



HADOOP ARCHITECTURE



Agenda for today's Session

1. Hadoop Components
2. DFS – Distributed File System
3. Hadoop Services
4. Blocks in Hadoop
5. Block Replication
6. Rack Awareness
7. HDFS Architecture
8. HDFS Read/Write Mechanism



Big Data Storage & Computation ?



Storing Big Data was a Problem

*Even if a part of Big Data is Stored-
Processing it, took Years*



Hadoop Solves Big Data Problems



Storing Big Data was no more a Problem



And Processing did not take Years

Hadoop has a Distributed File System.

But Why?

DFS – Distributed File System

Read 1TB Data



1 Machine
4 I/O Channels
Each channel - 100MB/s



43 Minutes

DFS – Distributed File System

Read 1TB Data



1 Machine
4 I/O Channels
Each channel - 100MB/s



43 Minutes



10 Machines
4 I/O Channels
Each channel - 100MB/s



Hadoop Components

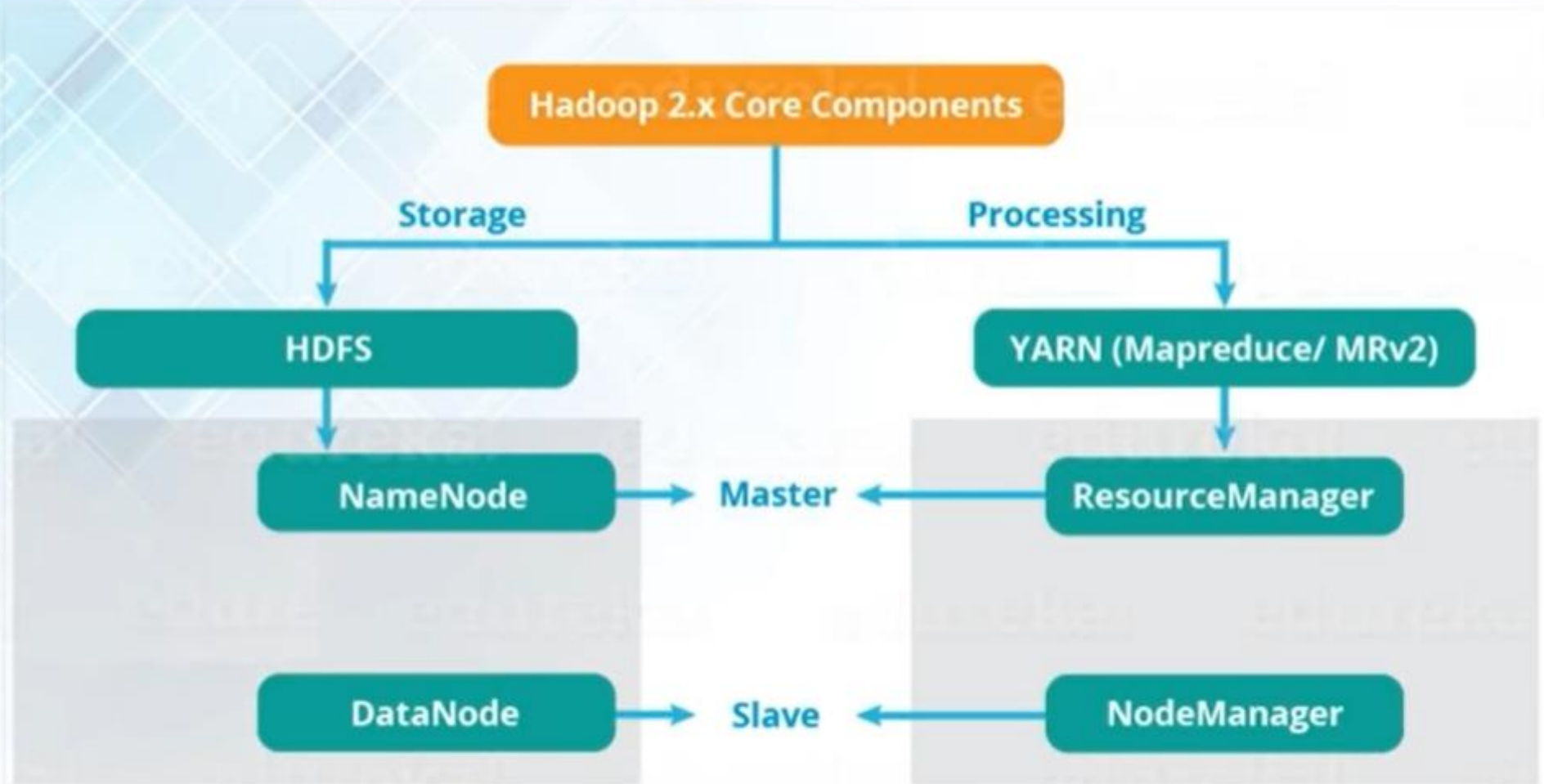
2 Main Hadoop Components

Storage

Processing



Hadoop 2.x Daemons



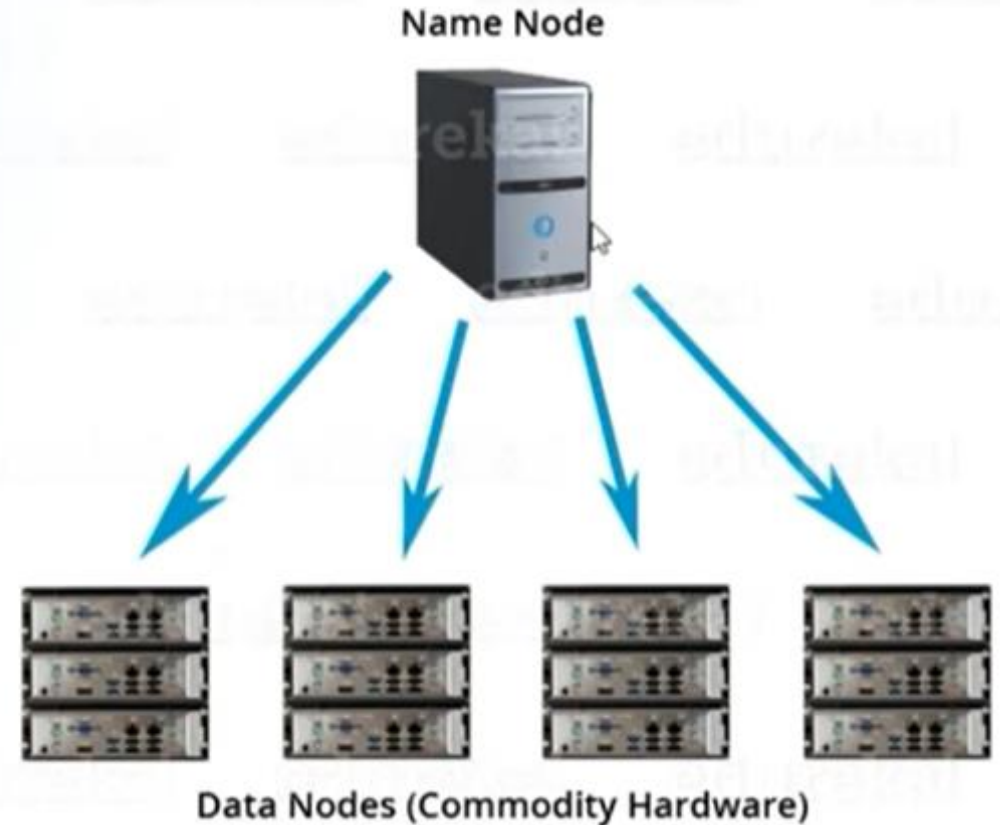
NameNode and DataNode

NameNode

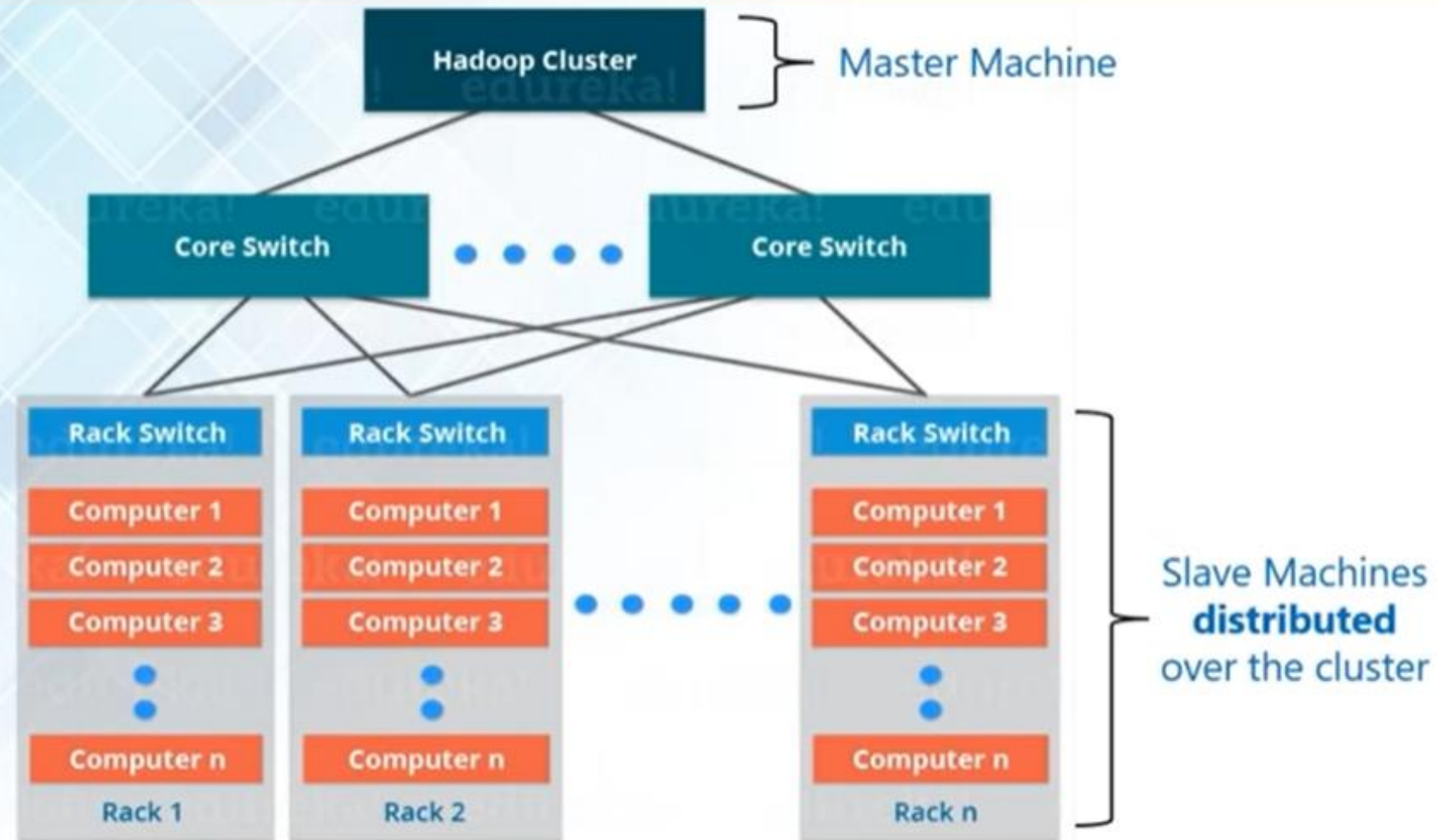
- Master daemon
- Maintains and Manages DataNodes
- Records metadata e.g. location of blocks stored, the size of the files, permissions, hierarchy, etc.
- Receives heartbeat and block report from all the DataNodes

DataNode

- Slave daemons
- Stores actual data
- Serves read and write requests from the clients



Hadoop Cluster Architecture – Master Slave Topology



Let us talk about,
how data is stored in HDFS?

HDFS Blocks

- Each file is stored on HDFS as blocks
- The default size of each block is **128 MB** in Apache Hadoop 2.x (64 MB in Apache Hadoop 1.x)
- Let us say, I have a file example.txt of size 248 MB. Below is the representation of how it will be stored on HDFS



HDFS Blocks

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- Let us say, I have a file example.txt of size 248 MB. Below is the representation of how it will be stored on HDFS



How many blocks will be created if a file of size 514 MB is copied to HDFS ?

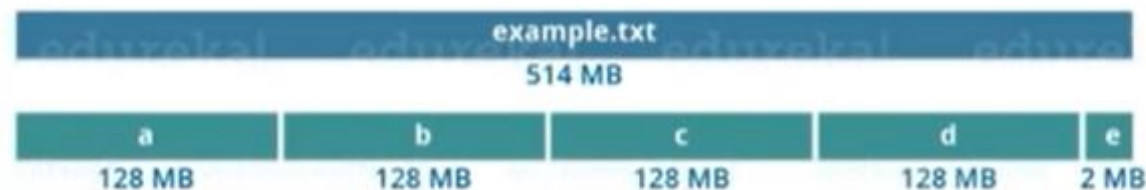


HDFS Blocks

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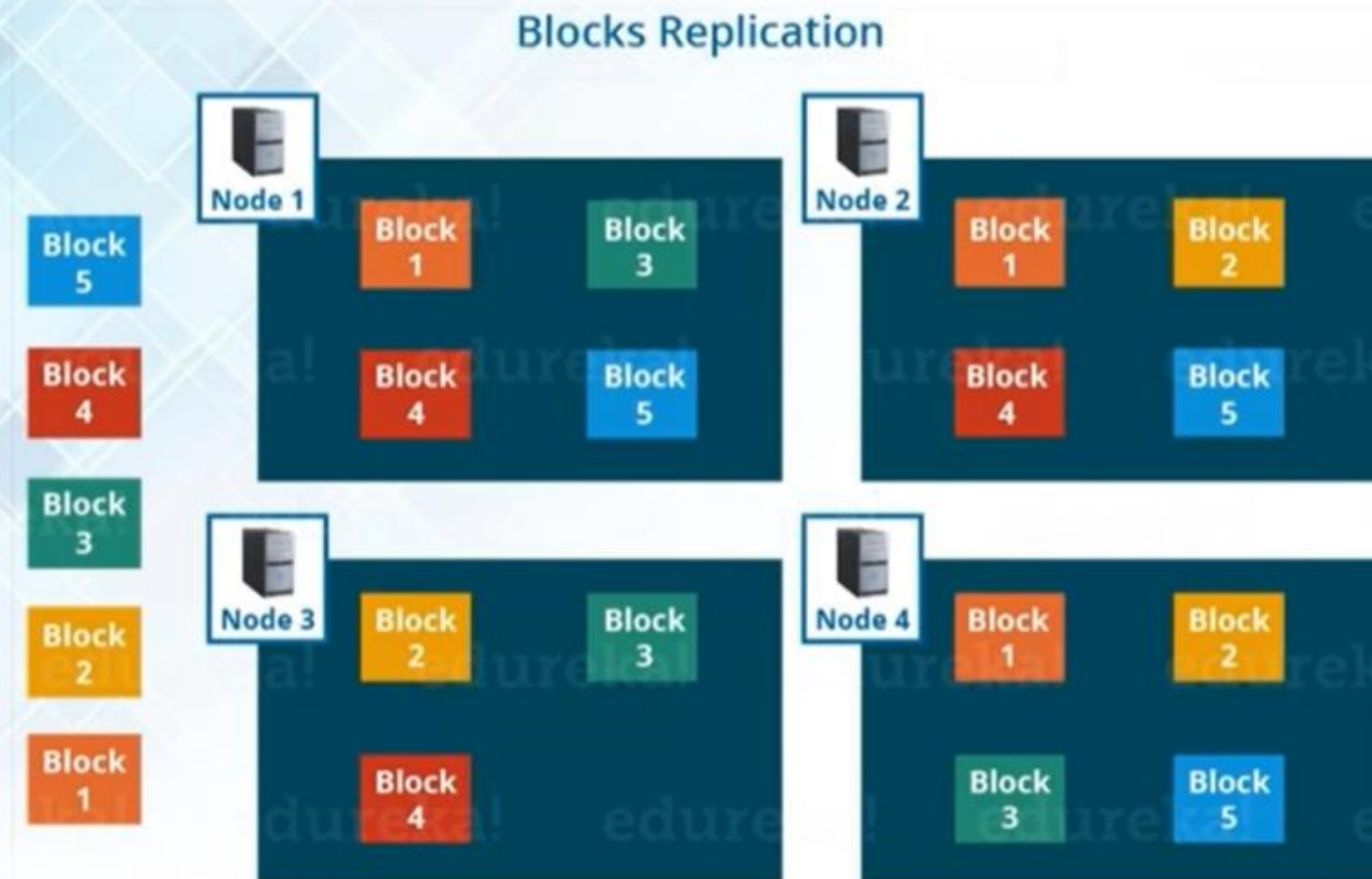
How many blocks will be created if a file of size 514 MB is copied to HDFS ?



Is it safe to have just 1 copy of each block?

What do you think?

Hadoop Architecture – Block Replication



Hadoop Architecture: Rack Awareness

Rack Awareness Algorithm

Block A : 

Block B: 

Block C: 

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

Hadoop Architecture: Rack Awareness

Rack Awareness Algorithm

Block A : 

Block B: 

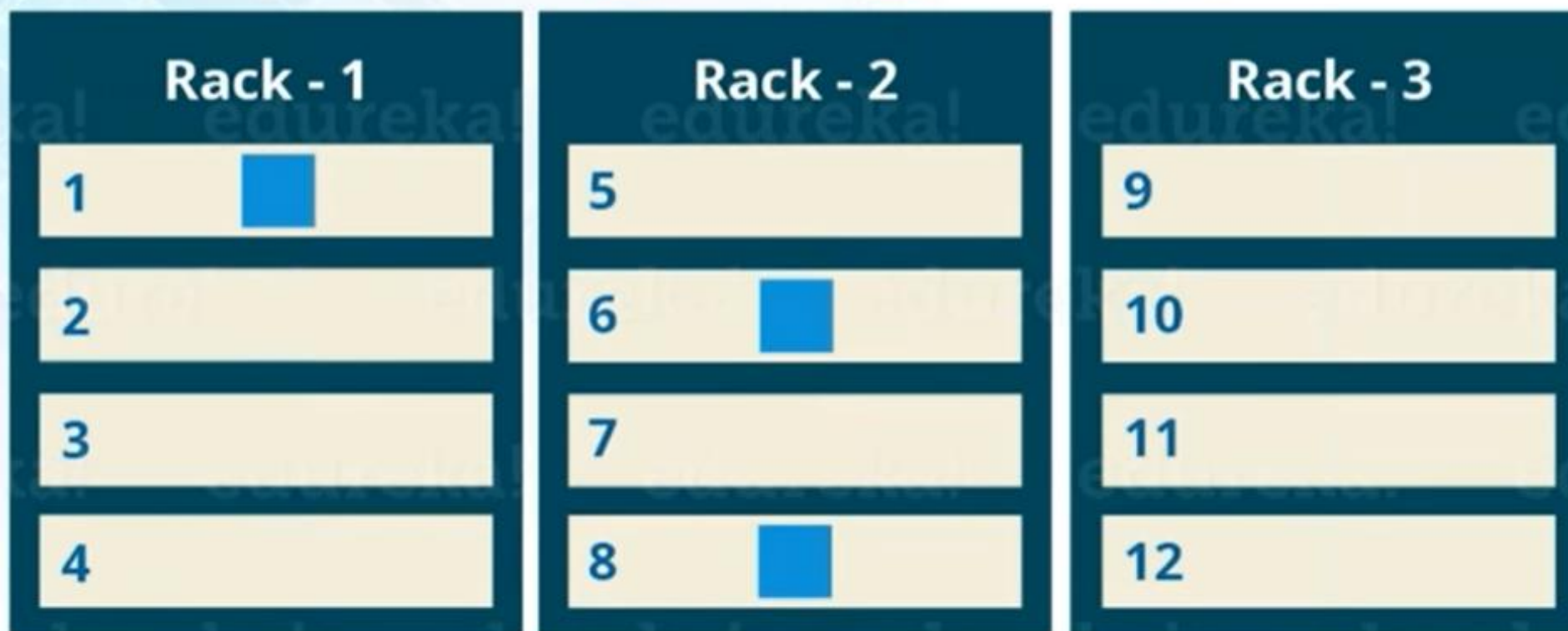
Block C: 



Hadoop Architecture: Rack Awareness

Rack Awareness Algorithm

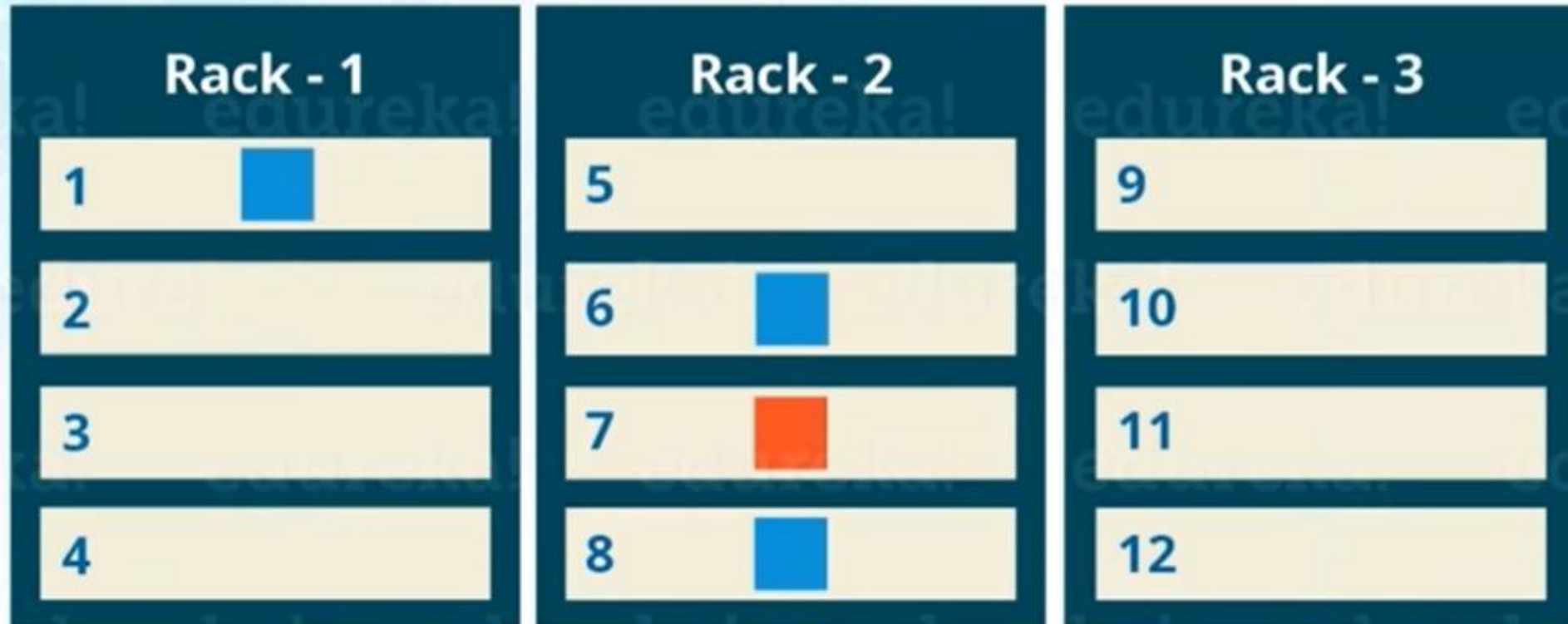
Block A :  Block B:  Block C: 



Hadoop Architecture: Rack Awareness




Rack Awareness Algorithm

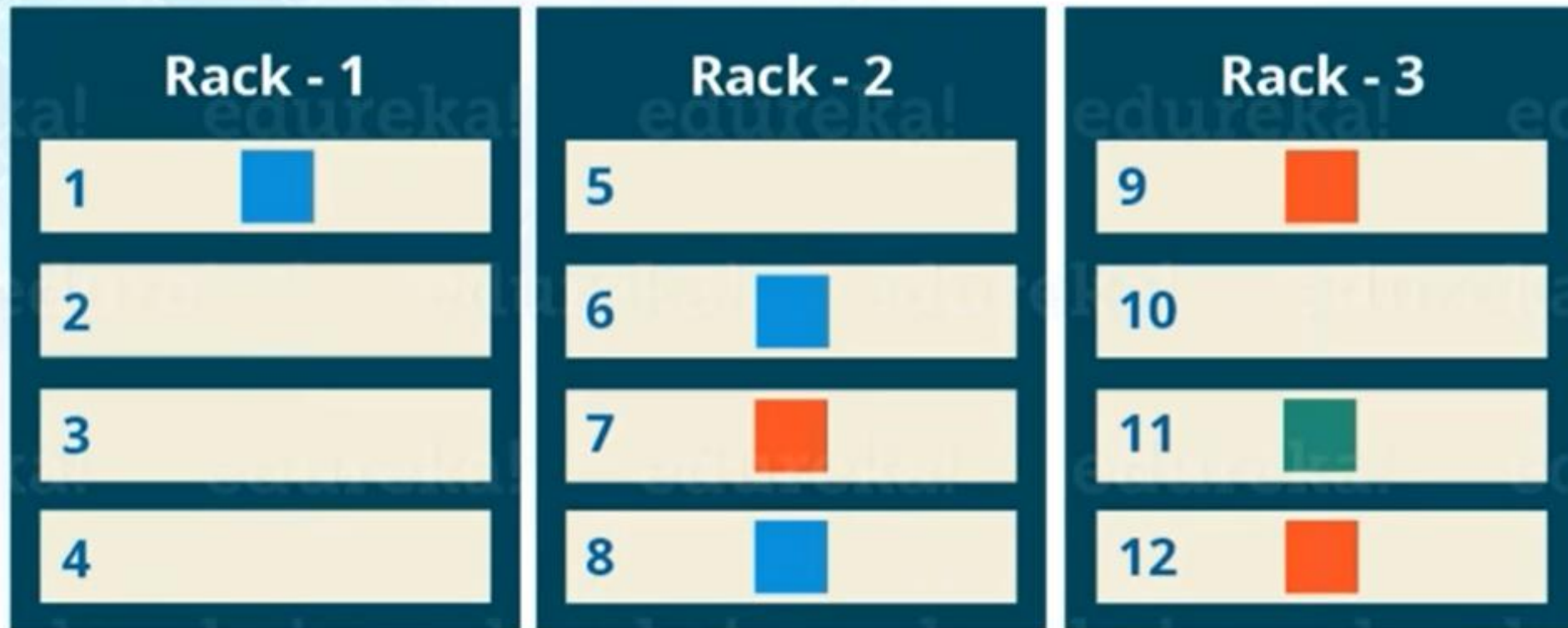
Block A :  Block B:  Block C: 



Hadoop Architecture: Rack Awareness

Rack Awareness Algorithm

Block A :  Block B:  Block C: 



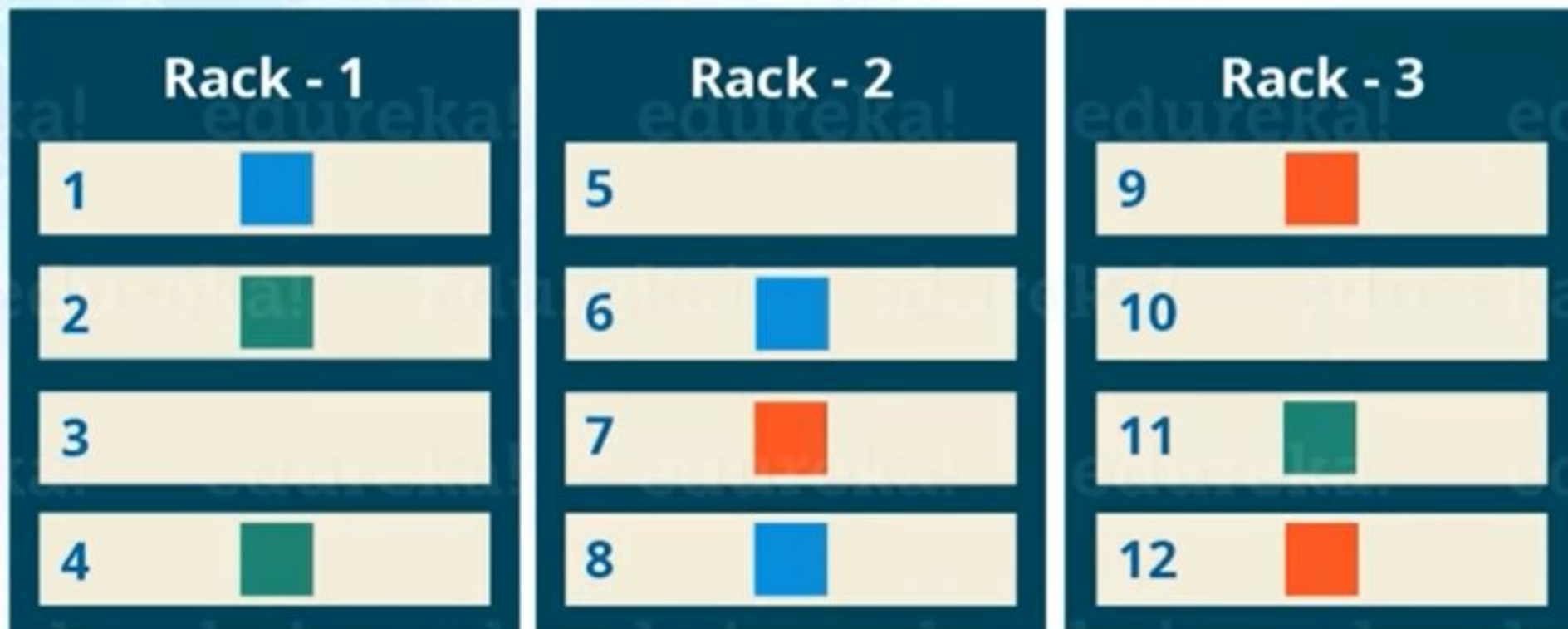
Hadoop Architecture: Rack Awareness

Rack Awareness Algorithm

Block A : 

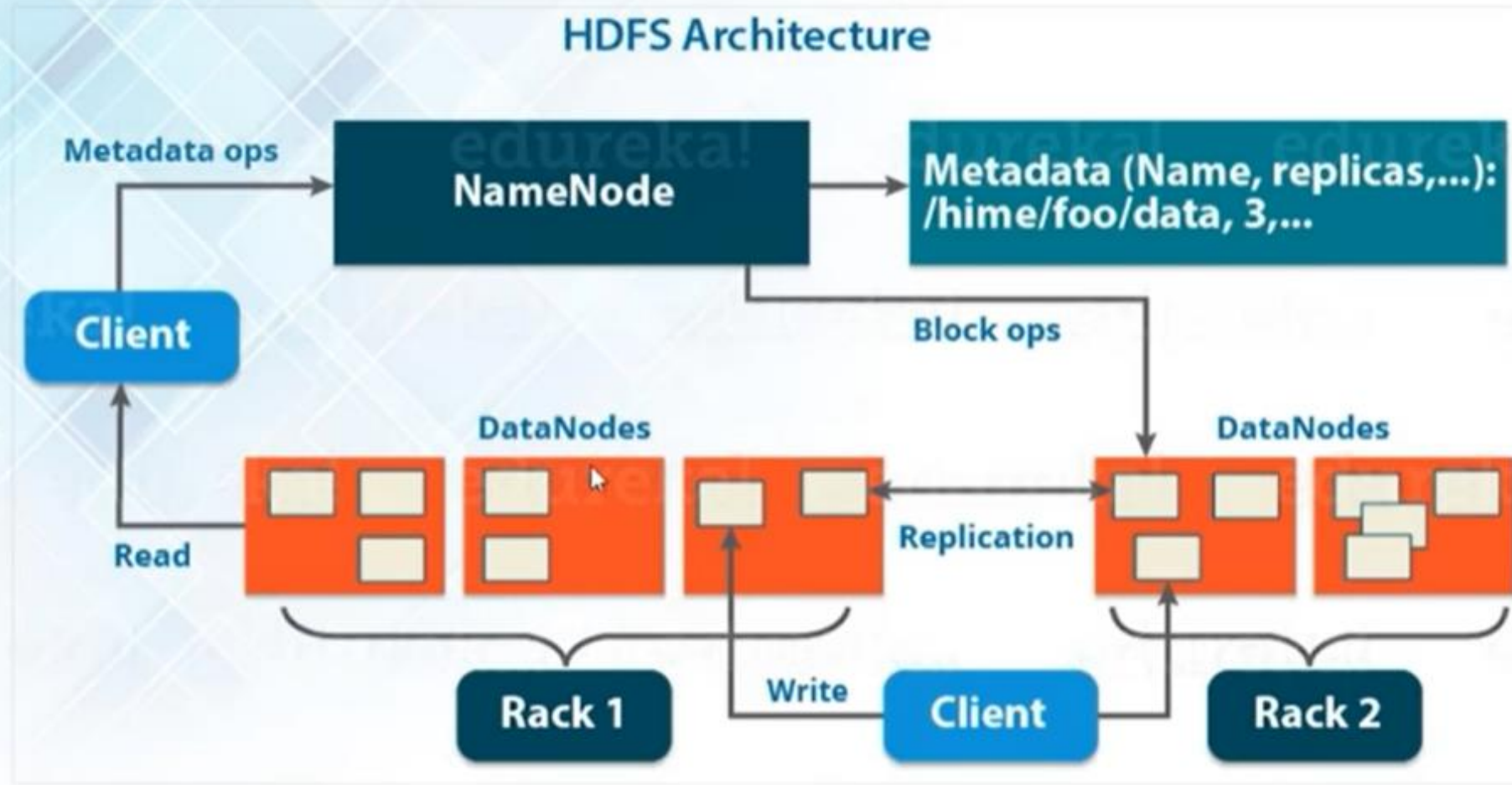
Block B: 

Block C: 



Architecture of HDFS

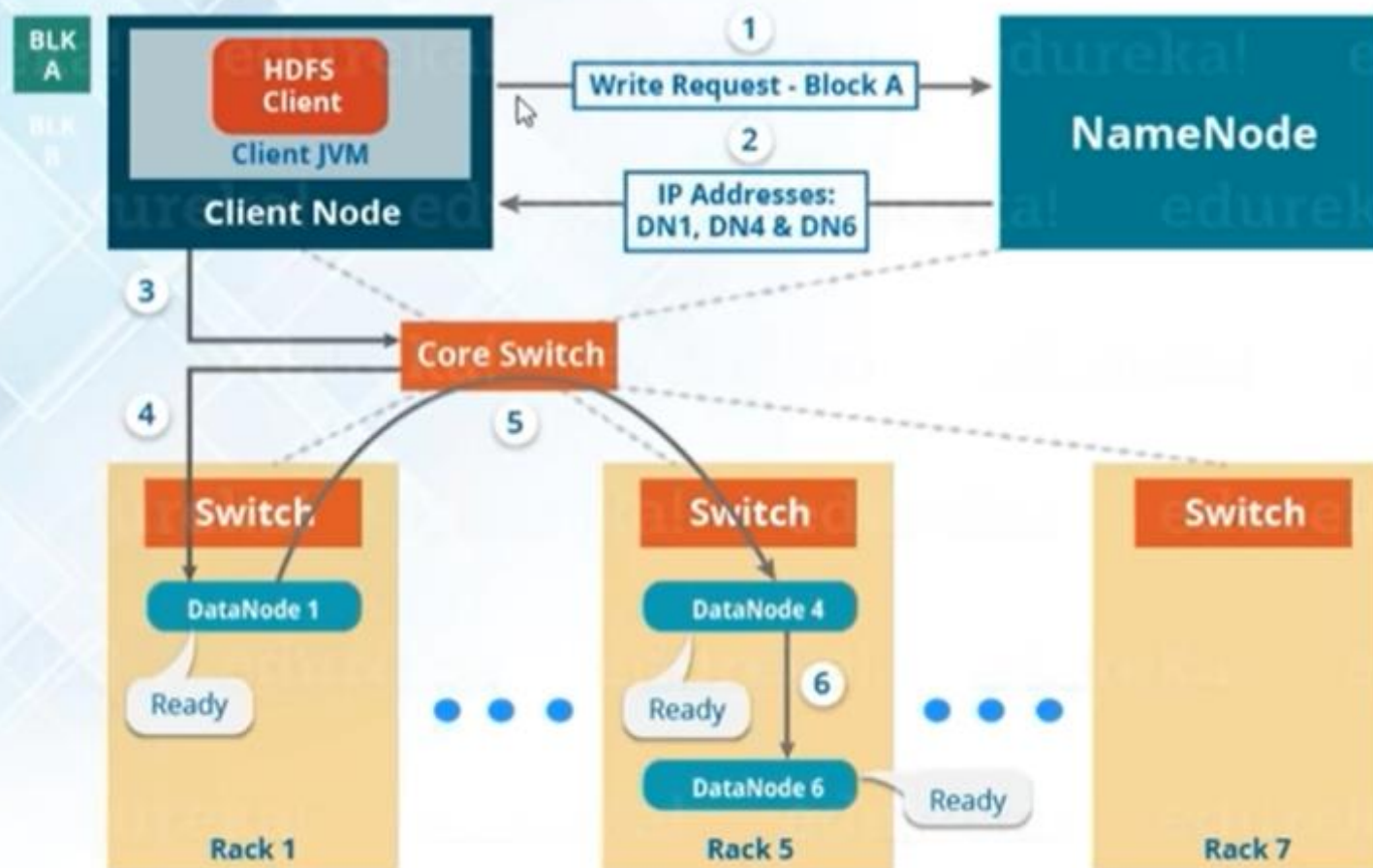
HDFS Architecture



HDFS Read/Write Mechanism

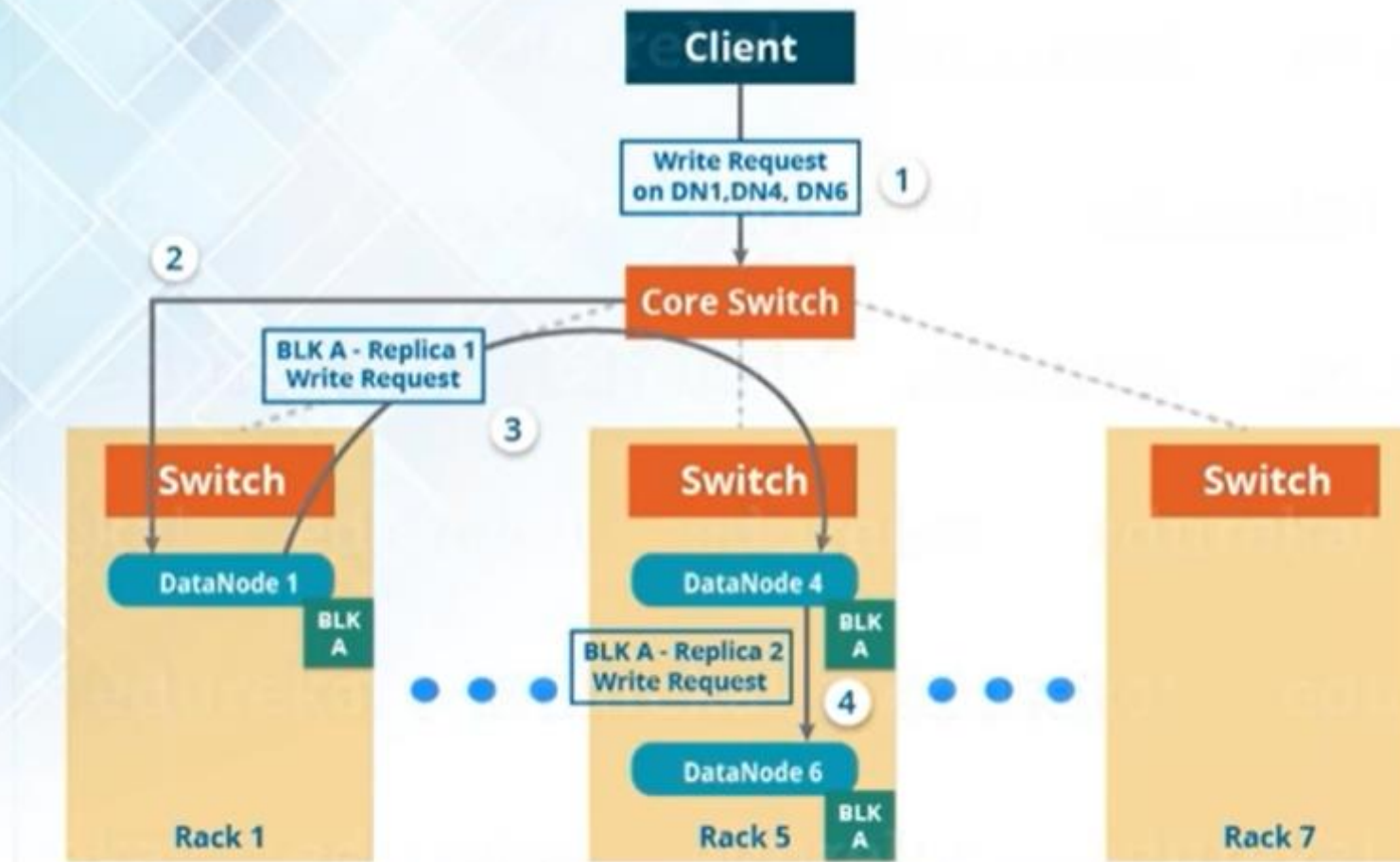
HDFS Write Mechanism – Pipeline Setup

Setting up HDFS - Write Pipeline



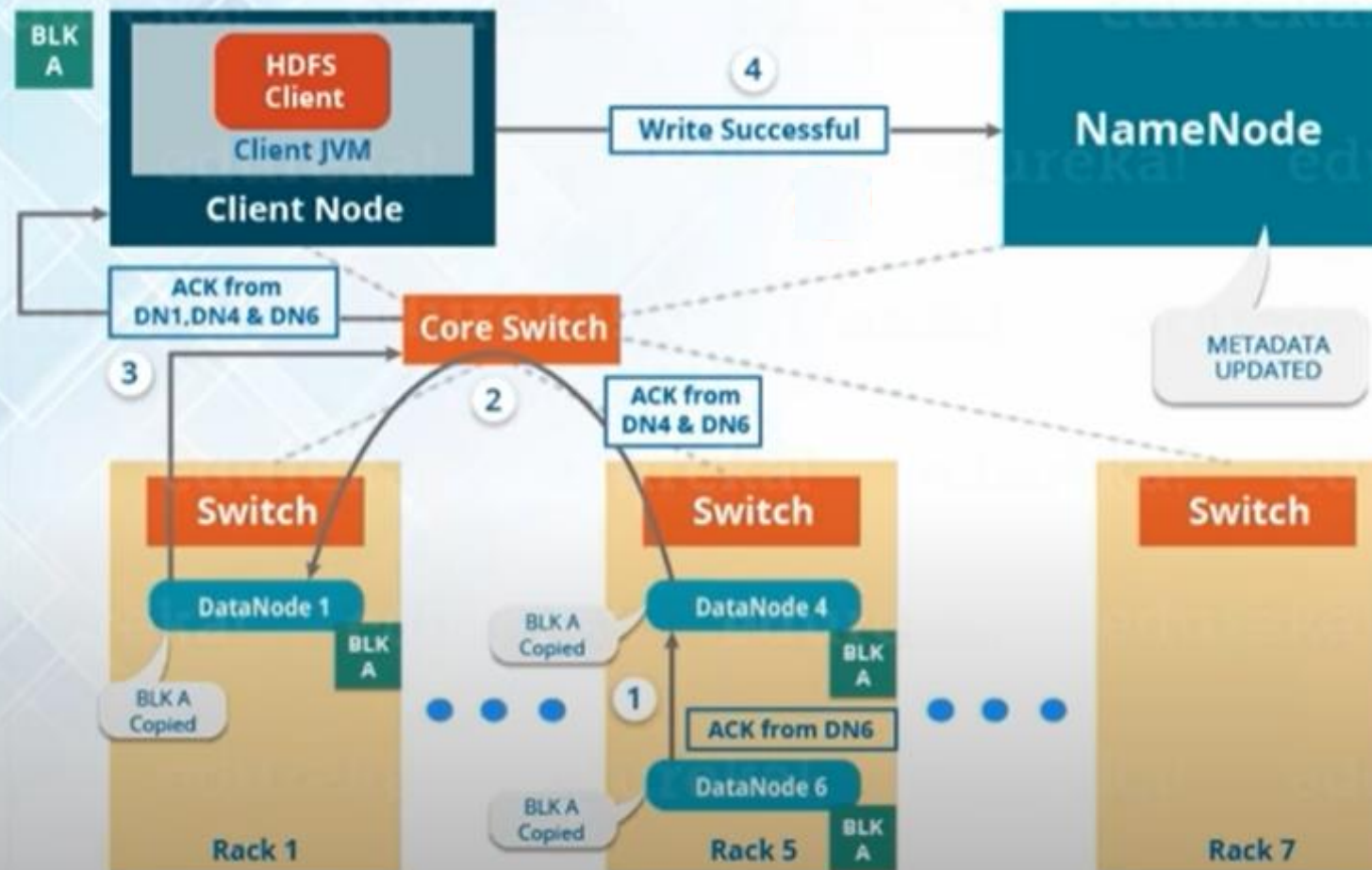
HDFS Write Mechanism – Writing a Block

HDFS - Write Pipeline



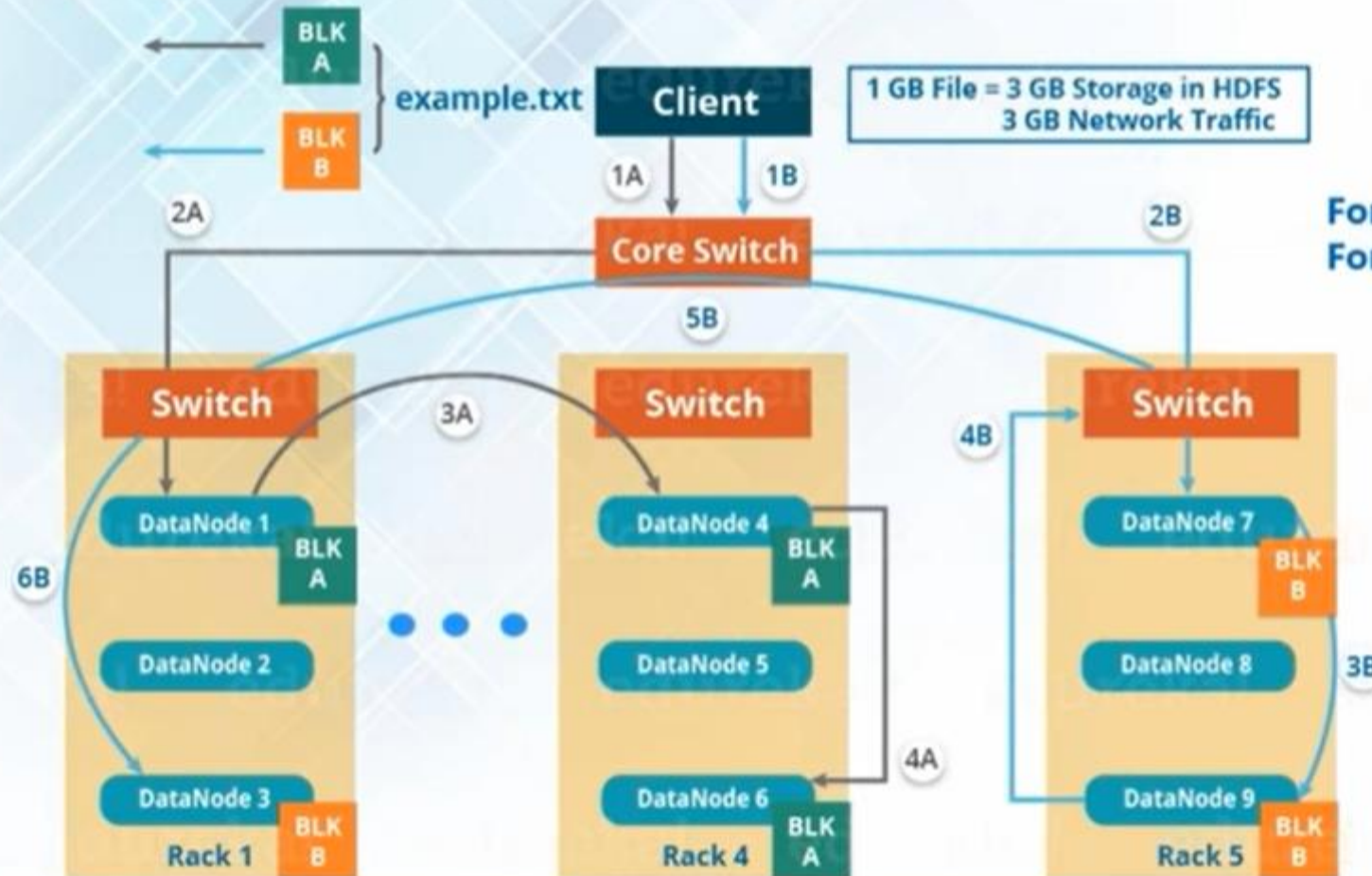
HDFS Write Mechanism - Acknowledgment

Acknowledgement in HDFS - Write



HDFS Multi-Block Write Mechanism

HDFS Multi - Block Write Pipeline

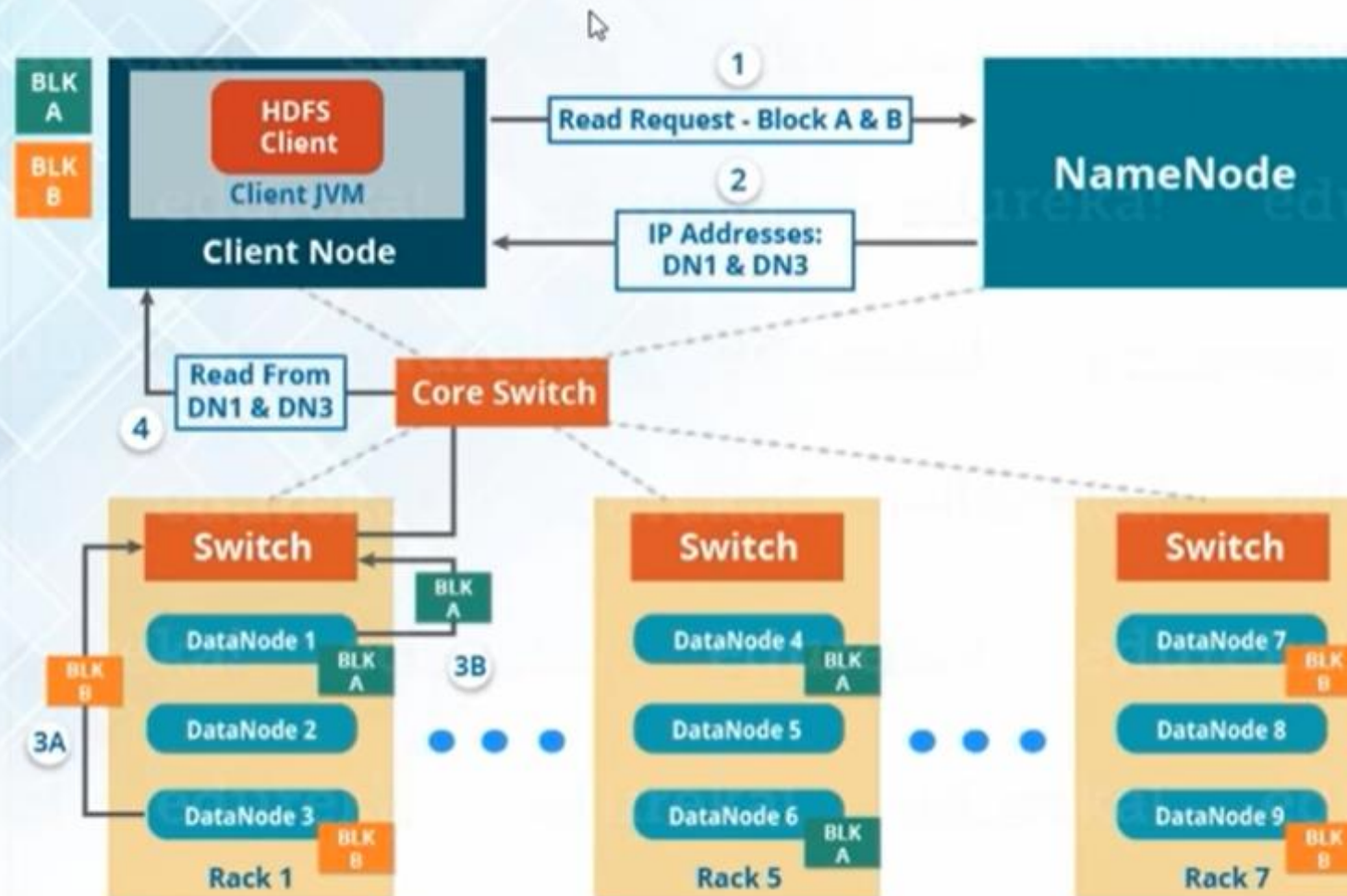


For Block A: 1A -> 2A -> 3A -> 4A

For Block B: 1B -> 2B -> 3B -> 4B -> 5B -> 6B

HDFS Read Mechanism

HDFS - Read Architecture



Let us see few Hadoop/HDFS Commands

HDFS commands

```
Administrator: Command Prompt

C:\WINDOWS\system32>hdfs fsck /
Connecting to namenode via http://localhost:9870/fsck?ugi=MarizzaMil&path=%2F
FSCK started by MarizzaMil (auth:SIMPLE) from /127.0.0.1 for path / at Thu Aug 26 17:56:47 IDT 2021

Status: HEALTHY
Number of data-nodes: 1
Number of racks:      1
Total dirs:           3
Total symlinks:        0

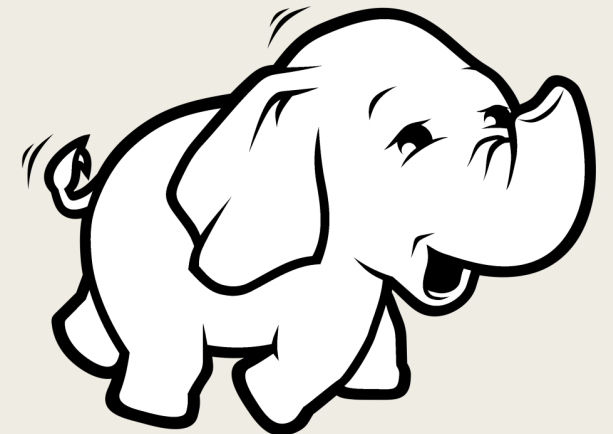
Replicated Blocks:
Total size:    69 B
Total files:   6
Total blocks (validated): 2 (avg. block size 34 B)
Minimally replicated blocks: 2 (100.0 %)
Over-replicated blocks:    0 (0.0 %)
Under-replicated blocks:   0 (0.0 %)
Mis-replicated blocks:     0 (0.0 %)
Default replication factor: 1
Average block replication:  1.0
Missing blocks:             0
Corrupt blocks:             0
Missing replicas:           0 (0.0 %)
Blocks queued for replication: 0

Erasure Coded Block Groups:
Total size:    0 B
Total files:   0
```

- fsck

HDFS Command to check the health of the Hadoop file system.

Command: hdfs fsck /



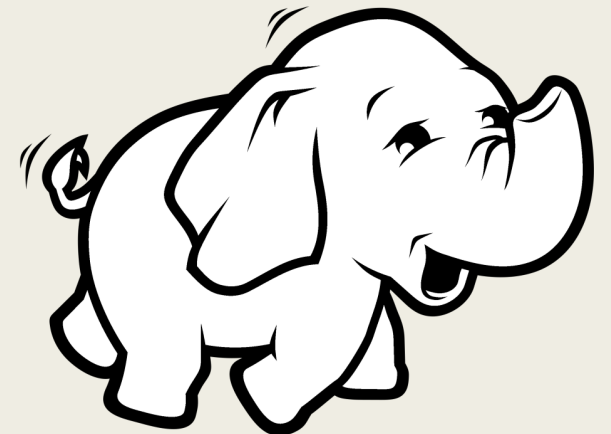
HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -ls /
Found 1 items
drwxr-xr-x  - MarizzaMil supergroup          0 2021-08-26 17:25 /newDataFlair
C:\WINDOWS\system32>
```

- ls

HDFS Command to display the list of Files and Directories in HDFS.

Command: hdfs dfs -ls /



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hadoop fs -mkdir /new_demo
```

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Browse Directory

Show entries

Search:

<input type="checkbox"/>	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name	
<input type="checkbox"/>	drwxr-xr-x	MarizzaMil	supergroup	0 B	Aug 26 17:25	0	0 B	newDataFlair	
<input type="checkbox"/>	drwxr-xr-x	MarizzaMil	supergroup	0 B	Aug 26 18:12	0	0 B	new_demo	

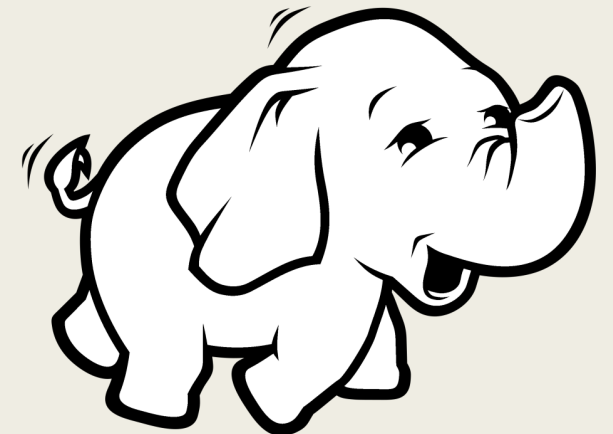
Showing 1 to 2 of 2 entries

- mkdir

HDFS Command to create the directory in HDFS.

Usage: `hadoop fs -mkdir /directory_name`

Command: `hadoop fs -mkdir /new_demo`



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hadoop fs -touchz /new_demo/sample
```

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Browse Directory

Show

25

 entries

Search:

<input type="checkbox"/>	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name	
<input type="checkbox"/>	-rw-r--r--	MarizzaMil	supergroup	0 B	Aug 26 18:24	1	128 MB	sample	<input type="button" value="🗑"/>

Showing 1 to 1 of 1 entries

Hadoop, 2021.

- touchz

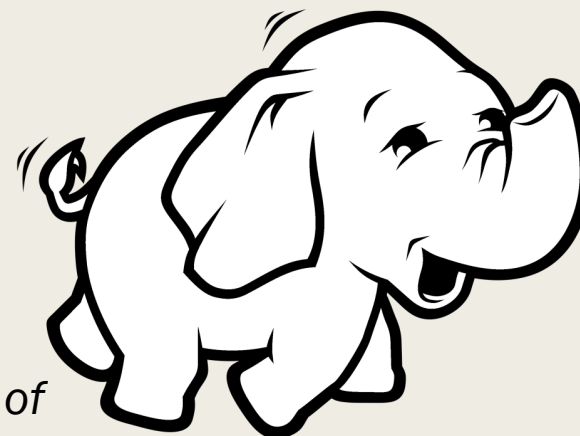
HDFS Command to create a file in HDFS with file size 0 bytes.

Usage:

hadoop fs -touchz /directory/filename

Command:

hadoop fs -touchz /new_demo/sample



Note: Here we are trying to create a file named “sample” in the directory “new_demo” of hdfs with file size 0 bytes.

HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32> hdfs dfs -du -s /new_demo/sample
0 0 /new_demo/sample
```

- du

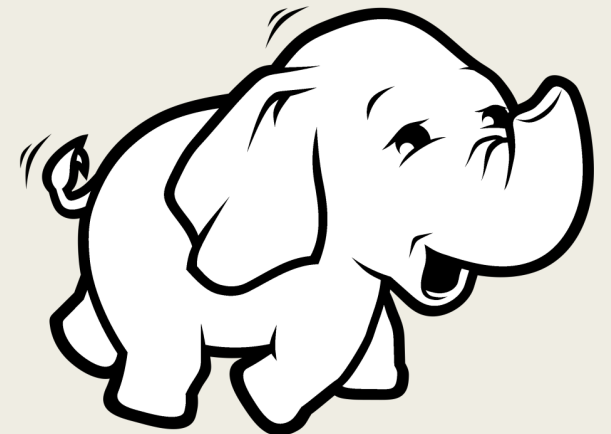
HDFS Command to check the file size.

Usage:

`hdfs dfs -du -s /directory/filename`

Command:

`hdfs dfs -du -s /new_demo/sample`



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -copyFromLocal C:\temp\test /new_demo
```

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Browse Directory

Show entries

Search:

<input type="checkbox"/>	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
<input type="checkbox"/>	-rw-r--r--	MarizzaMil	supergroup	9 B	Aug 26 19:07	1	128 MB	test.txt
<input type="checkbox"/>	-rw-r--r--	MarizzaMil	supergroup	7 B	Aug 26 19:07	1	128 MB	test01.txt
<input type="checkbox"/>	-rw-r--r--	MarizzaMil	supergroup	7 B	Aug 26 19:07	1	128 MB	test02.txt

Showing 1 to 3 of 3 entries

- copyFromLocal

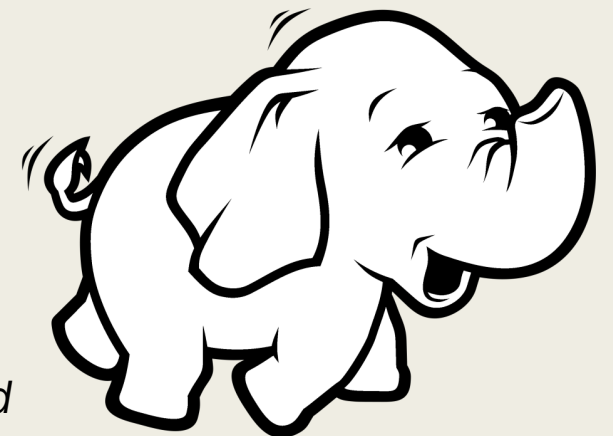
HDFS Command to copy the file from a Local file system to HDFS.

Usage:

hdfs dfs -copyFromLocal <localsrc> <hdfs destination>

Command:

hdfs dfs -copyFromLocal C:\temp\test/new_demo



Note: Here the test is the directory with files present in the local directory C:\temp and after the command gets executed the test file will be copied in /new_demo directory of

HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -copyToLocal /new_demo/test/test.txt C:\temp
```

Local Disk (C:) > temp

Name	Date modified	Type	Size
test	8/26/2021 5:52 PM	File folder	
user	8/26/2021 5:51 PM	File folder	
test	8/26/2021 7:26 PM	Text Document	1 KB

Note: Here test.txt is a file present in the new_demo/test directory of HDFS and after the command gets executed the test file will be copied to local directory C:\temp

- copyToLocal

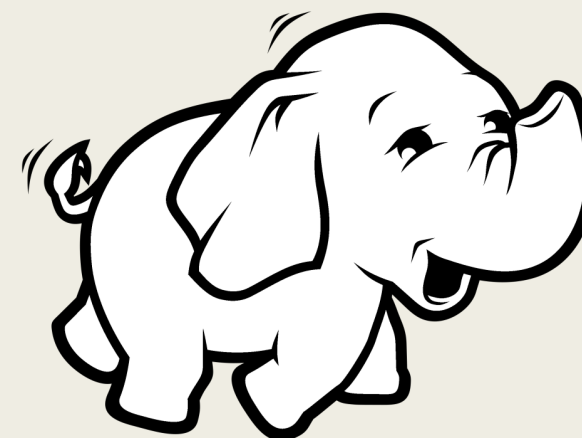
HDFS Command to copy the file from HDFS to Local File System

Usage:

hdfs dfs -copyToLocal <hdfs source> <localdst>

Command:

hdfs dfs -copyToLocal /new_demo/test/test.txt
C:\temp



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -put C:\temp /new_demo
```

Hadoop

Overview

Datanodes

Datanode Volume Failures

Snapshot

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Browse Directory

/new_demo

Go!

Show

25

entries

Search:

<input type="checkbox"/>	Permission	Owner	Group	Size	Last Modified	Replication	Block Size	Name
<input type="checkbox"/>	-rw-r--r--	MarizzaMil	supergroup	0 B	Aug 26 18:24	1	128 MB	sample
<input type="checkbox"/>	drwxr-xr-x	MarizzaMil	supergroup	0 B	Aug 26 18:59	0	0 B	temp

Showing 1 to 2 of 2 entries

Previous

1

Next

- put

HDFS Command to copy single source or multiple sources from local file system to the destination file system.

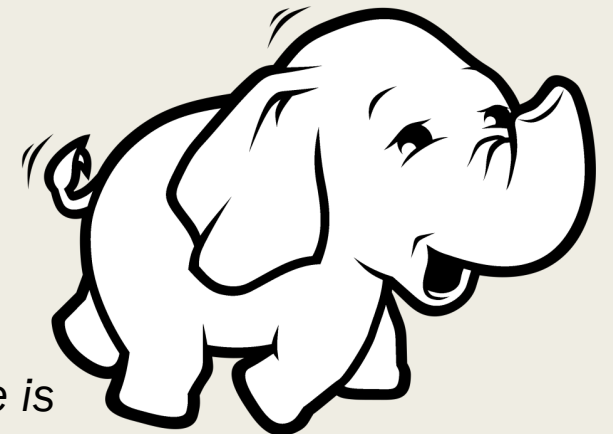
Usage:

`hdfs dfs -put <localsrc> <destination>`

Command:

`hdfs dfs -put C:\temp /new_demo`

Note: The command `copyFromLocal` is similar to `put` command, except that the source is restricted to a local file reference.



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -get /new_demo C:\temp
```

> Local Disk (C:) > temp

Search temp

Name	Date modified	Type	Size
new_demo	8/26/2021 7:39 PM	File folder	
test	8/26/2021 5:52 PM	File folder	
user	8/26/2021 5:51 PM	File folder	
test	8/26/2021 7:26 PM	Text Document	1 KB

- get

HDFS Command to copy files from hdfs to the local file system.

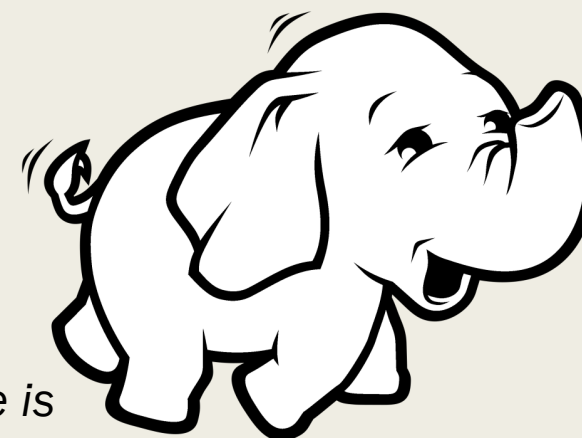
Usage:

`hdfs dfs -get <src> <localdst>`

Command:

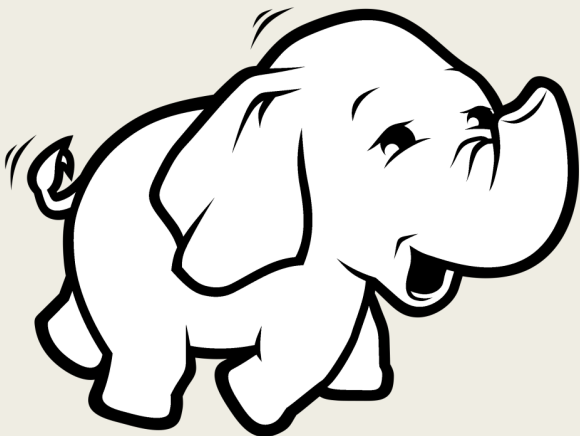
`hdfs dfs -get /new_demo C:\temp`

Note: The command `copyFromLocal` is similar to `put` command, except that the source is restricted to a local file reference.



HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -cat /new_demo/test/test01.txt
Test #1
```



- cat

HDFS Command that reads a file on HDFS and prints the content of that file to the standard output.

Usage:

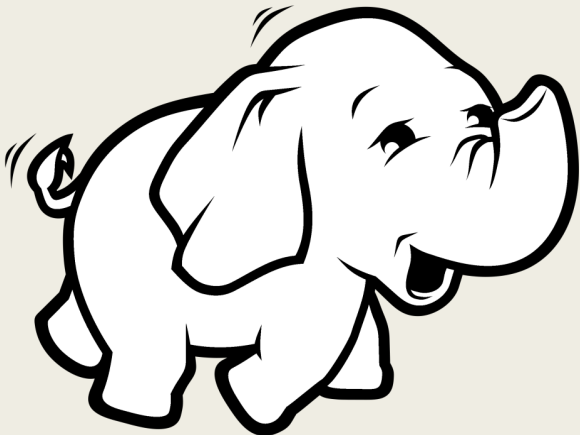
`hdfs dfs -cat /path/to/file_in_hdfs`

Command:

`hdfs dfs -cat /new_demo/test/test01.txt`

HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -count /new_demo
5          10          23 /new_demo
```



- count

HDFS Command to count the number of directories, files, and bytes under the paths that match the specified file pattern.

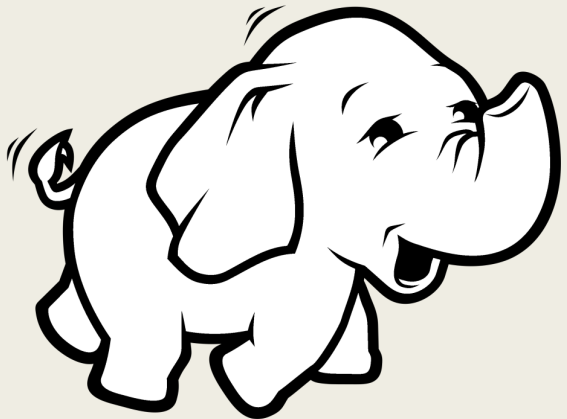
Usage:

`hdfs dfs -count <path>`

Command:

`hdfs dfs -count /new_demo`

HDFS commands



- rm

HDFS Command to remove the file from HDFS.

Usage:

`hdfs dfs -rm <path>`

Command:

`hdfs dfs -rm /new_demo/test`

- rm -r

HDFS Command to remove the entire directory and all of its content from HDFS.

Usage:

`hdfs dfs -rm -r <path>`

Command:

`hdfs dfs -rm -r /new_demo`

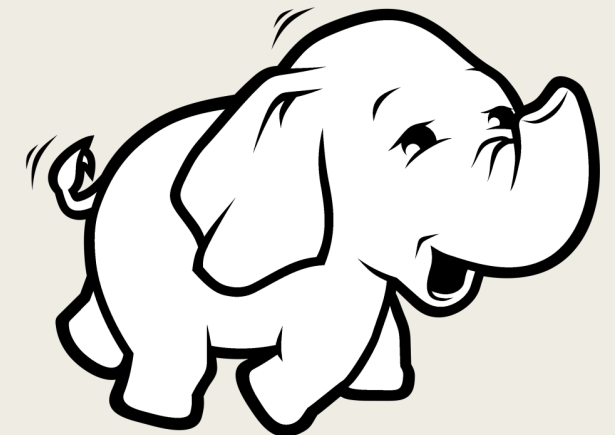
HDFS commands

```
Administrator: Command Prompt
C:\WINDOWS\system32>hdfs dfs -help
Usage: hadoop fs [generic options]
[-appendToFile <localsrc> ... <dst>]
[-cat [-ignoreCrc] <src> ...]
[-checksum [-v] <src> ...]
[-chgrp [-R] GROUP PATH...]
[-chmod [-R] <MODE[,MODE]... | OCTALMODE> PATH...]
[-chown [-R] [OWNER][:[GROUP]] PATH...]
[-concat <target path> <src path> <src path> ...]
[-copyFromLocal [-f] [-p] [-l] [-d] [-t <thread count>] <localsrc> ... <dst>]
[-copyToLocal [-f] [-p] [-ignoreCrc] [-crc] <src> ... <localdst>]
[-count [-q] [-h] [-v] [-t <storage type>]] [-u] [-x] [-e] [-s] <path> ...]
[-cp [-f] [-p | -p[topax]] [-d] <src> ... <dst>]
[-createSnapshot <snapshotDir> [<snapshotName>]]
[-deleteSnapshot <snapshotDir> <snapshotName>]
[-df [-h] [<path> ...]]
[-du [-s] [-h] [-v] [-x] <path> ...]
[-expunge [-immediate] [-fs <path>]]
[-find <path> ... <expression> ...]
[-get [-f] [-p] [-ignoreCrc] [-crc] <src> ... <localdst>]
[-getfacl [-R] <path>]
[-getfattr [-R] {-n name | -d} [-e en] <path>]
[-getmerge [-nl] [-skip-empty-file] <src> <localdst>]
[-head <file>]
[-help [cmd ...]]
[-ls [-C] [-d] [-h] [-q] [-R] [-t] [-S] [-r] [-u] [-e] [<path> ...]]
[-mkdir [-p] <path> ...]
[-moveFromLocal [-f] [-p] [-l] [-d] <localsrc> ... <dst>]
[-moveToLocal <src> <localdst>]
[-mv <src> ... <dst>]
[-put [-f] [-p] [-l] [-d] [-t <thread count>] <localsrc> ... <dst>]
[-renameSnapshot <snapshotDir> <oldName> <newName>]
[-rm [-f] [-r|-R] [-skipTrash] [-safely] <src> ...]
[-rmdir [--ignore-fail-on-non-empty] <dir> ...]
[-setfacl [-R] [{-b|-k} {-m|-x <acl_spec>} <path>][--set <acl_spec> <path>]]
[-setfattr {-n name [-v value] | -x name} <path>]
[-setrep [-R] [-w] <rep> <path> ...]
[-stat [format] <path> ...]
[-tail [-f] [-s <sleep interval>] <file>]
[-test -[defswrz] <path>]
```

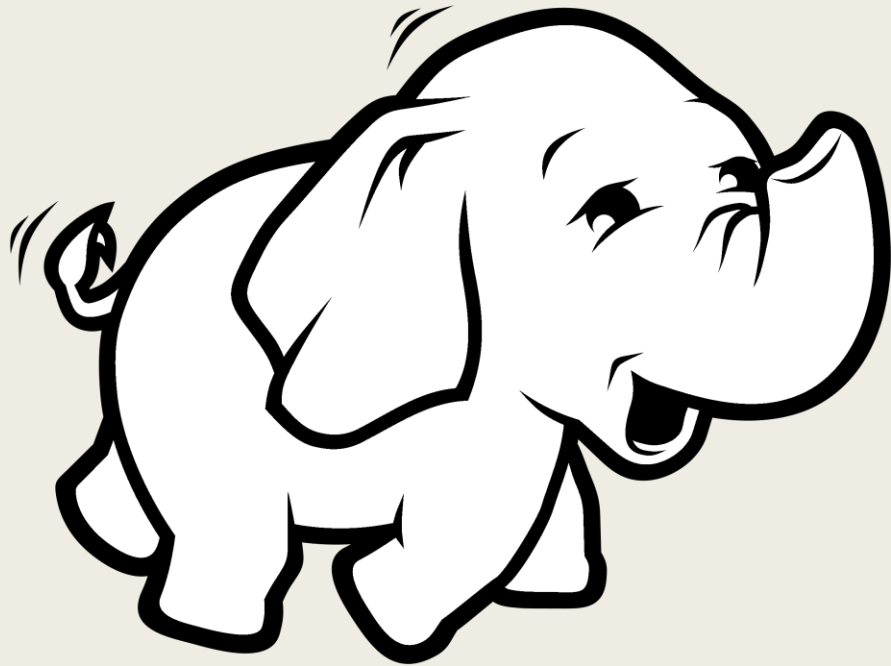
- help

HDFS Command that displays help for given command or all commands if none is specified.

Command: hdfs dfs-help



HDFS COMMANDS



For more HDFS Commands, you may refer Apache Hadoop documentation [here.](#)