

Lecture 2 - HDFS

BDAT 1002

Today's Lecture

- Review
- HDFS details
 - blocks
- Working with HDFS commands

Review - typical interview questions

- What are the three characteristics of Big data?
- The concept of HDFS is based on which proprietary file system?

Review - typical interview questions

- Assume you are asked to re-engineer an online shopping website which is currently using MySQL database server as its backend. The website fetches the data from the database and also insert/delete records in the database. Keeping in mind that users should not see a performance degradation after the re-engineering effort, replacing the MySQL database with core Hadoop based solution is the best strategy?

Review - typical interview questions

- Assume you are asked to re-engineer an online shopping website which is currently using MySQL database server as its backend. The website fetches the data from the database and also insert/delete records in the database. Keeping in mind that users should not see a performance degradation after the re-engineering effort, replacing the MySQL database with core Hadoop based solution is the best strategy?

Review - typical interview questions

- Assume your application receive data from multiple third party systems and your job is to design an ETL solution to consolidate the data received from various systems and analyze the data in the end. Can Hadoop be considered for this solution?

Review - typical interview questions

- Assume you have a database of size 500 GB and the size of the database did not drastically increase over a 6 month period and even the forecast does not indicate a dramatic increase in size in the future. It is best to convert this database (and its dependencies/jobs etc.) in to a Hadoop based solution.

Details of the HDFS File System

File systems

- Have you used any file system before?
 - If you have ever used a computer, you must have!
- But why do we need a file system?

Need for a file system

- Assume you have the following scenario

PILE OF PAPERS VS. BOOK



VS



Major functions of a file system

- Control how data is stored and retrieved
- Metadata about files and folders
 - What is metadata?
- Permissions and security
- Manage storage space efficiently
 - What does this mean?

Popular file systems



Microsoft

FAT32 - 4 GB File limit 32 GB Volume limit
NTFS - 16 EB File limit 16 EB Volume limit

HFS - 2 GB File limit 2 TB Volume limit
HFS+ - 8 EB File limit 8 EB Volume limit



ext3 - 2 TB File limit 32 TB Volume limit
ext4 - 16 TB File limit 1 EB Volume limit
XFS - 8 EB File limit 8 EB Volume limit

How to check for filesystem type?

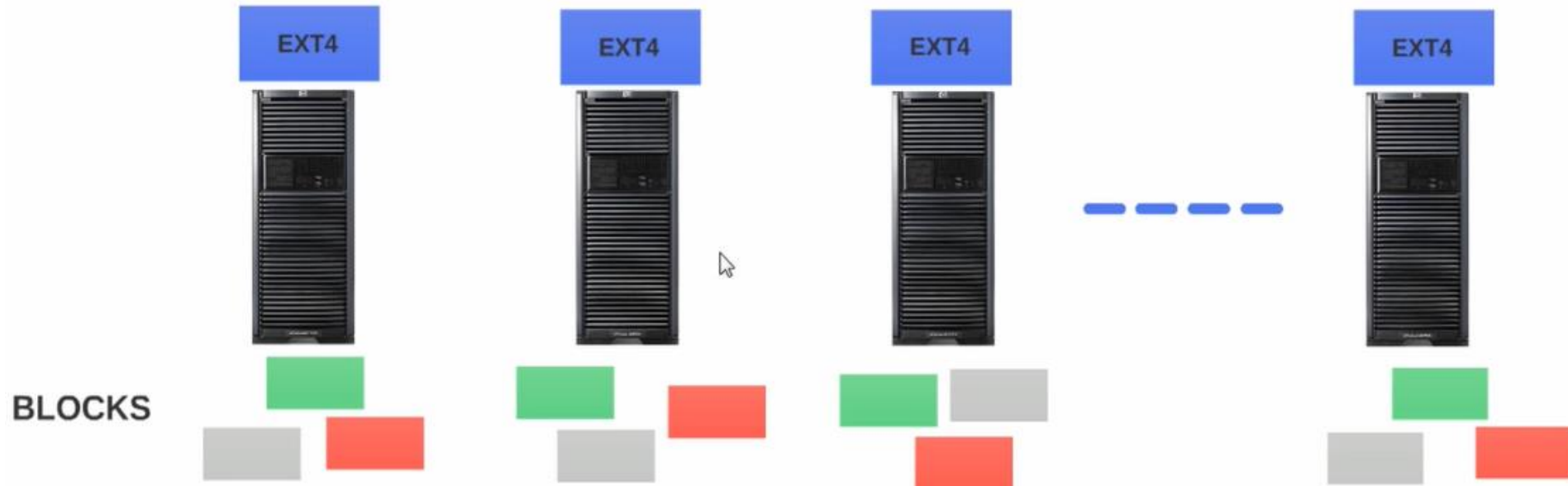
- Windows?
 - Right click and check properties
- Linux
 - Use command `df -T`
- Mac

Need for HDFS

- So clearly we have file systems that can store large files
- So what is the need for HDFS?
- Let's recap what we learned about storing big data
- HDFS will:
 - Sliced data into blocks
 - Replicate blocks into more than one node
 - Keep track of where everything is

HDFS Review

HADOOP DISTRIBUTED FILE SYSTEM



Block Sizes

- Old version of Hadoop 64 MB block size
- New Version 128 MB block sizes
- Default replication for blocks is 3

Interview Question

- Assume you copy a 700 MB file into HDFS what happens?
 - HDFS divides the file into 128 MB blocks → 5
 - One file will be 60 MB
- HDFS decides on where to put the blocks and the replicated versions

Interview Question

- When you have HDFS, what happens to the local files system that is on each node?
 - HDFS is not by any means a replacement for your local file system. Your operating system still relies on the local file system and doesn't care about HDFS
 - HDFS still goes through EXT4 to save the blocks to storage
 - HDFS is placed on top of file system

Summary : Benefits of HDFS

- Supports distributed processing
 - Blocks (not as whole files)
- Handles failures
 - Replicates blocks
- Scalability
 - Able to support future expansion
- Cost Effective
 - Commodity Hardware

HDFS Blocks

Introduction

- What's so special about blocks?
 - A lot going on than meets the eye
- Let's create a text file in Windows (or mac)
 - What size is it?
 - What size does it take on the system? Why?

Windows and block sizes

NTFS

4 KB BLOCK SIZE

FILE SIZE

UNUSED SPACE

2 KB

2 KB

8 KB

0 KB

13 KB

3 KB

Interview Question

- Let's say your block size in HDFS is 256 MB

HDFS

256 MB BLOCK SIZE

FILE SIZE

UNUSED SPACE

1 MB

?



Follow up Question

- How much space is unused?

HDFS

256 MB BLOCK SIZE

FILE SIZE

UNUSED SPACE

1 MB

?

Second Follow up Question

- If HDFS blocks are stored in the local file system, why are HDFS blocks so huge?
 - 128 MB vs 4KB?
 - Why not use 4KB?
- Typical answer: "Hadoop is designed for big data sets"
 - So what?
- Real answer?
 - Large sizes force native OS to save all data in same spot
 - Reads and writes are faster

Third Follow up Question

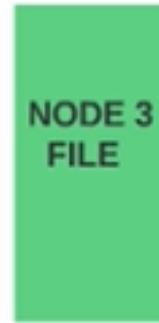
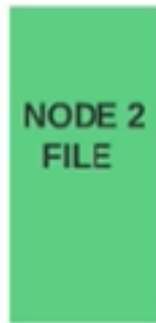
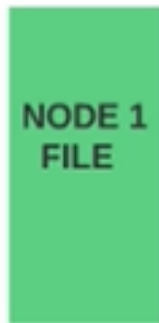
- If storing large files are advantageous in terms of read and write efficiency, why do we have to split the files in blocks at all?
 - Why don't we store the file as a whole?

Third Follow up Question

- By dividing the files into blocks, we can store dataset of any size and not limited to size of the volume of any individual hard disk
 - Ex. NTFS 16 EB, if you have 17 EB then you cannot store the file

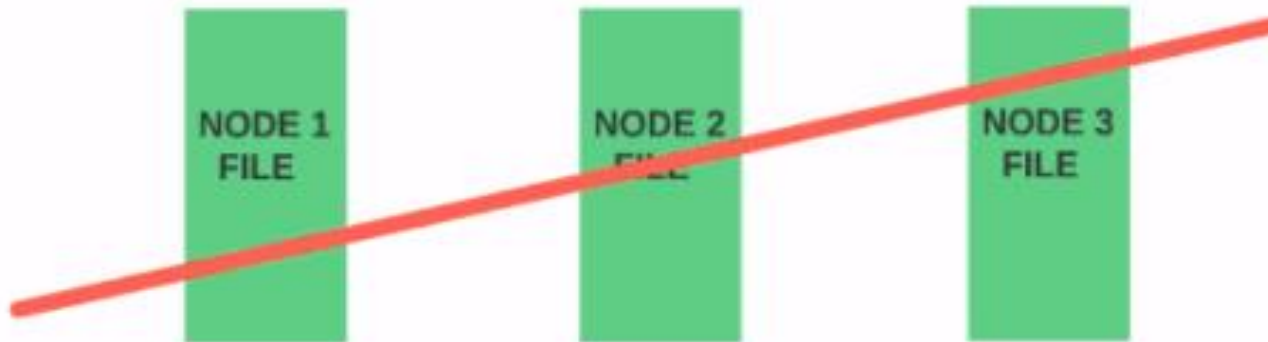
Third Follow up Question

- Replications offers fault tolerance, but more robust with blocks
- Let's say you store the whole file and replicate it three times



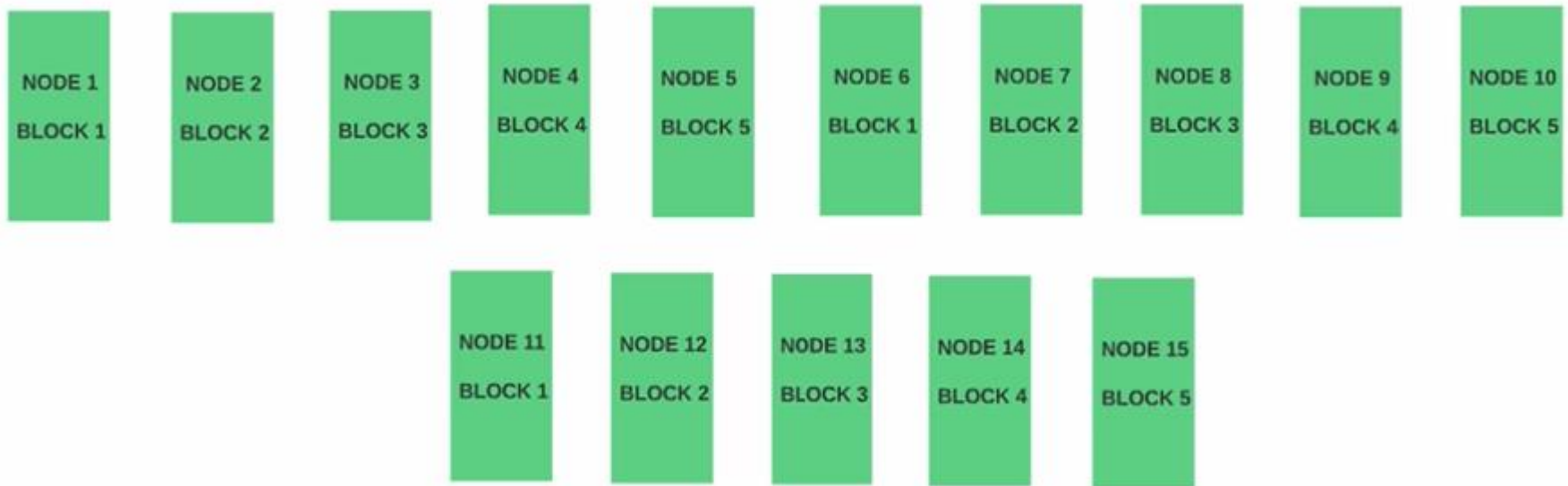
Third Follow up Question

- If all three nodes crash, you will lose the file



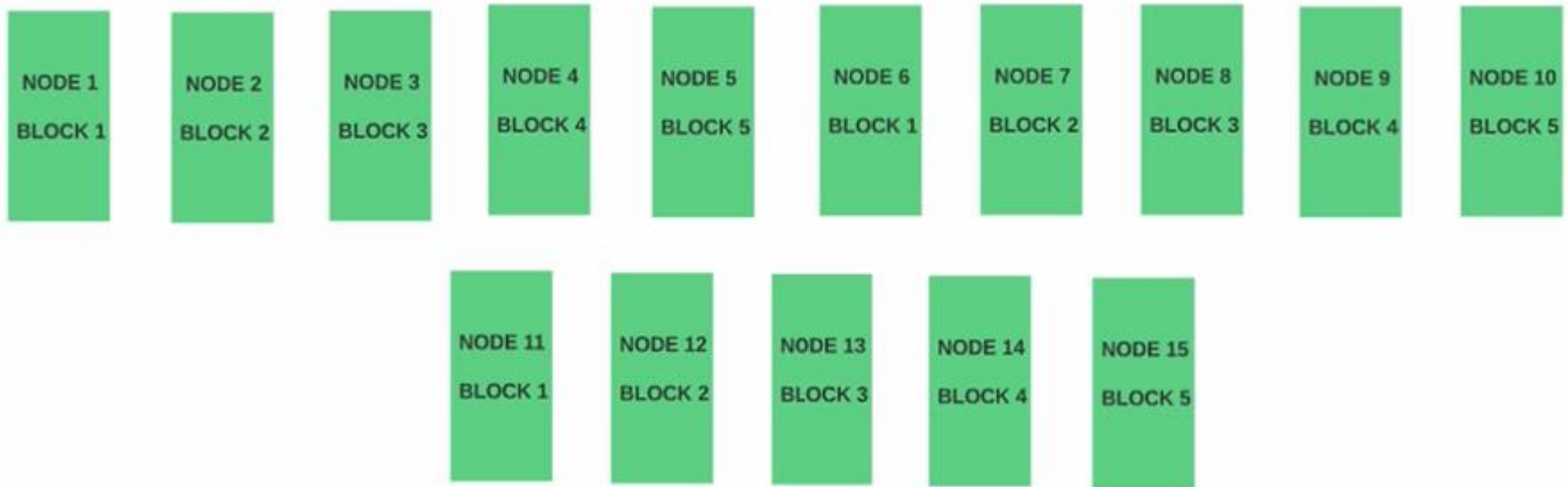
Third Follow up Question

- Now let's say you divide the file into three blocks with a replication factor of three
 - Possibly have up to 15 nodes to save the blocks to



Third Follow up Question

- To physically lose the file, all 15 nodes have to crash
- Less likely than 3 nodes going down at the same time



Summary

- We learned:
 - Why dividing files into blocks is beneficial
 - The difference between blocks in local file systems
 - Advantage of having large block sizes

Hadoop Installation Options

Installing

- Where can we get the Hadoop software?
 - Hadoop is open source
- However, most enterprise production setups used distributions
 - Company that package Hadoop and sell them
 - Cloudera
 - Hortonworks
 - MapR
- Why pay for an open source project?

Cloudera Distribution



Largest customer base

Chief architect - Doug Cutting

Cloudera Manager, Impala

- Found in 2008
- First to commercialize Hadoop
- A lot of the original open source developers now part of cloudera
- Some very notable propriety tools

Hortonworks Distribution

Hortonworks Data Platform

Hadoop on Windows

Partnership with Microsoft Azure



- Big strength is running Hadoop on Windows

MapR Distribution



Distributed Namenode

Google's technology partner

MapR on EMR

- Makes some significant changes to Hadoop architecture

How to choose a distribution?

- Many factors
- Often has to do with your current relationship with other technology vendors
- Cost always key

Cloud service providers

- Assume you have chosen a distribution (or will install something from scratch)
- Where to install?
 - Can either do in-house
 - Or choose a cloud service provider

Available Cloud Services



Why use Cloud Services?

- Running a data centre yourself requires a lot of human and financial resources
- Not always the case
 - If you are a big company like Facebook
 - Long term financial benefits offset short term
- Sometimes there is legal issues
 - Example banks, hospitals
 - Can't send your data "out" to the cloud

Amazon Web Services

- Very popular
 - Netflix, reddit, yelp
 - Very competitive pricing (cheap!)
- We will use AWS later in the term

Reviewing Linux Commands

Approach

- General structure of a command

command [-option(s)] [argument(s)]

- Command does not have to have options or arguments

sudo

- Super user do

ls

- List
- Used to get information on directory
- Sometimes we want to get detailed information about a direction

ls -l

- Sometimes we want human readable information

ls -lh

cd

- Change directory
- Can use "tab" to finish up what you are writing

cp

- Copy

cp source_file destination_folder

rm

- Remove

```
rm myfile.txt
```

- Remove a directory

```
rm -r directory/
```

Apt-get

- to install, remove and upgrade any package we have Advanced Packaging Tool (APT) package manager.

`sudo apt-get update`

whereis

- You want to execute a command but you don't know where it is located. `rm myfile.txt`

whereis hdf5

cat

- Concatenate
- Show a snippet of a file

cat alice.txt

gedit

- A text editor
- Many others

gedit alice.txt

chmod

- Change permission on file, folder
- Permission are owner, group, everyone else

If you need help on a command

- Use `man` or `help`

HDFS commands

Motivation

- We have a good idea about Hadoop and can now look at some HDFS commands
- We will look at the architecture of HDFS later
- We will emphasize how HDFS is different from the local file system

HDFS Review

HADOOP DISTRIBUTED FILE SYSTEM

