

Maharishi International University 1971-1995

MAHARISHI UNIVERSITY OF MANAGEMENT

Engaging the Managing Intelligence of Nature

CS522: Big Data

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2019

Maharishi's Eleventh Year of Global Ram Raj

Lesson 1

Introduction to Big Data:

*Transcendental consciousness is the simplest
form of awareness*

DFS

Problem 2

Read 1 TB data

a) 1 machine having 4 I/O channels (or 4 hard drives) such that each can read 100 MB/sec.

a) 10 machine having each having 4 I/O channels (or 4 hard drives) such that each can read 100 MB/sec.

Why DFS

Read 1 TB data

- 1 machine

- 4 I/O channels (4 hard drives)

- Each 100 MB/sec

- $1000000 \text{ MB} / 400 \text{ MB} = 41.666 \text{ minutes}$

- 10 machine

- 4 I/O channels

- Each 100 MB/sec

- $1000000 \text{ MB} / 4000 \text{ MB} = 4.1666 \text{ minutes}$

- I/O speed is the challenge; not the storage capacity. So we need to distribute data among many nodes (machines)

What is DFS

Machines are physically located at different places.

Logically, there is only one file system.

So we can read data in parallel into multiple machines.

What is Hadoop 1.x

Definition

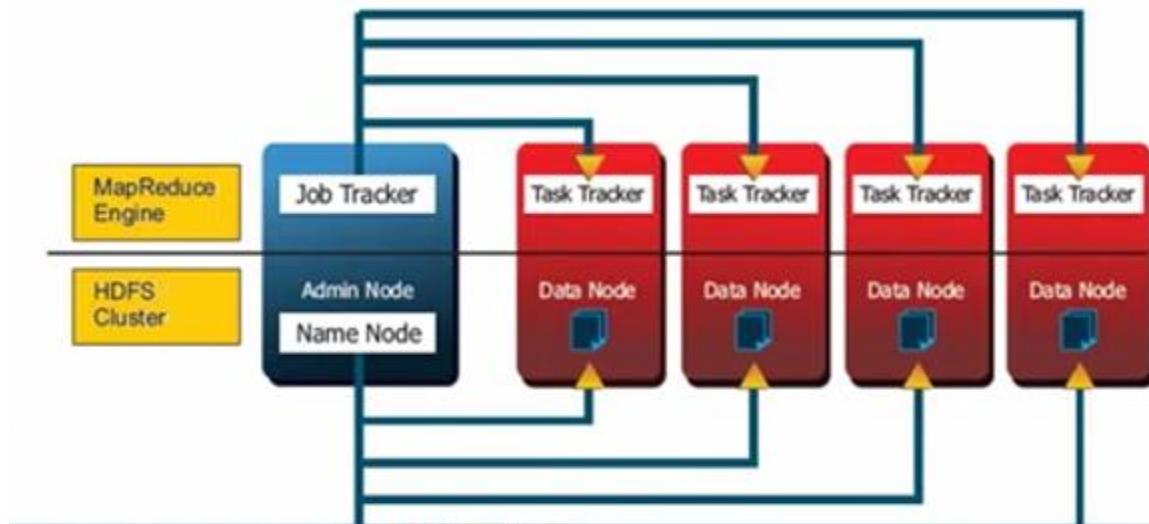
Hadoop is a framework that allows for distributed processing of large data sets across clusters of commodity computers using a simple computing model (called MapReduce to retrieve and analyze data).

Google, Yahoo, IBM, LinkedIn, Facebook, eBay, Amazon, ...

Hadoop 1.x

HDFS (Hadoop Distributed File System) for storage

MapReduce for processing



Main Point 1

Hadoop is a framework that allows distributed processing of large data sets across clusters of commodity computers using a simple computing model (called MapReduce to retrieve and analyze data). It is always advantageous to find a simple basis for a complex field because it provides a way to manage the complexity of the field. *Vedic Science has discovered that the simplest form of awareness is the basis for the universe.*

HDFS

Definition

HDFS is a file system designed for storing very large files (petabytes or hundreds of terabytes) with streaming data access patterns, running clusters on commodity hardware.

HDFS

- Highly fault-tolerant (replication of data in multiple nodes)
- High throughput (yahoo uses 5000 nodes)
- Suitable for applications with very large data sets
- Streaming access to file system data
 - Write once and read many times.
 - Where getting the entire data faster is more important than getting a specific record.
- Can be built out of commodity hardware

HDFS is not suitable for

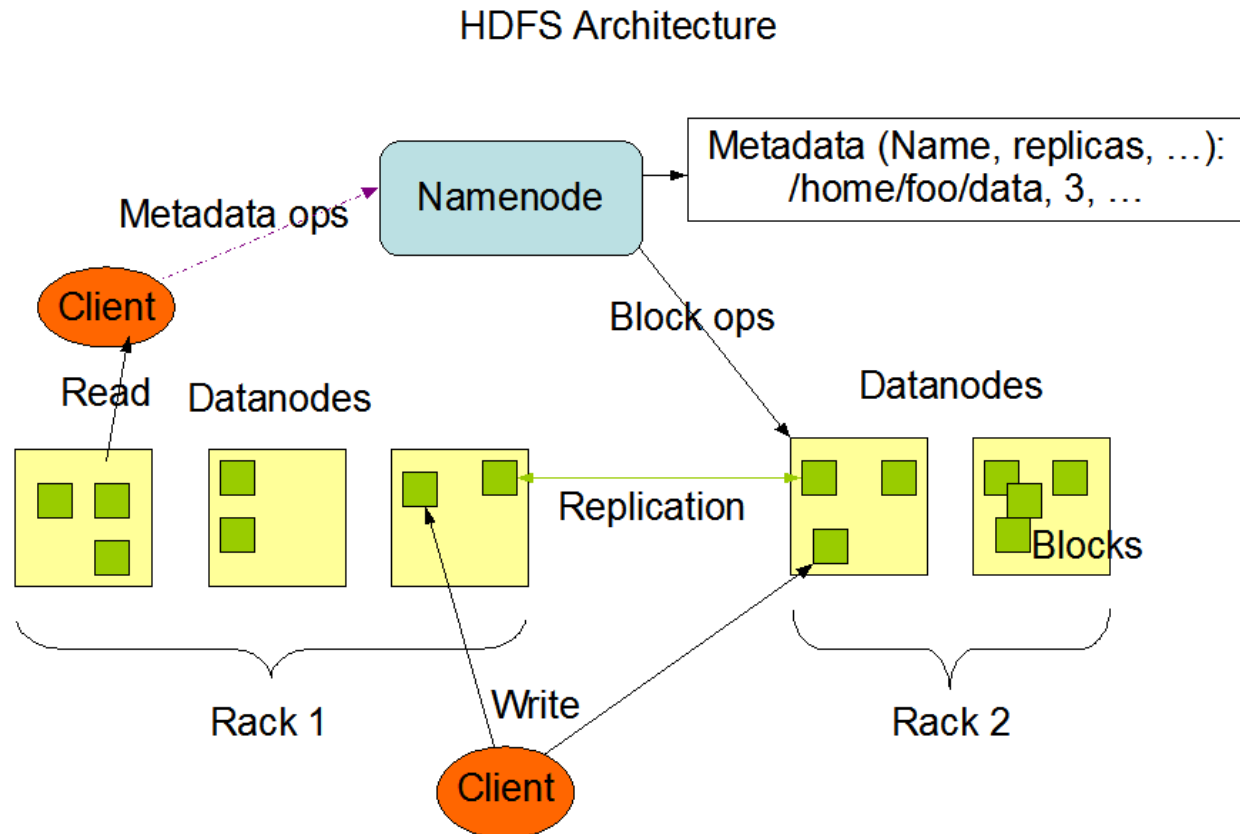
- Low-latency data access
 - latency: time interval between data request and data availability.
 - HDFS is optimized for high throughput of data at the expense of high latency
- Lots of small files
 - Because name node stores filesystem metadata in memory. Each file, directory, block takes about 150 bytes
- Multiple writers or file modification at arbitrary offsets
 - Might be supported in the future.

HDFS components

- NameNode
- DataNode

Note 1. NameNode, DataNode, Job Tracker and Task Tracker are daemons*

Note 2. Job Tracker and Task Tracker are in Hadoop 1.x and are NOT IN Hadoop 2.0 and up.



Img Ref:

<https://hadoop.apache.org/doc>

*daemon: a service or process that runs in the background in an environment

NameNode

- Master of the system
- Single Point of Failure (SPoF)
- Very expensive hardware with double/triple redundancy (RAID*)
- Responsibility: manages the filesystem namespace
 - maintains the filesystem tree and the metadata for all the files
 - maintains and manages the blocks that are present on DataNodes

*RAID (Redundant Array of Independent Disks) is a storage technology that combines multiple disk drive components into a logical unit for the purposes of data redundancy and performance improvement.

Secondary NameNode

- NameNode keeps all the data in the RAM.
- Secondary NameNode Reads data from the RAM of the NameNode and writes into hard drive.
- In Hadoop 1.x Secondary NameNode will not become (Primary) NameNode if the NameNode fails.

DataNode

- Slaves which are deployed on each machine to provide the actual storage
- Responsible for serving the read and write requests from the clients or namenode
- Datanodes report back to the namenode periodically with lists of blocks that they are storing

Main Point 2

HDFS is a file system designed for storing very large files (in terabytes) with streaming data access patterns, running on clusters of commodity hardware. *All information in nature is ultimately in the Unified Field.*

Job Tracker and Task Tracker (Hadoop 1.x) (Hadoop 2.0: Appendix Lesson 2)



HDFS Architecture

- A file in HDFS is broken into block-sized chunks, which are stored as independent units.
- Minimum Block size is 128MB (default in linux is 8KB)
- A file in HDFS that is smaller than a single block does not occupy a full block's storage space.
 - Example: A 1 MB file stored with block size of 128 MB uses 1 MB of disk space, not 128 MB.

Large block size: pros and cons

Minimizes the cost of seeks. If the block is large enough, the time to transfer the data from the disk can be significantly larger than the time to seek to the start of the block.

MapReduce tasks operate on one input-split (see next slide to see how input-split is related to a block) at a time. So if data is not distributed into many datanodes, we are not taking advantage of the parallelism possible to its fullest extent.

Input-Splits

Example. Assume the following:

data block size is 64 KB.

file size is 150 KB. 15 records; each of size 10 KB.

Now the file is stored in three data blocks:

0 – 63 KB in the first block, 64 – 127 KB in the second block, 128 – 149KB in the third block.

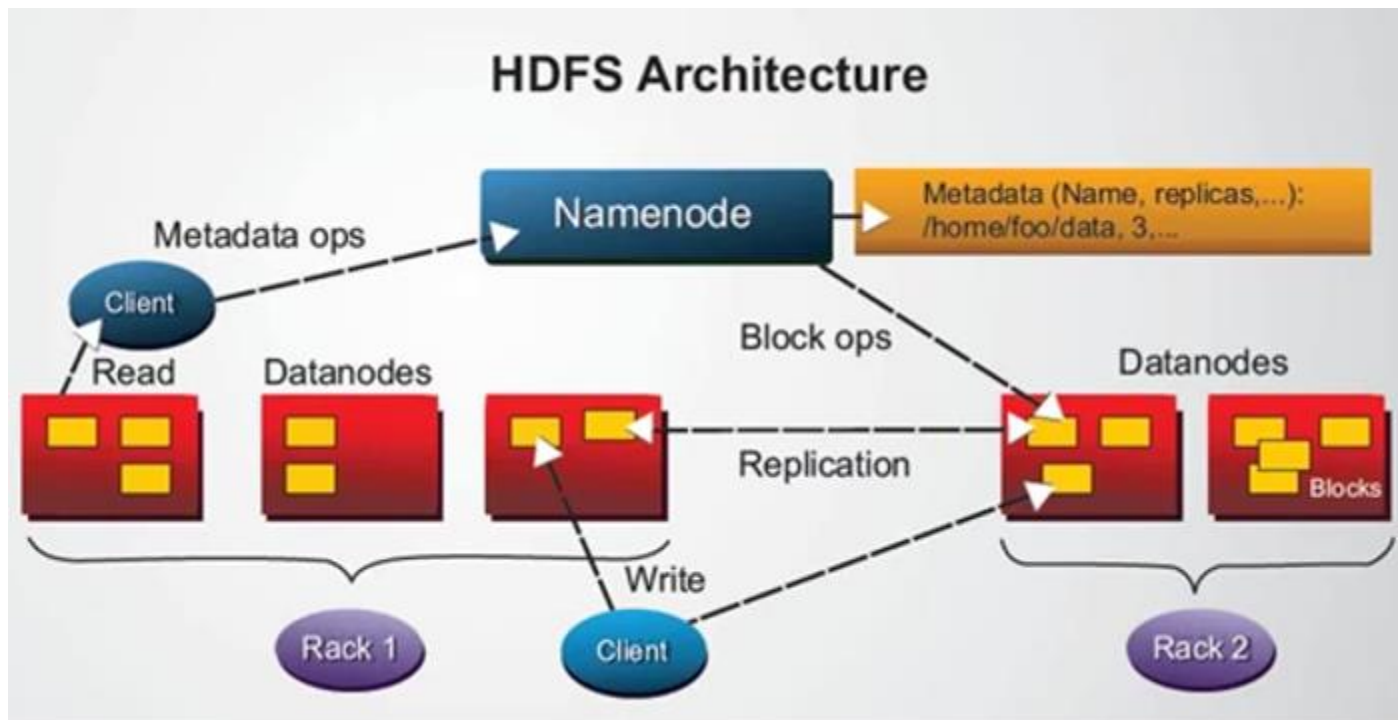
0-6 records are in the 1st input-split (0 – 69 KB) (the 1st split actually extends beyond the 1st block and gets the remaining record from block 2)

7-12 records are in the 2nd input-split (70 -129 KB)

13 and 14 records are in the 3rd input-split (130 - 149 KB)

HDFS Architecture

Read and Write



Anatomy of file read

Important Points:

1. Datanode directly perform the I/O.
2. Data never move through Namenode.

Read Tom White's Book for details.

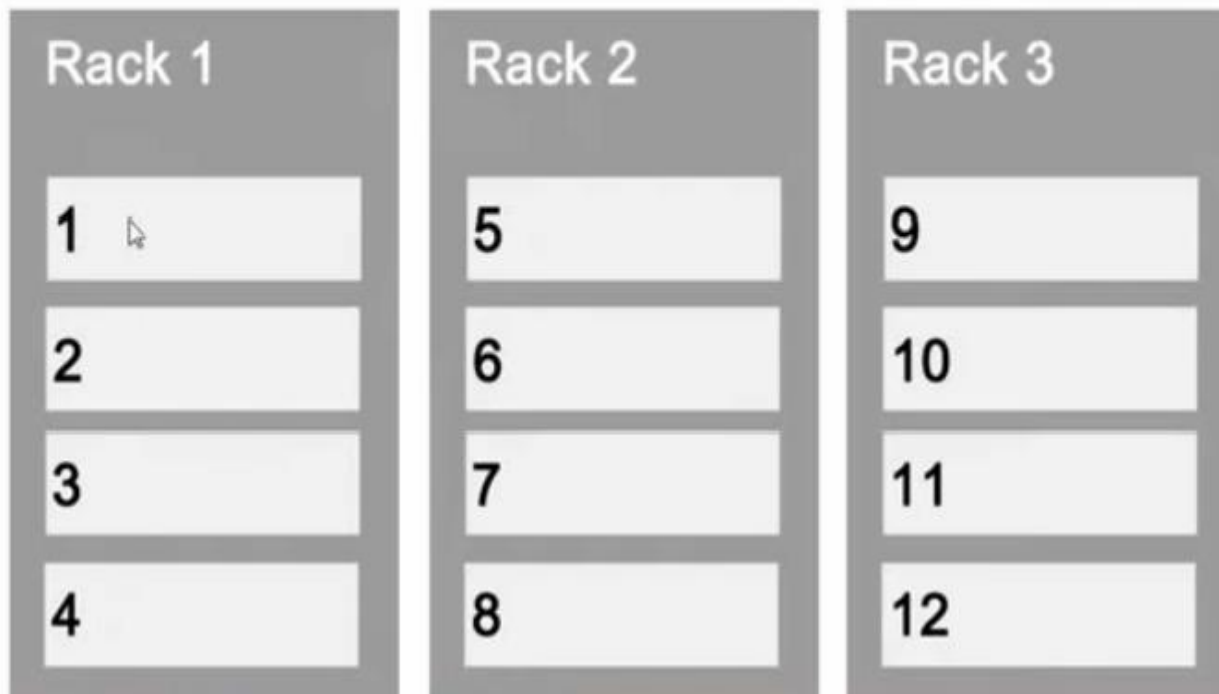
Replication Example:

Three data blocks (A, B, C), three racks and each rack has 4 datanodes

Block A : 

Block B : 

Block C : 






After placing Block A

Block A : 

Block B : 

Block C : 

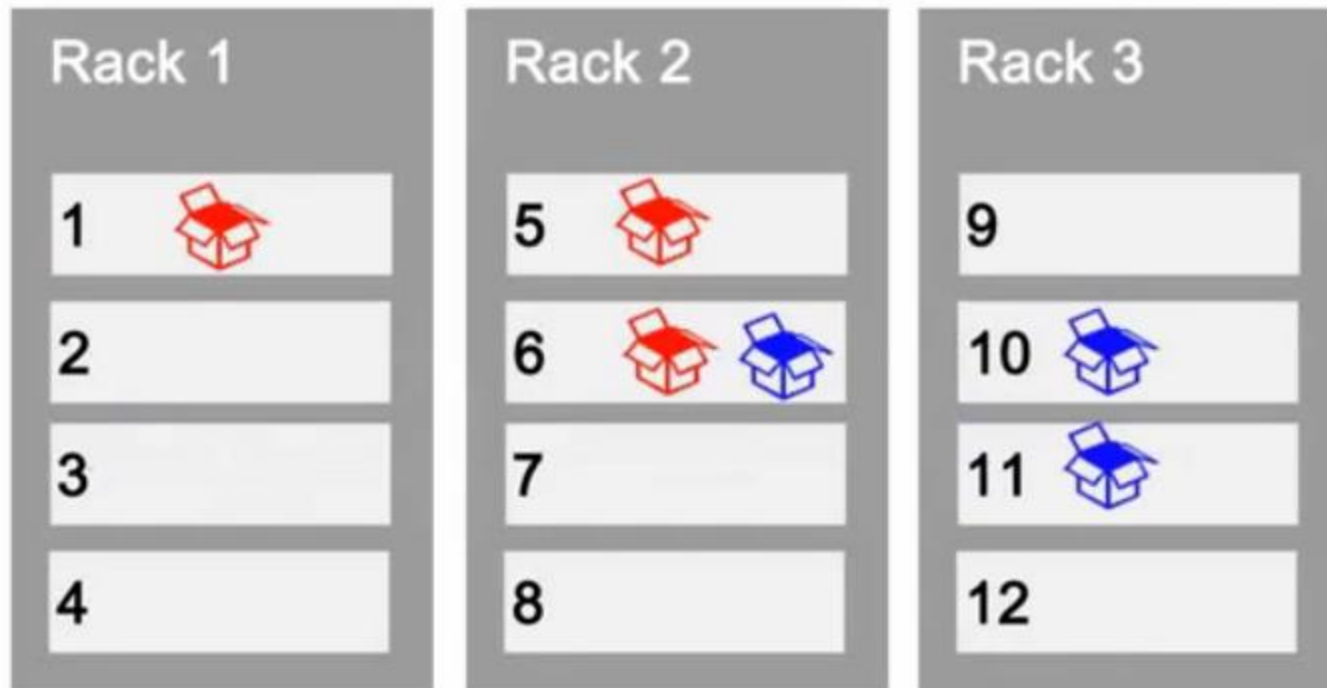
Rack 1	Rack 2	Rack 3
1 	5 	9
2	6 	10
3	7	11
4	8	12

After placing Block B

Block A : 

Block B : 

Block C : 



After placing Blocks A, B and C

Block A : 

Block B : 

Block C : 

Rack 1

1



2



3



4

Rack 2

5



6



7

8

Rack 3

9

10



11



12



Main Point 3

MapReduce paradigm is used to extract valuable information from big data. The objective means of gaining knowledge attempts to extract knowledge from the ever-changing relative field of existence. *The subjective means of gaining knowledge starts with the wholeness of the non-changing Absolute, which is the basis of the changing relative.*

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE

1. HDFS is a simple and abstract form of file system to store and retrieve large data sets.
 1. Hadoop is found to be an ideal solution to deal with big data.
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3. ***Transcendental consciousness:*** *is the experience of the simplest and most abstract state of awareness which underlies all states of greater excitation.*
 4. ***Impulses within the Transcendental Field:*** *Nature accomplishes what it needs by having its impulses in the transcendental field be as efficient as possible.*
 5. ***Wholeness moving within itself:*** *In unity consciousness one experiences everything as excitations of pure consciousness that underlies and connects all diversity.*
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