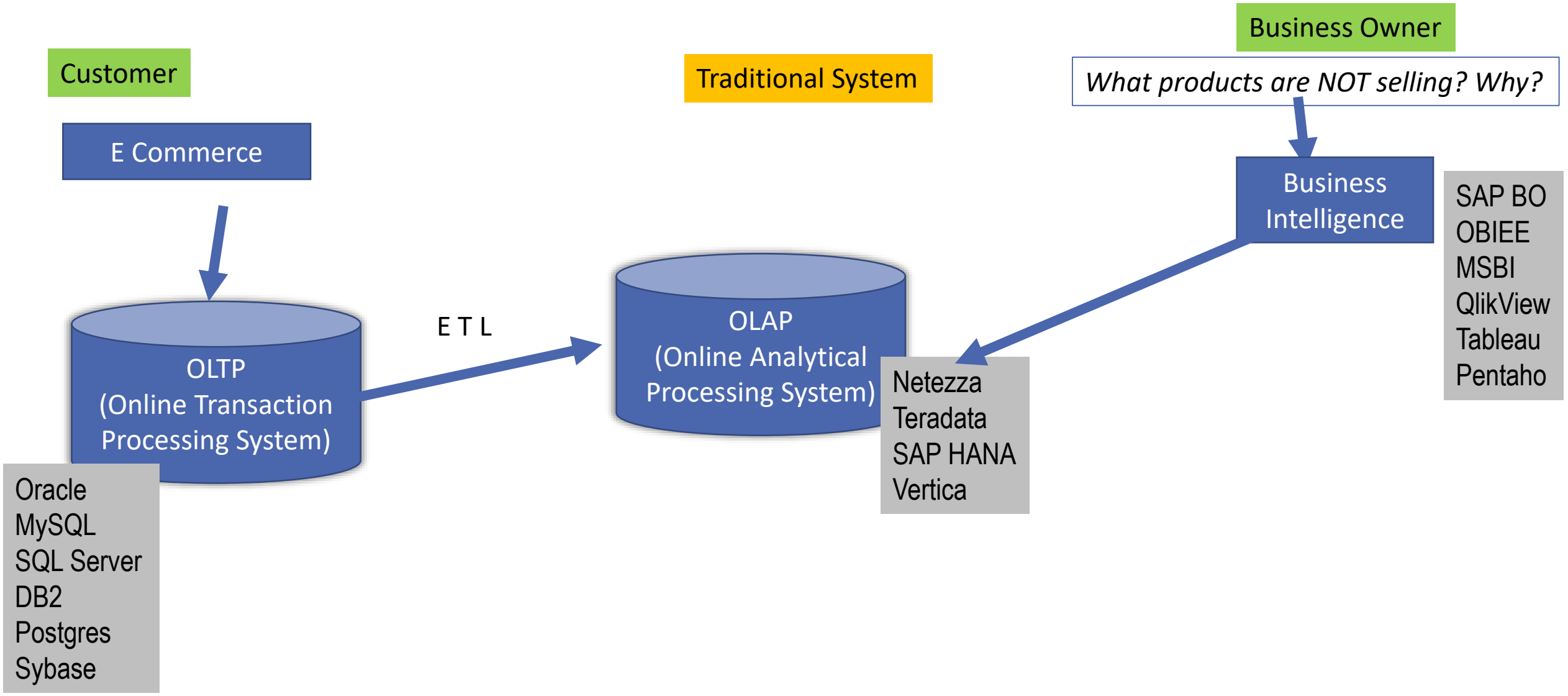
Understanding Hadoop and its ecosystem

Nagabhushan Mamadapur

Agenda – Day 1

- Introduction to Big Data & Hadoop
- Hadoop - Use Cases & History
- Working with Hadoop FsShell
- Hadoop Architecture

Traditional System



What is the traditional system?

- *Architecture is based on RDBMS (Relational Database Management System)*
- *Handling data in the enterprise*
- *Classifications*

- *OLTP --> Online Transaction Processing System*
- *Ex. A sale, POS*
- *Transactional Data, Customer data*
- *Oracle, MySQL, SQL Server, DB2, Sybase, PostgreSQL*

- *OLAP --> Online Analytical Processing System*
- *Ex. How is my business doing, profit, revenue and business metrics*
- *Analytics data, business owner*
- *Teradata, Netezza, SAP Hana, Vertica, Oracle*

What is Big Data? → Problem

- *3 Vs of Big Data*
  - *Volume → Size*
  - *Velocity → Speed*
  - *Variety → Different forms of data*

- *Hadoop's V → VALUE*

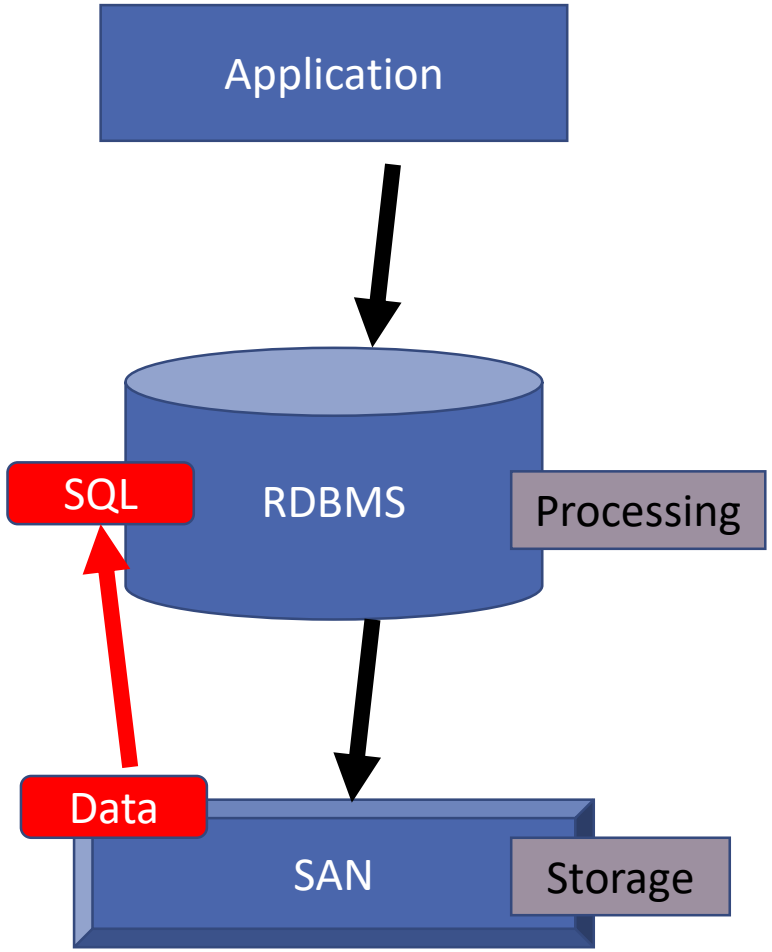
- *How to store Big Data? → HDFS*
- *How to process Big Data? → YARN*

Data Measurement Scale

1 Kilobyte	*KB*	*1000*
1 Megabyte	*MB*	*1000000*
1 Gigabyte	*GB*	*1000000000*
1 Terabyte	*TB*	*1000000000000*
1 Petabyte	*PB*	*1000000000000000*
1 Exabyte	*EB*	*1000000000000000000*
1 Zettabyte	***ZB***	***1000000000000000000000 X 16***
1 Yotabyte	*YB*	*1000000000000000000000000*

In Bytes

Problems with the traditional system



4 TB

- *Computation has been processor bound*
- *Intense processing on small amounts of data*
- *Goal was to have a bigger, powerful machine*
  - *Faster processor, more RAM*
- *Limitations to this approach*
  - *High Cost*
  - *Scalability*
  - *Latency (when the data is big)*

1 TB / day

Monolithic Computing

Challenges with the traditional system

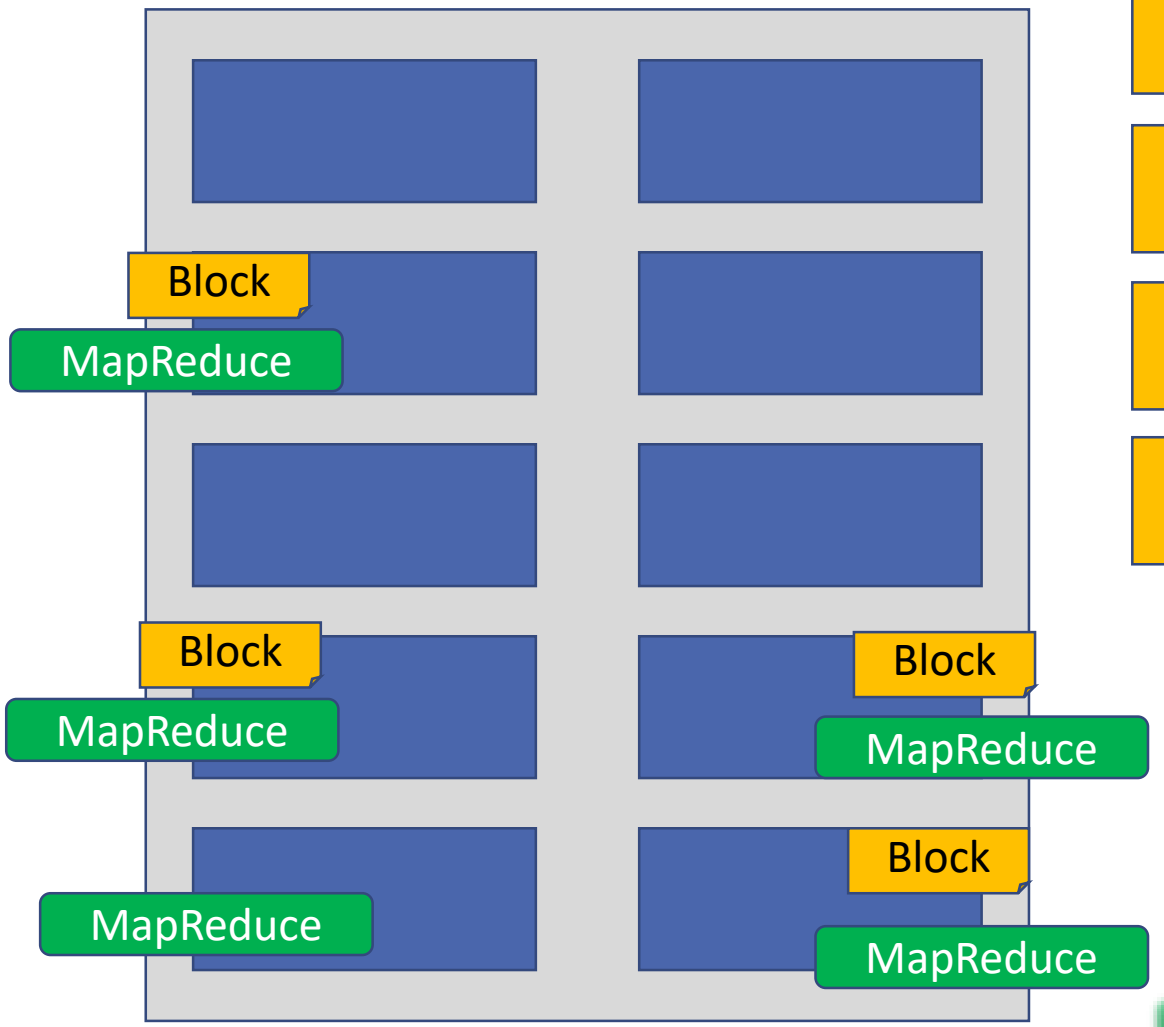
- *Handling Big Data*
- *Cost*
- *Scalability*
- *Latency*

Big Data Systems to the rescue → Hadoop

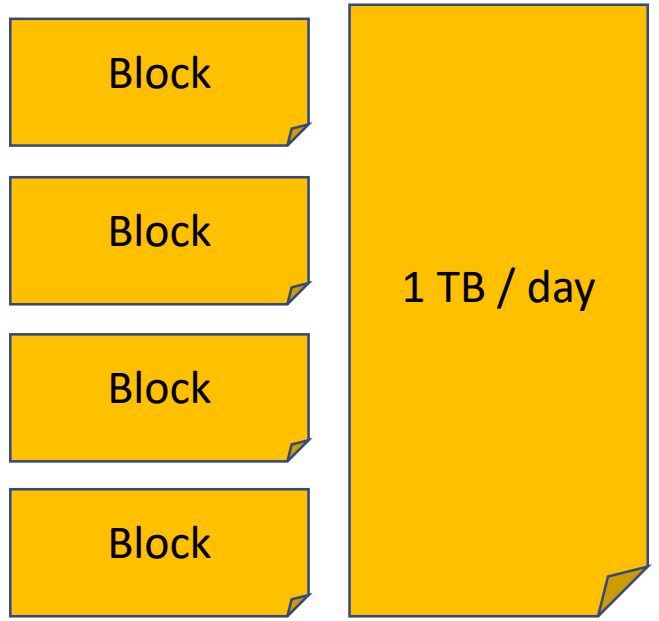
http://hadoop.apache.org

Per Node
- 8 Cores of Xeon Processor
- 64 GB RAM
- 24 TB Storage

Per Cluster
- 80 Cores CPU
- 640 GB RAM
- 240 / 4 TB Storage



10 Node Hadoop Cluster

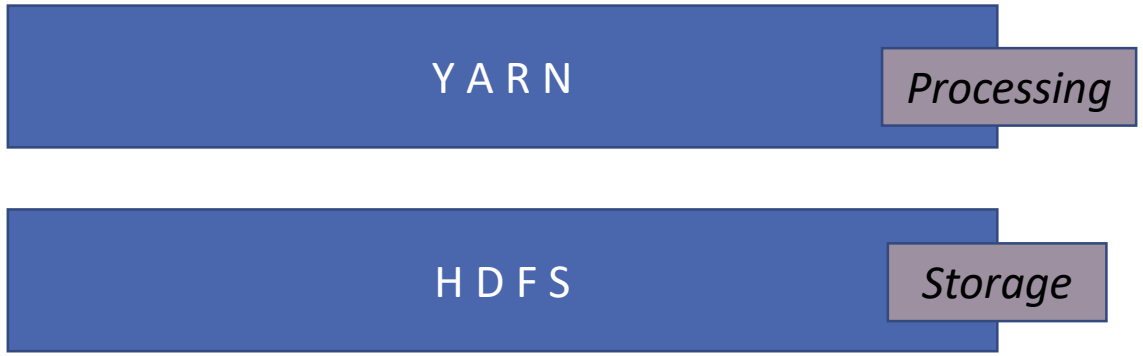


Distributed Computing

Hadoop Layout / Node

Yet Another Resource Negotiator

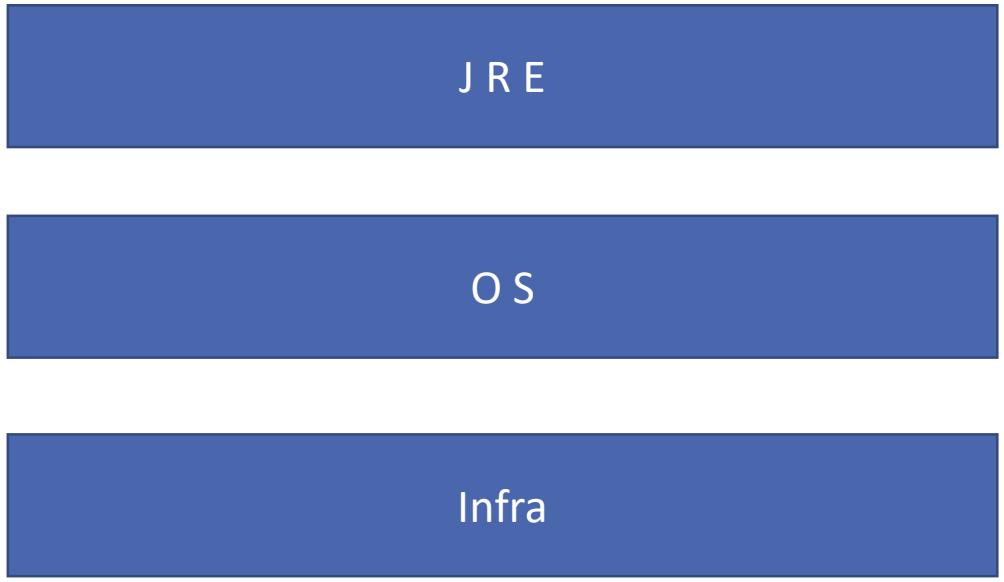
Hadoop Distributed File System



Java

Linux

Any Hardware



Features of Hadoop

- *Any infra*
- *Open source* http://hadoop.apache.org/
- *Distributed storage - Parallel processing*
- *Fault Tolerance - Hardware is prone to failure, high availability is handled by the framework*
- *Scale out architecture*
- *Each node is compute capable*
- *Data locality*
- *Hadoop can work on a single node up to 1000s of servers*
- *Distributed computing is reliable and scalable with Hadoop*
- *Hadoop framework is built in Java*

Note: HDFS datasets are immutable

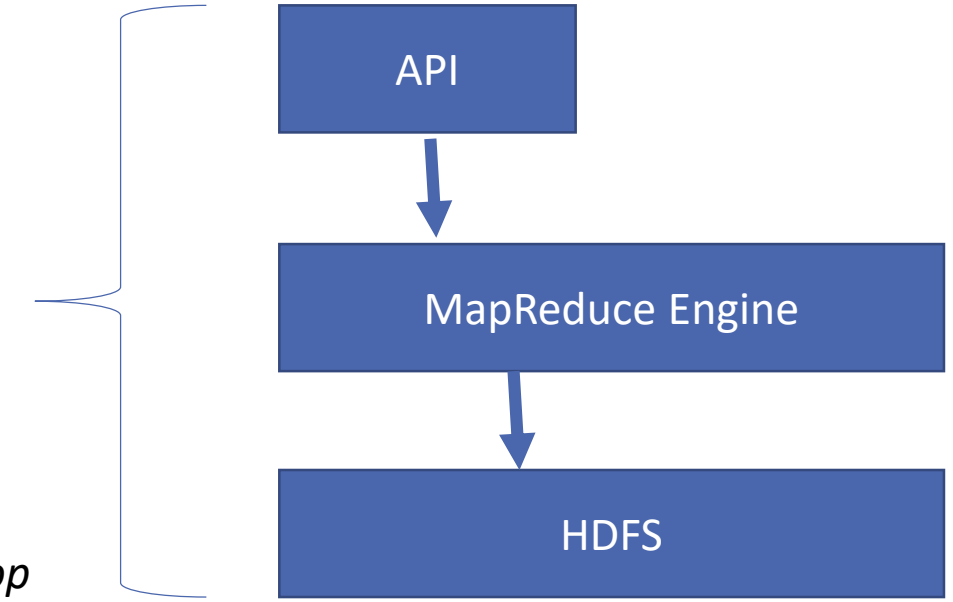
History of Hadoop

- *Google published whitepapers on GFS and MapReduce in 2004*
- *Yahoo hired Doug Cutting and Hadoop was born*
- *Yahoo handed over Hadoop project to Apache Software Foundation in 2006*

Java

Hadoop

Doug Cutting – Architect of Hadoop



Hadoop Ecosystem

HDFS + YARN + MapReduce

*Analytics → **Hive, Pig, Impala,** HBase, **Spark**…*

*Data Ingestion → **Sqoop, Flume,** Kafka*

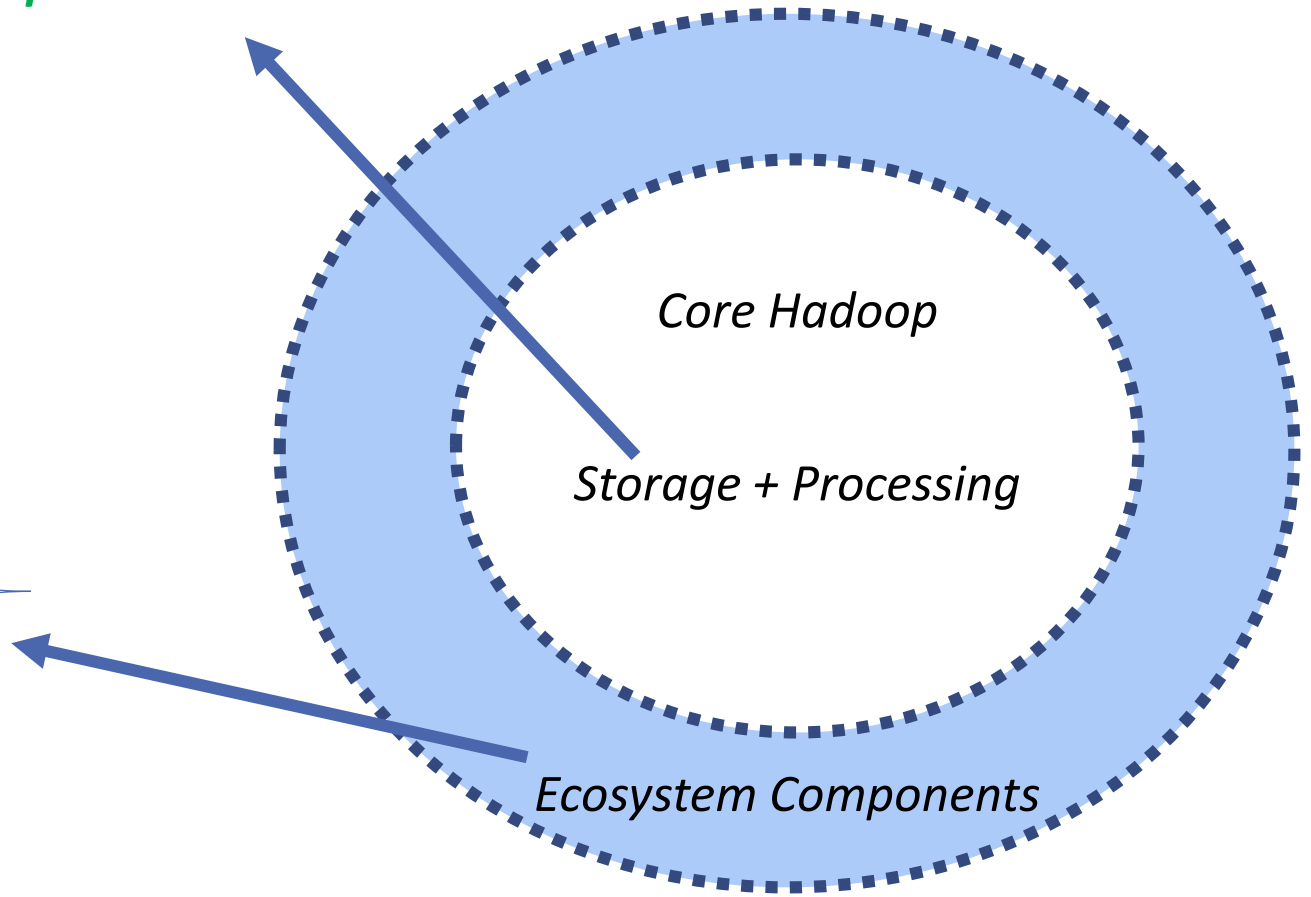
Administration → Ambari, Cloudera Manager, ZooKeeper

Security → Sentry, Kerberos

Workflows → Oozie

*Web UI → **Hue***

Reporting → Hue, Zeppelin

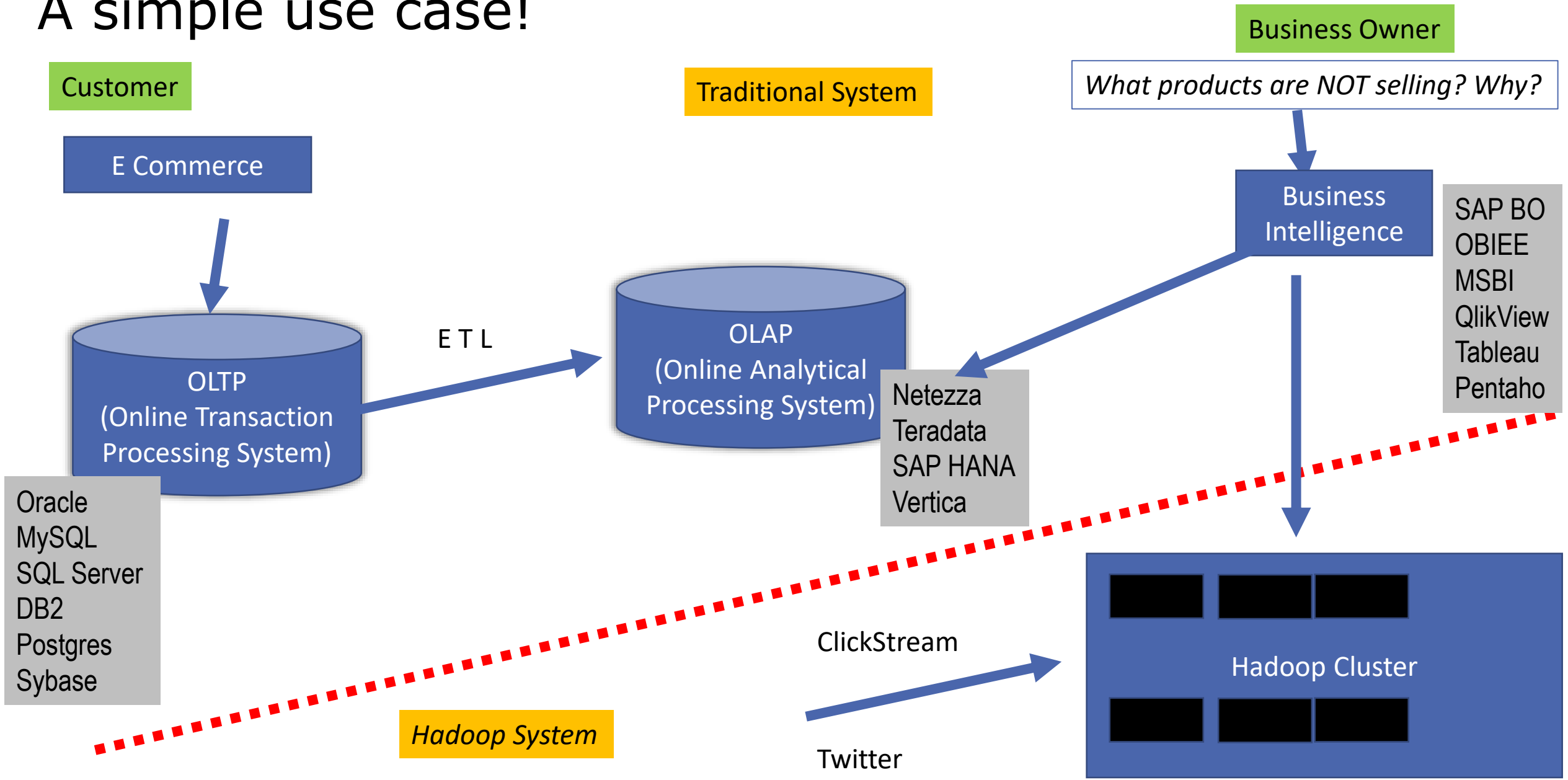


Commercial Distributions of Hadoop

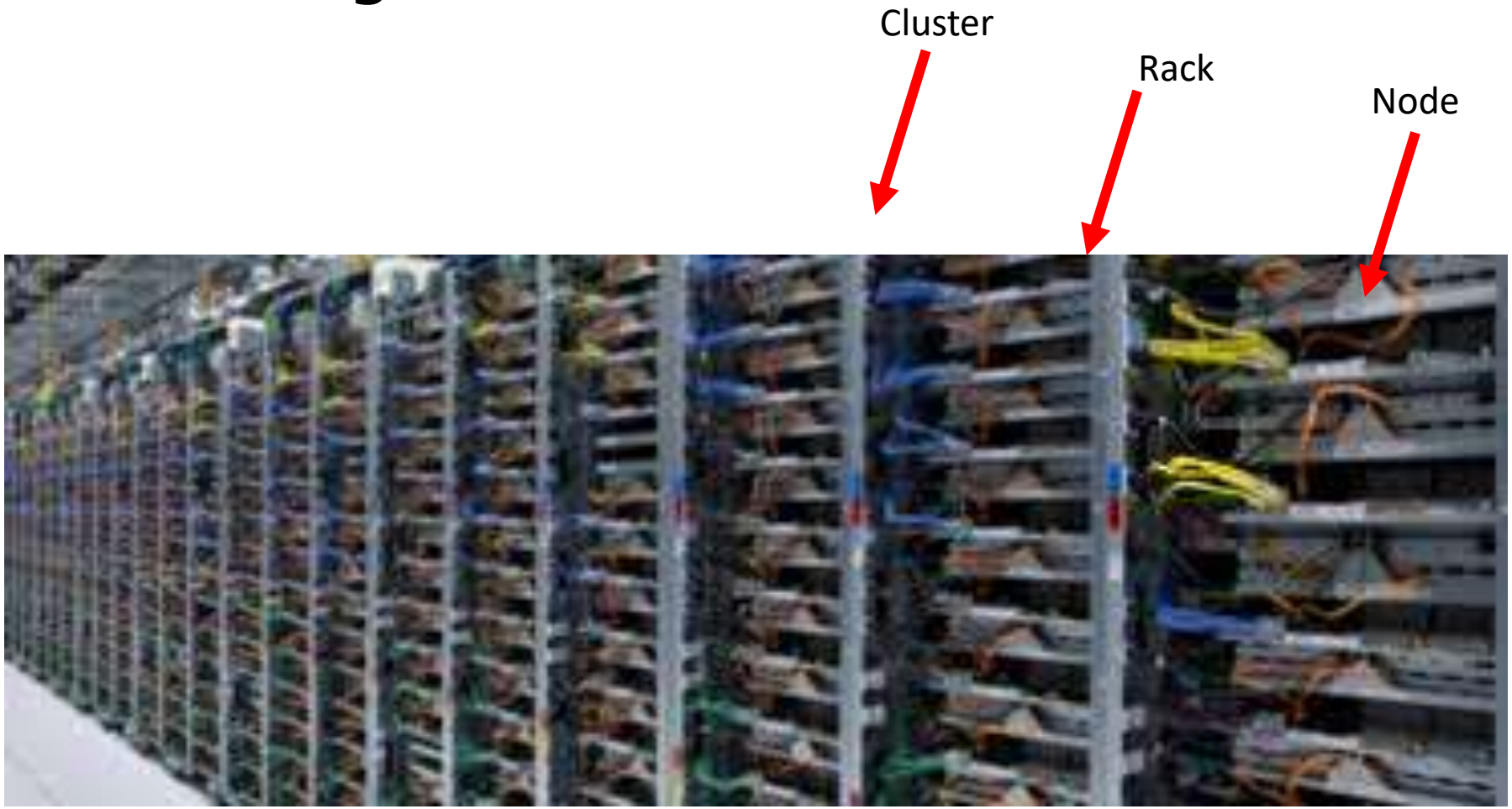
- *Cloudera* https://www.cloudera.com/
- *Hortonworks* https://hortonworks.com/
- *MAPR* https://mapr.com/
- *Big Insights (IBM)* https://www.ibm.com/analytics/us/en/technology/biginsights/

- *Apache Hadoop → Open Source* http://hadoop.apache.org/

A simple use case!

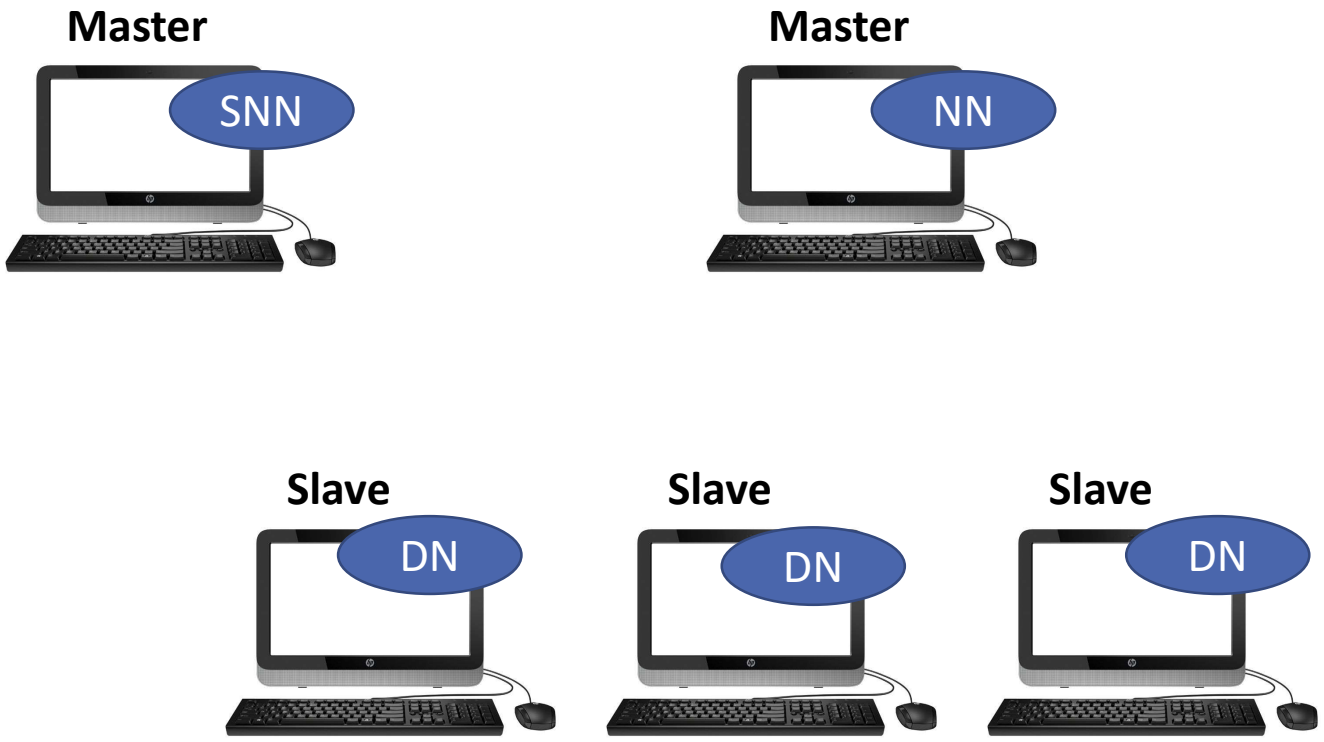


Hadoop Terminologies



HDFS Daemons

Master – Slave Architecture

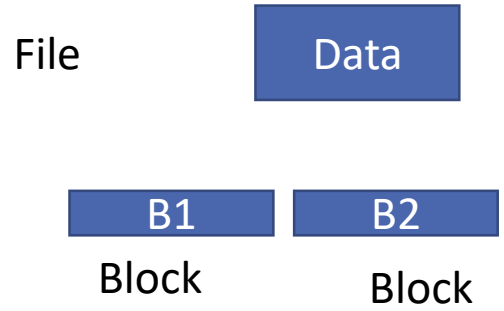


NN NameNode

DN DataNode

SNN Secondary NameNode

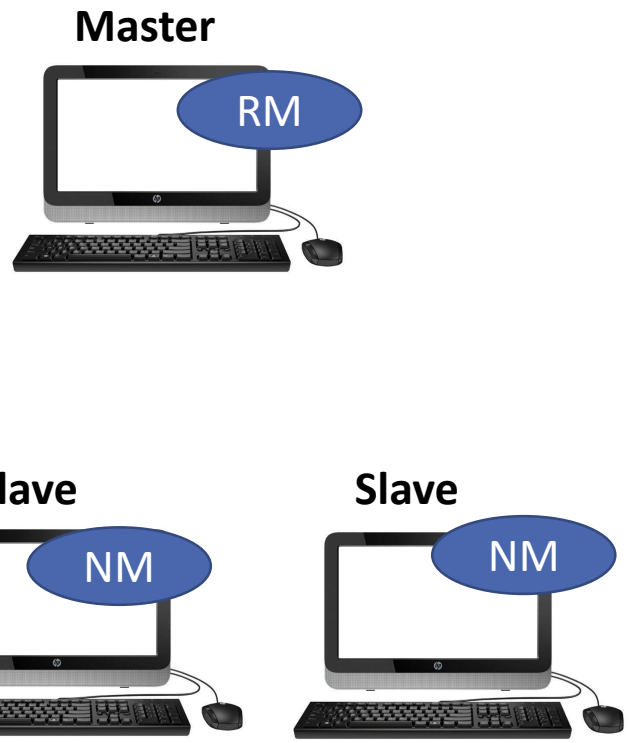
HDFS Components



- *NameNode* — *1 / cluster* — *Manage distribution, replication, maintain metadata*
- *Secondary NameNode* — *1 / cluster* — *Checkpoint Node*
- *DataNode* — *1 / Node* — *Store DataBlocks, Data Integrity*

YARN Daemons

Master – Slave Architecture



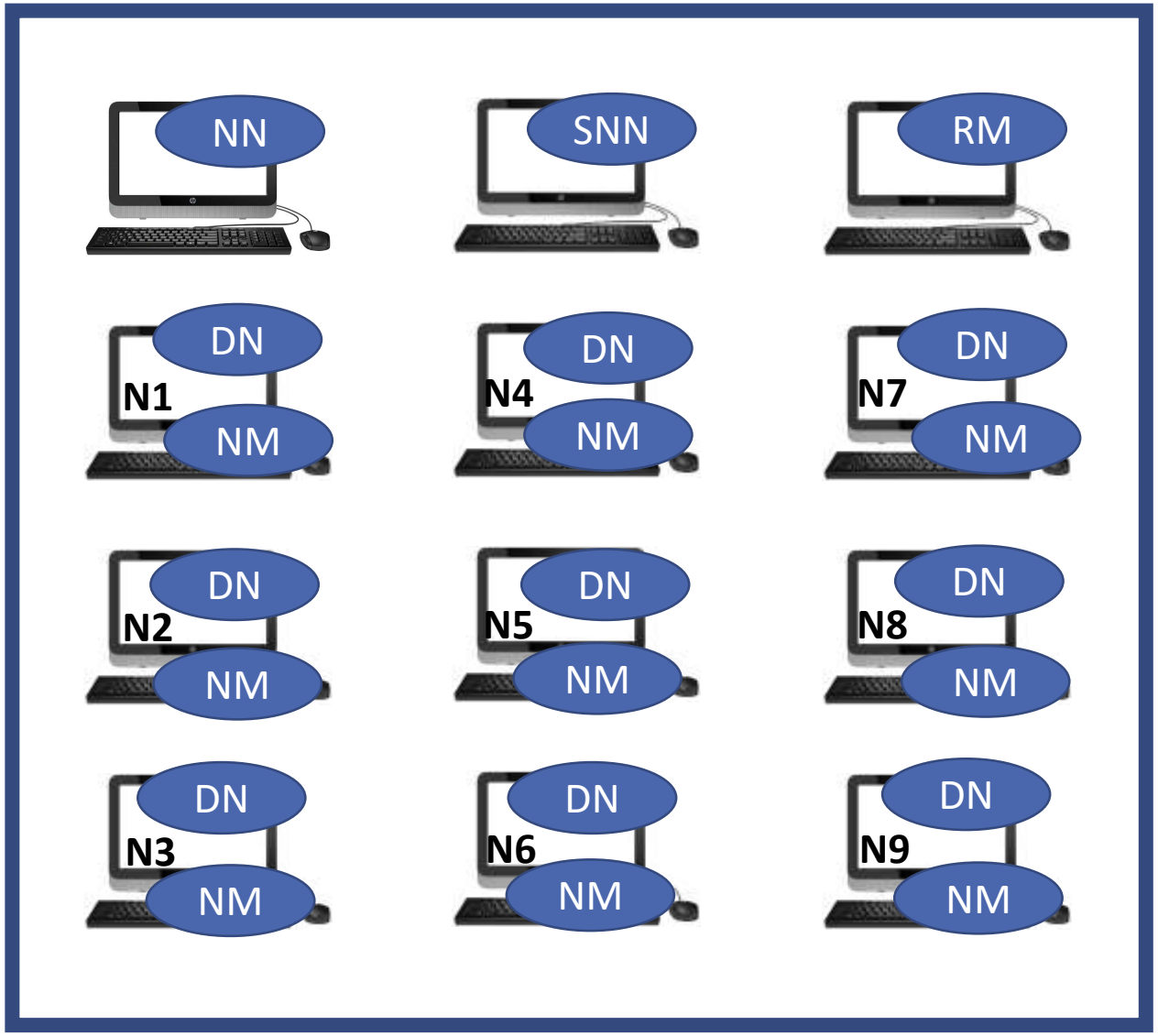
RM ResourceManager

NM NodeManager

Hadoop Daemons distributed over a cluster

Hadoop binaries and configs

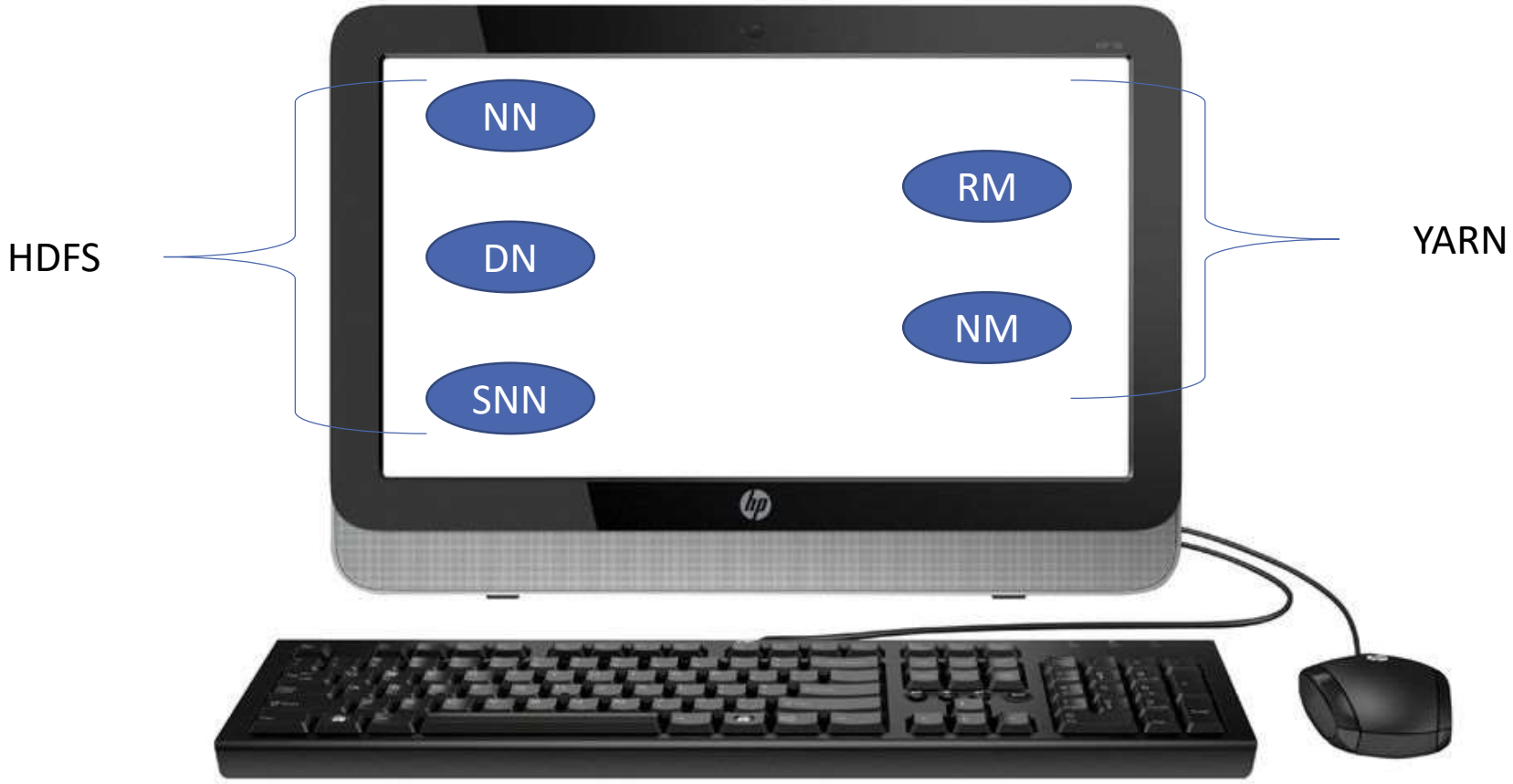
Gateway / Client node



DataNode and NodeManager co-exist

Hadoop Daemons distributed over a single node

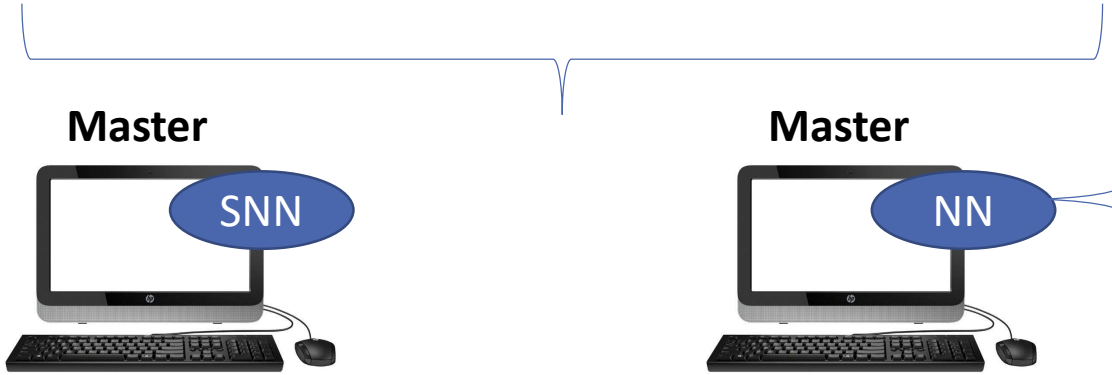
Pseudo Distributed Mode



HDFS Daemons - Responsibilities

Master – Slave Architecture

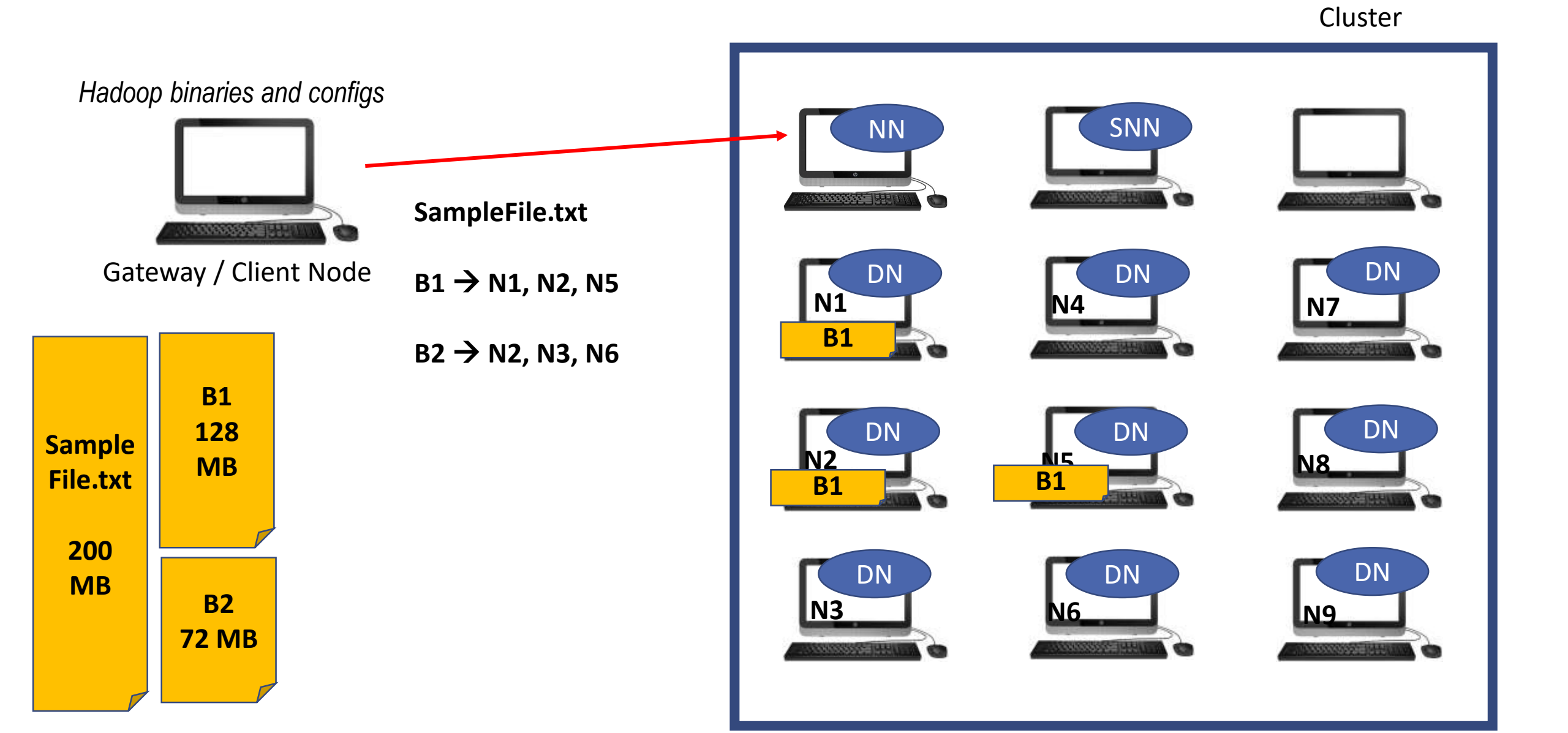
- *Checkpointing*
  - *Merge EditsInProgress with FSImage at regular intervals*



- *Stores metadata of the FileSystem*
  - *File Vs Block Mapping*
  - *Block Vs Node Mapping*
- *Allocate DN for a file to be written*
- *Manages Fault Tolerance*
- *The metadata is stored on the local file system of the node running NN*

- *Stores DataBlocks of a file*
- *Data Integrity*
- *Sends regular heartbeats to the NN*
- *The DataBlocks reside on the local file system of the node running DN*

HDFS Daemons distributed over a cluster



Rack Awareness

- *Common case where the replication factor is 3, HDFS block placement policy is to*
  - *Place the 1st block on a node in a local rack*
  - *Place the 2nd block on a different node in the same rack*
  - *Place the 3rd block on a different node in a remote rack*

http://hadoop.apache.org/docs/r2.7.5/hadoop-project-dist/hadoop-hdfs/HdfsDesign.html

Hadoop Setup

Infra

- In premise
- Cloud – AWS / GCP / Azure…
- Virtualization

http://virtualbox.org/

OS Distribution

- RHEL
- CentOS
- Ubuntu
- Fedora
- SUSE
- …..

Java Distribution

- Open JDK
- Oracle JDK
- IBM JDK
- ….

Hadoop Distribution

- Cloudera
- Hortonworks
- Apache
- MapR
- Big Insights

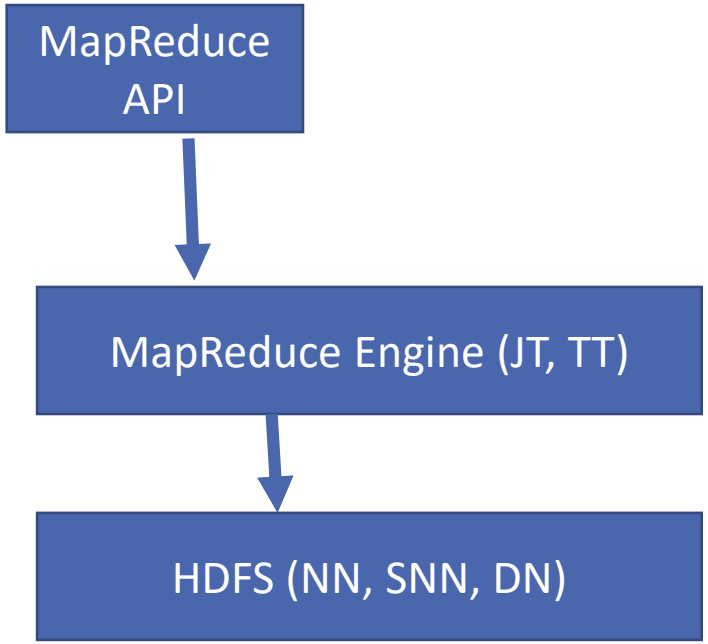
Hadoop Setup Mode

- Standalone Mode
- Pseudo Distributed Mode
- Fully Distributed Mode

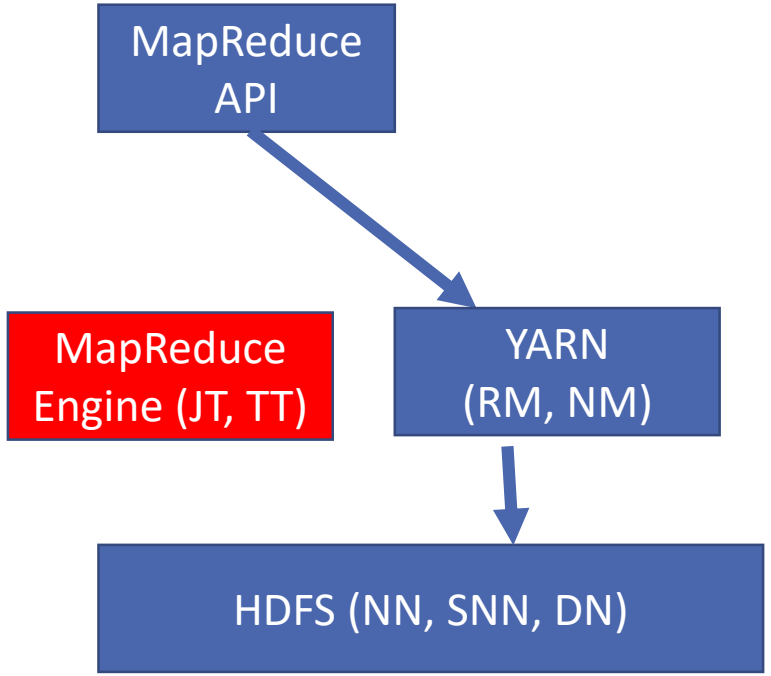
Hadoop Setup Modes

- Standalone Mode
  - Single node, non distributed (Default)
  - Hadoop works as a single Java Process
- *Pseudo Distributed Mode*
  - *Single node, distributed*
  - *Each Hadoop daemon runs inside a separate JVM*
    - *HDFS → 1 NN, 1 DN, 1 SNN*
    - *YARN → 1 RM, 1 NM*
- Fully Distributed Mode
  - Multi node, distributed
  - Hadoop daemons are distributed among many nodes → Typical production environment

Hadoop 1.x



Hadoop 2.x



Hadoop FsShell

- *FsShell is a command line interface that lets user interact with data in HDFS*

Hadoop FsShell Reference

- http://hadoop.apache.org/docs/r2.7.5/hadoop-project-dist/hadoop-common/FileSystemShell.html

FsShell Commands

- `$ sudo jps`
- `$ hadoop fs -mkdir /Sample`
- `$ hadoop fs -ls /`
- `$ hadoop fs -put /home/cloudera/Desktop/Labs/SampleFile.txt /Sample/`
- `$ hadoop fs -cat /Sample/SampleFile.txt`
- `$ hadoop fs -mkdir /Sample1`
- `$ hadoop fs -cp /Sample/SampleFile.txt /Sample1/`
- `$ hadoop fs -cp /Sample/SampleFile.txt /Sample1/ - Error`
- `$ hadoop fs -cp /Sample/SampleFile.txt /Sample1/SampleFile1.txt`
- `$ hadoop fs -mv /Sample1/SampleFile.txt /Sample1/SampleFile2.txt`
- `$ hadoop fs -rm /Sample/SampleFile.txt`
- `$ hadoop fs -rm -r /Sample1`
- `$ hadoop fs -put /home/cloudera/Desktop/Labs/SampleFile.txt /Sample/`
- `$ sudo watch 'jps | grep -v jps | sort -k 2'`

HDFS metadata backup

Master

Metadata is stored in these 2 files

- *FileSystem Image ➔ fsimage_0000000000000000019*
- *Edit Log / Transaction log ➔ edits_inprogress_0000000000000000020*

Master

FSImage is stored on SNN also, however no edits in progress

- *FileSystem Image ➔ fsimage_0000000000000000019*

HDFS metadata backup

- *SNN is not a hot backup for the NN*
- *SNN periodically merges **edits in progress** with **FSImage***
  - *Every 1 hour (dfs.namenode.checkpoint.period = 3600) **OR***
  - *1 million txns on the edits_inprogress_xxx file (dfs.namenode.checkpoint.txns = 1000000)*
- ***NN is the Single Point of Failure. To minimize the risk workarounds are possible***
  - *Reduce the checkpoint interval*
  - *Run NN on a better hardware, also have manual copies of the metadata created at regular intervals*

Note: Starting Hadoop 2.x, HDFS high availability can be configured, by having an active NameNode and standby NameNode

Agenda – Day 2

- MapReduce Paradigm
- Hive
- Impala
- Sqoop

WebUI Ports

- *WebUI for accessing HDFS*
  - *NameNode WebUI - http://localhost:50070*
  - *Secondary NameNode WebUI – http://localhost:50090*
  - *DataNode WebUI - http://localhost:50075*
- *WebUI for accessing HDFS*
  - *ResourceManager WebUI - http://localhost:8088*
  - *NodeManager WebUI - http://localhost:8042*
  - *JobHistoryServer WebUI - http://localhost:19888*
- *HUE (Cloudera)*
  - *WebUI - http://localhost:8888*

Note: Port numbers are changing in Hadoop 3.x

YARN Daemons

Master – Slave Architecture

RM — ResourceManager

NM — NodeManager

YARN Components

Application Job

- *Resource Manager* — *1 / cluster* — *Scheduling + allocation of compute resources*
- *Application Master* — *1 / job* — *Monitoring*
- *Node Manager* — *1 / DN* — *Monitor containers on the node*
- *YarnChild* — *Compute Resources on NM also termed as "Resource Containers" = (CPU + RAM)*

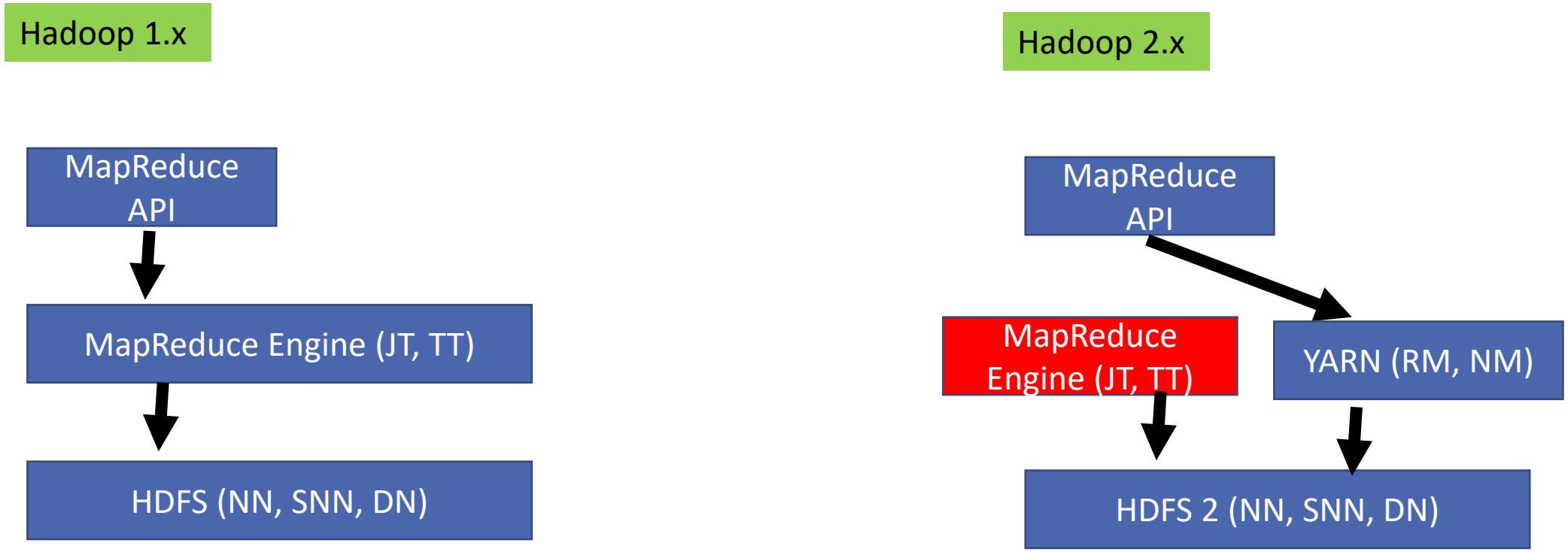
  Execution of tasks

Map Task Reduce Task

WordCount execution steps

- **Terminal 1**
  - `$ sudo watch 'jps | grep -v jps | sort -k 2'`
- **Terminal 2**
  - `$ yarn jar /usr/lib/hadoop-mapreduce/hadoop-mapreduce-examples.jar wordcount /Sample/SampleFile.txt /Sample/WC`
- **Once the program completed, check the output**
  - `$ hadoop fs -cat /Sample/WC/part-r-00000`

Hadoop 1.x Vs Hadoop 2.x



Hadoop 1.x Vs Hadoop 2.x

Hadoop 1.x

- *Scalability 4000+ nodes*
- *No High Availability on masters (Ex. NN, JT)*
- *JobTracker over burdened – Scheduling + Monitoring*
- *Fixed slots for task execution*

Hadoop 2.x

- *Scalability 25000+ nodes*
- *High Availability on masters (Ex. NN, RM) can be setup*
- *RM for scheduling + ApplicationMaster for monitoring*
- *Containers are dynamic*

Introduction to MapReduce

- *Data processing paradigm for distributed datasets*
- *With Hadoop 2.x, MapReduce is YARN-based*
- *Involves 2 phases (Developer) – Map phase and a Reduce phase*
- *MapReduce works on (Key, Value) pairs – Ex: Hadoop 5 → Hadoop is the key, 5 is the value*
- *Steps involved in MapReduce parallel processing*
  - *Input Split*
  - *Map*
  - *Shuffle & Sort*
  - *Reduce*
  - *Final Output*

Map → Transformation logic
Reduce → Aggregation logic

MapReduce with example

Problem Statement: WordCount → Count each word

Input

/Sample/SampleFile.txt

Welcome to Hadoop
Learning Hadoop is fun
Hadoop Hadoop Hadoop is the buzz

(Key, Value) pairs

WordCount.java

Output

/Sample/WC/part-r-00000

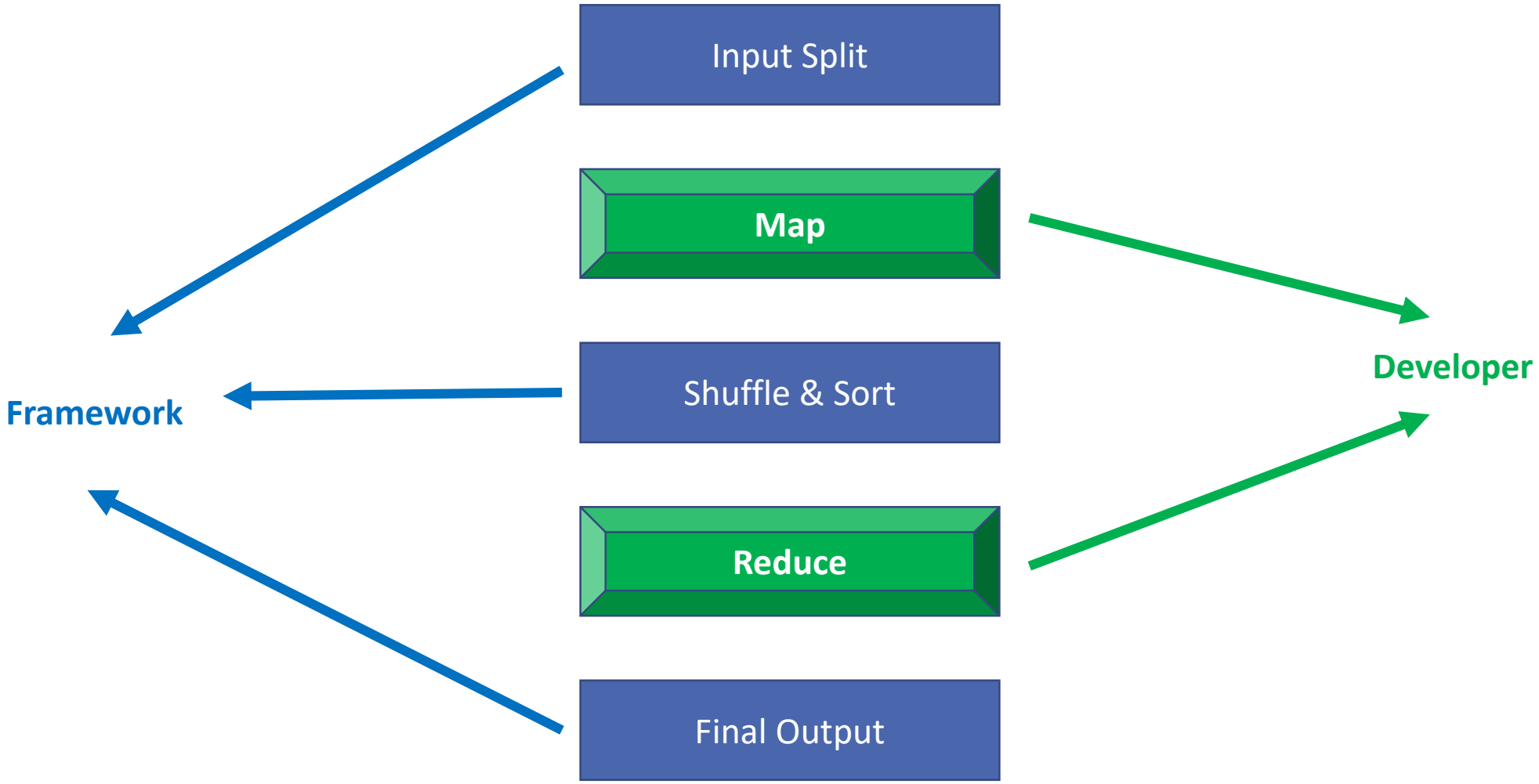
Hadoop	5
Learning	1
Welcome	1
buzz	1
fun	1
is	2
the	1
to	1

Steps in MapReduce

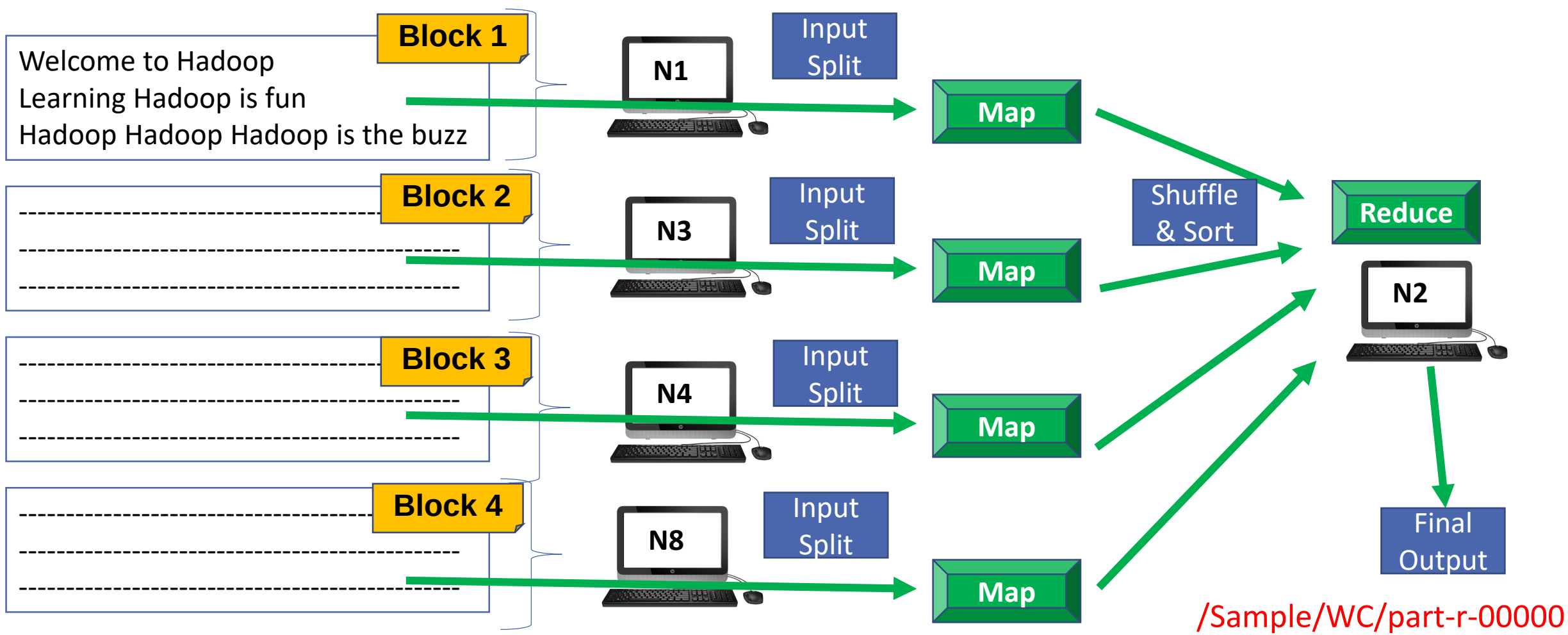
- Input Split
- Map
- Shuffle & Sort
- Reduce
- Final Output

- Map – Transformation → Convert into words
- Reduce – Aggregation → Count words

Steps in MapReduce



MapReduce Steps on a cluster



MapReduce Datatypes

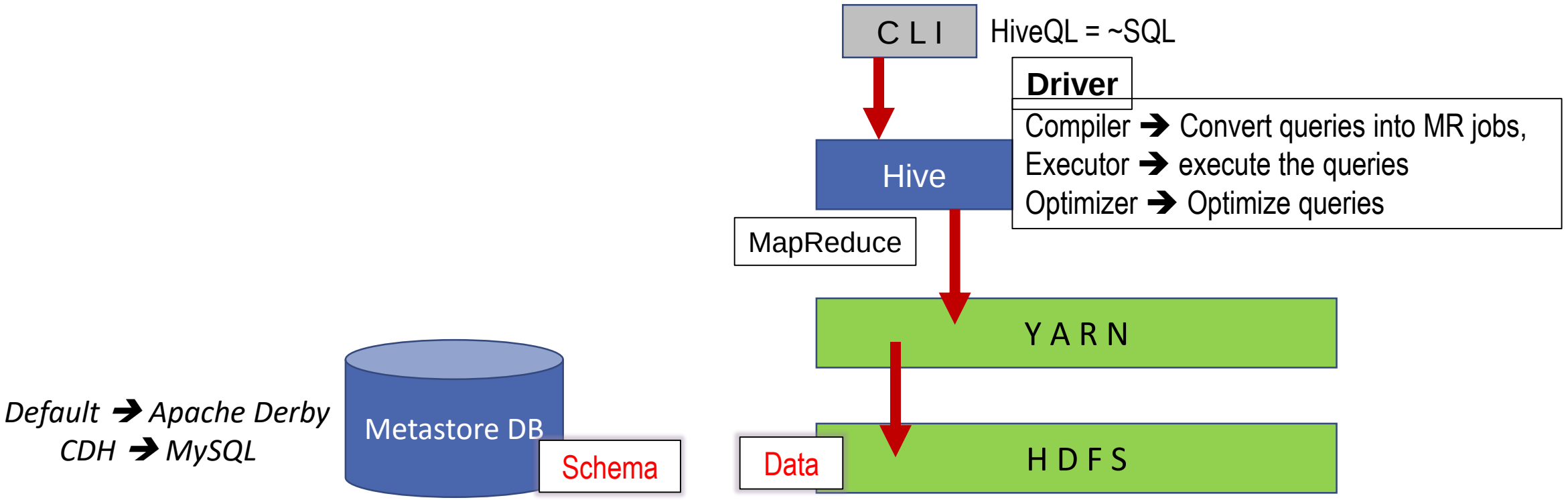
Java	MapReduce
int	IntWritable
float	FloatWritable
long	LongWritable
double	DoubleWritable
null	NullWritable
byte	BytesWritable
String	Text

Apache Hive

- *Apache Hive is considered the standard for SQL queries over petabytes of data in Hadoop*
- *Open sourced by Facebook in 2008*
- *Data analysts use Hive to query, summarize, explore and analyze that data, then turn it into actionable business insight*
- *Hive easily integrates with other critical technologies using a JDBC interface*
- *On a cluster managed by Cloudera Manager, Hive comes along with the base CDH installation and does not need to be installed separately. With Cloudera Manager, you can enable or disable the Hive service, but the Hive component always remains present on the cluster*

Hive Architecture

- *Data and Schema are stored separately, the data is validated against the schema when it is queried, a technique called **"Schema on Read"** ➔ Flexibility*
- *Structure can be projected on to data already in storage*



Hive Tables

- *Managed Table*
  - *Default tables*
  - *Hive manages ‘schema’ and ‘data’*

- *External Table*
  - *‘external’ keyword in DDL*
  - *Hive manages ‘schema’*

/user/hive/warehouse ➔ Hive’s default warehouse dir

Hive WordCount

- **Terminal 1**
  - `hadoop fs -mkdir /wc`
  - `$ hadoop fs -cp /Sample/SampleFile.txt /wc/`
- **Terminal 2**
  - `$ hive`
  - `hive> create external table table1(col1 string) row format delimited fields terminated by '\n' location '/wc';`
  - `hive> select word, count(*) from table1 LATERAL VIEW explode(split(col1, ' ')) ltable as word GROUP BY word;`
- **Once the query execution completed, the output was printed on the console**

Hive Joins

- ** emp.txt – Create file as /home/cloudera/Desktop/Labs/emp.txt
- swetha,250000,Bengaluru
- anamika,200000,Mysuru
- tarun,300000,Mangaluru
- anita,250000,Mumbai

- ** email.txt – Create file as /home/cloudera/Desktop/Labs/email.txt
- swetha,swetha@gmail.com
- tarun,tarun@gmail.in
- nagesh,nagesh@yahoo.com
- venkatesh,venki@gmail.com

Hive Joins

- hive> create table employee(name string, salary float,city string) row format delimited fields terminated by ',';
- hive> load data local inpath '/home/cloudera/Desktop/Labs/emp.txt' into table employee;
- hive> select * from employee where name='tarun';
- hive> create table mailid (name string, email string) row format delimited fields terminated by ',';
- hive> load data local inpath '/home/cloudera/Desktop/Labs/email.txt' into table mailid;
- hive> SET hive.auto.convert.join=false;
- hive> select a.name,a.city,a.salary,b.email from employee a inner join mailid b on a.name = b.name;
- hive> select a.name,a.city,a.salary,b.email from employee a left outer join mailid b on a.name = b.name;
- hive> select a.name,a.city,a.salary,b.email from employee a right outer join mailid b on a.name = b.name;
- hive> select a.name,a.city,a.salary,b.email from employee a full outer join mailid b on a.name = b.name;

Apache Impala

http://impala.apache.org/

- *Low latency SQL engine*
- *Developed by Cloudera*
- *Now an open source Apache project*
- *Impala provides high-performance, low-latency SQL queries on data stored in popular Apache Hadoop file formats*
- *The fast response for queries enables interactive exploration and fine-tuning of analytic queries, rather than long batch jobs traditionally associated with SQL-on-Hadoop technologies*
- *Impala integrates with the Apache Hive metastore database, to share databases and tables between both components*
- *The high level of integration with Hive, and compatibility with the HiveQL syntax, lets you use either Impala or Hive to create tables, issue queries, load data, and so on*

Advantages of Impala

- *Impala integrates with the existing Hadoop ecosystem, meaning data can be stored, shared, and accessed using the various solutions included with Hadoop. This also avoids data silos and minimizes expensive data movement*
- *Impala provides access to data stored in Hadoop without requiring the Java skills required for MapReduce jobs. Impala can access data directly from the HDFS file system*
- *Impala also provides a SQL front-end to access data in the HBase database system, or in the Amazon Simple Storage System (S3)*

Impala Architecture

- *Impala queries run on an additional set of daemons that run on the Hadoop cluster*
  - *Impala Daemon – typically runs on each worker node in the cluster*
    - *Co-located with the HDFS DataNode*
    - *Accepts queries from the impala-shell, HUE, JDBC, or ODBC*
    - *Checks the local metadata cache*
    - *Distributes the work to other Impala Daemons in the cluster*
  - *Two other daemons running on master nodes support query execution*
  - *Impala State Store (one per cluster)*
    - *Provides lookup service and status checks for Impala daemons*
  - *Impala Catalog Server (one per cluster)*
    - *Relays metadata changes to all the Impala Daemons in a cluster*

Impala Vs Hive

- *Like Hive, Impala allows users to query data in HDFS using an SQL-like language*
- *Unlike Hive, Impala does not turn queries into MapReduce jobs*
- *Impala is pioneering the use of the Parquet file format, a columnar storage layout that is optimized for large-scale queries typical in data warehouse scenarios*
- *Impala returns results typically within seconds or a few minutes, rather than the many minutes or hours that are often required for Hive queries to complete*

Running Hive queries using Impala

- `[quickstart.cloudera:21000] > invalidate metadata;`
- `[quickstart.cloudera:21000] > show tables;`
- `[quickstart.cloudera:21000] > select * from employee where name='tarun';`
- `[quickstart.cloudera:21000] > select a.name,a.city,a.salary,b.email  from employee a inner join mailid b on a.name = b.name;`
- `[quickstart.cloudera:21000] > select a.name,a.city,a.salary,b.email  from employee a left outer join mailid b on a.name = b.name;`
- `[quickstart.cloudera:21000] > select a.name,a.city,a.salary,b.email  from employee a right outer join mailid b on a.name = b.name;`
- `[quickstart.cloudera:21000] > select a.name,a.city,a.salary,b.email  from employee a full outer join mailid b on a.name = b.name;`

Apache Sqoop

http://sqoop.apache.org/

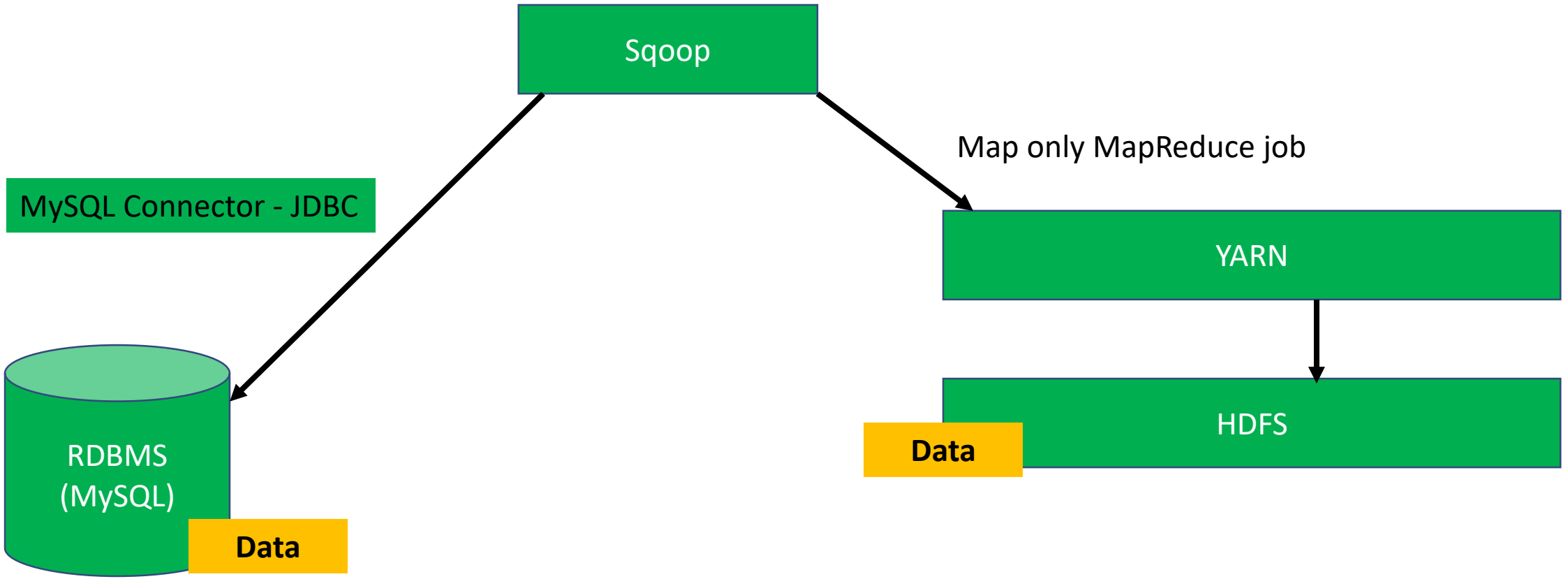
- *Sqoop is a tool to transfer data from RDBMS to Hadoop and vice versa*
- *Sqoop is "the SQL-to-Hadoop database import tool"*
- *Open-source Apache project*
- *Originally developed at Cloudera*
- *Designed to import data from RDBMSs into HDFS*
- *Can also send data from HDFS to an RDBMS*
- *Uses JDBC (Java Database Connectivity) to connect to the RDBMS*
- *Sqoop does batch import*

How does Sqoop work?

- *Sqoop examines each table and automatically generates a Java class to import data into HDFS*
- *It then creates and runs a Map-only MapReduce job to import the data*
  - *By default, four Mappers connect to the RDBMS*
  - *Each imports a quarter of the data*
  - *We can also perform a sequential import*

Apache Sqoop

http://sqoop.apache.org/



Apache Sqoop

- *Sqoop Import ➔ From RDBMS to HDFS*
- *Sqoop Export ➔ From HDFS to RDBMS*

- *Sequential Import ➔ m 1*
- *Parallel Import ➔ multiple maps*

Sqoop Installation and Configuration

- *Connectors and JDBC drivers are installed on every client*
- *Database connectivity required for every client*
- *CLI is the client interface (HUE evolving)*
- *Every invocation requires credentials to RDBMS*

http://sqoop.apache.org/docs/1.4.6/SqoopUserGuide.html

Sqoop commands

- **Terminal 1 - MySQL**
- `$ mysql -u root -p`
- `mysql> show databases;`
- `mysql> show databases;`
- `mysql> use retail_db;`
- `mysql> describe categories;`
- `mysql> select * from categories;`
- `mysql> select * from departments;`
- `mysql> select category_name from categories where category_department_id = 2;`

Sqoop commands

- **Terminal 2 - Sqoop**
- `$ sqoop version`
- `$ sqoop list-databases --connect jdbc:mysql://localhost:3306 --username root -P`
- `$ sqoop list-tables --connect jdbc:mysql://localhost:3306/retail_db --username root -P`
- `$ sqoop import --connect jdbc:mysql://localhost:3306/retail_db --username root -P --table categories --target-dir /categories_import -m 1`
- `$ sqoop import --connect jdbc:mysql://localhost:3306/retail_db --username root -P --table categories --target-dir /categories_import_p -m 2`

Sqoop commands

- **Terminal 2 - Sqoop**
- `$ sqoop version`
- `$ sqoop list-databases --connect jdbc:mysql://localhost:3306 --username root -P`
- `$ sqoop list-tables --connect jdbc:mysql://localhost:3306/retail_db --username root -P`
- `$ sqoop import --connect jdbc:mysql://localhost:3306/retail_db --username root -P --table categories --target-dir /categories_import -m 1`
- `$ sqoop import --connect jdbc:mysql://localhost:3306/retail_db --username root -P --table categories --target-dir /categories_import_p -m 2`

Sqoop, Hive and Impala

- **Terminal 3 - Hive**
- `hive> create table categories(cat_id int, dept_id int, cat_name string) row format delimited fields terminated by ','  location '/categories_import' ;`
- `hive> select * from categories;`
- `hive> select count(*) from categories;`

- **Terminal 4 - Impala**
- `[quickstart.cloudera:21000] > invalidate metadata;`
- `[quickstart.cloudera:21000] > select * from categories;`
- `[quickstart.cloudera:21000] > select count(*) from categories;`

Sqoop Export

- **Terminal 1 - MySQL**
- `$ mysql -u root -p`
- `mysql> create database sample;`
- `mysql> show databases;`
- `mysql> use sample;`
- `mysql>  CREATE TABLE categories_new(category_id int(11) PRIMARY KEY, category_dept_id int(11), category_name varchar(50));`
- `mysql> select * from categories_new;`

- **Terminal 2 - Sqoop**
- `sqoop export --connect jdbc:mysql://localhost:3306/sample --username root --P --table categories_new --export-dir /categories_import_p`

- **Terminal 1 - MySQL**
- `mysql> select * from categories_new;`

Agenda – Day 3

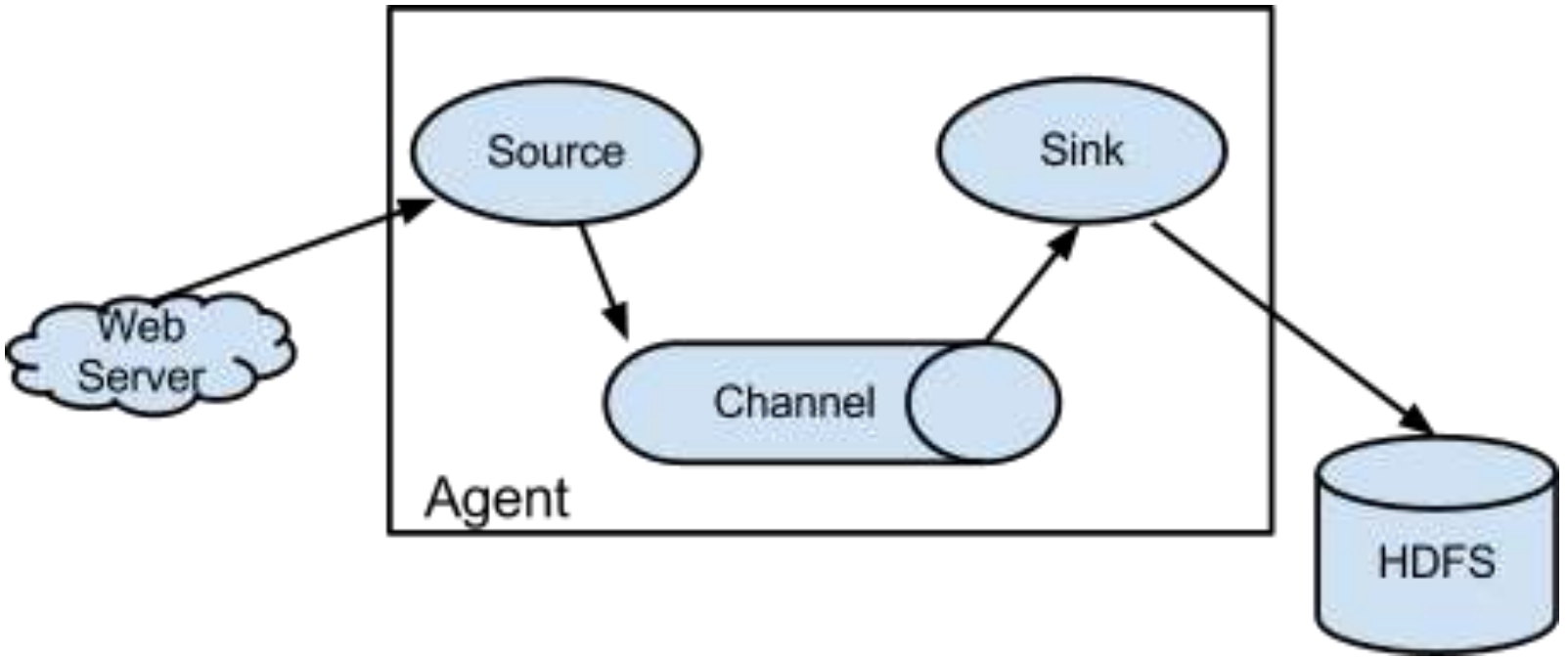
- Flume
- Pig
- Spark
- POC exercise

Apache Flume

http://flume.apache.org/

- *Flume is a distributed service for efficiently collecting and moving large amount of log data into HDFS*
- *Suitable for gathering logs from multiple systems and inserting them into HDFS as they get generated, architecture is based on streaming data flows*
- *Flume is an open source Apache project*
- *Flume was initially developed at Cloudera*

Flume example



Apache Flume

http://flume.apache.org/

- *Flume configuration file is a Java property file with key-value pairs*
- *Since we can have multiple agents in Flume, we will configure each agent based on their unique name agent*
- *Each Flume agent has a source, channel and a sink*
- *Source*
  - *Tells the node where to receive data from*
- *Sink*
  - *Tells the node where to send data to*
- *Channel*
  - *A queue between the Source and Sink*

Flume example

- **Data simulator shell script – Save as /home/cloudera/Desktop/Labs/data_gen.sh**

```
#!/bin/bash

while true
do
        echo "Welcome to Hadoop" >> /tmp/access_log
        sleep 1
done
```

Flume example

- **Configuration file**

```
tail1.sources = src1
tail1.channels = ch1
tail1.sinks = sink1

tail1.sources.src1.type = exec
tail1.sources.src1.command = tail -F /tmp/access_log
tail1.sources.src1.channels = ch1

tail1.channels.ch1.type = memory

tail1.sinks.sink1.channel = ch1
tail1.sinks.sink1.type = hdfs
tail1.sinks.sink1.hdfs.path = hdfs://localhost:8020/access_log
tail1.sinks.sink1.hdfs.fileType = DataStream
tail1.sinks.sink1.hdfs.writeFormat = Text
```

Flume example

- **Terminal 1 – Run data_gen**
  - `$ chmod 777 /home/cloudera/Desktop/Labs/data_gen.sh`
  - `$ ./home/cloudera/Desktop/Labs/data_gen.sh`
- **Terminal 2 – Run Flume agent**
  - `flume-ng agent -n tail1 -c conf -f /home/cloudera/Desktop/Labs/tail.conf`

Apache Pig

http://pig.apache.org/

- *A scripting platform for processing and analyzing large data sets*
- *Apache Pig allows Apache Hadoop users to write complex MapReduce transformations using a simple scripting language called Pig Latin*
- *Pig translates the Pig Latin script into MapReduce so that it can be executed within YARN for access to dataset stored in the Hadoop Distributed File System (HDFS)*
- *Pig was designed for performing a long series of data operations, making it ideal for Extract-transform-load (ETL) data pipelines*
- *Pig programs accomplish huge tasks, but they are easy to write and maintain*

Pig Processing Steps

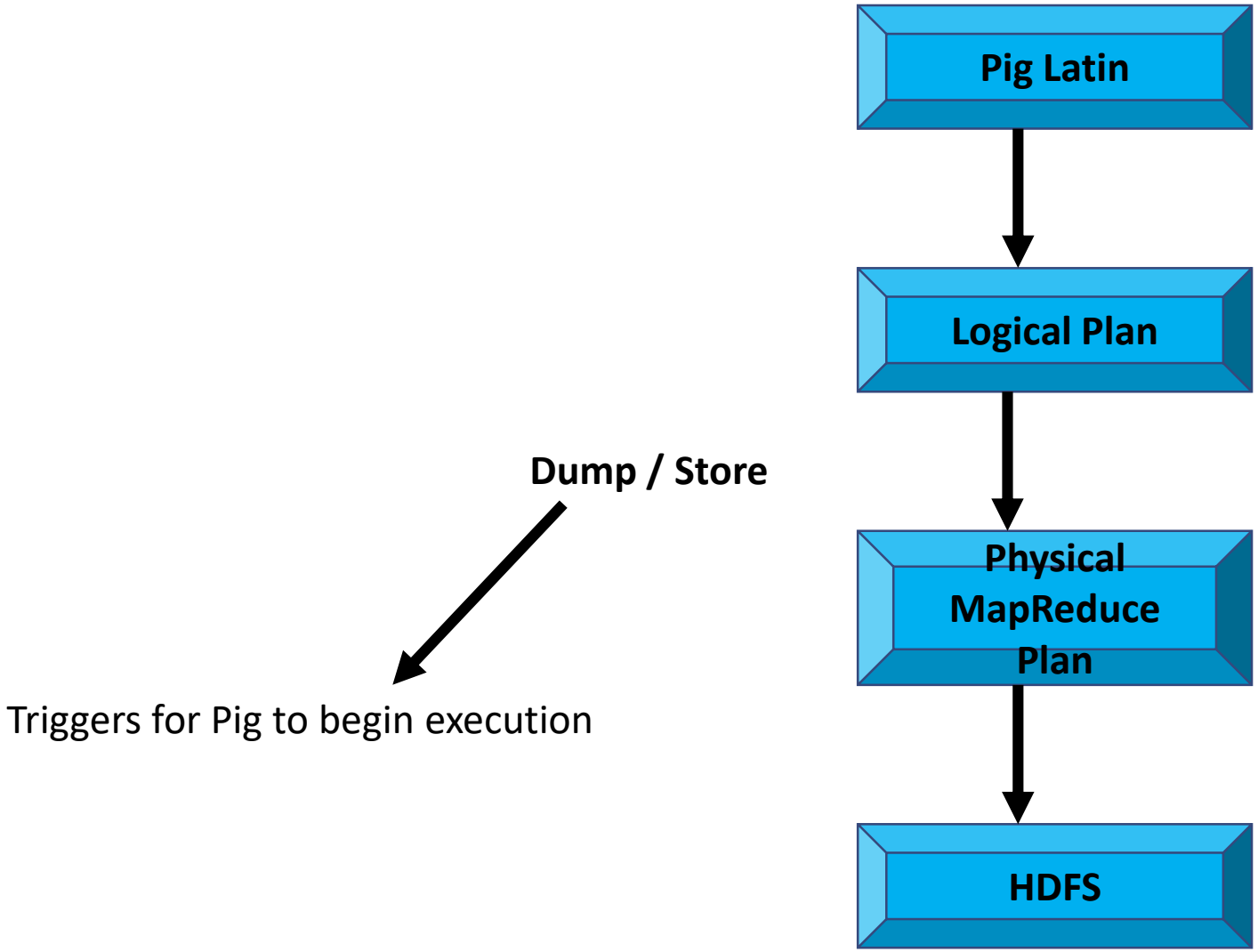
http://pig.apache.org/

Learn Pig Latin

http://pig.apache.org/docs/r0.15.0/basic.html

http://pig.apache.org/docs/r0.15.0/func.html

http://pig.apache.org/docs/r0.15.0/udf.html



Pig example

- **Example 1**

```
grunt>  A = LOAD '/wc/SampleFile.txt' AS (line:chararray);
grunt>  B = FOREACH A GENERATE FLATTEN(TOKENIZE(line)) as word;
grunt>  C = GROUP B BY word;
grunt>  D = FOREACH C GENERATE group, COUNT(B);
grunt>  DUMP D;
```

- **Example 2**

```
grunt> A = LOAD '/user/hive/warehouse/employee/emp.txt' using PigStorage(',')
AS (name:chararray, salary:float, city:chararray);
grunt> B = FOREACH A GENERATE name, city;
grunt> STORE B INTO '/Sample/OP';
```

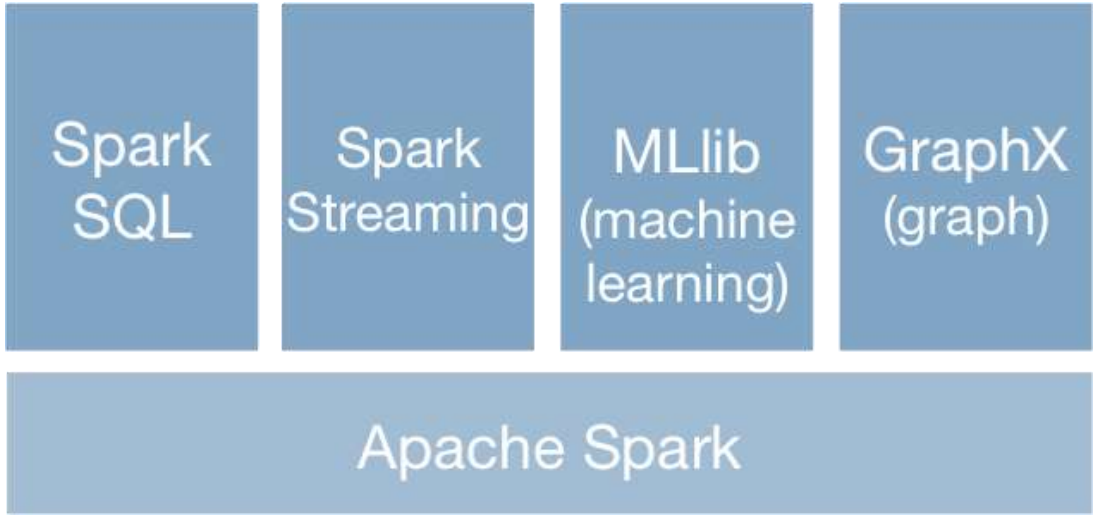
Apache Spark

http://spark.apache.org/

- *Spark is a general purpose, large-scale data processing engine*
- *Fast*
  - *Run programs up to 10x faster than Hadoop MapReduce*
- *Easy to use - Write jobs quickly in*
  - *Scala*
  - *Python*
  - *Java*
  - *R*

What is Spark?

- *General purpose*
  - *Spark powers a stack of libraries*
    - ***SQL** and **DataFrames** for SQL queries*
    - ***ML-Lib** for machine learning*
    - ***GraphX** for graph processing*
    - ***Spark Streaming** for building scalable fault tolerant streaming applications*

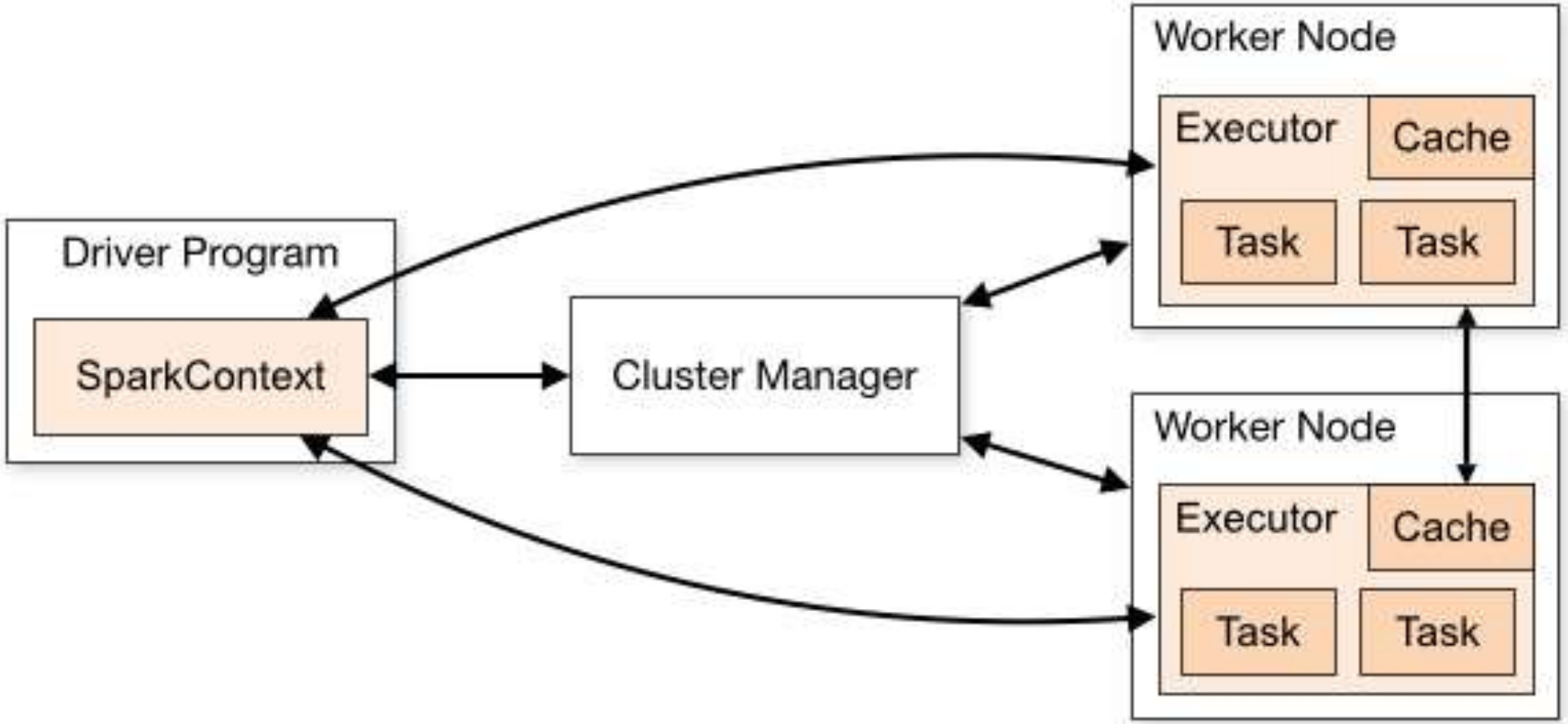


What is Spark?

- *Runs everywhere*
  - *Hadoop*
  - *Mesos*
  - *Kubernetes*
  - *Standalone*
  - *Cloud*

- *Data Sources*
  - *HDFS*
  - *Cassandra*
  - *HBase*
  - *S3*

Spark Architecture



Spark Architecture

- *Each application gets its own executor processes, which stay up for the duration of the whole application and run tasks in multiple threads*
- *This has the benefit of isolating applications from each other*
  - *Scheduling side – each driver schedules its own tasks*
  - *Executor side – tasks from different applications run in different JVMs*
- *It also means that data cannot be shared across different Spark applications without writing to an external storage system*

Spark Architecture

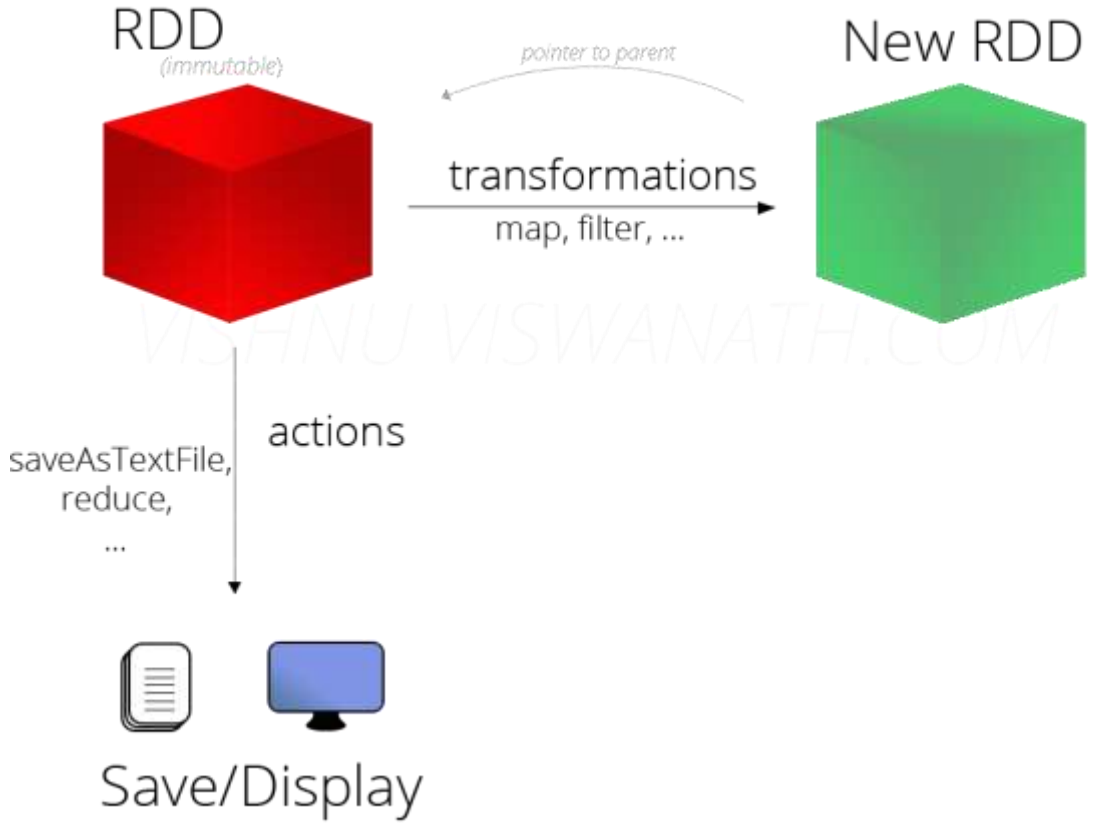
- *Spark is agnostic to the underlying cluster manager*
- *As long as it can acquire executor processes, and these communicate with each other, it is easy to run it on cluster manager that also supports other applications (Ex. YARN / Mesos)*
- *SparkContext must be network addressable from the worker nodes (preferably run on same LAN)*
- *The SparkContext must listen and accept incoming connections from its executors throughout its lifetime*

What is RDD?

- *Abbreviated as “Resilient Distributed Dataset”*
- *Fundamental data structure of Spark*
- *Immutable collection of objects*
- *Each RDD may have partitions and are distributed over different nodes*
- *In short, RDD is a read-only, fault-tolerant, partitioned collection of records*

RDD Operations

- *RDDs support two types of operations*
  - *Transformations*
  - *Actions*



RDD Transformations

- *Create a new dataset from existing one*
- *Ex.* ***`map`*** *is a transformation that passes each dataset element through a function and returns a new RDD representing the results*
- *All transformations in Spark are* ***lazy****, in that they do not compute the results right away*
- *Transformations are computed when an action requires a result to be returned to the driver program*
- *Each transformed RDD may be recomputed each time you run action on it; however, you may also persist an RDD in memory using* ***`persist (or cache)`*** *method, in which case Spark will keep the elements around on the cluster for much faster access the next time you query*
- *RDDs can also be persisted on disk*

RDD Actions

- *Return a value to the driver program after running a computation on dataset*
- *Ex.* **`reduce`** *is an action that aggregates all the elements of RDD using some function and returns the final result to the driver program*

Spark example

- **Terminal 1:**

```
$ spark-shell

scala> val textFile =
sc.textFile("hdfs://localhost:8020/Sample/SampleFile.txt")

scala> val counts = textFile.flatMap(line => line.split(" ")).map(word =>
(word, 1)).reduceByKey(_ + _)

scala> counts.saveAsTextFile("hdfs://localhost:8020/Sample/Spark_OP")
```

Further Reading

- https://www.tatacommunications.com/press-release/cloudera-tata-communications-launch-big-data-platform-tackle-data-deluge/
- http://blog.cloudera.com/blog/2013/08/how-to-select-the-right-hardware-for-your-new-hadoop-cluster/
- http://hadoop.apache.org/docs/r2.7.5/hadoop-project-dist/hadoop-hdfs/HdfsDesign.html
- http://hadoop.apache.org/docs/r2.7.5/hadoop-yarn/hadoop-yarn-site/YARN.html
- http://myriad.apache.org/
- https://www.kaggle.com/datasets
- https://hortonworks.com/ecosystems/

Connect with me:

Nagabhushan Mamadapur

+91 98 45 397813

nag.bhushan@outlook.com

https://in.linkedin.com/in/nagabhushan1