HDFS Architecture

Lesson Objectives

After completing this lesson, students should be able to:

- Present an overview of the Hadoop Distributed File System (HDFS)
- Detail the major architectural components and their interactions
  - NameNode
  - DataNode
  - Clients
- Discuss additional features
- Lab: *Using HDFS Commands*

HDFS Overview

HDFS Components and Interactions

Additional HDFS interactions

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What is HDFS?

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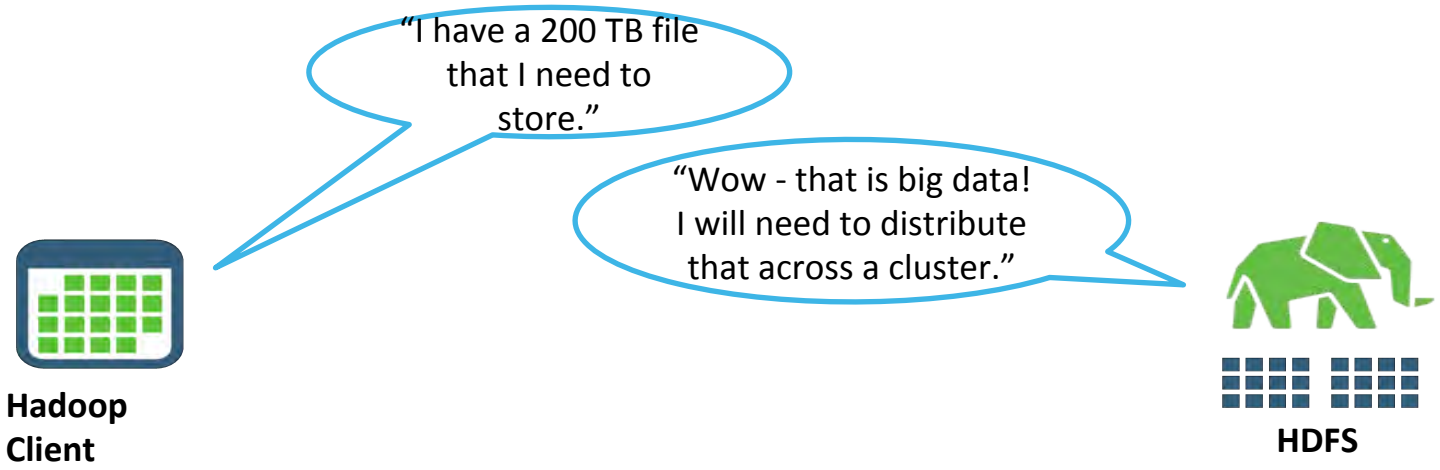

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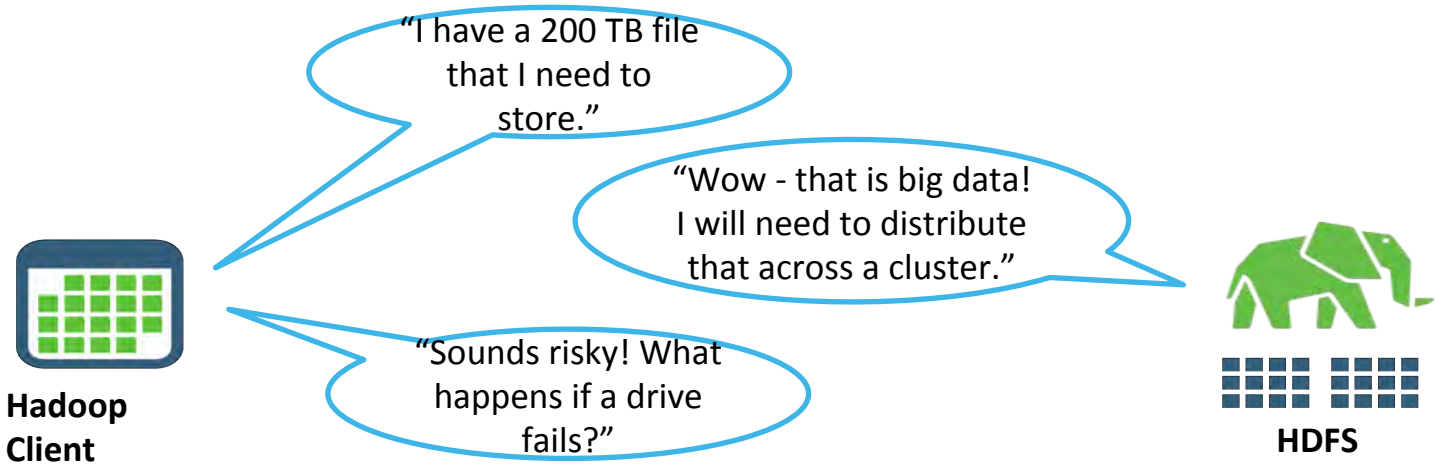

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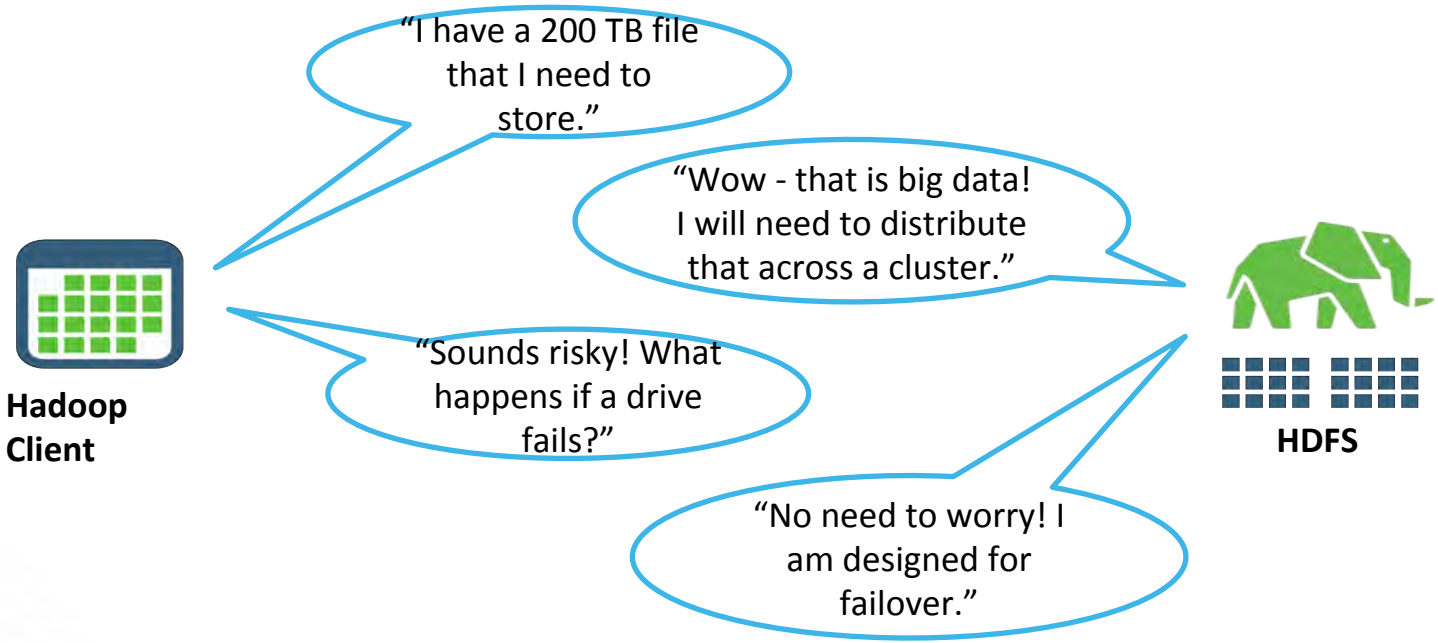
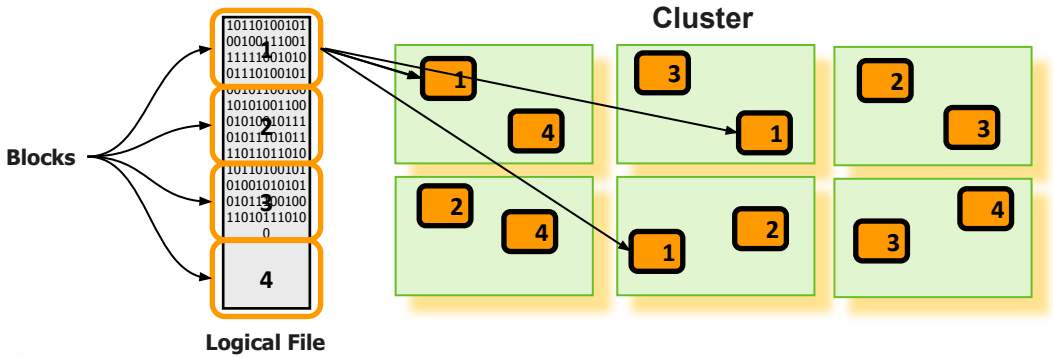


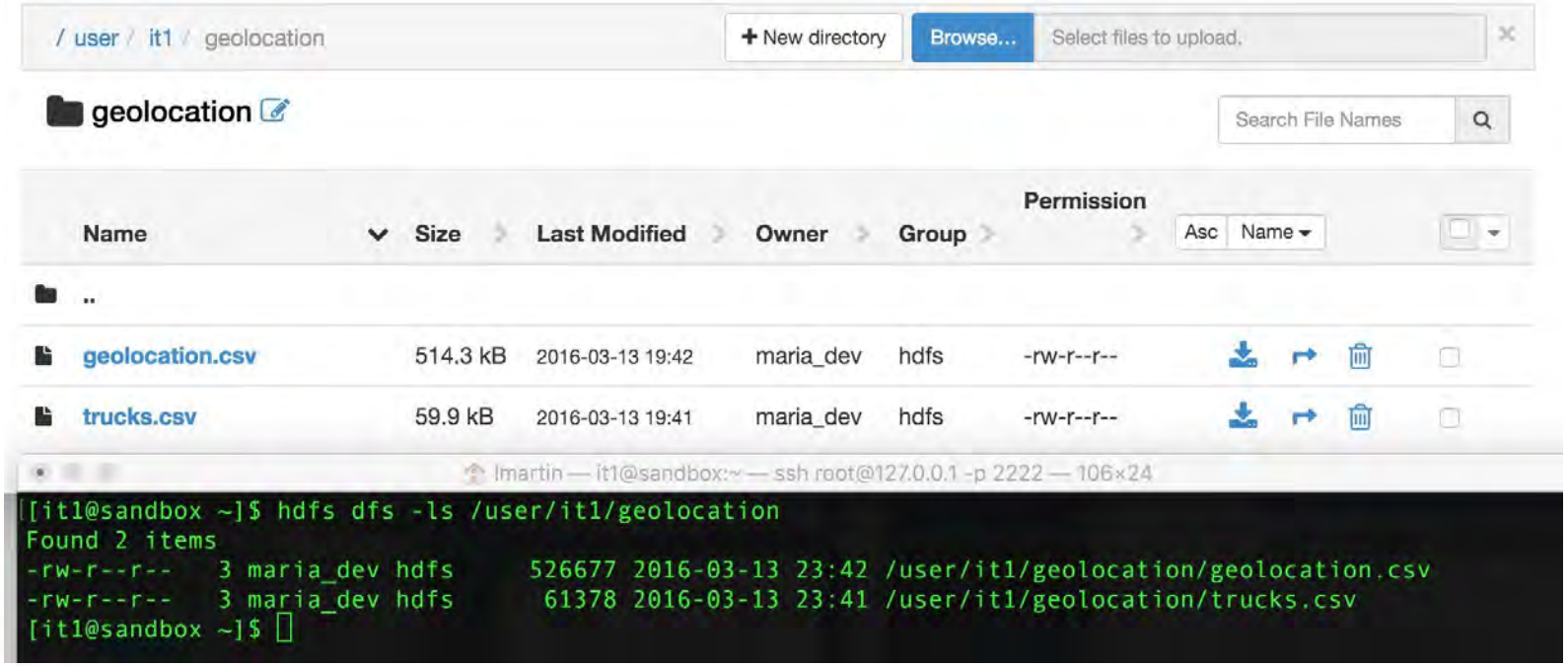
HDFS

Key Ideas

- Write Once, Read Many times (WORM)
- Divide files into big blocks and distribute across the cluster
- Store multiple replicas of each block for reliability
- Programs can ask "where do the pieces of my file live?”



It Looks Like a File System



It Acts Like a File System

```
hdfs dfs -command [args]
```

- A few of the almost 30 HDFS commands:

  `-cat`: display file content (uncompressed)
  `-text`: just like cat but works on compressed files
  `-chgrp`,`-chmod`,`-chown`: changes file permissions
  `-put`,`-get`,`-copyFromLocal`,`-copyToLocal`: copies files from the local file system to the HDFS and vice versa.
  `-ls`, `-ls -R`: list files/directories
  `-mv`,`-moveFromLocal`,`-moveToLocal`: moves files
  `-stat`: statistical info for any given file (block size, number of blocks, file type, etc.)

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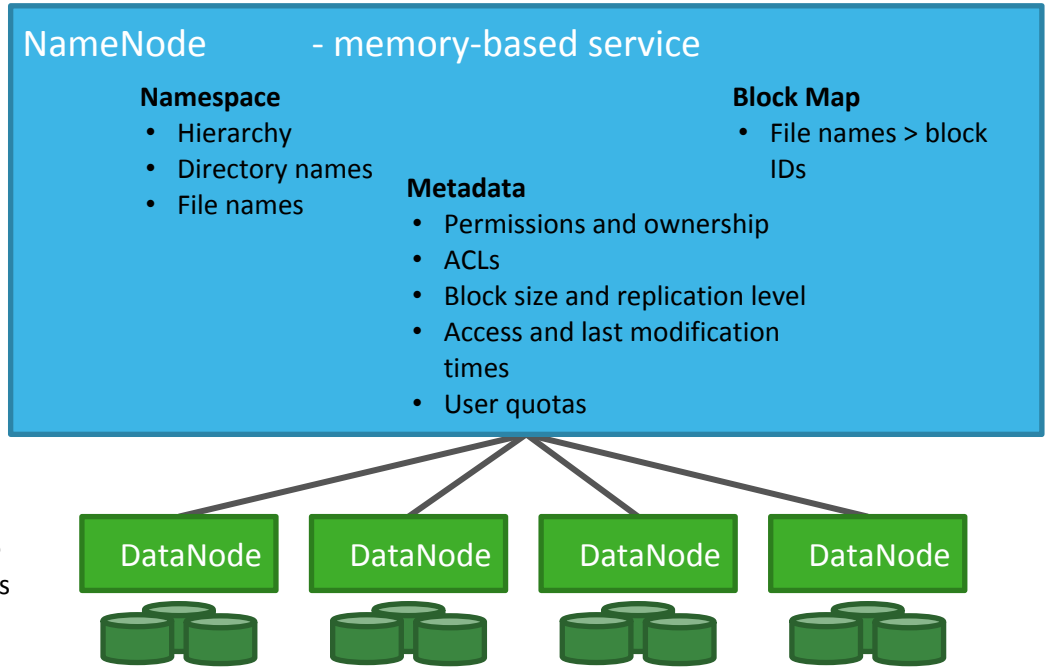
HDFS Components

- **NameNode**
  - Is the master service of HDFS
  - Determines and maintains how the chunks of data are distributed across the DataNodes

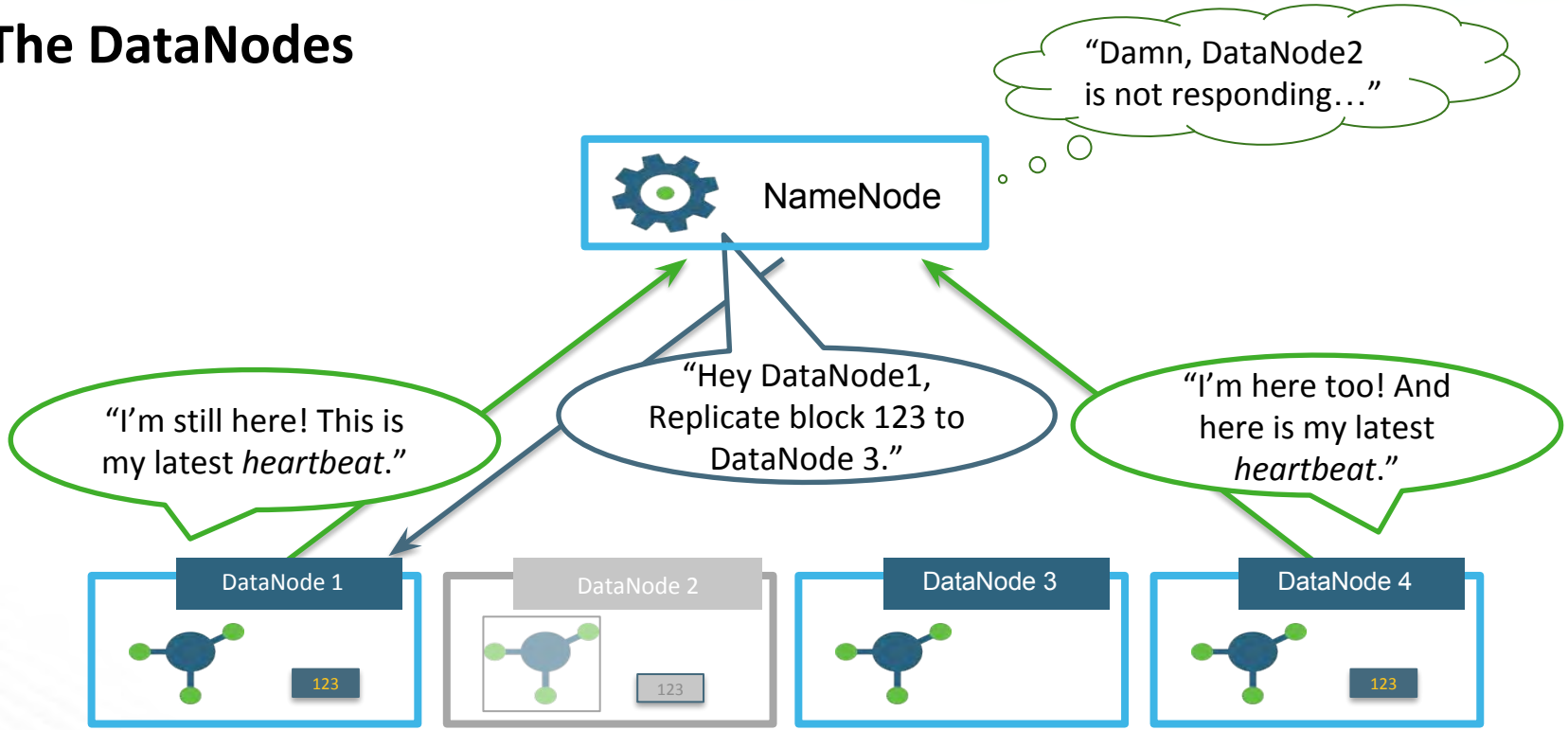
- **DataNode**
  - Stores the chunks of data, and is responsible for replicating the chunks across other DataNodes

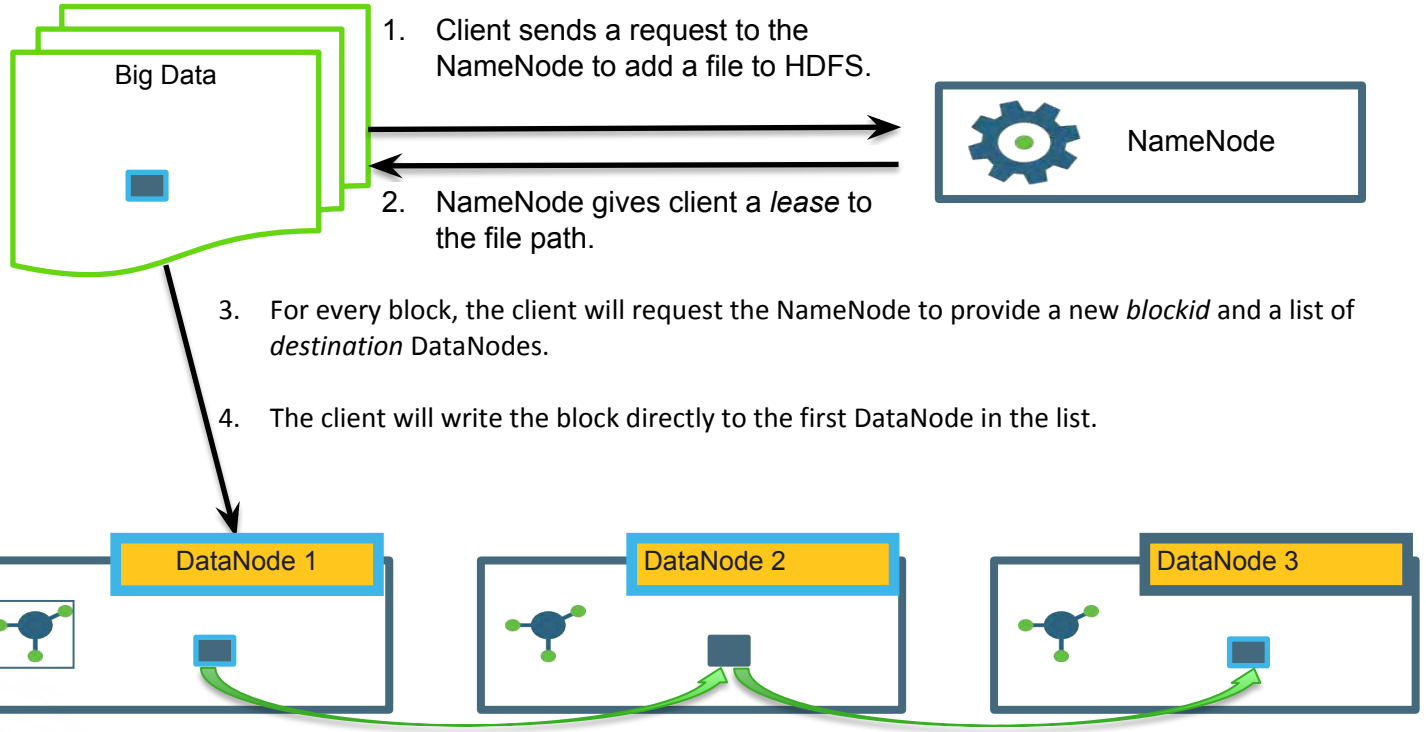
HDFS Architecture

- The NameNode (master node) and DataNodes (worker nodes) are daemons running in a Java virtual machine.



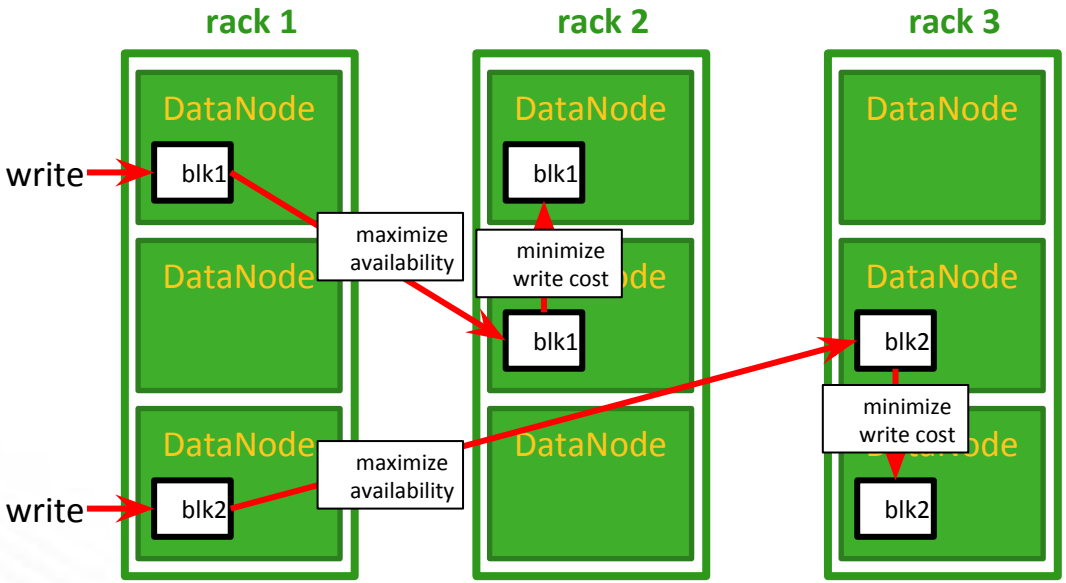
The DataNodes



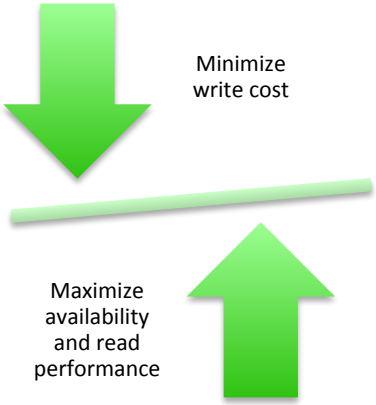


5. The first DataNode pipelines the replication to the next DataNode in the list.

Replication and Block Placement



HDFS is designed to assume, and handle, disk and system failures.



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NameNode High Availability

- The HDFS NameNode is a single point of failure.
  - The entire cluster is unavailable if the NameNode:
    - Fails or becomes unreachable
    - Is stopped to perform maintenance
- NameNode HA:
  - Uses a redundant NameNode
  - Is configured in an Active/Standby configuration
  - Enables fast failover in response to NameNode failure
  - Permits administrator-initiated failover for maintenance
  - Is configured by Ambari

HDFS Multi-Tenant Controls

- **Security**
  - Classic POSIX permissioning (ex: -rwxr-xr--)
  - Extended Access Control Lists (ACL) for richer scenarios
  - Centralized authorization policies and audit available via Ranger plug-in

- **Quotas**
  - Easy to understand data size quotas
  - Additional option for controlling the number of files


Knowledge Check
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Questions

1. HDFS breaks files into _____ and persists multiple _____ across the cluster to aid in the file system's _____ and the to help programs obtain _____.

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2. What is the primary master node service?
3. What is the worker node service?
4. True/False? Clients avoid writing data through the NameNode.
5. True/False? Clients write replica copies directly to each DataNode.

Summary

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- HDFS breaks files into blocks and replicates them for reliability and processing data locality
- The primary components are the master NameNode service and the worker DataNode service
- The NameNode is a memory-based service
- The NameNode automatically takes care of recovery missing and corrupted blocks
- Clients interact with the NameNode to get a list, for each block, of DataNodes to write data to

Demo: Loading Data into HDFS
Or
Lab: Using HDFS Commands

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