Big Data Hadoop and Spark Developer

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HDFS: The Storage Layer

Learning Objectives

By the end of this lesson, you will be able to:

- Summarize how the Hadoop Distributed File System (HDFS) stores data across a cluster
- Illustrate the HDFS architecture and its components
- Demonstrate the use of the HDFS Command Line Interface (CLI)

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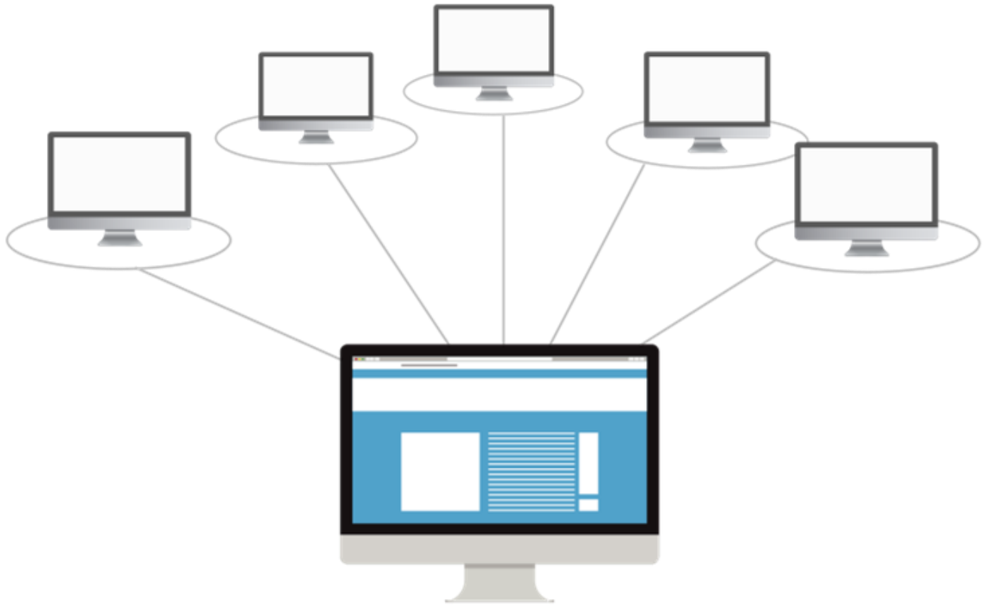
Hadoop Distributed File System (HDFS)

What Is HDFS?

HDFS is a distributed file system that provides access to data across Hadoop clusters.



It manages and supports the analyses of large volumes of big data.

Challenges of Traditional Systems

In the traditional system, storing and retrieving volumes of data had three major issues:

Cost

$10,000 to $14,000 per terabyte

Speed

Search and analysis is time-consuming

Reliability

Fetching data is difficult

Need for HDFS

HDFS resolves all the three major issues of the traditional file system.

Cost

Has zero licensing and support costs

Reliability

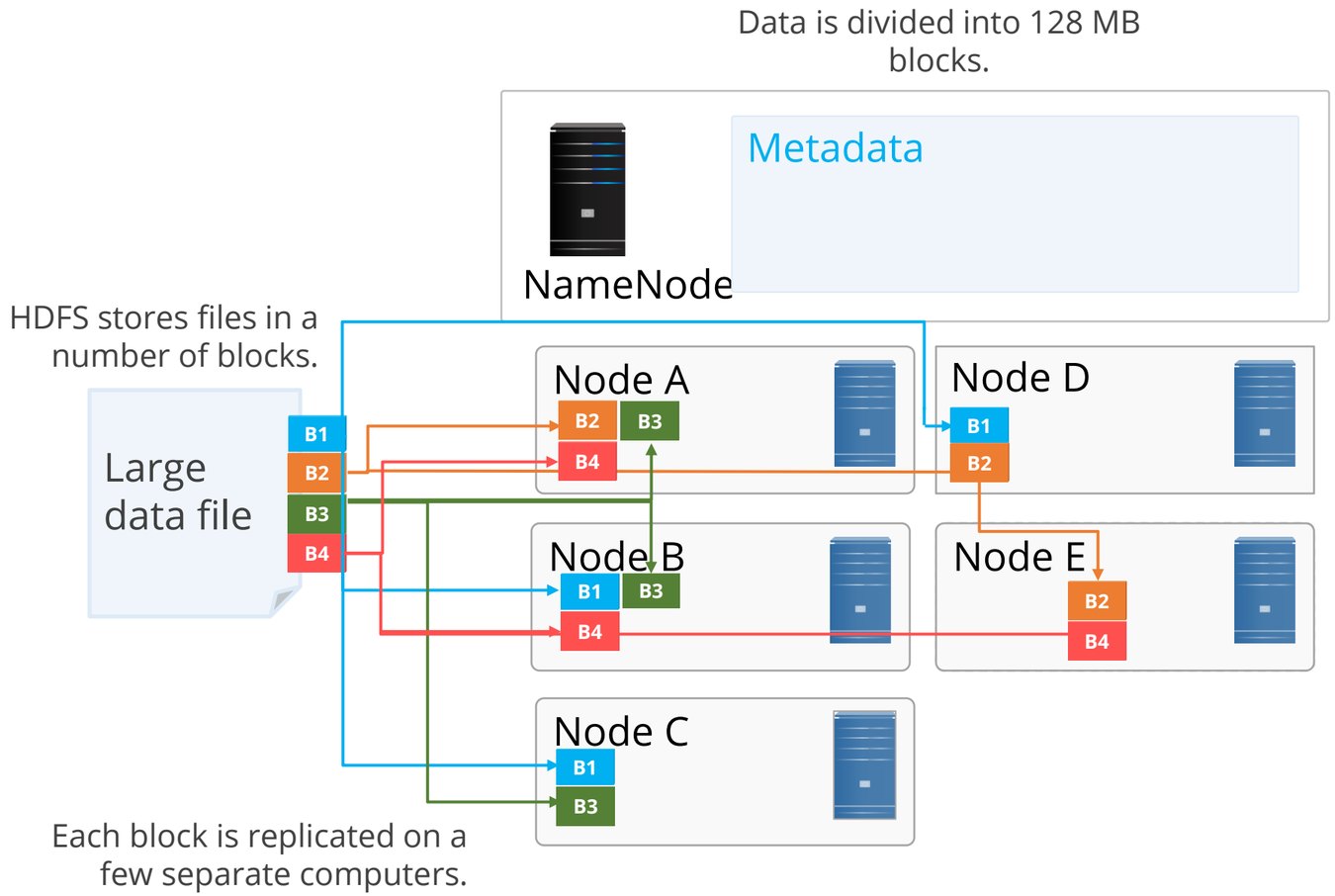
Copies data multiple times

Speed

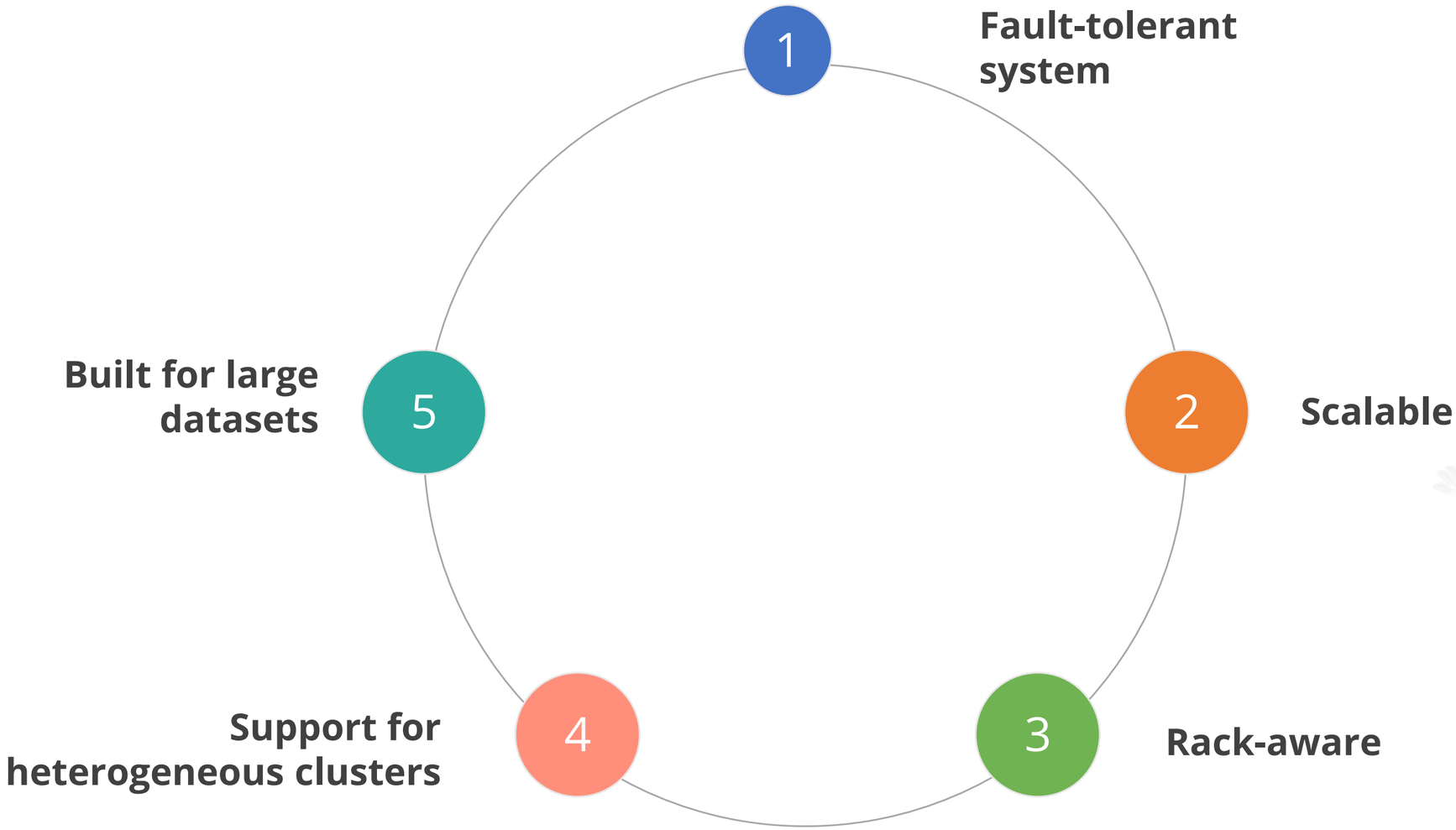
Reads or writes more than one terabyte of data per second

HDFS Storage

HDFS is a distributed file system that uses NameNode and DataNode architectures to allow high-performance data access across highly scalable Hadoop clusters.



Characteristics of HDFS



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HDFS Architecture and Components

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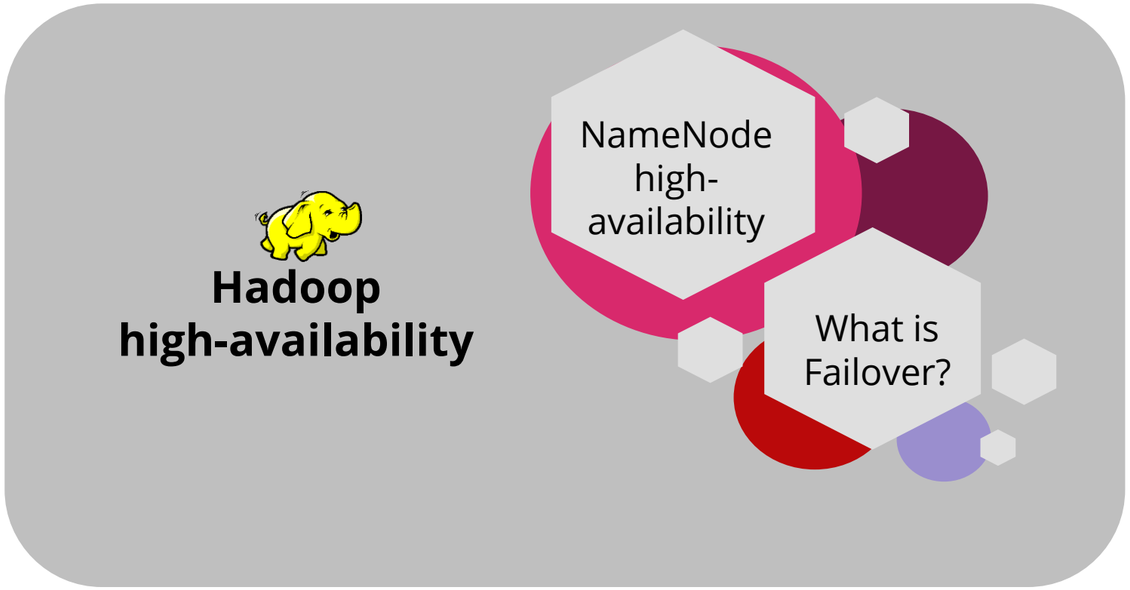
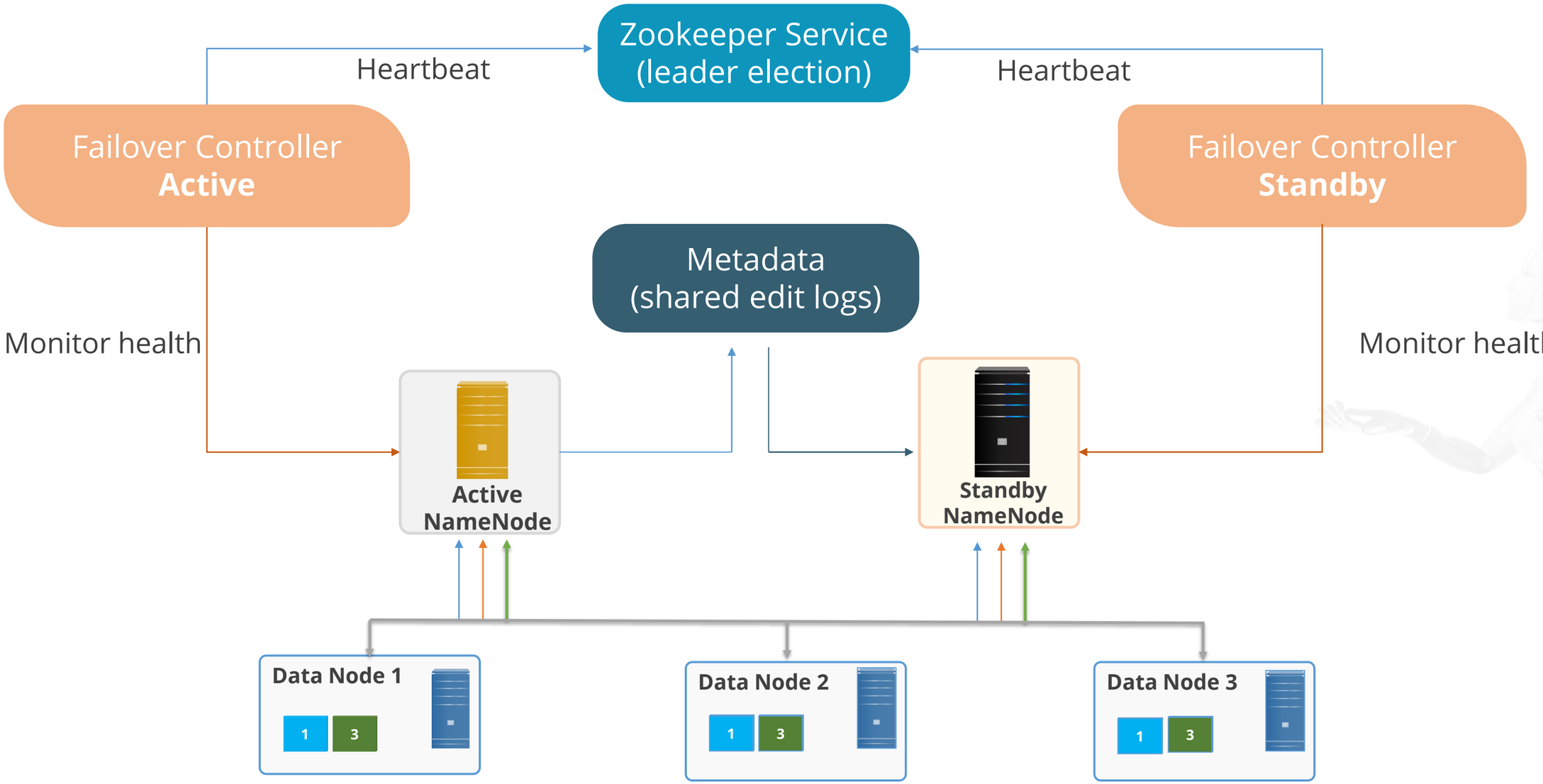
HDFS High-Availability Architecture

Hadoop's high-availability functionality ensures that the Hadoop cluster remains operational despite unfavorable conditions, such as NameNode failure, DataNode failure, or computer crashes. It indicates that the data will be available through a standby NameNode when the NameNode fails.



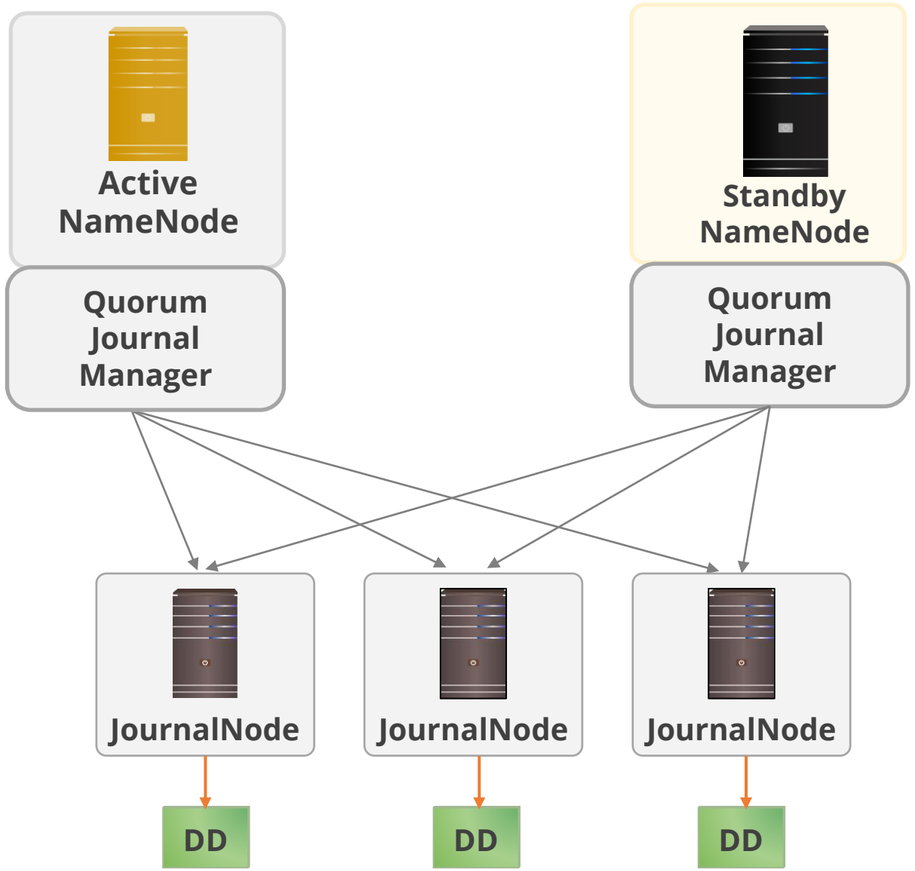
HDFS High-Availability Architecture



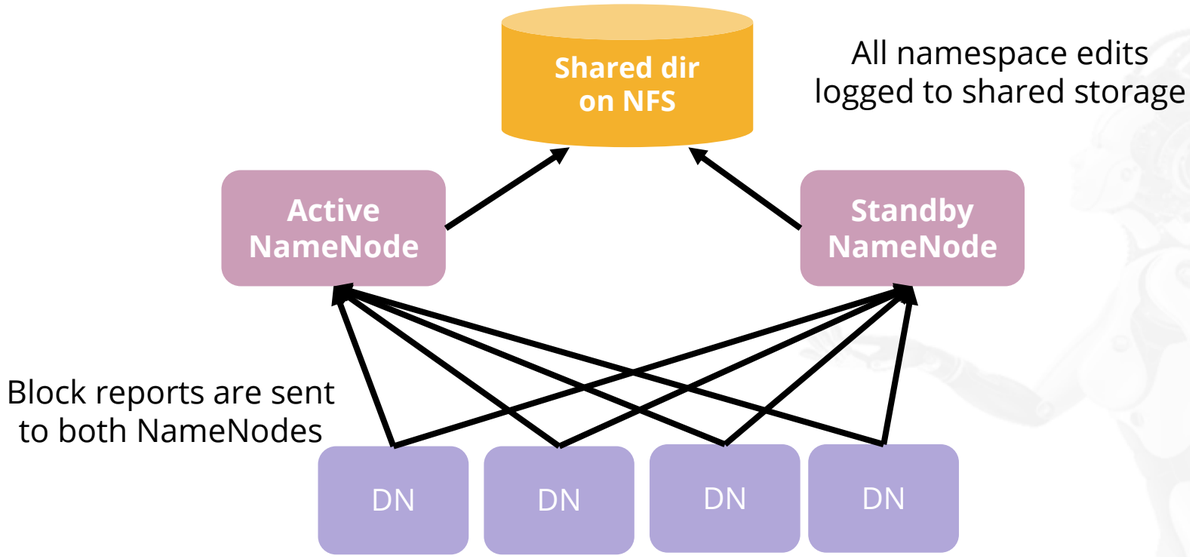
Types of HDFS Architectures

There are two types of HDFS high-availability architectures:

Quorum-based storage

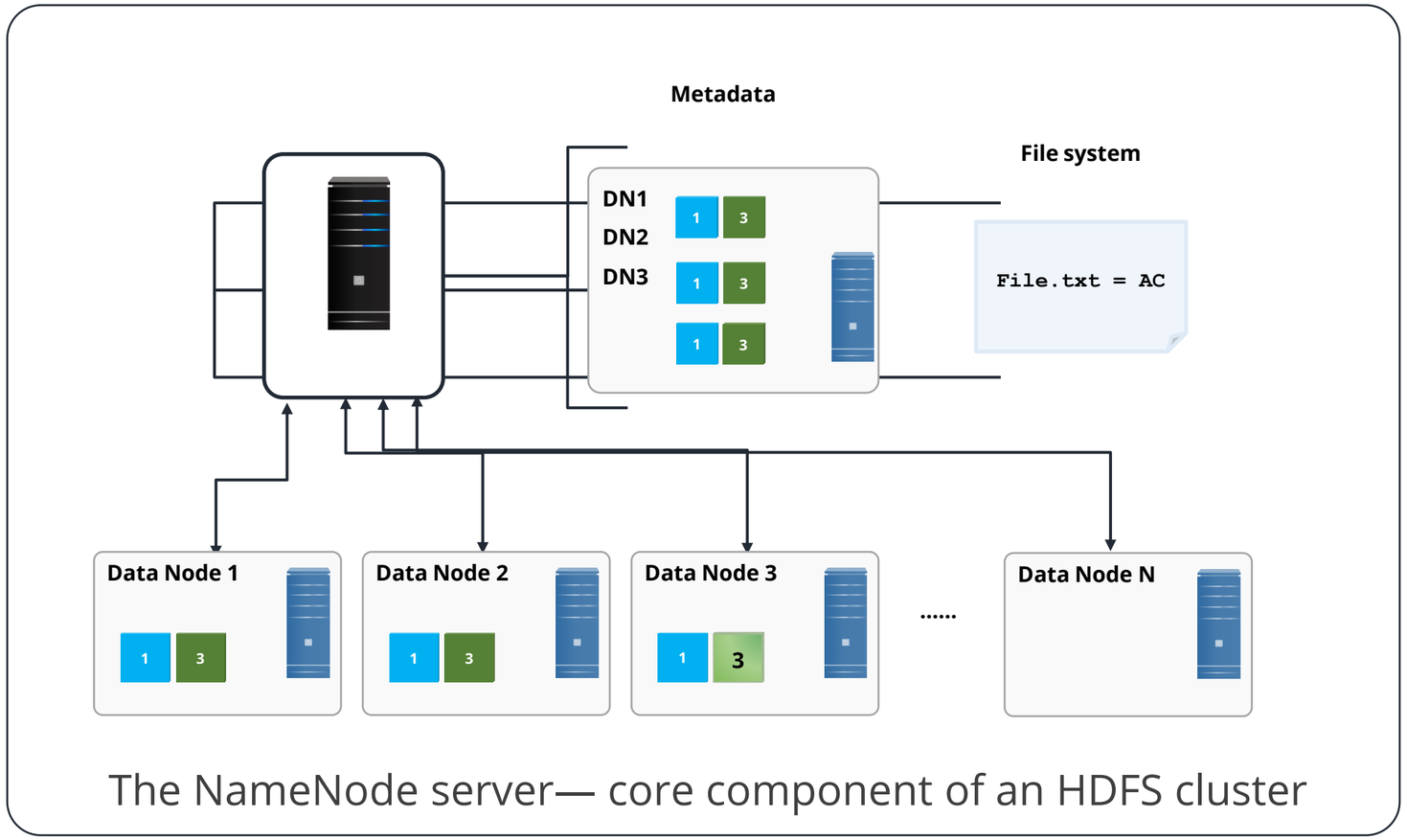


Shared storage using NFS



HDFS Component: NameNode

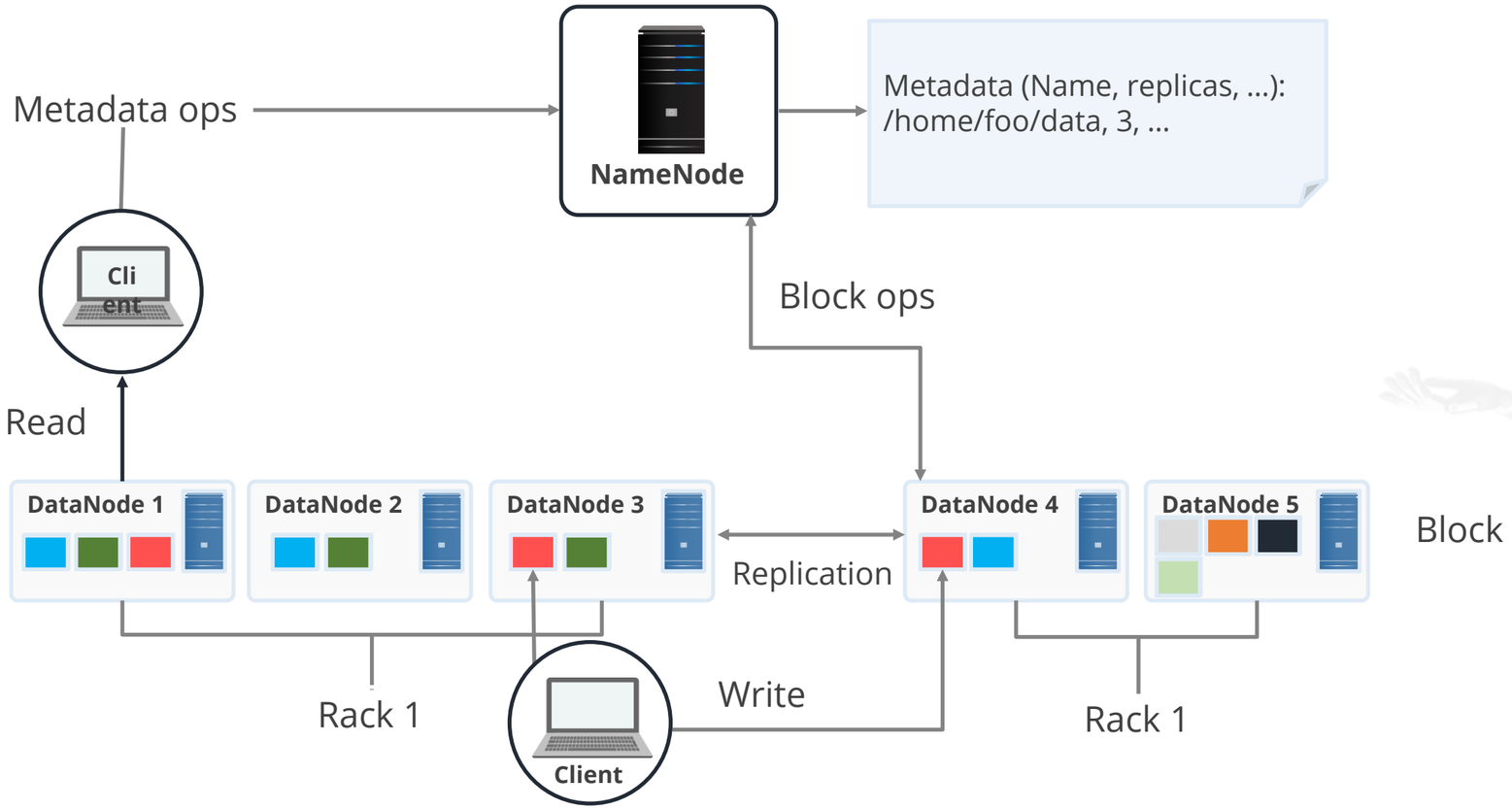
The HDFS components comprise different servers like NameNode, DataNode, and Secondary NameNode.



The NameNode server— core component of an HDFS cluster

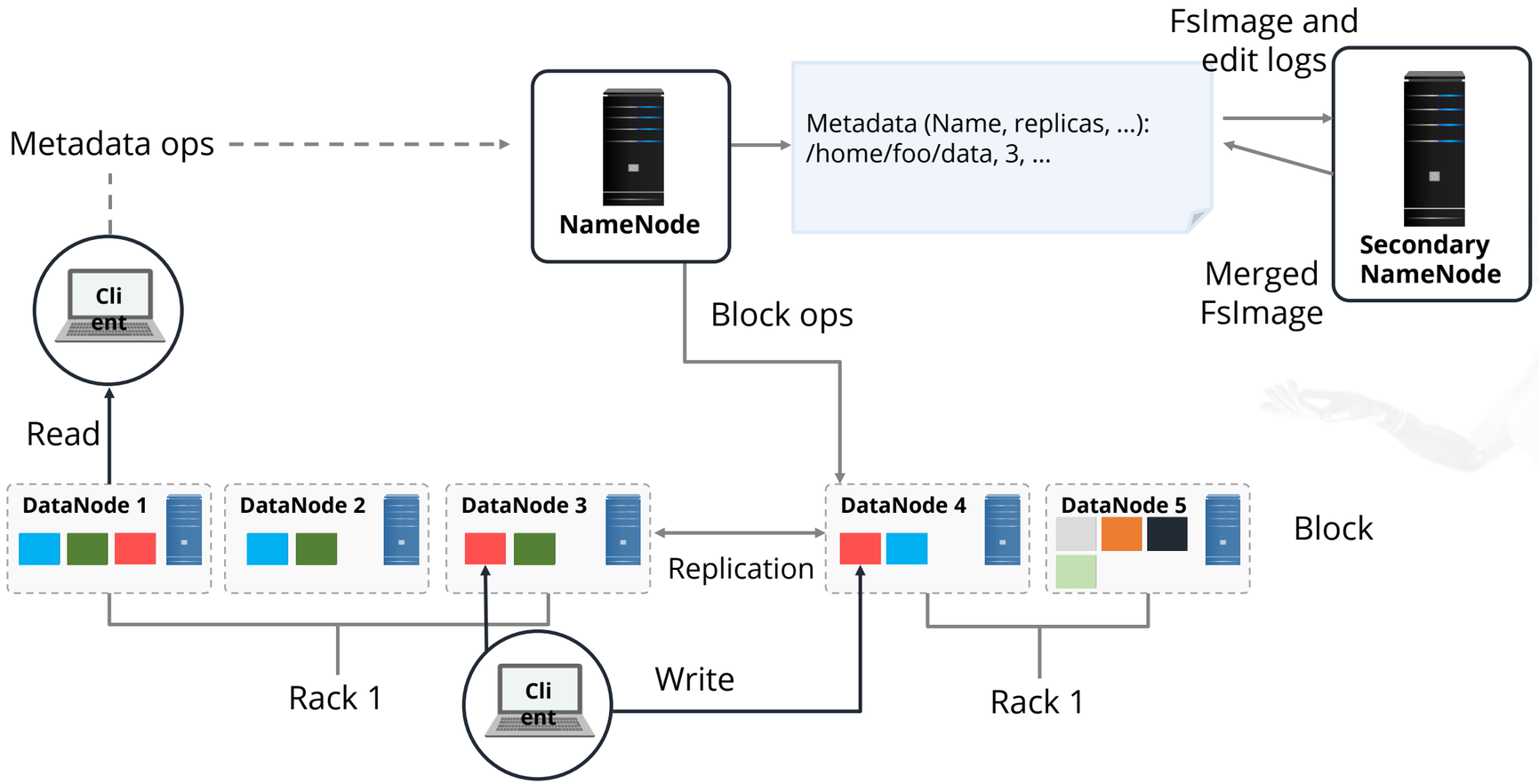
HDFS Component: DataNode

The DataNode is a multiple instance server. DataNode servers are responsible for storing and maintaining the data blocks.



HDFS Component: SNN

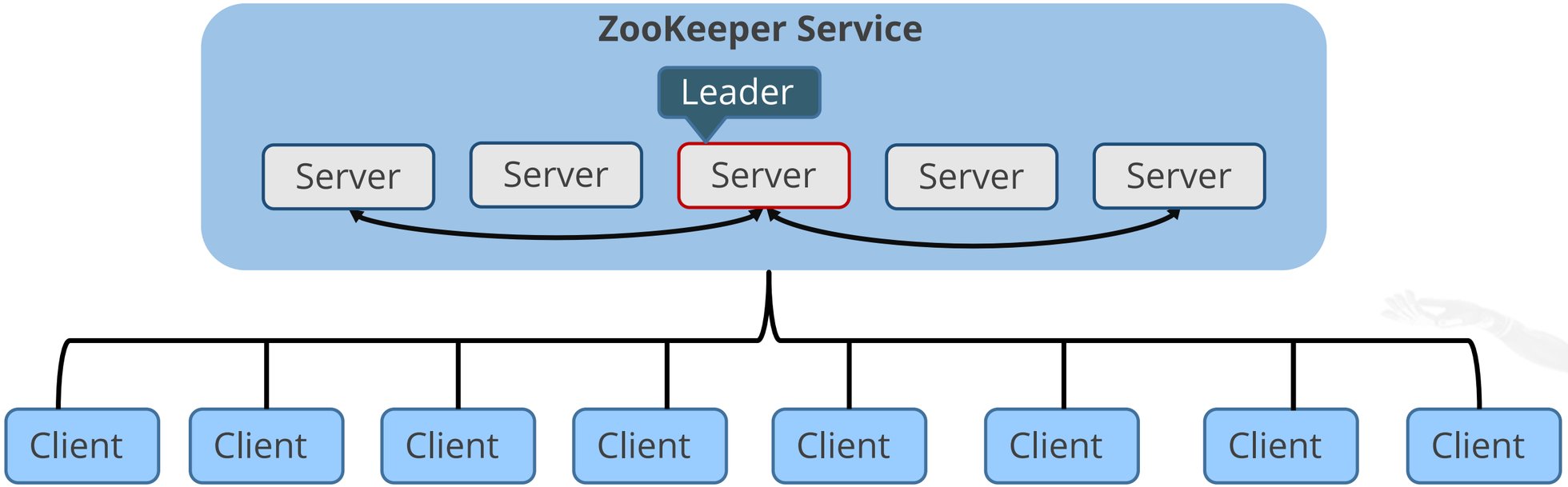
In the event of data loss or any disaster, NameNode acts as a backup node.



It takes hourly snapshots of data stored by an active NameNode and stores it in FsImage.

HDFS Component: ZooKeeper

ZooKeeper allows distributed processes to coordinate with each other through a shared hierarchical namespace.



The ZooKeeper implementation is simple and replicated, which puts a premium on high performance, high availability, and a strictly ordered access.

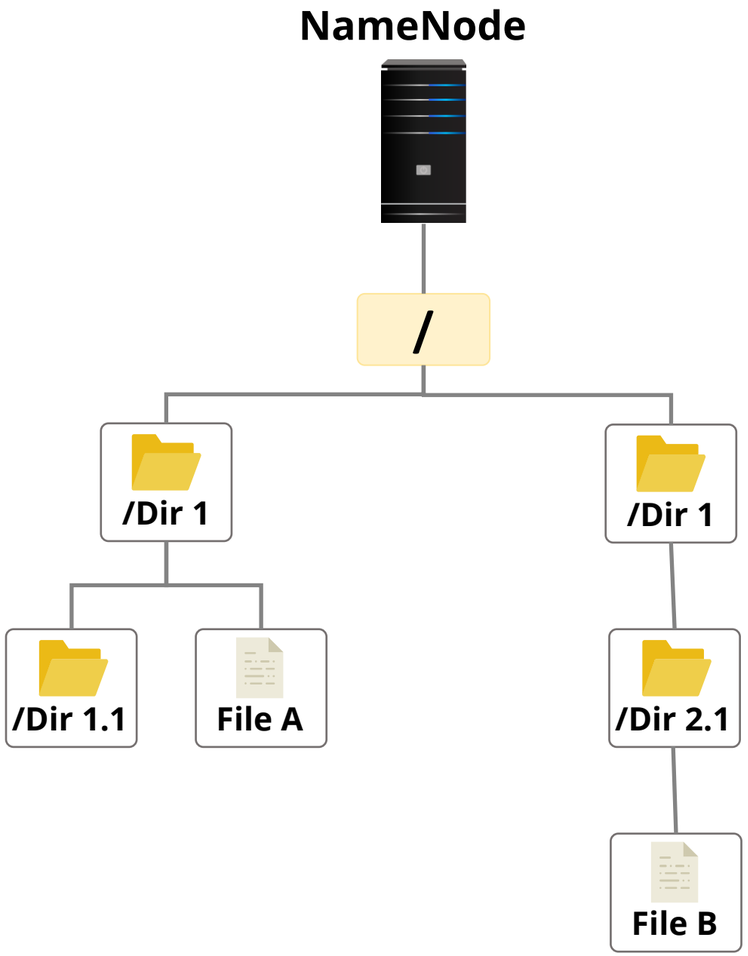
HDFS Component: ZooKeeper

Automatic HDFS Failover relies on ZooKeeper for the following:

Failure detection

Active NameNode election

HDFS Component: File System Namespace

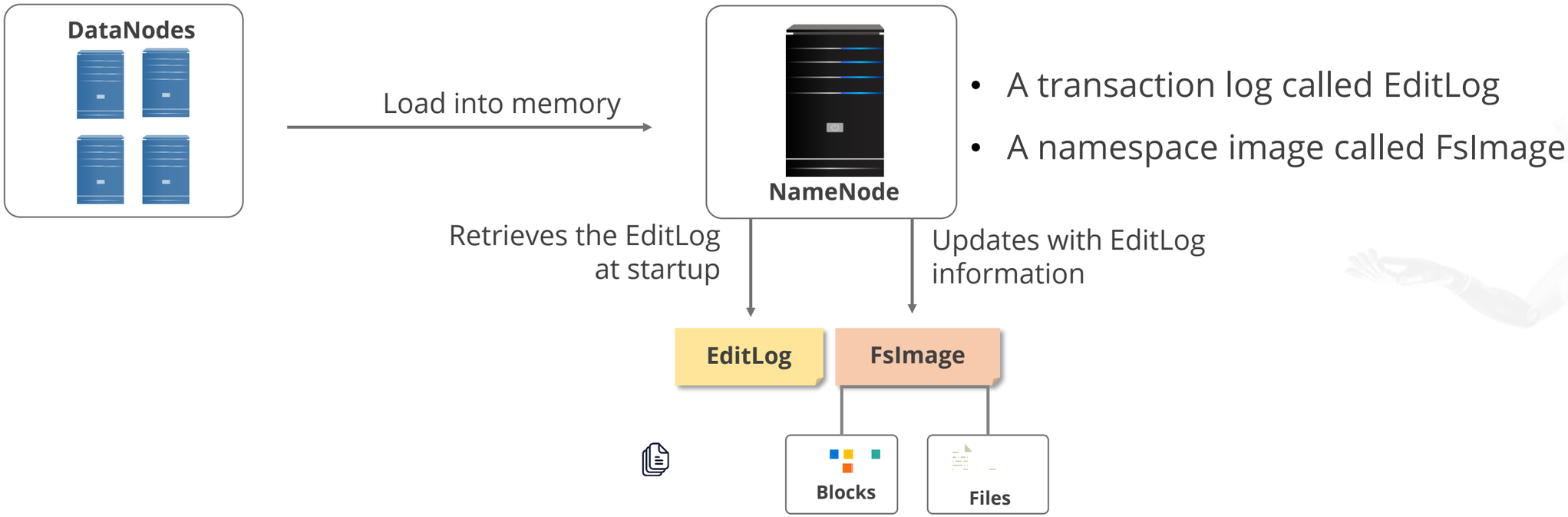


The HDFS file system:

- Allows user data to be stored in files
- Follows a hierarchical file system with directories and files
- Supports operations like create, remove, move, and rename

NameNode Operation

The NameNode maintains two persistent files:

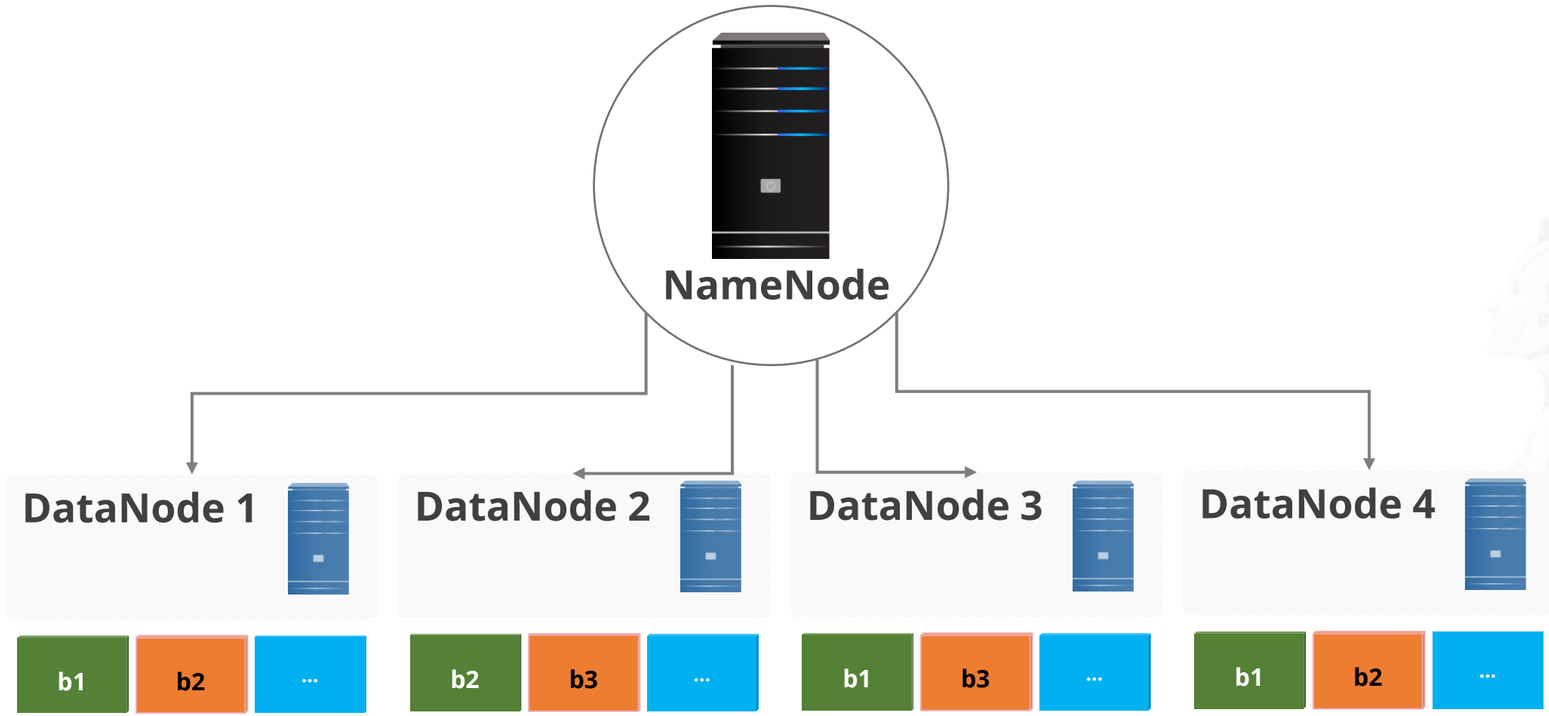


- A transaction log called EditLog
- A namespace image called FsImage

Data Block Split

Each file is split into one or more blocks that are stored and replicated in DataNodes.

A file split into blocks

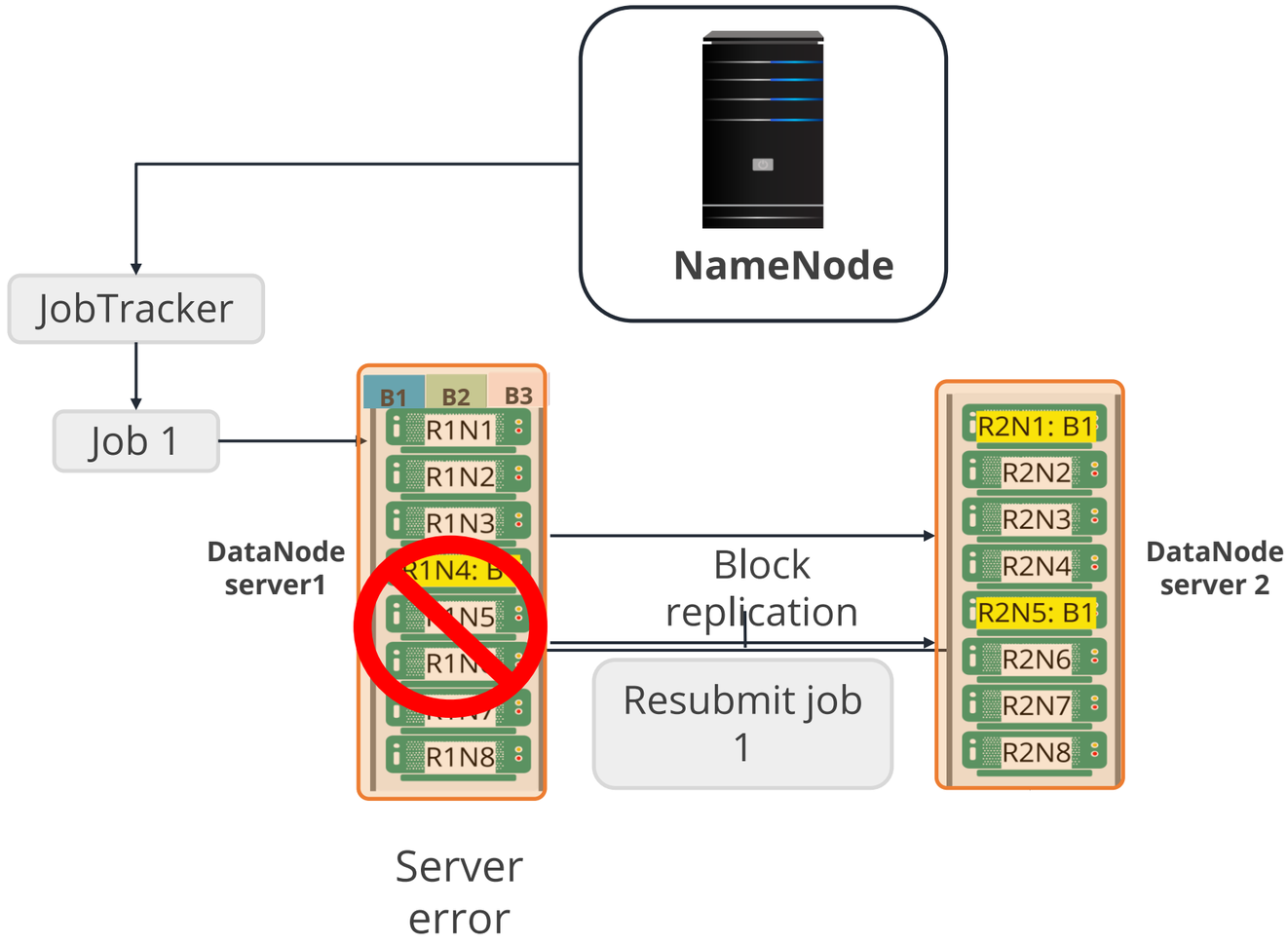


DataNodes managing blocks

The data block approach provides simplified replication, fault tolerance, and reliability.

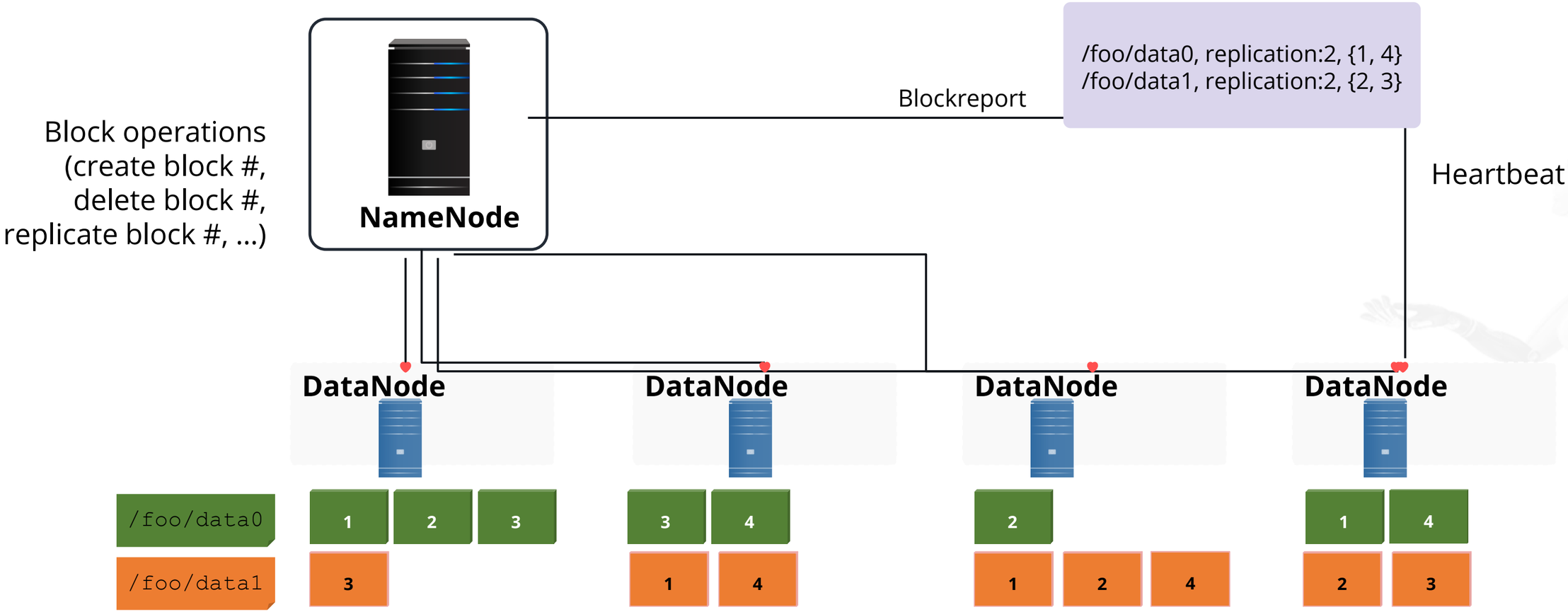
Block Replication Architecture

HDFS represents the unstructured data in the form of data blocks. It performs block replication on multiple DataNodes.



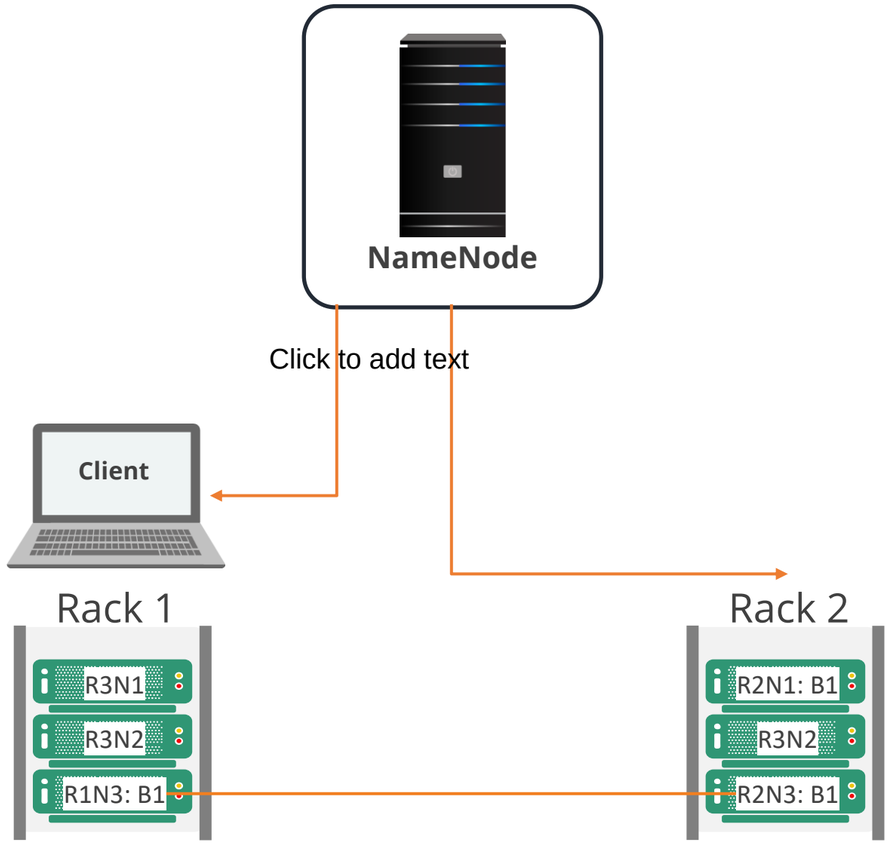
Replication Method

Each file is split into a sequence of blocks. Except for the last one, all blocks in the file are of the same size.



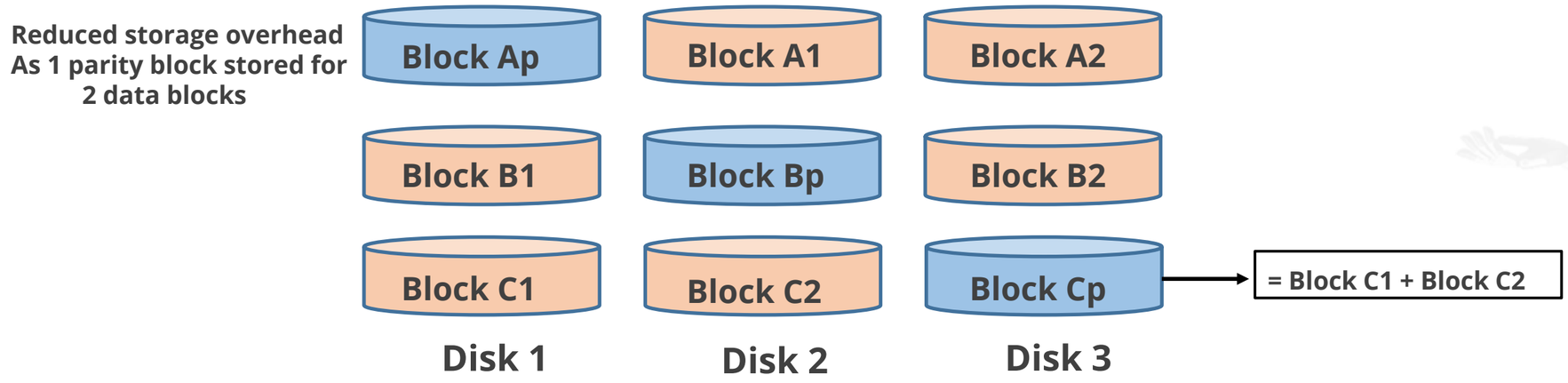
Data Replication Topologies

One of the suggested replication topologies is as follows:



HDFS: Erasure Coding

It is a data protection technique where data is broken into fragments, expanded, encoded with redundant information, and stored in different locations or storage media.



If a storage medium fails or data is corrupted, the data can be reconstructed from parts stored on other storage media.

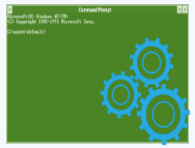
HDFS Access

HDFS provides the following access mechanisms:

Java API for applications

Python access and C wrapper for non-Java applications

Web GUI utilized through an HTTP browser



FS shell for executing commands on HDFS

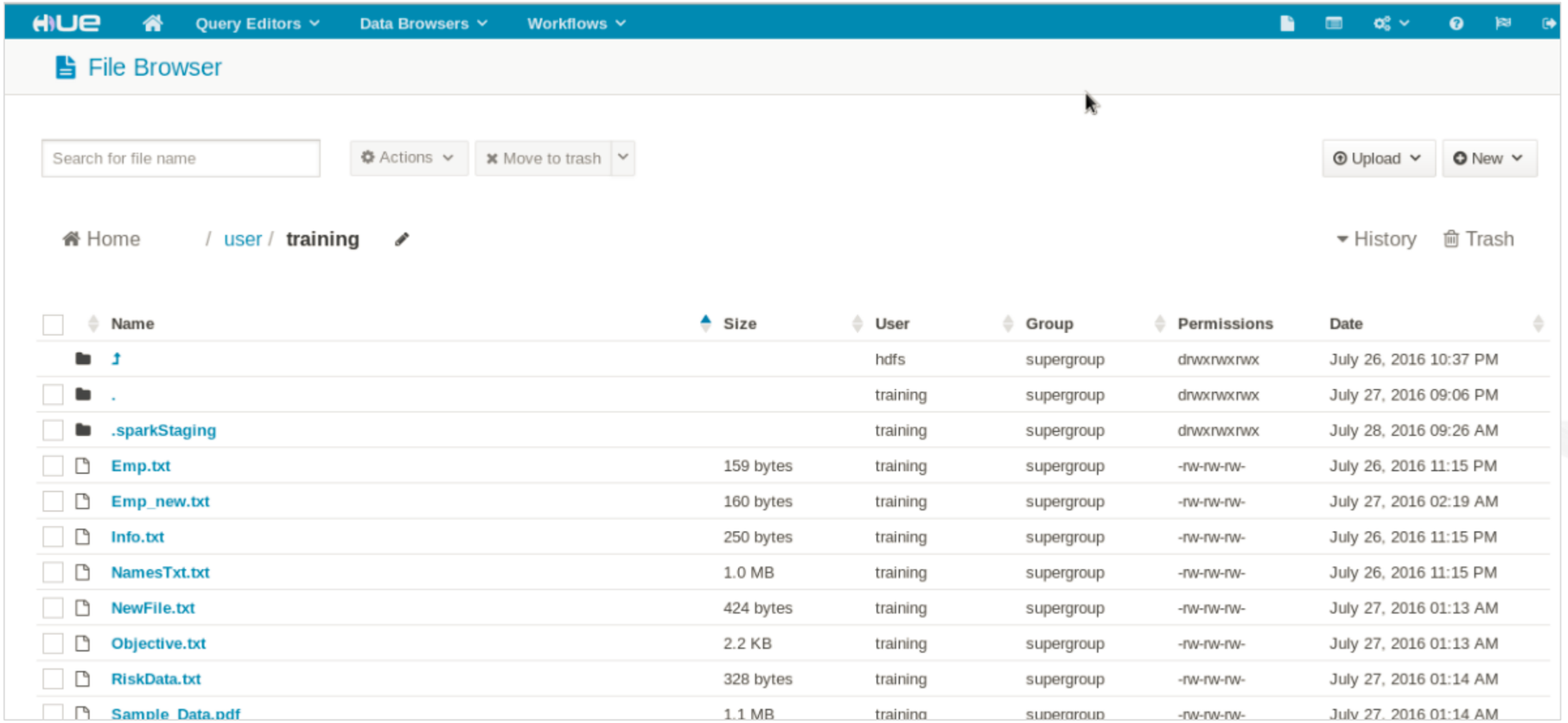
HDFS Command Line

Basic command lines of HDFS include:

Copies *simplilearn.txt* from the local disk to the user's directory in HDFS	$ hdfs dfs -put wordcount.txt test/
Displays a list of the contents of the directory path provided by the user, and shows the names, permissions, owner, size, and modification date for each entry	$hdfs dfs –ls /user/Simplilearn/
Creates a directory called *test* to the user's directory in HDFS	$hdfs dfs –mkdir test
Deletes the directory *test* and all content within	hdfs dfs -rm -r test

Hue File Browser

The file browser in Hue lets you view and manage your HDFS directories and files.



Name	Size	User	Group	Permissions	Date
..		hdfs	supergroup	drwxrwxrwx	July 26, 2016 10:37 PM
.		training	supergroup	drwxrwxrwx	July 27, 2016 09:06 PM
.sparkStaging		training	supergroup	drwxrwxrwx	July 28, 2016 09:26 AM
Emp.txt	159 bytes	training	supergroup	-rw-rw-rw-	July 26, 2016 11:15 PM
Emp_new.txt	160 bytes	training	supergroup	-rw-rw-rw-	July 27, 2016 02:19 AM
Info.txt	250 bytes	training	supergroup	-rw-rw-rw-	July 26, 2016 11:15 PM
NamesTxt.txt	1.0 MB	training	supergroup	-rw-rw-rw-	July 26, 2016 11:15 PM
NewFile.txt	424 bytes	training	supergroup	-rw-rw-rw-	July 27, 2016 01:13 AM
Objective.txt	2.2 KB	training	supergroup	-rw-rw-rw-	July 27, 2016 01:13 AM
RiskData.txt	328 bytes	training	supergroup	-rw-rw-rw-	July 27, 2016 01:14 AM
Sample_Data.pdf	1.1 MB	training	supergroup	-rw-rw-rw-	July 27, 2016 01:14 AM

Additionally, you can create, move, rename, modify, upload, download, and delete directories and files.

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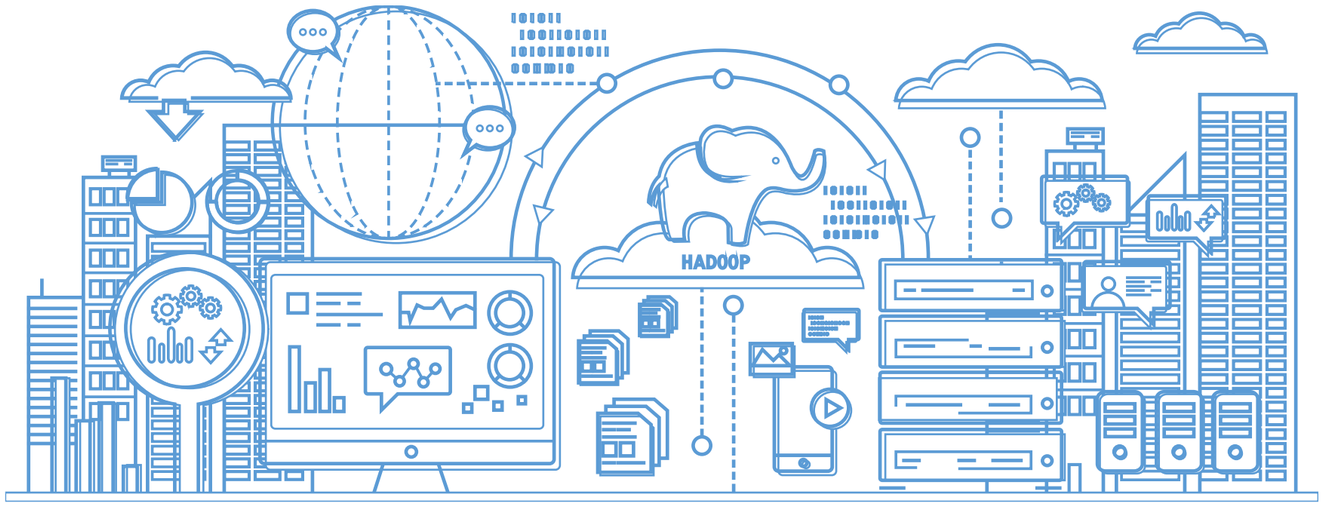
Case Study: Analyzing Uber Datasets Using Hadoop Framework

Analyzing Uber Datasets Using Hadoop Framework

Uber started by using RDBMS for storage, but there was a need for scalability and reliability after a few years, which increased by 400% every year. In 2016, there were about 100 petabytes of data, which was mixed, i.e., batch and real-time. After the previous solution failed, they began utilizing HDFS and then PRESTO.

They began using HDFS for batch and streaming analytics in a variety of applications, including fraud detection, machine learning, and ETA calculation.



Assisted Practice: HDFS Commands

Duration: 10 mins

Problem scenario: Write the commands to work with HDFS

Objective: In this demonstration, you will explore the basic command lines of HDFS.

Tasks to perform:

Step 1: Create a text file named “Sample.txt” in the vi editor

Step 2: Create a directory named “Simplilearn“ in HDFS

Step 3: Transfer a sample text file from your local filesystem to the HDFS director

Step 4: Show the content of the HDFS file uploaded on the command prompt

Step 5: Get details of all replicated blocks of the sample file uploaded

Step 6: Remove the text file from the HDFS directory

Note: The solution to this assisted practice is provided under the course resources section.

Key Takeaways

- HDFS is a distributed file system that provides access to data across Hadoop clusters.
- The HDFS components comprise different servers, like NameNode, DataNode, and Secondary NameNode.
- HADOOP CLI is an interactive command-line shell that makes working with Hadoop's Distributed File System (HDFS) easier and more intuitive than the traditional Hadoop command-line tools.

Knowledge Check

Knowledge Check 1

Which of the following statements best describes how a large (100 GB) file is stored in HDFS?

A. The file is replicated three times by default. Each copy of the file is stored on a separate DataNode.

B. The master copy of the file is stored on a single DataNode. The replica copies are divided into fixed-size blocks which are stored on multiple DataNodes.

C. The file is divided into fixed-size blocks which are stored on multiple DataNodes. Each block is replicated three times by default. Multiple blocks from the same file might reside on the same DataNode.

D. The file is divided into fixed-size blocks which are stored on multiple DataNodes. Each block is replicated three times by default. HDFS guarantees that different blocks from the same file are never on the same DataNode.

Knowledge Check 1

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D. The file is divided into fixed-size blocks which are stored on multiple DataNodes. Each block is replicated three times by default. HDFS guarantees that different blocks from the same file are never on the same DataNode.

The correct answer is **D**

The large file is divided into fixed-size blocks which are stored on multiple DataNodes. Each block is replicated three times by default. HDFS guarantees that different blocks from the same file are never on the same DataNode.

Knowledge Check 2

How many blocks are required to store a file that is 514 MB in size in HDFS using default block size configuration?

A. 4

B. 5

C. 6

D. 7

Knowledge Check 2

How many blocks are required to store a file of size 514 MB in HDFS using default block size configuration?

A. 4

B. 5

C. 6

D. 7

The correct answer is **B**

The default block size in Hadoop 3. x is 128 MB. So, a file of size 514 MB will be divided into 5 blocks, where the first four blocks will be 128 MB and the last block will be 2 MB.

Knowledge Check

3

Which of the following statements is NOT true about HDFS?

A. We cannot modify files already present in HDFS

B. Multiple clients can write into an HDFS file concurrently

C. Both A and B

D. None of the above

Knowledge Check

3

Which of the following statements is NOT true about HDFS?

A. We cannot modify files already present in HDFS

B. Multiple clients can write into an HDFS file concurrently

C. Both A and B

D. None of the above

The correct answer is **B**

HDFS follows the *write once, read many* model. So, multiple clients cannot write into an HDFS file concurrently.

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Thank You