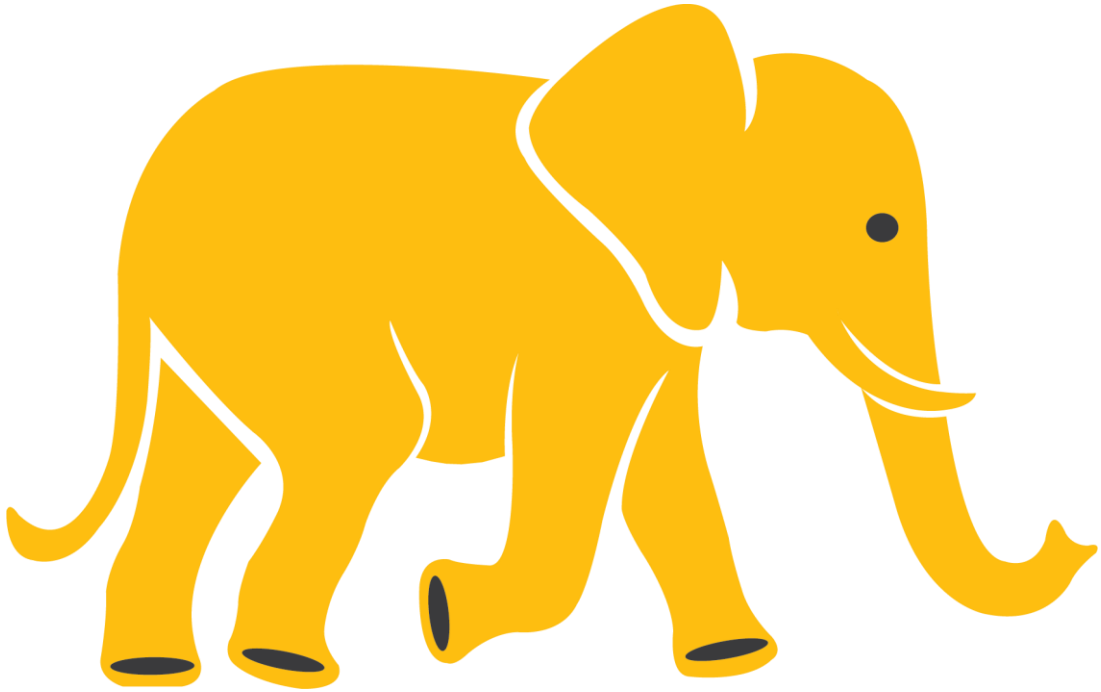


Big Data & Hadoop

Module : 2 HDFS Architecture , Hadoop Configurations & Data Loading

Topics

MODULE 1
BIG DATA AND HADOOP INTRODUCTION

MODULE 2
HDFS ARCHITECTURE, HADOOP CONFIGURATIONS & DATA LOADING

MODULE 3
INTRODUCTION TO MAP REDUCE

MODULE 4
ADVANCED MAP REDUCE CONCEPTS

MODULE 5
INTRODUCTION TO PIG AND ADVANCE PIG

MODULE 6
INTRODUCTION TO HIVE AND ADVANCE HIVE

MODULE 7
INTRODUCTION TO HBASE AND ADVANCED HBASE

MODULE 8
SQOOP AND FLUME

MODULE 9
BASIC OOZIE AND OOZIE CONFIGURATION

MODULE 10
PROJECT DISCUSSIONS

Session Objectives

This Session helps you to understand :

- Hadoop Daemons
- Block Replication and Replication Factor
- Rack Awareness in HDFS
- Read and Write Operation in HDFS
- HDFS Architecture
- Hands –on HDFS
- YARN concept
- Basic MapReduce Execution Flow

Hadoop Daemons

NameNode: (Single instance)

- Runs in Master Node
- Manages the file metadata
- Client connects to NameNode for initiating all reads and writes in HDFS.

Data Node: (Multiple instances/ one in each slave node

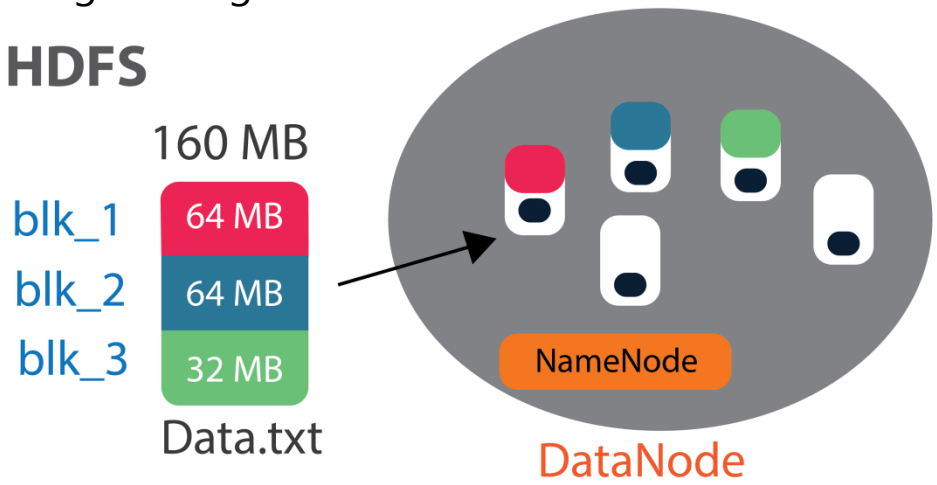
- Runs in all slave nodes
- Data files are stored in the DataNodes in a distributed manner
- Reports to NameNode, periodically with lists of blocks they store

Secondary NameNode:

- Acts as back up node to name node
- It periodically copies metadata into its own storage

Blocks

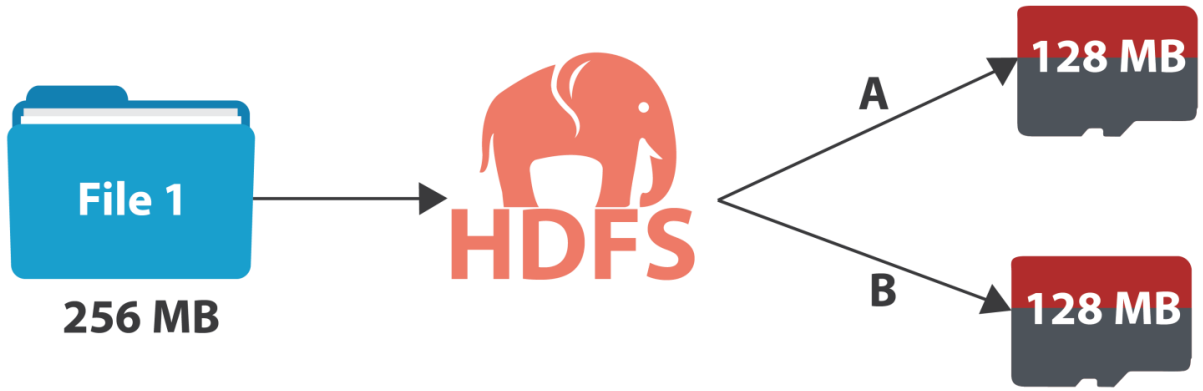
- HDFS stores the data in terms of blocks, the Data/File is broken down into multiple blocks when stored
- The default size of HDFS block is 64MB
- The files are split into 64MB blocks and then stored into the hadoop file system
- The hadoop application is responsible for distributing the data blocks across multiple nodes
- Excellent for storage of large files



Blocks in Hadoop 2.0

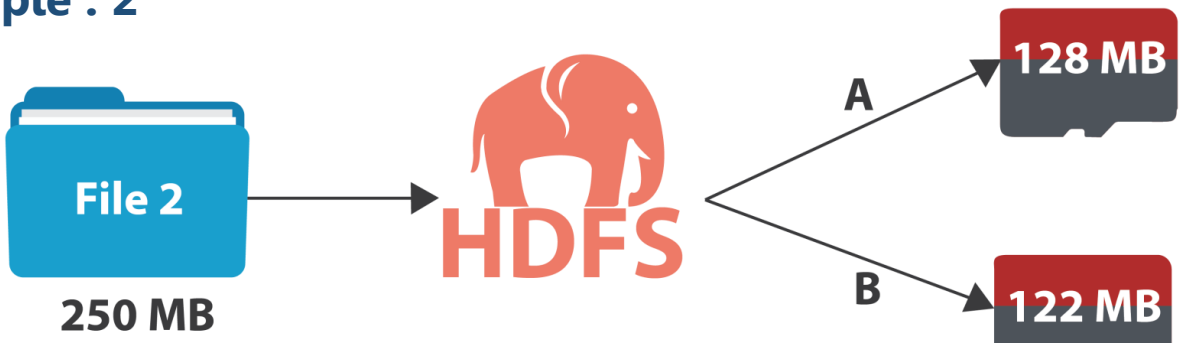
- Default size of the blocks in Hadoop 2.0 is 128 MB
- It is excellent for the storage of large files as the minimum size of file read & write is 128MB.

Example : 1

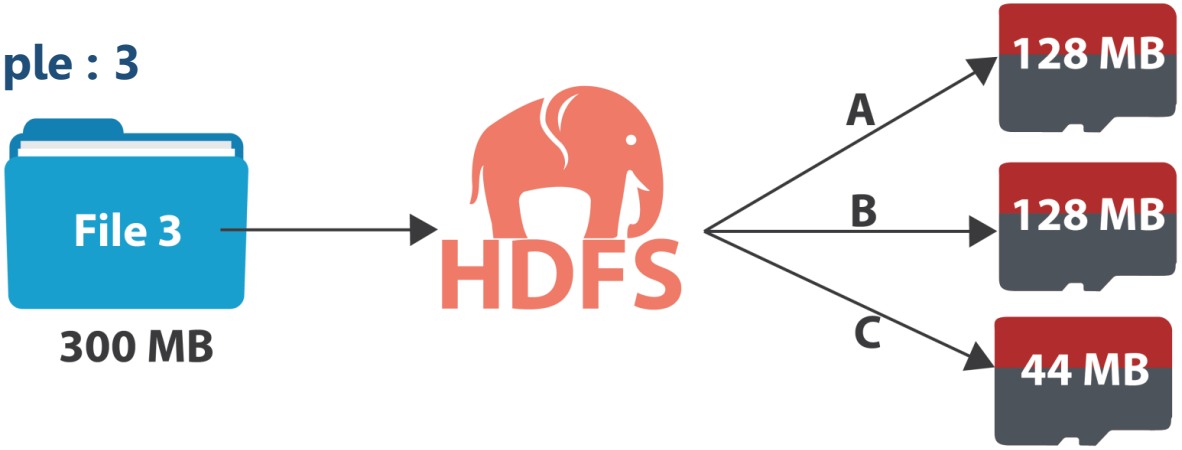


Blocks in Hadoop 2.0(Cont'd)

Example : 2



Example : 3



Block Replication and Replication Factor

Block Replication

- Hadoop has a mechanism of Block replication among the Data Nodes.
- This means that the data that is available in one machine would get replicated and available on other machine as well.
- This will assure data availability all the time.
- Block replication provides redundancy and fault tolerance

Replication Factor:

- The default replication factor is 3.

Computer Racks

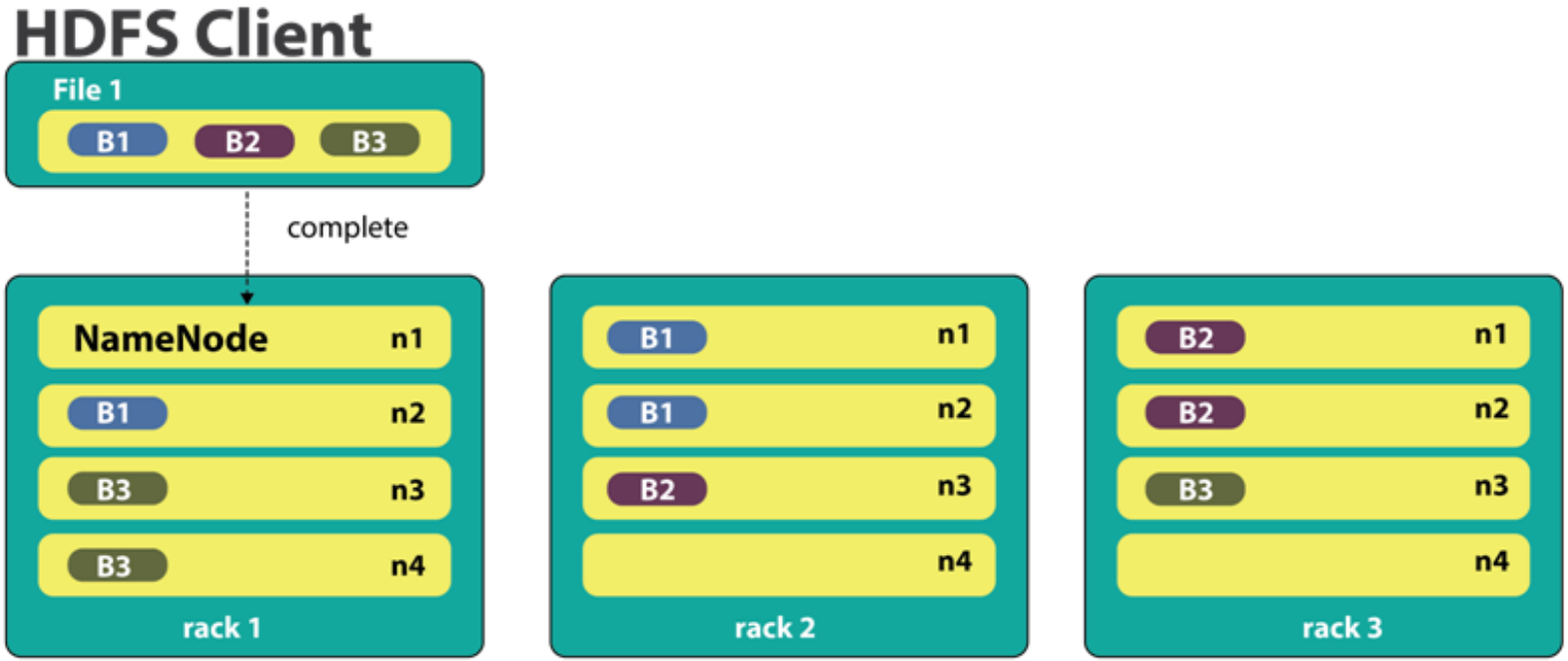
Computer Racks :

- A computer racks is a metal frame used to hold various hardware devices such as servers, hard disk drives, modems and other electronic equipment.
- While racks come in many different shapes and sizes, the standard (traditional) size rack is 19-inches wide.

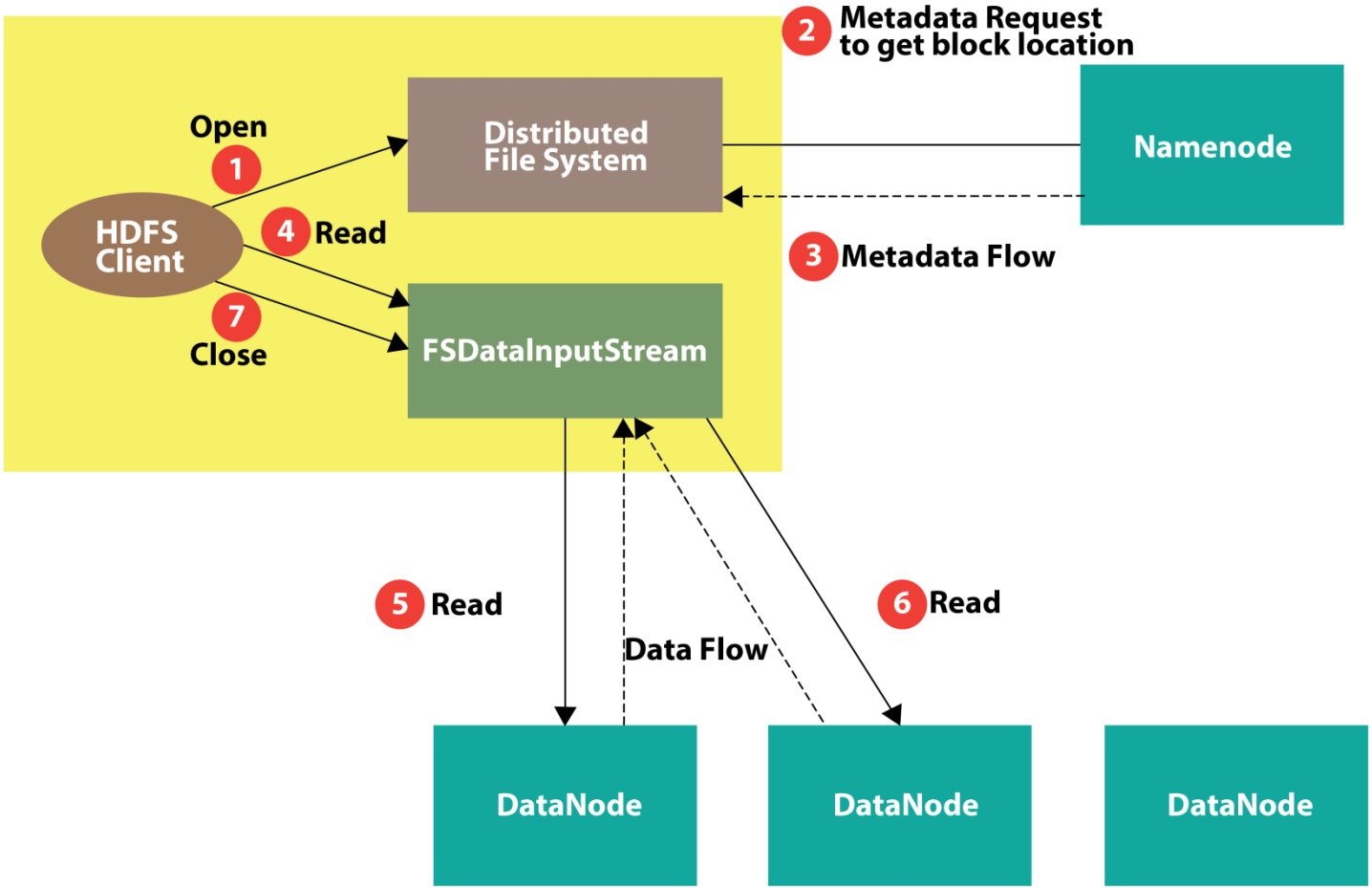
Rack Awareness in HDFS

- Rack consists of sequence of Data Nodes.
- Single Hadoop cluster may have one or more Racks depending on the size of the cluster.
- HDFS stores blocks on the cluster in a rack aware fashion i.e. one block on one rack and the other two blocks on other rack.
- The HDFS is aware of the location of each server in the rack; this is referred to a rack awareness.

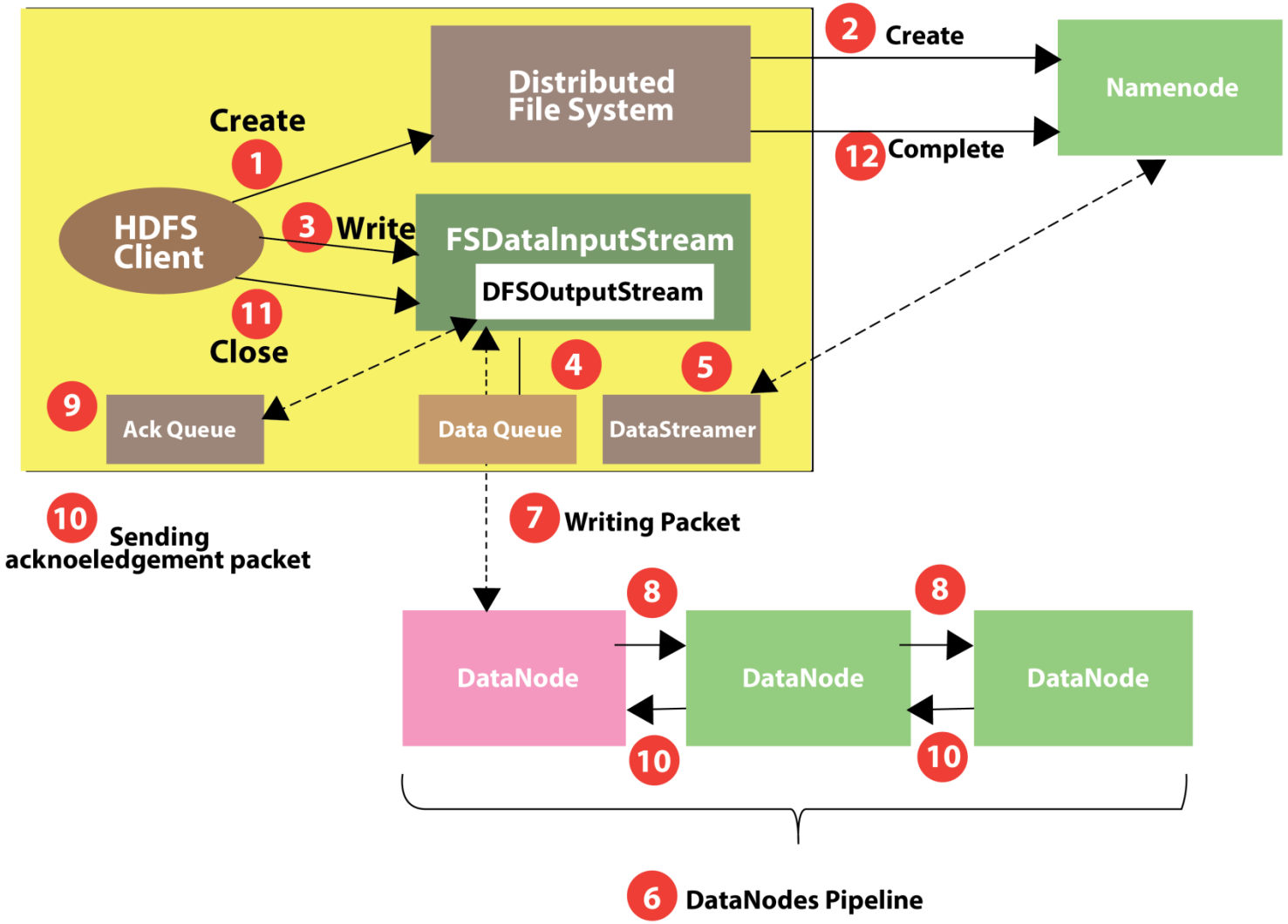
Rack Awareness in HDFS(Cont'd)



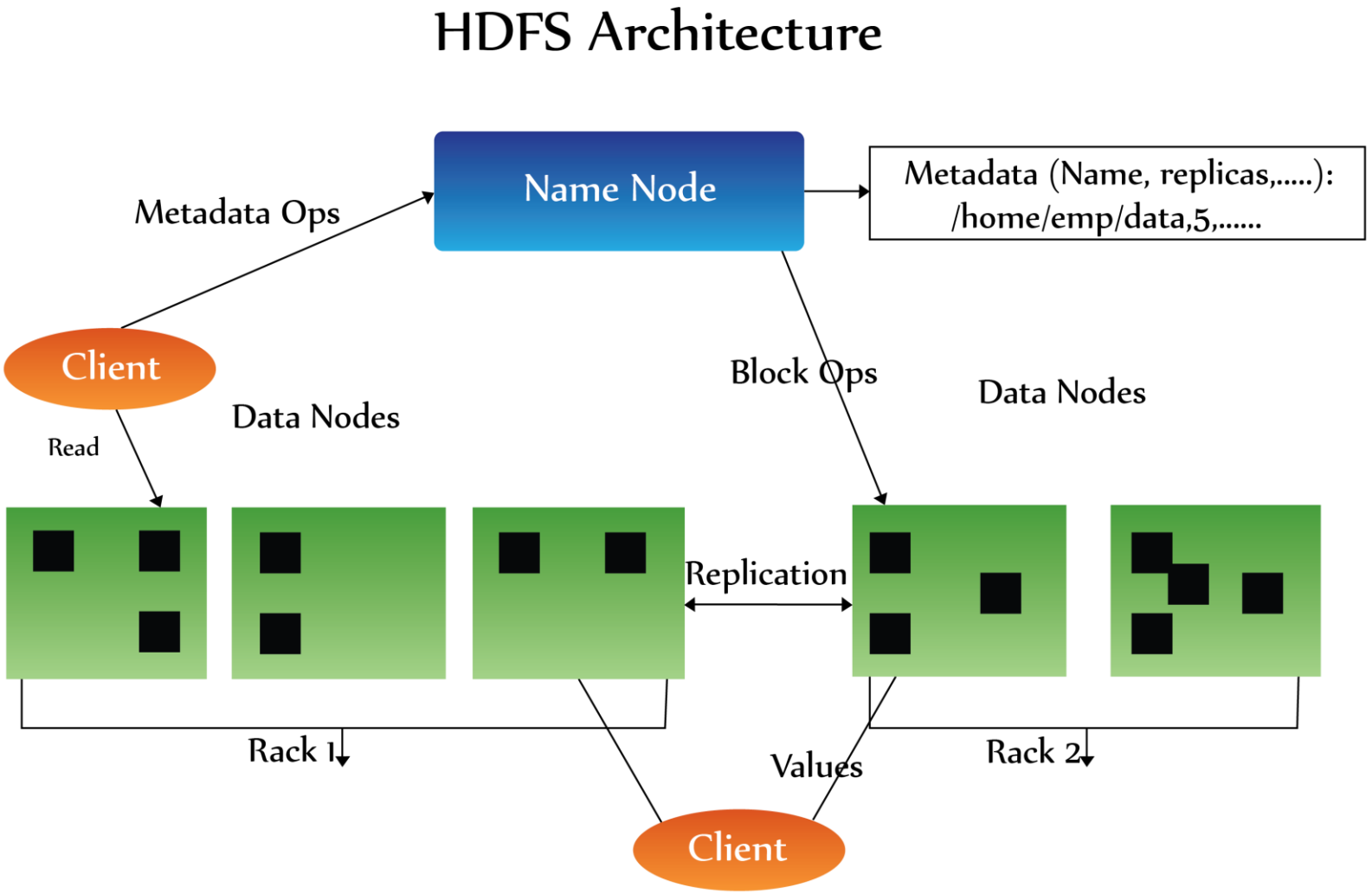
File Read Operation in HDFS



File Write Operation in HDFS



HDFS Architecture



Hadoop Configuration Files

Configuration Filenames	Description of Log Files
hadoop-env.sh	Environment variable that are used in the scripts to run Hadoop
core-site	Configuration setting for Hadoop Core such as I/O settings that are common to HDFS and MapReuce
hdfs-site.xml	HDFS Configuration settings for HDFS daemons, the NameNode, the secondary NameNode and the data nodes
mapred-site.xml	MapReduce specific Configuration settings like Job History Server
yarn-site.xml	Configuration settings for Shuffle Mechanism with respect to YARN implementation.
masters	A list of machines (one per line) that each run a secondary NameNode
slaves	A list of machines (one per line) that each run a slave machine running DataNode and a NodeManager daemons

Hadoop Configuration Files(Cont'd)

conf/core-site.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--core-site.xml -->
<configuration>
<property>
<name>fs.default.name</name>
<value>hdfs://localhost:9000</value>
</property>
</configuration>
```

Hadoop Configuration Files(Cont'd)

conf/hdfs-site.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--hdfs-site.xml -->
<configuration> <property>
<name>dfs.replication</name>
<value>1</value> </property>
<property> <name>dfs.permissions</name>
<value>false</value> </property>
<property> <name>dfs.namenode.name.dir</name>
<value>/home/user/hadoop-2.2.0/hadoop2_data/hdfs/namenode </value>
</property>
<property>
<name>dfs.datanode.data.dir</name>
<value>/home/user/hadoop-2.2.0/hadoop2_data/hdfs/datanode</value>
</property> </configuration>
```

Hadoop Configuration Files(Cont'd)

conf/mapred-site.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--mapred-site.xml -->
<configuration>
<property>
<name>mapreduce.framework.name</name>
<value>yarn</value>
</property>
</configuration>
```

Hadoop Configuration Files(Cont'd)

conf/yarn-site.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>
<!--yarn-site.xml -->
<configuration>
<property>
<name>yarn.nodemanager.aux-services</name>
<value>mapreduce_shuffle</value>
</property>
<property>
<name>yarn.nodemanager.aux-services.mapreduce.shuffle.class</name>
<value>org.apache.hadoop.mapred.ShuffleHandler</value>
</property>
</configuration>
```

Hadoop Copy Options

- **put :** Copy single source, or multiple sourrces from local file system to the destination file system. Also reads input from stdin and writes to destination file system.

  hadoop dfs –put weather.txt hdfs://<target Namenode>

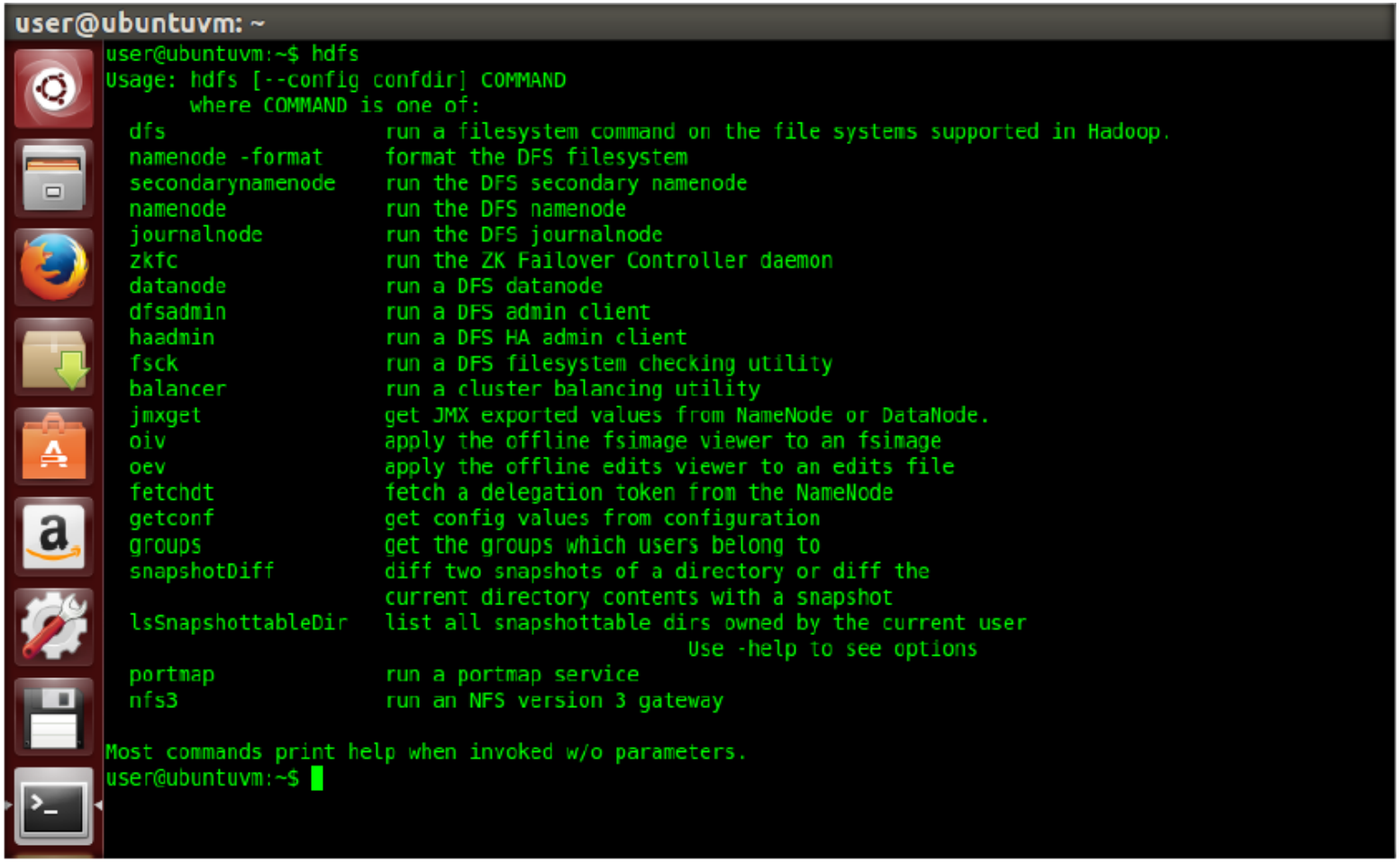
  hadoop dfs –copyFromLocal weather.txt hdfs://<target Namenode>

- **distcp :** Distributed copy to move data between clusters, used for backup and recovery.

  hadoop distcp hdfs://<source NN> hdfs://<target NN>

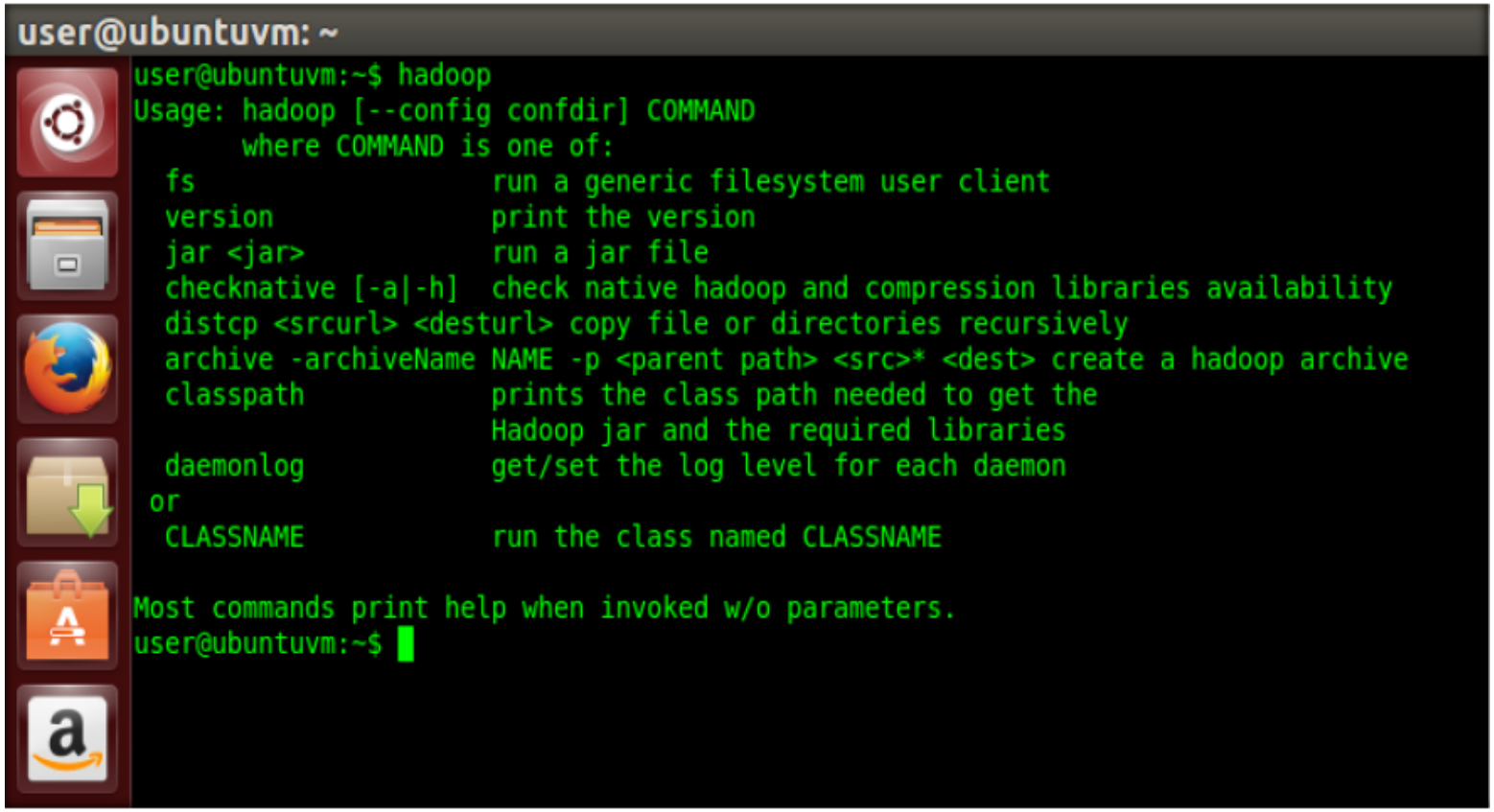
Demo - HDFS Commands

Checking HDFS Commands



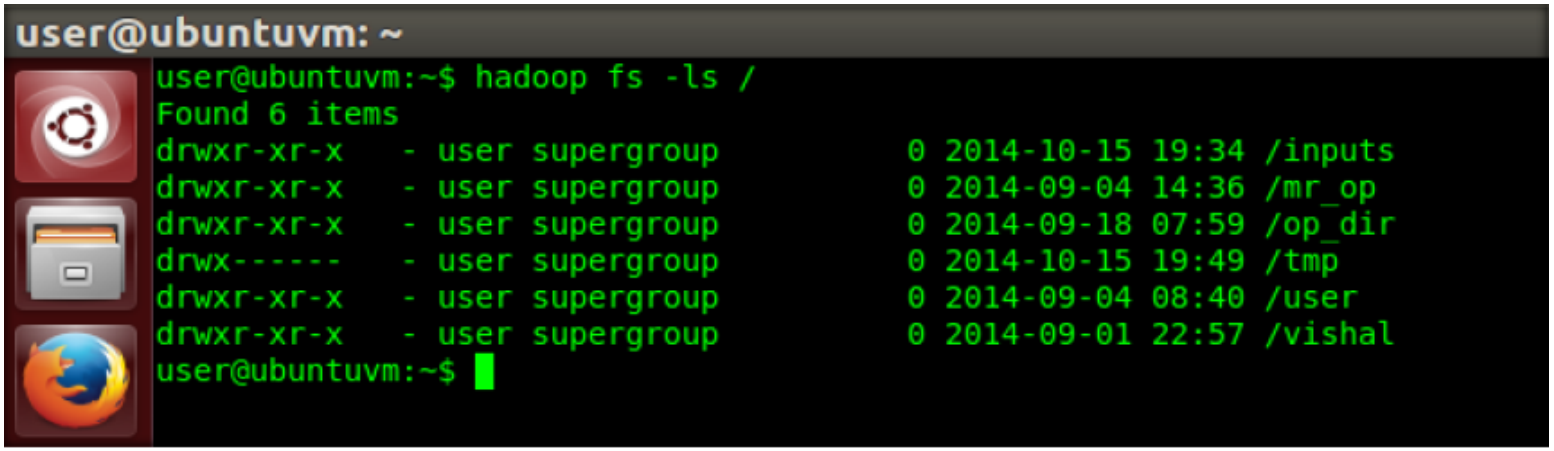
Demo - HDFS Commands(Cont'd)

Checking HDFS Commands

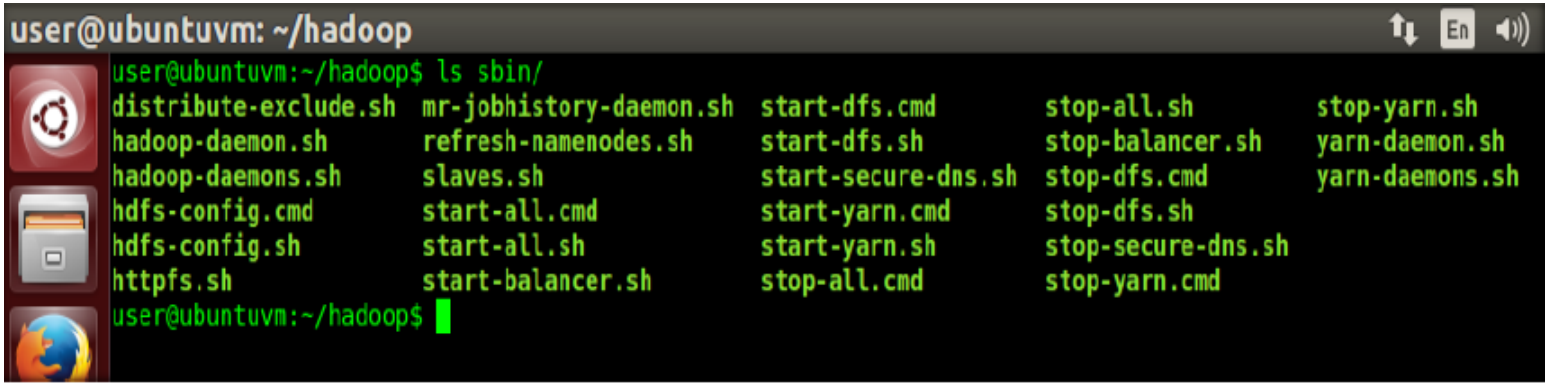


Demo - HDFS Commands(Cont'd)

Listing the HDFS Directories



sbin Directory of Hadoop Instalation



HDFS High Availability

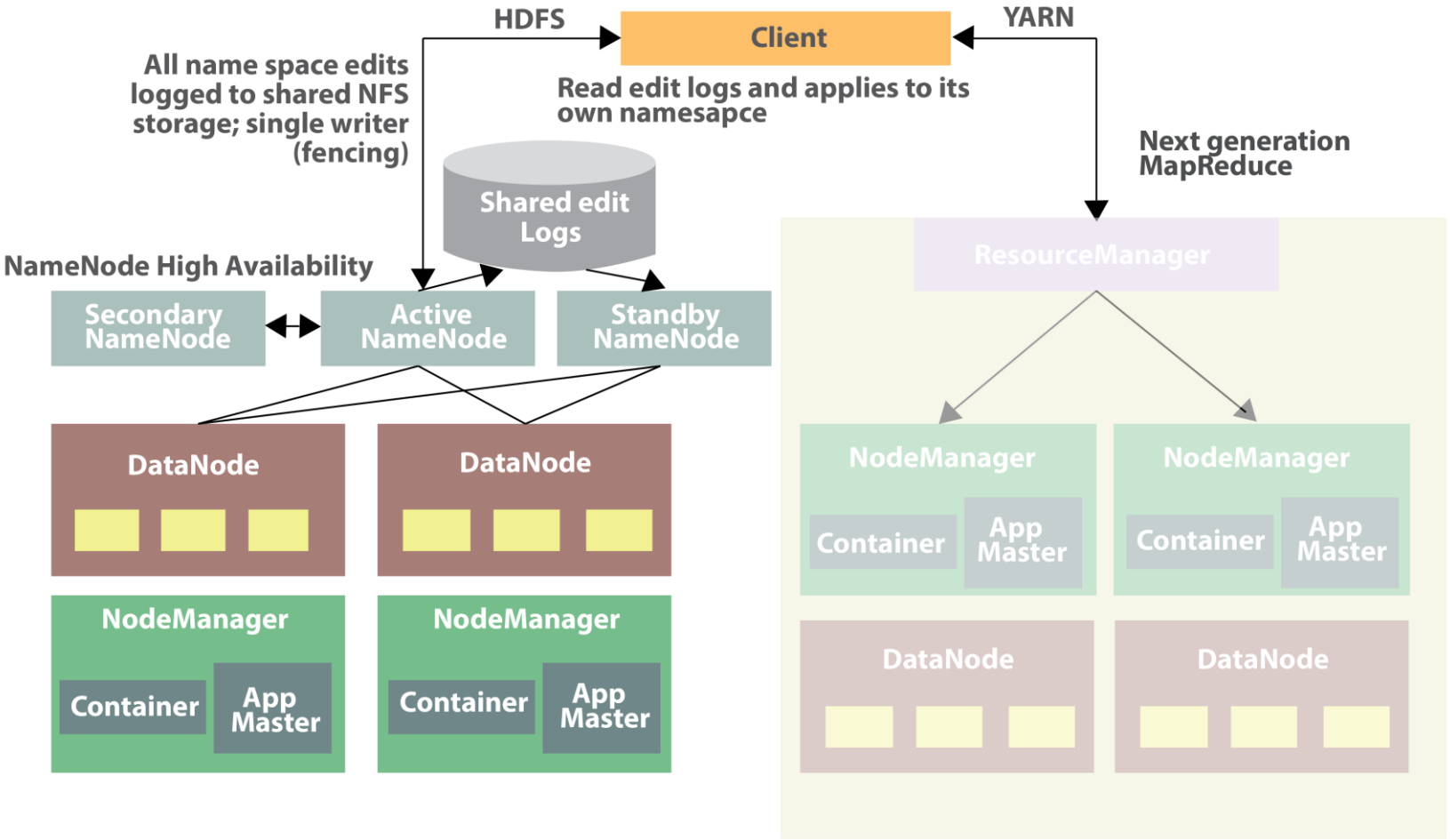
Problem Statement:

- If the NameNode process or machine fails, then the entire cluster will not be available in Hadoop 1.x until either the NameNode is rebooted.

Solution :

- This was solved in Hadoop 2.x by HDFS High Availability (HDFS HA)

HDFS High Availability(Cont'd)



HDFS Federation

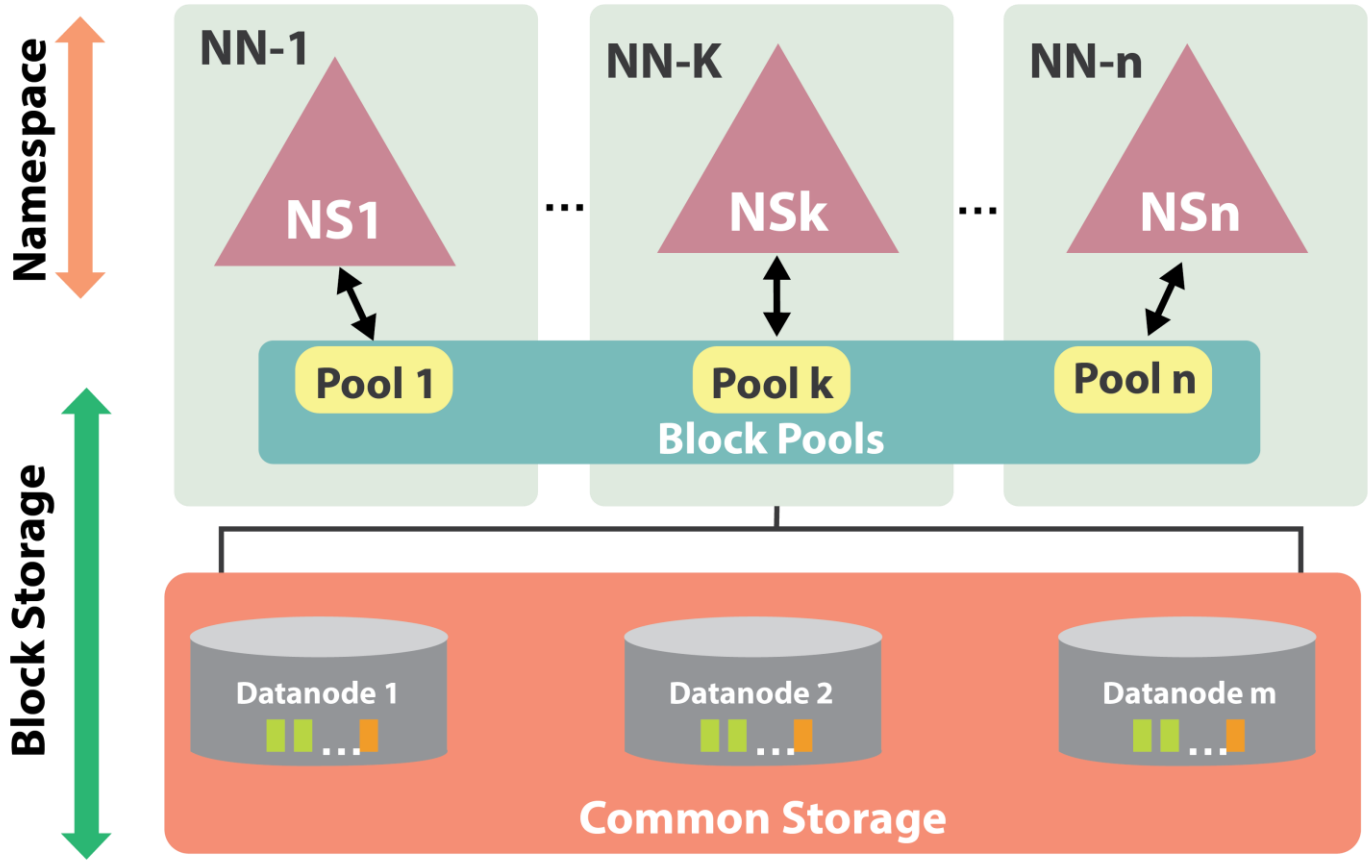
Problem Statement:

- The name node can store a limited amount of meta data(which is usually 64 GB in Hadoop 1.x)
- In Hadoop 1.x, the above limitation meant that the maximum amount of meta data that the Namenode can store is limited to Admin node's RAM
- Also, number of nodes that a Hadoop 1.x cluster could manage was 4000 node / slaves / commodity machines

Solution:

- This was solved in Hadoop 2.x by HDFS Federation

HDFS Federation(Cont'd)



Key Benefits of Federation

- NameSpace Scalability – Due to the ScaleOut nature of HDFS Federation; instead of having only one name-node in a cluster; we can have multiple name-nodes. This results in horizontal scalability; wherein it is easy to carry out intensive operations.
- Greater Output – Due to greater scalability; via multiple name-nodes. The file system operations have a greater rate of output.
- Isolation – In large scale systems; the complete data is segregated by either function or vertical.
- New Implementations – As Federation opens up the architecture it is very friendly to customized applications & use-cases on a HDFS cluster.

Basic Mapper - Reducer Concepts

Mappers:

- Mappers are java programs confirming to Google's Map Reduce algorithm framework. These programs run on each of the blocks of big data file saved on the cluster
- The mapper's job is to process the input data. Generally the input data is in the form of file or directory and is stored in HDFS.
- The input file is passed to the mapper function line by line. The mapper processes the data and creates several small chunks of data.

Basic Mapper - Reducer Concepts(Cont'd)

Reducers:

- Similar to Mappers, Reducers are also java programs confirming to Google's Map Reduce algorithm framework. They are aggregate functions which are supposed to run on the outputs coming out of mappers
- The Reducer's job is to process the data that comes from the mapper. After processing, it produces a new set of output, which will be stored in the HDFS.

YARN

Problem statement :

- JobTracker runs on single machine doing several task like Resource management, Job scheduling, task scheduling and Monitoring etc although there are so many machines (DataNode) available, they are not getting used. This limits scalability.

Solution :

- This was addressed in Hadoop 2.x with a new framework called YARN(This is an acronym for Yet Another Resource Negotiator)

YARN

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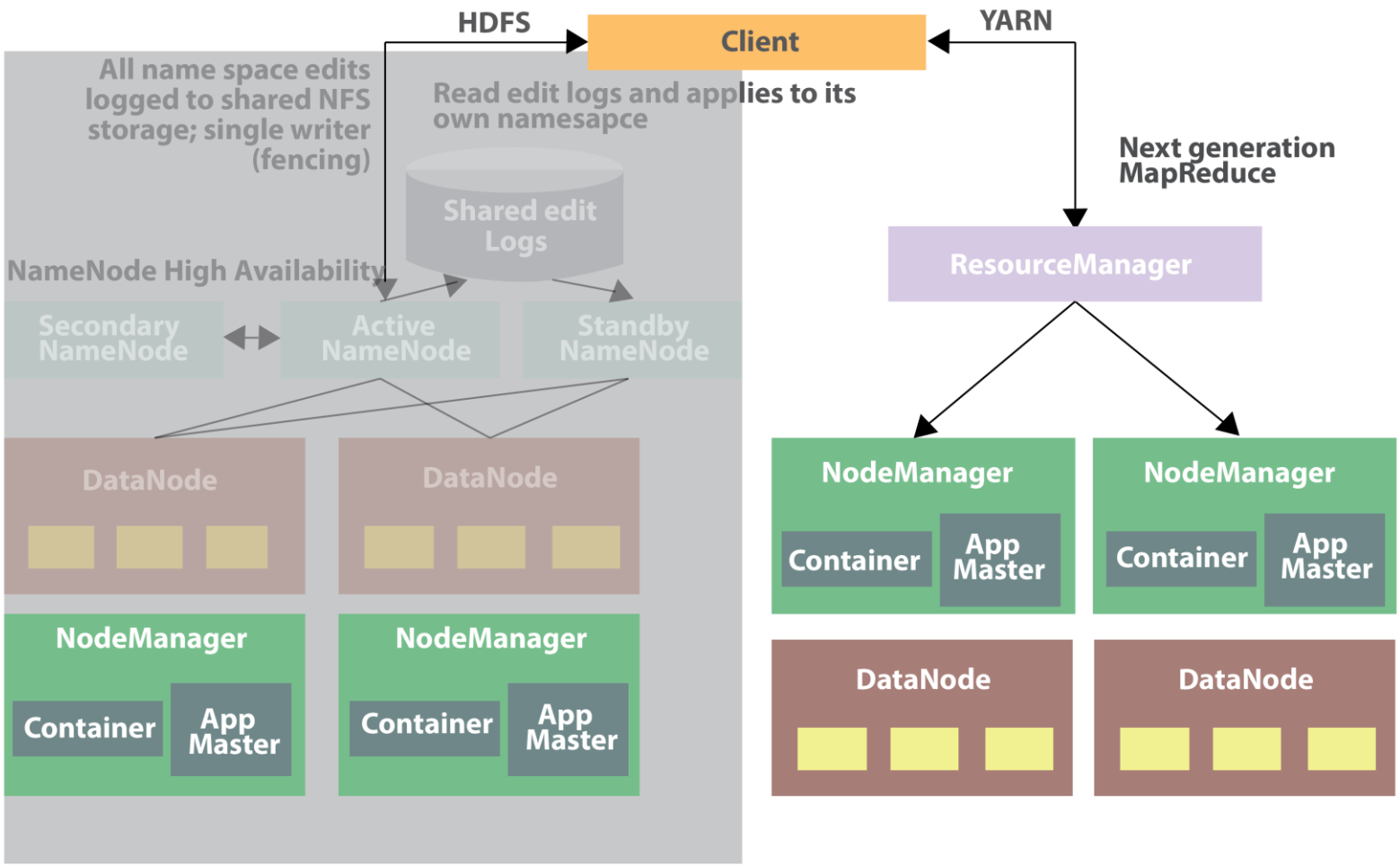
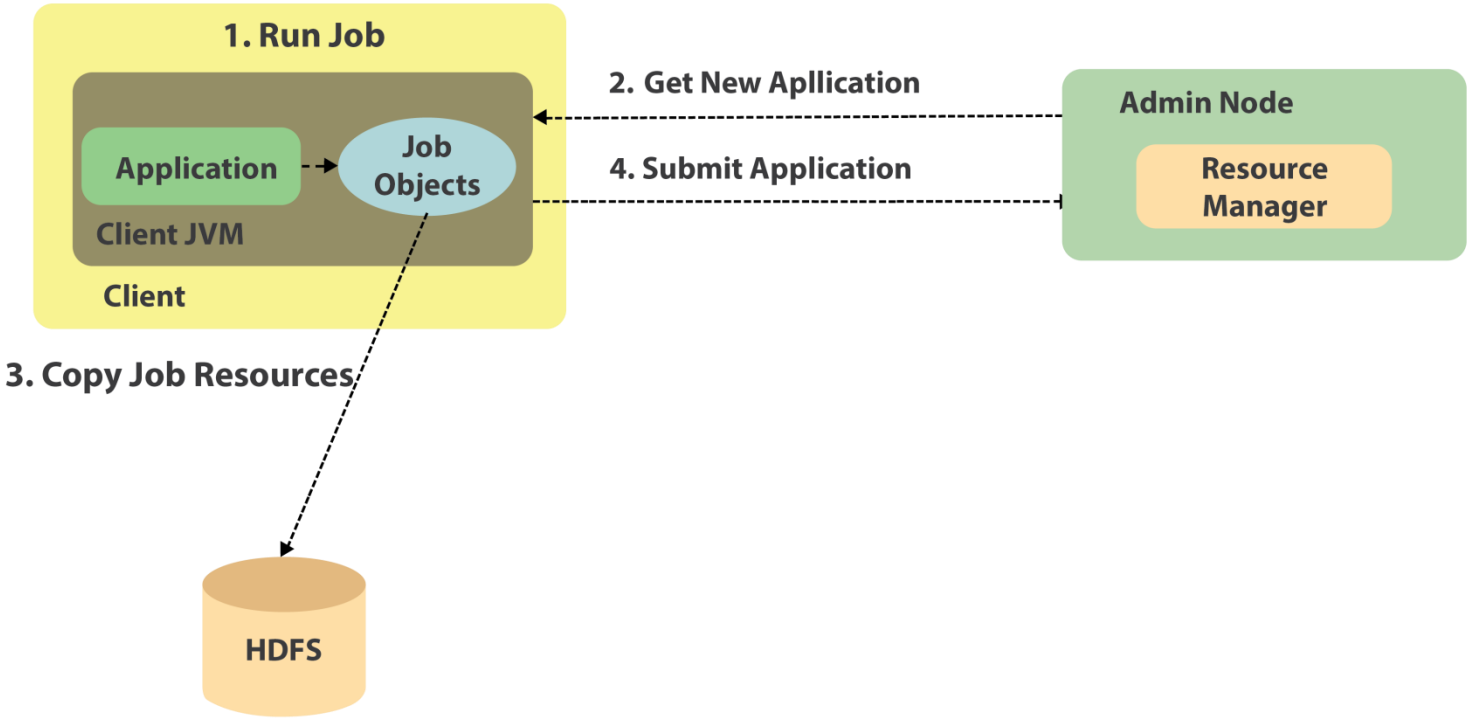
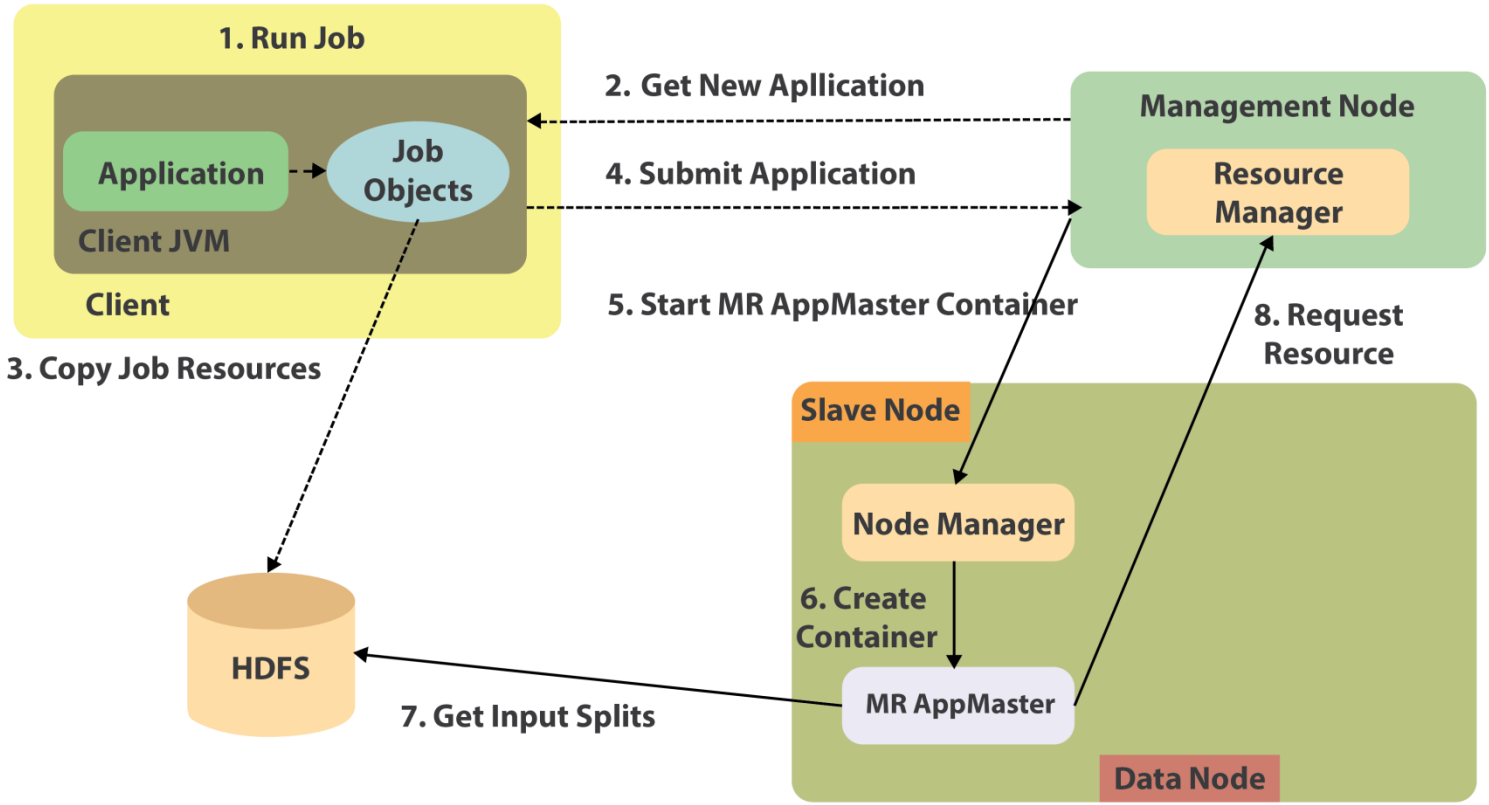
YARN(Cont'd)



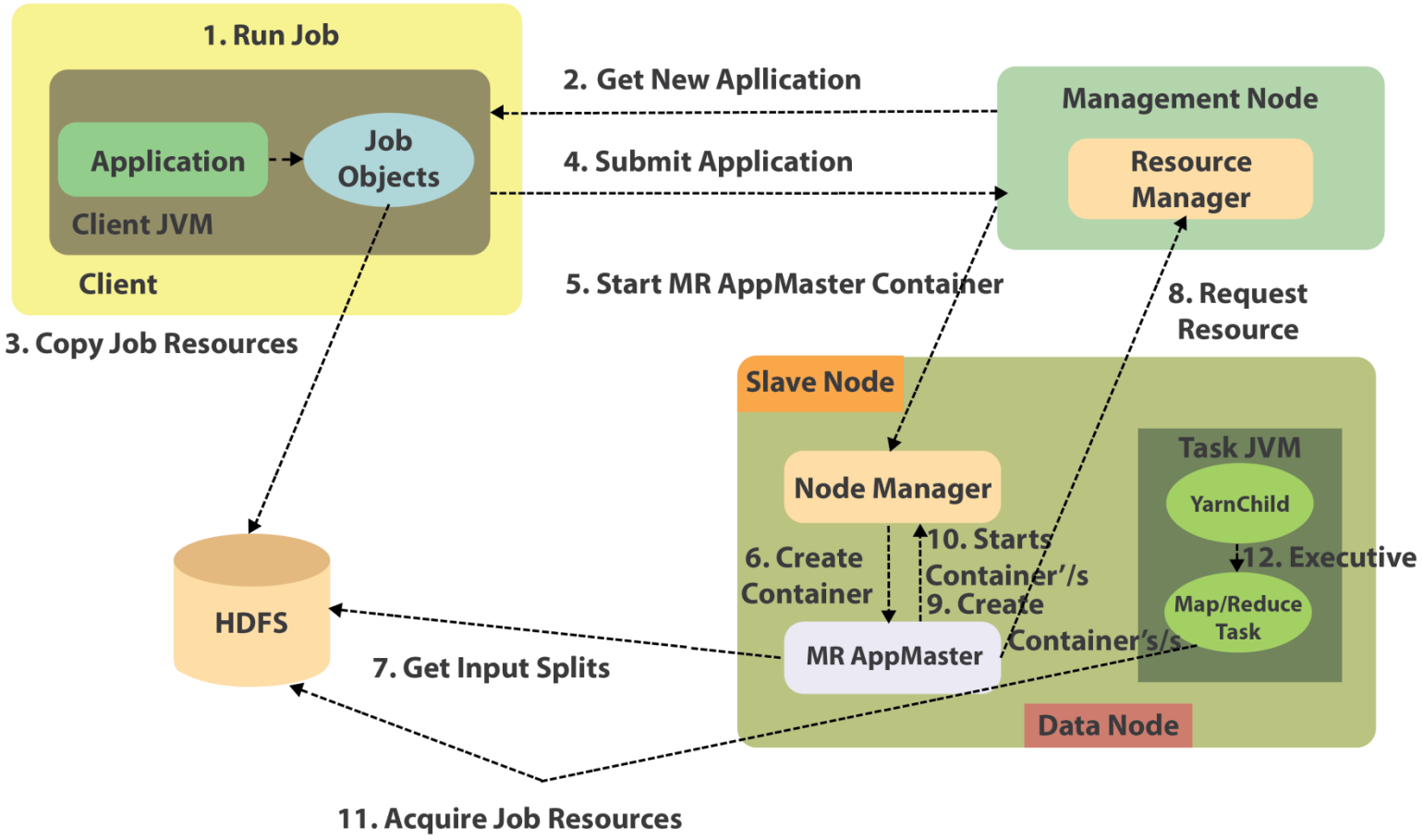
YARN MR Application Execution Flow



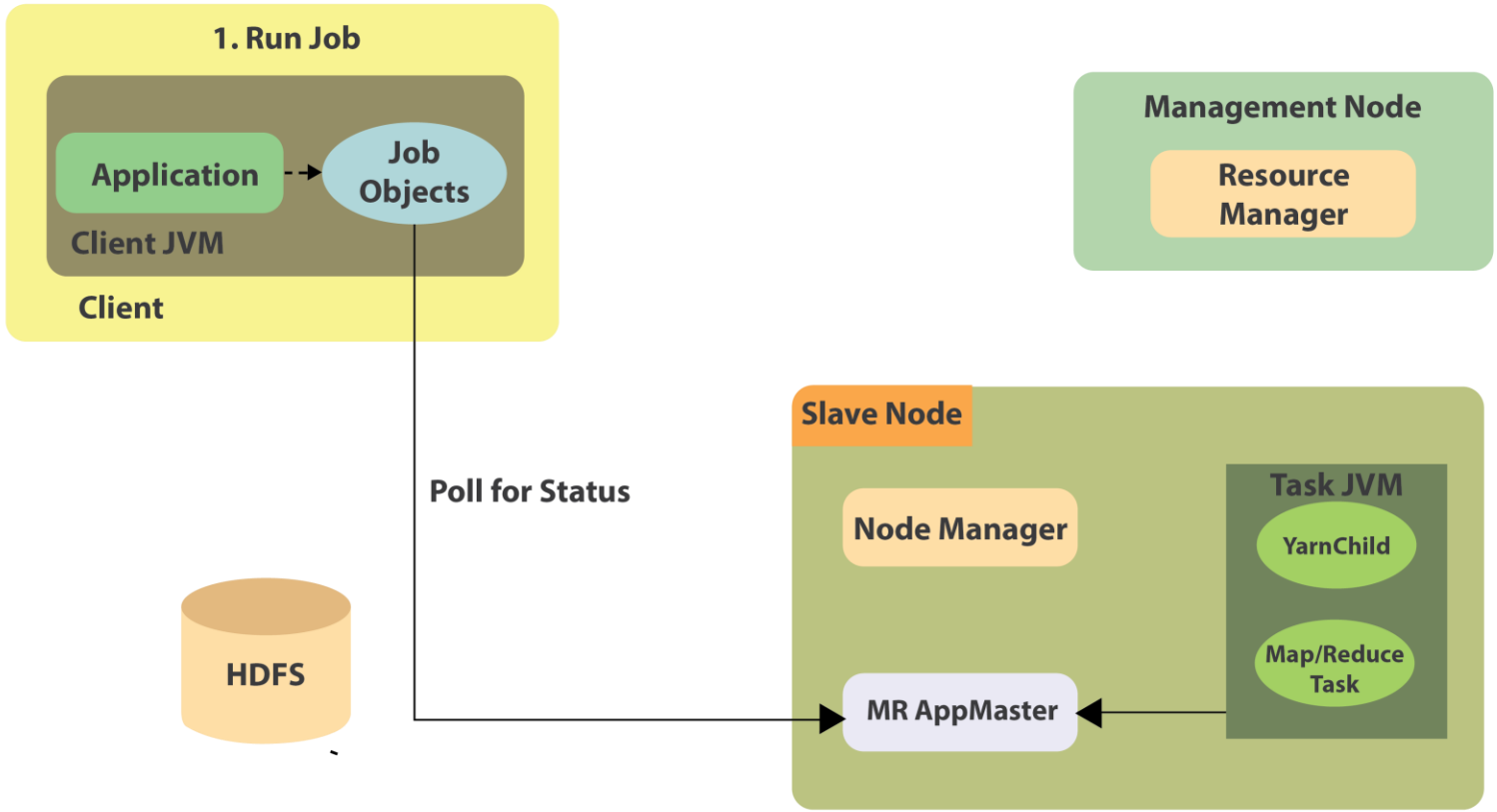
YARN MR Application Execution Flow(Cont'd)



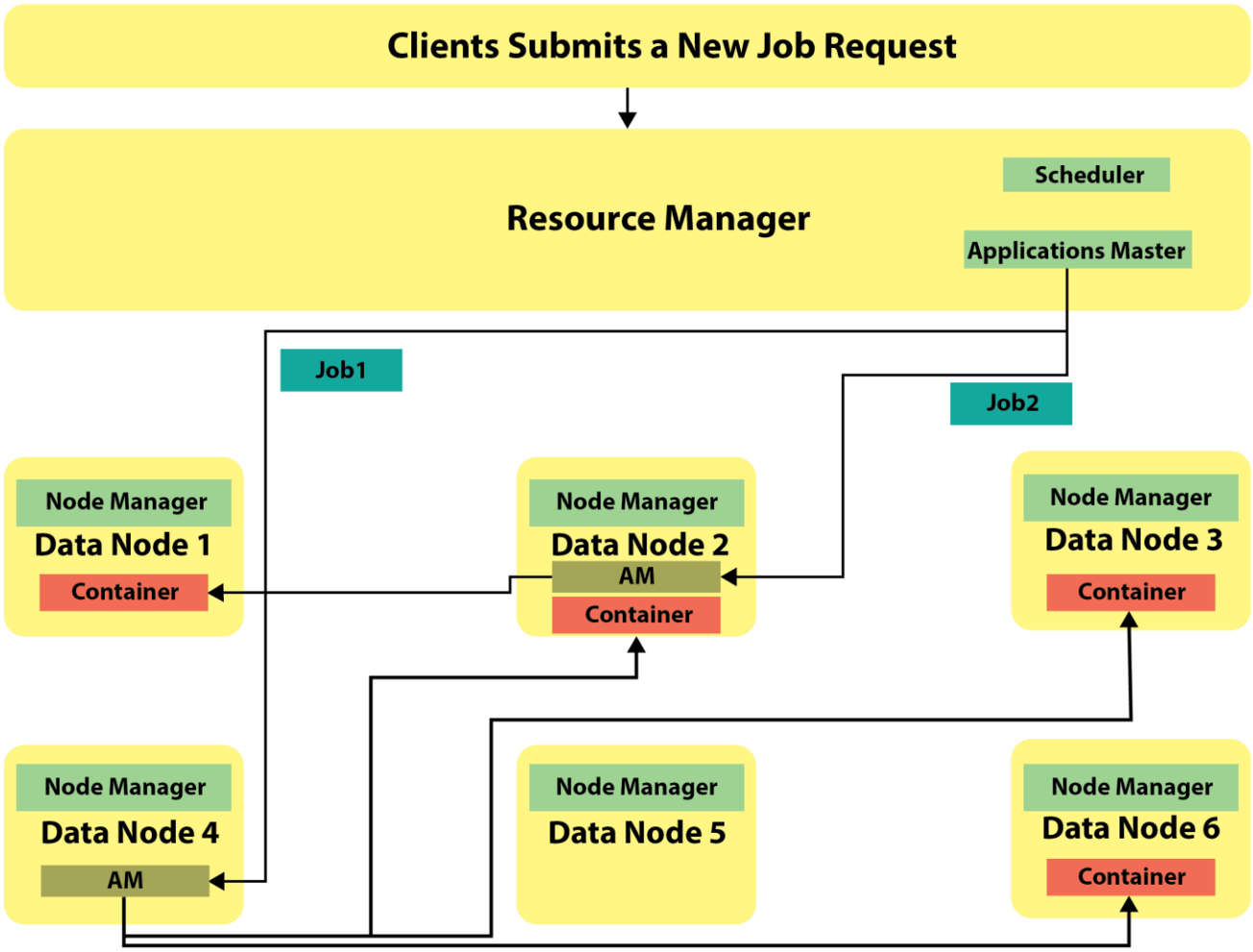
YARN MR Application Execution Flow(Cont'd)



YARN MR Application Execution Flow(Cont'd)



YARN MR Application Execution Flow(Cont'd)



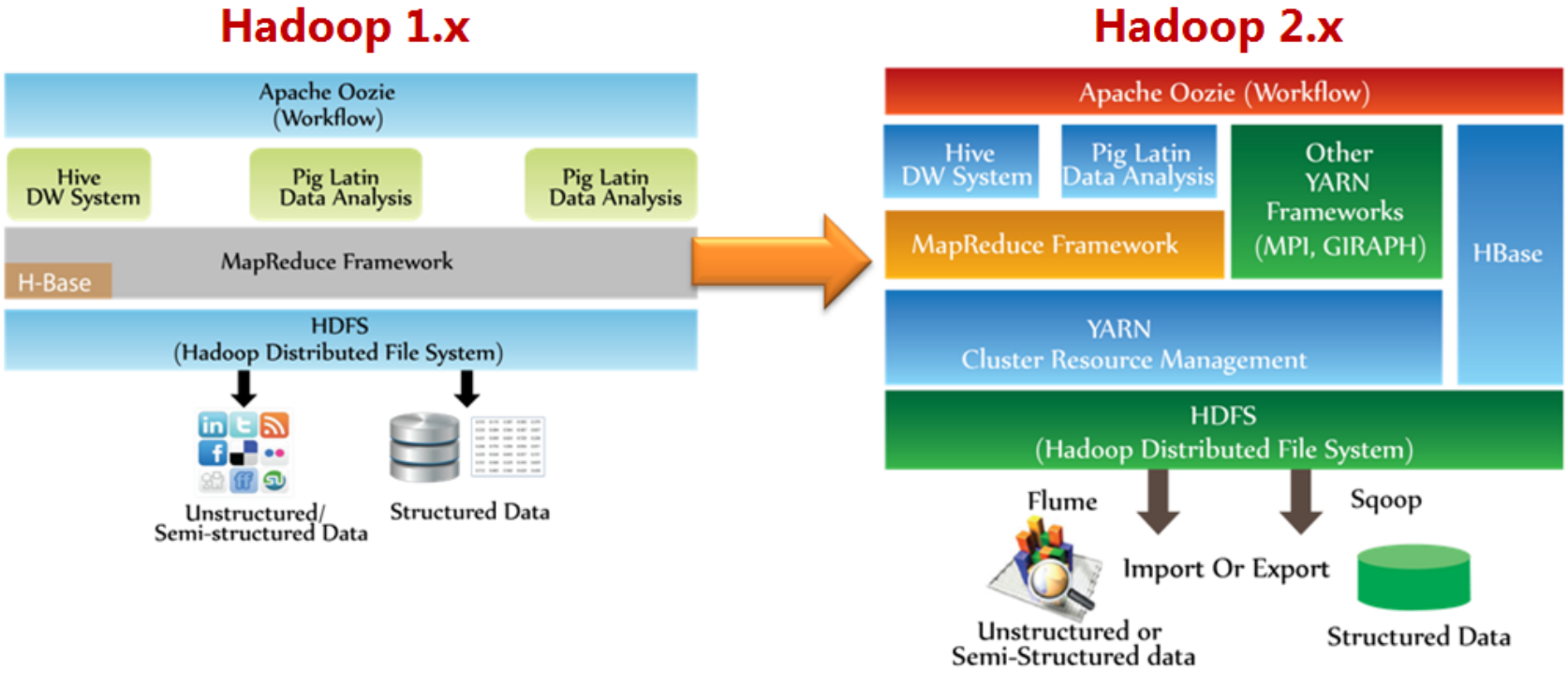
Drawbacks of Hadoop 1.0

- Namenode is not at all backed up by any hot standby systems
- In case of primary Namenode failure, the entire cluster becomes inaccessible
- Also, the namespaces are limited to one, with no horizontal scalability
- The Job Tracker becomes a bottleneck with all the initiation, monitoring and re-creation of jobs
- It support only map task and reduce task ,other EcoSystem Tools have limited support
- The huge amount of cluster data cannot be utilized by other for different outputs such as graph Processing

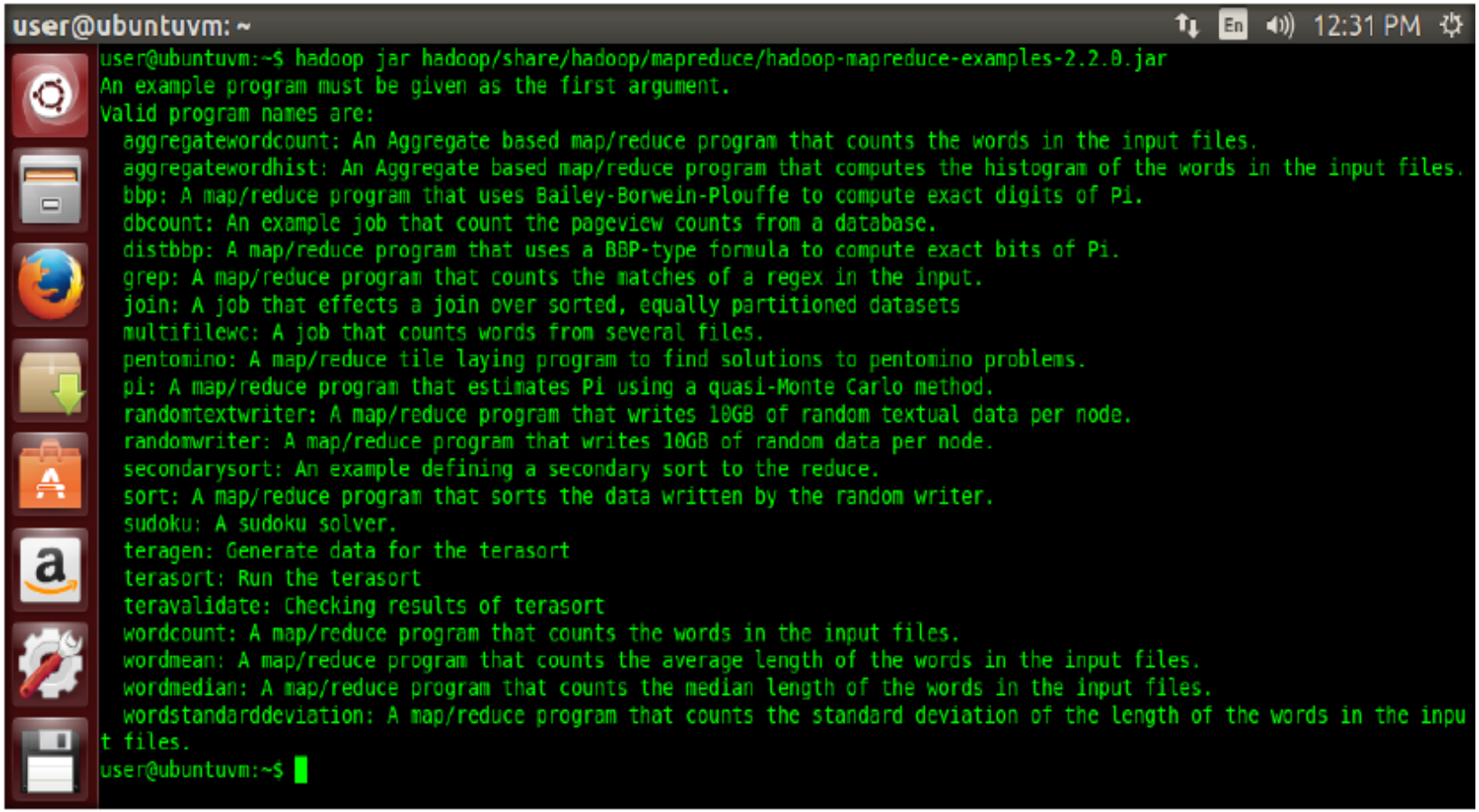
Solution is Hadoop 2.0

- Hadoop 2.x provides the following features to overcome the drawbacks of Hadoop 1.x.
- NameNode Federation for horizontal scalability
- NameNode High Availability
- YARN architecture for better job execution
- Supports almost all the latest EcoSystem processes

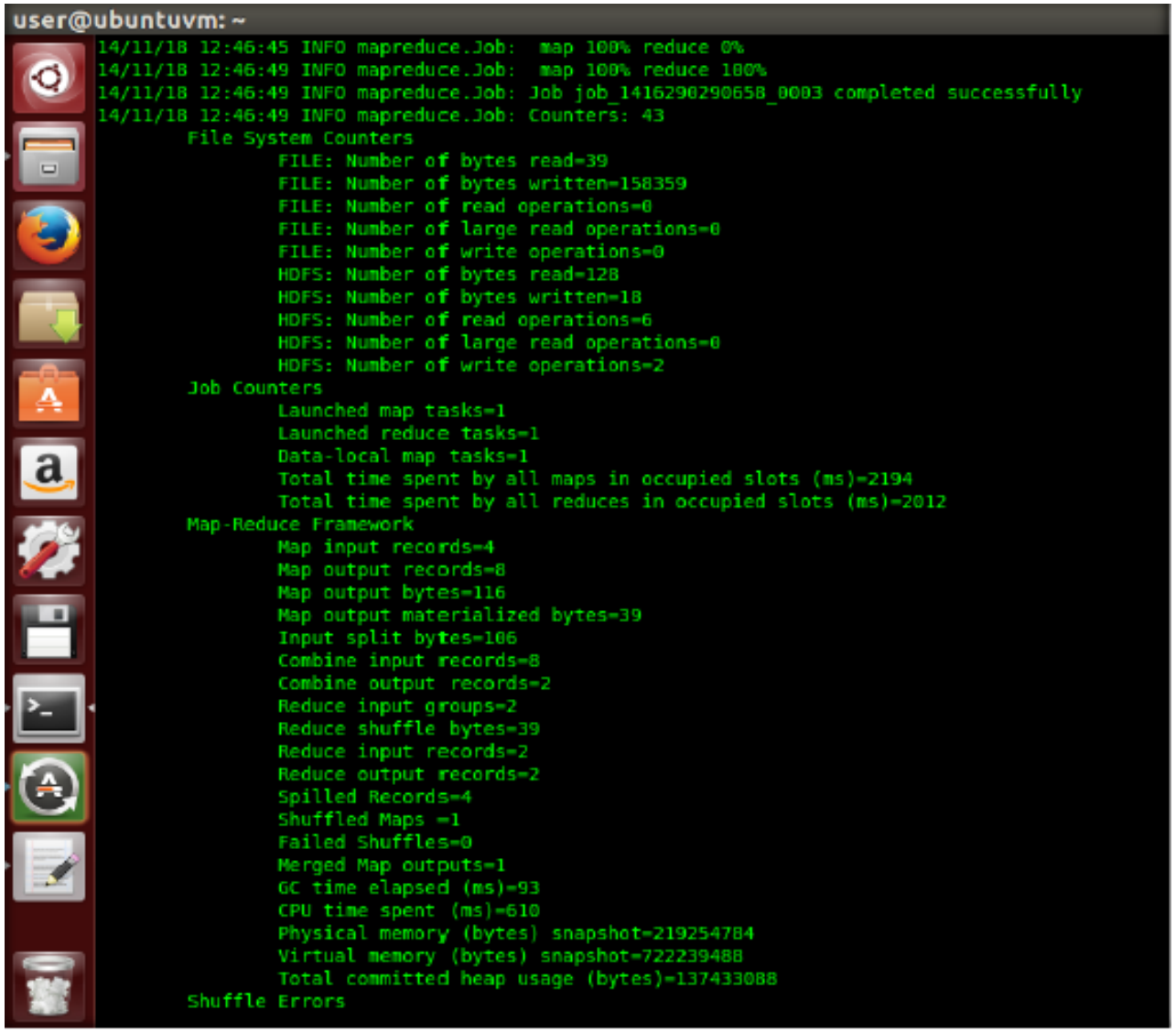
Hadoop 1.x Vs. Hadoop 2.x



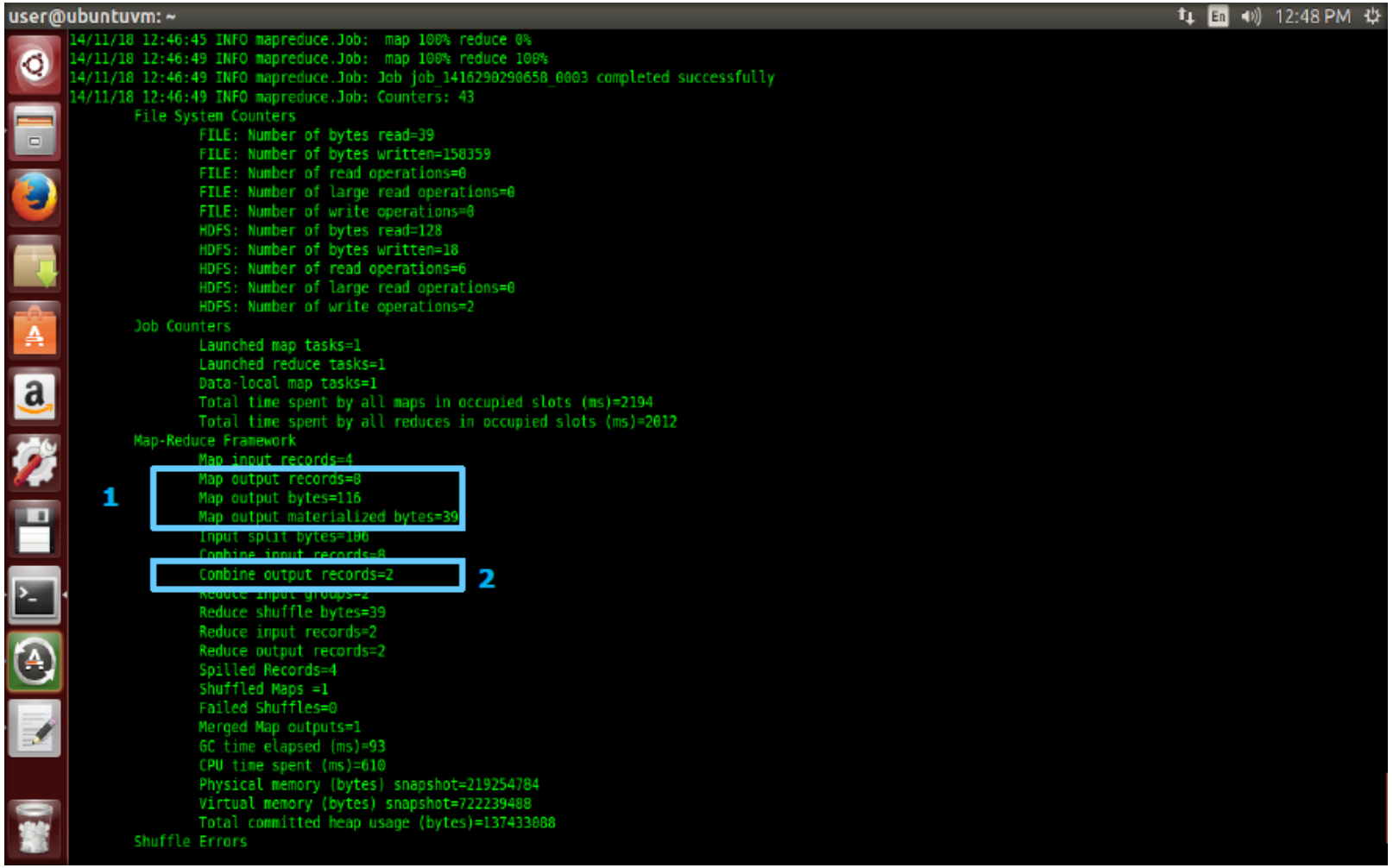
Listing Hadoop Sample Programs



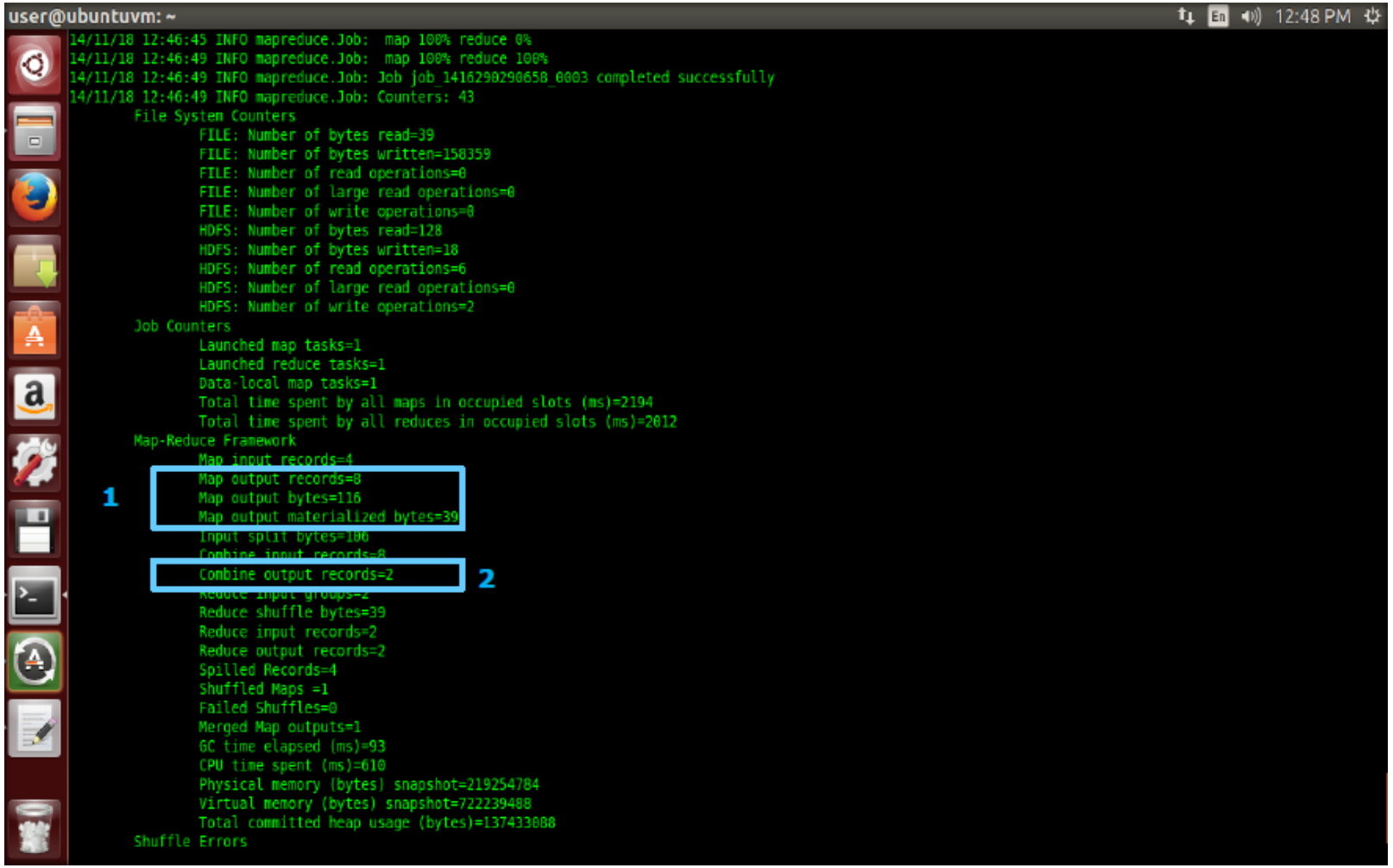
Firing a MapReduce Job



Understanding Dump of MapReduce Job



Understanding Dump of MapReduce Job



Quiz - 1

Which one of the following nodes manages other nodes?

A - Name node

B - Data node

C - slave node

D - None of these

Quiz - Solution

Which one of the following nodes manages other nodes?

✓ **A** - Name node

B - Data node

C - slave node

D - None of these

Quiz - 2

Which of the following components retrieves the input splits directly from HDFS to determine the number of map tasks.

A - The NameNode.

B - The TaskTrackers.

C - The JobClient.

D - The JobTracker.

E - None of the options is correct.

Quiz - Solution

Which of the following components retrieves the input splits directly from HDFS to determine the number of map tasks.

A - The NameNode.

B - The TaskTrackers.

C - The JobClient.

✓ **D** - The JobTracker.

E - None of the options is correct.

Quiz - 3

Under HDFS federation

A - Each namenode manages metadata of the entire filesystem.

B - Each namenode manages metadata of a portion of the filesystem.

C - Failure of one namenode causes loss of some metadata availability from the entire filesystem.

D - Each datanode registers with each namenode.

.

Quiz - Solution

Under HDFS federation

A - Each namenode manages metadata of the entire filesystem.

✓ **B** - Each namenode manages metadata of a portion of the filesystem.

C - Failure of one namenode causes loss of some metadata availability from the entire filesystem.

D - Each datanode registers with each namenode.

.

Quiz - 4

Under Hadoop High Availability, Fencing means

A - Preventing a previously active namenode from start running again.

B - Preventing the start of a failover in the event of network failure with the active namenode.

C - Preventing the power down to the previously active namenode.

D - Preventing a previously active namenode from writing to the edit log.

.

Quiz - 4

Under Hadoop High Availability, Fencing means

A - Preventing a previously active namenode from start running again.

B - Preventing the start of a failover in the event of network failure with the active namenode.

C - Preventing the power down to the previously active namenode.

✓ **D** - Preventing a previously active namenode from writing to the edit log.

Any Doubts?

Summery

- HDFS components are name node, secondary name node, data nodes , job tracker and task tracker.
- NameNode maintains, manages, and administers the data blocks saved on slave machines and managed by Data Nodes.
- An application adds data to HDFS by creating a new file and writing the data to it.
- Concept of rack awareness is important to prevent HDFS from placing all the copies of the block in same rack which might result in loss of data if rack fails.
- The mapper processes the data and creates several small chunks of data.
- The Reducer's job is to process the data that comes from the mapper.
- YARN – a resource-management platform responsible for managing computing resources in clusters and using them for scheduling of users' applications.

Kratoes
for the quick learner

Thank You!