



Introduction to Hadoop and MapReduce Programming - Session 2

Course: Data Engineering - I

Lecture On: Introduction to
HDFS

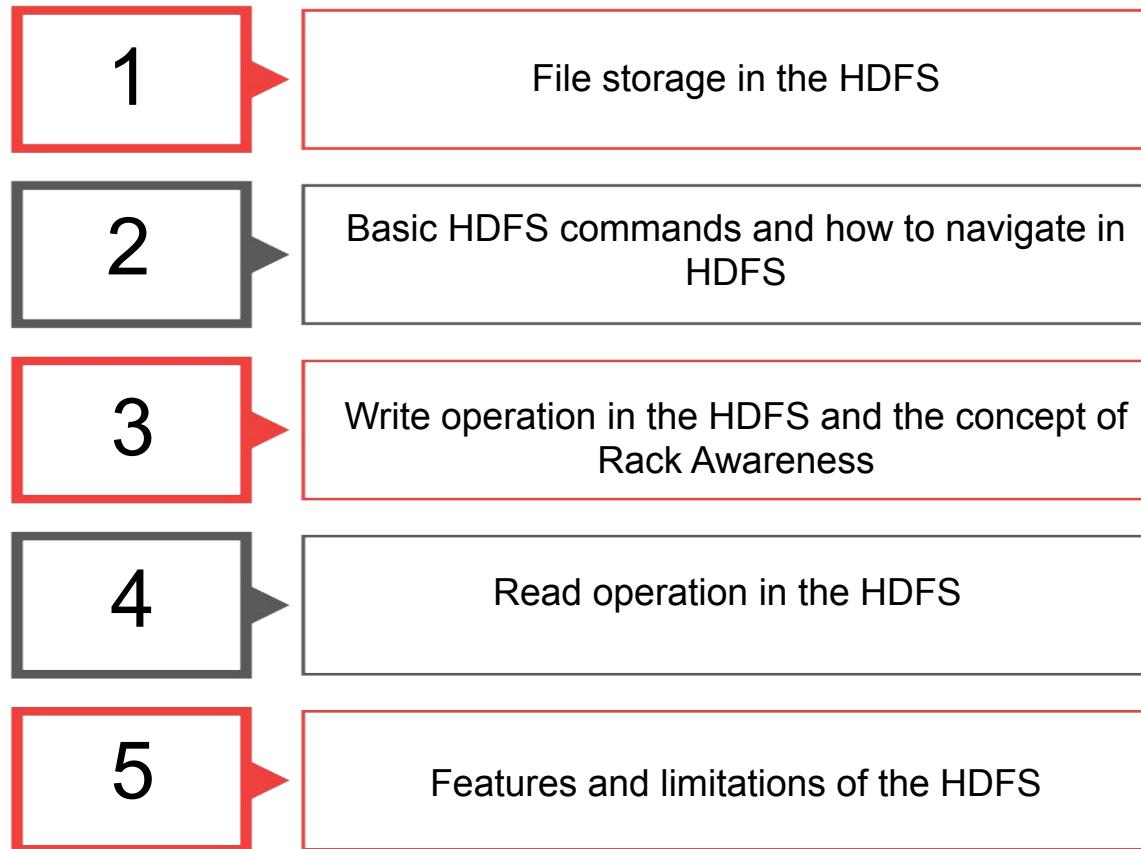
Instructor: Vishwa Mohan



Segment - 01

Introduction: Introduction to HDFS

Session Overview



Segment - 02

File Storage in the HDFS

Segment Overview

1

Process of file storage in the HDFS

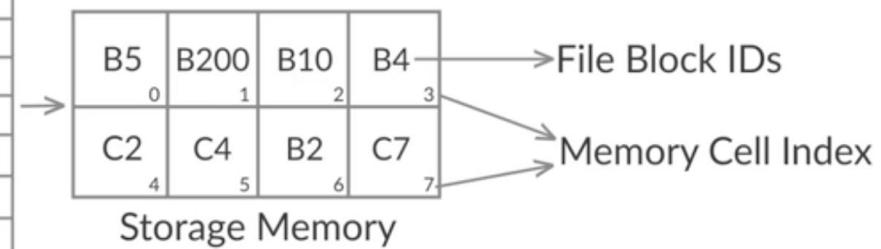
2

Block-size considerations and
optimal replication factor

File Storage in the HDFS

Metadata/
Mapping Table

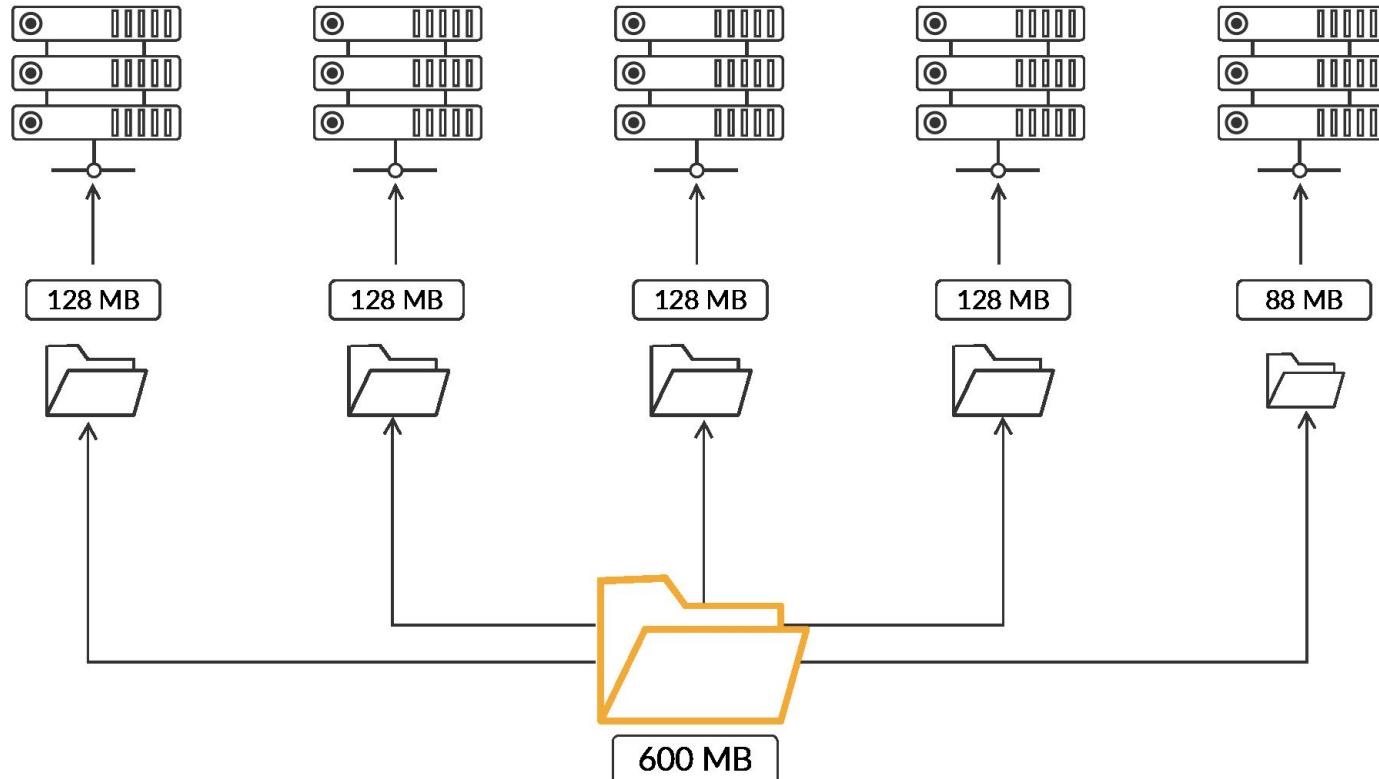
File Name	Block ID	Memory Location
B	B5	0
B	B200	1
B	B10	2
B	B4	3
B	B2	6
C	C2	4
C	C4	5
C	C7	7



Files are stored in fixed-size blocks in the **Hadoop Distributed File System (HDFS)**. All file systems maintain a **metadata** of the files to reduce the seek time.

The default block size in the HDFS is **128 MB**. The blocks are stored in different machines in the form of separate files. The last file may not occupy the full block.

File Storage in the HDFS



File Storage in the HDFS

Why such a large block size of 128 MB for the HDFS?

1

Minimise the cost of seeks

2

Fewer TCP connections to different machines containing the blocks

3

Reduced size of metadata

4

Location information of all blocks can be cached by the client

File Storage in the HDFS

Some limitations of a large block size

1 A large block size reduces the overall throughput

2 Parallelism is severely limited by a large block size

File Storage in the HDFS

The HDFS is based on a large number of commodity machines

The failure rate of machines is quite high, and failure of some machines becomes the norm rather than an exception.

The HDFS keeps **2 replicas** of the data of a machine to maintain fault tolerance. Each block, thus, has **3 copies** in the file system.

File Storage in the HDFS

Why is the replication factor set to 3?

Number of Replicas	Failure Probability of a Machine	Probability of All Machines Failing Simultaneously	Probability that Data is Not Lost or at least One Replica is Available	Marginal Improvement
1	0.05	0.05	0.95	-
2	0.05	0.0025	0.9975	0.0475
3	0.05	0.000125	0.999875	0.002375
4	0.05	0.000006250	0.999993750	0.000118750
5	0.05	0.000000313	0.999999688	0.000005937
6	0.05	0.000000016	0.999999984	0.000000297

File Storage in the HDFS

Why is the replication factor an odd number?



Consistency in odd numbered replications



Consistency in even numbered replications

File Storage in the HDFS

To retrieve a file from the HDFS, we must know the number of blocks of the file and their locations

The following two components constitute the entire file system's functions:

1. **NameNode**
 - a. File hierarchy
 - b. Metadata of files and directories
 - c. Locations of blocks
2. **DataNode**
 - a. Stores the actual data blocks

Segment Summary

1

Learnt about the process of file storage in the HDFS

2

Discussed block-size considerations and optimal replication factor

Segment - 04

Write Operation in the HDFS

Segment Overview

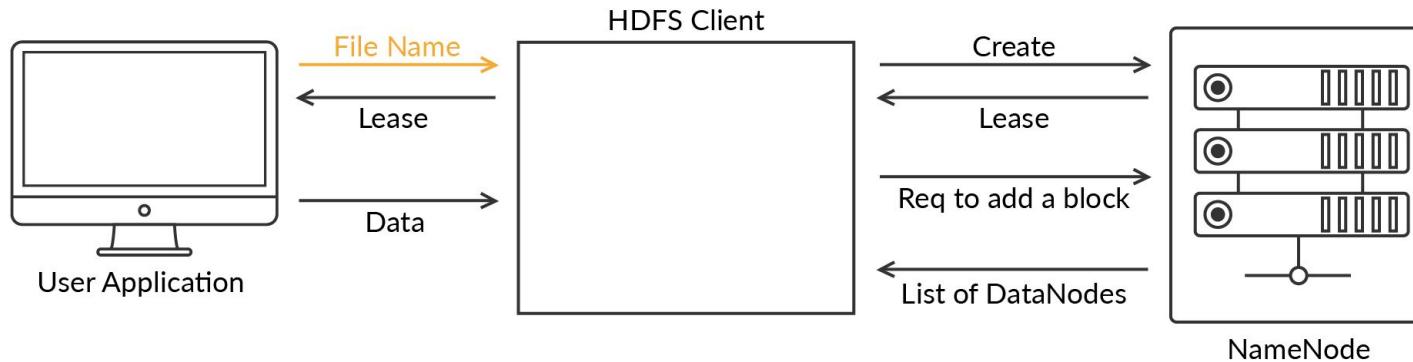
1

Steps performed in a Write operation in the HDFS

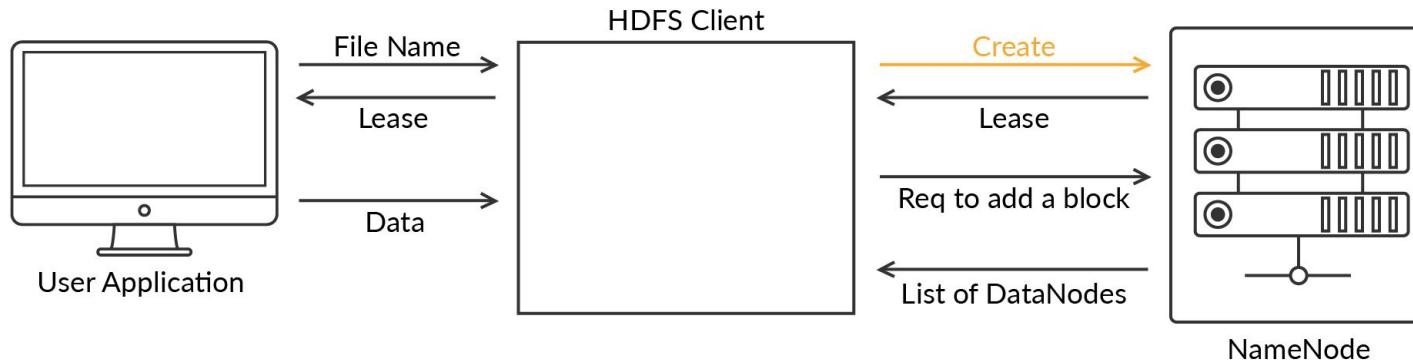
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How the components of the HDFS interact in a Write operation

Write Operation in the HDFS



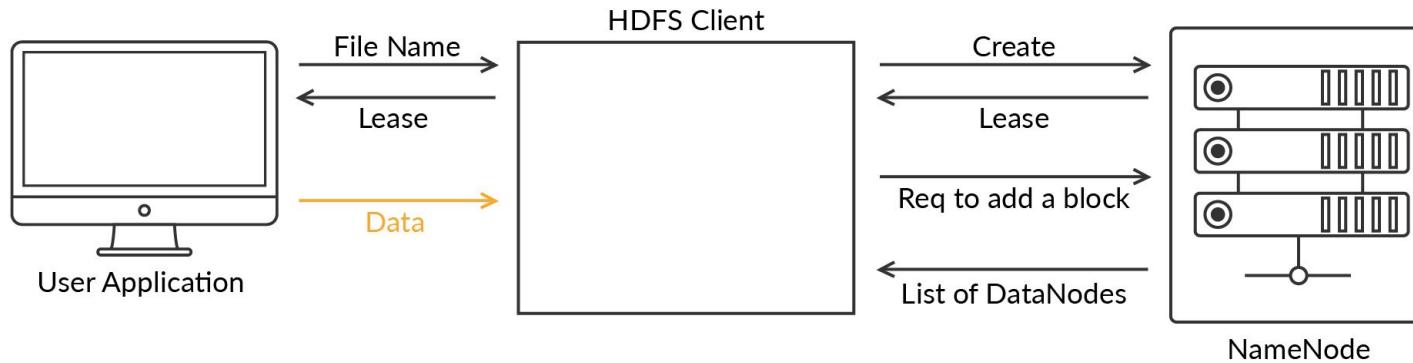
Write Operation in the HDFS



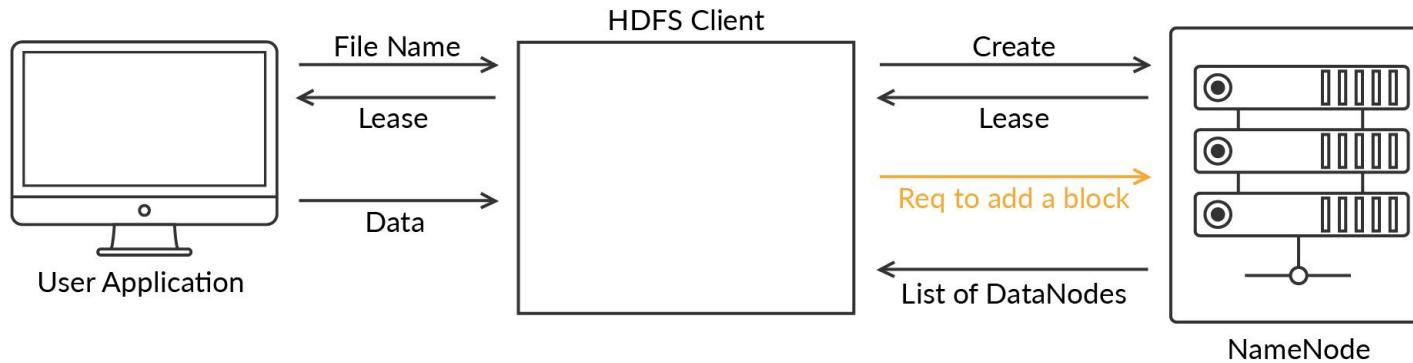
Write Operation in the HDFS



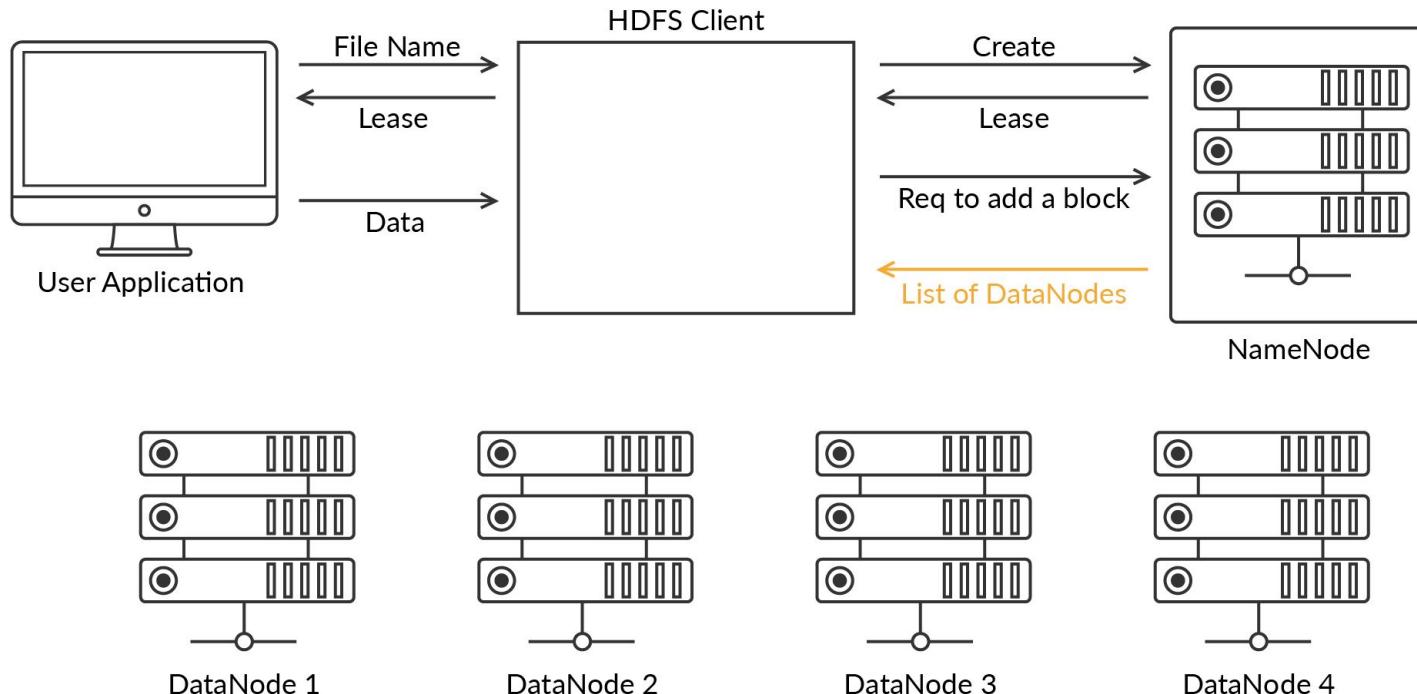
Write Operation in the HDFS



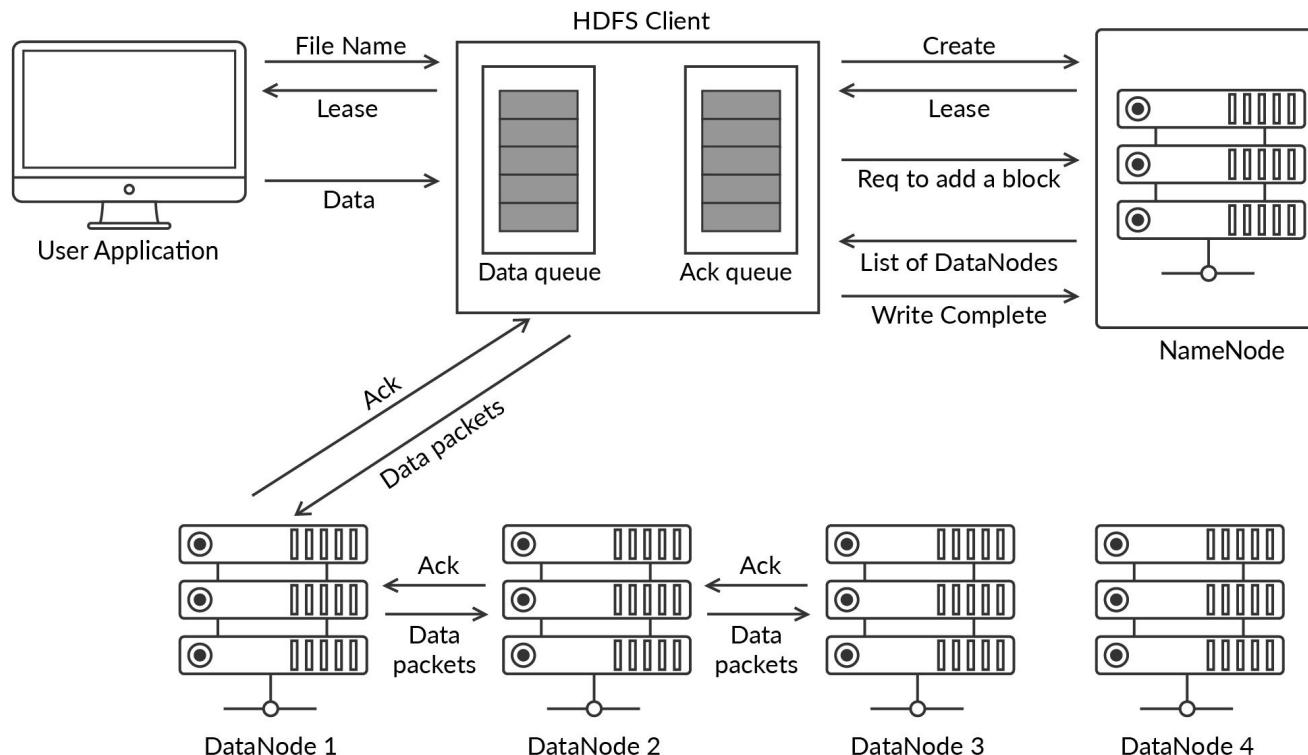
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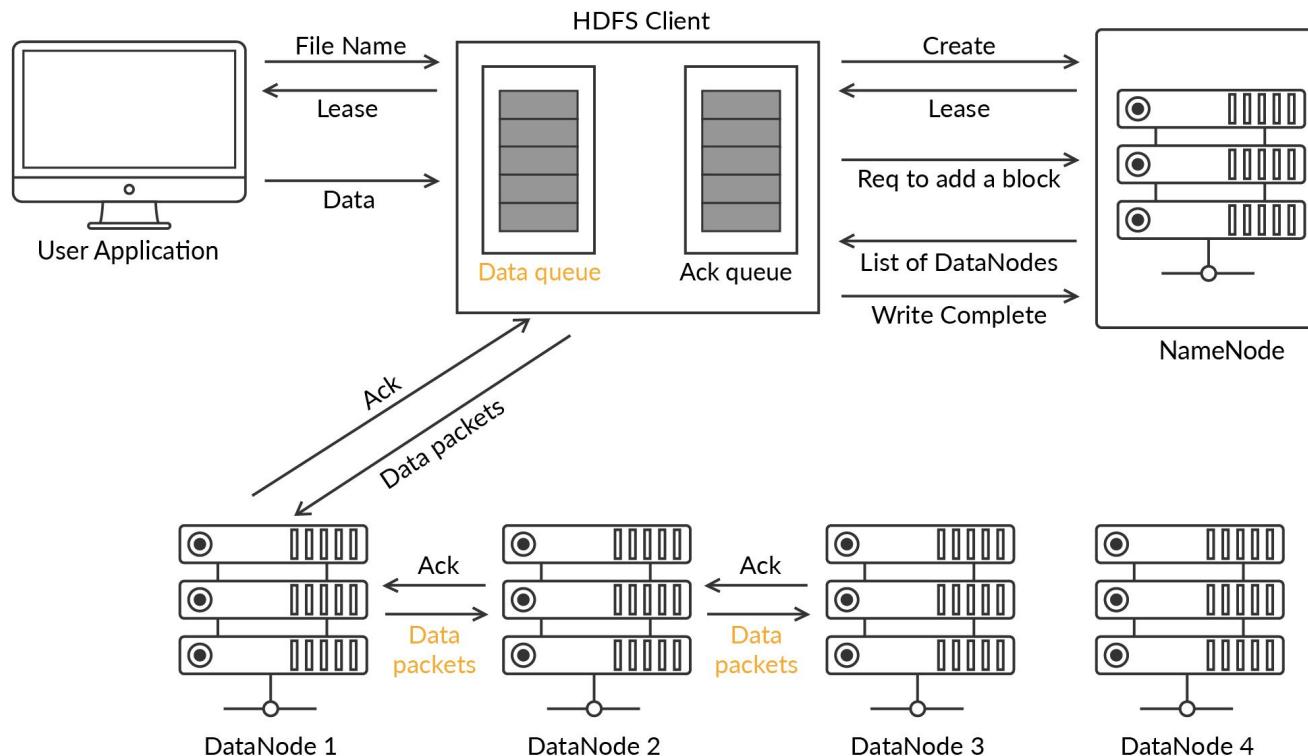
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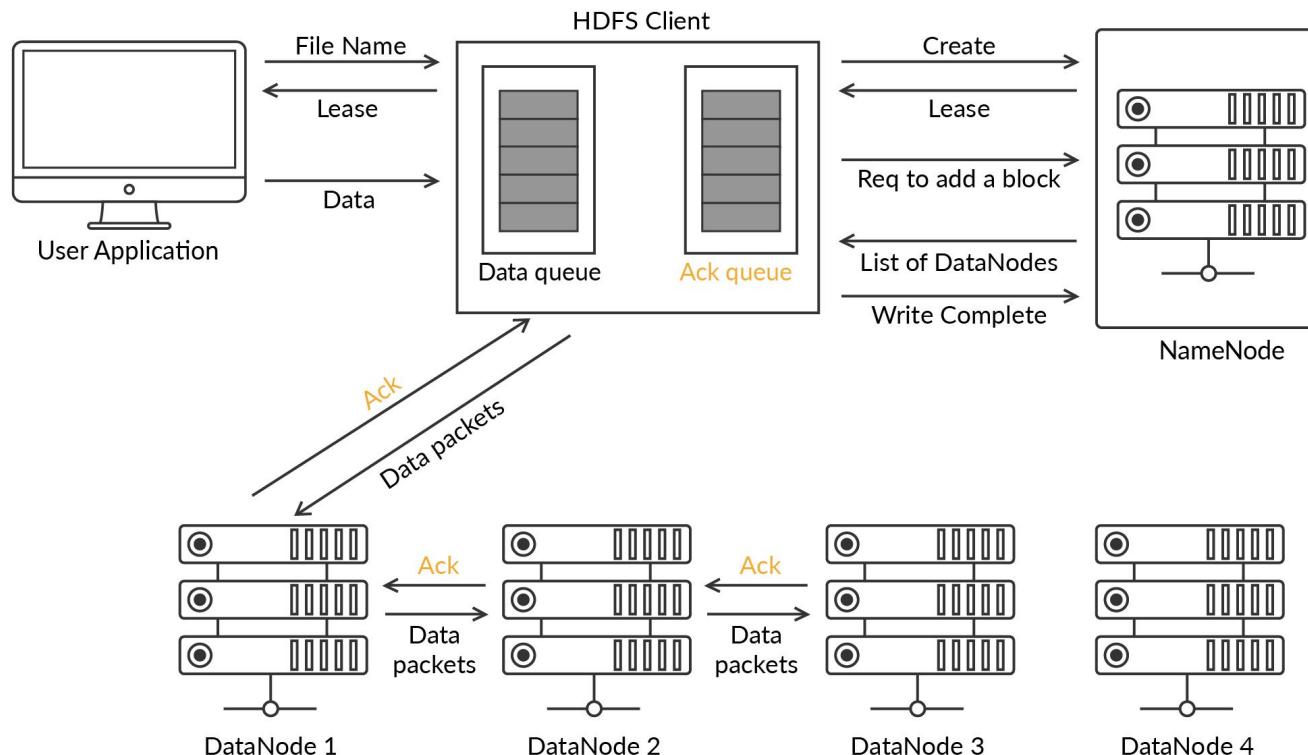
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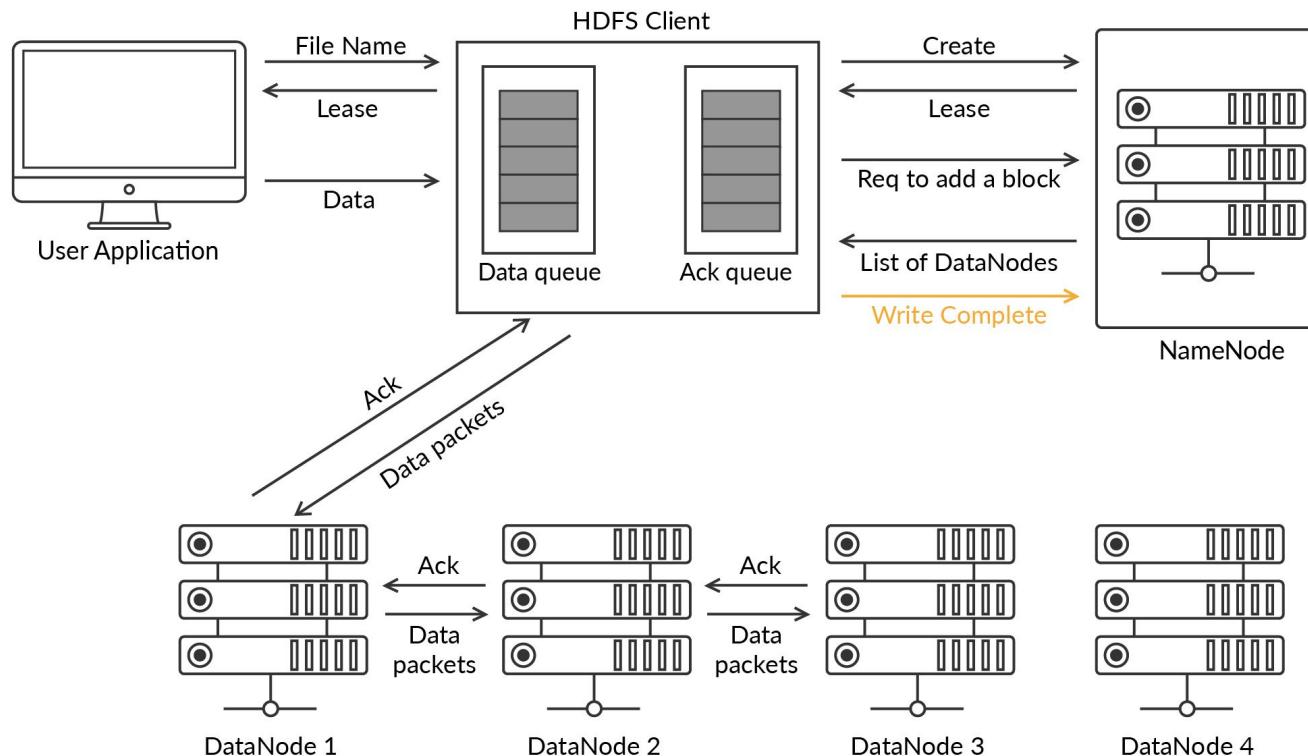
Write Operation in the HDFS



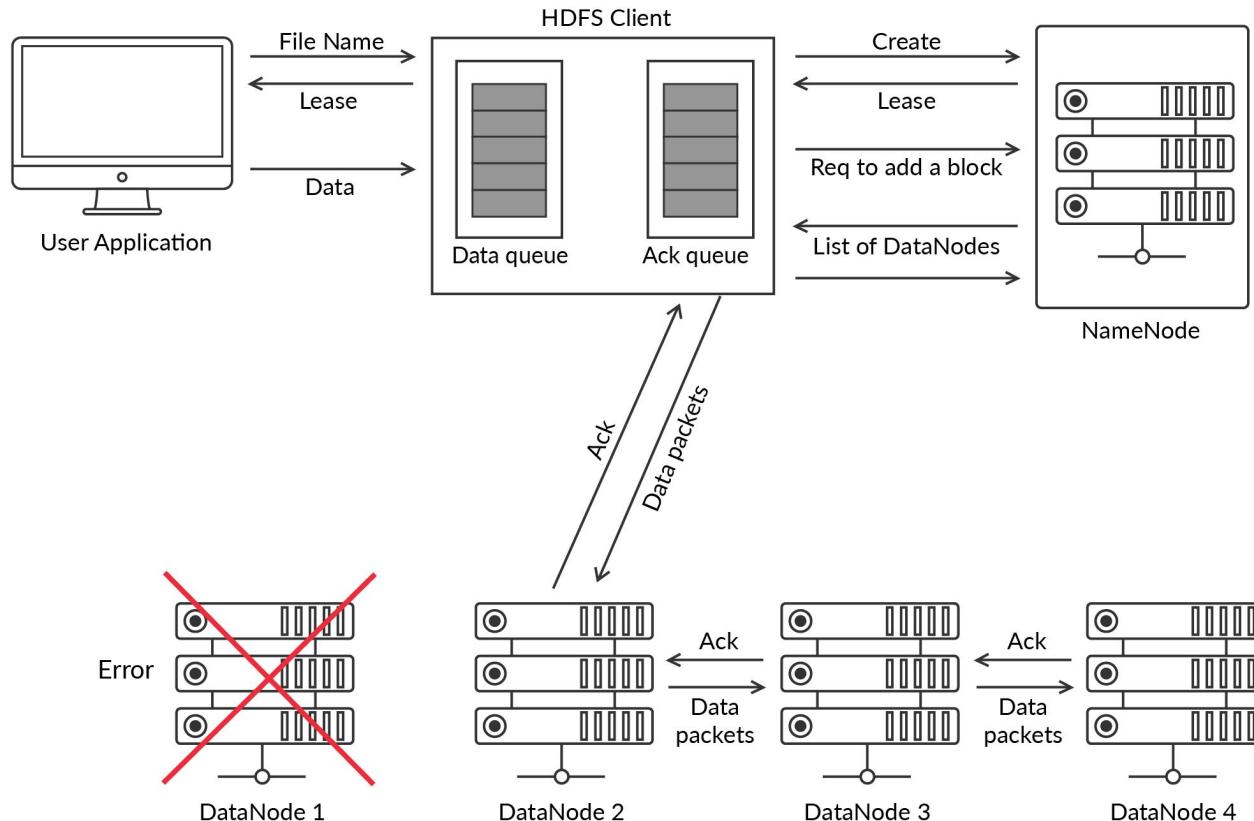
Write Operation in the HDFS



Write Operation in the HDFS



Write Operation in the HDFS



Segment Summary

1

Learnt about the steps performed
in a write operation

2

Discussed how the components of
the HDFS interact in a write
operation

Segment - 06

Read Operation in the HDFS

Segment Overview

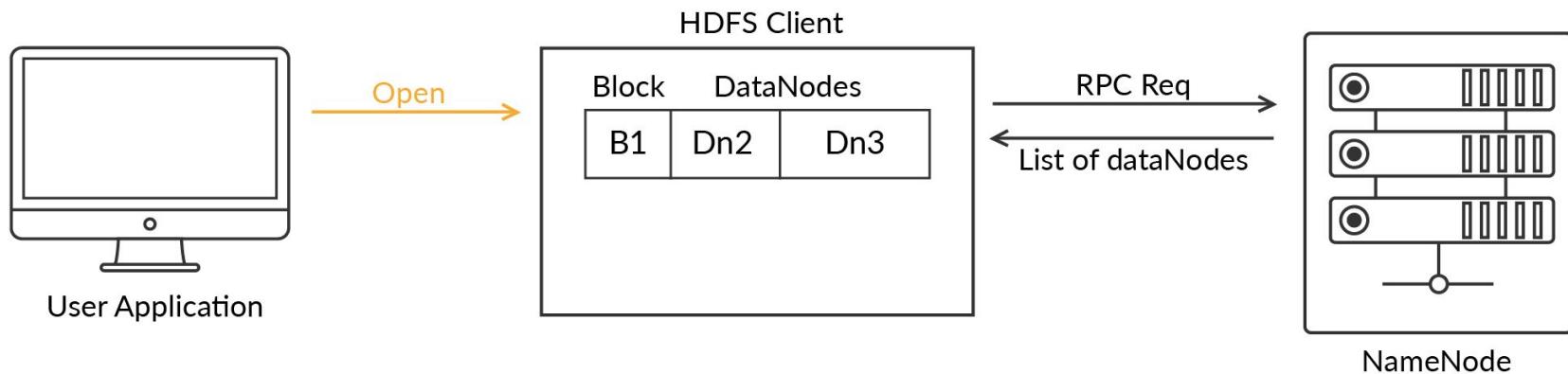
1

Steps performed in a Read
operation in the HDFS

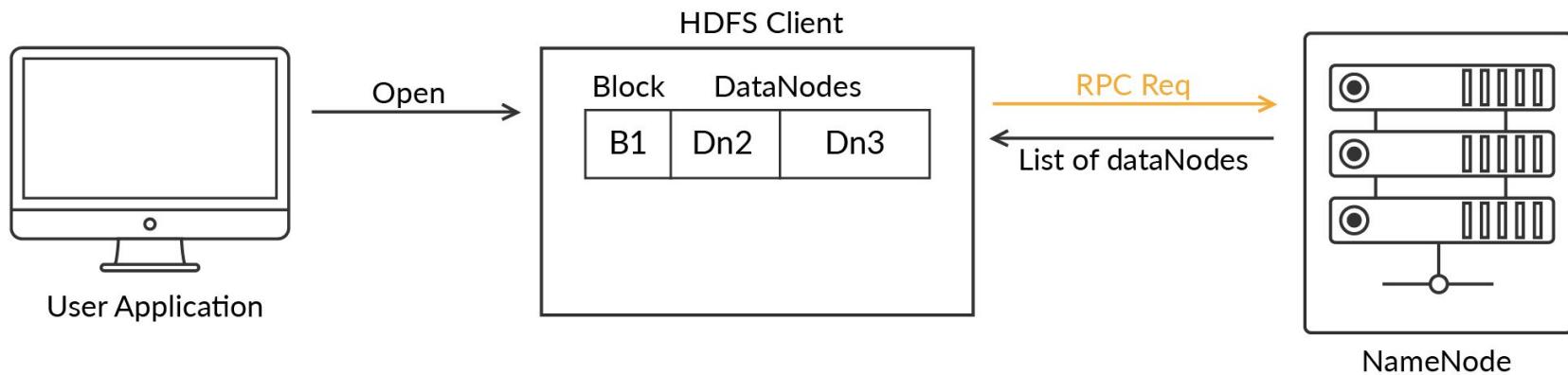
2

How the components of the HDFS
interact in a Read operation

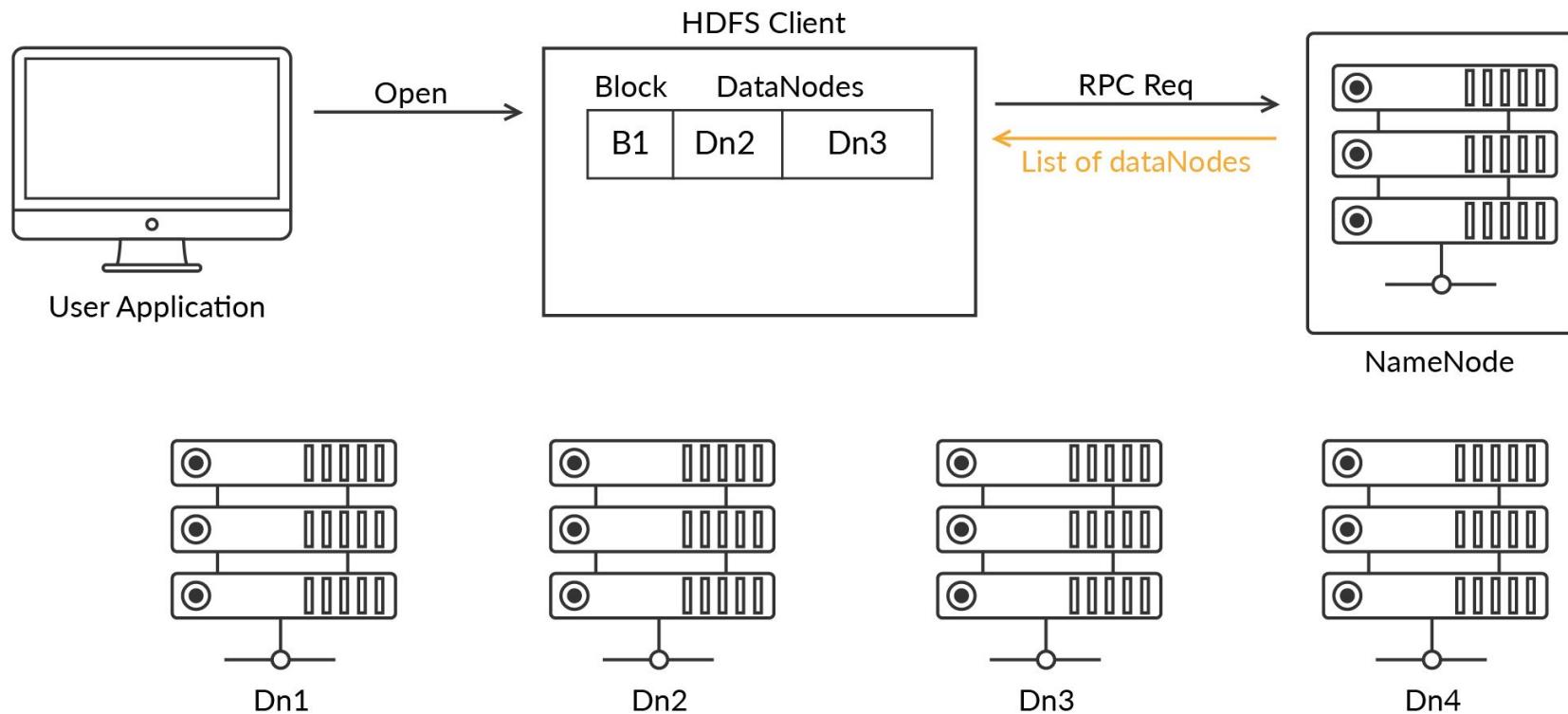
Read Operation in the HDFS



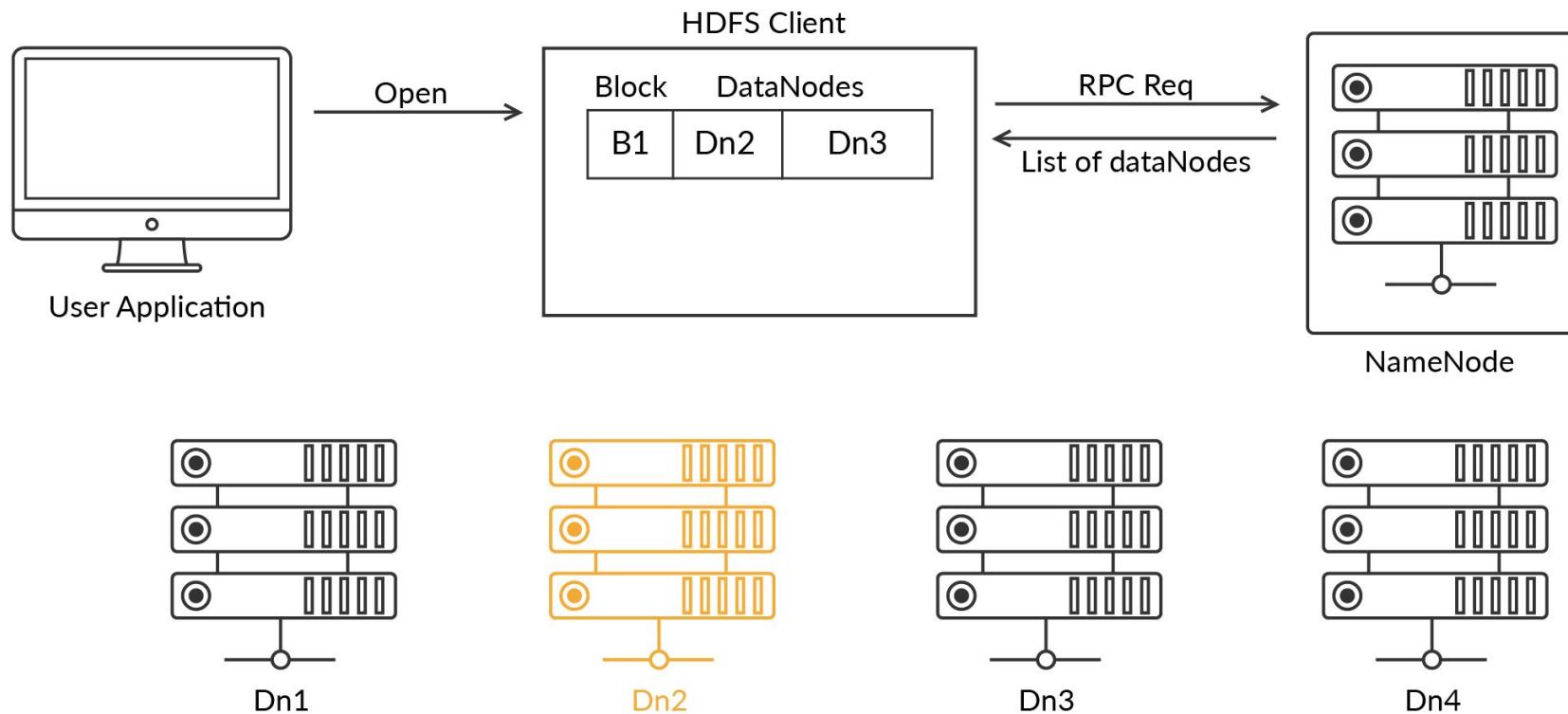
Read Operation in the HDFS



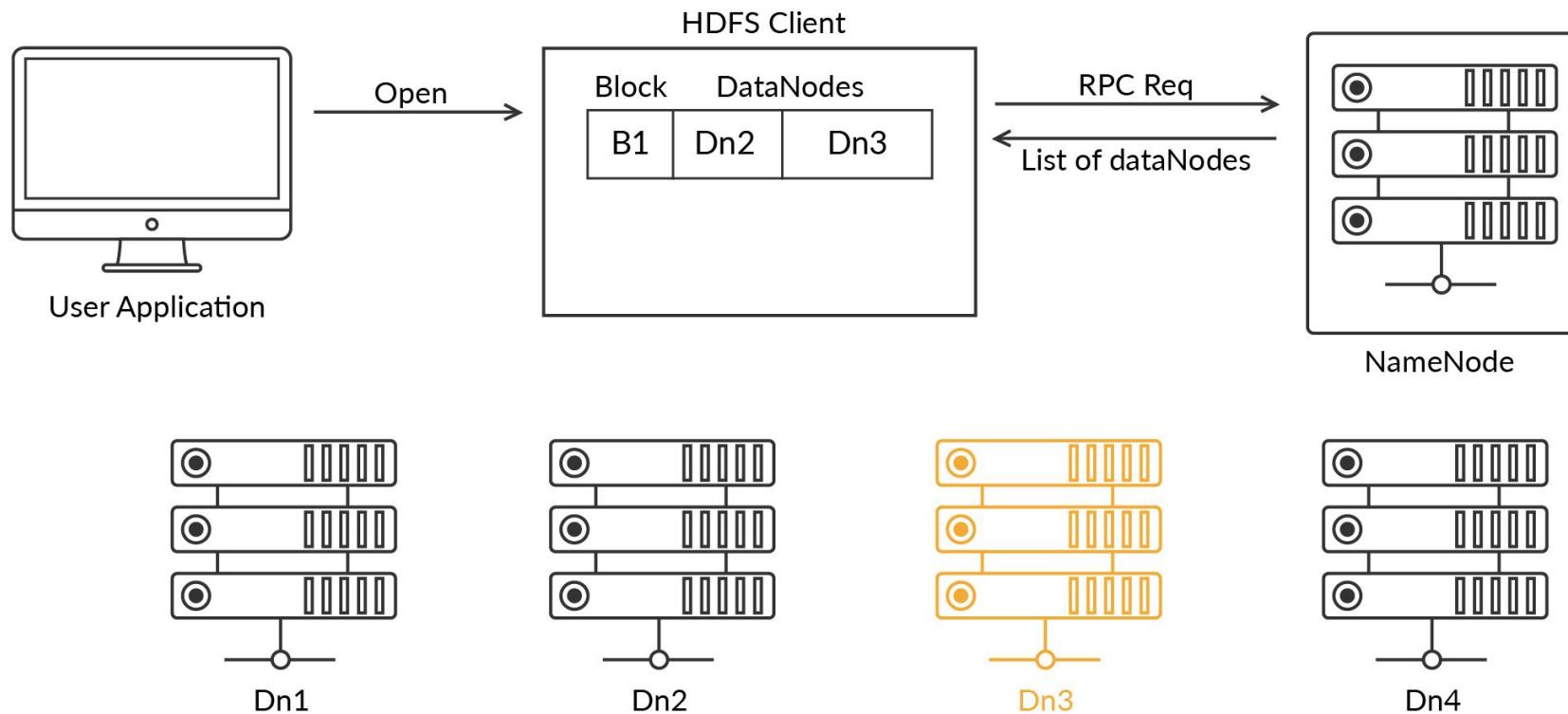
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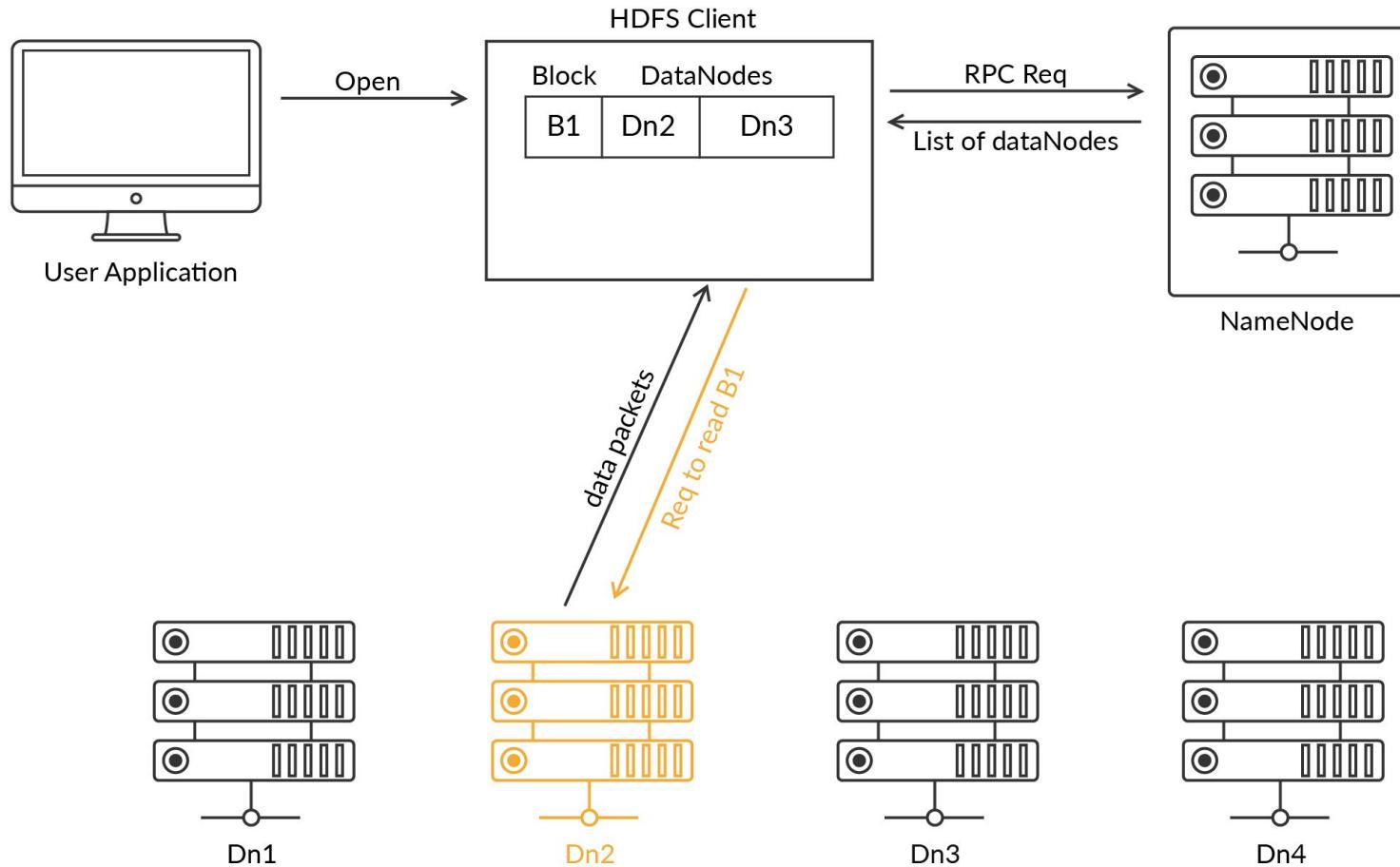
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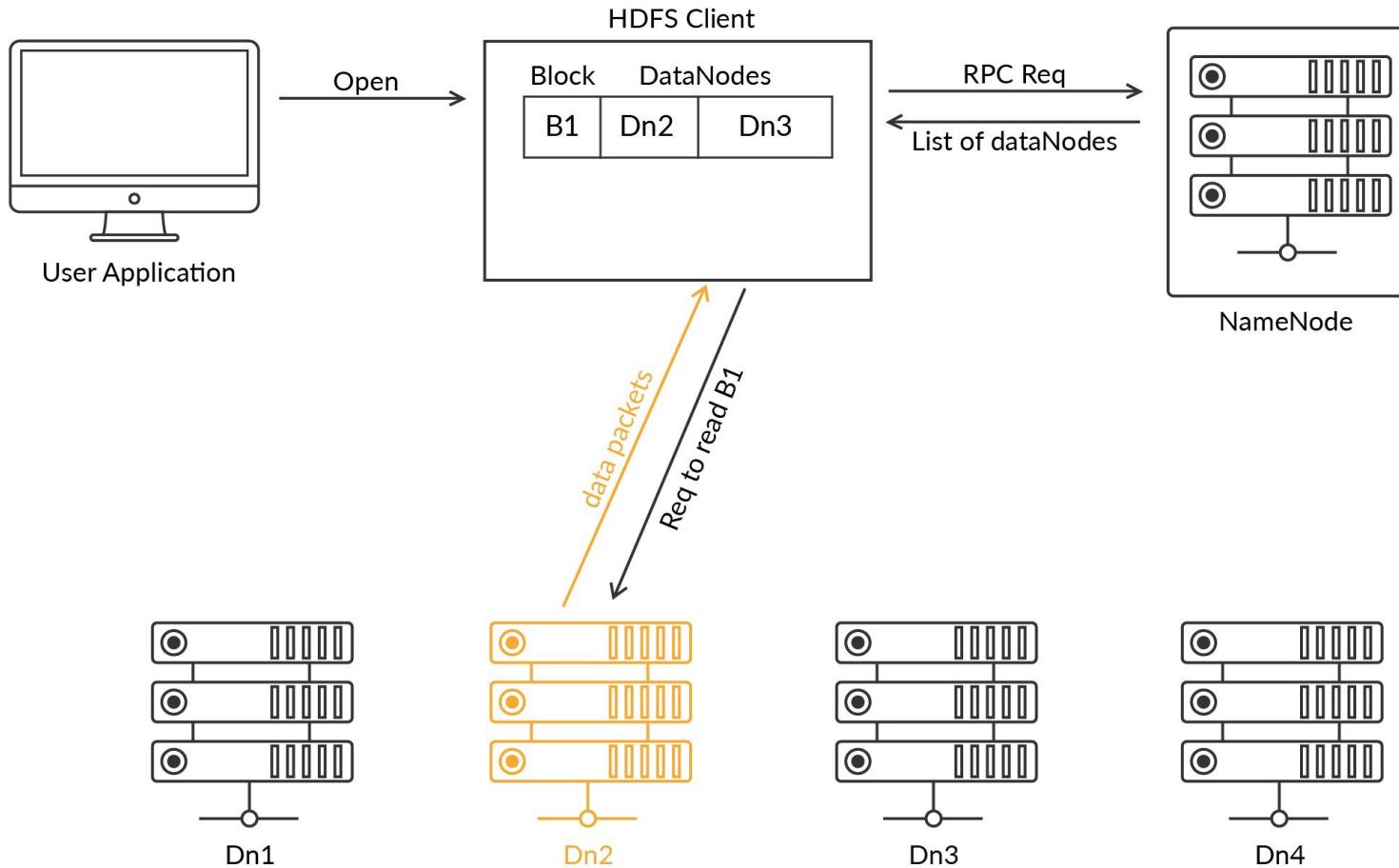
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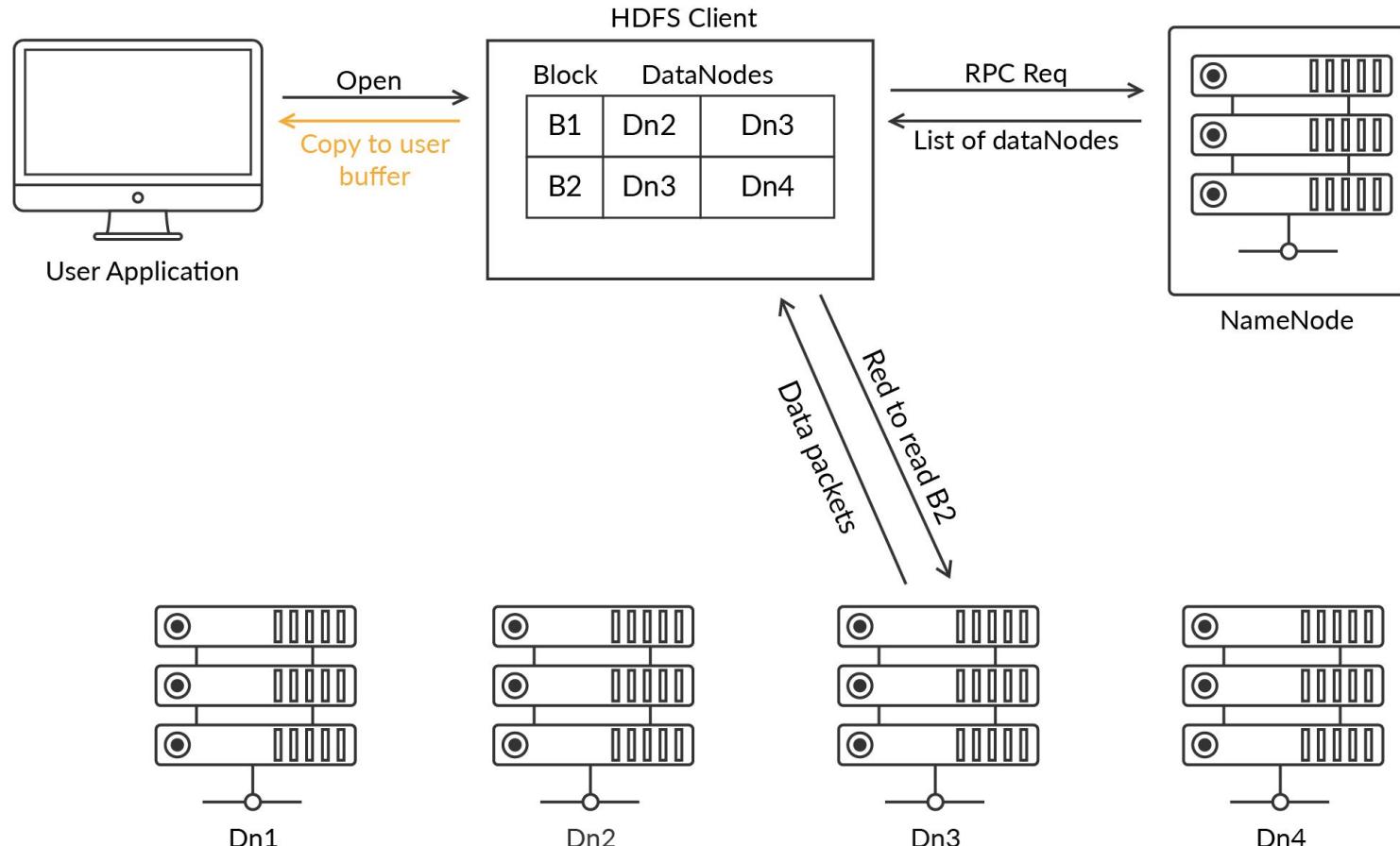
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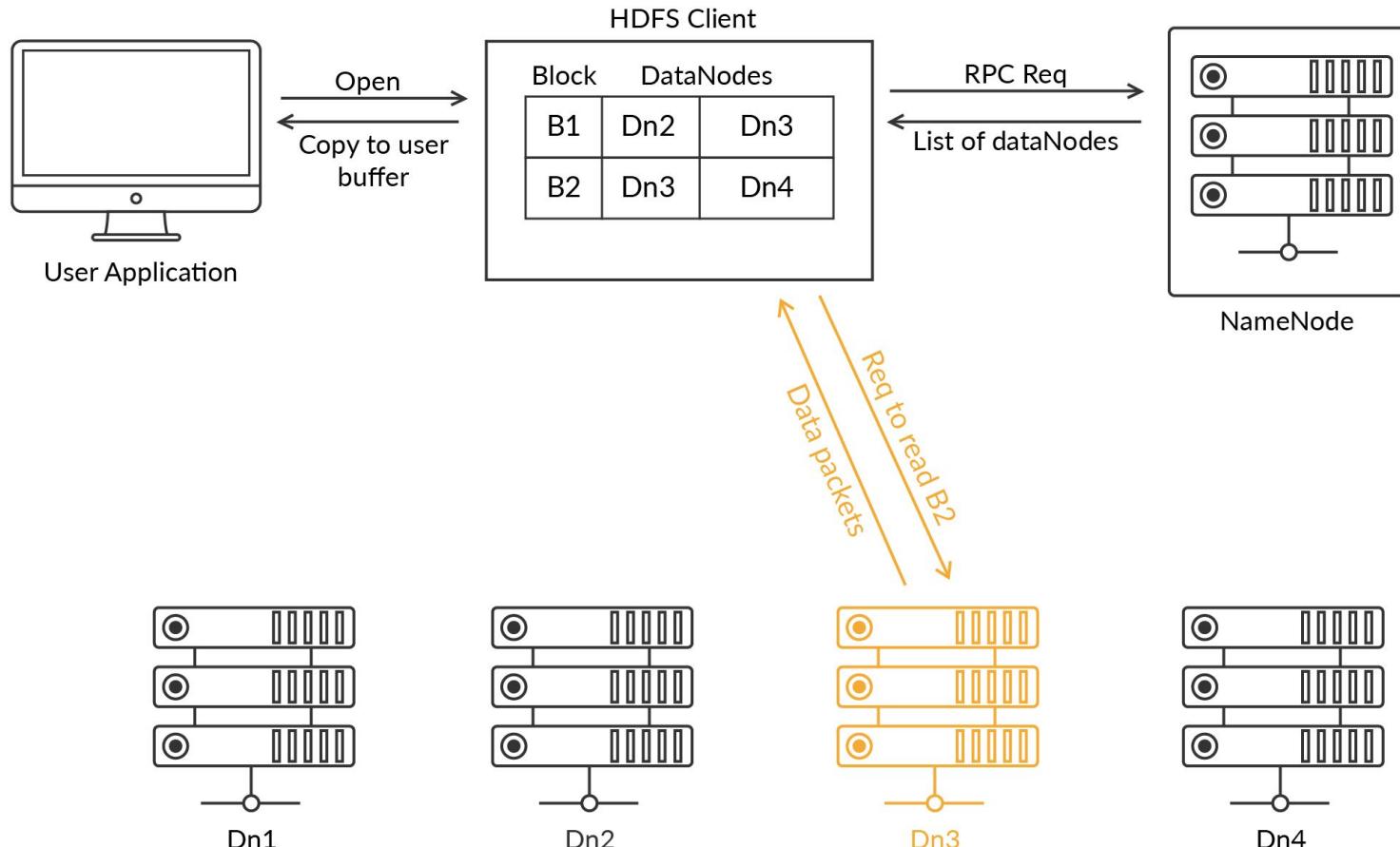
Read Operation in the HDFS



Read Operation in the HDFS



Read Operation in the HDFS



Segment Summary

1

Learnt about the steps performed
in a Read operation

2

Discussed how the components of
the HDFS interact in a Read
operation

Segment - 07

Features and Limitations of the HDFS

Segment Overview

1

Discuss the features of the HDFS

2

Discuss the limitations of the HDFS

Features and Limitations of the HDFS

Features of the HDFS

1. Cost

- a. Can be deployed on commodity hardware
- b. Can easily scale horizontally with low investment

Features and Limitations of the HDFS

Features of the HDFS

1. Cost
2. Variety and Volume
 - a. Allows storing huge volumes of data
 - b. Allows different types of data, structured, semi-structured and unstructured

Features and Limitations of the HDFS

Features of the HDFS

- 1. Cost**
- 2. Variety and Volume**
- 3. Reliability and Fault-Tolerance**
 - a. Can replicate data so that fault tolerance is maintained

Features and Limitations of the HDFS

Features of the HDFS

- 1. Cost**
- 2. Variety and Volume**
- 3. Reliability and Fault Tolerance**
- 4. Data Locality**
 - a. Processing of data is done near the data, instead of moving the data to the processing logic

Features and Limitations of the HDFS

Features of the HDFS

- 1. Cost**
- 2. Variety and Volume**
- 3. Reliability and Fault-Tolerance**
- 4. Data Locality**
- 5. High Throughput**
 - a. Can process data in-parallel

Features and Limitations of the HDFS

Limitations of the HDFS

1. **Latency in data access due to:**
 - a. NameNode interaction
 - b. Sequential data access by DataNodes

Features and Limitations of the HDFS

Limitations of the HDFS

- 1. Latency in data access due to:**
 - a. NameNode interaction
 - b. Sequential data access by DataNodes
- 2. Not suited for storing small files because of the resulting memory overhead on the NameNode**

Features and Limitations of the HDFS

Limitations of the HDFS

- 1. Latency in data access due to:**
 - a. NameNode interaction
 - b. Sequential data access by DataNodes
- 2. Not suited for storing small files because of the resulting memory overhead on the NameNode**
- 3. Once stored, files can only be appended at the end**

Features and Limitations of the HDFS

Limitations of the HDFS

- 1. Latency in data access due to:**
 - a. NameNode interaction
 - b. Sequential data access by DataNodes
- 2. Not suited for storing small files because of the resulting memory overhead on the NameNode**
- 3. Once stored, files can only be appended at the end**
- 4. Does not support parallel write operation on a file**

Segment Summary

1

Discussed the various features
of the HDFS

2

Discussed the various limitations of
the HDFS

Session Summary

1

Discussed how file storage works in HDFS

2

Learnt how to run basic HDFS commands and
how to navigate in HDFS

3

Learnt about the Write operation in HDFS and the
concept of Rack Awareness

4

Learnt how Read operations work in HDFS

5

Discussed the various features and limitations of
HDFS

Thank You