Introduction to **HDFS**

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"Big Data is at the foundation of all the megatrends that are happening today."

What's HDFS

- HDFS is a distributed file system that is fault tolerant, scalable and extremely easy to expand.
- HDFS is the primary distributed storage for Hadoop applications.
- HDFS provides interfaces for applications to move themselves closer to data.
- HDFS is designed to 'just work', however a working knowledge helps in diagnostics and improvements.

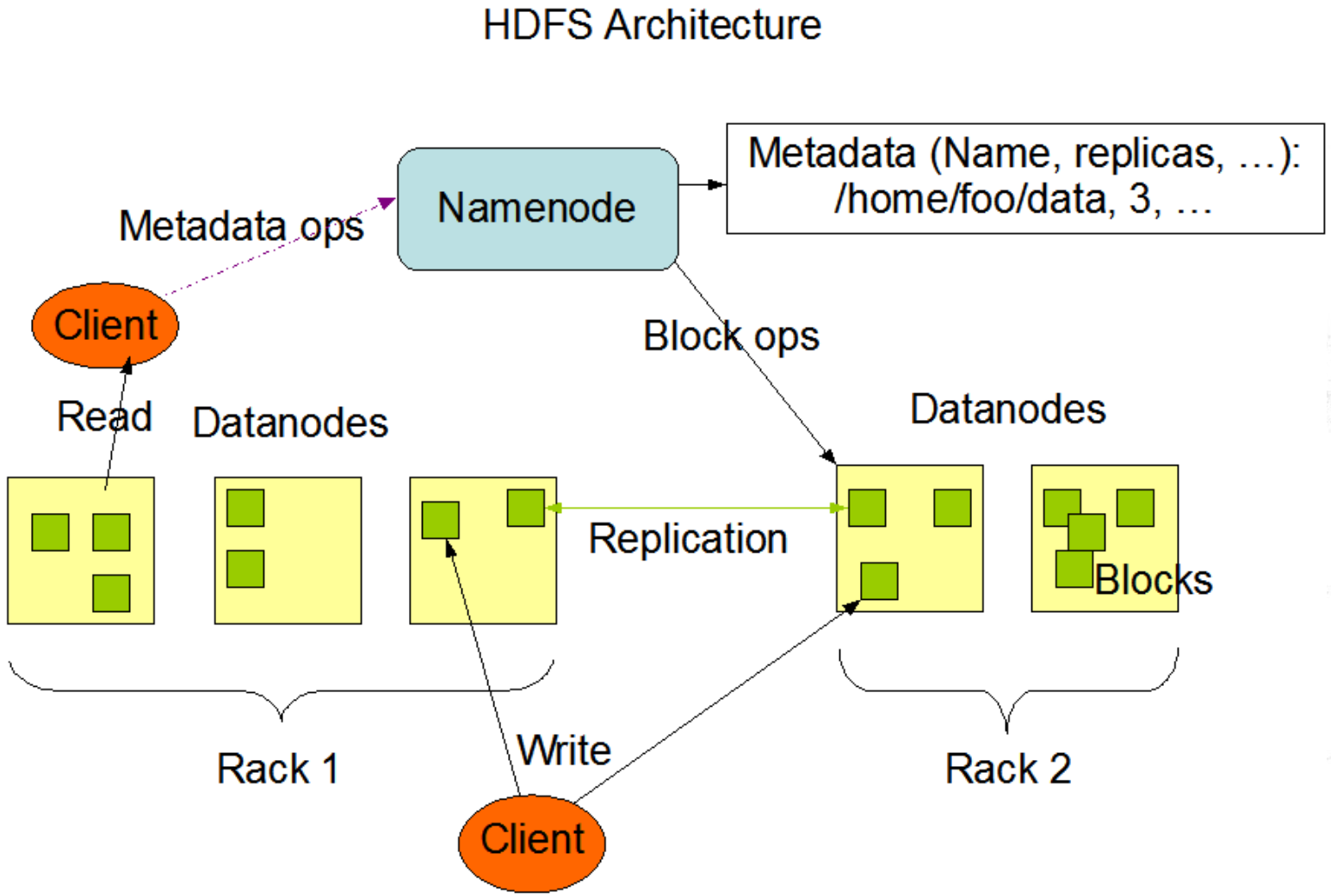
Goals of HDFS

- **Very Large Distributed File System**
  - –10K nodes, 100 million files, 10 PB
- **Assumes Commodity Hardware**
  - –Files are replicated to handle hardware failure
  - –Detect failures and recovers from them
- **Optimized for Batch Processing**
  - –Data locations exposed so that computations can move to where data resides
  - –Provides very high aggregate bandwidth
- **User Space, runs on heterogeneous OS**

The Design of HDFS

- Single Namespace for entire cluster
- Data Coherency
  - Write-once-read-many access model
  - Client can only append to existing files
- Files are broken up into blocks
  - Typically 64MB-128MB block size
  - Each block replicated on multiple DataNodes
- Intelligent Client
  - Client can find location of blocks
  - Client accesses data directly from DataNode

HDFS Architecture

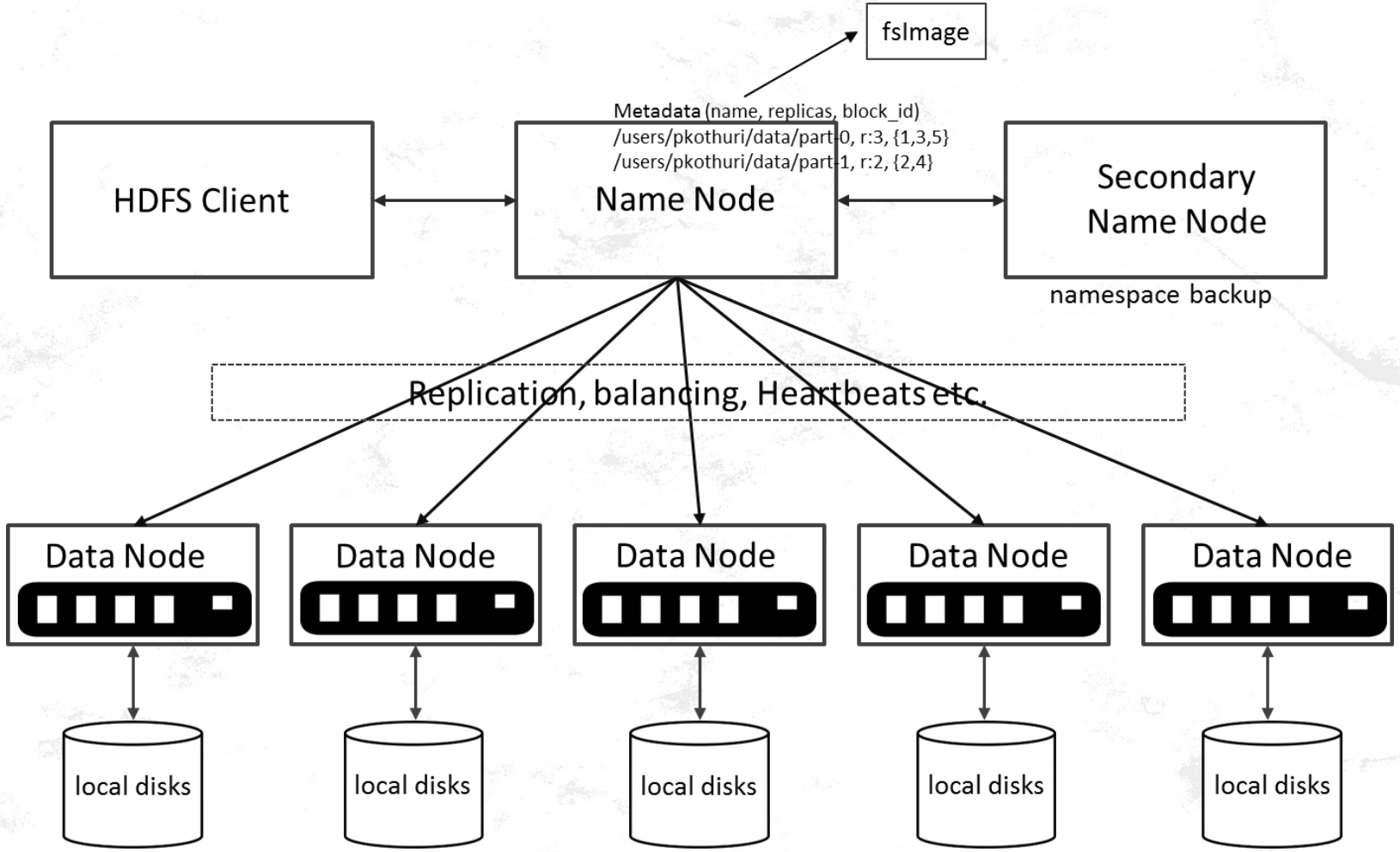


Components of HDFS

There are two (*and a half*) types of machines in a HDFS cluster

- NameNode :– is the heart of an HDFS filesystem, it maintains and manages the file system metadata. E.g; what blocks make up a file, and on which datanodes those blocks are stored.
- DataNode :- where HDFS stores the actual data, there are usually quite a few of these.

HDFS Architecture



Unique features of HDFS

HDFS also has a bunch of unique features that make it ideal for distributed systems:

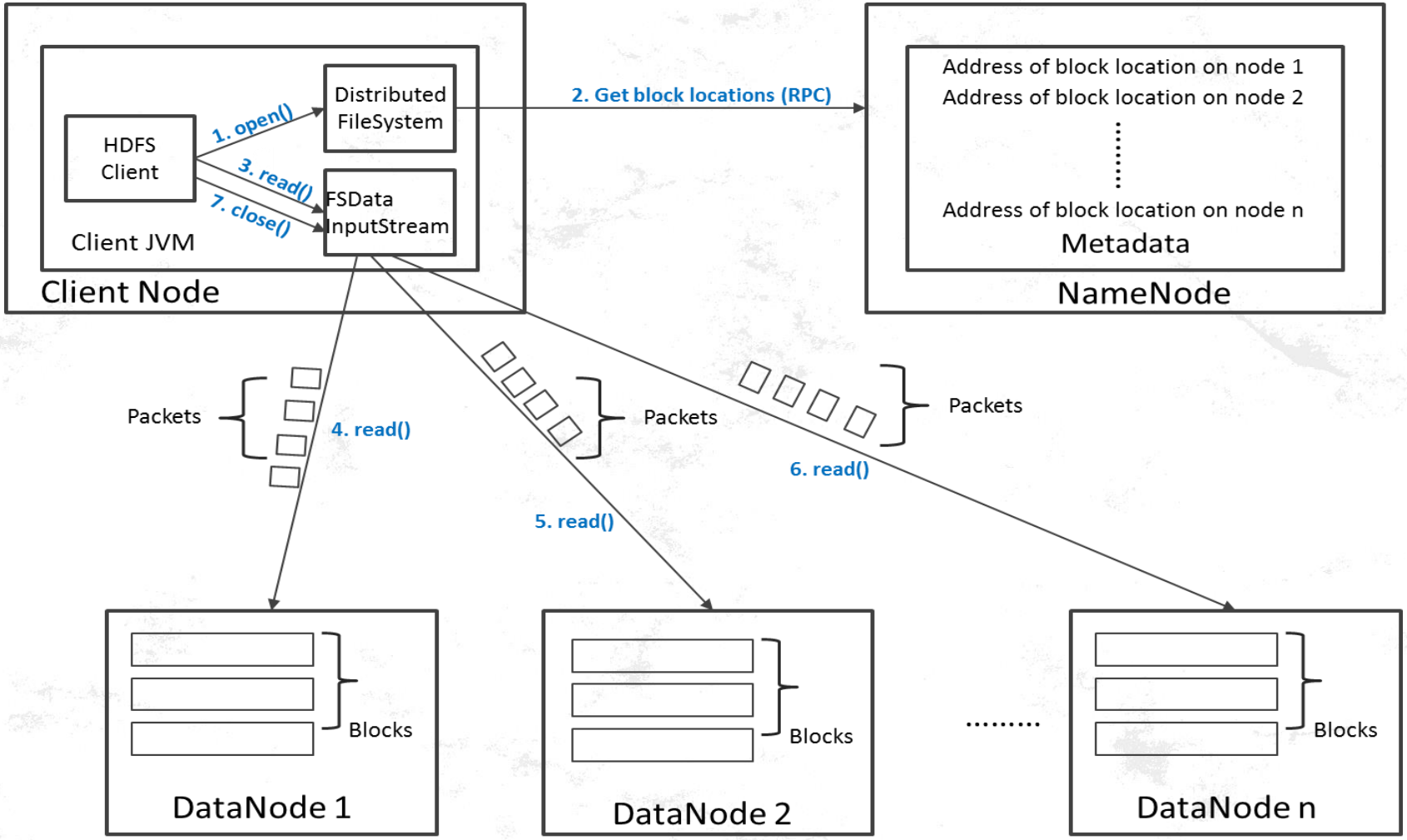
- Failure tolerant - data is duplicated across multiple DataNodes to protect against machine failures. The default is a replication factor of 3 (every block is stored on three machines).
- Scalability - data transfers happen directly with the DataNodes so your read/write capacity scales fairly well with the number of DataNodes
- Space - need more disk space? Just add more DataNodes and re-balance
- Industry standard - Other distributed applications are built on top of HDFS (HBase, Map-Reduce)

HDFS is designed to process large data sets with write-once-read-many semantics, it is not for low latency access

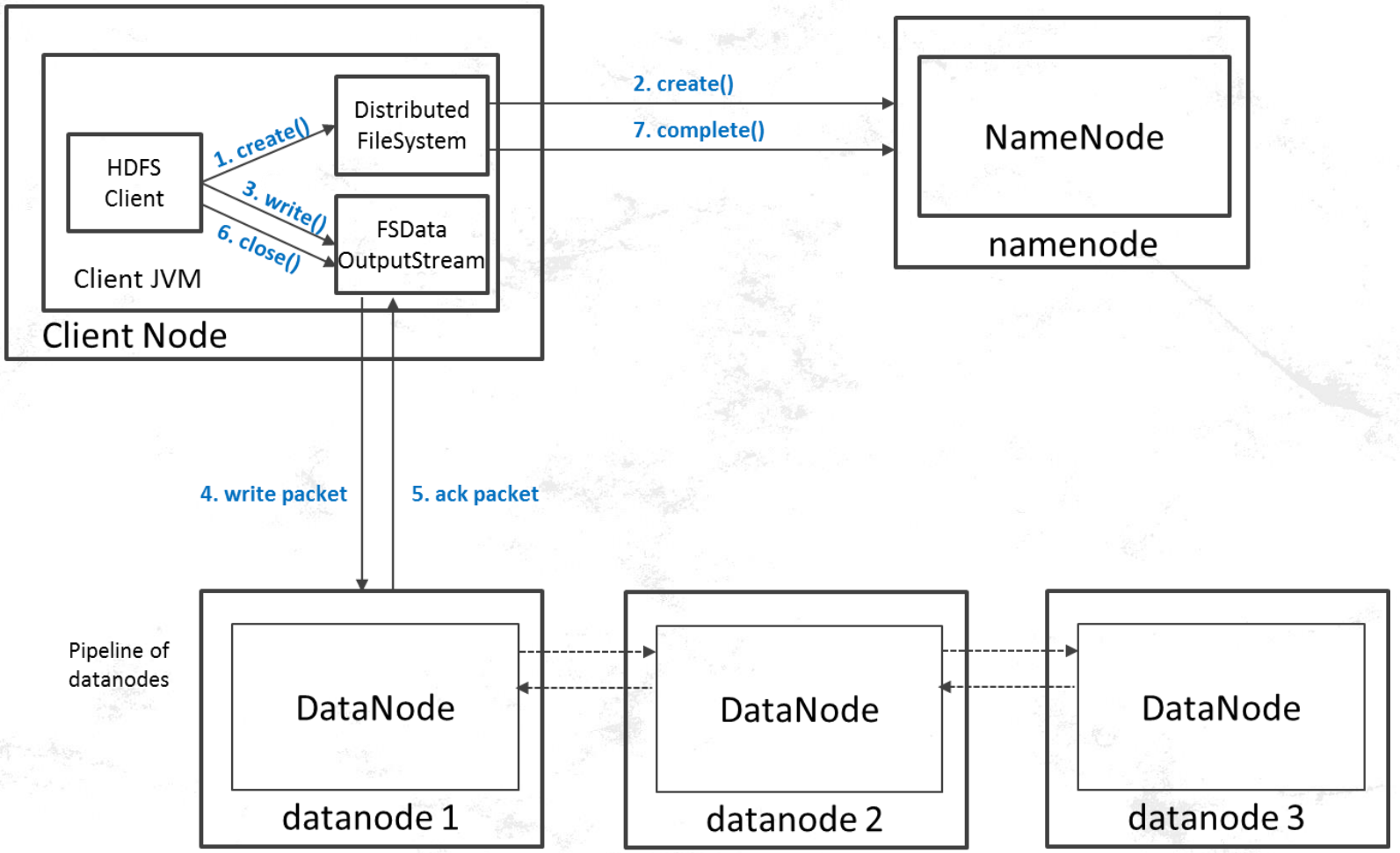
HDFS – Data Organization

- Each file written into HDFS is split into data blocks
- Each block is stored on one or more nodes
- Each copy of the block is called replica
- Block placement policy
  - First replica is placed on the local node
  - Second replica is placed in a different rack
  - Third replica is placed in the same rack as the second replica

Read Operation in HDFS



Write Operation in HDFS



HDFS Security

- Authentication to Hadoop
  - Simple – insecure way of using OS username to determine hadoop identity
  - Kerberos – authentication using kerberos ticket
  - Set by `hadoop.security.authentication=simple|kerberos`
- File and Directory permissions are same like in POSIX
  - read (r), write (w), and execute (x) permissions
  - also has an owner, group and mode
  - enabled by default `(dfs.permissions.enabled=true)`
- ACLs are used for implemention permissions that differ from natural hierarchy of users and groups
  - enabled by `dfs.namenode.acls.enabled=true`

Interfaces to HDFS

- Java API (`DistributedFileSystem`)
- C wrapper (`libhdfs`)
- HTTP protocol
- WebDAV protocol
- Shell Commands

However, the command line is one of the simplest and most familiar

HDFS – Shell Commands

There are two types of shell commands

User Commands

`hdfs dfs` – runs filesystem commands on the HDFS

`hdfs fsck` – runs a HDFS filesystem checking command

Administration Commands

`hdfs dfsadmin` – runs HDFS administration commands

HDFS – Shell Commands

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User Commands

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HDFS – User Commands (dfs)

- **List Files and Directories**

View files in an HDFS directory.

hdfs dfs -ls /

Example Output:

drwxr-xr-x - user supergroup 0 2024-12-15 /user

- **Make a New Directory**

Create a directory in HDFS.

hdfs dfs -mkdir /user/mydir

Create a file in Ubuntu

- **Create a file**

To create a file first and then upload it to HDFS, follow these steps:

Step 1: Create a File on the Local Filesystem

Use a text editor like nano, vim, or a simple echo command to create a file locally.

Example 1: Using echo

echo "Hello, HDFS!" > localfile.txt

Verify the File is Created List the file in your local directory to ensure it exists.

ls -l localfile.txt

HDFS – User Commands (dfs)

- **Put the File into HDFS**

Use the hdfs dfs -put command to upload the file to HDFS.

hdfs dfs -put localfile.txt /user/mydir/

Verify the File in HDFS List the HDFS directory to ensure the file was uploaded successfully.

hdfs dfs -ls /user/mydir/

Output:

-rw-r--r-- 3 user supergroup 13 2024-12-15 12:00 /user/mydir/localfile.txt

HDFS – User Commands (dfs)

- Display the contents of a file stored in HDFS.

hdfs dfs -cat /user/mydir/localfile.txt

- Remove a file stored in HDFS.

hdfs dfs -rm /user/mydir/localfile.txt

- Remove a Directory

Delete a directory from HDFS (and its contents).

hdfs dfs -rm -r /user/mydir

View the Contents of a File

- View File Contents

Display file contents:

hdfs dfs -cat /user/mydir/localfile.txt

- Display the first few lines of a file:

hdfs dfs -head /user/mydir/localfile.txt

- Display the last few lines of a file:

hdfs dfs -tail /user/mydir/localfile.txt

HDFS – Commands (dfs)

- Move Files in HDFS Move files between directories in HDFS.

hdfs dfs -mv /user/mydir/localfile.txt /user/mydir2/

- Check Disk Usage

See the size of files or directories in HDFS.

hdfs dfs -du -h /user/mydir/localfile.txt

Check file status

hdfs dfs -stat /user/mydir/localfile.txt

Displays the status of a file or directory in HDFS.

Hadoop Installation on Docker

Hadoop Basic Commands