git
IJ
HIVE
sqoop
APACHE
HBASE

Recap

- Sqoop
- HBase

Hadoop

Processing nature	Tool
Batch processing on unstructured data	Pig
Batch processing on structured data	Hive
Ad-hoc analysis on structured data	Impala
Machine Learning	Apache Mahout
Graph processing	Apache Giraph
Stream processing	Apache Storm/Kafka

Lots of tools

Image Ref: http://hunteryoung.com/wp-content/uploads/2017/05/Too-many-Tools-1160x770.jpg

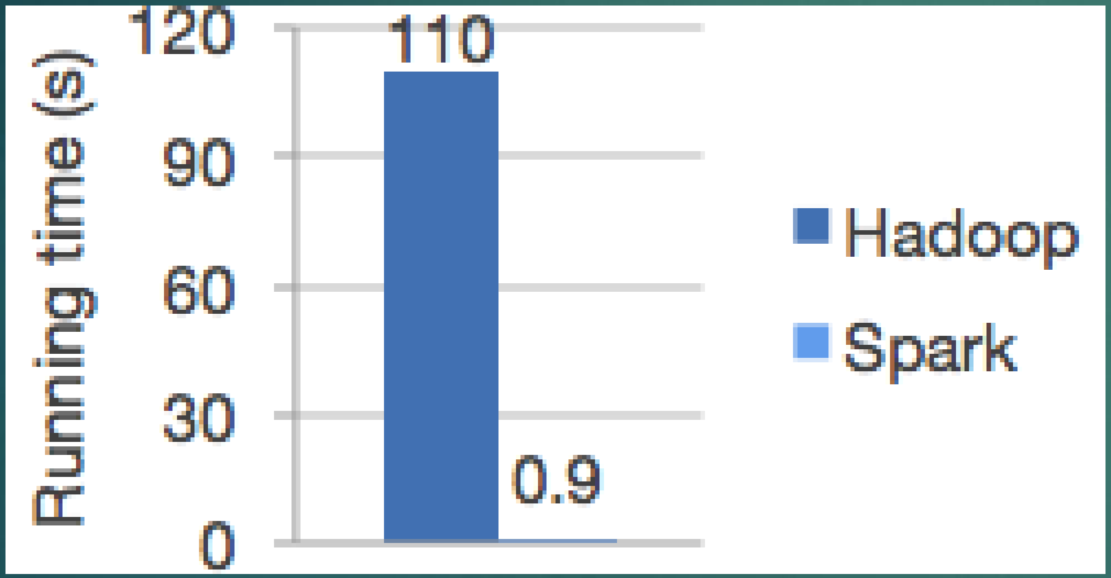
One solution for all

Why Spark?

Processing nature	**Spark**
Batch processing on unstructured data	Spark RDD API
Batch processing on structured data	SparkSQL
Ad-hoc analysis on structured data	SparkSQL
Machine Learning	MILib
Graph processing	Graphax
Stream processing	Spark Streaming

Why Spark: cont…

- Faster



Logistic regression in Hadoop and Spark

Why Spark: cont…

- ▶ Ease of use
- ❑ Support for multiple languages
- ❑ REPL for development and ad-hoc analysis
- ❑ Fewer lines of code

Why Spark: cont…

- Inter operability with other platforms

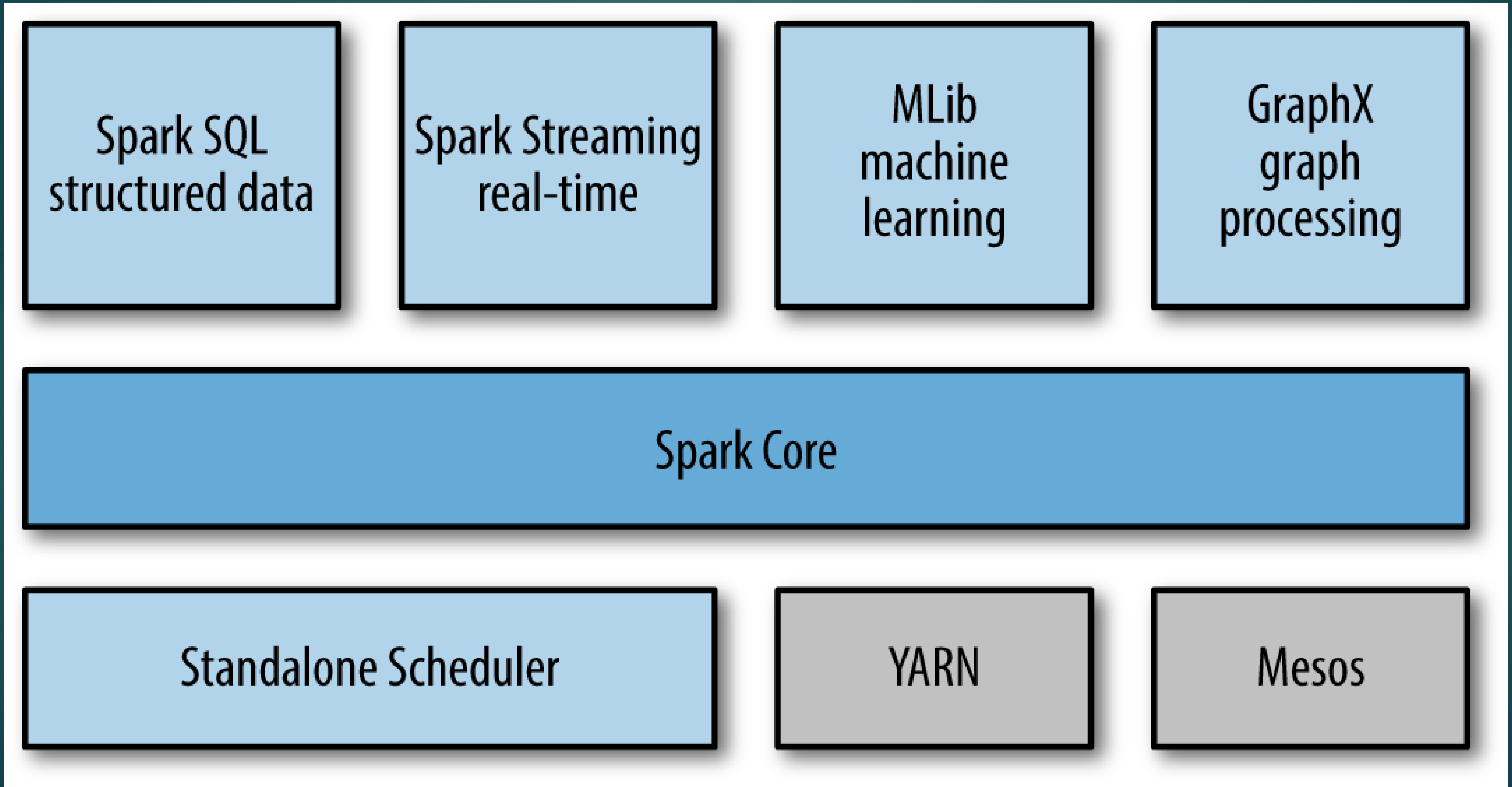
❑ Hadoop

❑ Mesos

❑ Hbase

❑ Cassandra

Components



Spark SQL
structured data
Spark Streaming
real-time
MLib
machine
learning
GraphX
graph
processing
Spark Core
Standalone Scheduler
YARN
Mesos

Core of Spark: RDD

- **R**esilient **D**istributed **D**ataset

  Fault tolerant

  Distributed across multiple processes

  Source could be a file or program generated

- Immutable collection of elements, partitioned across multiple processes to operate in parallel

RDD Operations

- Transformation
- Action

Activity

- Instruction set
- Result

RDD Operation: Transformation

- Evaluated lazily
- Can be applied on any RDD
- Generates another RDD as result
- Example: map, flatMap, filter, reduceByKey…

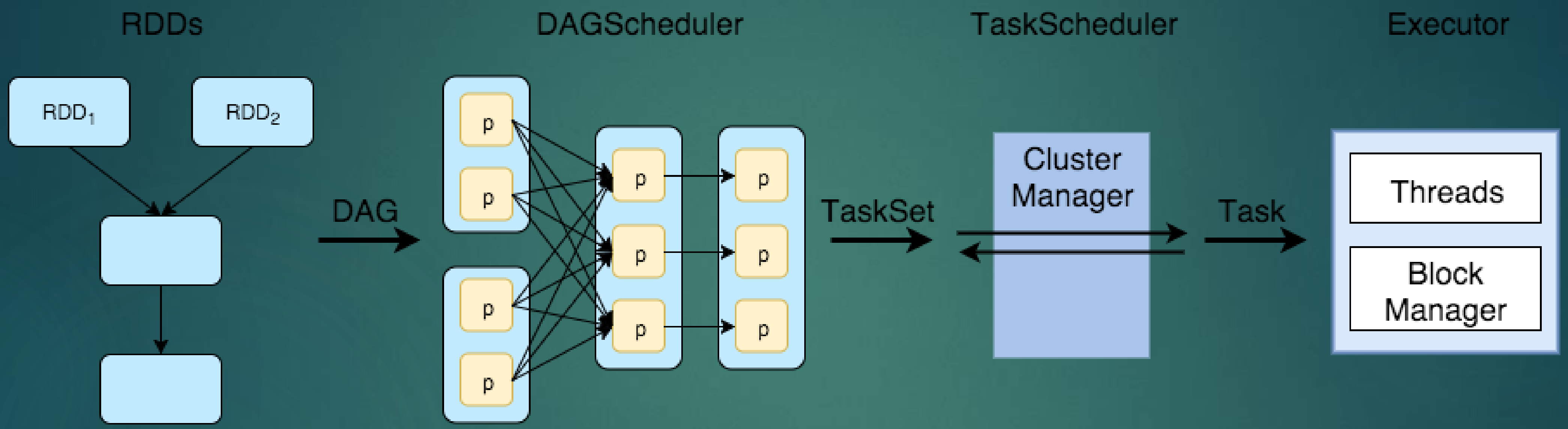
RDD Operation: Action

- Call for evaluation of complete DAG
- Can be applied on any RDD
- Generates result on driver program
- Example: count, take, saveAsTextFile, collect…

DAG

- Directed Acyclic Graph prepared on RDD
- DAG scheduler prepares stages and tasks
- Tasks within a stage will be executed when stage is ready to execute
- Shuffle operation is the stage boundary

Execution and Coordination



Ref: http://datastrophic.io/core-concepts-architecture-and-internals-of-apache-spark/

Launch spark shell

- Standalone:

```
./bin/spark-shell --master spark://IP:PORT
```

- YARN

```
./bin/spark-shell --master yarn
```

- Mesos

```
./bin/spark-shell --master mesos://host:5050
```

Submit Application

- Scala/Java

```
spark-submit --class SparkWordCount --master local --deploy-mode client --executor-memory 1g --name WebHitCount --conf "spark.app.id=WebHitCount" SparkWebHitCount.jar <other parameters to JAR file>
```

- Python

```
spark-submit --master yarn --deploy-mode client --executor-memory 1g --name WebHitCount --conf "spark.app.id=WebHitCount" webhitcount.py <Other parameters>
```

Language comparison matrix

Metrics	Scala	Java	Python	R
Type	Compiled	Compiled	Interpreted	Interpreted
JVM based	Yes	Yes	No	No
Verbosity	Less	More	Less	Less
Code Length	Less	More	Less	Less
Productivity	High	Less	High	High
Scalability	High	High	Less	Less
OOPS Support	Yes	Yes	Yes	Yes

REPL

- Scala

spark-shell

- Python

pyspark

Spark
SQL

Why SparkSQL?

- Integrated

```
context = HiveContext(sc)
results = context.sql(
  "SELECT * FROM people")
names = results.map(lambda p: p.name)
```

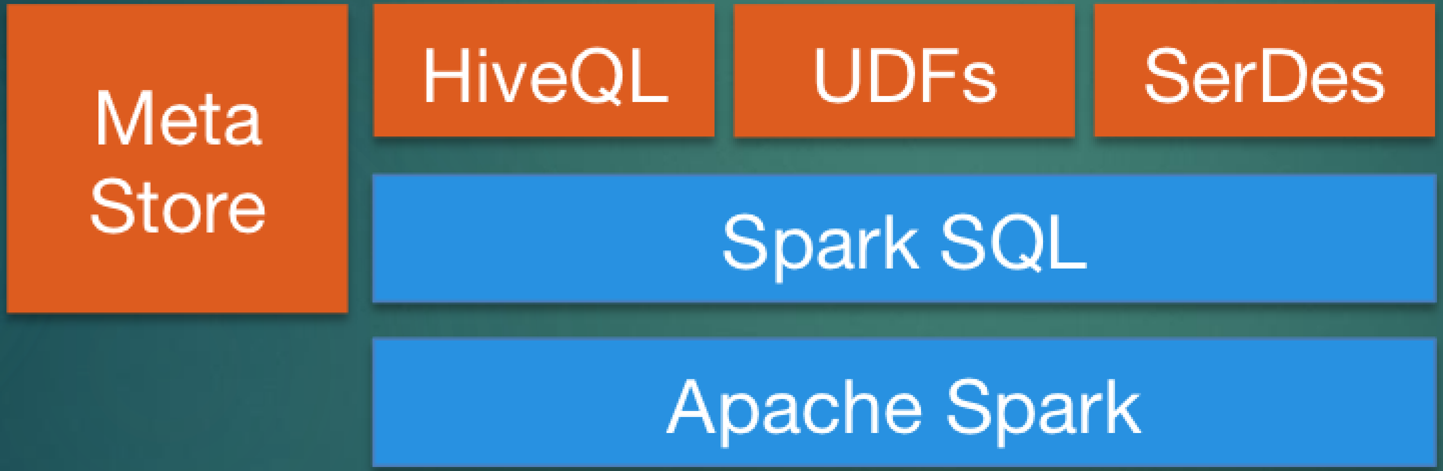
Why SparkSQL: cont…

- Uniform Data access

```
context.jsonFile(“filename.json")
  .registerTempTable("json")
results = context.sql(
  '""'SELECT *
     FROM people
     JOIN json ...'""')
```

Why SparkSQL: cont…

- Hive Integration



Meta Store

HiveQL

UDFs

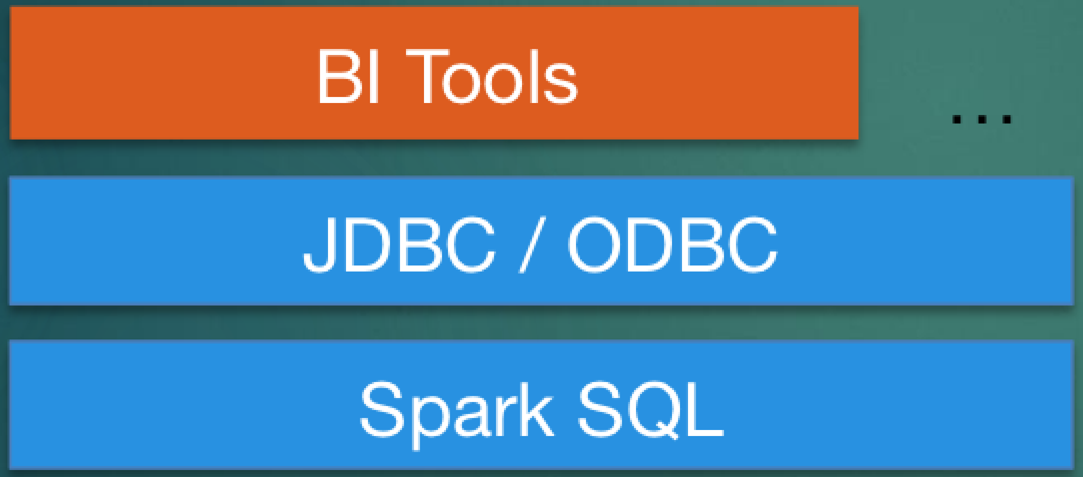
SerDes

Spark SQL

Apache Spark

Why SparkSQL: cont…

- Standard Connectivity



BI Tools

…

JDBC / ODBC

Spark SQL

Introduction

- Relationship with Shark project
  - Shark had limited integration with Spark
  - Hive optimizer was not best fit for Spark
  - Spark SQL reused Hive data loading as well as in-memory column storage features of Shark
  - Additionally, introduced RDD-aware optimizer and rich language interface

Data holders

- RDD
- Dataframe: RDD with schema
- Dataset:

  introduced in 1.6 version

  provides strong type over RDD

Data source

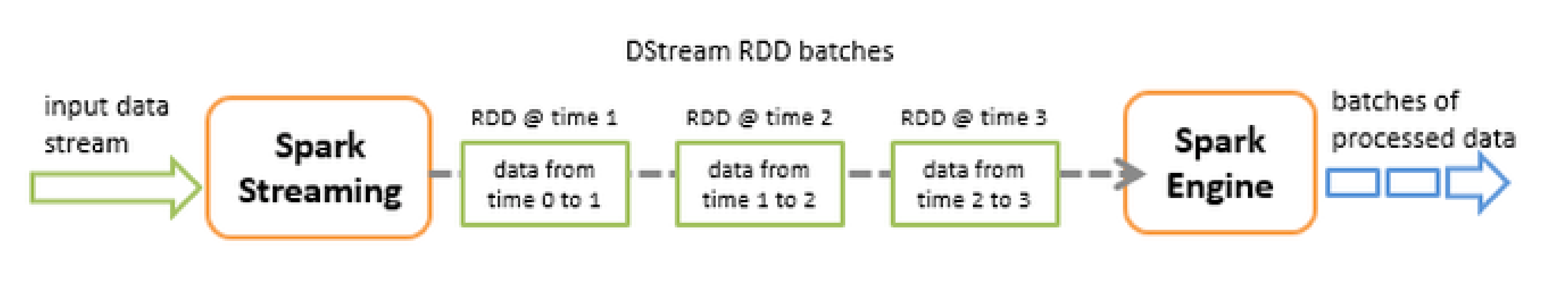
- Hive existing table
- Structured files. Json file for example
- RDD

Hive integration

- Can use most of the SQL features available in Hive
- Insert data through Spark and read in Hive
- Executes DDL statements
- Refers Hive metastore for metadata

Spark
Streaming

DStream


DStream RDD batches
input data stream
Spark Streaming
RDD @ time 1
data from time 0 to 1
RDD @ time 2
data from time 1 to 2
RDD @ time 3
data from time 2 to 3
Spark Engine
batches of processed data

Source

- Kafka
- Flume
- HDFS/S3
- Amazon Kinesis
- Twitter

Storage/Target

- HDFS
- Databases
- Dashboard

Program flow

- Set streaming context
- Define source for the streaming context
- Apply all transformations of Dstream
- Start the streaming context

Examples

- https://github.com/apache/spark/tree/master/examples/src/main/scala/org/apache/spark/examples

Persist/Cache data

- Helpful to reuse the same dataset

- Multiple storage levels:
  https://spark.apache.org/docs/latest/rdd-programming-guide.html

- How to check current storage level:
  <Object name>.getStorageLevel

Further studies

- https://www.cloudera.com/documentation/enterprise/5-6-x/PDF/cloudera-spark.pdf
- https://databricks.com/product/getting-started-guide/quick-start
- Cloud hosted community spark setup

  https://community.cloud.databricks.com/

References

- http://spark.apache.org/docs/1.3.0/cluster-overview.html
- Hadoop: the definitive guide 4th edition