Cloud Computing

Apache Hadoop

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Apache Hadoop

➤ Apache Hadoop is the driving force behind the big data industry.

➤ It is an open-source, Java-based framework.

➤ Hadoop …

- Stores data (Hadoop Distributed File System – HDFS)

- Executes jobs (MapReduce) on large clusters of commodity servers.

➤ Hadoop is highly fault tolerant and it is scalable from a single server to thousands of servers.

Hadoop Components

➢ *Common*

- Utilities supporting the other Hadoop modules, components, etc.

➢ *MapReduce (YARN)*

- A framework for job scheduling and cluster resource management.

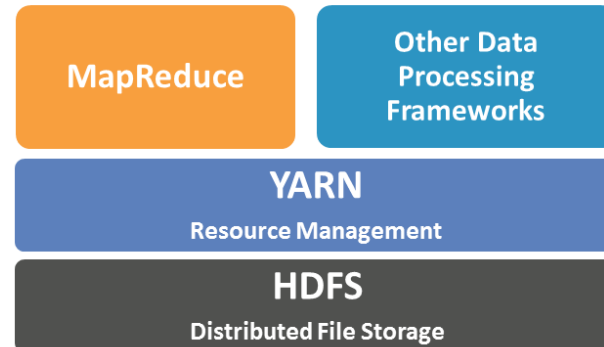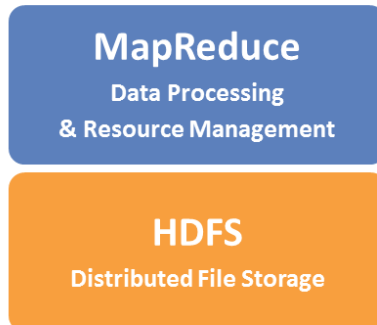- It is a programming model and an execution engine running on clusters of commodity servers.

➢ *HDFS*

- A distributed file system running on clusters of commodity computers.

Hadoop MapReduce v.2

➢ **YARN (Yet Another Resource Negotiator)**

- ▪ The major new improvement introduced in Hadoop v2.
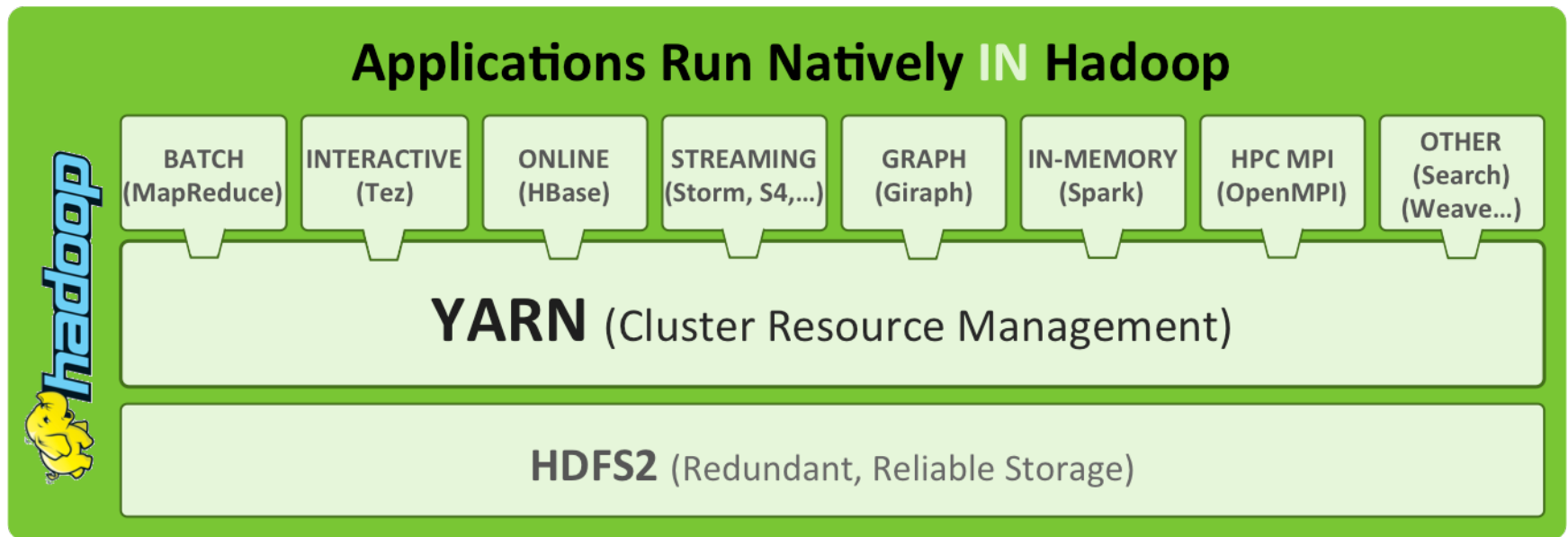

https://www.h2kinfosys.com/blog/hadoop-yarn-tutorial-learn-the-fundamentals-of-yarn-architecture/

Hadoop MapReduce v.2 (cont.)

➢ YARN is **a central component** in the Hadoop v2 ecosystem and provides a common platform for many different types of distributed applications.

➢ Some examples of the current YARN applications include:

  ▪ The **MapReduce** framework

  ▪ **Spark** processing engine

  ▪ The Storm real-time stream processing framework

Hadoop YARN

Applications Run Natively IN Hadoop

| BATCH (MapReduce) | INTERACTIVE (Tez) | ONLINE (HBase) | STREAMING (Storm, S4,…) | GRAPH (Giraph) | IN-MEMORY (Spark) | HPC MPI (OpenMPI) | OTHER (Search) (Weave…) |

YARN (Cluster Resource Management)

HDFS2 (Redundant, Reliable Storage)

https://devveri.com/hadoop/hadoop-2-0-yarn

Hadoop MapReduce v.2

YARN is a resource management system that allows ***multiple distributed processing frameworks*** to effectively share the compute resources of a Hadoop cluster and to utilize the data stored in HDFS.

Hadoop YARN (cont.)

➢ The **YARN ResourceManager** process is the central resource scheduler that manages and allocates resources to the different applications (also known as jobs) submitted to the cluster .

➢ **YARN NodeManager is a per node process** that manages the resources of a single compute node .

Hadoop YARN (cont.)

➢ Scheduler component of the ResourceManager allocates

resources in response to the applications resource request.

➢ Factors taken into consideration:

- The cluster capacity

- The other scheduling policies that can be specified through the

  YARN policy plugin framework.

Hadoop YARN (cont.)

➢YARN has a concept called **containers**, which is the unit of resource allocation.

- Each allocated container has the rights to a certain amount of CPU and memory in a particular compute node.

- Applications can request resources from YARN by specifying the required number of containers and the CPU and memory required by each container.

Hadoop YARN (cont.)

➢ApplicationMaster is a per-application process that coordinates the computations for a single application.

➢The first step of executing a YARN application is to deploy the ApplicationMaster.

Hadoop YARN (cont.)

➢After an application is submitted by a YARN client, the

ResourceManager allocates a container and deploys the

ApplicationMaster for that application.

➢Once deployed, the ApplicationMaster is responsible for

requesting and negotiating the necessary resource containers

from the ResourceManager.

Hadoop YARN (cont.)

➢Once the resources are allocated by the ResourceManager,

ApplicationMaster coordinates with the NodeManagers to

launch and monitor the application containers in the allocated

resources.

Hadoop MapReduce (cont.)

https://hadoop.apache.org/docs/stable/hadoop-yarn/hadoop-yarn-site/YARN.html
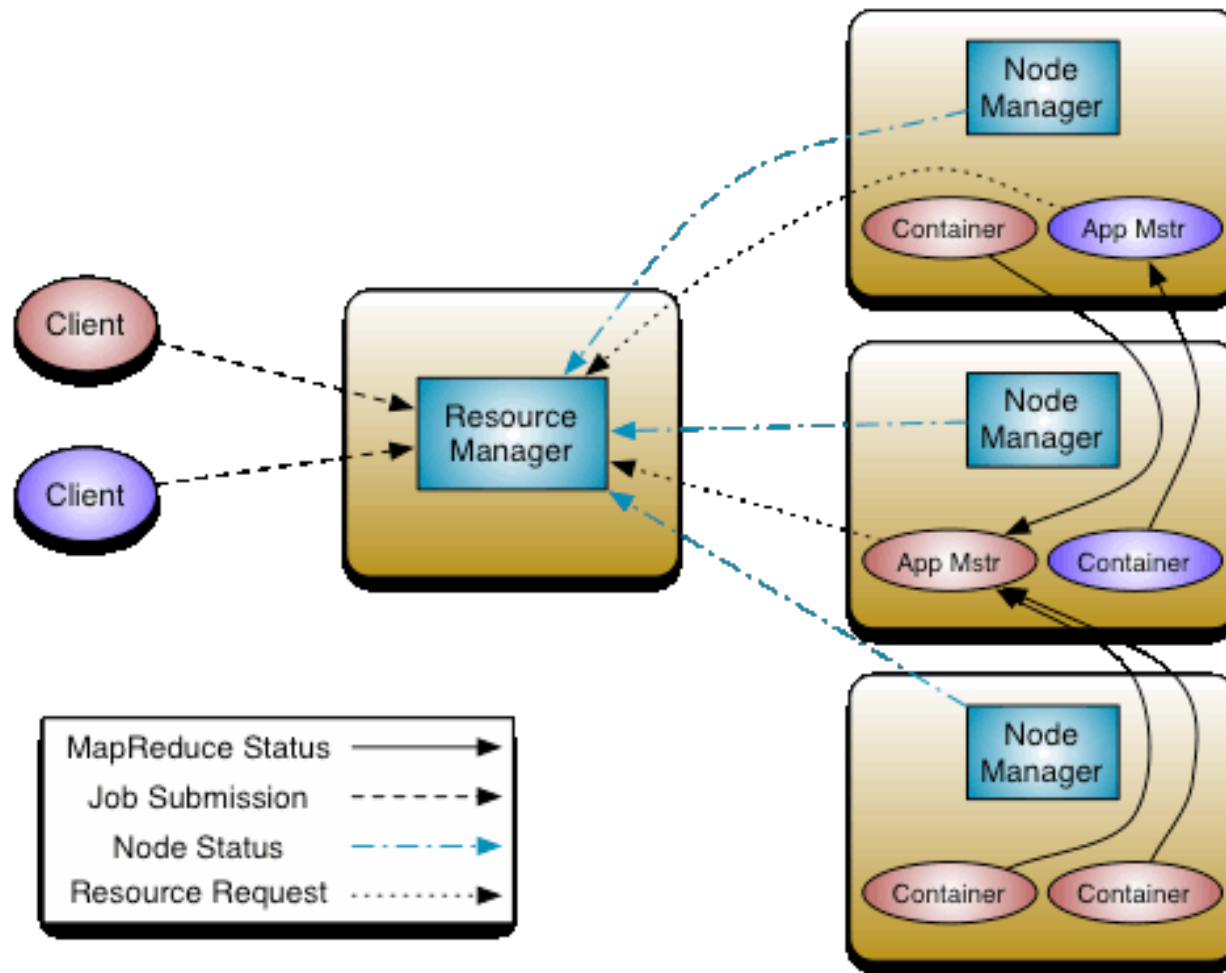
Hadoop MapReduce (cont.)

➢ A MapReduce **job** is a unit of work that the client wants to be performed.

- It consists of the **input data**, the **MapReduce program**, and **configuration information**.

➢ Hadoop runs the job by dividing it into tasks, of which there are two types: **map tasks** and **reduce tasks.**

Hadoop MapReduce (cont.)

➢ Hadoop divides the input to a MapReduce job into fixed-size pieces called **input splits**, or just **splits**.

➢ Hadoop creates **one map task for each split**, which runs the user defined map function for each record in the split.

Hadoop MapReduce (cont.)

➤ For most jobs, a good split size tends to be the size of an HDFS block, 128 MB by default.

➤ Hadoop does its best **to run the map task on a node where the input data resides in HDFS**.

➤ **Why does Hadoop do this?**

Hadoop MapReduce (cont.)

➢ Hadoop does its best **to run the map task on a node where the input data resides in HDFS**.

➢ This is called the **data locality optimization**

  ▪ It should now be clear why the optimal split size is the same as the block size.

➢ **Map tasks write their output to the local disk, not to HDFS**

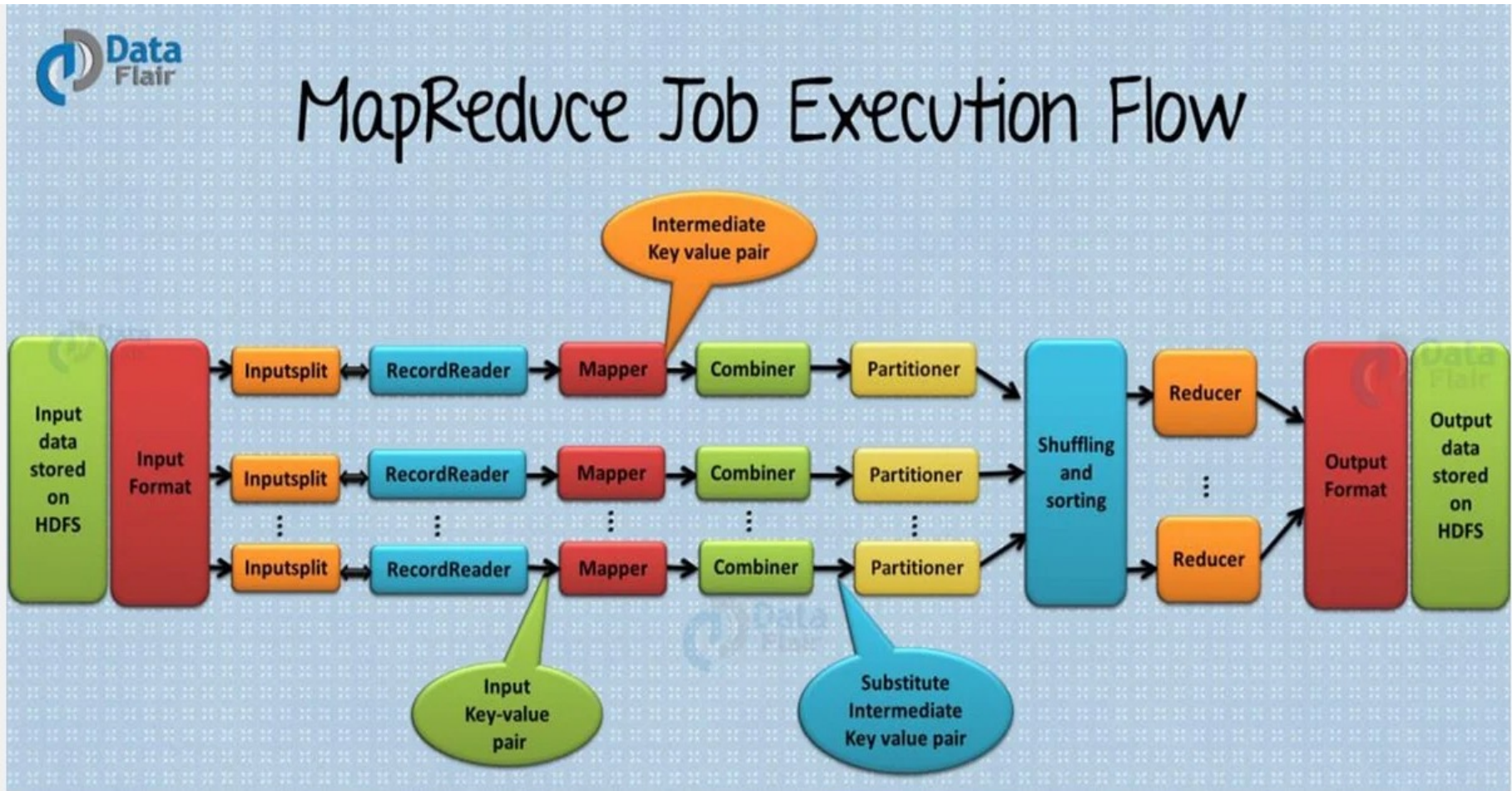 ▪ Because the Map output is intermediate output, not the final output.

Hadoop MapReduce (cont.)

➢ Reduce tasks don't have the advantage of data locality.

➢ When there are multiple reducers, the map tasks **partition** their output, each creating one partition for each reduce task.
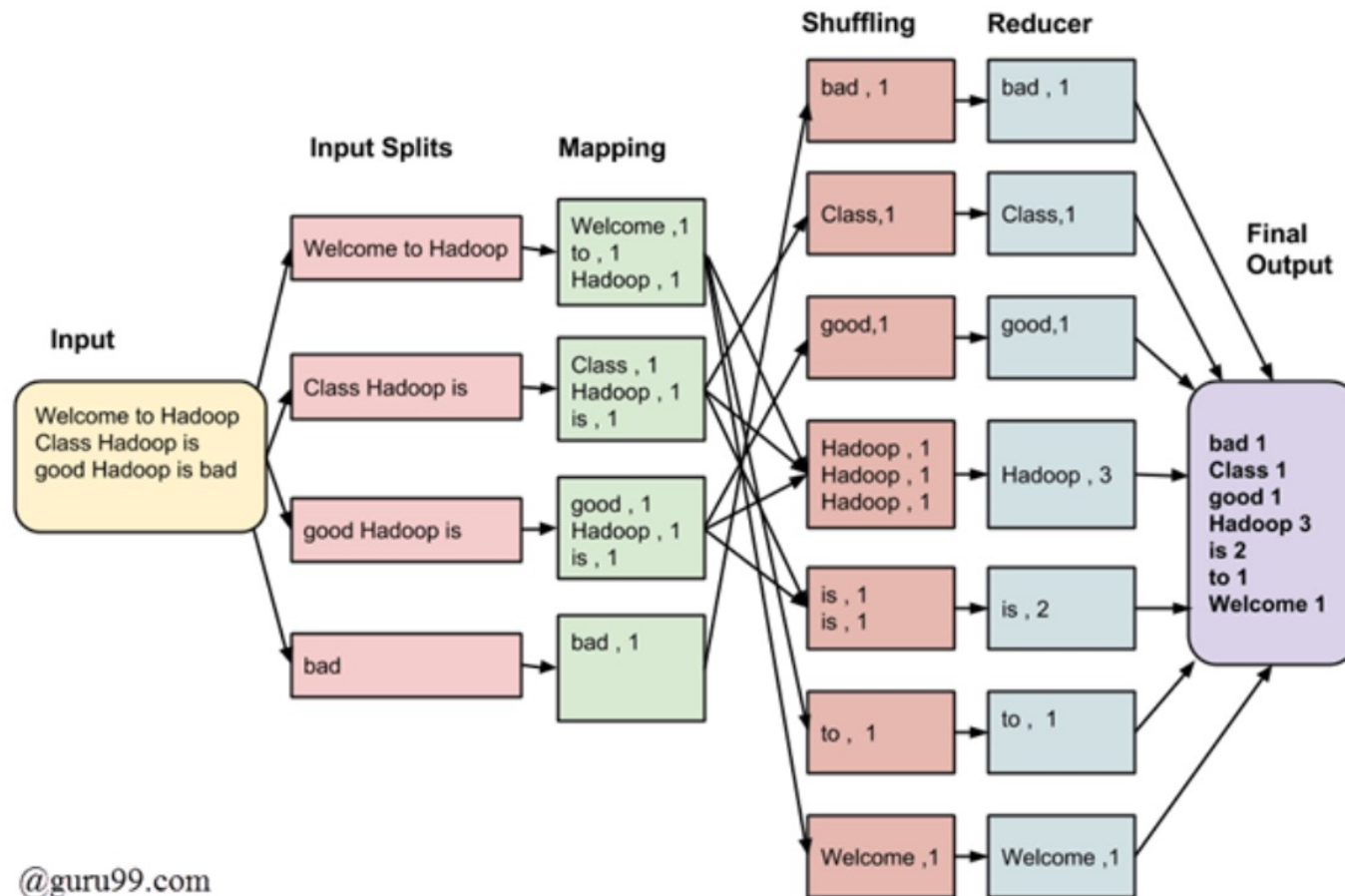
Hadoop MapReduce (cont.)

➢There can be many keys (and their associated values) in each partition, but the records for **any given key are all in a single partition.**

➢The partitioning can be controlled by a user-defined partitioning function, but normally the default partitioner works very well.

- ▪ Default partitioner buckets keys using a **hash function**.

MapReduce Job Execution Flow

https://data-flair.training/blogs/how-hadoop-mapreduce-works/

MapReduce Example

https://www.guru99.com/introduction-to-mapreduce.html

MapReduce on Utility Clouds

➤ Amazon offers an analytic cloud service called [Amazon Elastic MapReduce (EMR)](#) which provides a managed Hadoop MapReduce on Amazon EC2 instances.

➤ Microsoft also offers a big data service, which is called [Windows Azure HDInsight](#) Service, which deploys and provisions ApacheHadoop clusters in the Azure cloud.

MapReduce on Utility Clouds (cont.)

➢ AppEngine-MapReduce is an open-source library for doing

MapReduce-style computations on the Google App Engine

platform with pricing that is completive with Amazon EMR.