

Date : _____

Small Data (RDBMS)

MOSTLY STRUCTURED

STORE IN MB, GB, TB

SPEED INCREASES GRADUALLY
(Moderate)

LOCALLY PRESENT CENTRALIZED

SQL SERVER, ORACLE

SINGLE NODE
(One server)

Big Data

MOSTLY UNSTRUCTURED

STORE IN PB, EB (4PB)
fb generates

INCREASES EXPONENTIALLY ↑

GLOBALLY PRESENT, DISTRIBUTED

→ HADOOP, SPARK

→ MULTINODE CLUSTER
(facebook has more than
80,000 servers)

In 1990's American Scientist John R Mashey
father of Big Data.

In 2005 Roger芒属 Moughalas from O'Reilly media
coined the term Big Data for the first time.

Hadoop started with Doug Cutting & Mike Cafarella in year 2002

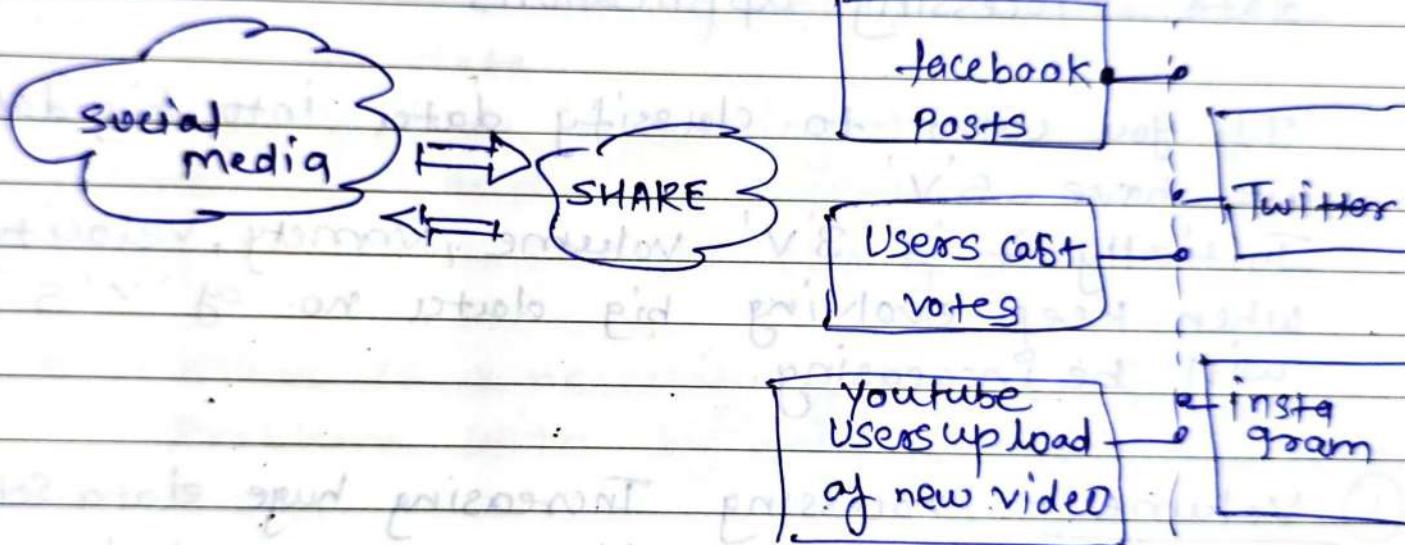
Date: 10/7/2023

Hadoop is framework, it sets the foundation for big data, where we can store process & then analyze that data.

Data is generated through every seconds.

Data is converted into big data due to enhancement in technology

Data generated every, 60 seconds



Big data growth exponentially.

For example, one room temperature sensor which adjust ac temperature, refrigerator temperature automatically based on room temperature. For this we require millions of sensor at particular time interval they transmit the data in that case huge amount of data collected which helps in growth of big data exponentially.

Date :
Petabytes 10^{18} (1000 of TB)
Exabytes 10^{18} (1000 of PB)
Zettabytes 10^{18} (1000 of EB)

unlimited data & shared plans
plan contain calling, messaging & data.

what is Big data

Big data is the term for a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications.

If you want to classify data into big data we have '3V'

Initially it is '3V' volume, variety, velocity when keep evolving big data no. of 'V's will be increasing.

① Volume :- Processing Increasing huge data sets.
Processing different types of data.

② Variety - Data present in various format.

structured data present in row, column format stored in table, various relation in table. RDBMS, MySQL, ORACLE

unstructured data audio, video, continuous streaming data, which can not convert in structured format. It is very complex to convert also.

Semi structured data ^{partial organize separated data} Comma, ^{structured} values, tab separated values. XML, JSON file parse converted into structured format

Date : _____

③ Velocity :- Data is being generated at an alarming rate.

Data generated exponentially.

④ Value :- Finding correct meaning out of the data see the big data as opportunity organisation find some meaningful insights based on that we you can make decisions, to make benefits for organisation. ^{actionable items}

⑤ Variety :- uncertainty and inconsistencies in the data.

Variety of data is coming there can be inconsistent data, or uncertainty (values are missing, there can be wrong data).

Why there is a necessity of big data?

Problems with big data & traditional system with story.

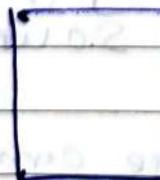
Bob has opened a small restaurant in the city.

Traditional scenario.
2 orders per hour

Traditional Data Processing system
Data is generated at a steady rate & is structured in nature



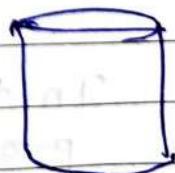
Single look



food
shelf



Traditional processing system

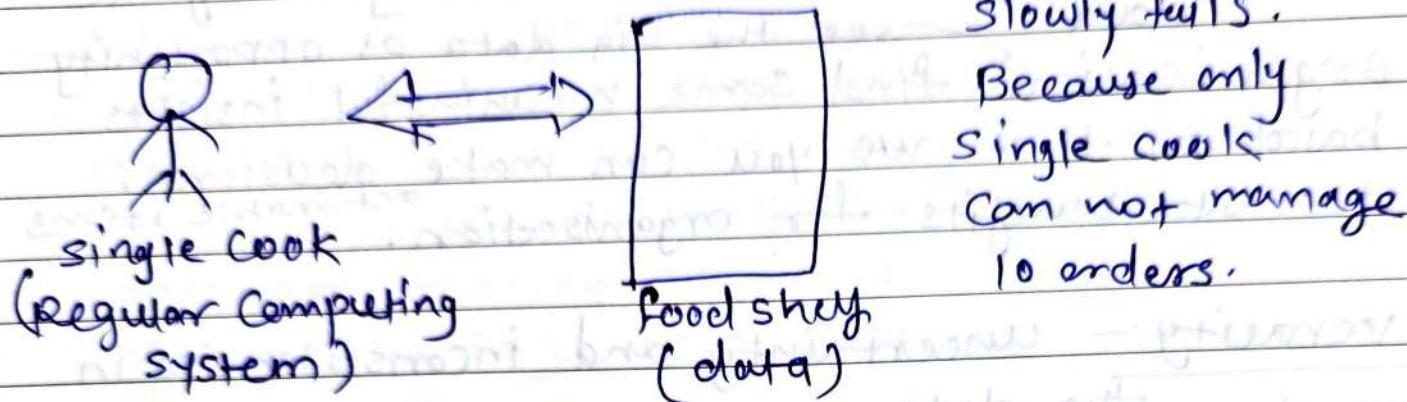


RDBMS
(MySQL
Oracle)

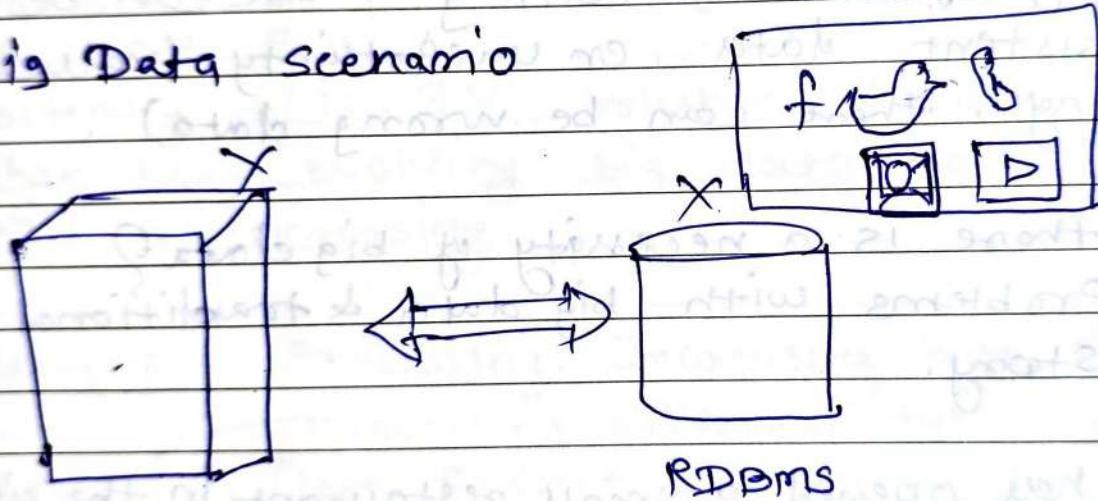
Date :

Failure of Traditional system

They started taking online orders
10 orders per hour



Big Data scenario



Traditional Processing system

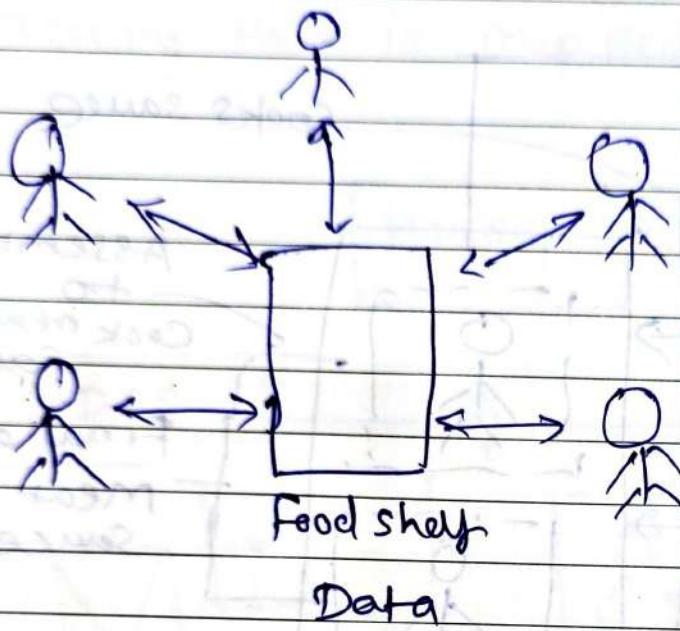
Heterogeneous data is being generated at an alarming rate by multiple sources.

In this storing of large amount data is problem as well as traditional system can not handle structured, unstructured, semistructured data.

Date : _____

Issue — Too many orders per hour
Solution — Hiring multiple cooks.

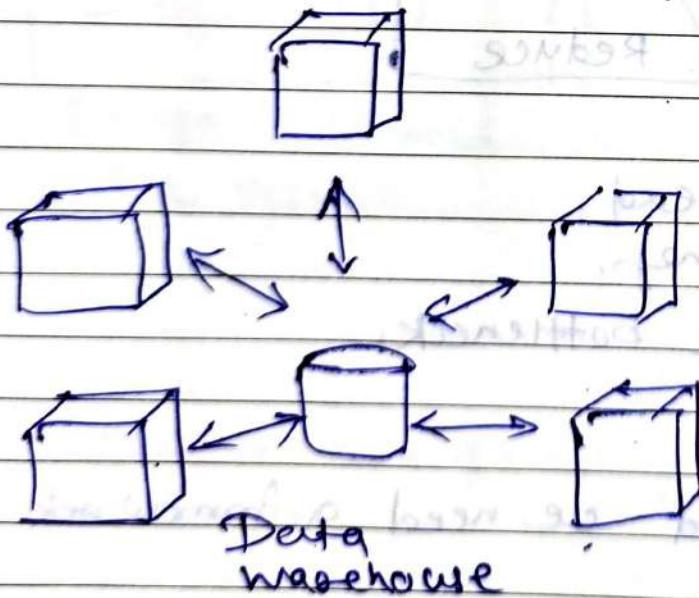
Need of an effective solution.



Scenario:
multiple cook
cooking food.

issue
Food shelf becomes
bottleneck
spices containers
limited

Issue in Traditional system



Scenario

multiple processing unit
for data processing

issue:
Bringing data to
processing generated
lot of N/W overhead.
(R/w overhead)

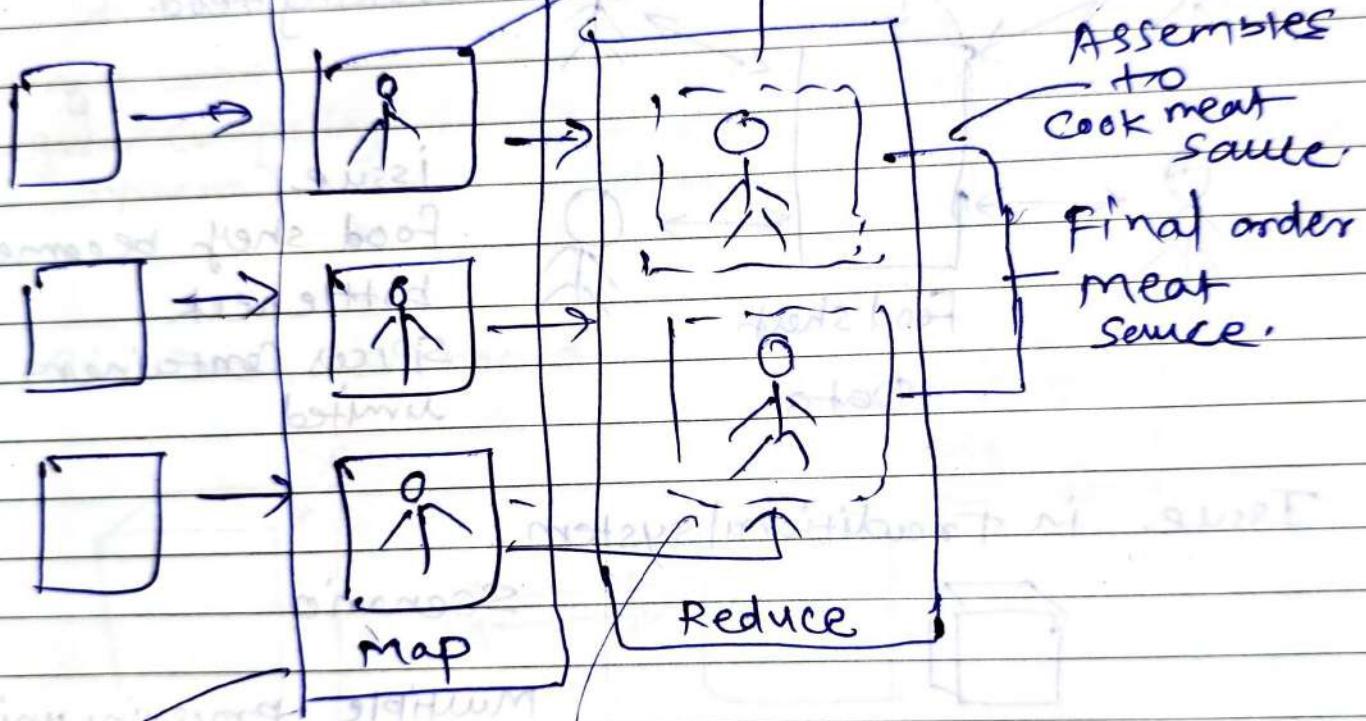
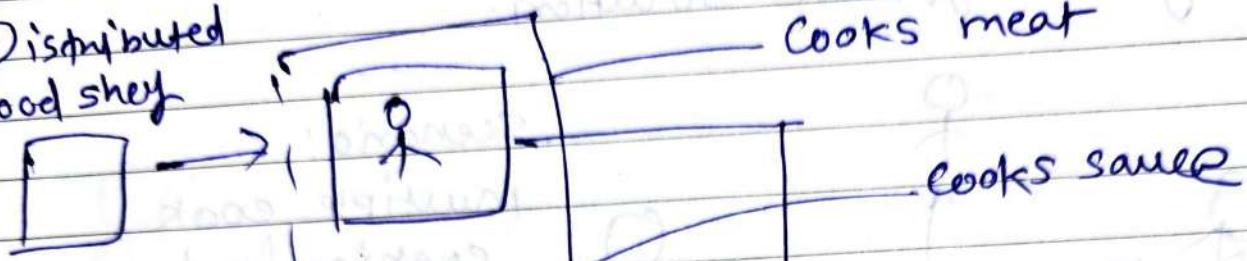
Data base becomes
bottleneck

Date:

Issue 2:

Foodchef becomes the bottleneck
solution: Distributed & parallel approach.

Distributed
Foodchef



Junior
chef

(head)
chef.

Foodchef will not be bottleneck.

Similarly for big data we need a framework.

Apache Hadoop framework to process big data

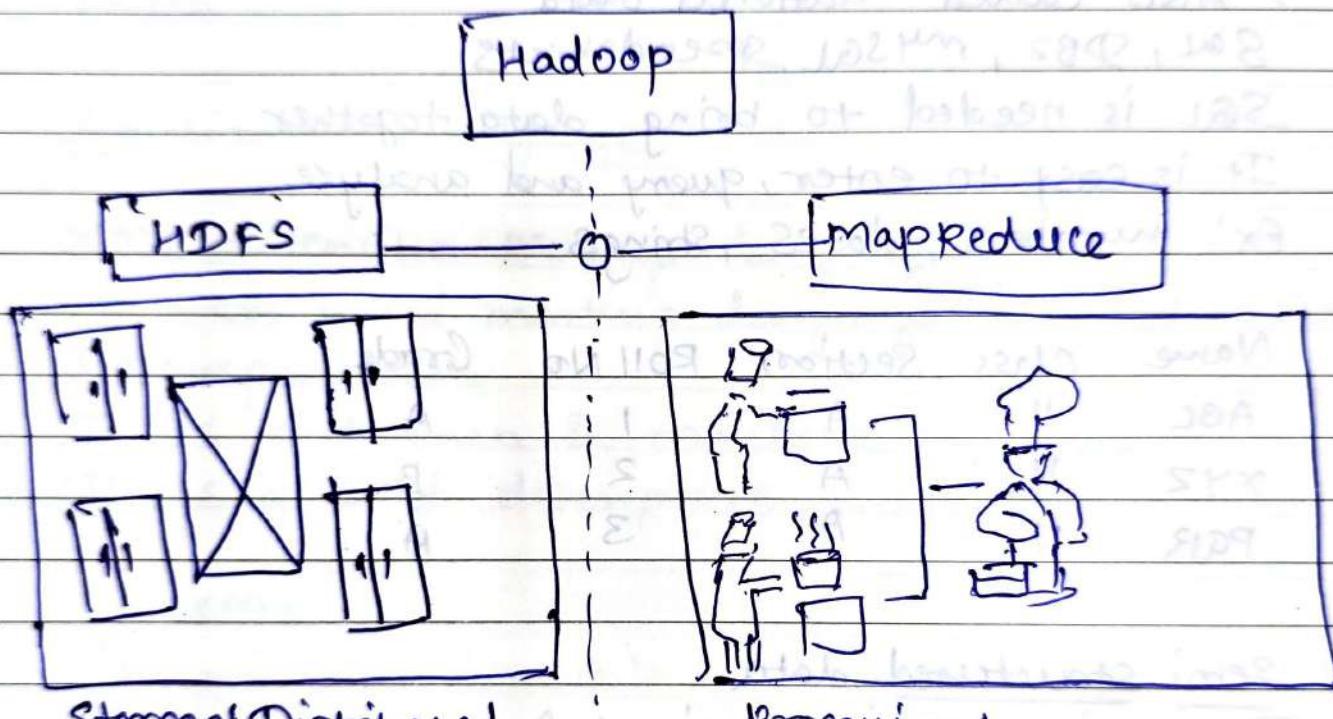
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"Hadoop is a framework in which data can be stored in distributed & parallelly process the data"

Storage part is HDFS

Hadoop distributed file system

Processing part is Map Reduce



Storage! Distributed
file system

Processing!
Allows parallel &
distributed processing.

Cluster is a group of machines.

Date : _____

~~Hadoop~~ Master Slave Architecture -

Types of Big data

① Structured Data

→ Data that resides in a fixed field within a record.

→ Also called relational data
SQL, DB2, MySQL, spreadsheets

SQL is needed to bring data together

It is easy to enter, query and analyze

Ex: numbers, dates, strings.

Name	Class	Section	Roll No	Grade
ABC	II	A	1	A
XYZ	II	A	2	B
PQR	II	A	3	A

② Semi structured data

→ Data is not in relational format

→ Does not need SQL commonly called NoSQL

→ Data Serialization language used to exchange semi structured data across systems.

→ Semi structured is often used to store metadata about business process but it can also include file containing machine instruction for computer programs.

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Data comes from external sources such as social media platforms or other web based data feeds

→ Data is created in plain text format

S/w developers use serialization languages to write memory based data in files, transit, store, & parse

Serialization language

XML extensible Markup language.

→ text based markup language designed to store & transport data.

It is a human & machine readable.

It is a self descriptive

XML

<ProgrammerDetails>

<FirstName> James </FirstName>

<LastName> Smith </LastName>

<codingPlatforms>

<codingPlatform Type="Fav"> Code4Eva </codingPlatform>

<codingPlatform Type="2ndFav"> CodeisLife </codingPlatform>

</codingPlatforms>

</ProgrammerDetails>

XML expresses data using tags (text within angular brackets) to shape the data (Ex FirstName) & attributes (Ex: Type) to feature the data.

Date : _____

JSON (Javascript object Notation)

- lightweight open standard file format for data interchange.
- It is easy to use & uses human/machine readable text to store & transmit data objects.

Javascript

{

```
"FirstName": "John",
"LastName": "Smith",
"CodingPlatforms": [
    {"type": "Fav", "value": "code4eva"},
    {"type": "2ndFav", "value": "codeislife"}]
```

}

It is a key/value pair model than a formal data depiction

YAML Yet another Markup Language

YAML Example

Employee Record

Empl:

name: Mary Jacobs

job: Developer

Skills:

- Java

- Go

- Rust

Emp2:

name: Jane Doe

job: QA

Skills:

- Manual

- Automated.

Date : _____

Suppose multiple values are to be loaded in specific data structure as mentioned below

eggs

ham

spam

basil

When you load this into YAML the values are taken in array data structure which is a form of list

```
>>> yaml.load ('''
```

```
- eggs
```

```
- ham
```

```
- spam
```

```
- basil
```

```
''' )
```

```
[ 'eggs', 'ham', 'spam', 'basil' ]
```

```
firstName: Jane  
lastName: Doe  
CodingPlatforms:  
- type: fav  
  value: Code4Eva!  
- type: 2ndFav  
  value: Codeislife
```

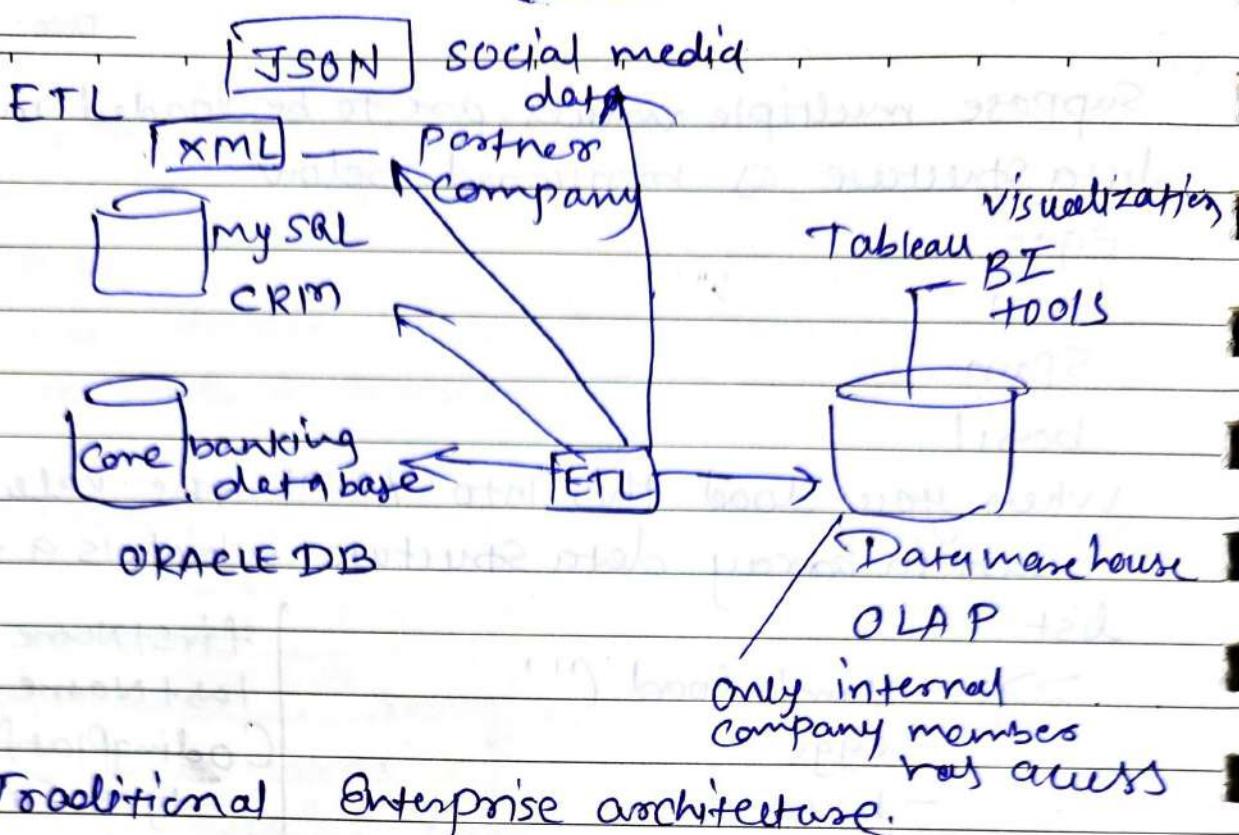
It is portable between programming languages
Easily readable by humans.

③ Unstructured (also called as Dark data)

Photos, videos, text documents, & log files can be generally considered unstructured data

Extract Transform Load

Date : _____



ICICI collect data from fileback page of ICICI in the JSON format

Customer care

Bank is collecting data in log files (generally text)
Ex chat logs, call history, call record

- marking Complaint

The above data is in separate places.

If we want to analyze data we collect all these data (SBI, oracle, JSON, XML) put in one place called datawarehouse

Datawarehouse not solve Customer queries as they don't have Customer interaction.

So we have ETL tools - (Pentaphobia)

(as different types of data work together)

Challenges phase face. (ETL tool typically run on single)

→ ETL tool has limitation how much amount of data can be pulled (TB, PB, EB, ZB)

→ No real time,

nonreal time something

can be run at

ETL tools are talend, alooma, informatica,
ORACLE, Pentaho

Date:

setup

→ Datawarehouse is very costly.

Realtime any type of data can be integrate
cheaper
Scalable

Alternate solution

MPP - Massive parallel Processing

If datawarehouse is very slow then use parallel processing on diff. machine we can not divide table logically apply join query.

They wanted to go for better Solution.

Hadoop came into 2005

on top of hadoop is a mapreduce

Hive is a datawarehouse

program written in java

SPARK also uses
Some concept of
mapreduce

Hadoop is a open source project
many of types of bugs are coming
one man can't solve the problem.
by using apache

Cloudera Company which gives hadoop if these
problem they will fix it the problem.

Sell hadoop, spark.

Cloudera product for free, or with support
will get technical support by paying.

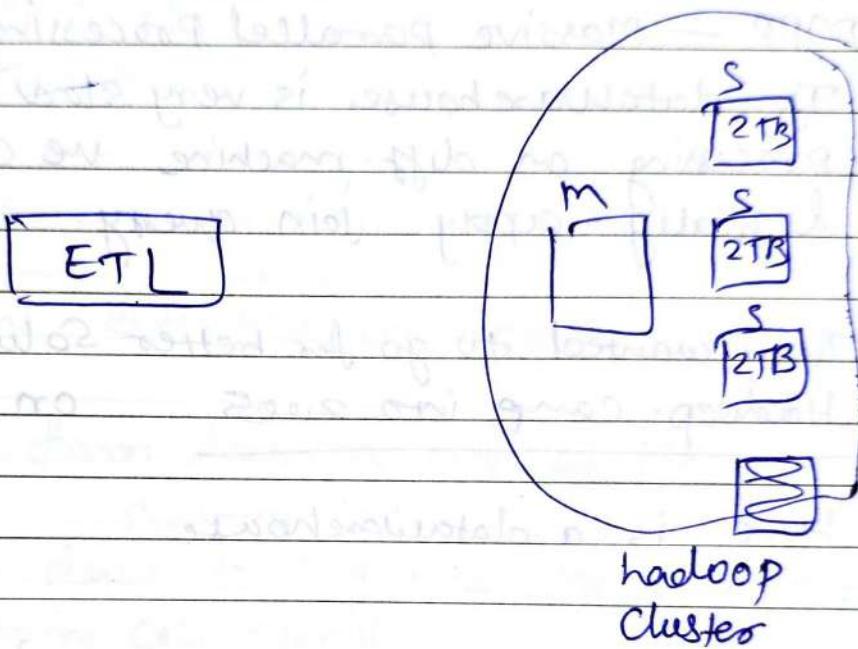
MAPR (vendor)

Hadoop is a batch processing system

Date : _____

Every Company has their big data & hadoop platform

Rather one machine you take a bunch of machine
After downloading Cloudera it will ask for
which machine is master & which is slave



Hadoop is a framework or provider Platform.
Combine 2TB of 3 machine & combines the
storage (as 6TB) you keep on adding machine
if u want to store more data called as hadoop
cluster.

$$1000 \text{ TB} = 1 \text{ PB}$$

This architecture is called scaling out.

This called hadoops cluster

Each node 256 GB RAM & 100TB storage , we
have 50 machines = $50 \times 100 = 5 \text{ PB}$

Hadoop is installed in all machine.

Commodity HW - any machine without any label.

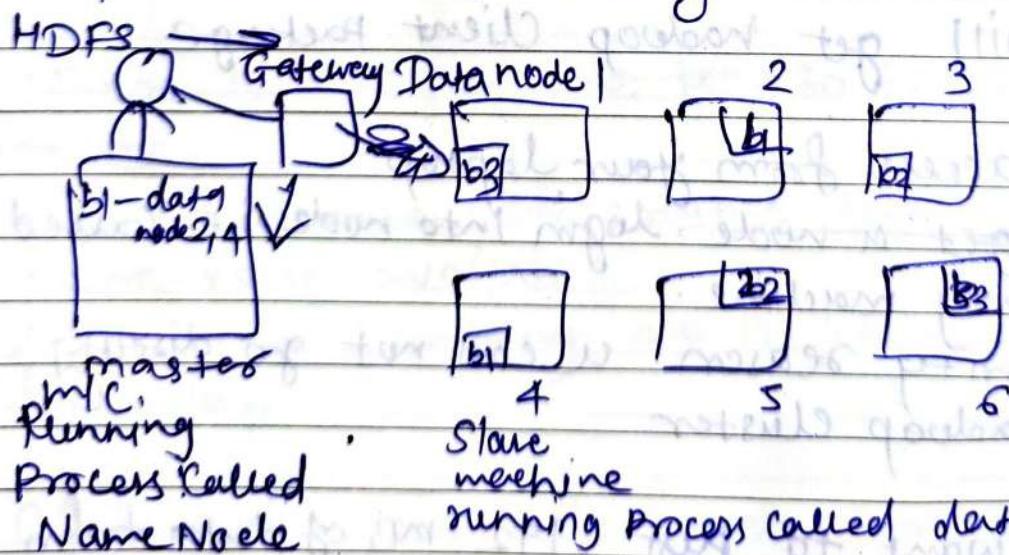
Let's say if you are buying some 500 servers. Cost of each server very high ie the reason we called that machines commodity HW. We will never buy dell server, build with cheap throwaway servers.
(But should be these)

In typically hadoop cluster we use commodity HW or (assemble server)
we cannot use IBM server (high cost)

How failures can be handled in hadoop cluster.

Hadoop has 3 major Components.

- HDFS → Storage file system.
- YARN → Resource Manager
- mapReduce → Processing.



If we want store the file in hadoop cluster, hadoop. You can store the file in any format.

Date :

if u are storing while processing text file in map reduce once you store the file it can not be edited otherwise deleted (you store it & delete it) on the file system editing is not possible append it.

Read the file in sequentially.
there is a sequential access.

On the file system editing is not possible.

(In helps analysis system minute edit not possible)

You can delete & restore the file

(Aggregate query can be used
Select cannot be used, we can load whole data for processing only one line why should I load whole data)

In real time System - if we want to connect hadoop Hadoop cluster is somewhere else So we will get hadoop Client package.

- ① U can access from your laptop
- ② U can get a node, login into node i.e. called as gateway machine.
for security reason U can not go directly into hadoop cluster

If we want to put 192 MB of data from your machine U will connect to Gateway machine, execute commands & connect to hadoop cluster & upload data

Gateway has hadoop client installed.

Date : _____

When u upload a data, data is chopped into & stored in a hard disk, whole data is not stored at a time.

Assume that ur Name node has blocksize of 64MB so file 192MB divided into 3 blocks.

Name node will say I have 64MB of blocksize to store the data. Name node will say hadoop client you divide the ~~the~~ the data. Name node has Commⁿ with all data nodes.

Now data is divided into 3 blocks stored on 3 machines.

Each block is replicated 3 machines.

The purpose of name node is used to store metadata or index. If namenode crashes you cannot access cluster.

3 files

b1 - 3, 2, 6

There is a active node is also passive node is ^{name} these.

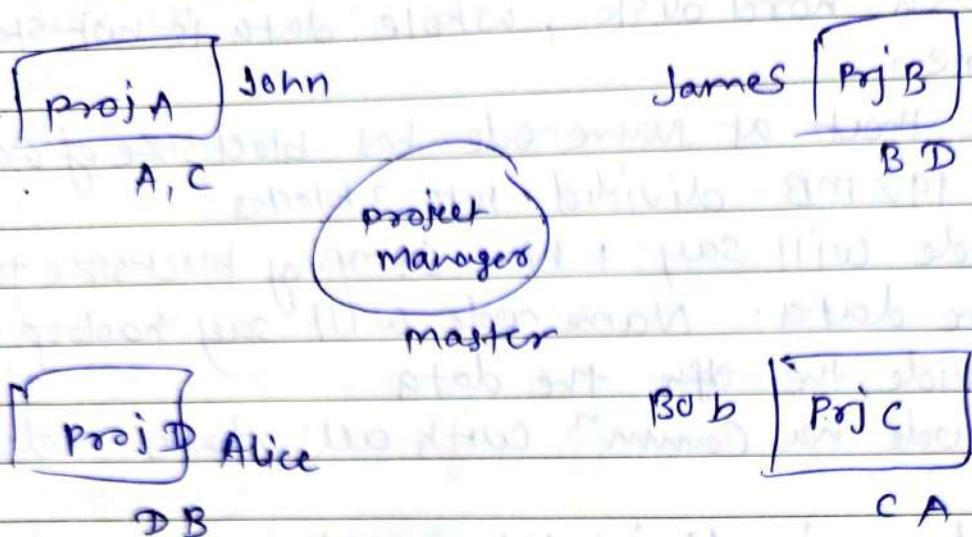
If active name node crashes there is also passive name node available.

Manisco company do the disaster recovery for hadoop.

Oozie tool in HDFS for batch processing system. Schedule a program

Date :

Master slave architecture



Active Project

Passive backup Project

Hadoop - master/slave architecture
HDFS, YARN, mapreduce available

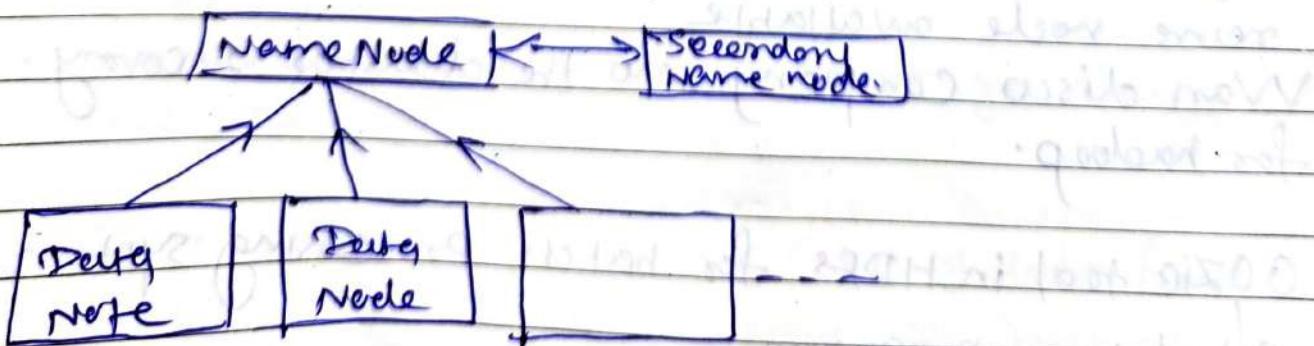
HDFS basic is Storage unit

→ Components

Name node

Data Node

Secondary Name node



Name Node

- maintain & manages dataNodes
- Records metadata, i.e. information about data blocks
e.g. location of blocks stored, the size of the files,
permissions, hierarchy etc.
- Recent Receives heartbeat & block report from
all the dataNodes. (Data node is active or fail)

Data Nodes

- Slave Daemons
- Stores actual data
- Serves read & write requests from the clients

Consider a file, file is divided into different block.
which block is reside in which data Node, file
permission.

Secondary Name node

Actually a helper node (Not a backup node)

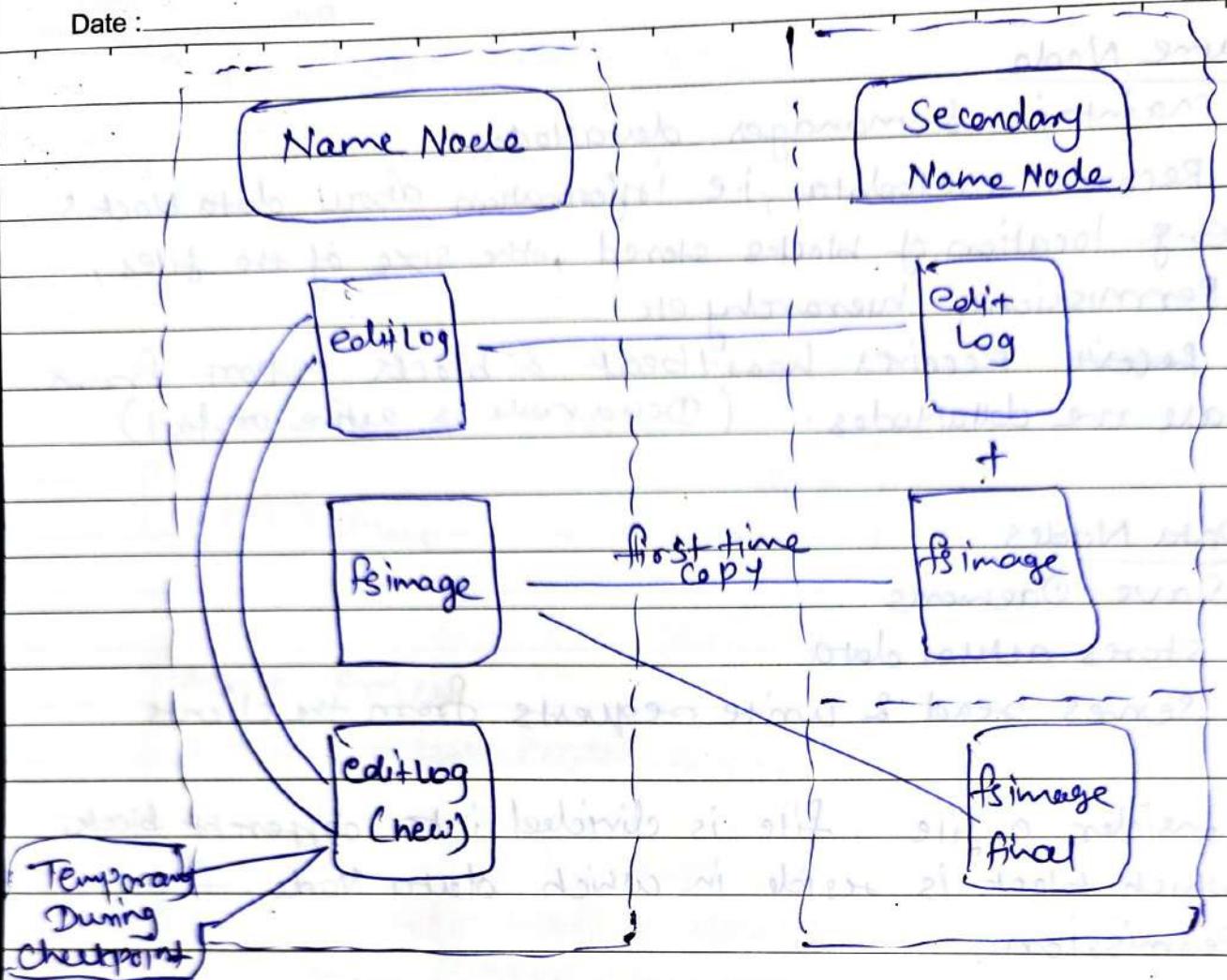
- Checkpointing is a process of Combining edit logs
and fsimage.
fsimage (^{complete image} file system as we have stored the data)

we can not update fsimage Continuously

Whatever changes are made in file system are
done at name node. in edit logs.

Name Node Copy the old fsimage merge the
recent edit logs then final fsimage made
i.e checkpointing process

Date : _____



By using secondary Name node copy recent edit logs & fsimage & merge into final fsimage
(About newly written data, new permission)

- No overhead of continuous R/W
- if Name node fails from secondary name node recover.

Usually checkpointing done periodically after 1 hour.

Hadoop gives option for time frame.

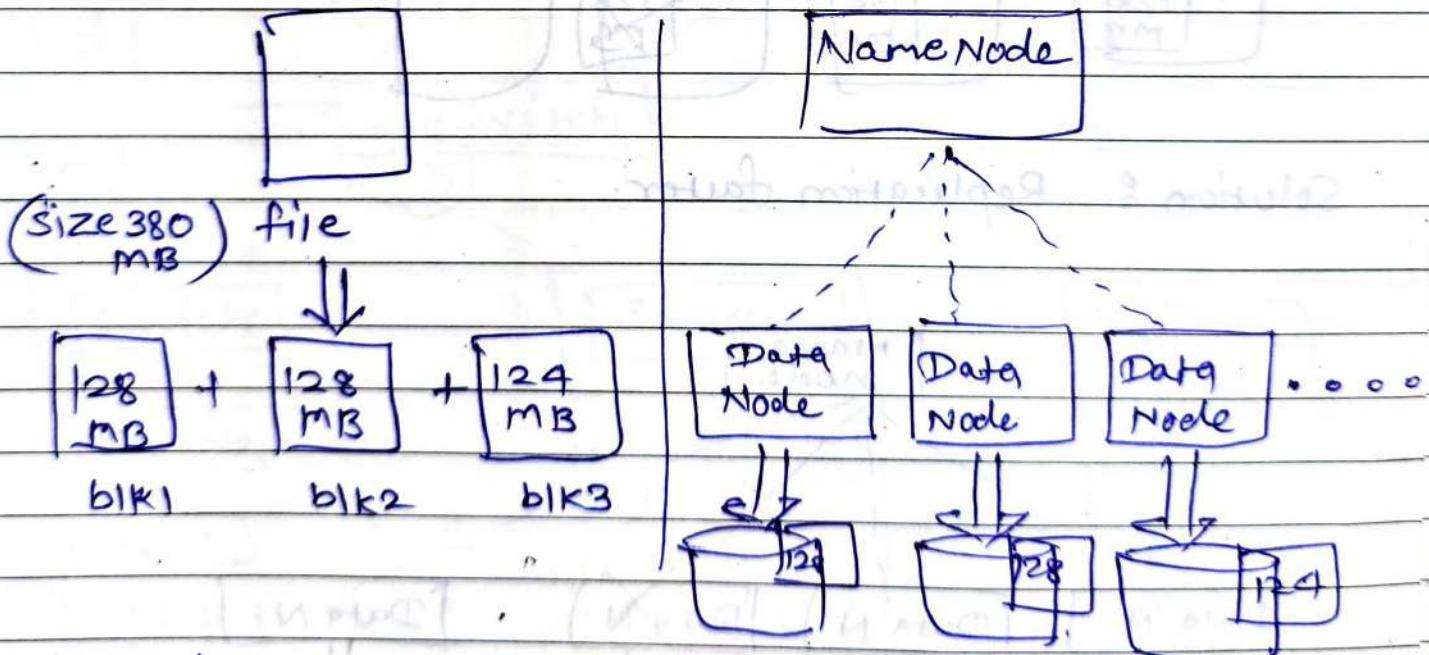
- secondary Namenode takes over the responsibility of checkpointing therefore making namenodes more available
- Allows faster failover as it prevents edit logs from getting too huge.
- checkpointing happens periodically (default : 1 hr).

How data actually stored in data Nodes?

HDFS data blocks

Each file is stored on HDFS as blocks

The default size of each block is 128MB in Apache hadoop 2.x (64 MB in Apache hadoop in 1.x)



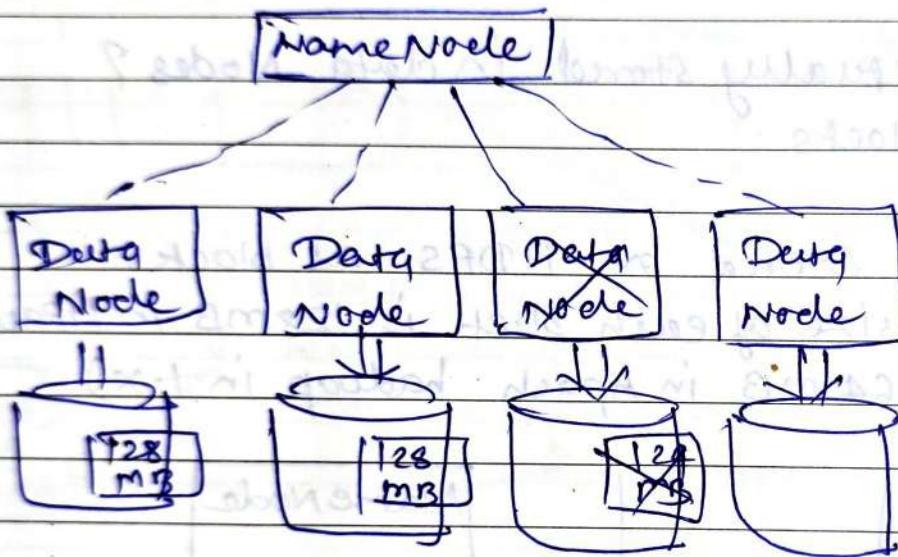
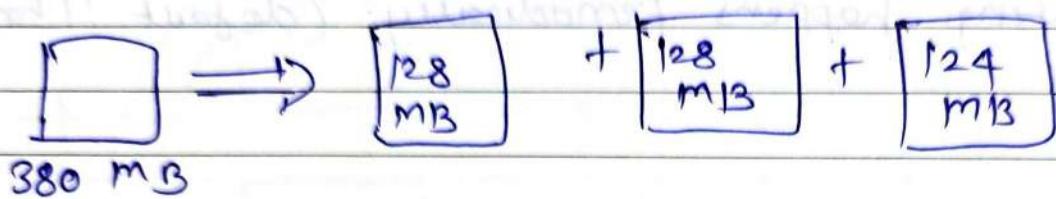
3 data blocks are stored differently at 3 different data node.

Default size block is configurable

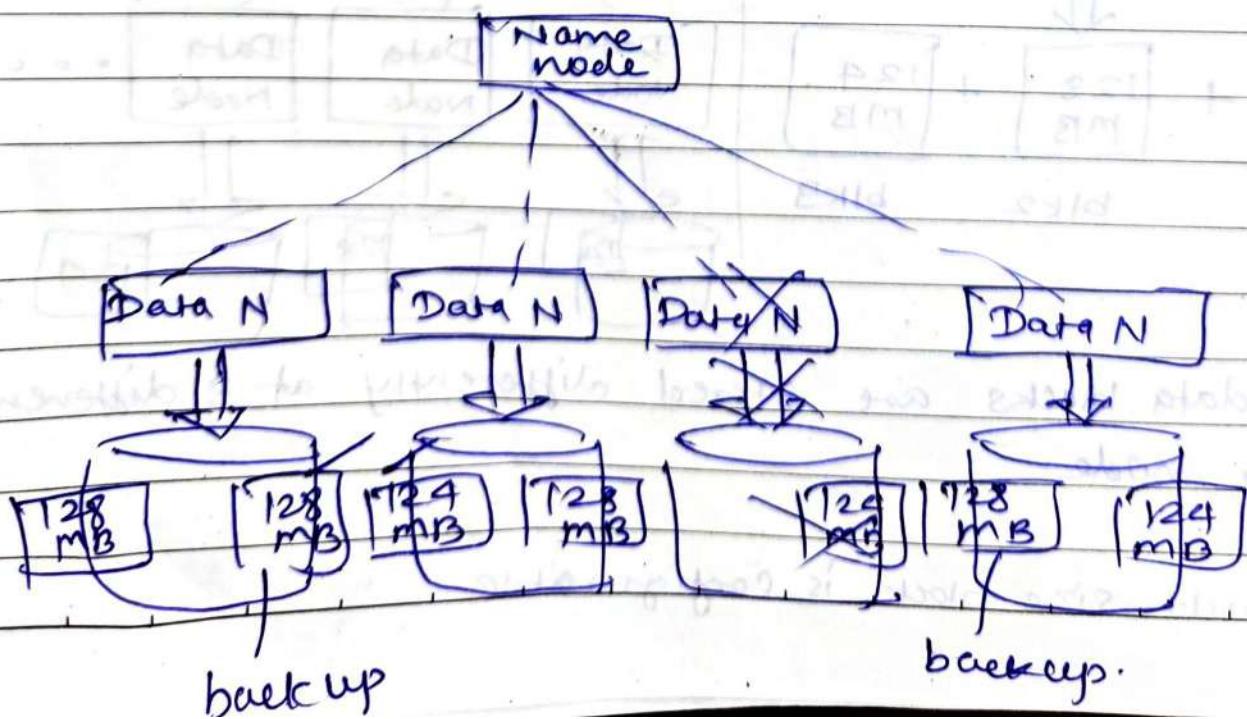
Date : _____

Fault Tolerance: How hadoop cope up with Data Node failure?

If one of the DataNodes crashed Containing the data blocks.



Solution: Replication factor.



Date : _____

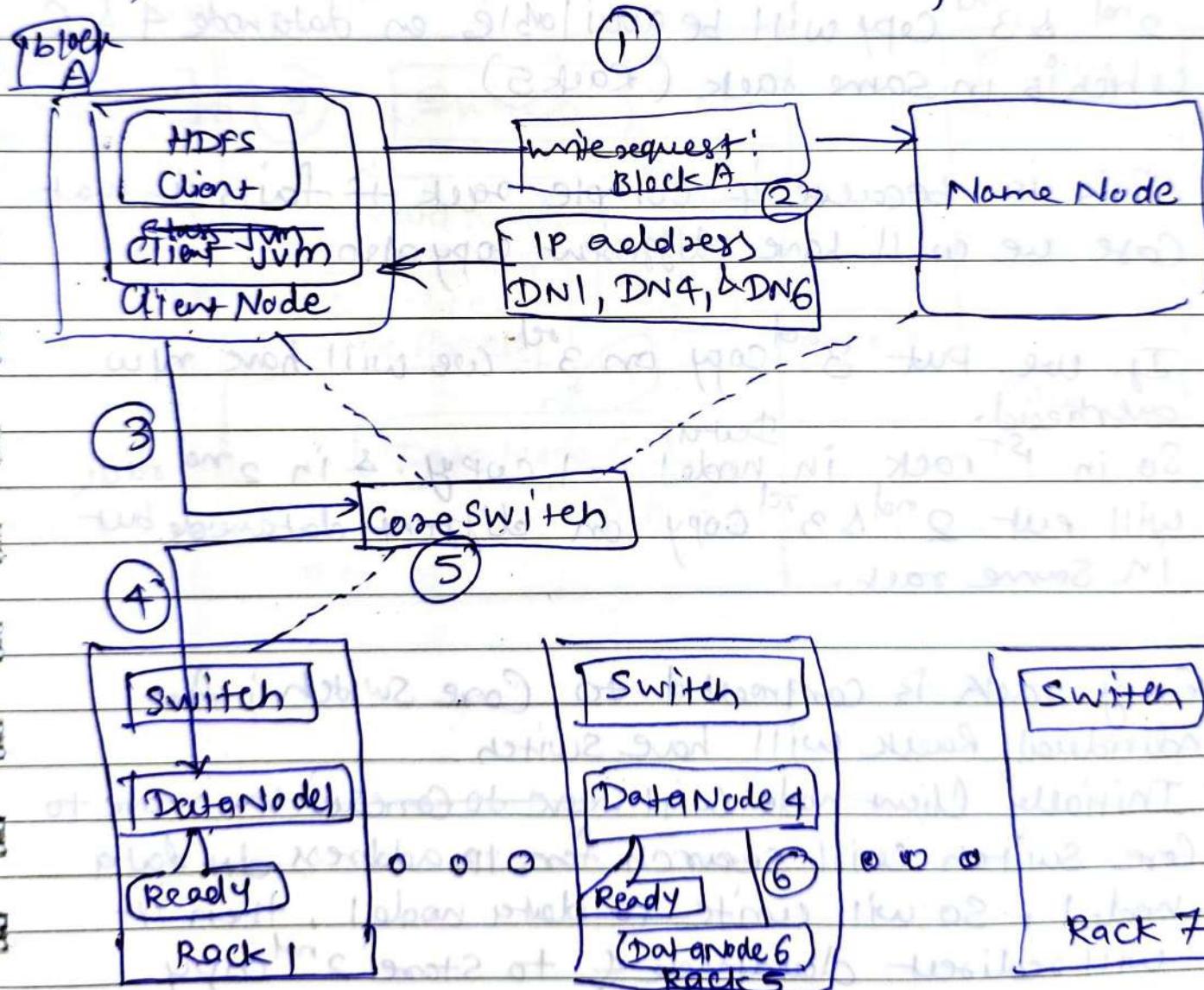
Each data blocks are replicated (three by default) and are distributed across different data Nodes.

(total 3 copies
are stored for data)

You should keep optimum no. of copies block)

How replication can be done.

Step 1 → write mechanism pipeline setup



- ① If client want to write block A
Client send a request to NAME Node
to write Block A in HDFS

Date: _____

② Name node will check availability to write data

We have 3 rack, in these 3 racks various data nodes are there.

In replication 1 copy available in data nodes in rack 1.

2nd & 3rd copy will be available on data node 4 & 6 which is in same rack (Rack 2).

This is because if complete rack i.e. fails in that case we will have different copy also.

If we put 3rd copy on 3rd we will have no overhead.

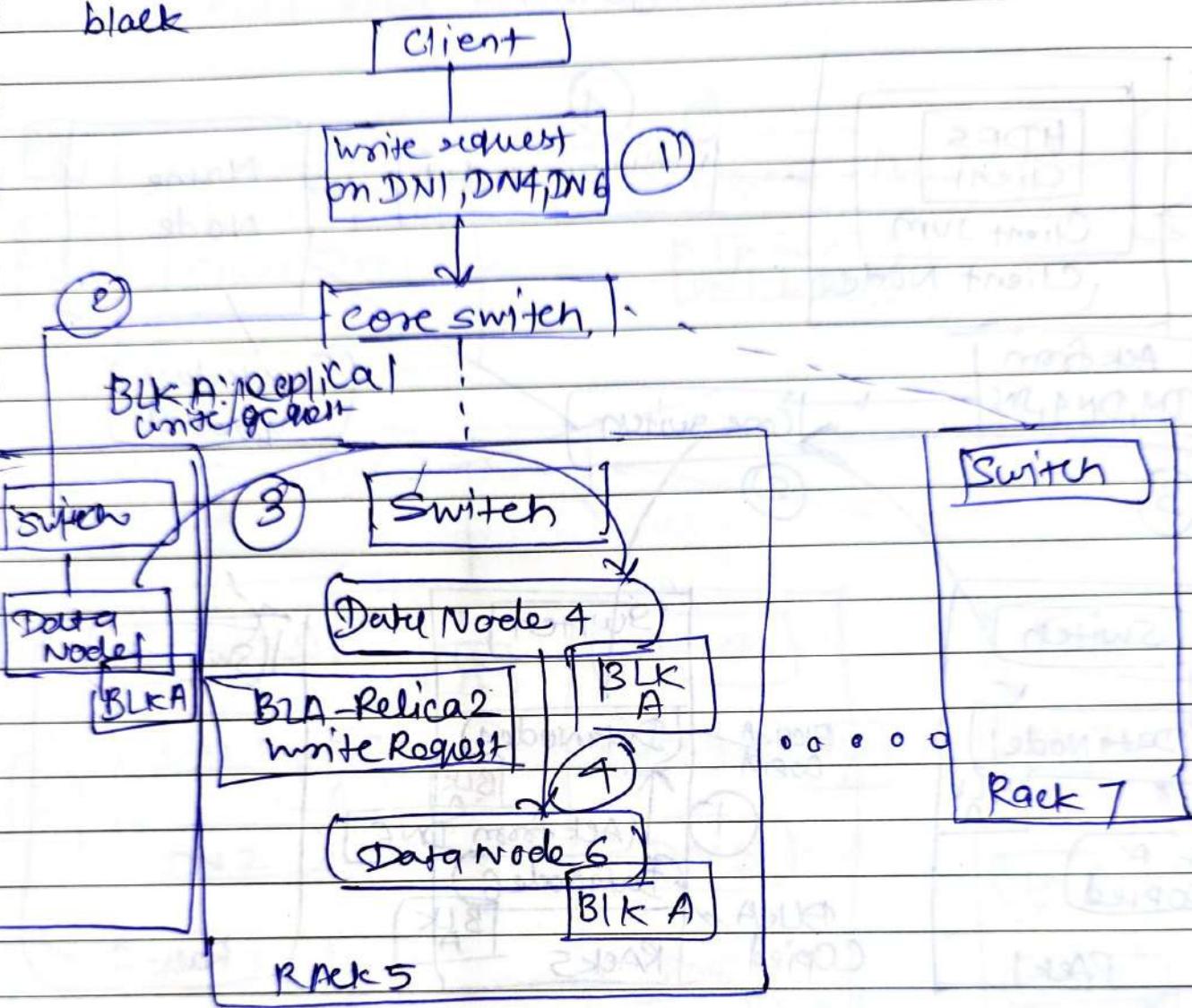
So in 1st rack in node 1 — 1 copy. & in 2nd rack will put 2nd & 3rd copy on different datanode but in same rack.

Every rack is connected to Core switch; for individual rack will have switch.

Initially Client node will move to ~~Core switch~~ move to Core Switch will search for IP address of data node, so will write to data node 1, then it will replicate datanode 4 to store 2nd copy move to datanode 6. In this way write pipeline is setup create it.

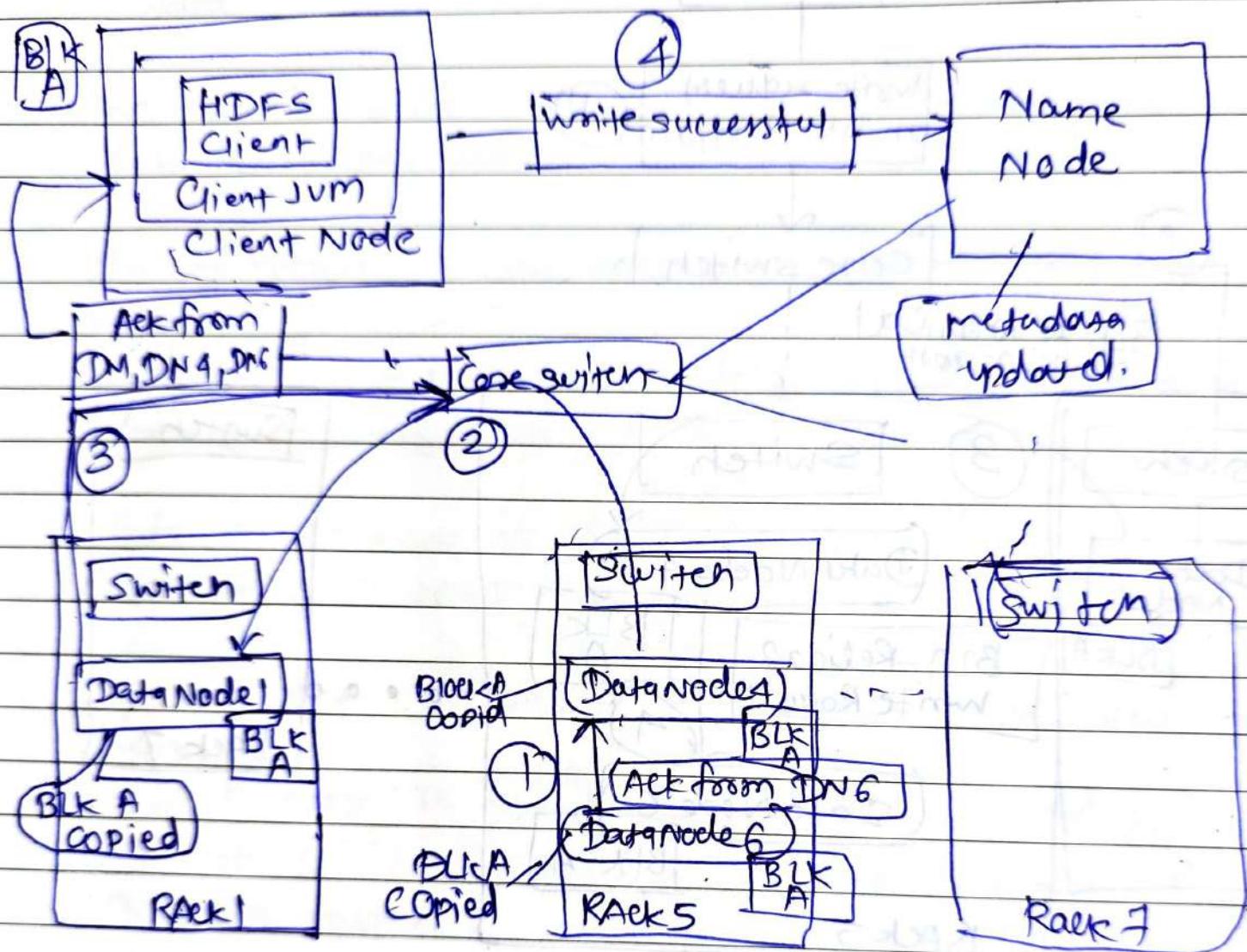
HDFS write mechanism - writing a block

Date : _____



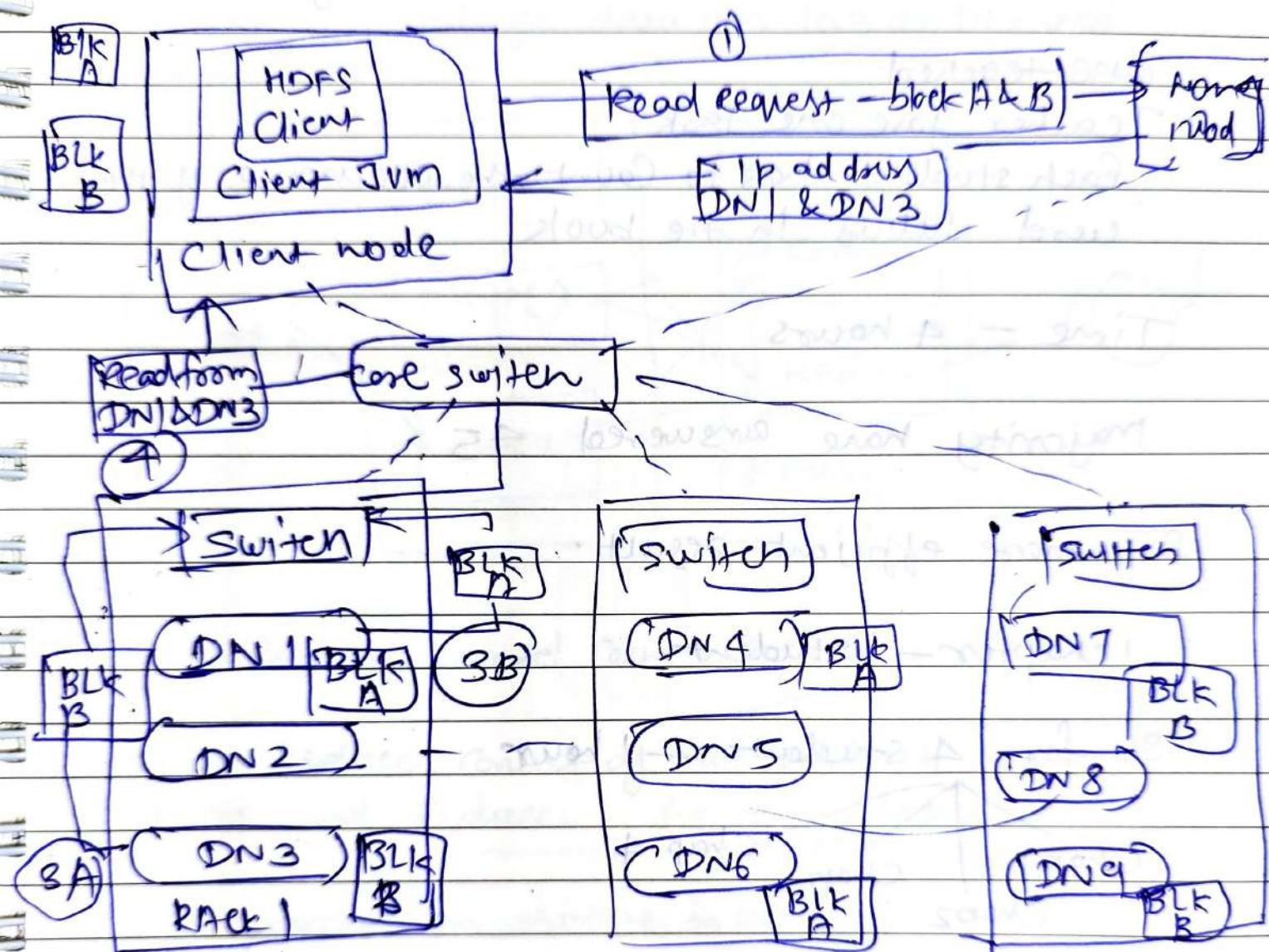
Date :

HDFS Write Mechanism Acknowledgement



Date: _____

HDPS Read Architecture



Date:

MAP Reduce

Processing

Allows parallel & distributed processing

~~one teacher~~

Teacher gave one task

Each student has to Count the occurrence of the word Julius in the book

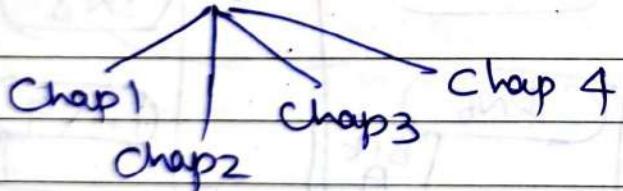
Time - 4 hours

Majority have answered 45

For more efficient result

1 chapter - 1 student

So for 4 student - 1 hour



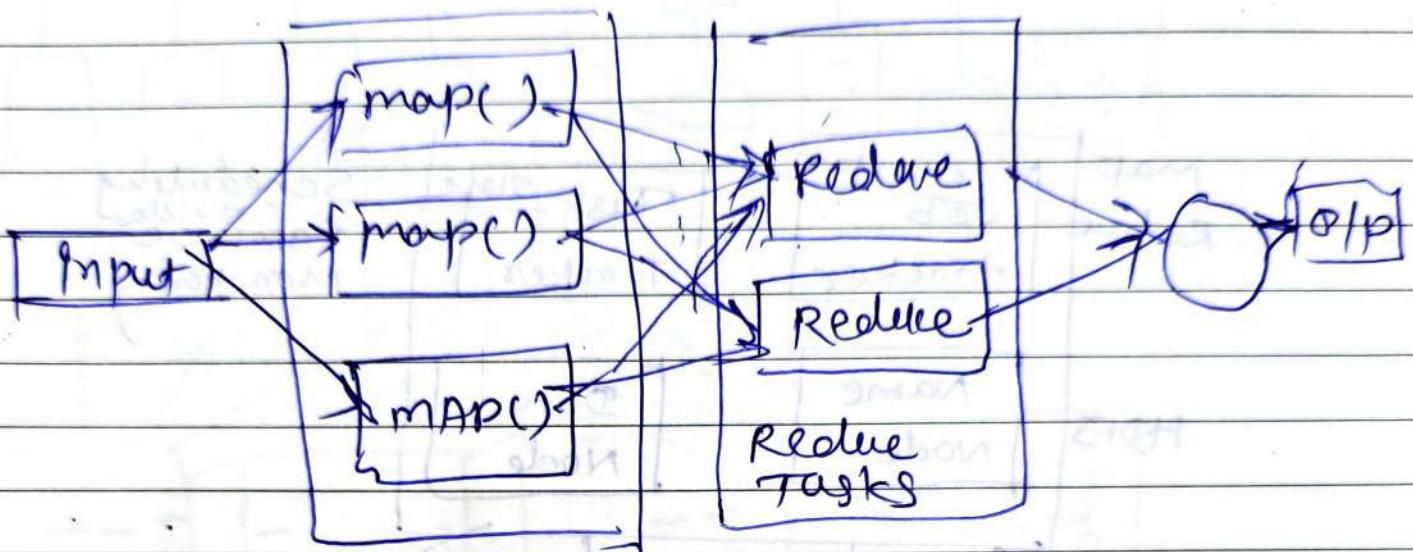
Each student Count the no of occurrence in each chapter parallelly

$$12 + 8 + 14 + 11 = 45 \quad - 1 \text{ hr } 2 \text{ min.}$$

Processing unit of Apache Hadoop

Date : _____

MapReduce is a programming framework that allows us to perform distributed & parallel processing on large datasets in a distributed environment.



map Reduce and Count program.

Map Reduce consists of two distinct tasks.

Map and Reduce i.e. two class

Mapper
Reducer

→ It works on divide & conquer approach.

Divide a big problem to small partition

then we will reduce (intermediate result we will get that we have to combine)

Then we will get o/p in key value pair format

→ Two essential daemons of mapReduce:

Job tracker & Task tracker

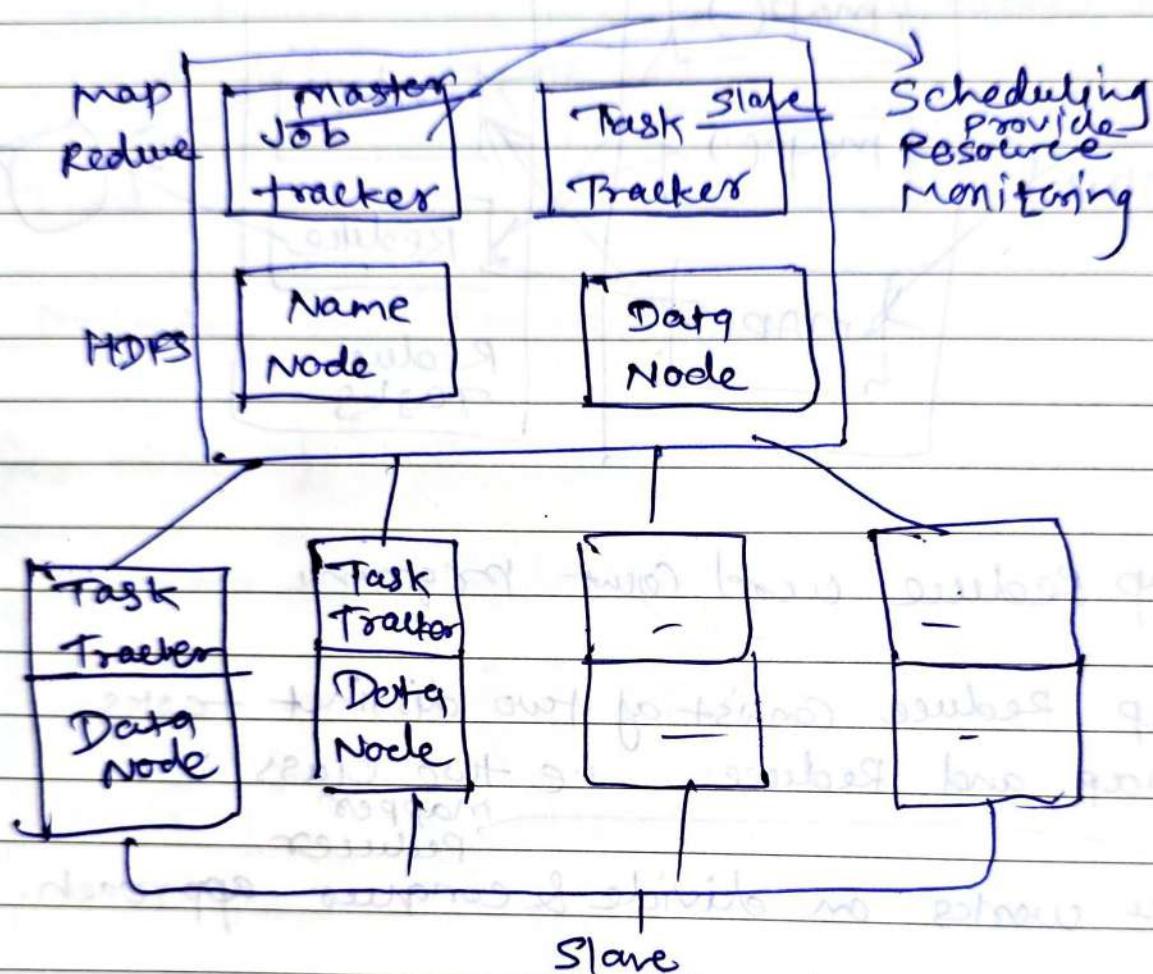
works in
background.

Date :

(Boss) (Name Node)

job tracker works is to schedule the processes, resources provide.

Task tracker

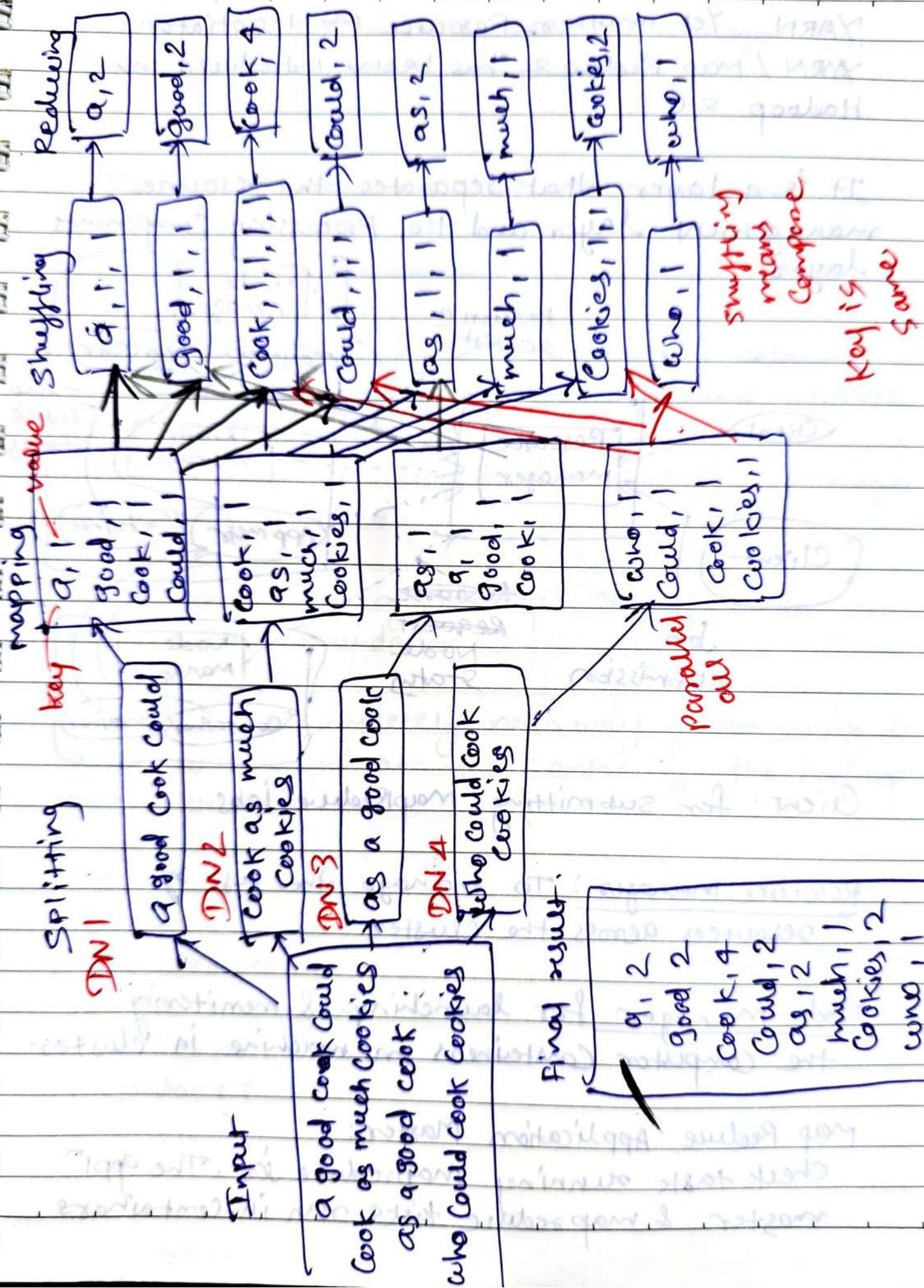


Ex :-

where is the huge amount of sale (Domino Pizza) all over india at month end in particular state. we keep data locally but in os

$$P D = \frac{\text{Distance}}{\text{time (velocity)}}$$

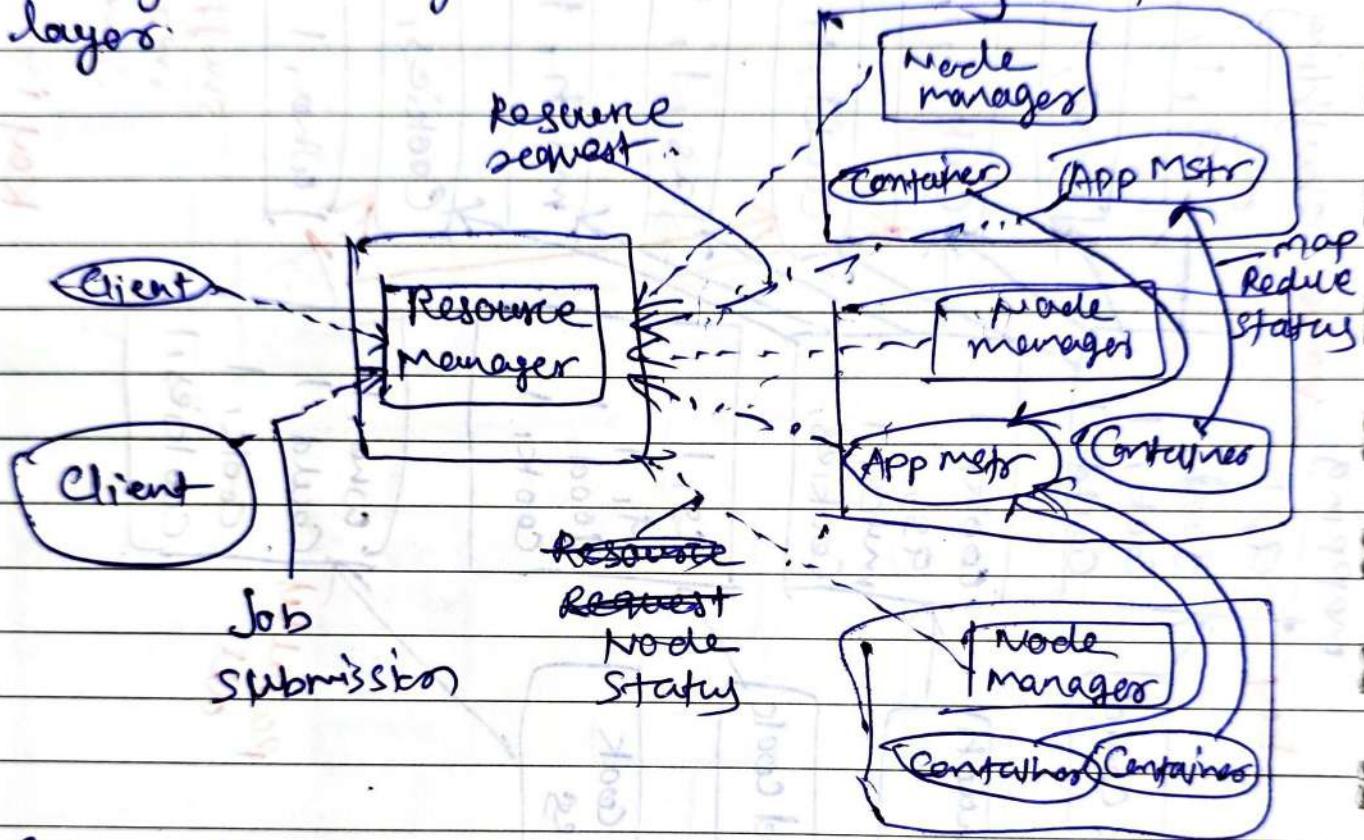
In this processing unit will goto data data node & work on it



Date :

YARN Yet another Resource Negotiator
YARN / Map Reduce 2 has been introduced in
Hadoop 2.0

It is a layer that separates the resource management layer and the processing components layers.



Client: for submitting MapReduce jobs

Resource Manager: To manage the use of resources across the cluster

Node manager for launching & monitoring the computer containers on machine in cluster

map Reduce Application Master:

check task running mapreduce job . The appl master & mapreduce tasks run in containers

Client, - To submit mapreduce jobs.

Date: _____

that are scheduled by resource manager & managed by node managers.

Resource manager has two main components,

Scheduler

Application manager.

Container: Name given to package of resource including RAM, CPU, Network, HDD etc.

YARN

It is very efficient tool technology to manage the hadoop cluster.

YARN is a part of Hadoop 2 version under the Apache SW foundation.

YARN is a completely new way of processing data & is now right at the centre of the hadoop architecture.

Main Components

Client

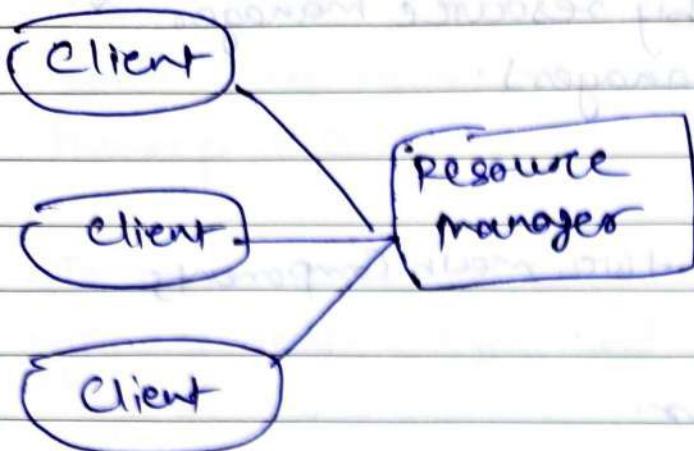
Resource manager

Node Manager

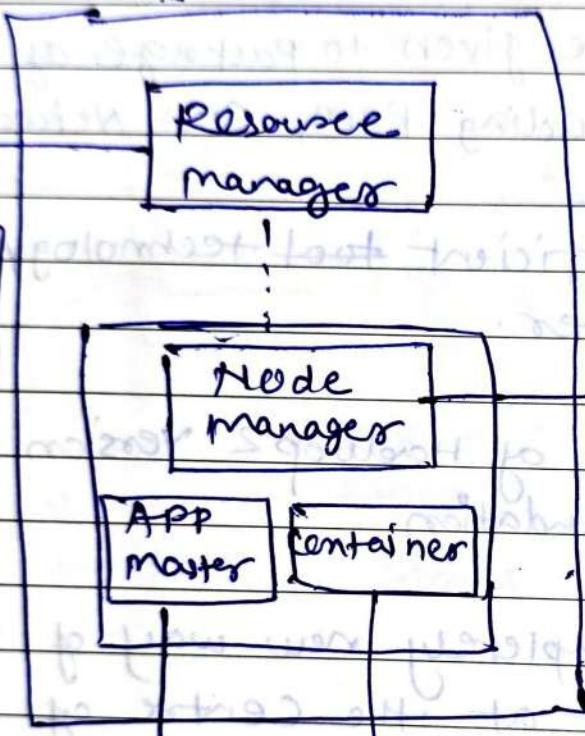
Application Master

Containers

Date :



Resource manager
master daemon
that manages
all other
daemons &
accepts job
submission



Node manager
Responsible for
Containers,
monitoring their
resource usage
(i.e CPU, disk,
memory, network)
& reports the same
to RM

App master
one per application
coordinates & manages MR
jobs
Negotiates resources from RM

Container:
Allocates certain
amount of resources
(memory, CPU) on a
slave Node.

Date : _____

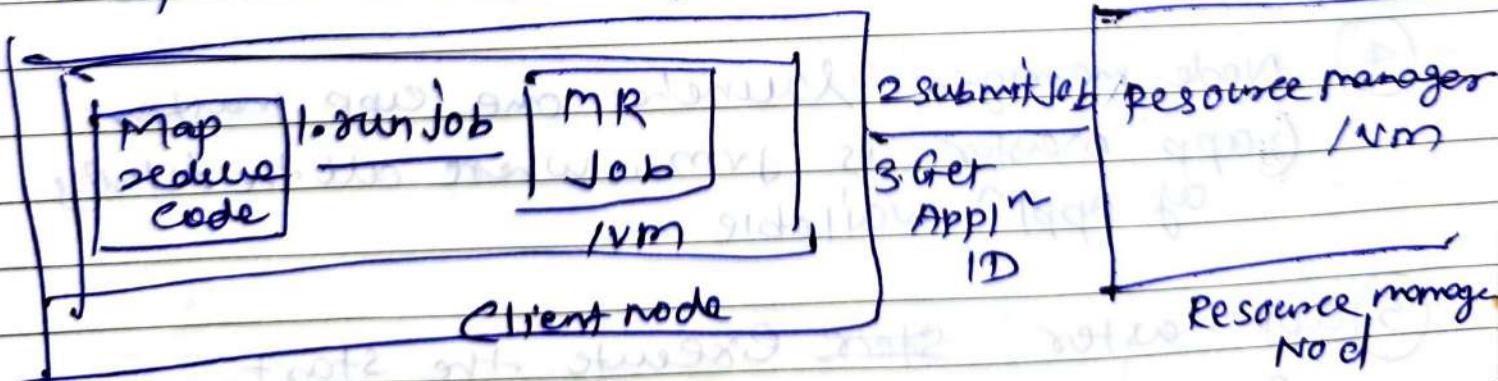
Client negotiates directly with resource manager
Node manager are slave daemon

~~for each app separate appl^n master available~~
Resource manager manages everything

Node manager informs resource manager about health of node manager. It says what are the utilization of resources, how many containers are free, data communicate

~~It launches containers on different nodes.~~
~~for each app separate appl^n master available~~
It launches different nodes on the container.
~~Different containers are executed on different node managers.~~

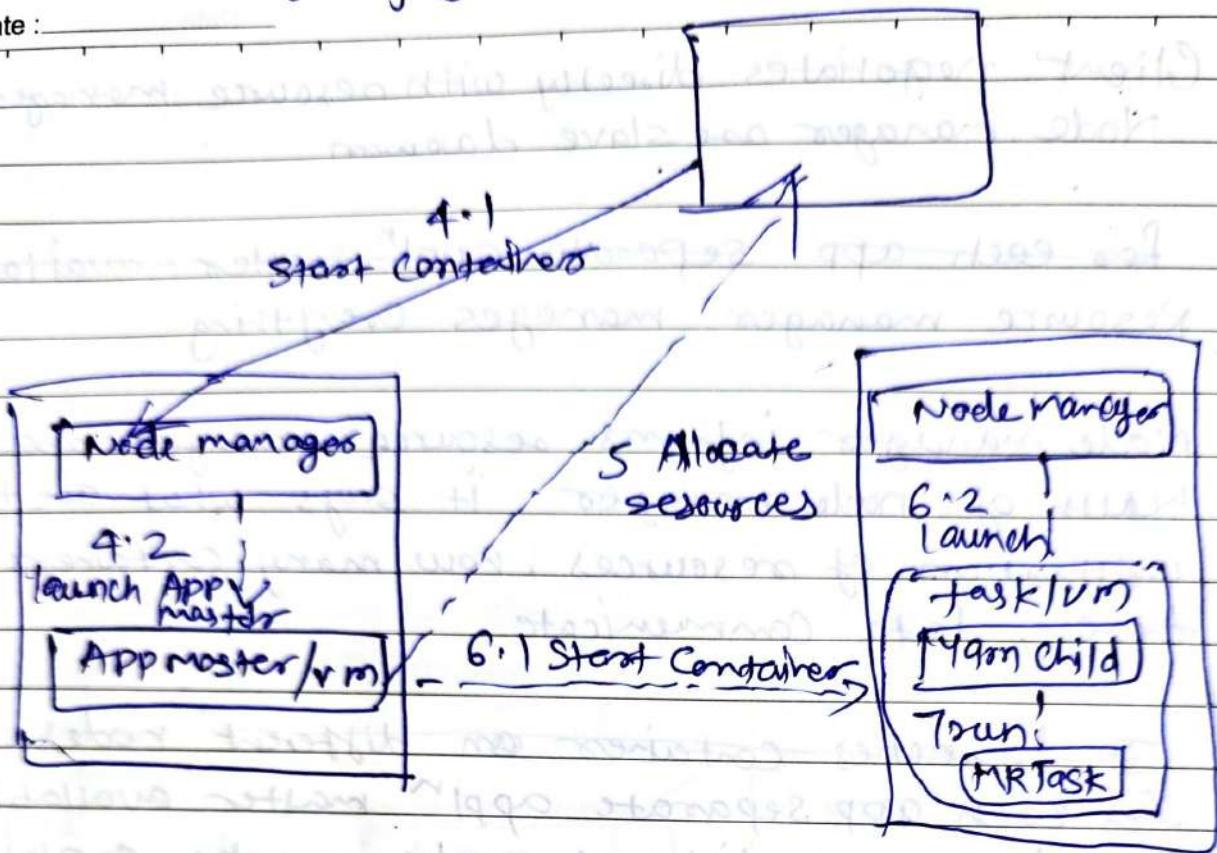
Map reduce Job workflow



Gala Moksha

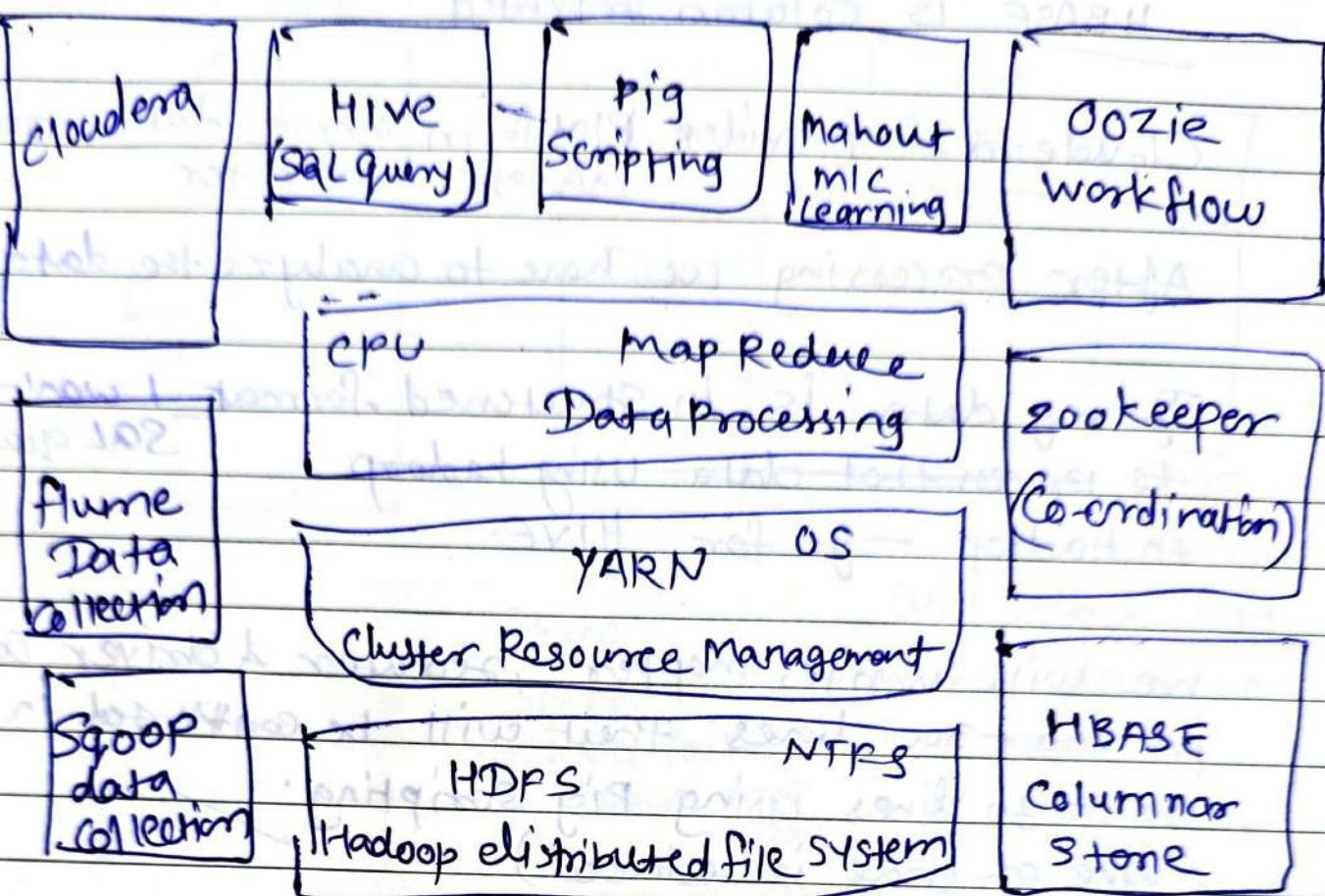
mapreduce is a code we run it as a one job

Date:



- ① Client submit job to resource manager
- ② Resource manager send appl^n ID to client
- ③ Resource manager communicate with node manager there we get available resources
- ④ Node manager launches one app master (app master is jvm, where all the details of appl^n available)
- ⑤ app master ~~start~~ execute the start container command on node manager & Node manager launches one container where our task will be executed.

Date :



Data is collection is done from flume & sqoop
flume (unstructured & semistructured) in HDFS
Sqoop (structured data) MySQL, ORACLE

HBASE — in RDBMS in table format we store the data

without any structure we store data for that we use NoSQL concept.

Date :

HBASE is column oriented

Cloudera — provides Platform where data properly manage & monitor.

After processing we have to analyze the data.

If my data is in structured format i want to use to process that data using hadoop .
in hadoop — go for HIVE .
SAL query

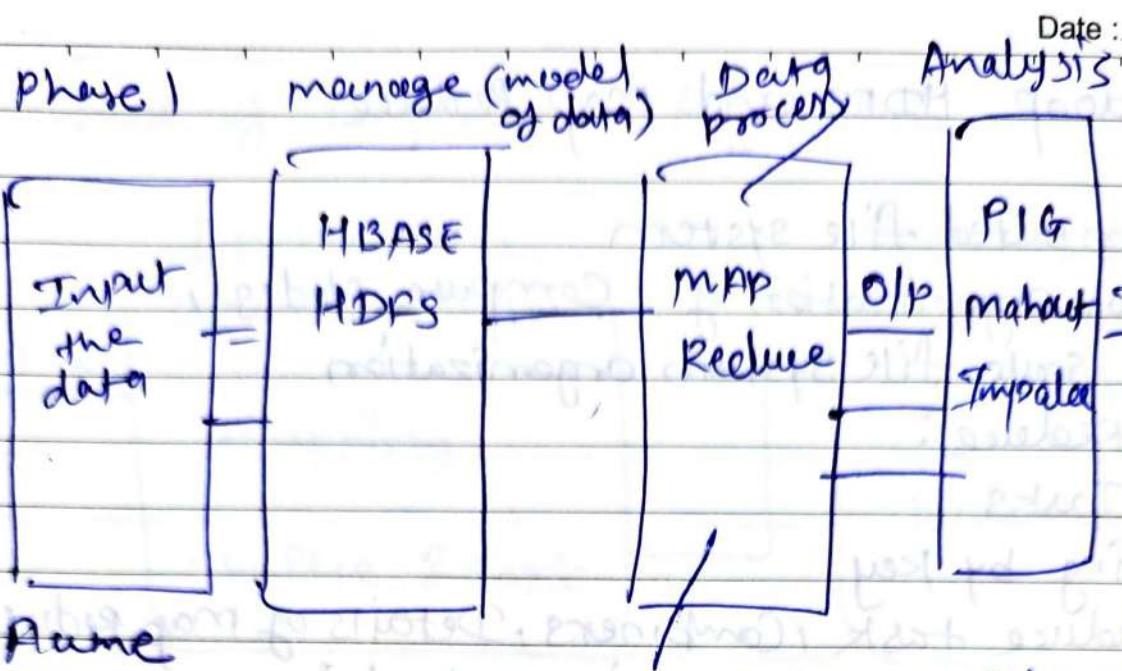
we will write mapper , reducer & driver code in 200 - 300 lines that will be converted in 20 to 30 lines using Pig Scripting :
(line of code is reduced)

Mahout machine algorithm one used machine learning feature is added .

Oozie — job scheduling , (which job should be completed automation , alarm , at time interval) s' o clock task should be executed .

Zookeeper — (Resource management)

yarn is used at laptop level managing but when we see server — it has to manage 100 of machines so same to handle all cluster we require zookeeper



Name
sqoop

Storm

SPARK

100 times faster

than map
reduce

HDFS user

will search data
it uses CloudSearch.

Manage
monitor
data.

SQL data used in HDFS system using Sqoop
Flume used for real time data

Pig : is scripting lang.

Date : _____

2. Hadoop HDFS and Map Reduce

2.1 Distributed file system

Physical organization of Compute Nodes,

Large Scale file System organization

2.2 Map Reduce:

Map Tasks

Grouping by key

The reduce task, Combiners, Details of Map Reduce
Job execution, Coping with Node failures

2.3 Algorithms using Map Reduce

Matrix vector multiplication by map reduce

Relational algebra operations

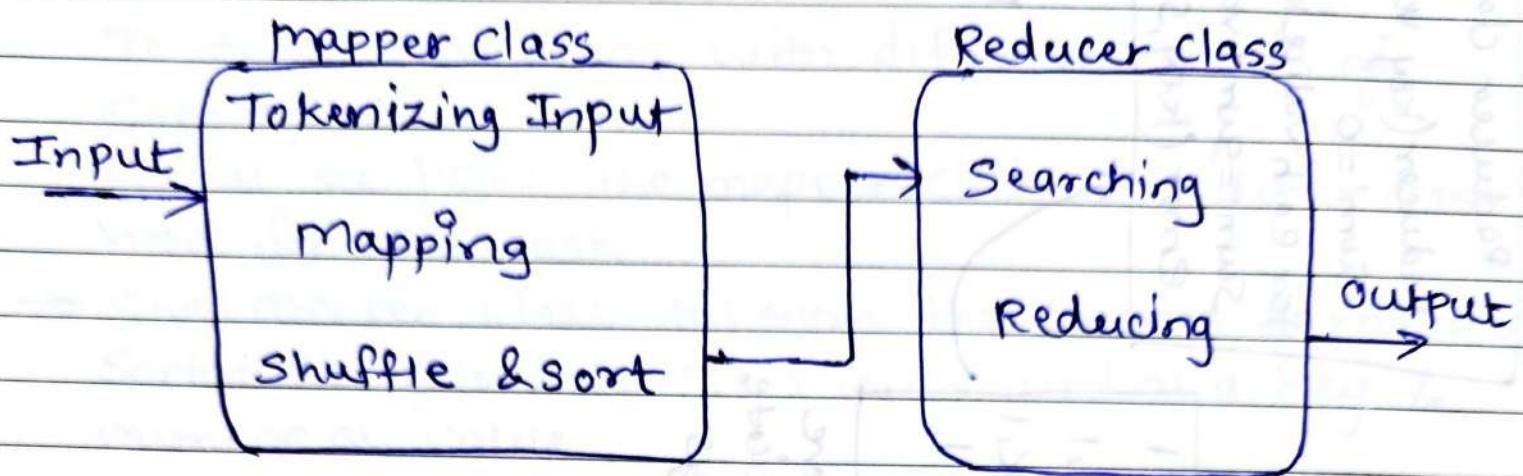
Computing Selection by mapreduce

Computing Projection by mapreduce, union,

Intersection & difference by mapreduce

2.4 Hadoop Limitations.

Basic of Map Reduce Algorithm



Different Tasks in MapReduce Algorithms.

The mapreduce programs have two tasks
 map task
 Reduce task

Map task is done by the mapper class & Reduce task is done by reducer class.

Mapper class takes the input, tokenizes it, maps & sorts it. The output of mapper class is used as input by reducer class, which in turn searches matching Pairs and reduces them.

