PYSPARK IN PRACTICE

PySpark as a stack for IoT Data Analysis

Agenda

- 4 Stage Solution Architecture for IoT
- Unique Challenges for IoT Analytics
- Short introduction of Spark and PySpark
- Data structures in Spark
- Transformations
- Actions
- Walk through of some code
- Industry use cases
- NCR’s Predictive Maintenance using Spark
- Questions

About Me....

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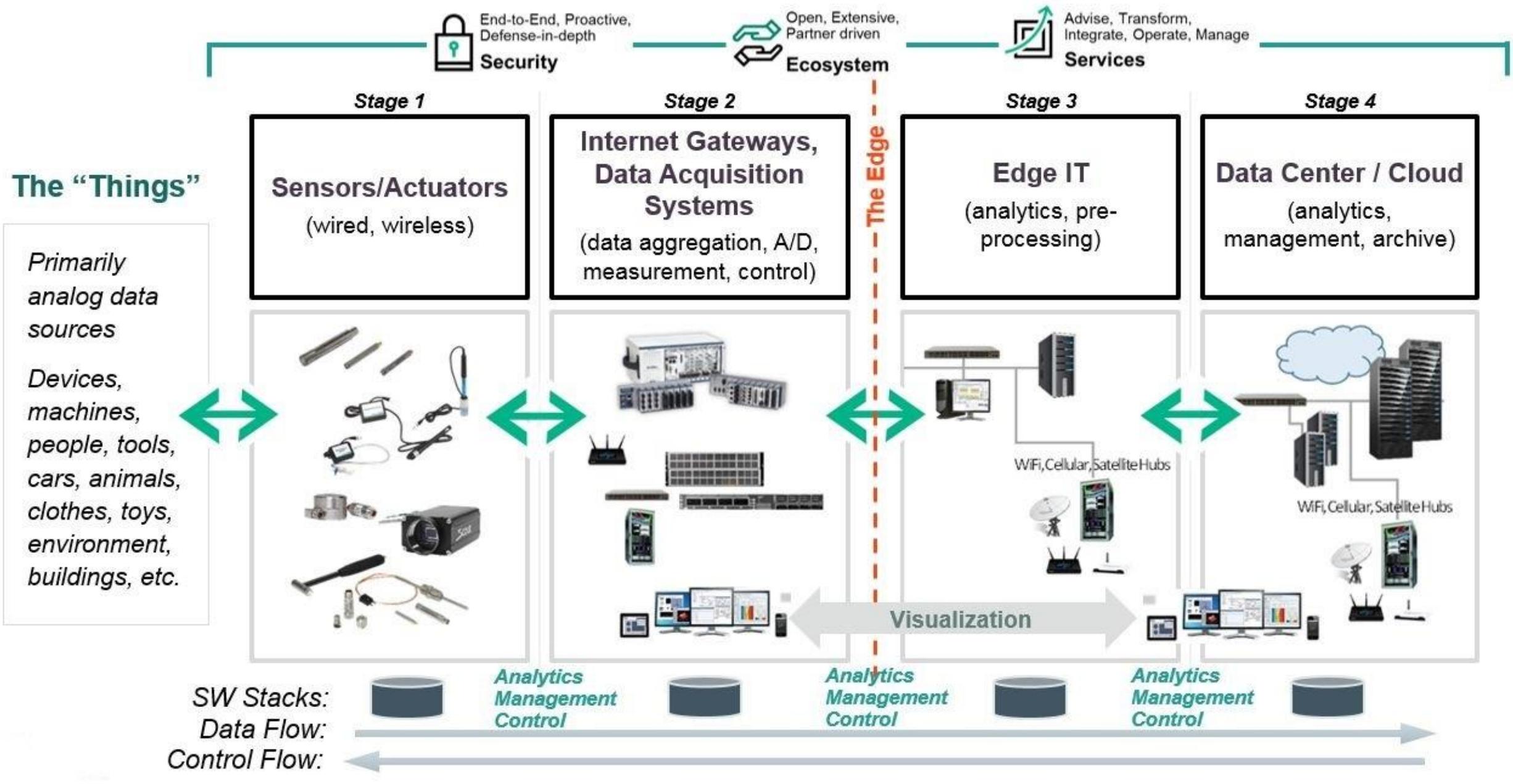
The 4 Stage IoT Solutions Architecture



Source: https://techbeacon.com/4-stages-iot-architecture

Unique Challenges for IoT Analytics

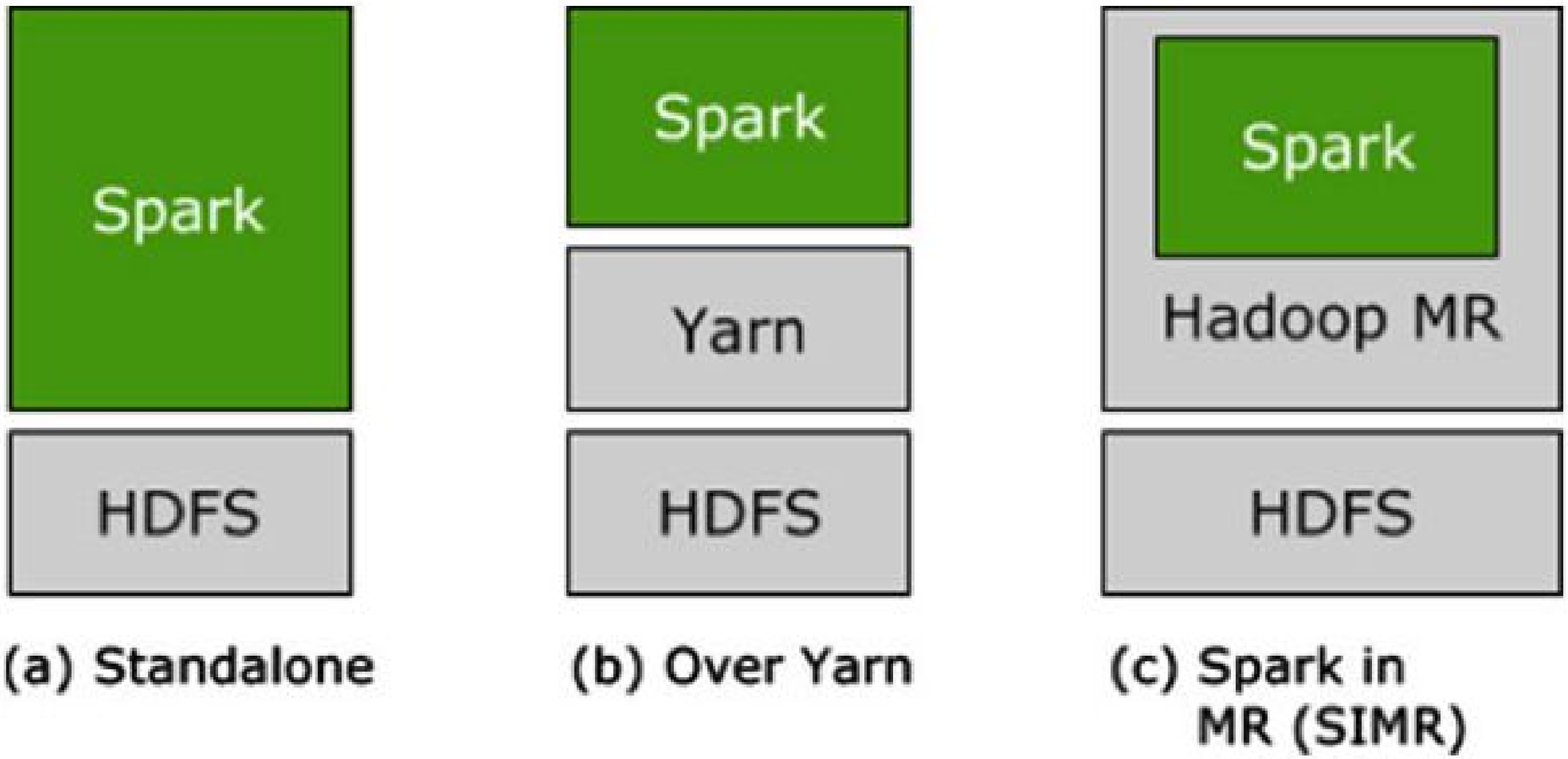
IoT projects generally fall into four categories:

1. Operational efficiencies (cited by 45% of ESG research respondents), such as preventative and predictive maintenance.
2. Better and differentiated customer service (39%), such as connectivity to enhance products like connected cars, consumer appliances, and industrial/construction equipment.
3. Creation of new products and services (38%), via visibility into product or equipment performance and diagnostics.
4. Development of new business models (26%), including shifting from product sales to “as-a-service” models.

What is Apache Spark?

- A fast and general engine for large-scale data processing
- An Open-source cluster computing framework
- End-to-End Analytics platform
- Developed to overcome limitations of Hadoop/Map Reduce
- Runs from a single desktop or a huge cluster
- Iterative, interactive or stream processing
- Supports multiple languages –Scala, Python, R, Java
- Major companies like Amazon, eBay, Yahoo use Spark.

Spark Execution Models

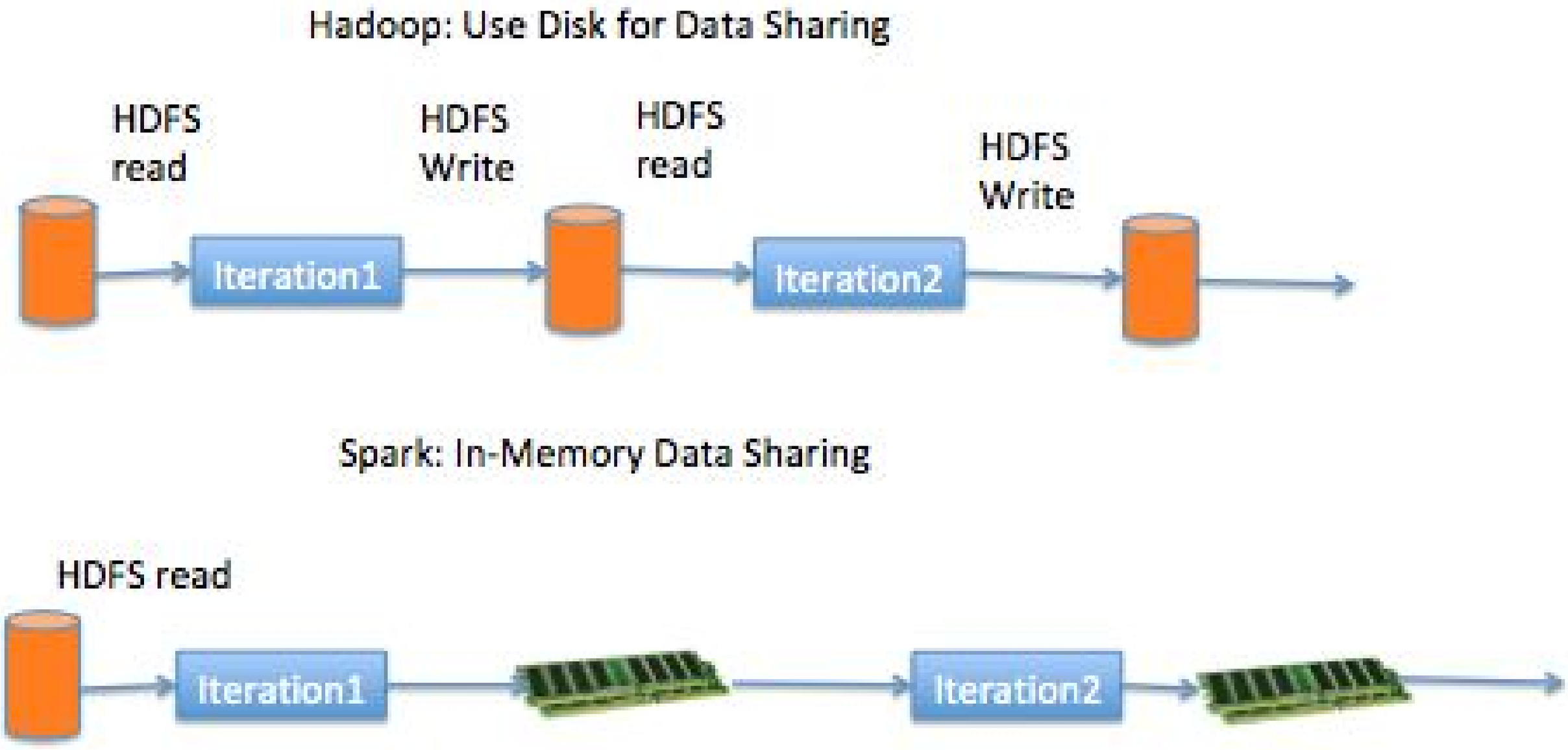


(a) Standalone (b) Over Yarn (c) Spark in MR (SIMR)

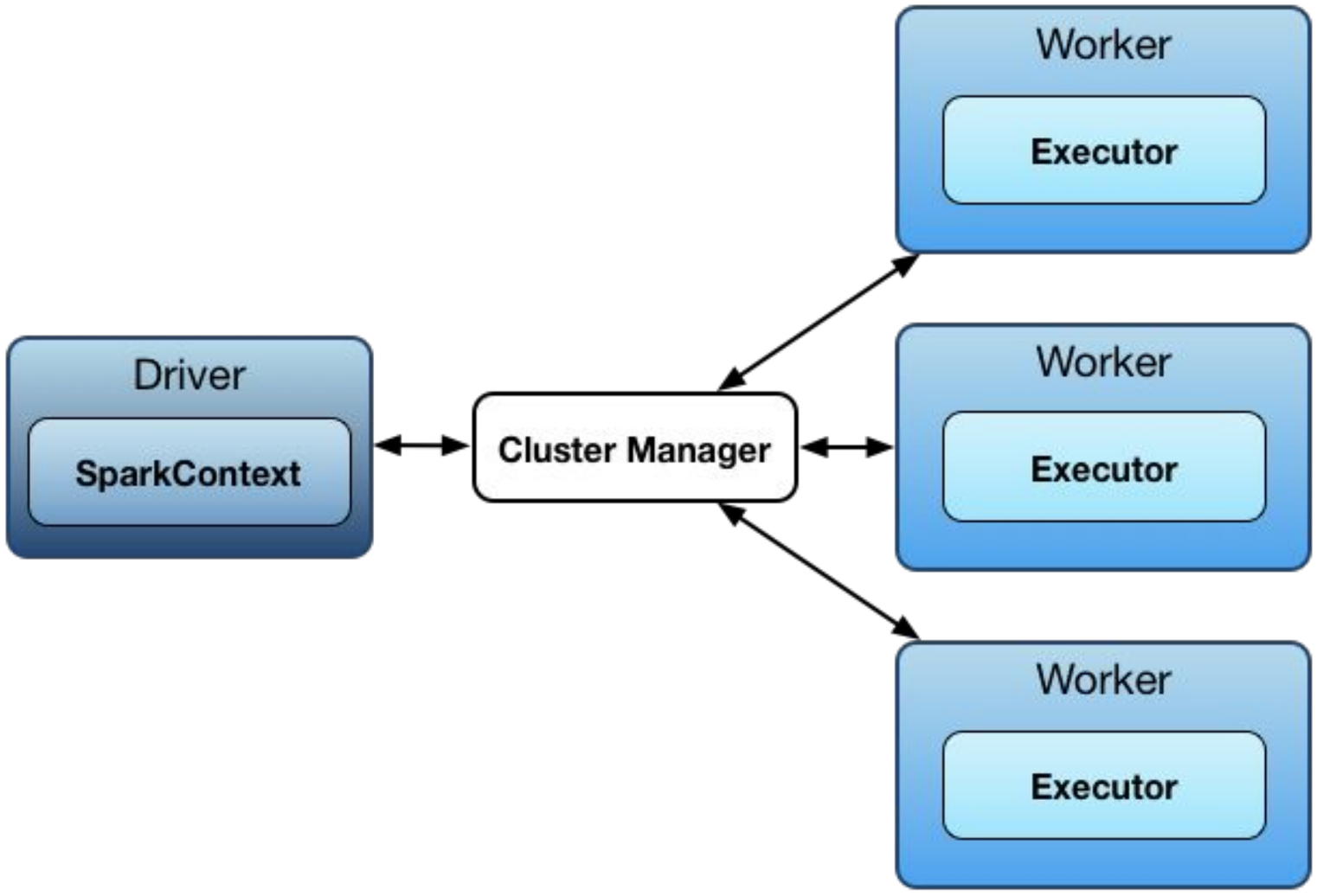
There are three ways Apache Spark can run :

1. **Standalone** – The Hadoop cluster can be equipped with all the resources statically and Spark can run with MapReduce in parallel. This is the simplest deployment.
2. **On Hadoop YARN** – Spark can be executed on top of YARN without any pre-installation. This deployment utilizes the maximum strength of Spark and other components.
3. **Spark In MapReduce (SIMR)** – If you don't have YARN, you can also use Spark along with MapReduce. This reduces the burden of deployments.

Spark Uses Memory instead of Disk

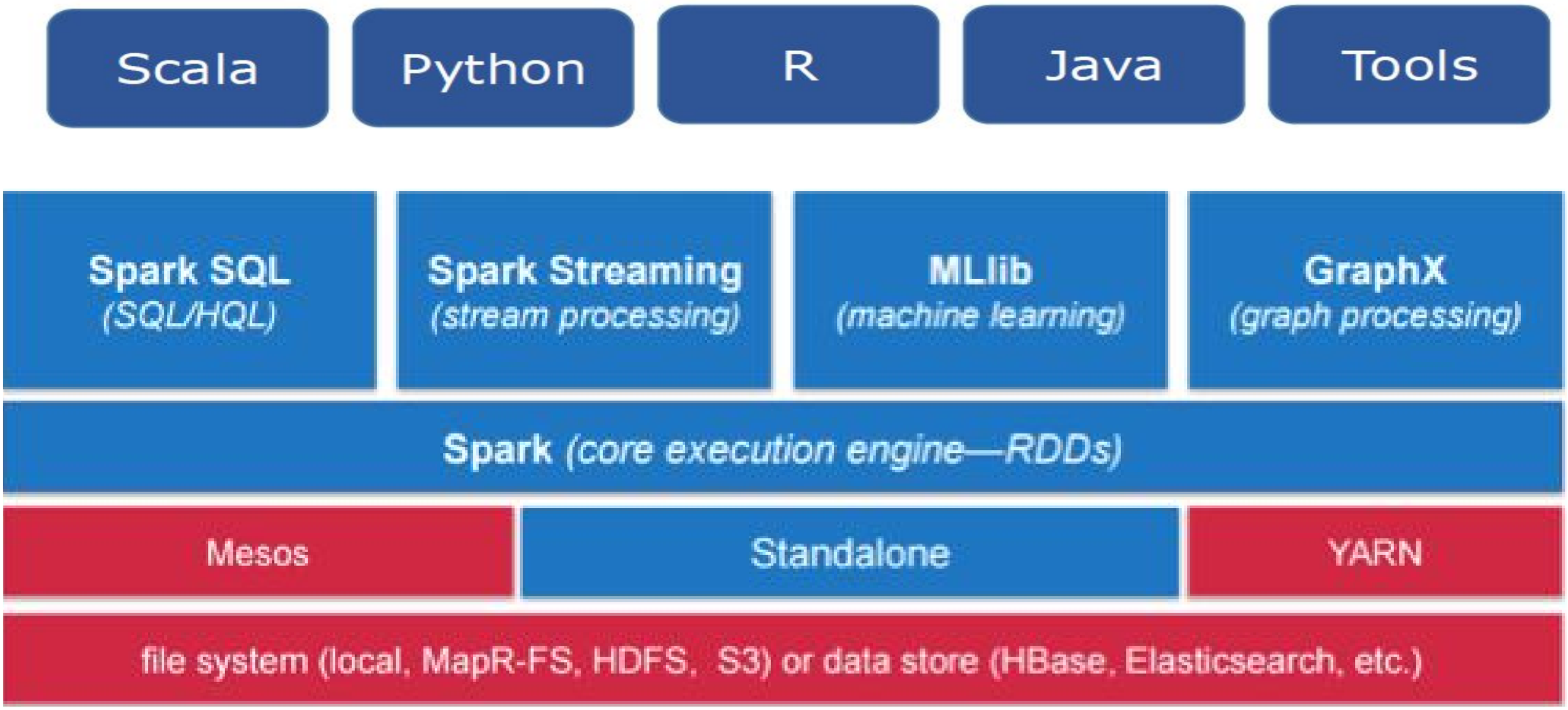


Spark Architecture



- Spark uses a **Master/Worker** Architecture.
- There is a Driver talks to a single coordinator called **Master / Cluster Manager** that manages **workers** in which the **executors** run.

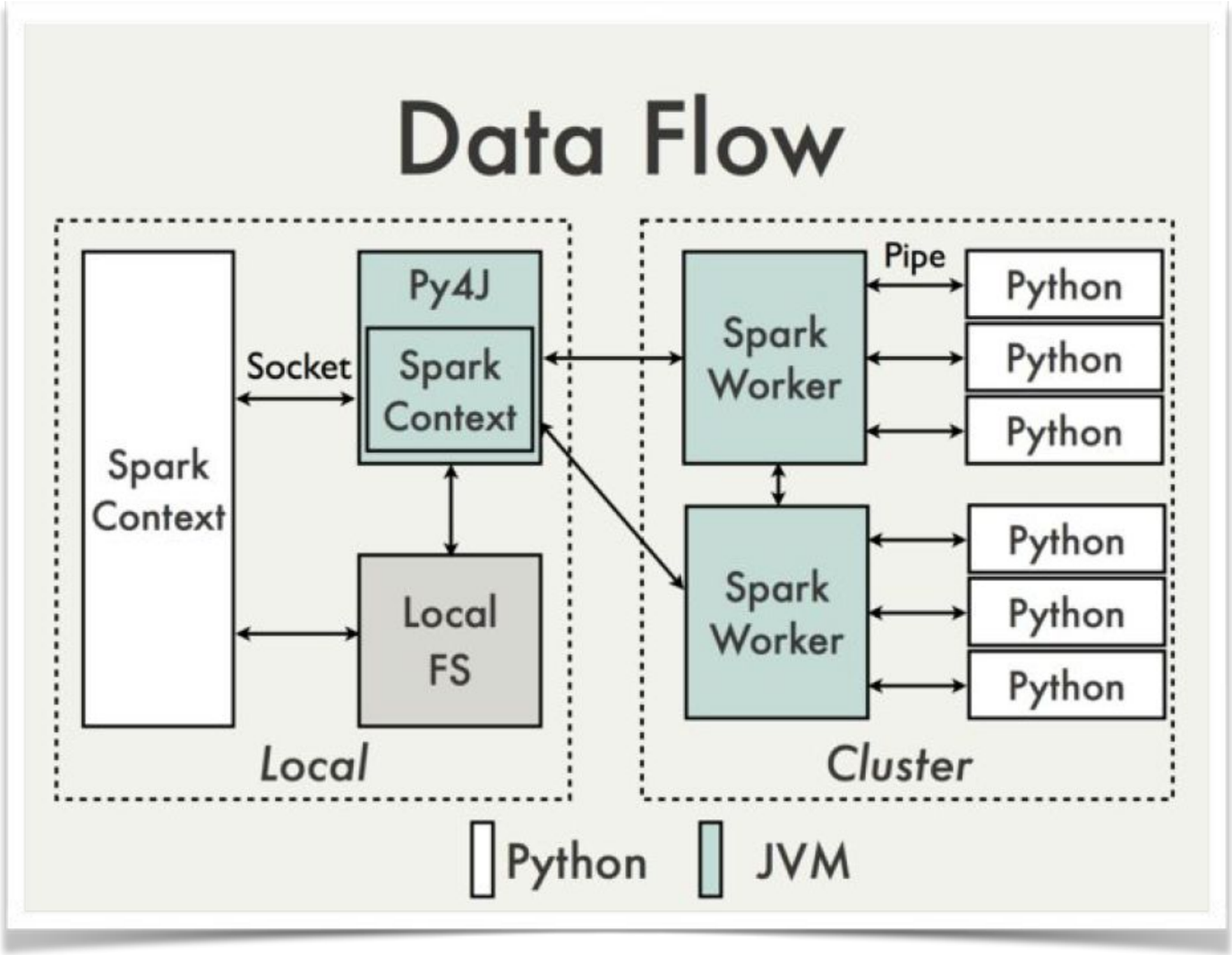
Spark Framework



One Solution in Spark

- A new general framework, which solves many of the shortcomings of MapReduce
- It capable of leveraging the Hadoop ecosystem, e.g. HDFS, YARN, HBase, S3, …
- Has many other workflows, i.e. join, filter, flatMapdistinct, groupByKey, reduceByKey, sortByKey, collect, count, first…
  - (around 30 efficient distributed operations)
  - in-memory caching of data (for iterative, graph, and machine learning algorithms, etc.)
- Native Scala, Java, Python, and R support
- Supports interactive shells for exploratory data analysis
- Spark API is extremely simple to use
- Developed at AMPLab UC Berkeley, now by Databricks.com

What is PySpark



- **PySpark** helps users interface with Resilient Distributed Datasets in apache spark and python.
- Py4J is a popularl library integrated within **PySpark** that lets python interface dynamically with JVM objects (RDD's).

DATA STRUCTURES

There 3 Data Structures in Spark,

1. RDD
2. DataFrames
3. DataSets

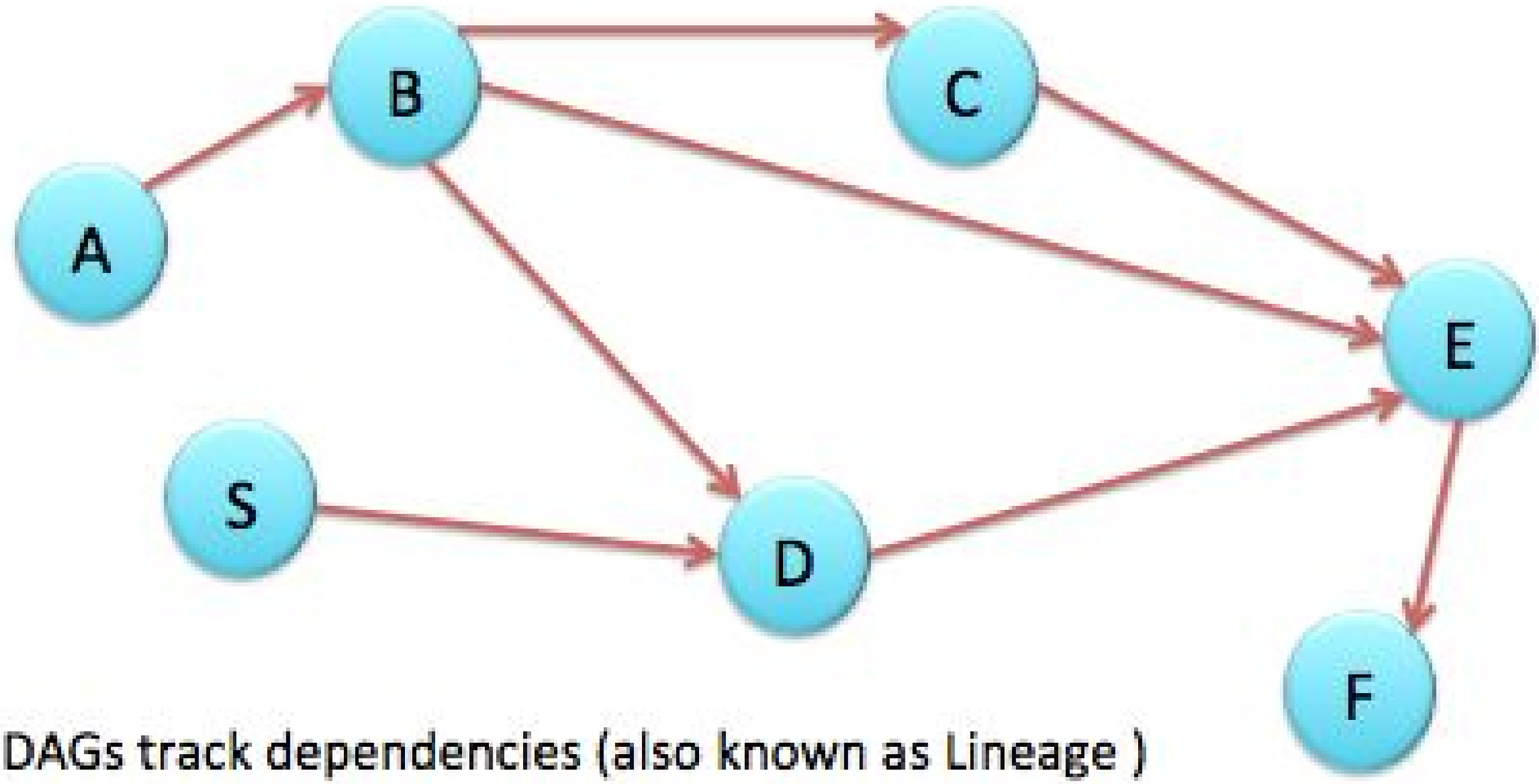
RDD abstraction

- → Resilient Distributed Datasets
- → Building blocks of Spark and original API's
- → Partitioned collection of records
- → Spread across the cluster
- → Read-only
- → caching dataset in memory
  - ◆ different storage levels available
    - The Storage tab on the **Spark** UI shows where partitions exist (**memory** or disk) across the cluster at any given point in time. Note that **cache**() is an alias for persist(StorageLevel.MEMORY_ONLY) which may not be ideal for **datasets** larger than available cluster **memory**.
  - ◆ fallback to disk possible

DataFrames & SparkSQL

- DataFrames (DFs) is one of the other distributed datasets organized in named columns
- Similar to a relational database, Python Pandas Dataframe or R's DataTables
  - Immutable once constructed
  - Track lineage - DAG's
  - Enable distributed computations
- How to construct Dataframes
  - **Read from file(s)**
  - **Transforming an existing DFs(Spark or Pandas)**
  - **Parallelizing a python collection list**
  - **Apply transformations and actions**

Directed Acyclic Graphs (DAG)

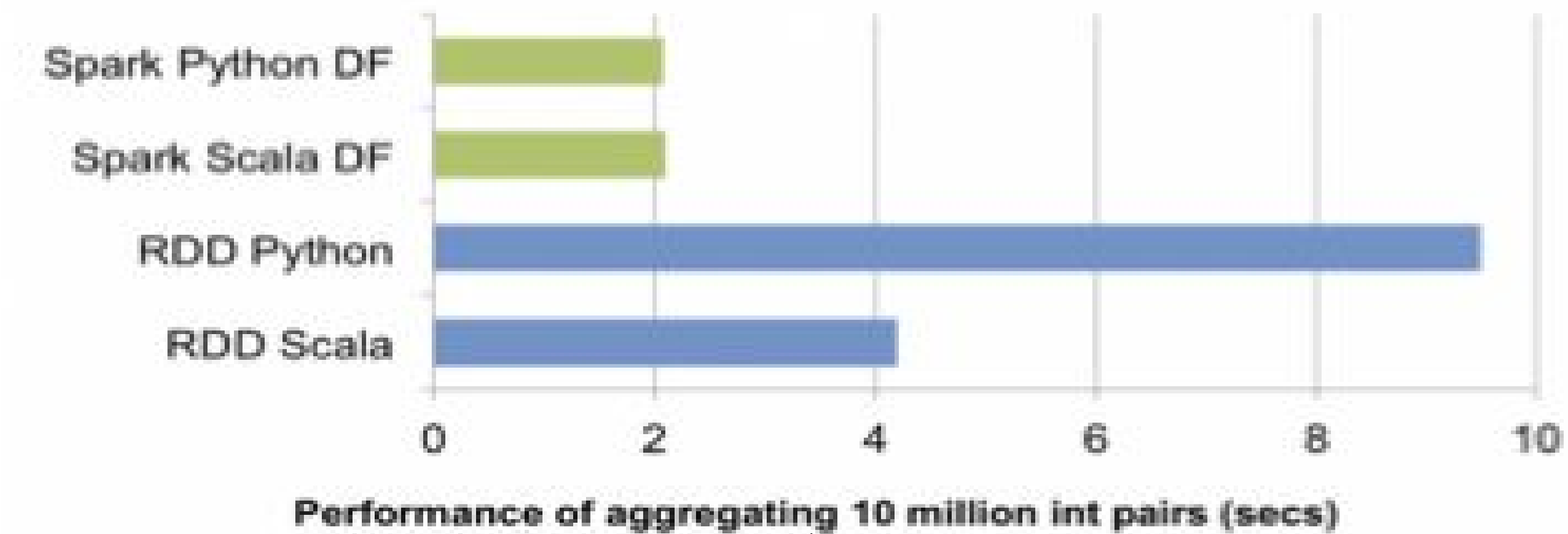


DAGs track dependencies (also known as Lineage)

- nodes are RDDs
- arrows are Transformations

RDDs vs. DataFrames

- RDDs provide a low level interface into Spark
- DataFrames have a schema
- DataFrames are cached and optimized by Spark
- DataFrames are built on top of the RDDs and the core Spark API



Spark operations

- *transformations* to build RDDs through deterministic operations on other RDDs
  - transformations include *map*, *filter*, *join*
  - lazy operation
- *actions* to return value or export data
  - actions include *count*, *collect*, *save*
  - triggers execution

Let's walk through the code samples for these and continue further

Spark in the Real World (I)

- Uber – the online taxi company gathers terabytes of event data from its mobile users every day.
  - By using Kafka, Spark Streaming, and HDFS, to build a continuous ETL pipeline
  - Convert raw unstructured event data into structured data as it is collected
  - Uses it further for more complex analytics and optimization of operations

- Pinterest – Uses a Spark ETL pipeline
  - Leverages Spark Streaming to gain immediate insight into how users all over the world are engaging with Pins—in real time.
  - Can make more relevant recommendations as people navigate the site
  - Recommends related Pins
  - Determine which products to buy, or destinations to visit

Spark in Real World(II)

- **NCR – National Cash Register company**
  - With an enterprise-grade data lake built on Hadoop/Spark, NCR can monitor every ATM it manufactured, everywhere, and build predictive models based on data from 100% of those ATMs.
  - By using Kafka, Spark Streaming, and HDFS, to build a continuous ETL pipeline
  - Convert raw unstructured event data into structured data as it is collected
  - A Predictive Maintenance Model is been built on Spark
  - The Model is productionised in May 2017 and is running successfully since then.

When to use Spark?

- Data Integration and ETL
- Interactive Analytics
- High Performance Batch computation
- Machine Learning and Advanced Analytics
- Real time stream processing and IoT
- **Example applications**
  a. Credit Card Fraud Detection
  b. Network Intrusion Detection
  c. Advertisement Targeting
  d. Predictive Maintenance for ATM’s

Spark: when not to use

- Even though Spark is versatile, that doesn't mean Spark's in-memory capabilities are the best fit for all use cases:
  - For many simple use cases Apache MapReduce and Hive might be a more appropriate choice
  - Spark was not designed as a multi-user environment
  - Spark users are required to know that memory they have is sufficient for a dataset
  - Adding more users adds complications, since the users will have to coordinate memory usage to run code

Questions?

- You can ask me any questions you have now. In future if you wanted to reach me, you can @ ksjpswaroop@gmail.com
- The code and slides are on github : https://github.com/ksjpswaroop/IoTConference-2017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SUKSAMA
EKHMET
SPASIBO
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