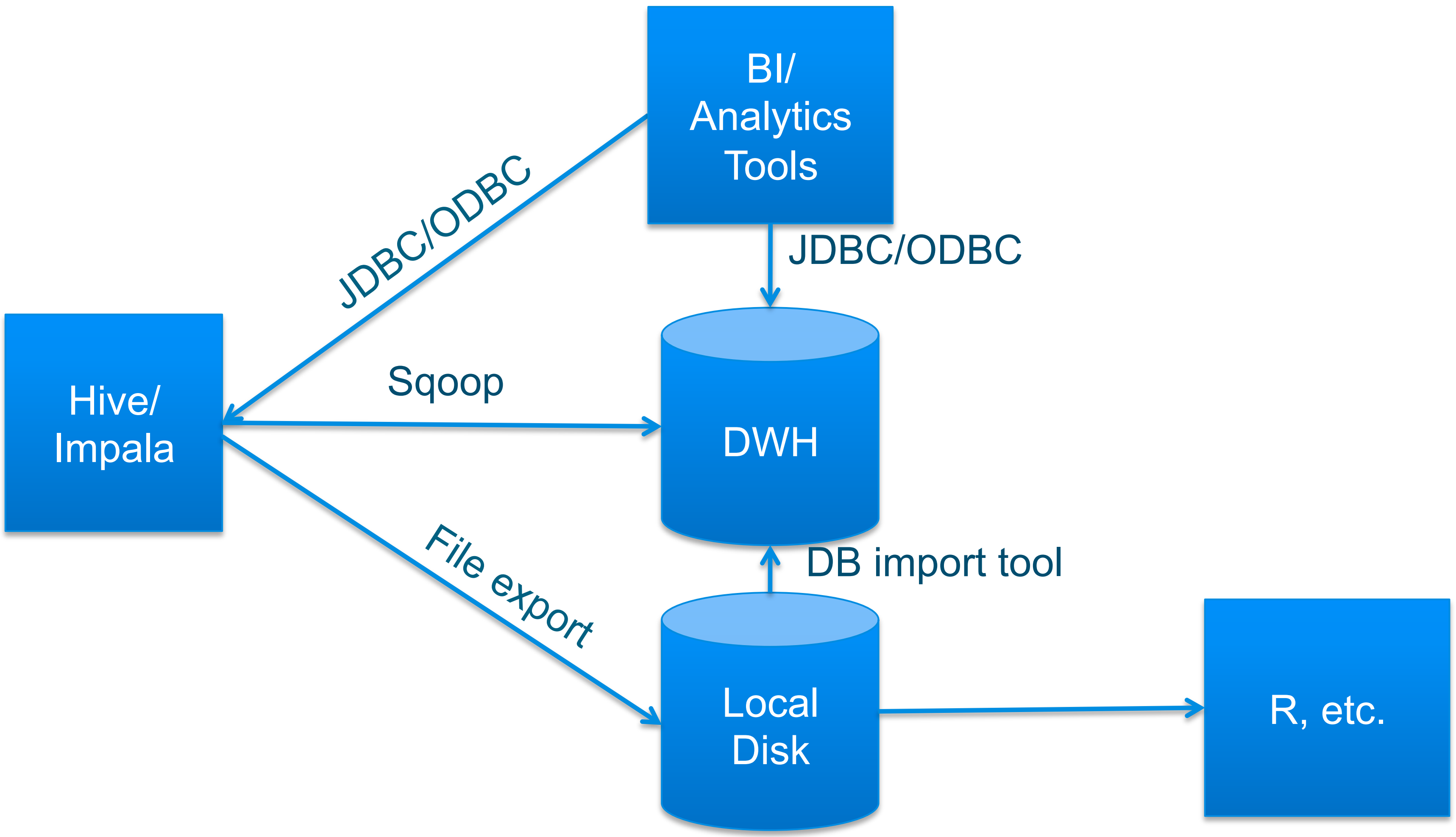
Final Architecture – Data Access



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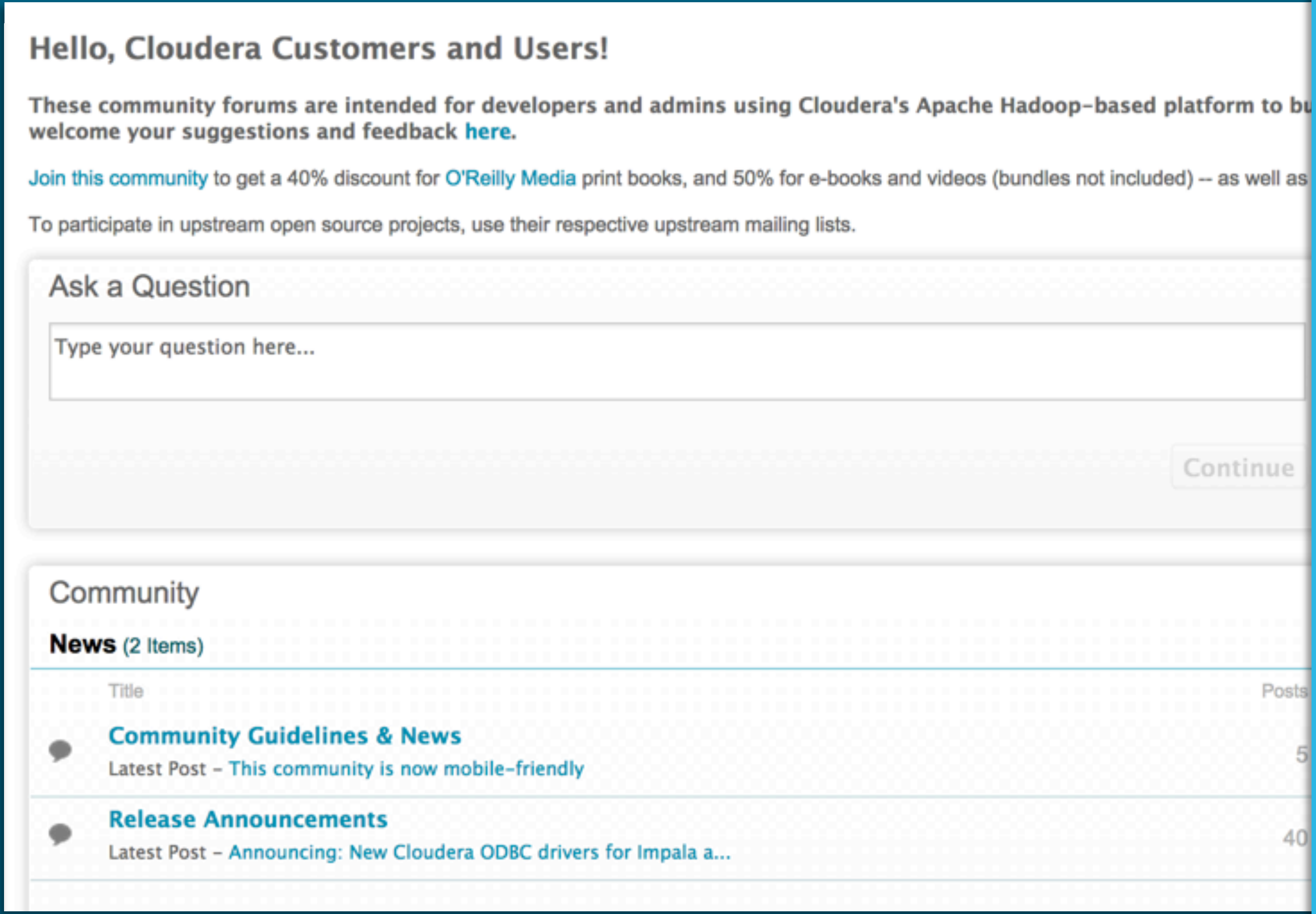
Demo

Join the Discussion



Hello, Cloudera Customers and Users!

These community forums are intended for developers and admins using Cloudera's Apache Hadoop-based platform to bu
welcome your suggestions and feedback here.

Join this community to get a 40% discount for O'Reilly Media print books, and 50% for e-books and videos (bundles not included) -- as well as

To participate in upstream open source projects, use their respective upstream mailing lists.

Ask a Question

Type your question here...

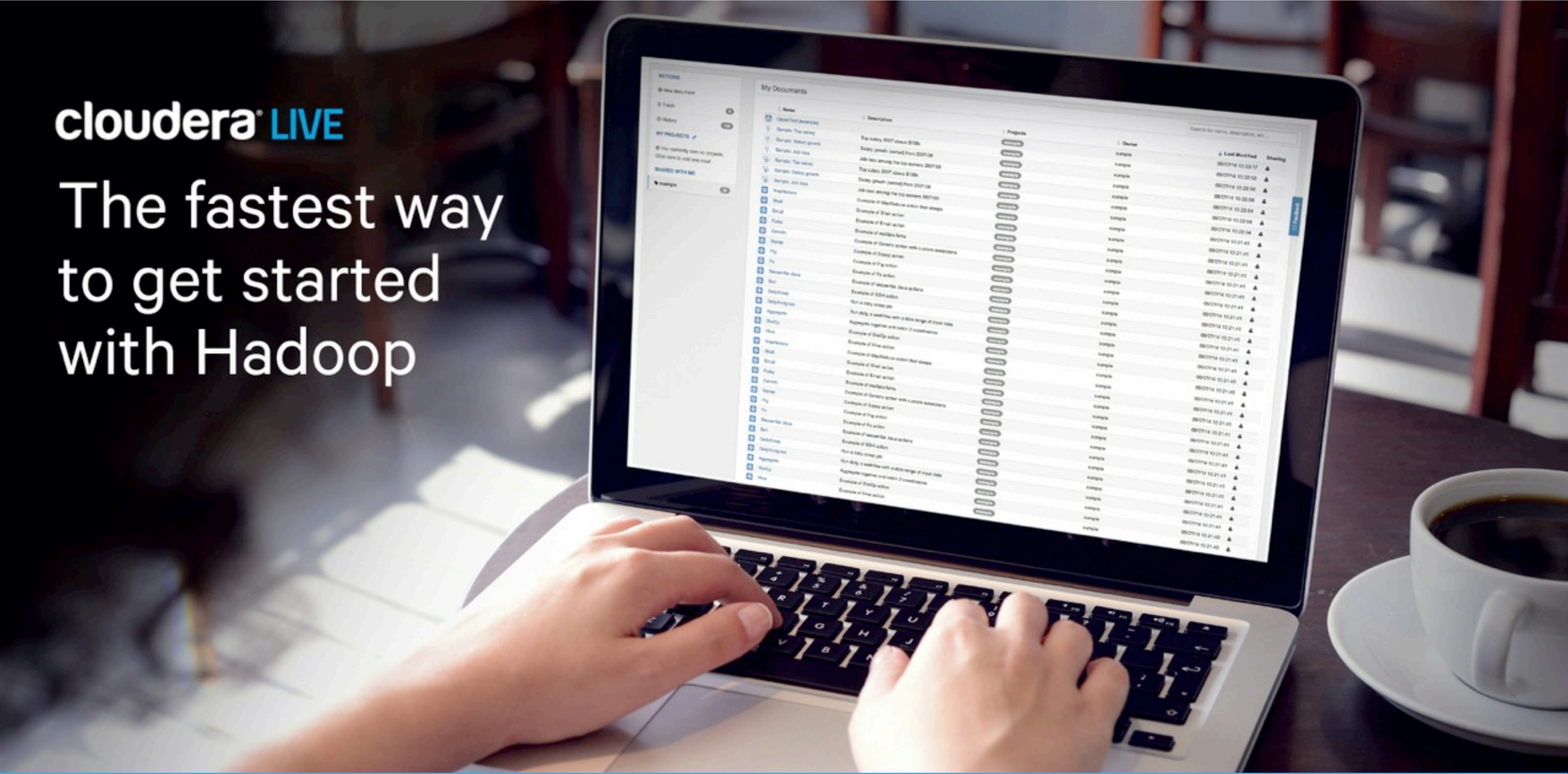
Community

News (2 Items)

Title	Posts
Community Guidelines & News Latest Post – This community is now mobile-friendly	5
Release Announcements Latest Post – Announcing: New Cloudera ODBC drivers for Impala a...	40

Get community help or provide feedback

cloudera.com/community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HIGHLIGHTS:

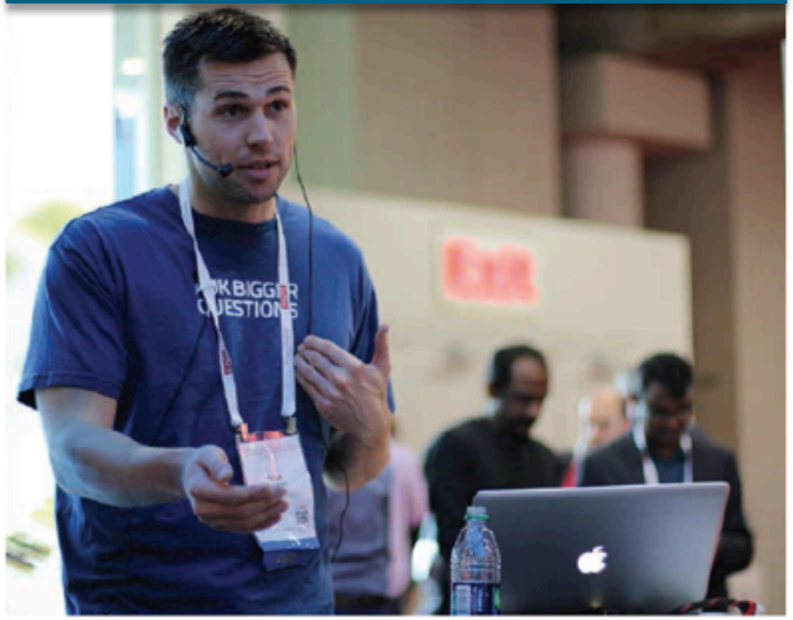
Apache Kafka is now fully supported with Cloudera

Learn why Cloudera is the leader for security in Hadoop

BOOK SIGNINGS

THEATER SESSIONS

TECHNICAL DEMOS



GIVEAWAYS

cloudera

Free books and Lots of Q&A!

- Ask Us Anything!
  - Feb 19th, 1:30-2:10PM in 211 B
- Book signings
  - Feb 19th, 11:15PM in Expo Hall – Cloudera Booth (#809)
  - Feb 19th, 3:00PM in Expo Hall - O'Reilly Booth
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