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DARMSTADT
07.11.13

Now with
Hadoop 2.0

uweseiler

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Introduction to the Hadoop Ecosystem

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About me

Big Data Nerd

Hadoop Trainer

MongoDB Author

Photography Enthusiast

Travelpirate

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About us

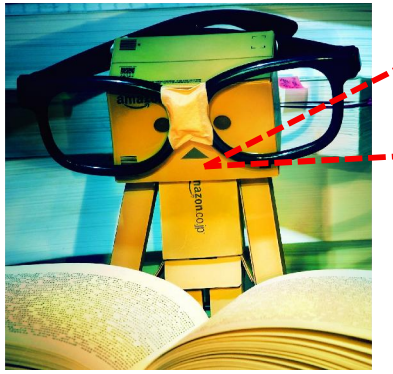
codecentric is a bunch of...

Big Data Nerds

Agile Ninjas

Continuous Delivery Gurus

Enterprise Java Specialists



Performance Geeks

Join us!

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Agenda

- What is Big Data & Hadoop?
- Core Hadoop
- The Hadoop Ecosystem
- Use Cases
- What‘s next? Hadoop 2.0!

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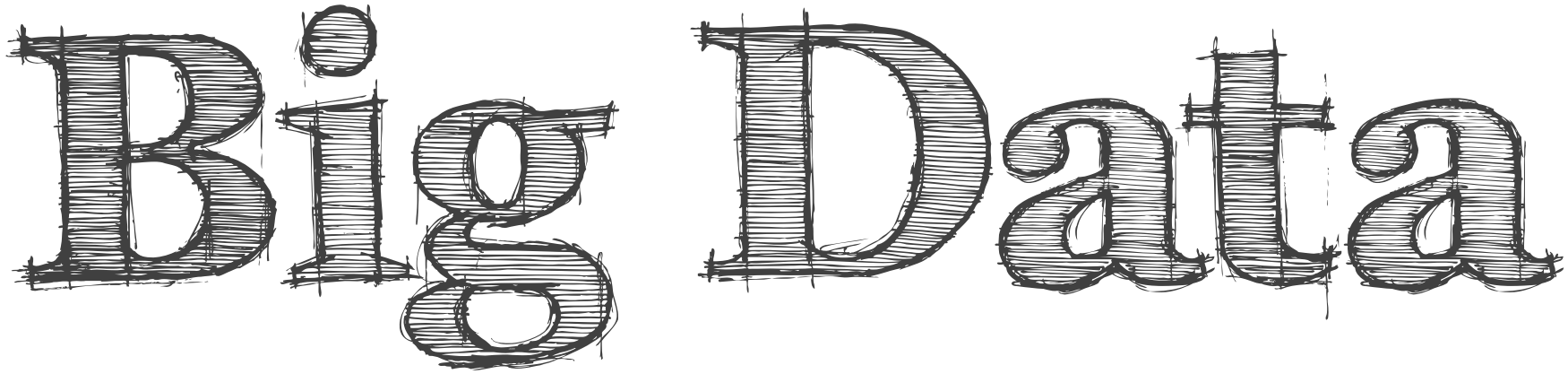
Agenda

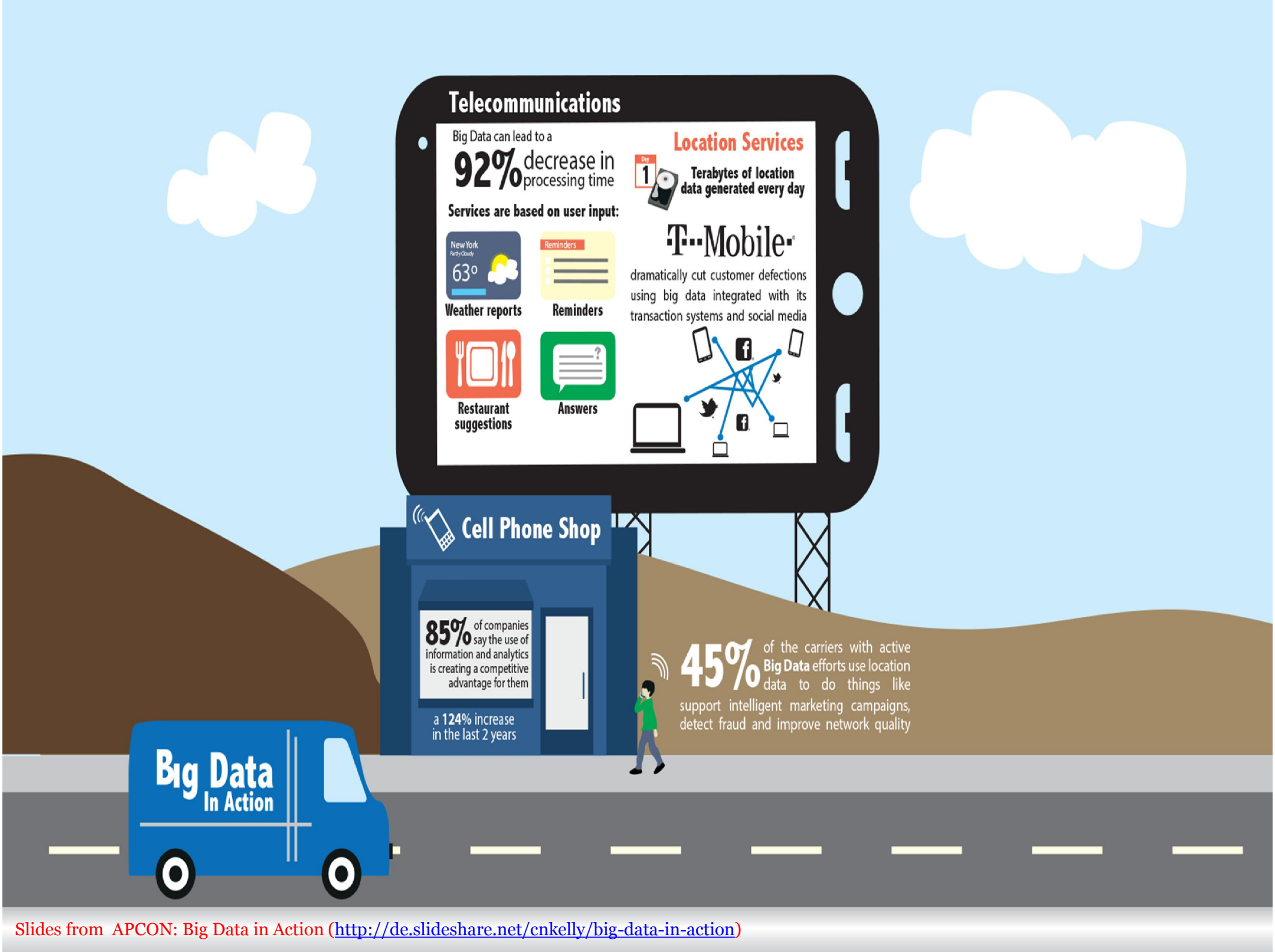
- **What is Big Data & Hadoop?**
- **Core Hadoop**
- **The Hadoop Ecosystem**
- **Use Cases**
- **What‘s next? Hadoop 2.0!**


Big Data

Big Data is like teenage sex:

everybody talks about it, nobody really knows how to do it, everyone thinks everyone else is doing it, so everyone claims they are doing it...

Slides from APCON: Big Data in Action (http://de.slideshare.net/cnkelly/big-data-in-action)



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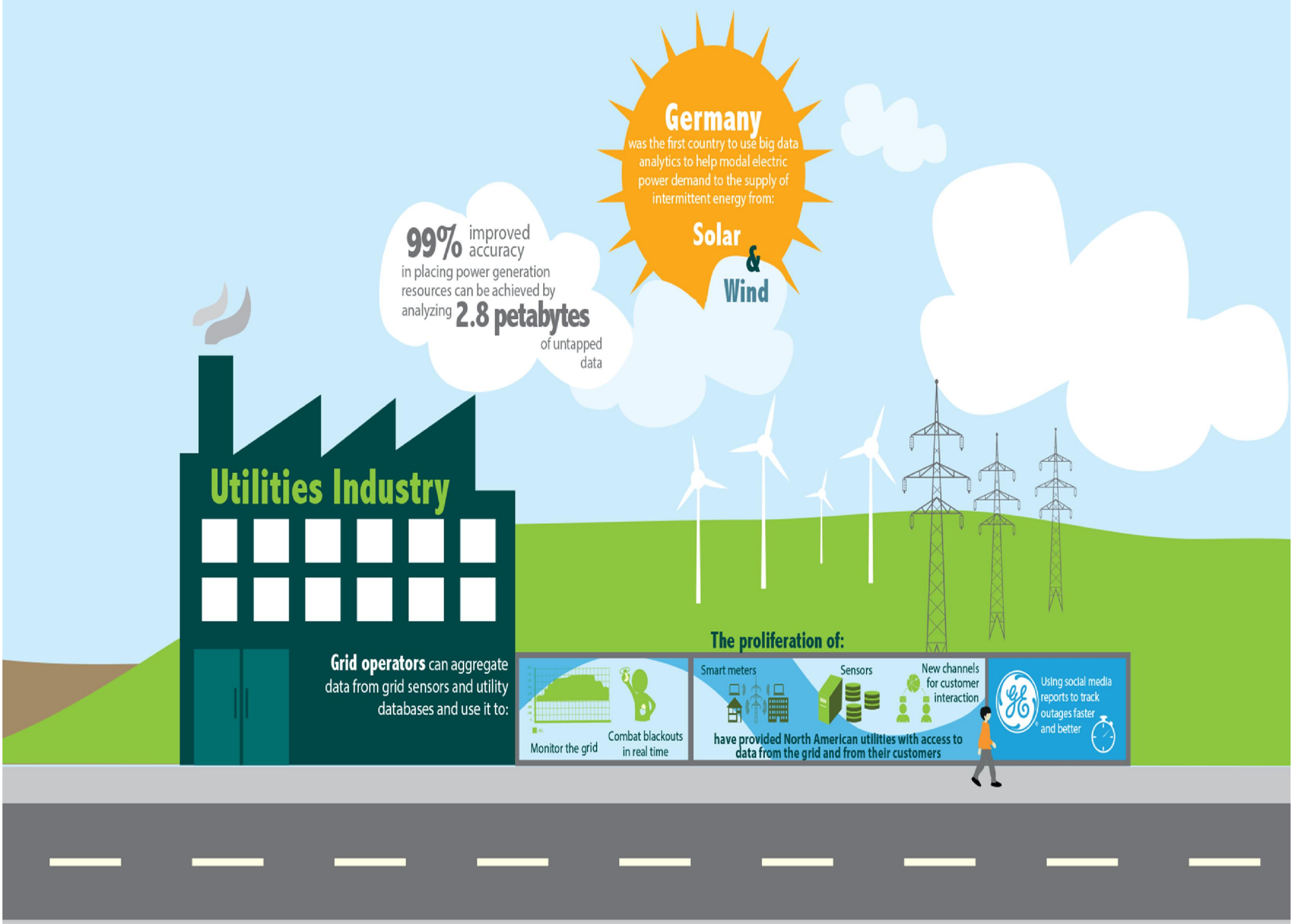

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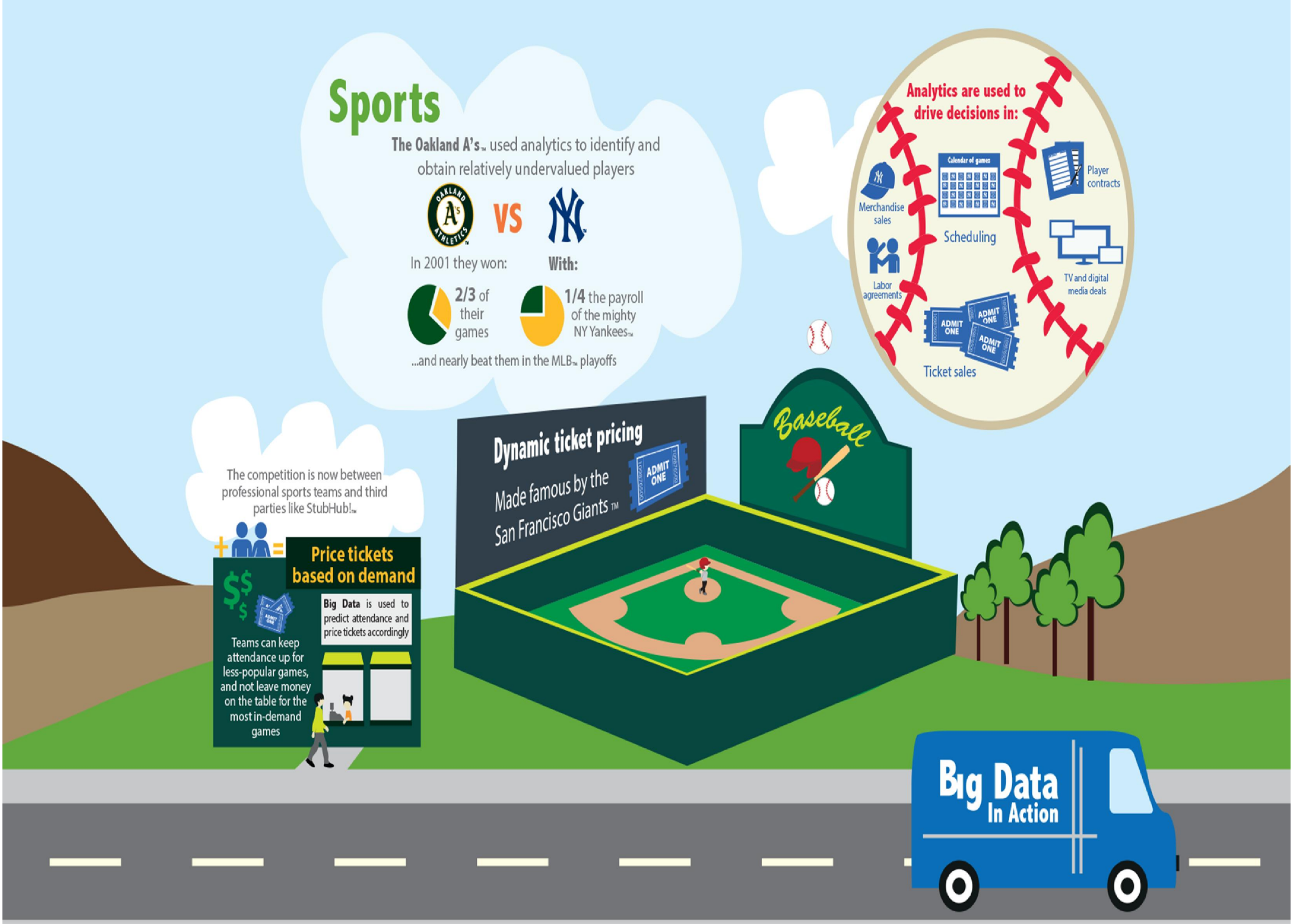

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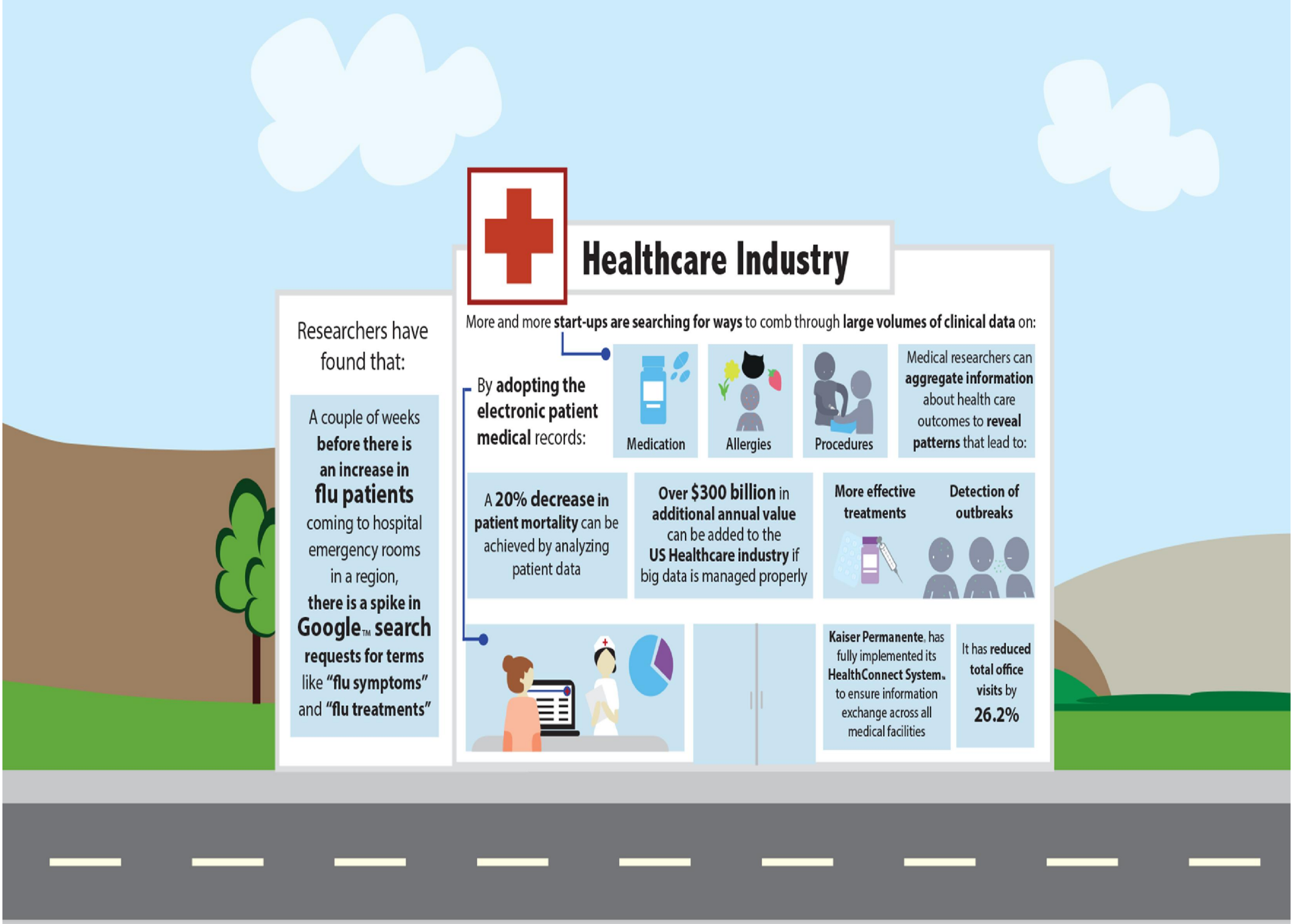

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My favorite definition

Big Data is when the data itself becomes part of the problem.

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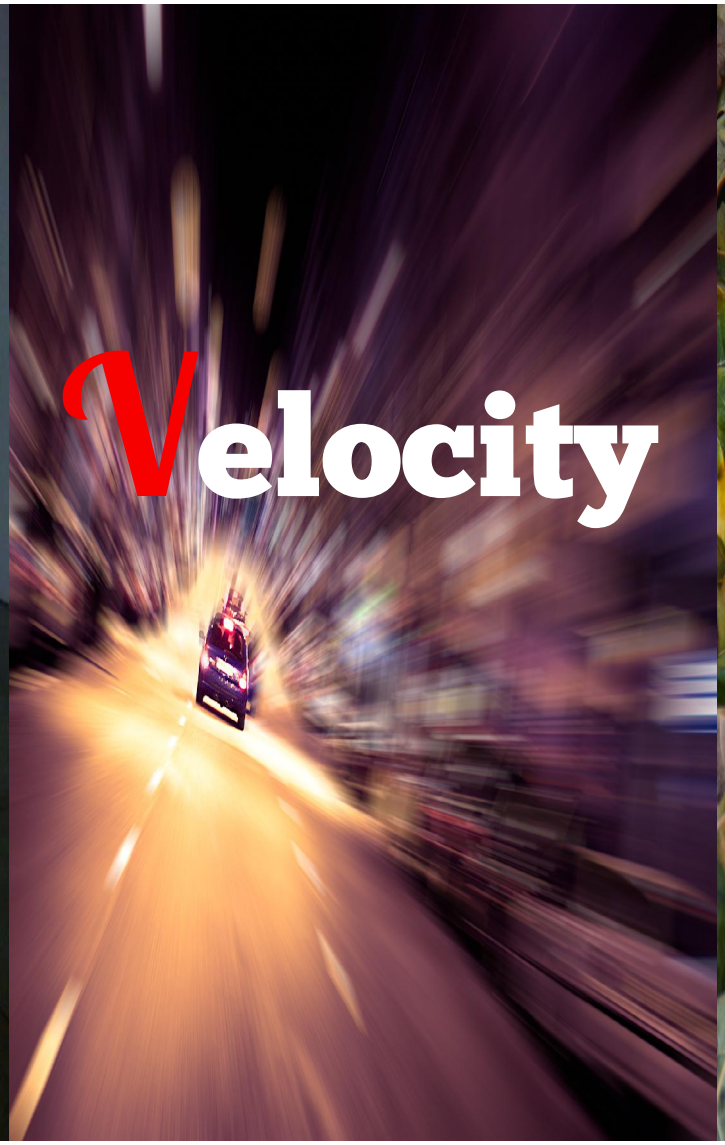
The classic definition



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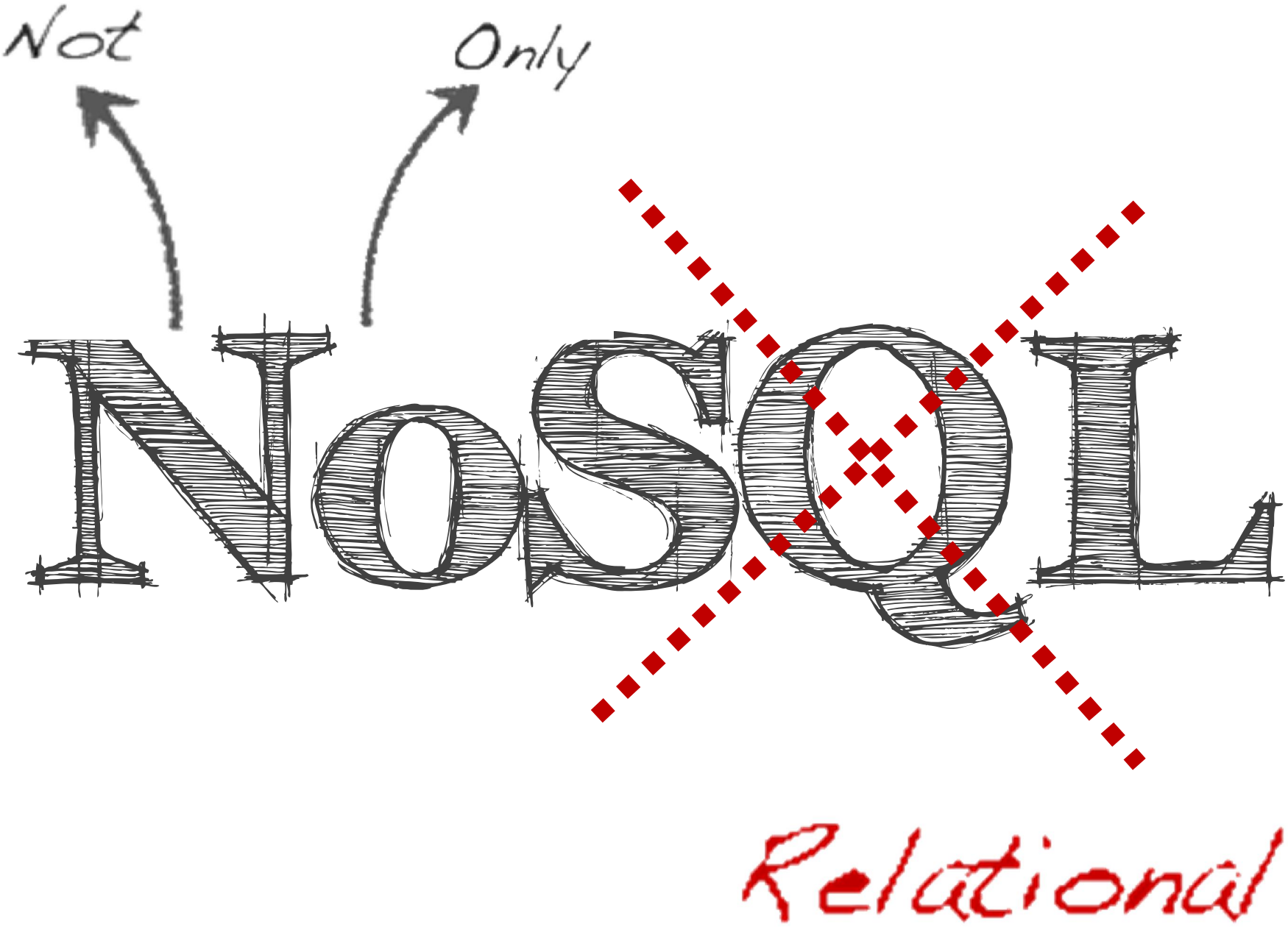
Not
Only
NoSQL
Relational

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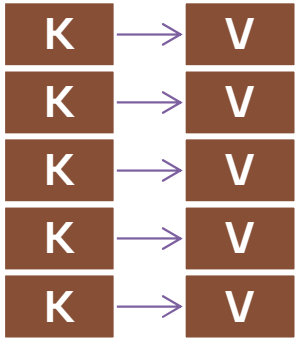
Classification of NoSQL

Key-Value Stores

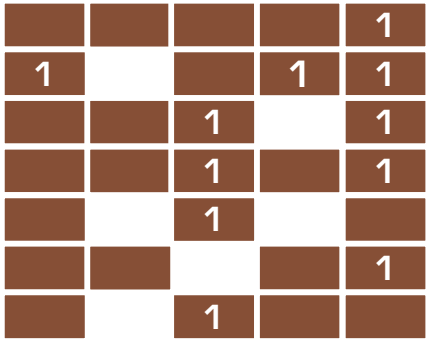


amazon web services Amazon DynamoDB

redis

riak

Column Stores

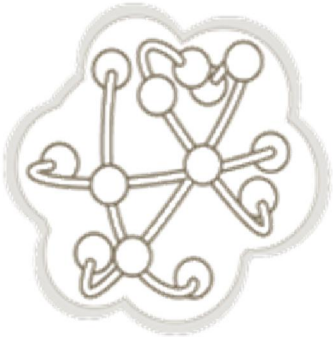


Google Bigtable

APACHE HBASE

Cassandra

Graph Databases

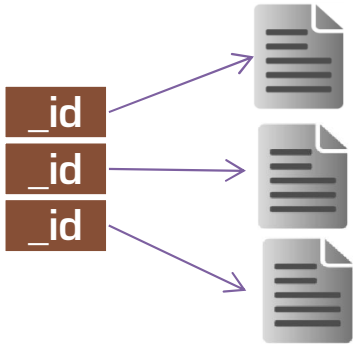


Neo4j The World's Leading Graph Database

HYPERGRAPHDB

*dex

Document Stores



mongoDB

CouchDB relax

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Horizontal Scaling

Vertical Scaling

RAM
CPU
Storage

Vertical Scaling

RAM
CPU
Storage

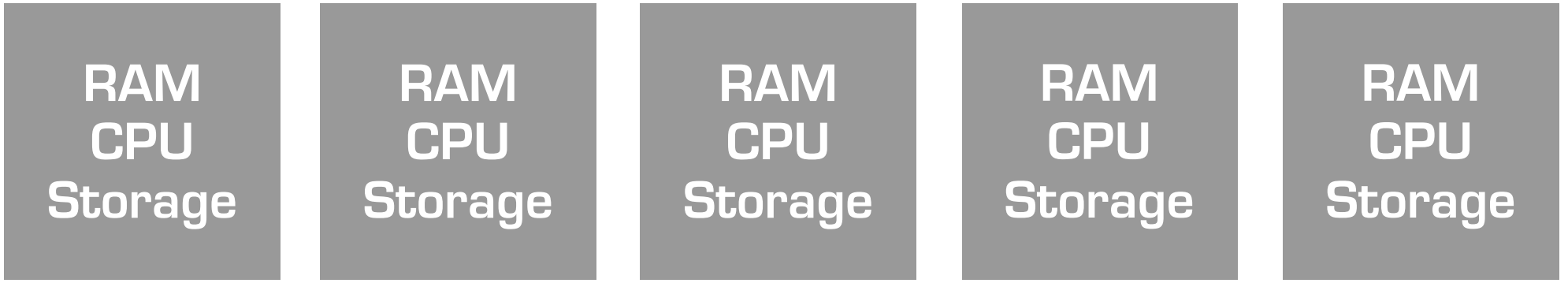
Vertical Scaling

RAM
CPU
Storage

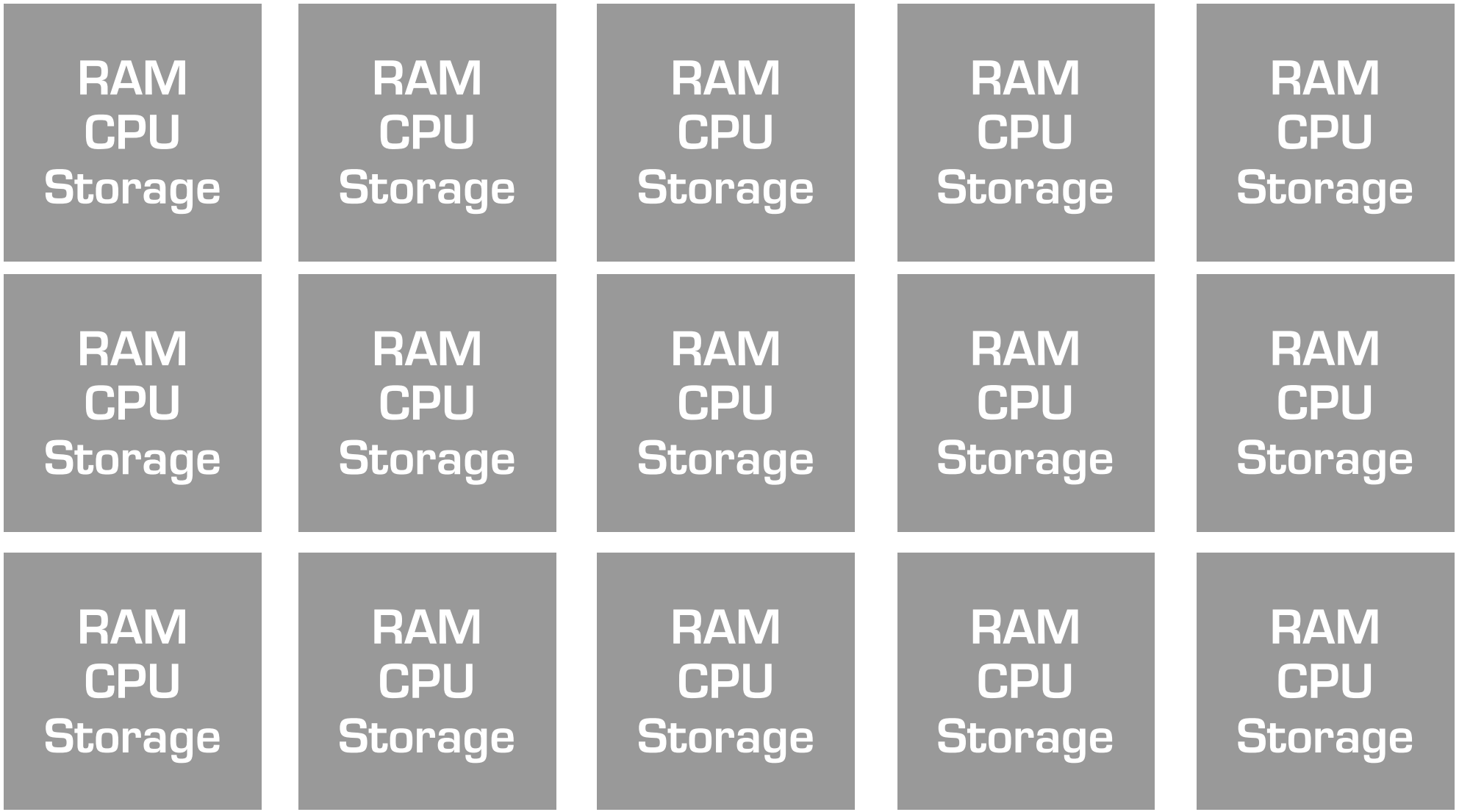
Horizontal Scaling

RAM
CPU
Storage

Horizontal Scaling



Horizontal Scaling



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Why Hadoop?

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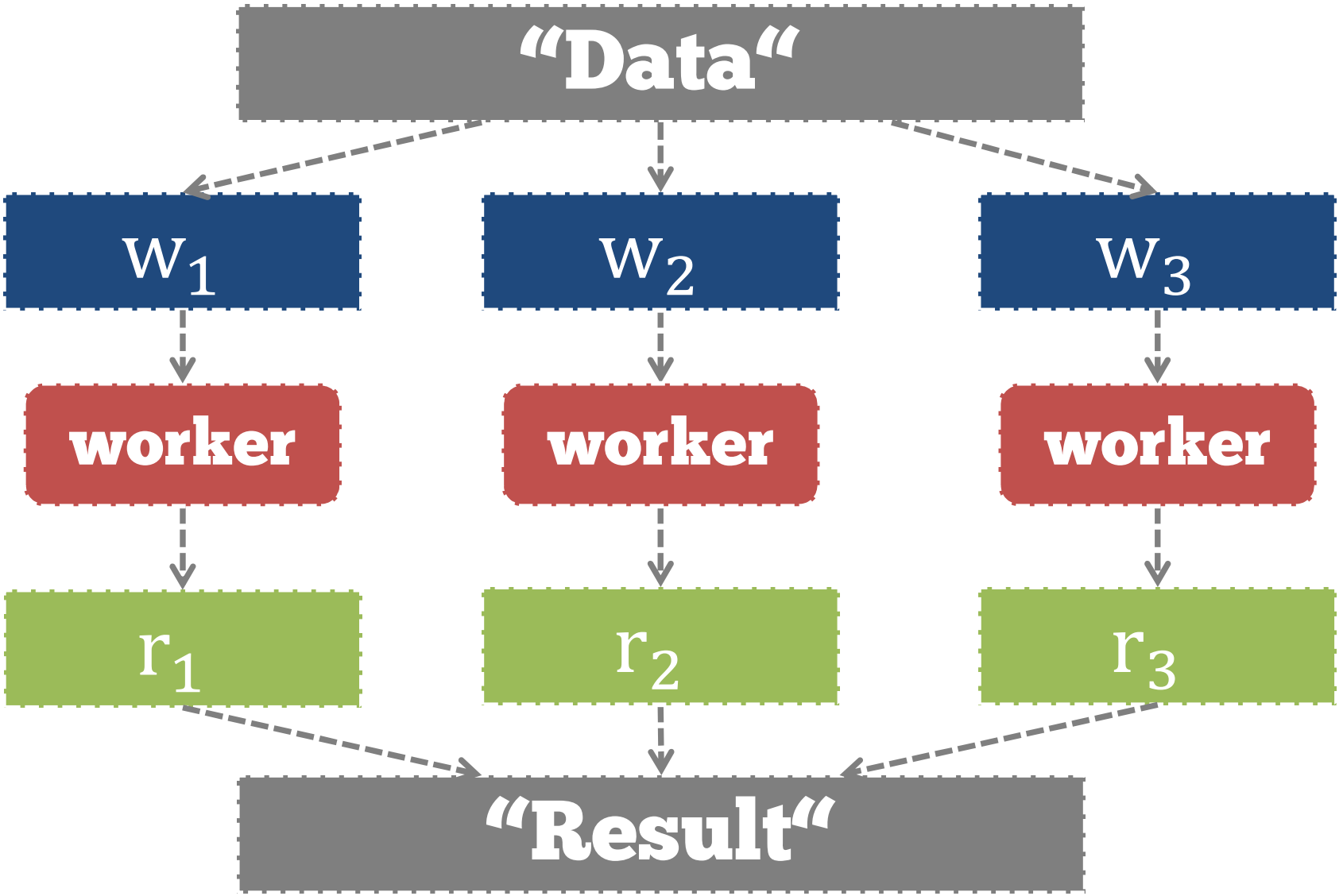
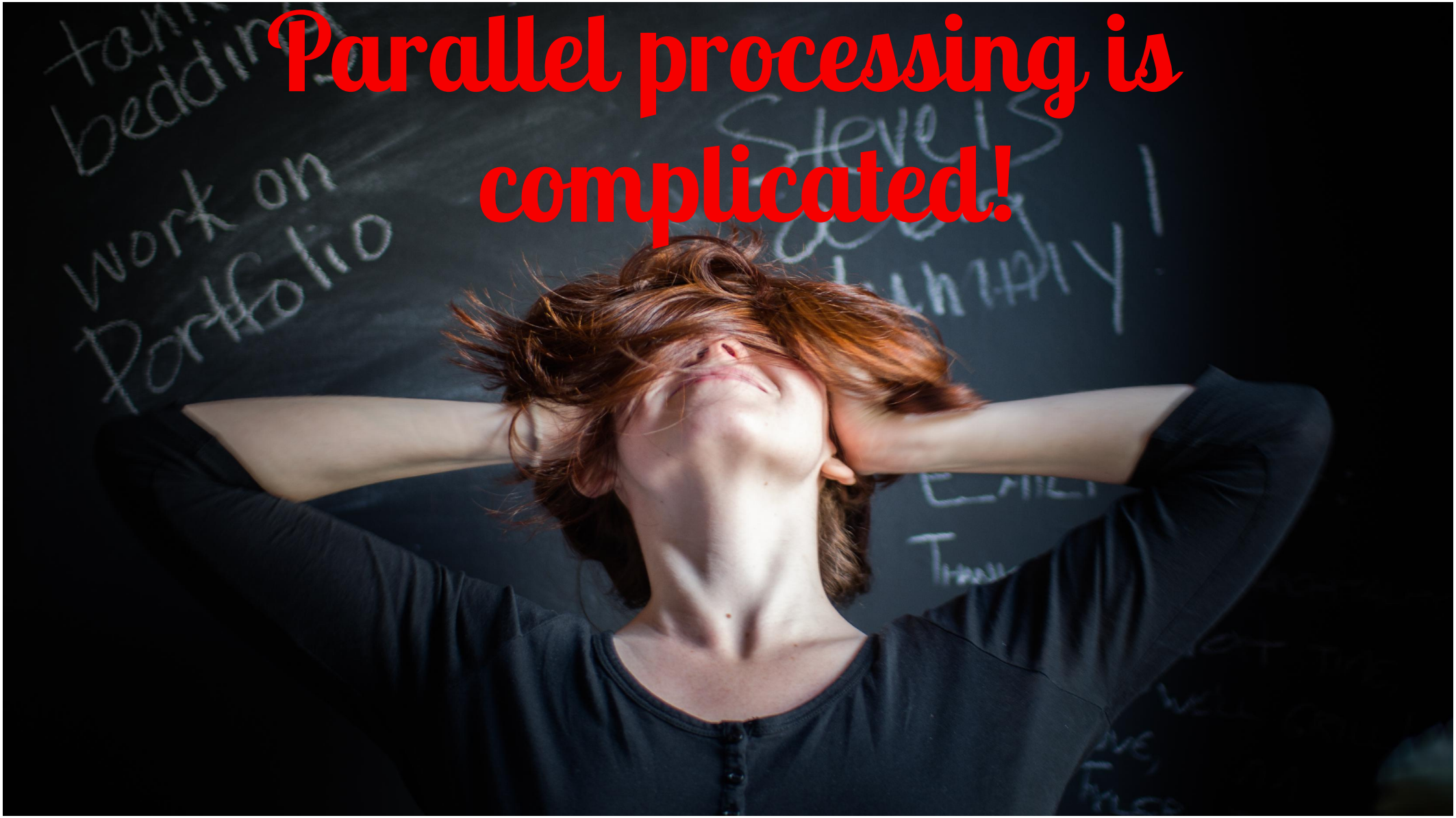
How to scale data?



But...



But...

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What is Hadoop?

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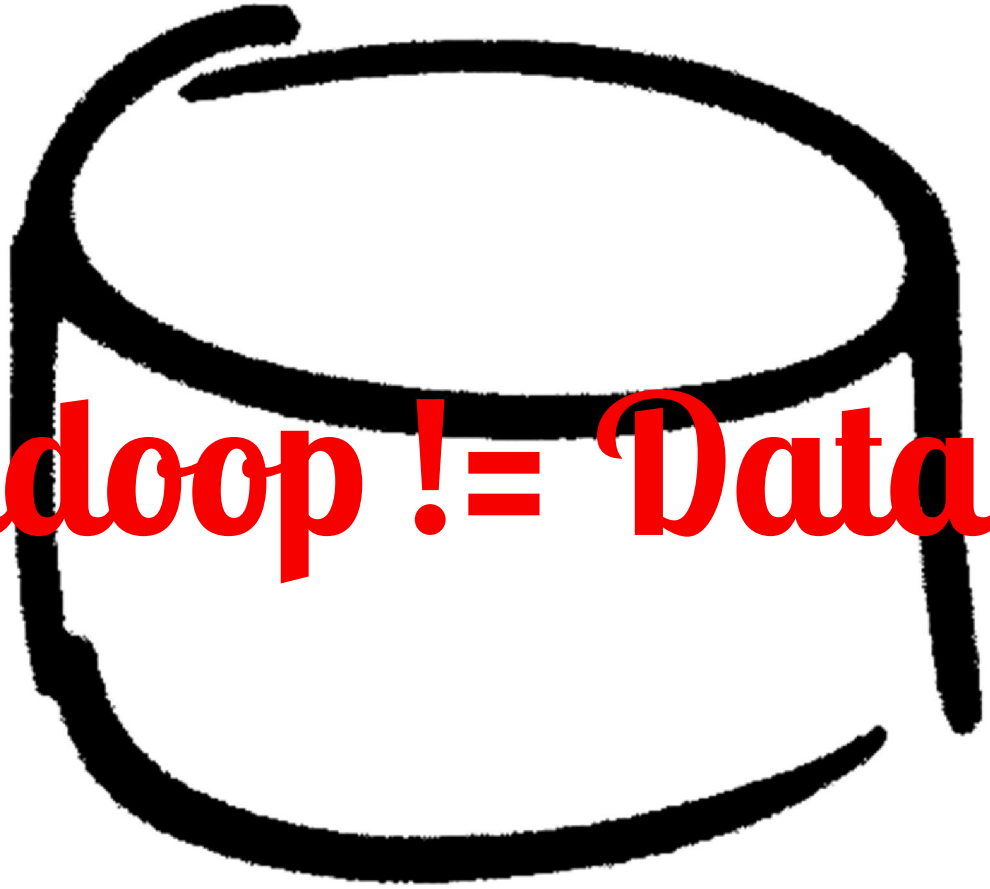
What is Hadoop?



Hadoop != Database

What is Hadoop?

http://www.guardian.co.uk/technology/2011/mar/25/media-guardian-innovation-awards-apache-hadoop

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The Hadoop App Store

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The Hadoop App Store

Apache Hadoop

- HDFS
- MapReduce
- Hadoop Ecosystem
- Hadoop YARN

Hadoop Distributions

+

- Test & Packaging
- Installation
- Monitoring
- Business Support

+

- Integrated Environment
- Visualization
- (Near-)Realtime analysis
- Modeling
- ETL & Connectors

Big Data Suites

less — **Functionality** — more

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Agenda

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OK, first things first!

I want to store all of my <<Big Data>>

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Data Storage

There is an app for that!

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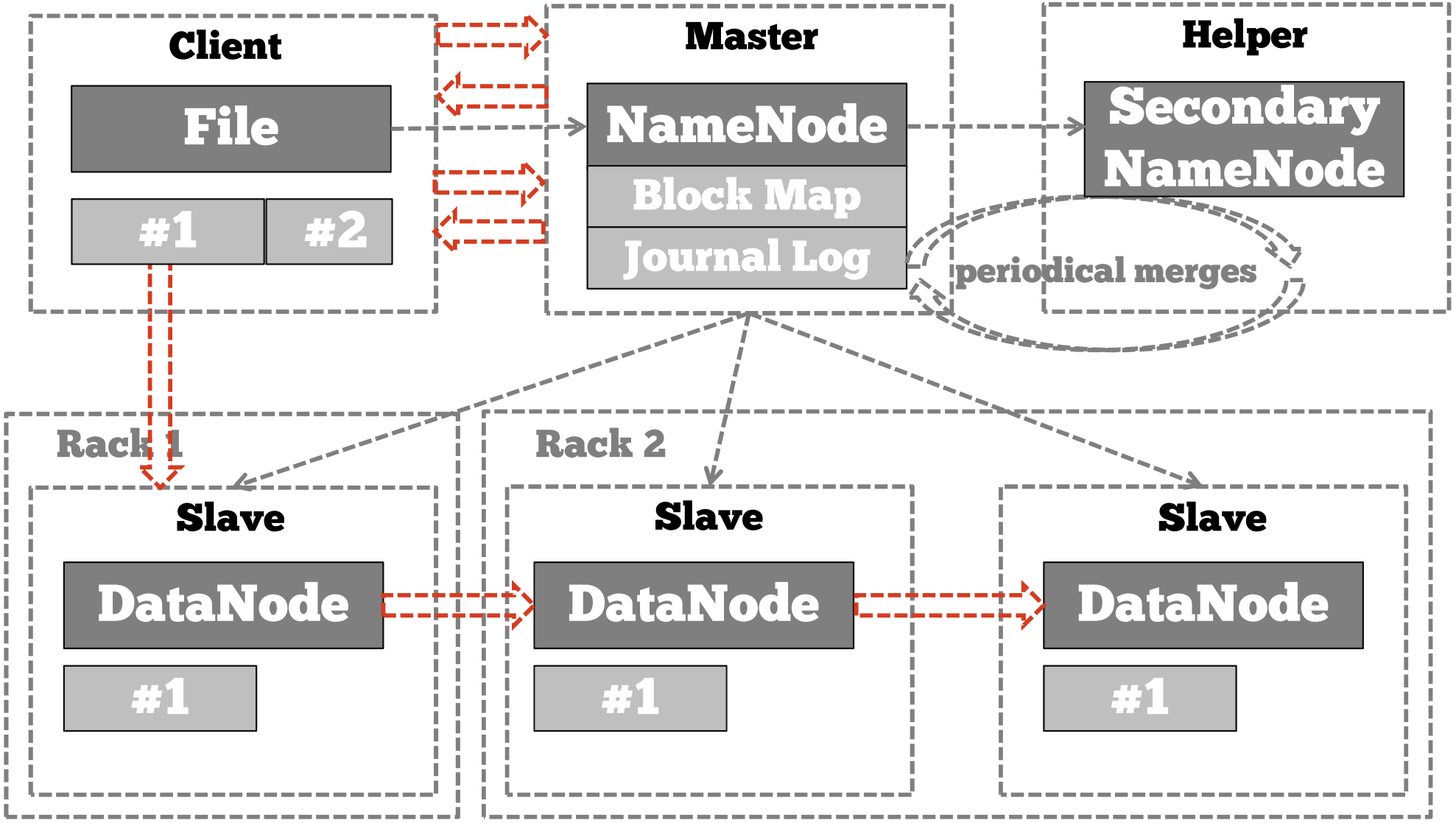
Hadoop Distributed File System

- **Distributed file system for redundant storage**
- **Designed to reliably store data on commodity hardware**
- **Built to expect hardware failures**

Hadoop Distributed File System

HDFS Architecture



Let's have a look...

Data Processing

Data stored, check!

Now I want to create insights from my data!

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Data Processing

There is an app for that!

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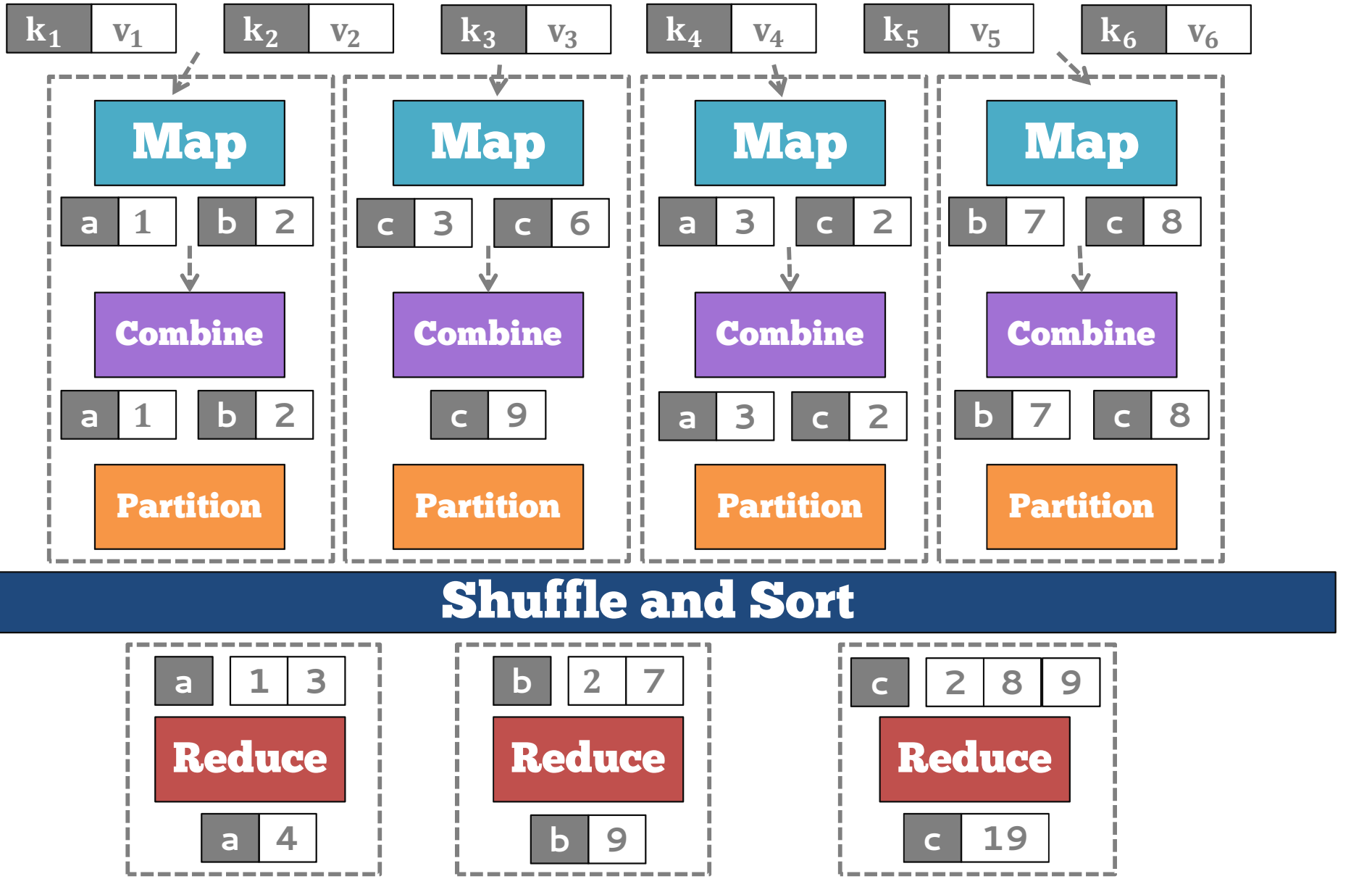
MapReduce

- **Programming model for distributed computations at a massive scale**
- **Execution framework for organizing and performing such computations**
- **Data locality is king**

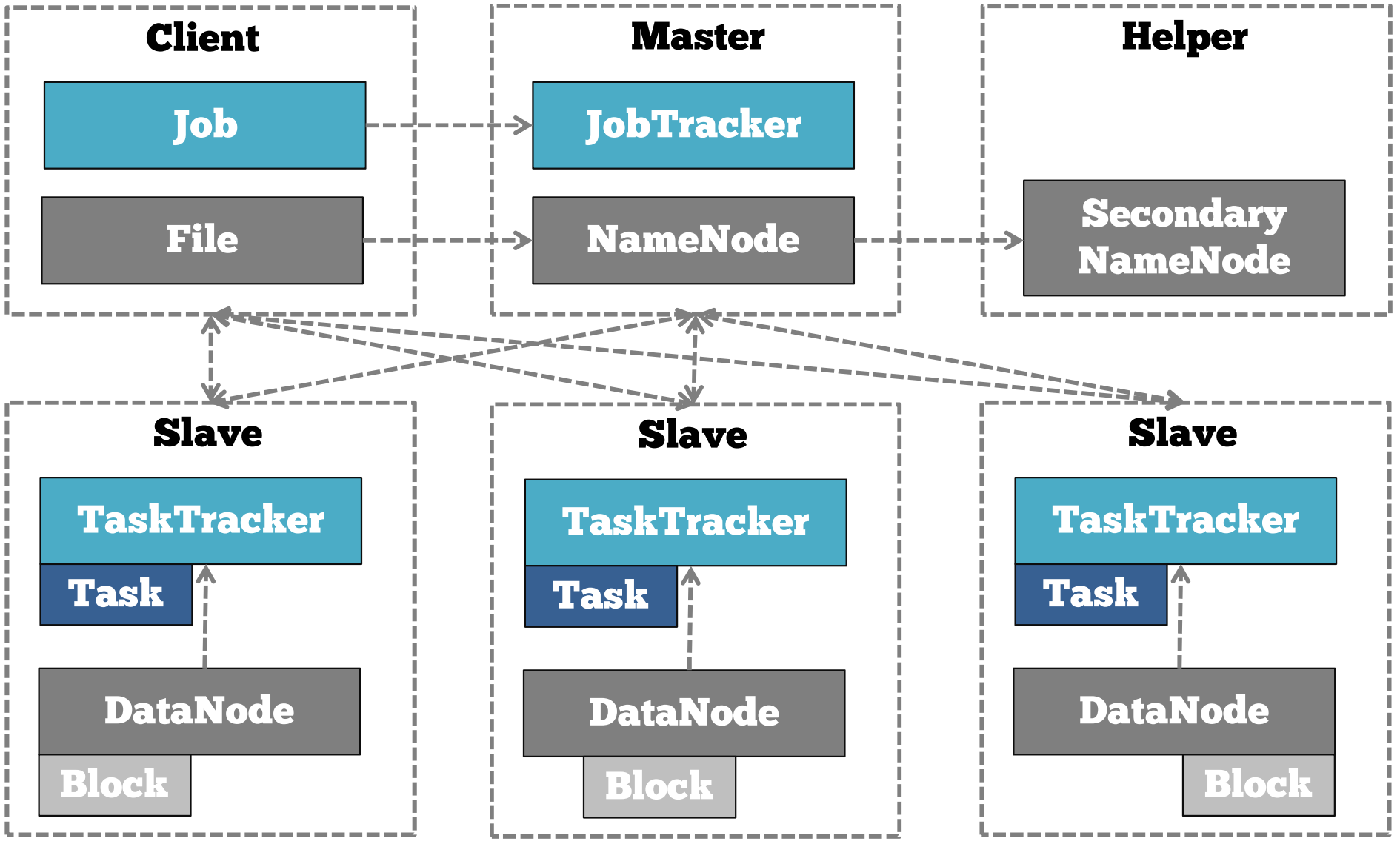
Typical large-data problem

- Iterate over a large number of records
- Extract something of interest from each
- Shuffle and sort intermediate results
- Aggregate intermediate results
- Generate final output

MapReduce Flow



Combined Hadoop Architecture



Word Count Mapper in Java

```
public class WordCountMapper extends MapReduceBase implements
        Mapper<LongWritable, Text, Text, IntWritable>
{
    private final static IntWritable one = new IntWritable(1);
    private Text word = new Text();

    public void map(LongWritable key, Text value, OutputCollector<Text,
        IntWritable> output, Reporter reporter) throws IOException
    {
        String line = value.toString();
        StringTokenizer tokenizer = new StringTokenizer(line);
        while (tokenizer.hasMoreTokens())
        {
            word.set(tokenizer.nextToken());
            output.collect(word, one);
        }
    }
}
```

Word Count Reducer in Java

```
public class WordCountReducer extends MapReduceBase
    implements Reducer<Text, IntWritable, Text, IntWritable>
{
    public void reduce(Text key, Iterator values, OutputCollector
            output, Reporter reporter) throws IOException
    {
        int sum = 0;
        while (values.hasNext())
        {
            IntWritable value = (IntWritable) values.next();
            sum += value.get();
        }
        output.collect(key, new IntWritable(sum));
   }
}
```

Let's have a look...

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Scripting for Hadoop

Java for MapReduce?
I dunno, dude…

I'm more of a
scripting guy…

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Scripting for Hadoop

There is an app for that!

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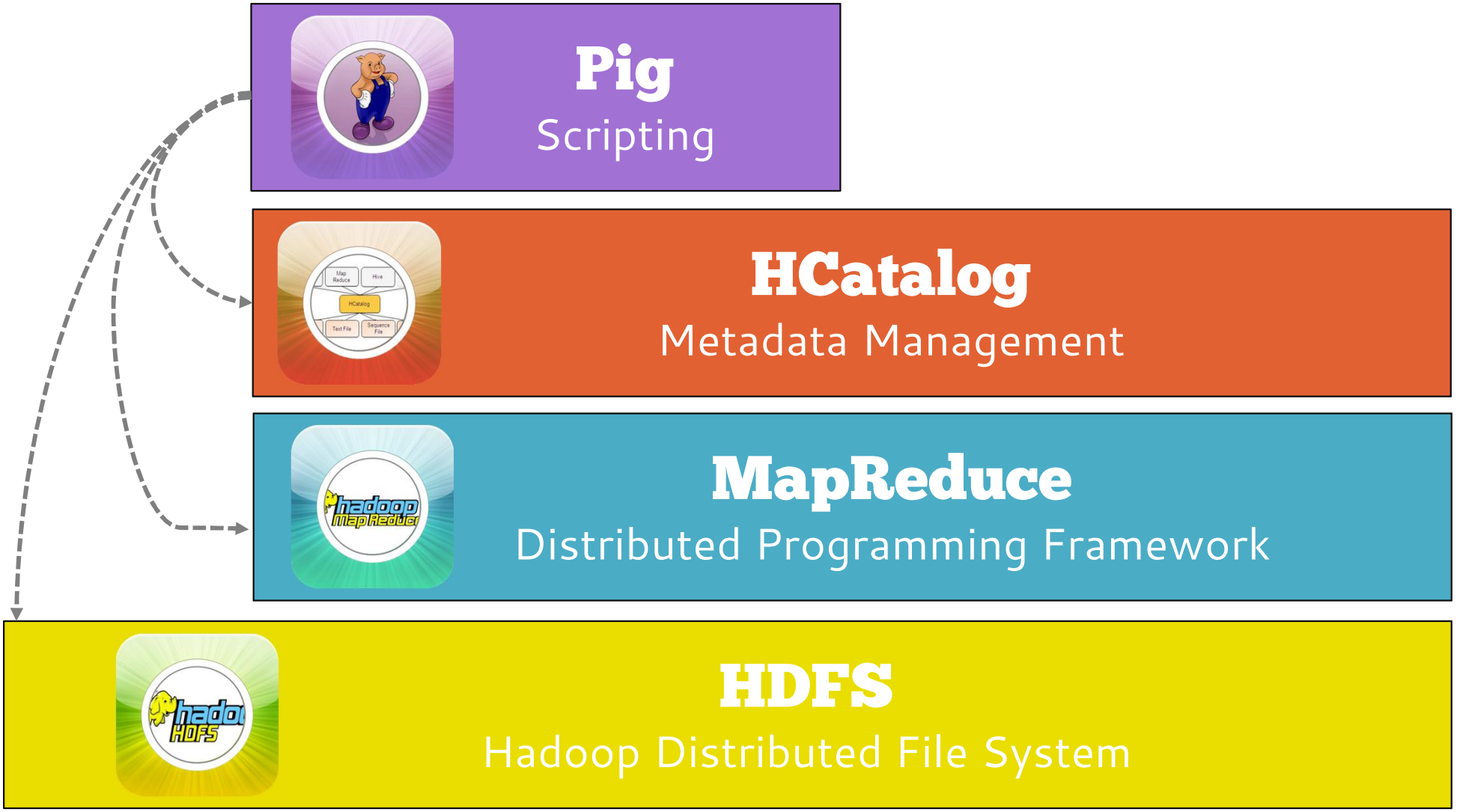
Apache Pig

- **High-level data flow language**
- **Made of two components:**
  - **Data processing language Pig Latin**
  - **Compiler to translate Pig Latin to MapReduce**

Abstracts you from specific details and allows you to focus on data processing

Pig in the Hadoop ecosystem



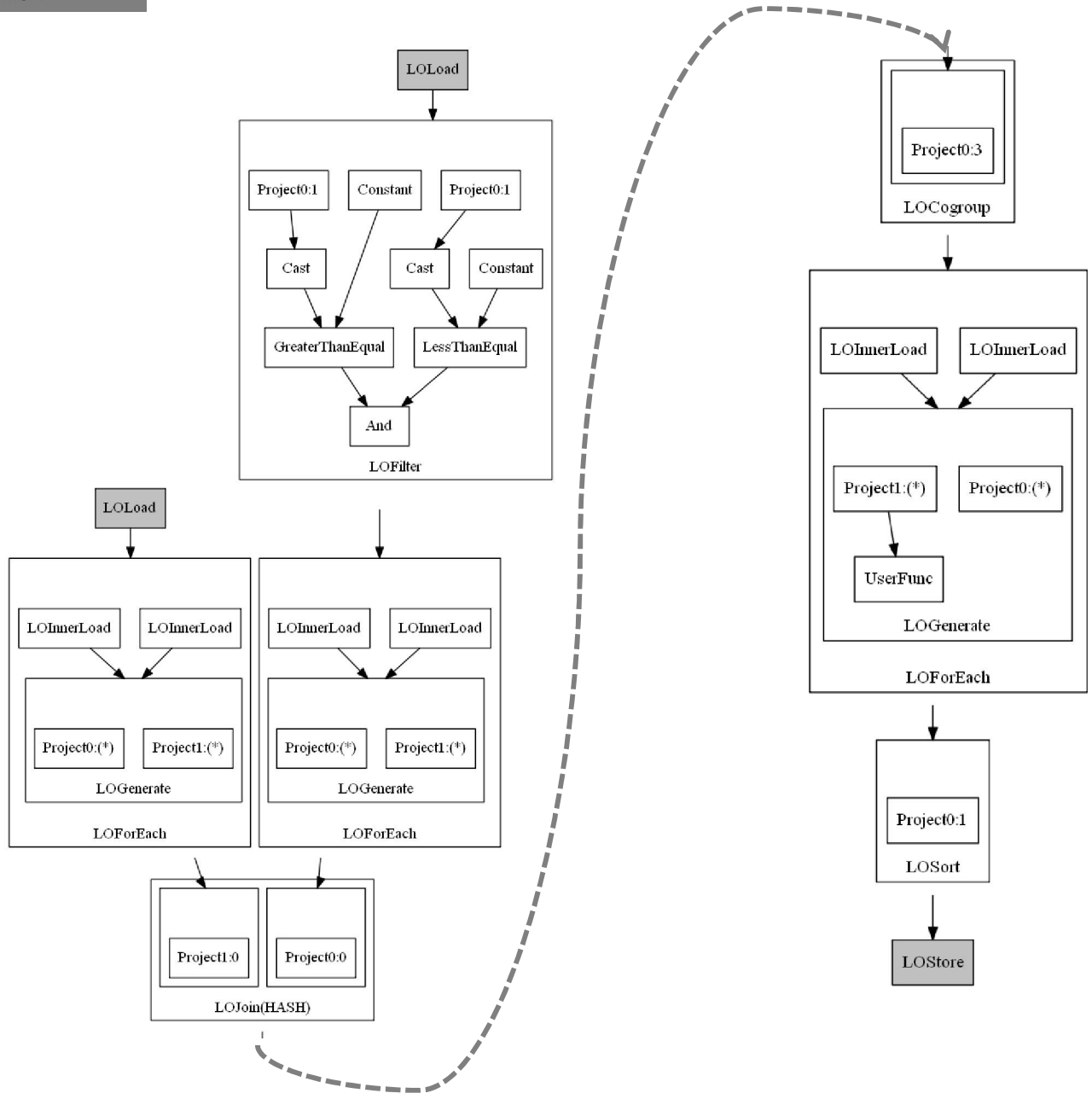
Pig Latin

```
users = LOAD 'users.txt' USING PigStorage(',') AS (name,
   age);
pages = LOAD 'pages.txt' USING PigStorage(',') AS (user,
   url);

filteredUsers = FILTER users BY age >= 18 and age <=50;
joinResult = JOIN filteredUsers BY name, pages by user;
grouped = GROUP joinResult BY url;
summed = FOREACH grouped GENERATE group,
   COUNT(joinResult) as clicks;
sorted = ORDER summed BY clicks desc;
top10 = LIMIT sorted 10;

STORE top10 INTO 'top10sites';
```

Pig Execution Plan



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Try that with Java...

```
import java.io.IOException;
import java.util.ArrayList;
import java.util.Iterator;
import java.util.List;

import org.apache.hadoop.fs.Path;
import org.apache.hadoop.io.LongWritable;
import org.apache.hadoop.io.Text;
import org.apache.hadoop.io.Writable;
import org.apache.hadoop.io.WritableComparable;
import org.apache.hadoop.mapred.FileInputFormat;
import org.apache.hadoop.mapred.FileOutputFormat;
import org.apache.hadoop.mapred.JobConf;
import org.apache.hadoop.mapred.KeyValueTextInputFormat;
import org.apache.hadoop.mapred.Mapper;
import org.apache.hadoop.mapred.MapReduceBase;
import org.apache.hadoop.mapred.OutputCollector;
import org.apache.hadoop.mapred.RecordReader;
import org.apache.hadoop.mapred.Reducer;
import org.apache.hadoop.mapred.Reporter;
import org.apache.hadoop.mapred.SequenceFileInputFormat;
import org.apache.hadoop.mapred.SequenceFileOutputFormat;
import org.apache.hadoop.mapred.TextInputFormat;
import org.apache.hadoop.mapred.jobcontrol.Job;
import org.apache.hadoop.mapred.jobcontrol.JobControl;
import org.apache.hadoop.mapred.lib.IdentityMapper;

public class MRExample {
    public static class LoadPages extends MapReduceBase
        implements Mapper<LongWritable, Text, Text, Text> {

        public void map(LongWritable k, Text val,
                OutputCollector<Text, Text> oc,
                Reporter reporter) throws IOException {
            // Pull the key out
            String line = val.toString();
            int firstComma = line.indexOf(',');
            String key = line.substring(0, firstComma);
            String value = line.substring(firstComma + 1);
            Text outKey = new Text(key);
            // Prepend an index to the value so we know which file
            // it came from.
            Text outVal = new Text("1" + value);
            oc.collect(outKey, outVal);
        }
    }
    public static class LoadAndFilterUsers extends MapReduceBase
        implements Mapper<LongWritable, Text, Text, Text> {

        public void map(LongWritable k, Text val,
                OutputCollector<Text, Text> oc,
                Reporter reporter) throws IOException {
            // Pull the key out
            String line = val.toString();
            int firstComma = line.indexOf(',');
            String value = line.substring(firstComma + 1);
            int age = Integer.parseInt(value);
            if (age < 18 || age > 25) return;
            String key = line.substring(0, firstComma);
            Text outKey = new Text(key);
            // Prepend an index to the value so we know which file
            // it came from.
            Text outVal = new Text("2" + value);
            oc.collect(outKey, outVal);
        }
    }
    public static class Join extends MapReduceBase
        implements Reducer<Text, Text, Text, Text> {

        public void reduce(Text key,
                Iterator<Text> iter,
                OutputCollector<Text, Text> oc,
                Reporter reporter) throws IOException {
            // For each value, figure out which file it's from and
store it
            // accordingly.
            List<String> first = new ArrayList<String>();
            List<String> second = new ArrayList<String>();

            while (iter.hasNext()) {
                Text t = iter.next();
                String value = t.toString();
                if (value.charAt(0) == '1')
first.add(value.substring(1));
                else second.add(value.substring(1));

                reporter.setStatus("OK");
            }

            // Do the cross product and collect the values
            for (String s1 : first) {
                for (String s2 : second) {
                    String outVal = key + "," + s1 + "," + s2;
                    oc.collect(null, new Text(outVal));
                    reporter.setStatus("OK");
                }
            }
        }
    }
    public static class LoadJoined extends MapReduceBase
        implements Mapper<Text, Text, Text, LongWritable> {

        public void map(
                Text k,
                Text val,
                OutputCollector<Text, LongWritable> oc,
                Reporter reporter) throws IOException {
            // Find the url
            String line = val.toString();
            int firstComma = line.indexOf(',');
            int secondComma = line.indexOf(',', firstComma);
            String key = line.substring(firstComma, secondComma);
            // drop the rest of the record, I don't need it anymore,
            // just pass a 1 for the combiner/reducer to sum instead.
            Text outKey = new Text(key);
            oc.collect(outKey, new LongWritable(1L));
        }
    }
    public static class ReduceUrls extends MapReduceBase
        implements Reducer<Text, LongWritable, WritableComparable,
Writable> {

        public void reduce(
                Text key,
                Iterator<LongWritable> iter,
                OutputCollector<WritableComparable, Writable> oc,
                Reporter reporter) throws IOException {
            // Add up all the values we see

            long sum = 0;
            while (iter.hasNext()) {
                sum += iter.next().get();
                reporter.setStatus("OK");
            }

            oc.collect(key, new LongWritable(sum));
        }
    }
    public static class LoadClicks extends MapReduceBase
        implements Mapper<WritableComparable, Writable, LongWritable,
Text> {

        public void map(
                WritableComparable key,
                Writable val,
                OutputCollector<LongWritable, Text> oc,
                Reporter reporter) throws IOException {
            oc.collect((LongWritable)val, (Text)key);
        }
    }
    public static class LimitClicks extends MapReduceBase
        implements Reducer<LongWritable, Text, LongWritable, Text> {

        int count = 0;
        public void reduce(
            LongWritable key,
            Iterator<Text> iter,
            OutputCollector<LongWritable, Text> oc,
            Reporter reporter) throws IOException {

            // Only output the first 100 records
            while (count < 100 && iter.hasNext()) {
                oc.collect(key, iter.next());
                count++;
            }
        }
    }
    public static void main(String[] args) throws IOException {
        JobConf lp = new JobConf(MRExample.class);
        lp.setJobName("Load Pages");
        lp.setInputFormat(TextInputFormat.class);
        lp.setOutputKeyClass(Text.class);
        lp.setOutputValueClass(Text.class);
        lp.setMapperClass(LoadPages.class);
        FileInputFormat.addInputPath(lp, new
Path("/user/gates/pages"));
        FileOutputFormat.setOutputPath(lp,
                new Path("/user/gates/tmp/indexed_pages"));
        lp.setNumReduceTasks(0);
        Job loadPages = new Job(lp);

        JobConf lfu = new JobConf(MRExample.class);
        lfu.setJobName("Load and Filter Users");
        lfu.setInputFormat(TextInputFormat.class);
        lfu.setOutputKeyClass(Text.class);
        lfu.setOutputValueClass(Text.class);
        lfu.setMapperClass(LoadAndFilterUsers.class);
        FileInputFormat.addInputPath(lfu, new
Path("/user/gates/users"));
        FileOutputFormat.setOutputPath(lfu,
                new Path("/user/gates/tmp/filtered_users"));
        lfu.setNumReduceTasks(0);
        Job loadUsers = new Job(lfu);

        JobConf join = new JobConf(MRExample.class);
        join.setJobName("Join Users and Pages");
        join.setInputFormat(KeyValueTextInputFormat.class);
        join.setOutputKeyClass(Text.class);
        join.setOutputValueClass(Text.class);
        join.setMapperClass(IdentityMapper.class);
        join.setReducerClass(Join.class);
        FileInputFormat.addInputPath(join, new
Path("/user/gates/tmp/indexed_pages"));
        FileInputFormat.addInputPath(join, new
Path("/user/gates/tmp/filtered_users"));
        FileOutputFormat.setOutputPath(join, new
Path("/user/gates/tmp/joined"));
        join.setNumReduceTasks(50);
        Job joinJob = new Job(join);
        joinJob.addDependingJob(loadPages);
        joinJob.addDependingJob(loadUsers);

        JobConf group = new JobConf(MRExample.class);
        group.setJobName("Group URLs");
        group.setInputFormat(KeyValueTextInputFormat.class);
        group.setOutputKeyClass(Text.class);
        group.setOutputValueClass(LongWritable.class);
        group.setOutputFormat(SequenceFileOutputFormat.class);
        group.setMapperClass(LoadJoined.class);
        group.setCombinerClass(ReduceUrls.class);
        group.setReducerClass(ReduceUrls.class);
        FileInputFormat.addInputPath(group, new
Path("/user/gates/tmp/joined"));
        FileOutputFormat.setOutputPath(group, new
Path("/user/gates/tmp/grouped"));
        group.setNumReduceTasks(50);
        Job groupJob = new Job(group);
        groupJob.addDependingJob(joinJob);

        JobConf top100 = new JobConf(MRExample.class);
        top100.setJobName("Top 100 sites");
        top100.setInputFormat(SequenceFileInputFormat.class);
        top100.setOutputKeyClass(LongWritable.class);
        top100.setOutputValueClass(Text.class);
        top100.setOutputFormat(SequenceFileOutputFormat.class);
        top100.setMapperClass(LoadClicks.class);
        top100.setCombinerClass(LimitClicks.class);
        top100.setReducerClass(LimitClicks.class);
        FileInputFormat.addInputPath(top100, new
Path("/user/gates/tmp/grouped"));
        FileOutputFormat.setOutputPath(top100, new
Path("/user/gates/top100sitesforusers18to25"));
        top100.setNumReduceTasks(1);
        Job limit = new Job(top100);
        limit.addDependingJob(groupJob);

        JobControl jc = new JobControl("Find top 100 sites for users
18 to 25");
        jc.addJob(loadPages);
        jc.addJob(loadUsers);
        jc.addJob(joinJob);
        jc.addJob(groupJob);
        jc.addJob(limit);
        jc.run();
    }
}
```

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Pig

Let's have a look...

OK, Pig seems quite useful…

But I'm more of a SQL person…

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SQL for Hadoop

There is an app for that!

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Apache Hive

- **Data Warehousing Layer on top of Hadoop**
- **Allows analysis and queries using a SQL-like language**

Hive is best for data analysts familiar with SQL who need to do dynamic queries, summarization and data analysis

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Hive in the Hadoop ecosystem

Pig
Scripting

Hive
Query

HCatalog
Metadata Management

MapReduce
Distributed Programming Framework

HDFS
Hadoop Distributed File System

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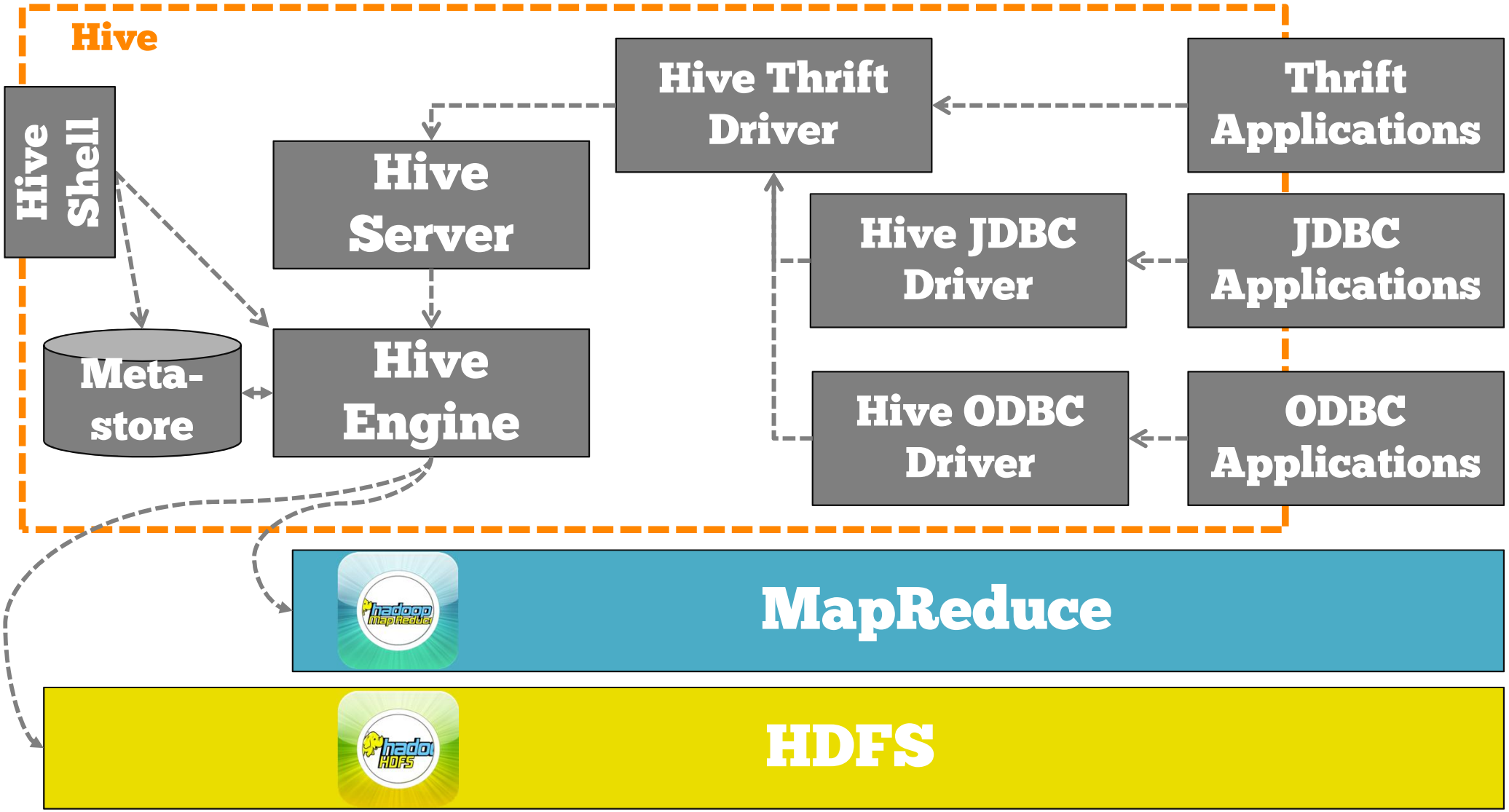
Hive Architecture



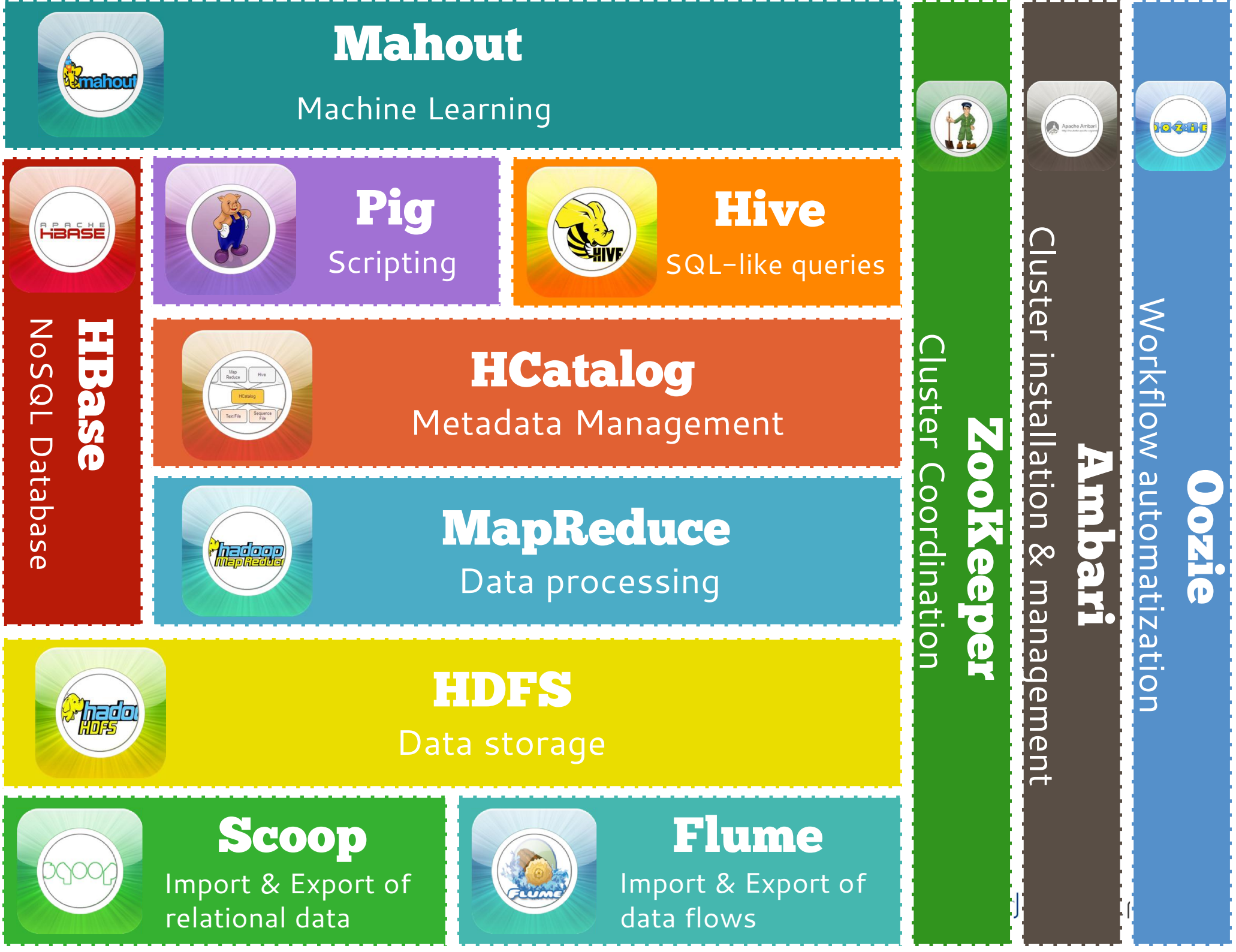
Hive Example

```
CREATE TABLE users(name STRING, age INT);
CREATE TABLE pages(user STRING, url STRING);

LOAD DATA INPATH '/user/sandbox/users.txt' INTO
TABLE 'users';
LOAD DATA INPATH '/user/sandbox/pages.txt' INTO
TABLE 'pages';

SELECT pages.url, count(*) AS clicks FROM users JOIN
pages ON (users.name = pages.user)
WHERE users.age >= 18 AND users.age <= 50
GROUP BY pages.url
SORT BY clicks DESC
LIMIT 10;
```

Let's have a look...

But wait, there's still more!

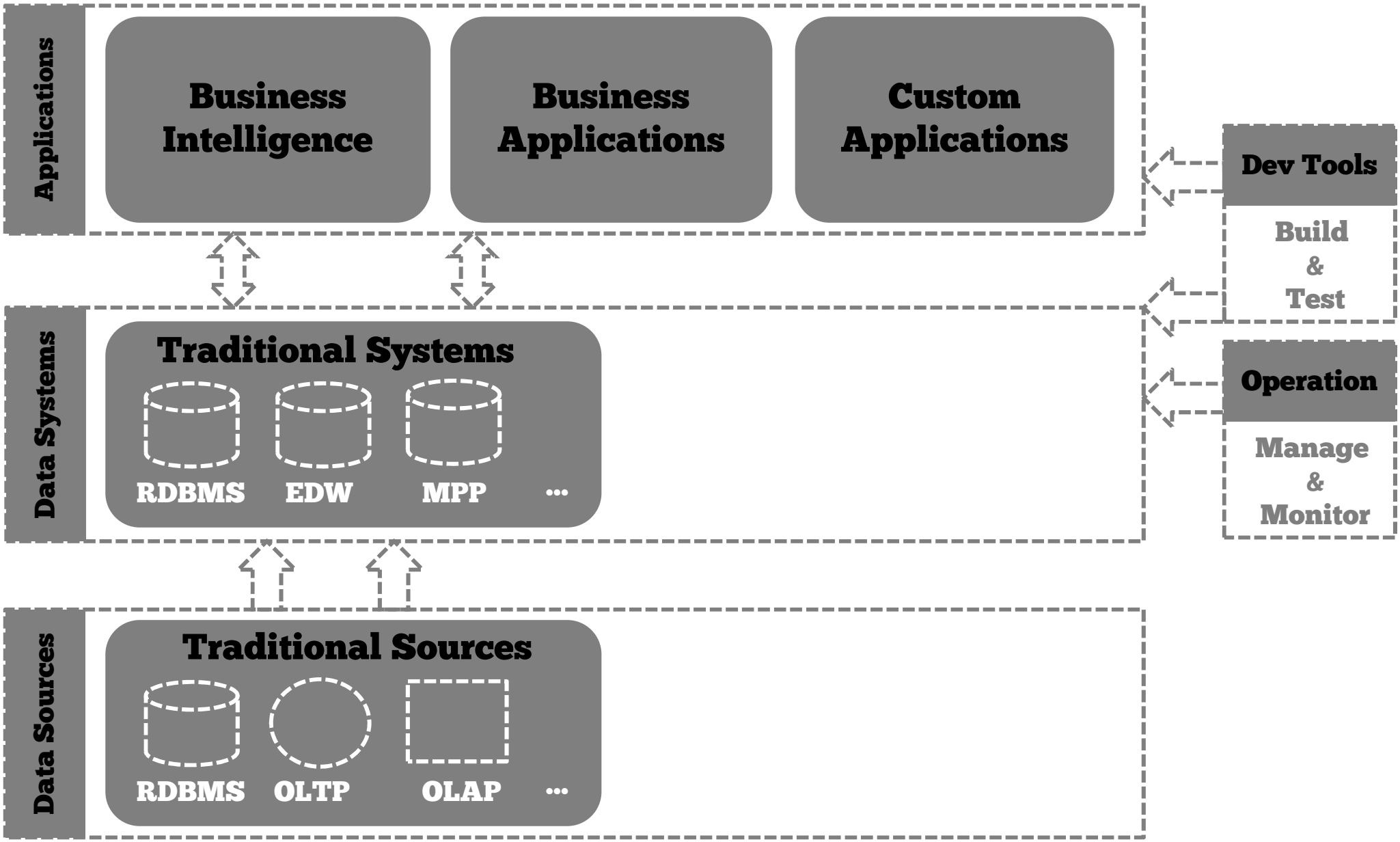
More components of the Hadoop Ecosystem


Mahout
Machine Learning
Pig
Scripting
Hive
SQL-like queries
HBase
NoSQL Database
HCatalog
Metadata Management
MapReduce
Data processing
HDFS
Data storage
Scoop
Import & Export of relational data
Flume
Import & Export of data flows
ZooKeeper
Cluster Coordination
Ambari
Cluster installation & management
Oozie
Workflow automatization

Agenda

- What is Big Data & Hadoop?
- Core Hadoop
- The Hadoop Ecosystem
- Use Cases
- What's next? Hadoop 2.0!

Classical enterprise platform



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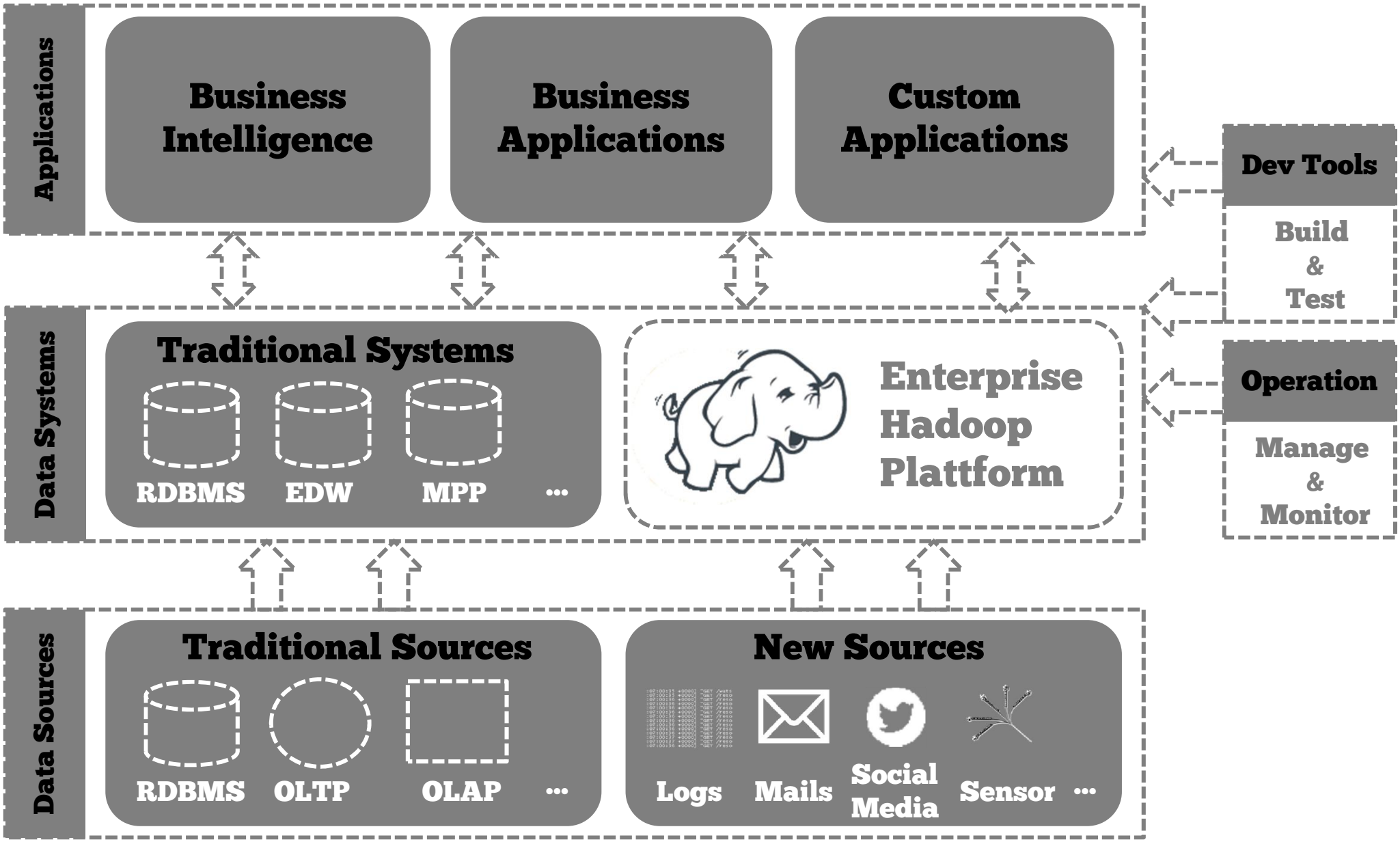
Big Data Platform



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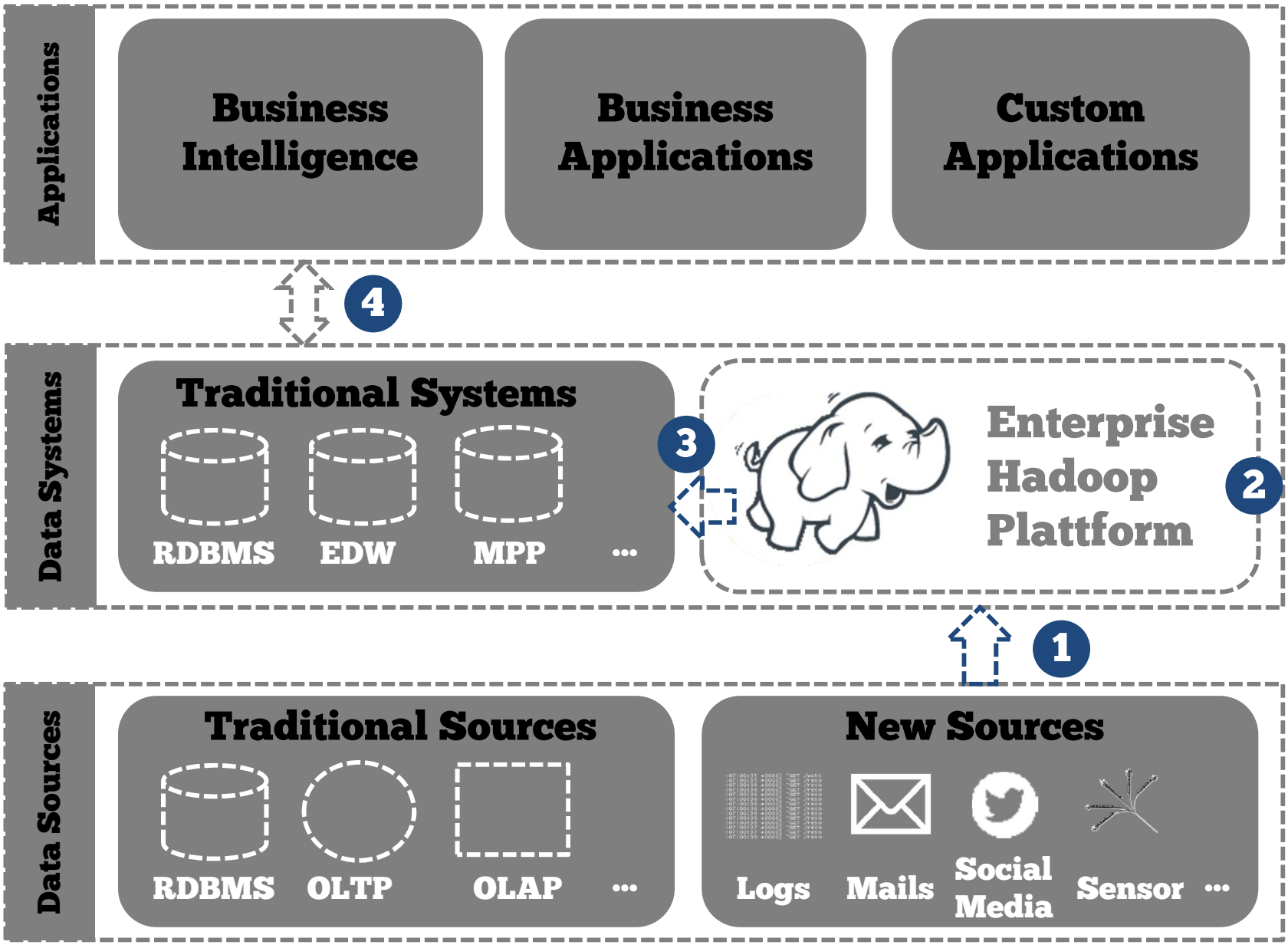
Pattern #1: Refine data



1. Capture all data
2. Process the data
3. Exchange using traditional systems
4. Process & Visualize with traditional applications

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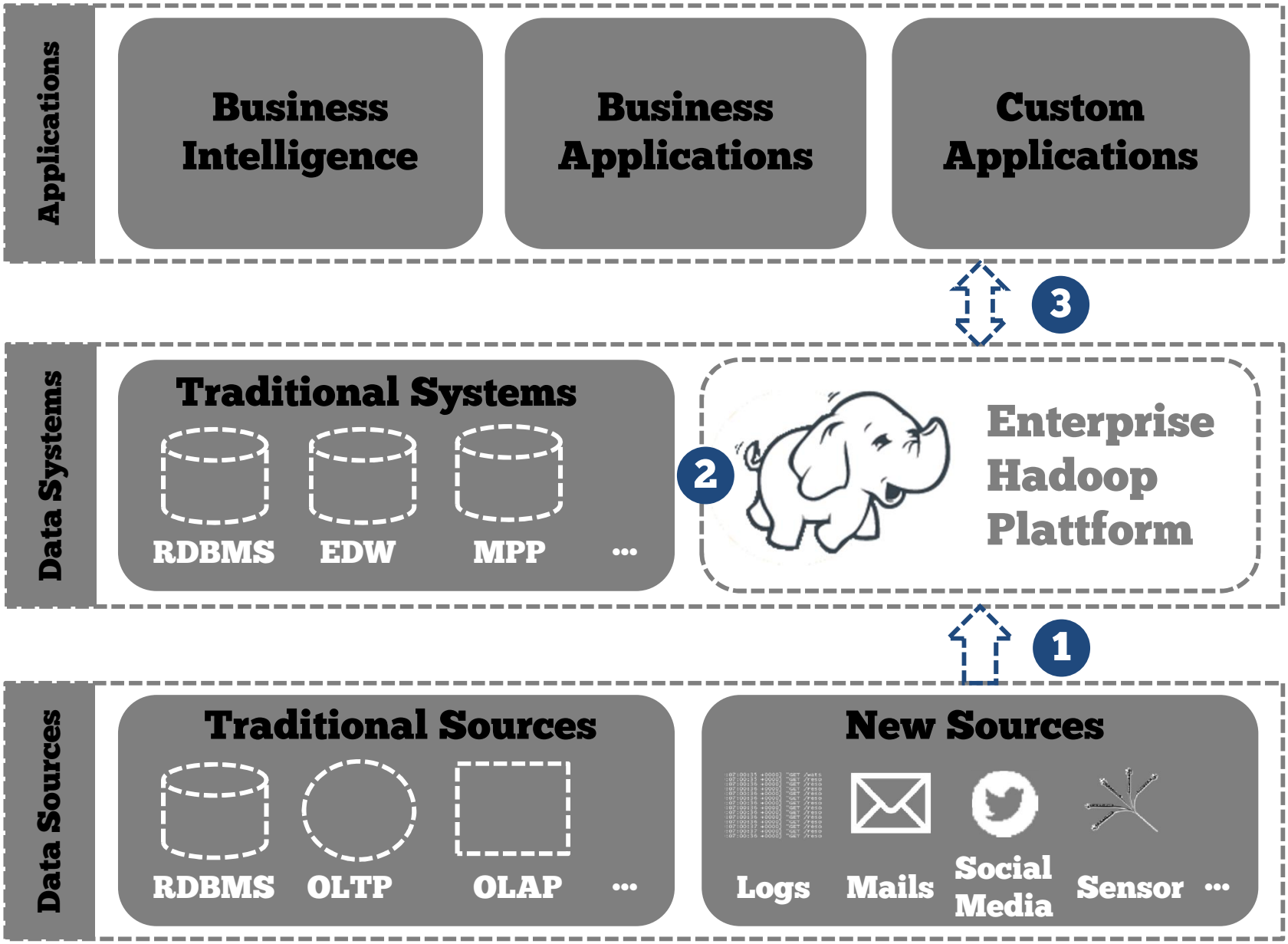
Pattern #2: Explore data



1. **Capture all data**
2. **Process the data**
3. **Explore the data using applications with support for Hadoop**

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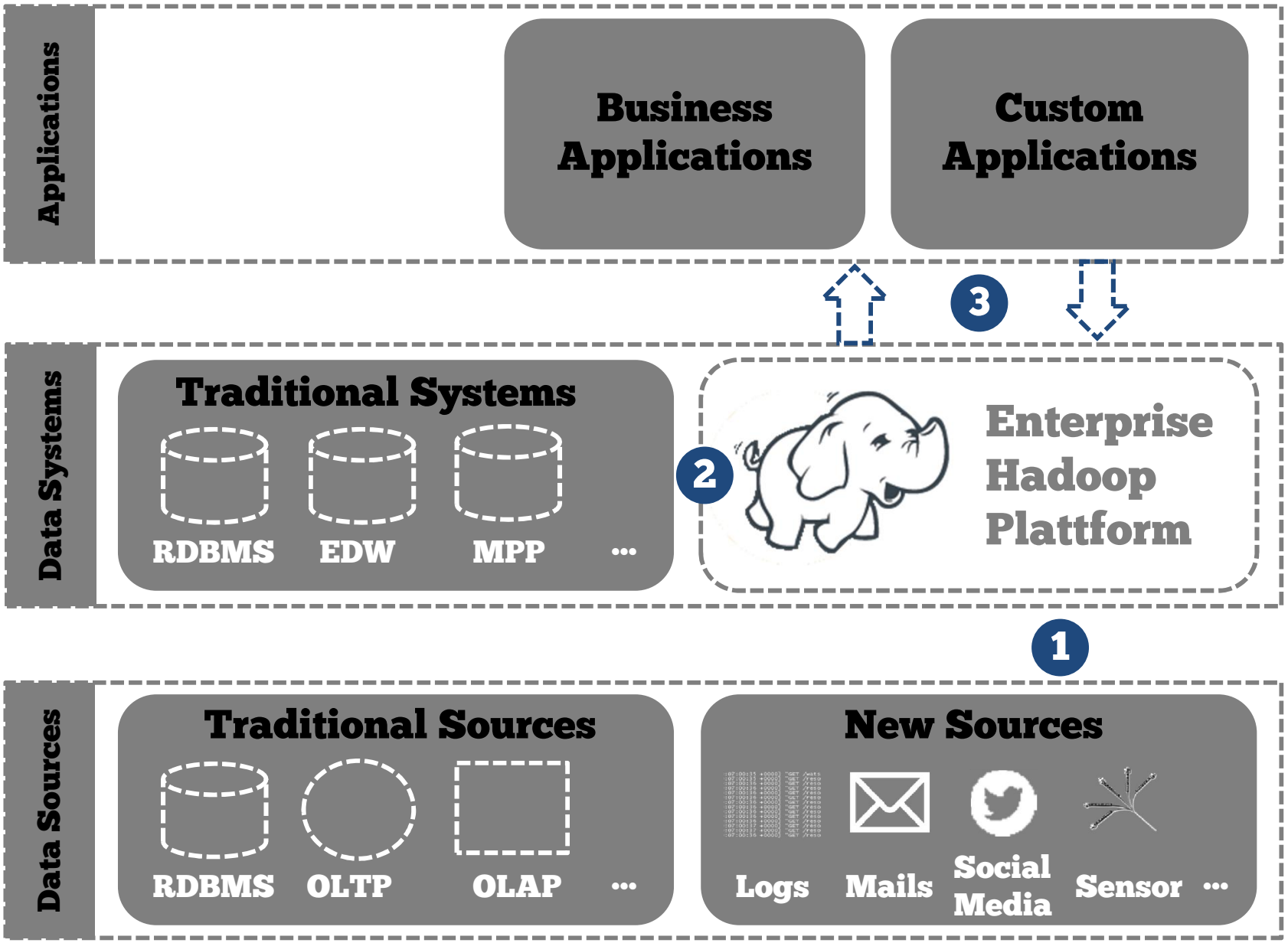
Pattern #3: Enrich data



1. Capture all data
2. Process the data
3. Directly ingest the data

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Bringing it all together...

One example...

Digital Advertising

- 6 billion ad deliveries per day
- Reports (and bills) for the advertising companies needed
- Own C++ solution did not scale
- Adding functions was a nightmare

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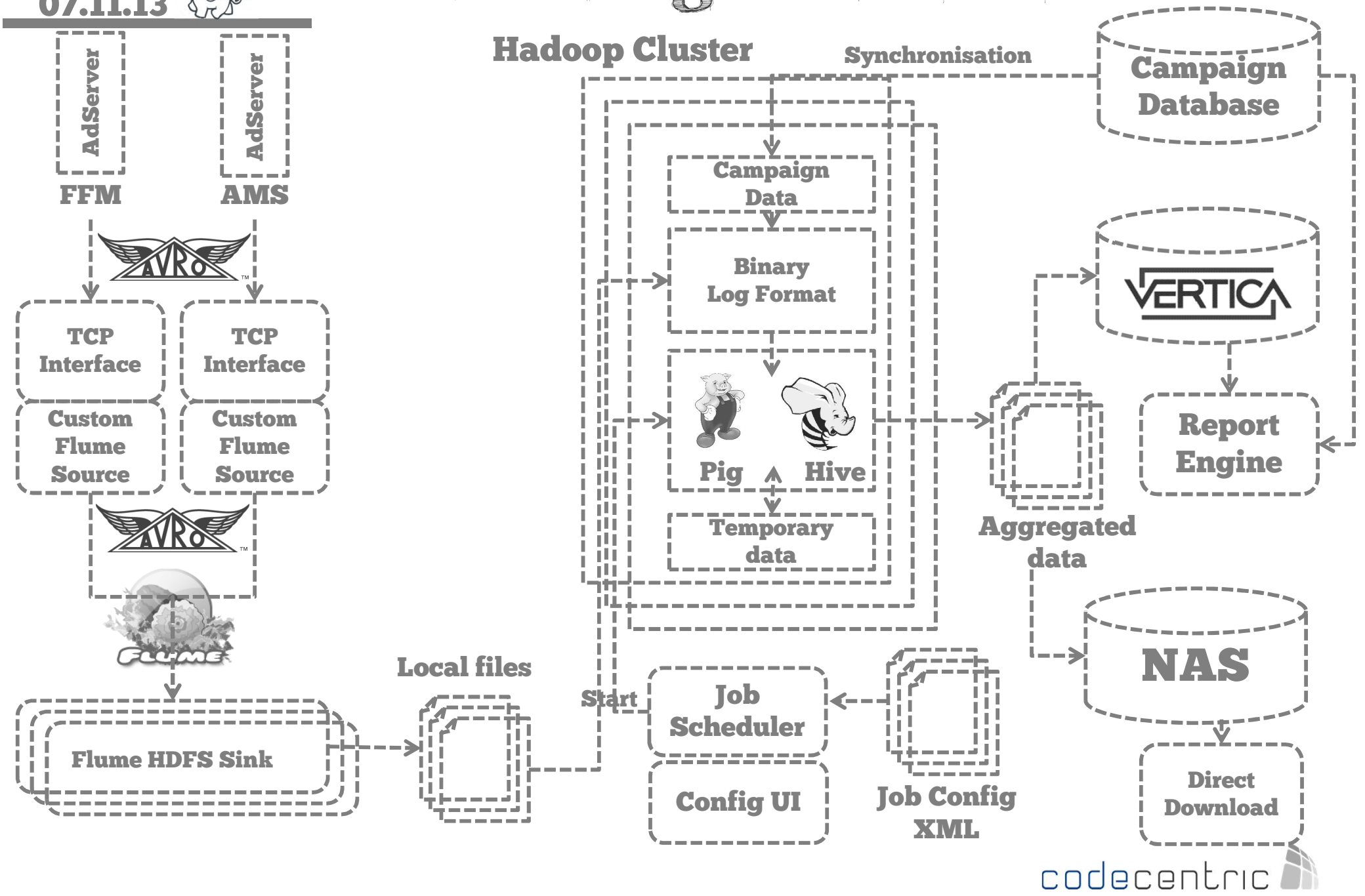
AdServing Architecture



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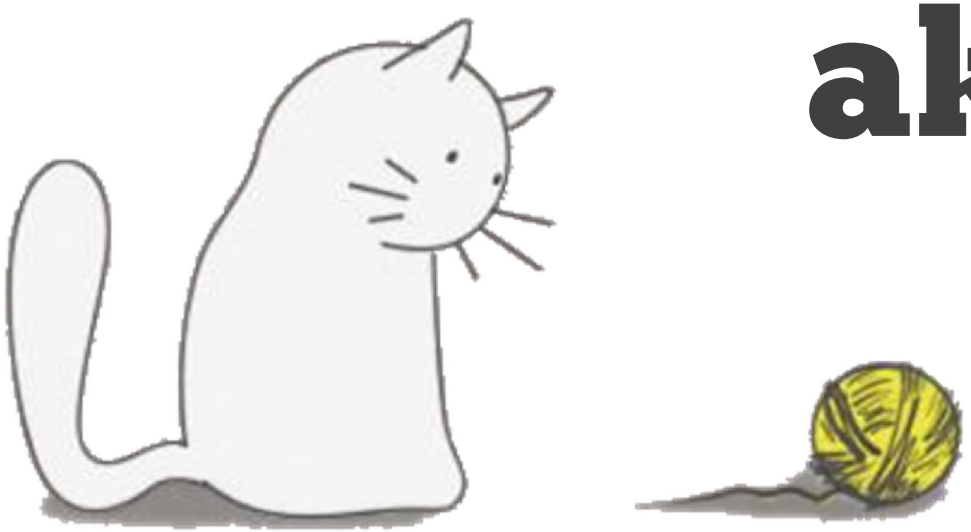
What's next?

Hadoop 2.0 aka YARN



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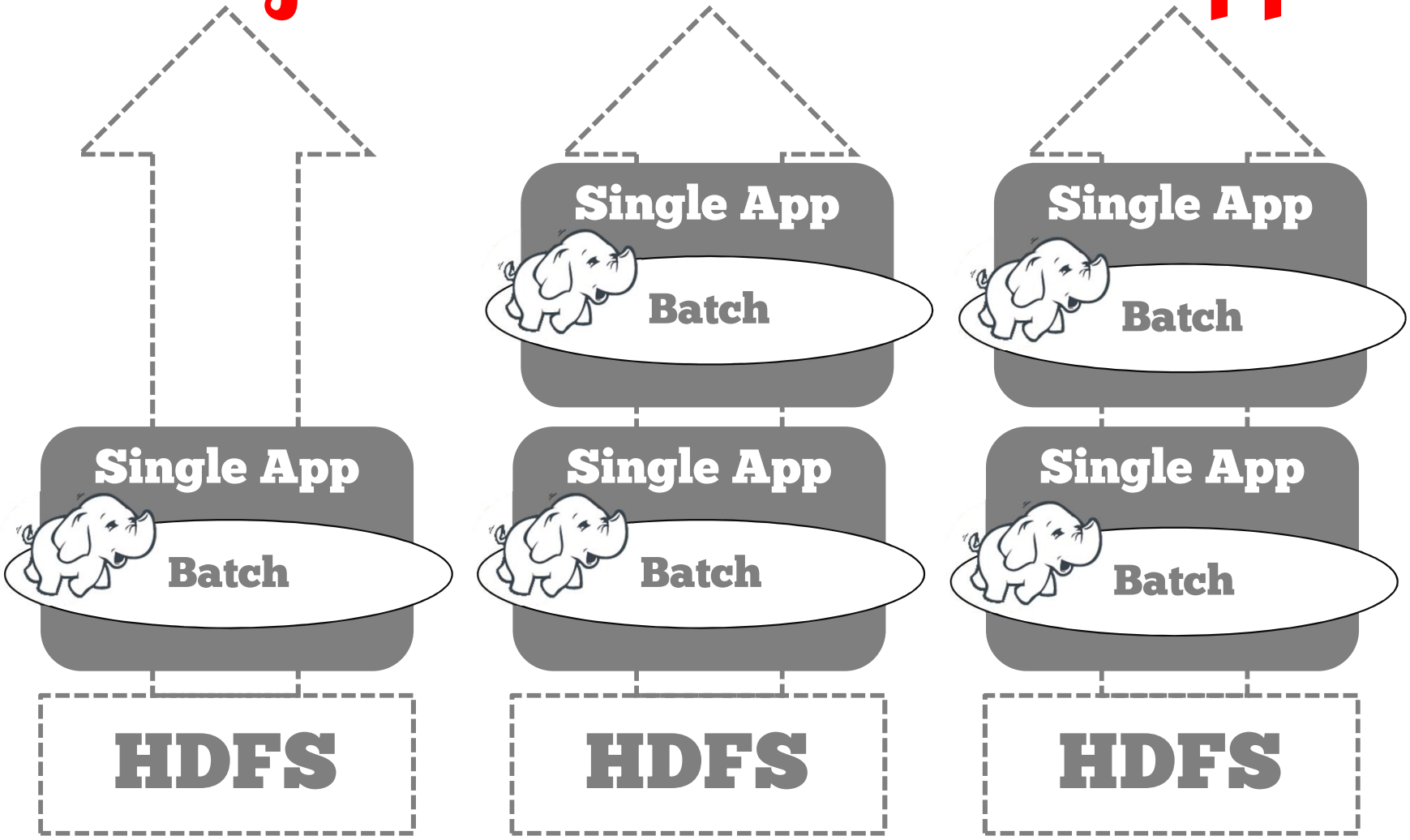
Hadoop 1.0

Built for web-scale batch apps



MapReduce is good for...

- **Embarrassingly parallel algorithms**
- **Summing, grouping, filtering, joining**
- **Off-line batch jobs on massive data sets**
- **Analyzing an entire large dataset**

MapReduce is OK for...

- **Iterative jobs (i.e., graph algorithms)**
  - **Each iteration must read/write data to disk**
  - **I/O and latency cost of an iteration is high**

MapReduce is not good for...

- **Jobs that need shared state/coordination**
  - **Tasks are shared-nothing**
  - **Shared-state requires scalable state store**
- **Low-latency jobs**
- **Jobs on small datasets**
- **Finding individual records**

MapReduce limitations

- **Scalability**
  - Maximum cluster size ~ 4,500 nodes
  - Maximum concurrent tasks – 40,000
  - Coarse synchronization in JobTracker
- **Availability**
  - Failure kills all queued and running jobs
- **Hard partition of resources into map & reduce slots**
  - Low resource utilization
- **Lacks support for alternate paradigms and services**
  - Iterative applications implemented using MapReduce are 10x slower

Hadoop 2.0: Next-gen platform

Single use system

Batch Apps

Hadoop 1.0

MapReduce
Cluster resource mgmt.
+ data processing

HDFS
Redundant, reliable storage

Multi-purpose platform

Batch, Interactive, Streaming, ...

Hadoop 2.0

MapReduce
Data processing

Others
Data processing

YARN
Cluster resource management

HDFS 2.0
Redundant, reliable storage

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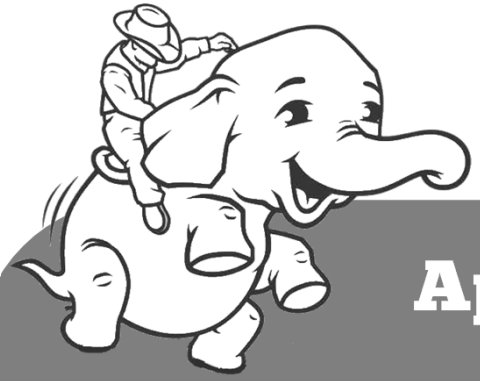
Taking Hadoop beyond batch



Store all data in one place

Interact with data in multiple ways

Applications run natively in Hadoop

Batch	Interactive	Online	Streaming	Graph	In-Memory	Other
MapReduce	Tez	HOYA	Storm, ...	Giraph	Spark	Search, ...

YARN

Cluster resource management

HDFS 2.0

Redundant, reliable storage

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A brief history of Hadoop 2.0

- **Originally conceived & architected by the team at Yahoo!**
  - **Arun Murthy created the original JIRA in 2008 and now is the YARN release manager**
- **The team at Hortonworks has been working on YARN for 4 years:**
  - **90% of code from Hortonworks & Yahoo!**
- **Hadoop 2.0 based architecture running at scale at Yahoo!**
  - **Deployed on 35,000 nodes for 6+ months**

GA in October as Hadoop 2.2

Hadoop 2.0 Projects

- **YARN**
- **HDFS Federation aka HDFS 2.0**
- **Stinger & Tez aka Hive 2.0**

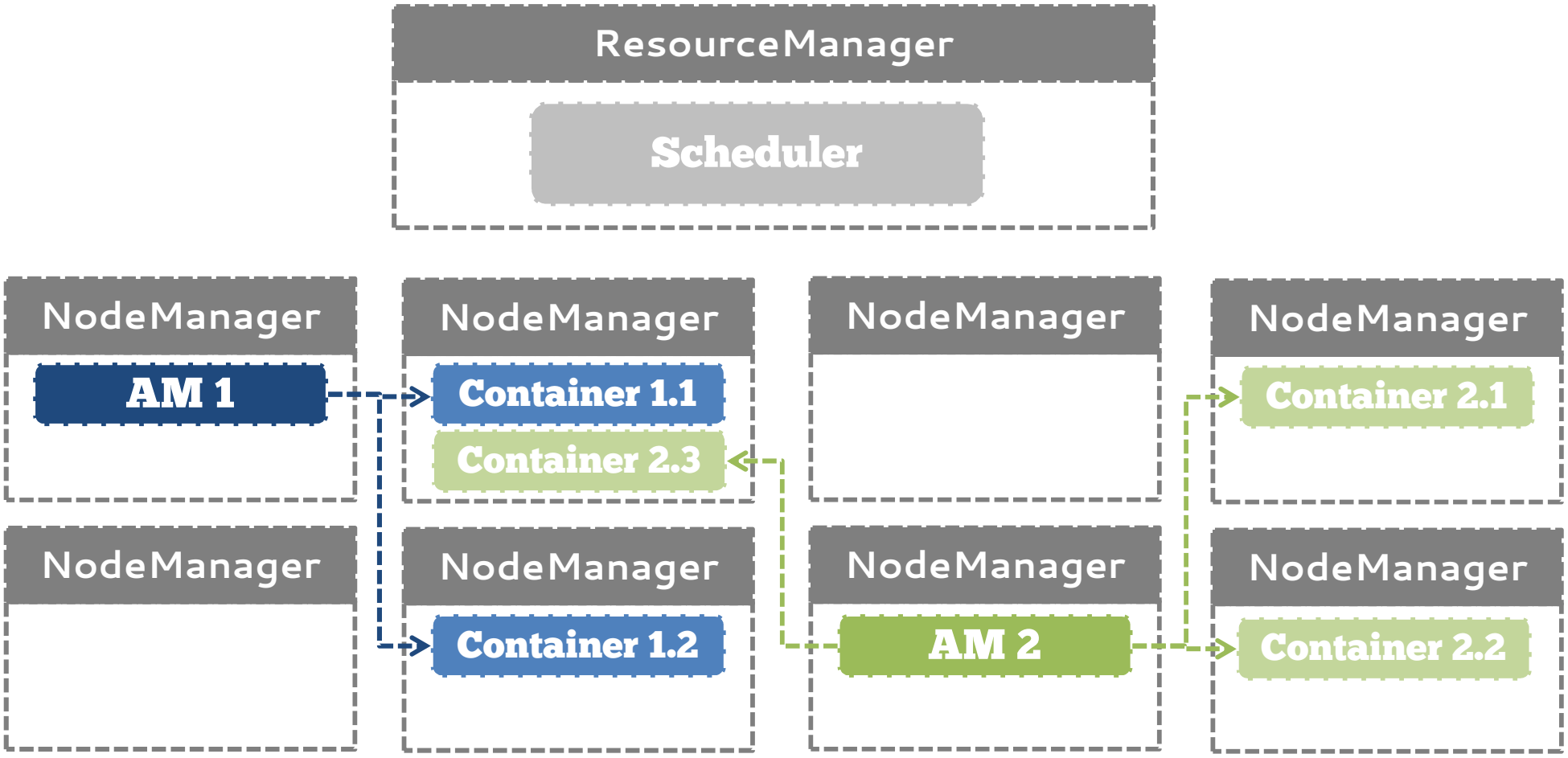
Hadoop 2.0 Projects

- **YARN**
- **HDFS Federation aka HDFS 2.0**
- **Stinger & Tez aka Hive 2.0**

YARN: Architecture

Split up the two major functions of the JobTracker

Cluster resource management & Application life-cycle management



YARN: Architecture

- **Resource Manager**
  - Global resource scheduler
  - Hierarchical queues
- **Node Manager**
  - Per-machine agent
  - Manages the life-cycle of container
  - Container resource monitoring
- **Application Master**
  - Per-application
  - Manages application scheduling and task execution
  - e.g. MapReduce Application Master

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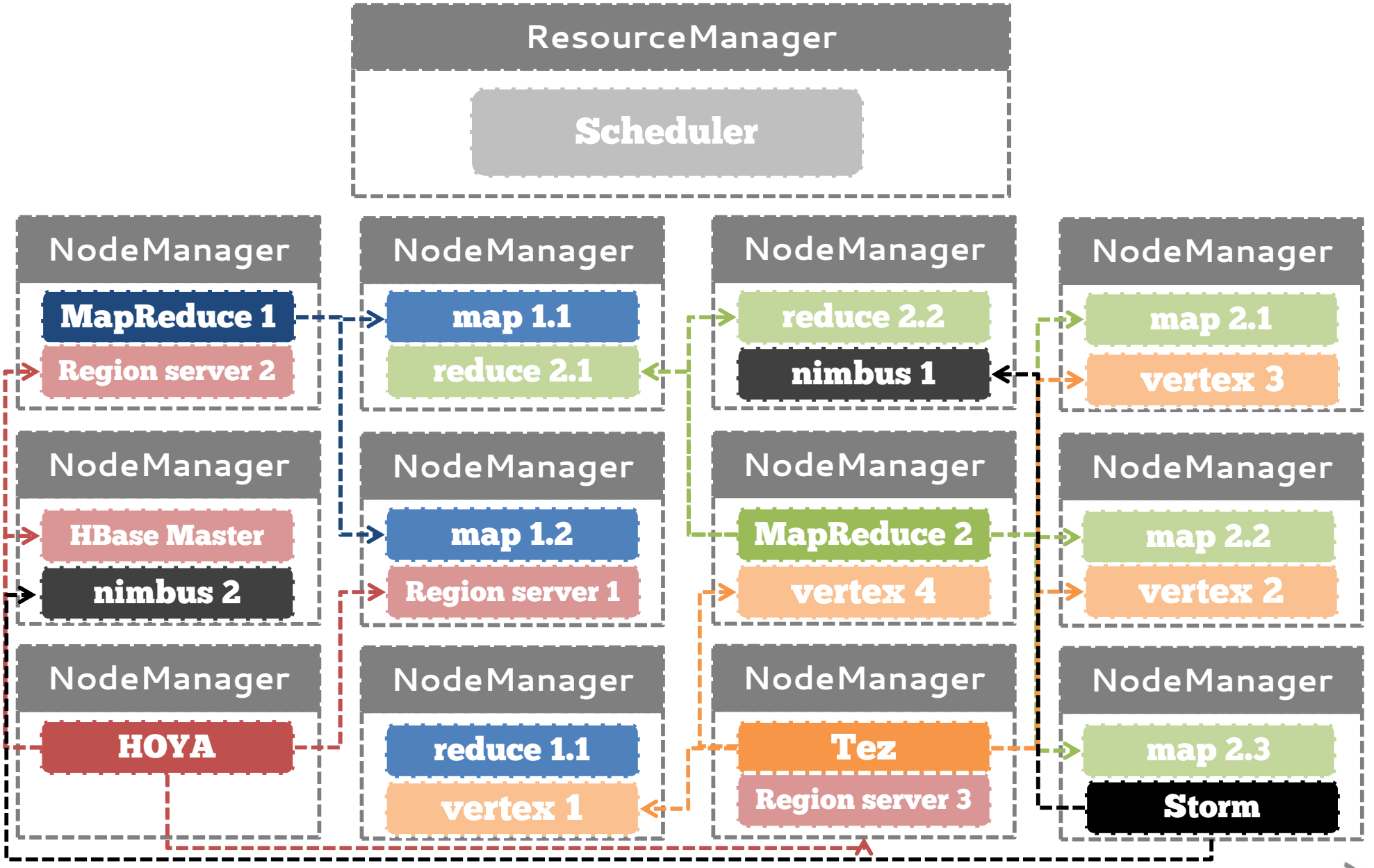
YARN: Architecture



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Hadoop 2.0 Projects

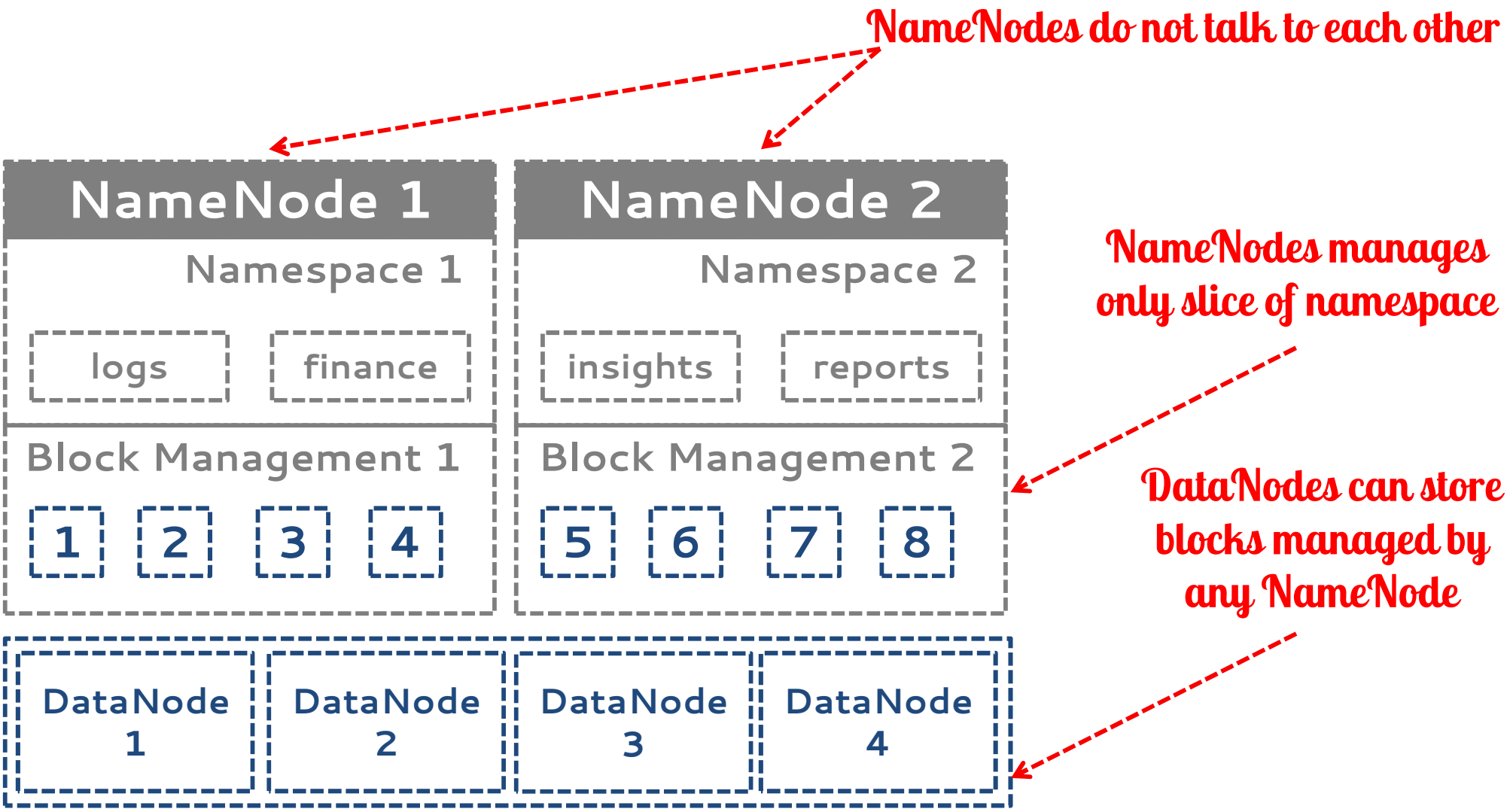
- **YARN**
- **HDFS Federation aka HDFS 2.0**
- **Stinger & Tez aka Hive 2.0**

HDFS Federation

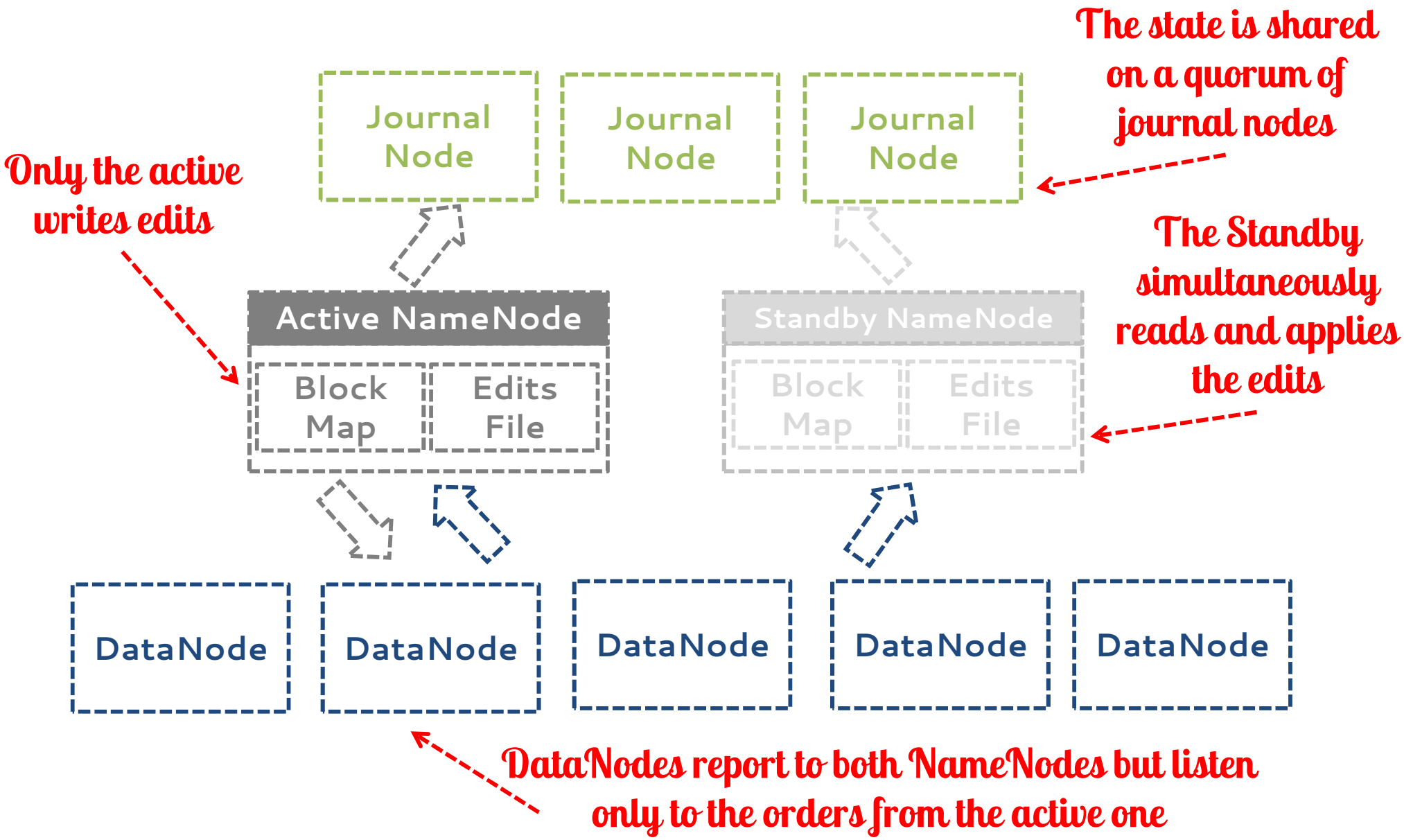
- **Removes tight coupling of Block Storage and Namespace**
- **Scalability & Isolation**
- **High Availability**
- **Increased performance**

Details: https://issues.apache.org/jira/browse/HDFS-1052

HDFS Federation: Architecture



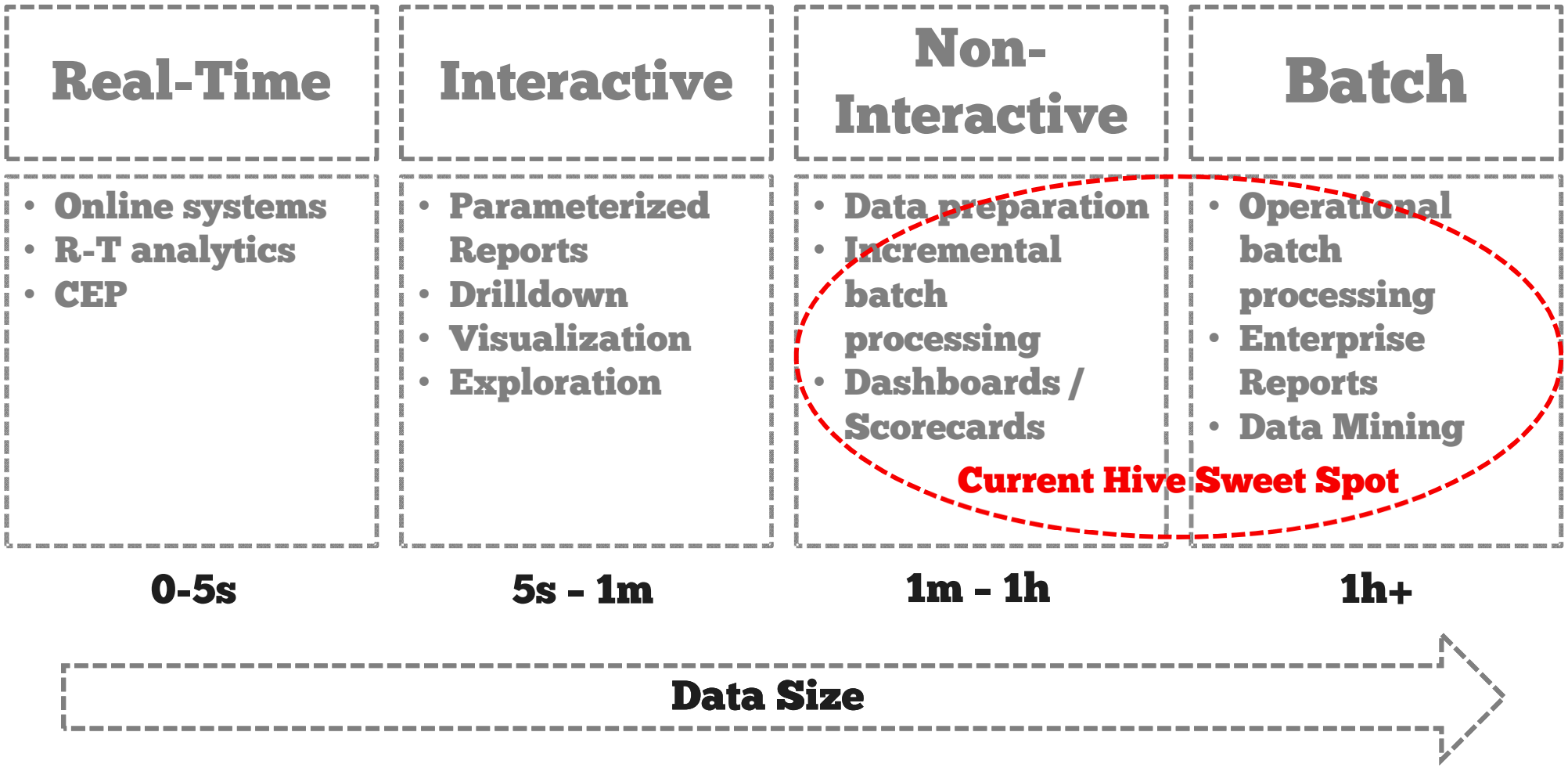
HDFS: Quorum based storage



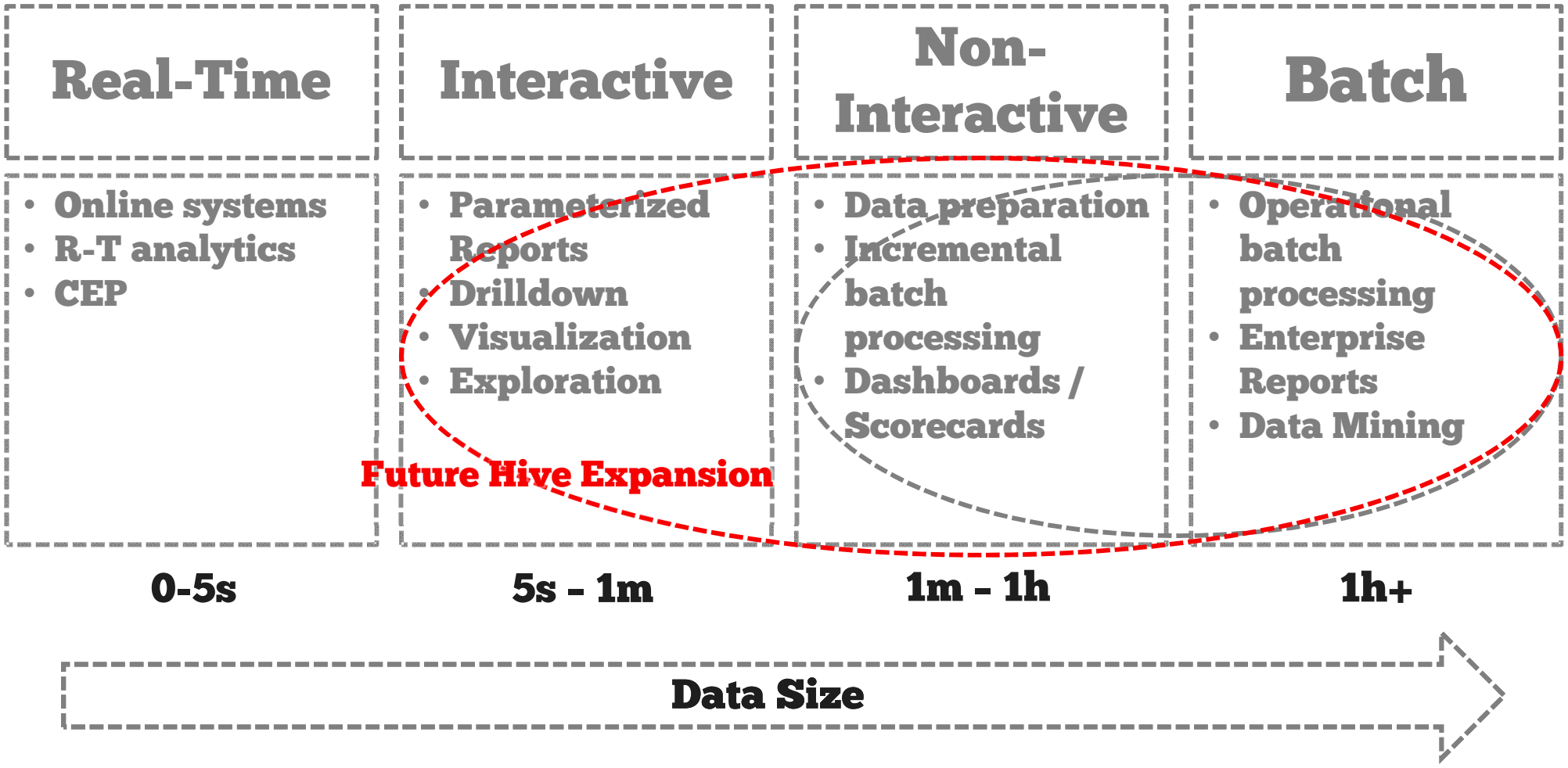
Hadoop 2.0 Projects

- **YARN**
- **HDFS Federation aka HDFS 2.0**
- **Stinger & Tez aka Hive 2.0**

Hive: Current Focus Area



Stinger: Extending the sweet spot



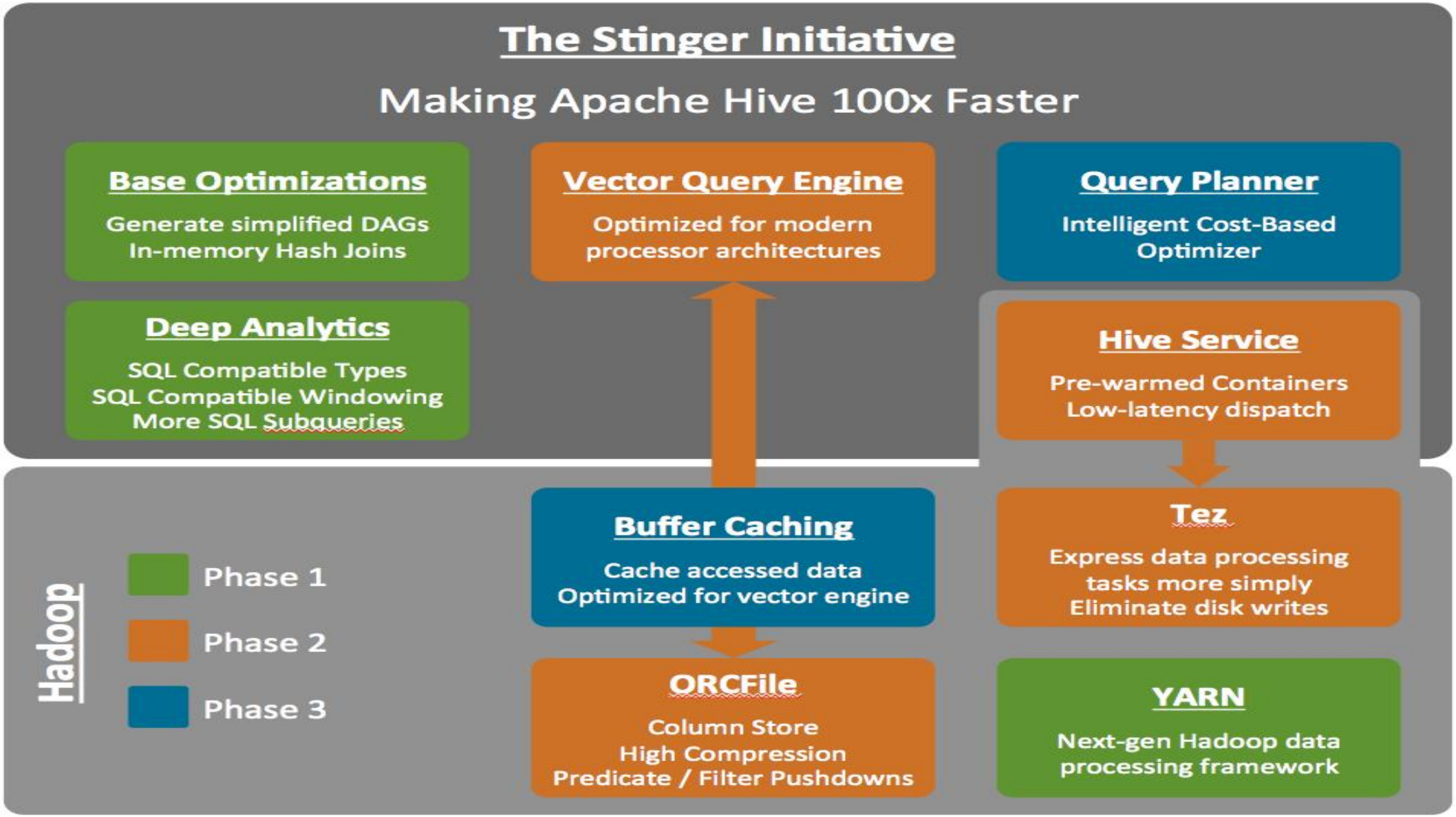
Improve Latency & Throughput

- Query engine improvements
- New "Optimized RCFile" column store
- Next-gen runtime (elim's M/R latency)

Extend Deep Analytical Ability

- Analytics functions
- Improved SQL coverage
- Continued focus on core Hive use cases

Stinger Initiative at a glance

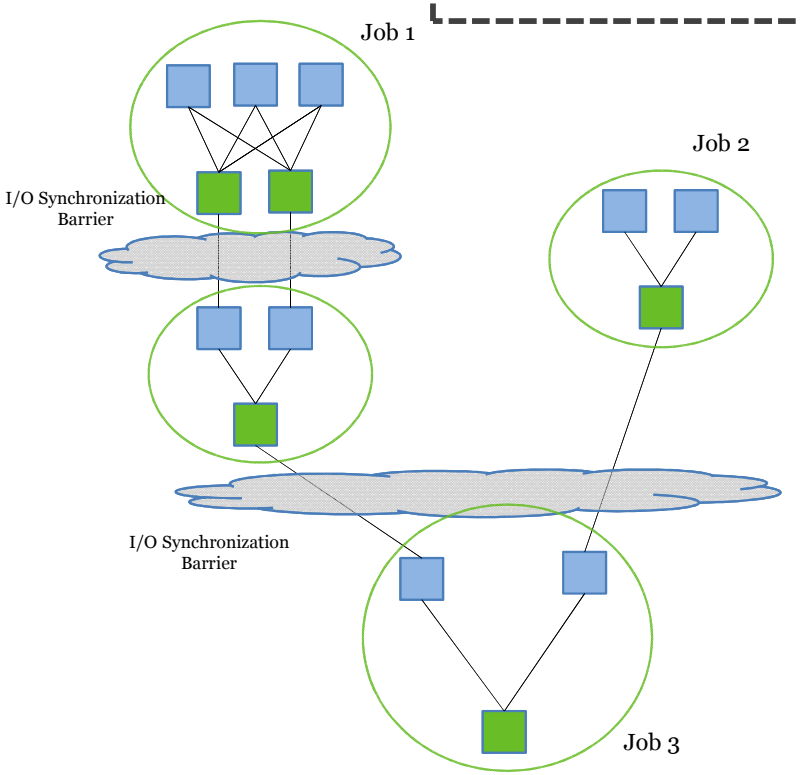


Tez: The Execution Engine

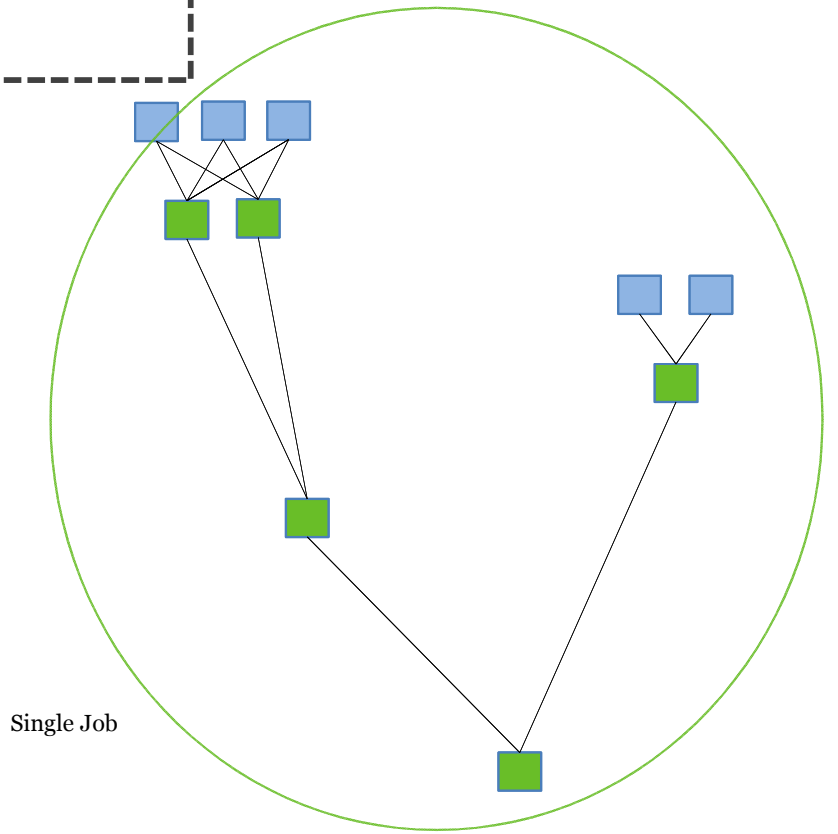
- Low level data-processing **execution engine**
- Use it for the base of MapReduce, Hive, Pig, etc.
- Enables pipelining of jobs
- Removes task and job launch times
- Hive and Pig jobs no longer need to move to the end of the queue between steps in the pipeline
- Does not write intermediate output to HDFS
  - Much lighter disk and network usage
- Built on YARN

Pig/Hive MR vs. Pig/Hive Tez

```
SELECT a.state, COUNT(*),
AVERAGE(c.price)
FROM a
JOIN b ON (a.id = b.id)
JOIN c ON (a.itemId = c.itemId)
GROUP BY a.state
```



Pig/Hive - MR



Pig/Hive - Tez

Tez Service

- **MapReduce Query Startup is expensive:**
  - Job launch & task-launch latencies are fatal for short queries (in order of 5s to 30s)

- **Solution:**
  - Tez Service (= Preallocated Application Master)
    - Removes job-launch overhead (Application Master)
    - Removes task-launch overhead (Pre-warmed Containers)
  - Hive/Pig
    - Submit query-plan to Tez Service
  - Native Hadoop service, not ad-hoc

Tez: Low latency

```
SELECT a.state, COUNT(*),
    AVERAGE(c.price)
        FROM a
    JOIN b ON (a.id = b.id)
JOIN c ON (a.itemId = c.itemId)
        GROUP BY a.state
```

Existing Hive	
Parse Query	0.5s
Create Plan	0.5s
Launch Map-Reduce	20s
Process Map-Reduce	10s
Total	31s

Hive/Tez	
Parse Query	0.5s
Create Plan	0.5s
Launch Map-Reduce	20s
Process Map-Reduce	2s
Total	23s

Tez & Tez Service	
Parse Query	0.5s
Create Plan	0.5s
Submit to Tez Service	0.5s
Process Map-Reduce	2s
Total	3.5s

*** No exact numbers, for illustration only**

Stinger: Summary

File Type	Number of MR Jobs	Input Size	Mappers	Time
Text/Hive 10	5	43.1 GB	179	21 minutes
Text/Hive 11	1	38 GB	151	246 seconds
RC/Hive 11	1	8.21 GB	76	136 seconds
ORC/Hive 11	1	2.83 GB	38	104 seconds
RC/Hive 11/ Partitioned/ Bucketed	1	1.73 GB	19	104 seconds
ORC/Hive 11/ Partitioned/ Bucketed	**1**	**687 MB**	**27**	**79.62**

*** Real numbers, but handle with care!**

Hadoop 2.0 Applications

- **MapReduce 2.0**
- **HOYA - HBase on YARN**
- **Storm, Spark, Apache S4**
- **Hamster (MPI on Hadoop)**
- **Apache Giraph**
- **Apache Hama**
- **Distributed Shell**
- **Tez**

Hadoop 2.0 Applications

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MapReduce 2.0

- **Basically a porting to the YARN architecture**
- **MapReduce becomes a user-land library**
- **No need to rewrite MapReduce jobs**
- **Increased scalability & availability**
- **Better cluster utilization**

Hadoop 2.0 Applications

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- Tez

HOYA: HBase on YARN

- Create on-demand HBase clusters
- Configure different HBase instances differently
- Better isolation
- Create (transient) HBase clusters from MapReduce jobs
- Elasticity of clusters for analytic / batch workload processing
- Better cluster resources utilization

Hadoop 2.0 Applications

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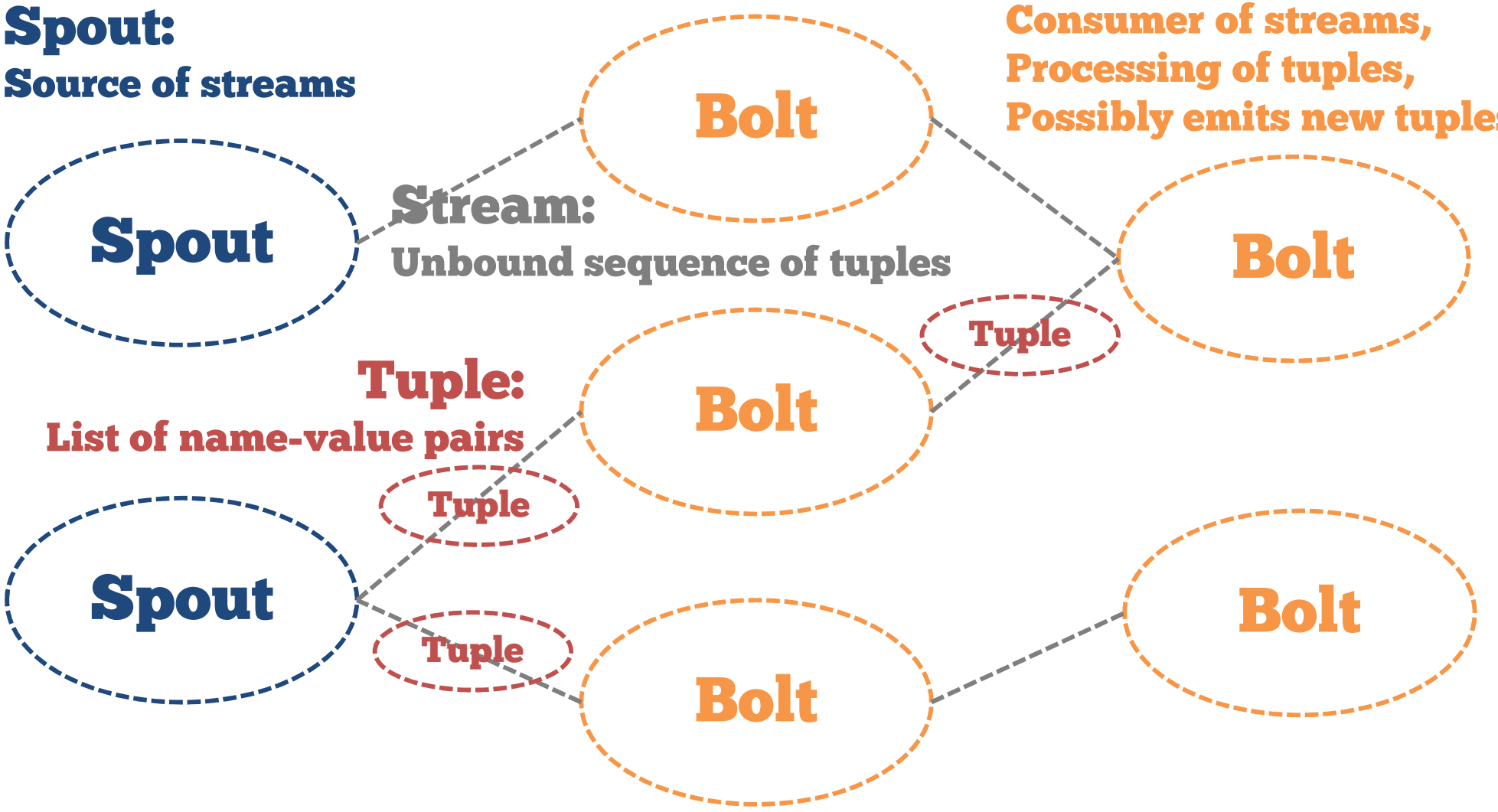
Twitter Storm

- **Stream-processing**
- **Real-time processing**
- **Developed as standalone application**
  - **https://github.com/nathanmarz/storm**
- **Ported on YARN**
  - **https://github.com/yahoo/storm-yarn**

Storm: Conceptual view

Spout:
Source of streams

Bolt:
Consumer of streams,
Processing of tuples,
Possibly emits new tuples



Topology: Network of Spouts & Bolts as the nodes and stream as the edge

Hadoop 2.0 Applications

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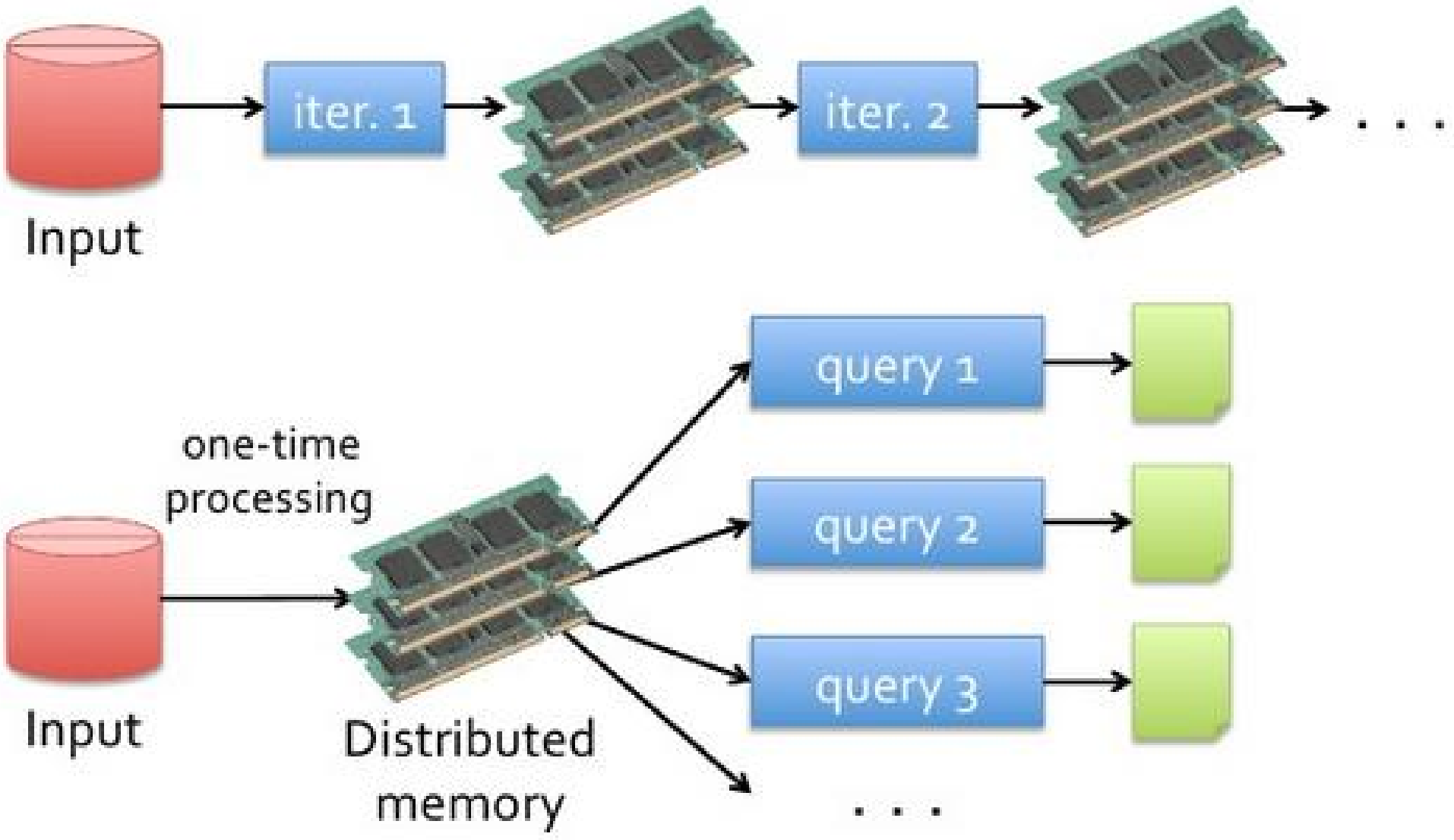
Spark

- **High-speed in-memory analytics over Hadoop and Hive**
- **Separate MapReduce-like engine**
  - **Speedup of up to 100x**
  - **On-disk queries 5-10x faster**
- **Compatible with Hadoop's Storage API**
- **Available as standalone application**
  - **https://github.com/mesos/spark**
- **Experimental support for YARN since 0.6**
  - **http://spark.incubator.apache.org/docs/0.6.0/running-on-yarn.html**

Data Sharing in Spark



Hadoop 2.0 Applications

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- Hamster (MPI on Hadoop)
- **Apache Giraph**
- Apache Hama
- Distributed Shell
- Tez

Apache Giraph

- **Giraph is a framework for processing semi-structured graph data on a massive scale.**
- **Giraph is loosely based upon Google's Pregel**
- **Giraph performs iterative calculations on top of an existing Hadoop cluster.**
- **Available on GitHub**
  - **https://github.com/apache/giraph**

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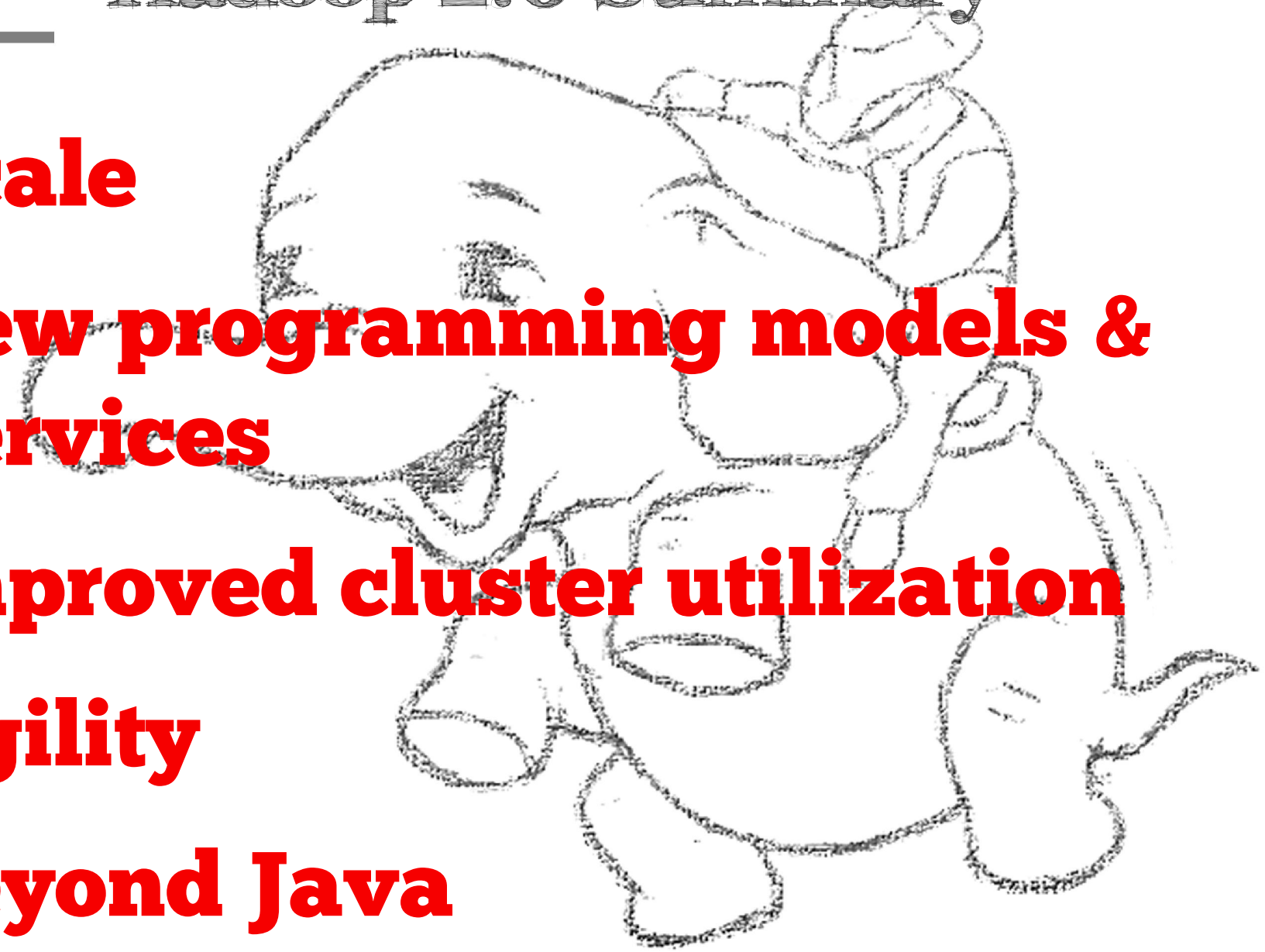
Hadoop 2.0 Summary



1. Scale
2. New programming models & Services
3. Improved cluster utilization
4. Agility
5. Beyond Java

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Getting started...

One more thing...

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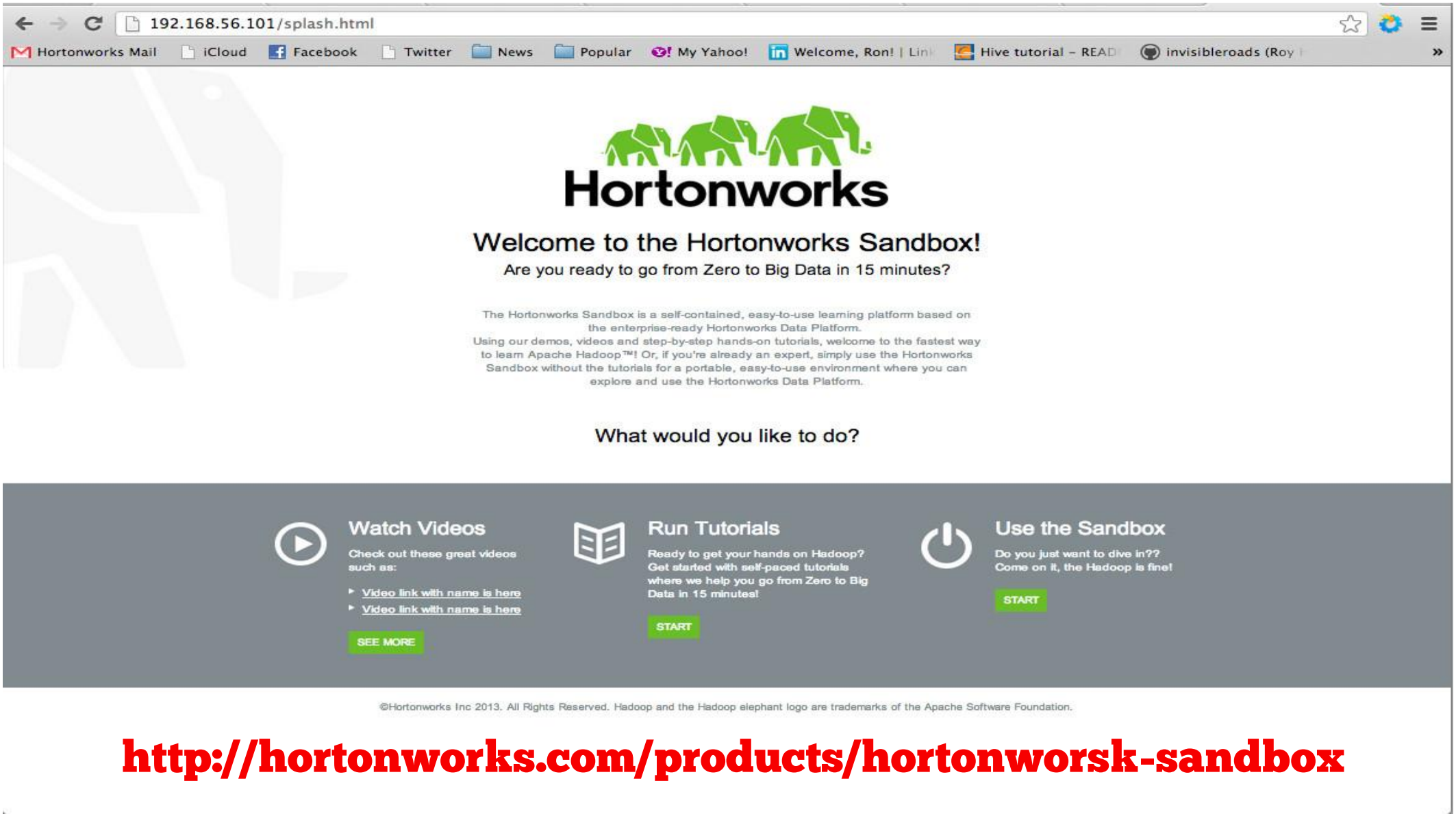
Hortonworks Sandbox



http://hortonworks.com/products/hortonworsk-sandbox

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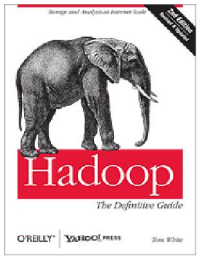
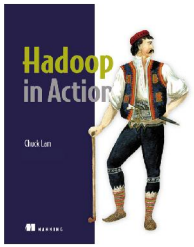
Books about Hadoop



Hadoop - The Definite Guide, Tom White,

3rd ed., O'Reilly, 2012.

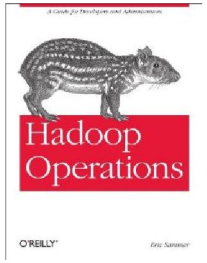


Hadoop in Action, Chuck Lam,

Manning, 2011

Programming Pig, Alan Gates

O'Reilly, 2011



Hadoop Operations, Eric Sammer,

O'Reilly, 2012

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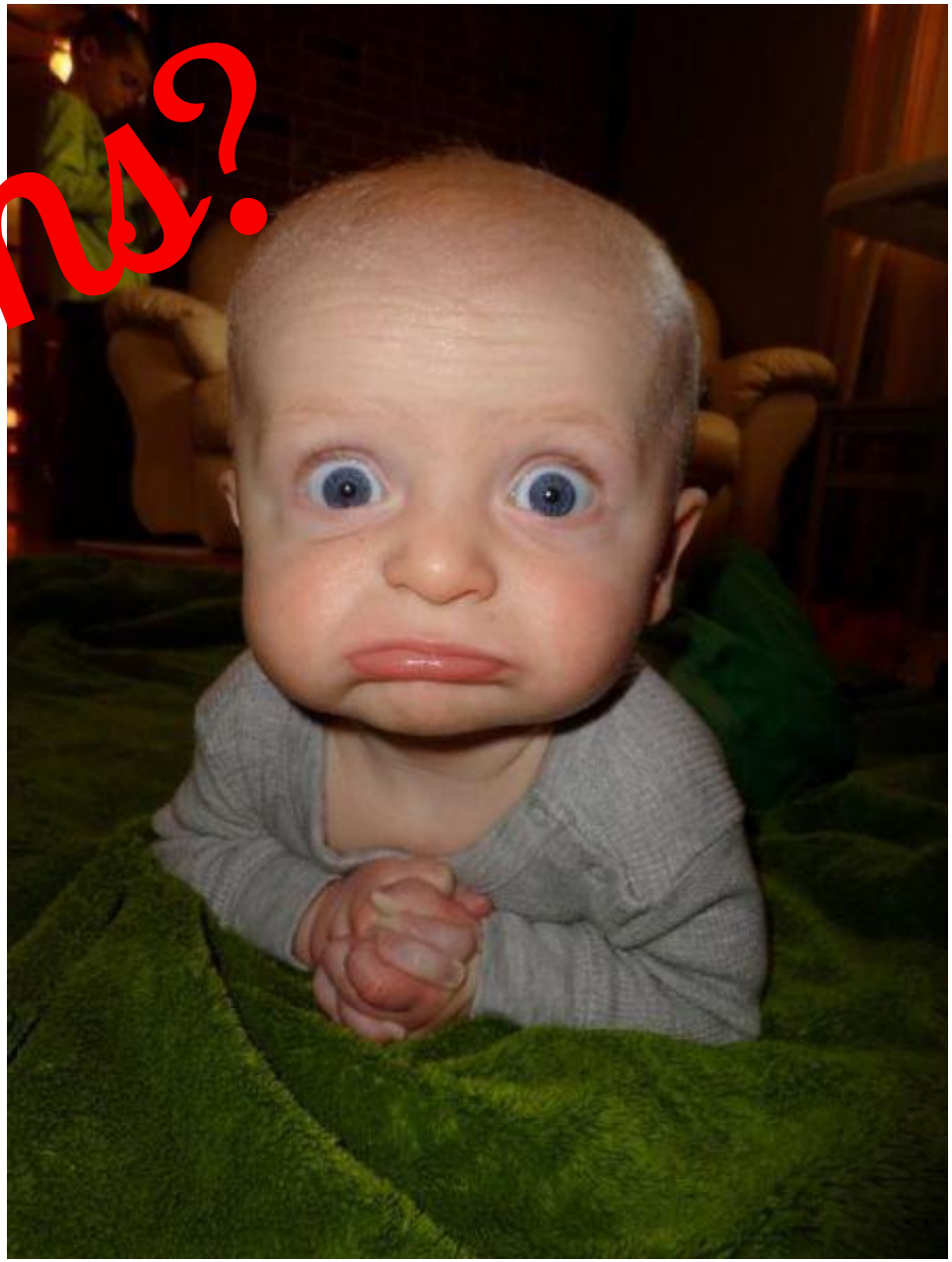
The end... or the beginning?

Questions?



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