Reducers
File System
Cassandra
Flume
Combiners
Distributed
MapReduce
HBase
HiveQL
API
Sqoop
MRUnit
Hive
Big Data
Hadoop
Petabytes
Oozie
Zookeeper
Architecture
HDFS
YARN
PIG
Mappers
Partitioners
TaskTracker
Localization
JobTracker
MongoDB

Certificate in Big Data and Hadoop

April 4/5 → May 17/18

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Course Content

- **Module1**
  - BigData Introduction
- **Module2**
  - HDFS Installation and Commands
- **Module 3**
  - Deployment Modes
- **Module 4**
  - Mapreduce
- **Module 5**
  - Advance Mapreduce - Part1
  - Join and Counters
- **Module 6**
  - Advance MapReduce - Part 2
  - Custom Input Formats and MRUnit
- **Module 7**
  - Pig and Pig Latin
- **Module 8**
  - Hive, Hive QL and HIve Architecture
- **Module 9**
  - Advance Hive QL, Rollups and Custom Functions

- **Module 10**
  - Flume
- **Module 11**
  - Sqoop
- **Module 12**
  - Oozie
- **Module 13**
  - NoSQL Databases
- **Module 14**
  - MongoDB and Cassandra
- **Module 15**
  - Hbase and Advanced Hbase
- **Module 16**
  - Zookeeper
- **Module 17**
  - Hadoop 2.0
  - HA and YARN and MRV2
- **Module 18**
  - Project

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Agenda for the day

1. What is BigData

2. Types of data - Structured, Unstructured, Semi-structured data

3. Companies using Hadoop and usecases in different domains

4. Limitations of traditional large scale systems architecture

5. How Hadoop is solving the traditional large scale system architecture problem

6. Why DFS ?

7. Introduction to Hadoop

8. History of Hadoop

9. Core components of Hadoop

10. Understanding Hadoop Master-Slave Architecture

11. Learn about NameNode, DataNode, Secondary Node

12. Understanding HDFS Architecture

13. Anatomy of Read and Write data on HDFS

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What and Where is BIG DATA

photo credit:caribb via photopin cc

An airline jet collects 10 TB of sensor data for every 30 minutes of flying time.

photo credit:MattHurst via photopin cc

NYSE generates about 1TB of new trade data per day to perform stock trading analytics and determine trends for optimal trade.

- Data is every where, we either ignore or destroy it
  - Rolling web data
  - Network Logs
  - System Logs
  - Click information from websites
  - Stock Trading Data
  - Personal data like
    - Photo Stream
    - Social Media Stream

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Facebook Example

20 Minutes on Facebook

1,587,000 Wall Posts
1,000,000 Links Shared
1,484,000 Event Invites
1,323,000 Tagged Photos
2,716,000 Messages Sent
1,851,000 Status Updates
2,716,000 Photos Uploaded
10,208,000 Comments Made
1,972,000 Friend Request Accepted

- There are over 1 billion active Facebook users. Aprox. 1 in Every 9 people on earth. Half of the them are logged in on any given day.
- A record-breaking 750 Million photos were uploaded to Facebook over new year's weekend.
- There are 230 million internet users in the US. That means 71.2% of the US web audience is on Facebook.
- Facebook users spend 10.5 billion minutes (almost 20,000 years) online on the social network.
- Facebook has an average of 3.2 billion Likes comments posted every day

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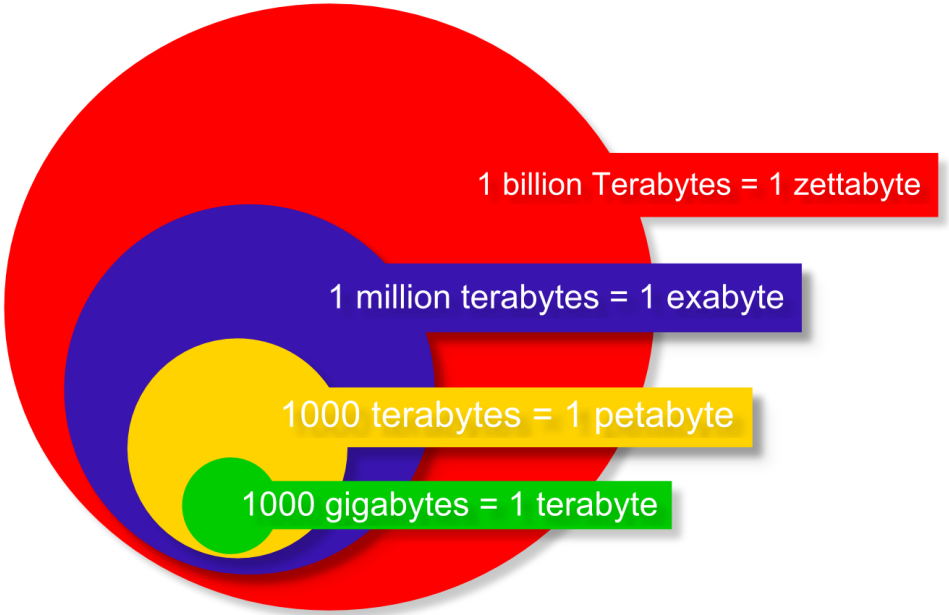
Twitter Example

- Twitter has over 650 million registered users.
- The USA, has 141.8 million accounts representing 27.4 percent of all Twitter users. This is well ahead of Brazil, Japan, the UK and Indonesia.
- 79% of US Twitter users are more likely to recommend brands they follow.
- 67% of US Twitter users are more likely to buy from brands they follow.
- 57% of all companies that use social media for business use Twitter.

Data Volume Growth.....Exponential !!



Humanity passed 1 Zettabyte mark in 2010.
1 zetabyte = 1,00,00,00,00,00,00,00,00,00,000 bytes (21 Zero's)
Thats enough data to file 75 trillion 16 GB iPad's.

Estimated Global Data Volume

- 2011 : 1.8 ZB
- 2012 : 7.9 ZB

The world's information doubles every two years

Over the next 10 Years

- The number of servers worldwide will grow by 10X.
- Amount of information managed by world data centers will grow by 50X.
- Number of "files" enterprise data centers handle will grow by 75X.

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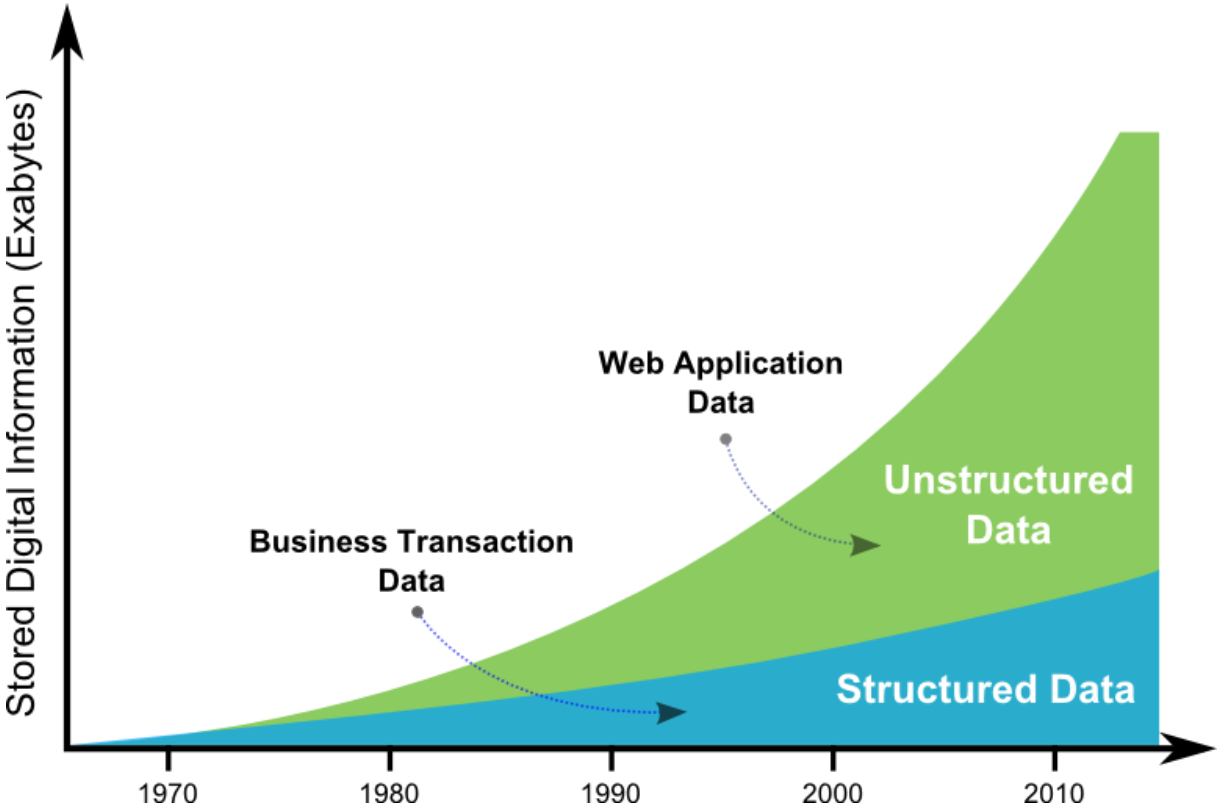
Structured vs Unstructured



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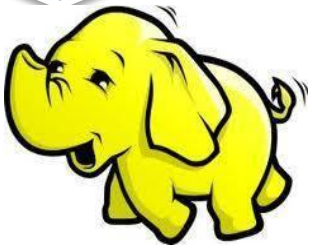
Hadoop Wants to Know?

Tell me 3 common big data scenarios?



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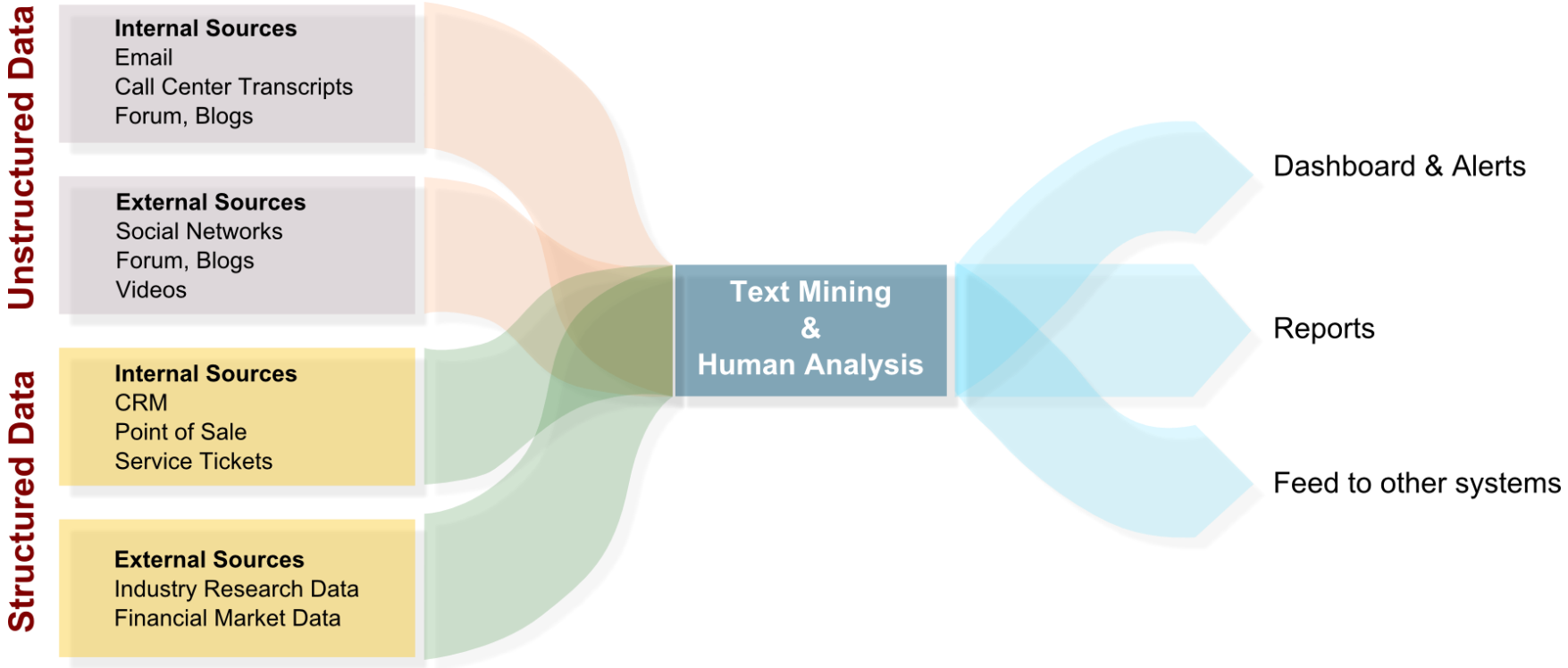
Structured vs Unstructured



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What is BIG DATA

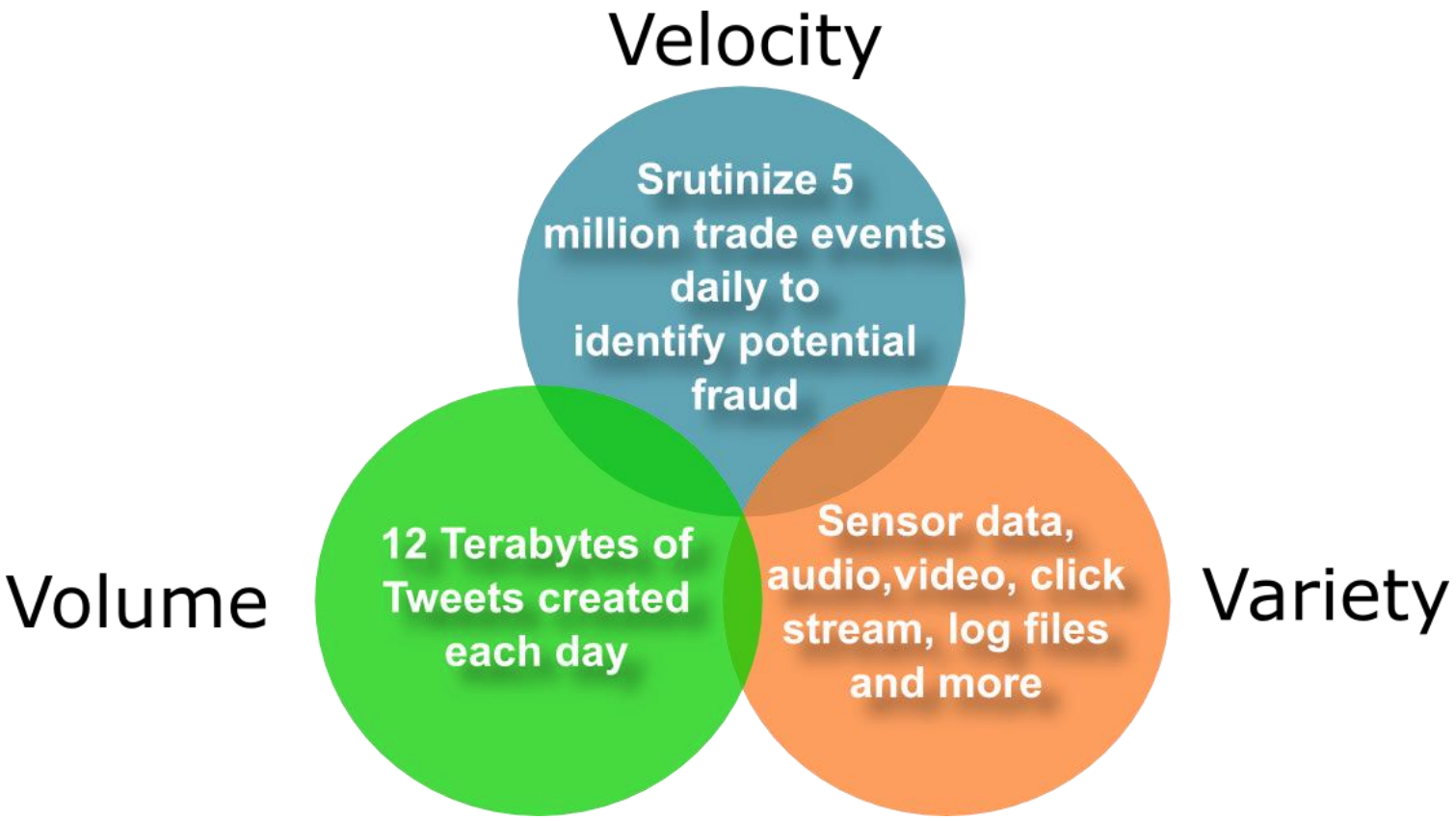
Big data is a phrase, used to describe a massive volume of both structured and unstructured data. In most enterprise scenarios the **data is too big or it moves too fast** or it exceeds current processing capacity.

For Example:
Rolling web log data
Network & System logs
Click information

What is considered "big data" varies depending on the capabilities of the organization managing the set, and on the capabilities of the applications that are traditionally used to process and analyze the data set in its domain.

photo credit:CarbonNYC via photopin cc

Big Data Dimensions



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Big Data – Common Scenarios

Financial Services

- Modeling True Risk
- Threat Analysis
- Fraud Detection
- Trade Surveillance
- Credit Scoring and Analysis

Web & E-Tailing

- Recommendation Engine
- Ad Targeting
- Search Quality
- Abuse and Click Fraud Detection

Retail

- Point of Sale Transaction Analysis
- Customer Churn Analysis
- Sentiment Analysis

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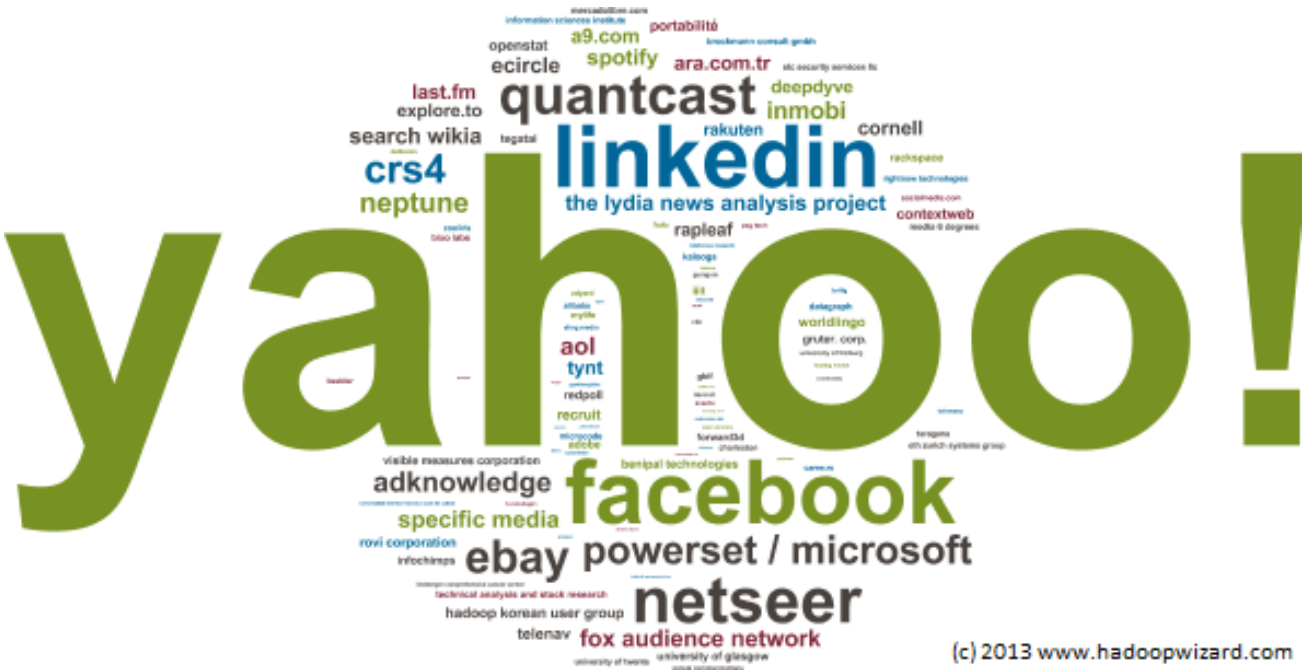
Companies using Hadoop

Company	Nodes
Yahoo!	42,000
LinkedIn	4,100
Facebook	1,400
NetSeer	1,050
Quantcast	750
Ebay	532
CRS4	400
PowerSet / Microsoft	400
AdKnowledge	200
Neptune	200



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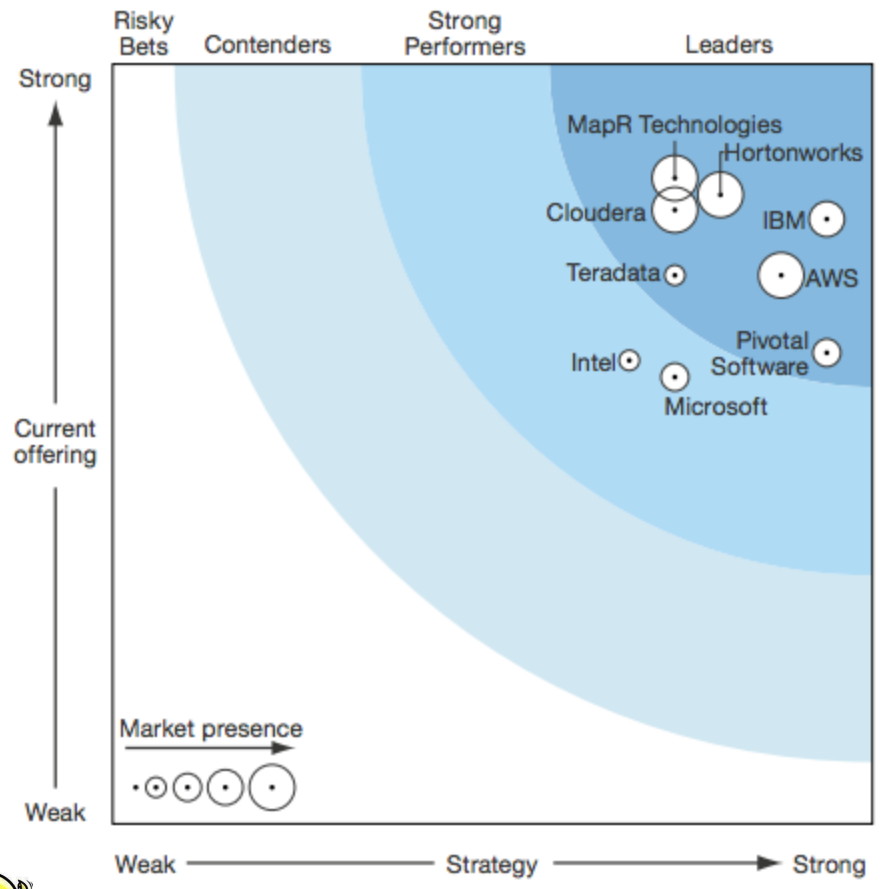
Hadoop Vendors



- MapR Technologies
- Hortonworks
- Cloudera
- IBM
- AWS
- Teradata
- Intel
- Microsoft
- Pivotal Software

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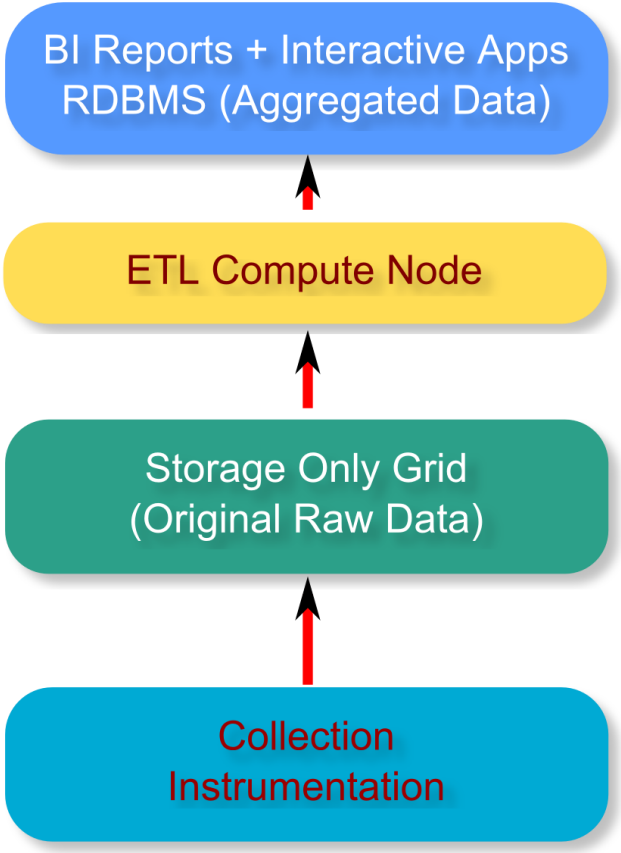
Existing Data Analytics Architectures



1. Can't Explore High Fidelity Raw Data

2. Cannot move data to scale

3. Premature data death (Data Archiving)

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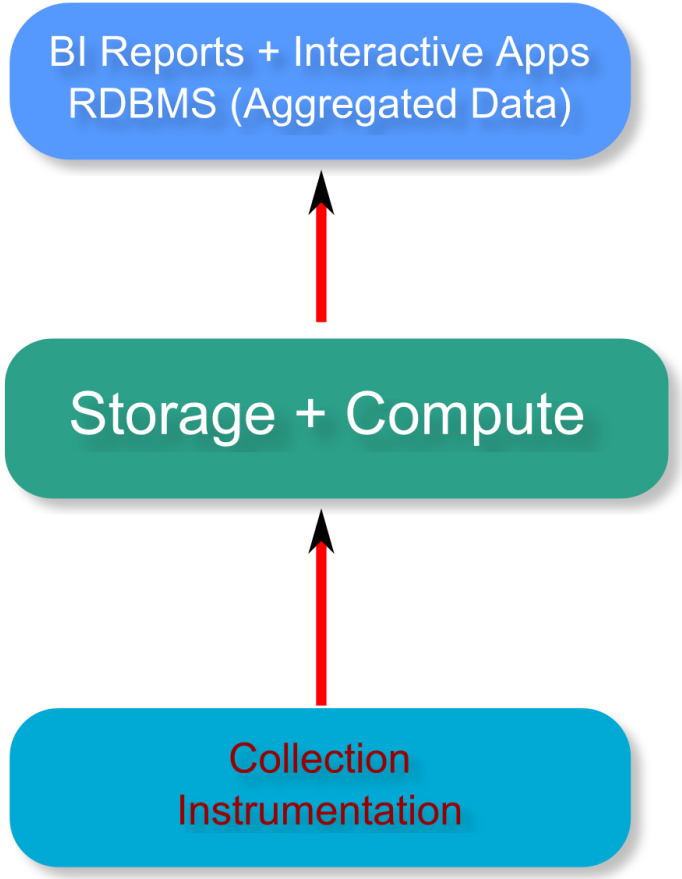
How Hadoop Solves the Problem



1. Scalable Throughput

2. Keep data alive forever

3. Data exploration and advanced analytics

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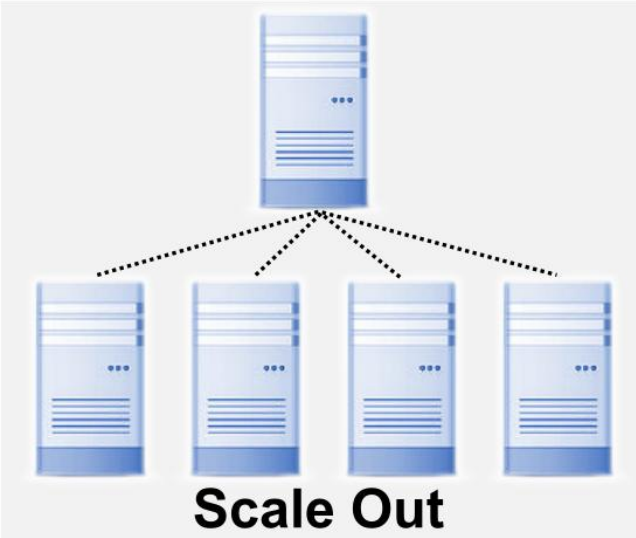
Scale – Horizontally vs Vertically

VS



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Why DFS

While Reading 1TB data …

1 Machine
4 I/O Channel
Each Channel - 100MB/S

Why DFS

While Reading 1TB data …

45 Minutes

1 Machine
4 I/O Channel
Each Channel - 100MB/S

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Why DFS

While Reading 1TB data …

45 Minutes

1 Machine
4 I/O Channel
Each Channel - 100MB/S

10 Machines
4 I/O Channel
Each Channel - 100MB/S

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Why DFS

While Reading 1TB data …

45 Minutes

4.5 Minutes

1 Machine
4 I/O Channel
Each Channel - 100MB/S

10 Machines
4 I/O Channel
Each Channel - 100MB/S

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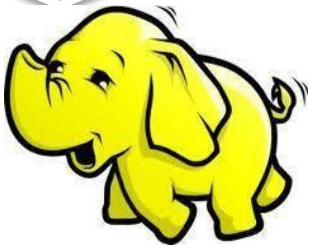
Hadoop Wants to Know?

Who is the creator of Hadoop?



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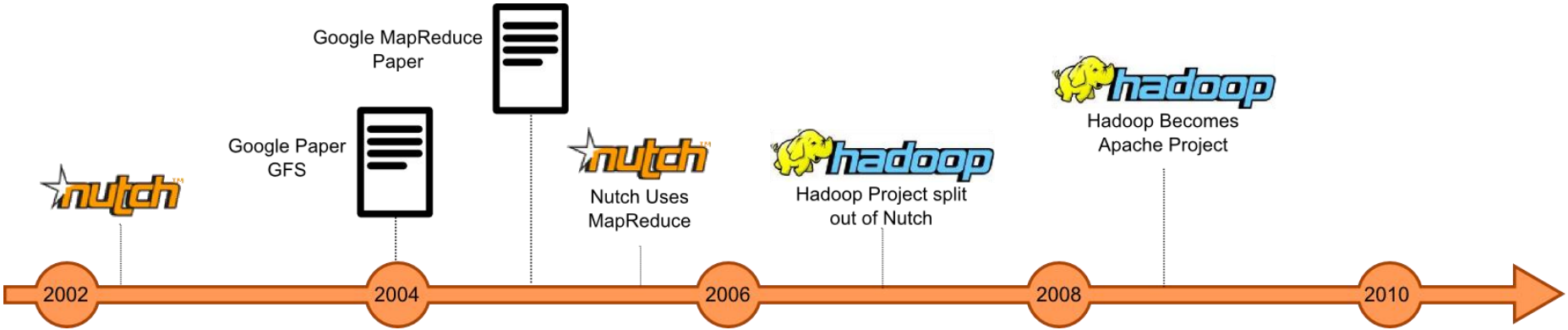
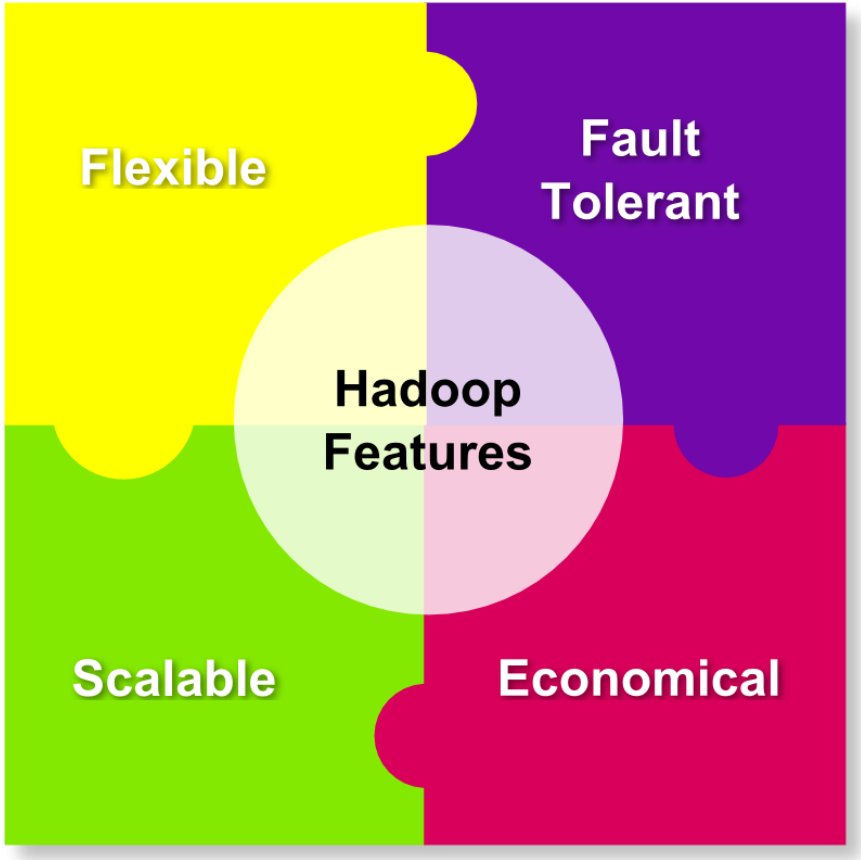
History of Hadoop



Hadoop Features



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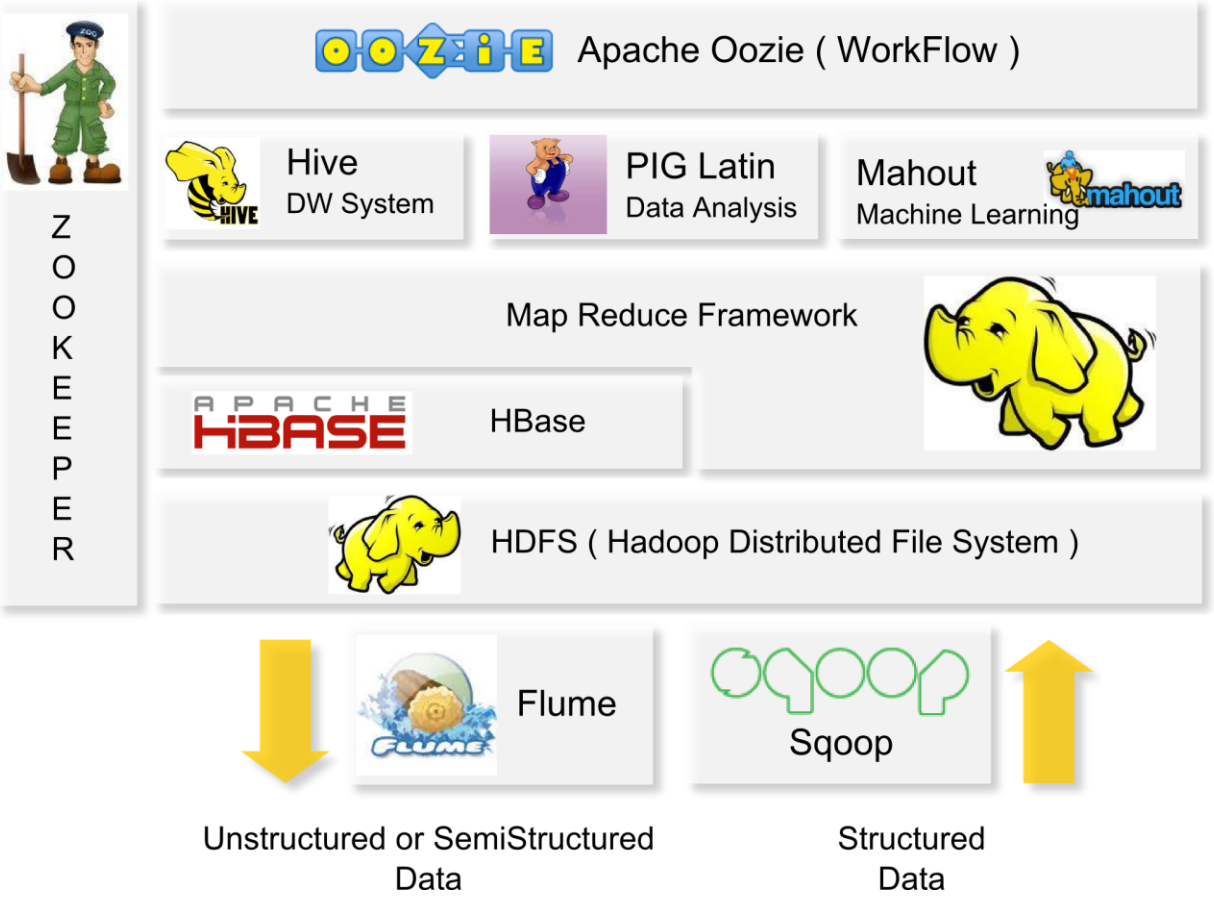
Hadoop Ecosystem



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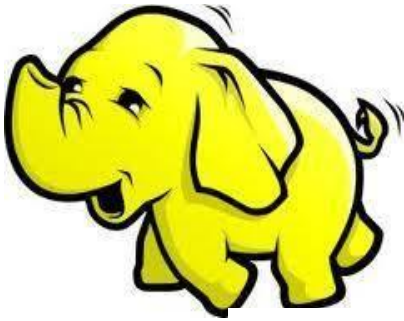
Hadoop Ecosystem

Apache Hadoop is a framework that allows for the distributed processing of large data sets across clusters of commodity computers using a simple programming model.

It is an Open-source Data Management with scale-out storage & distributed processing. It scales horizontally to manage Peta-bytes of data, abstracts away distributed storage and computing.

The storage abstraction is hidden behind Hadoop Distributed file system (HDFS) and analytics via Map Reduce Framework.

- HDFS: Distributed File System
- Map Reduce: A Distributed data processing model
- Hbase: A Distributed Column Oriented database
- Hive: A Distributed data warehouse
- Pig: A data flow language
- Zookeeper: A Distributed highly available Coordination Service
- Oozie: A Service for running and scheduling workflows of hadoop jobs
- Sqoop: A tool for efficient bulk transfer of data between hadoop and other RDBMS



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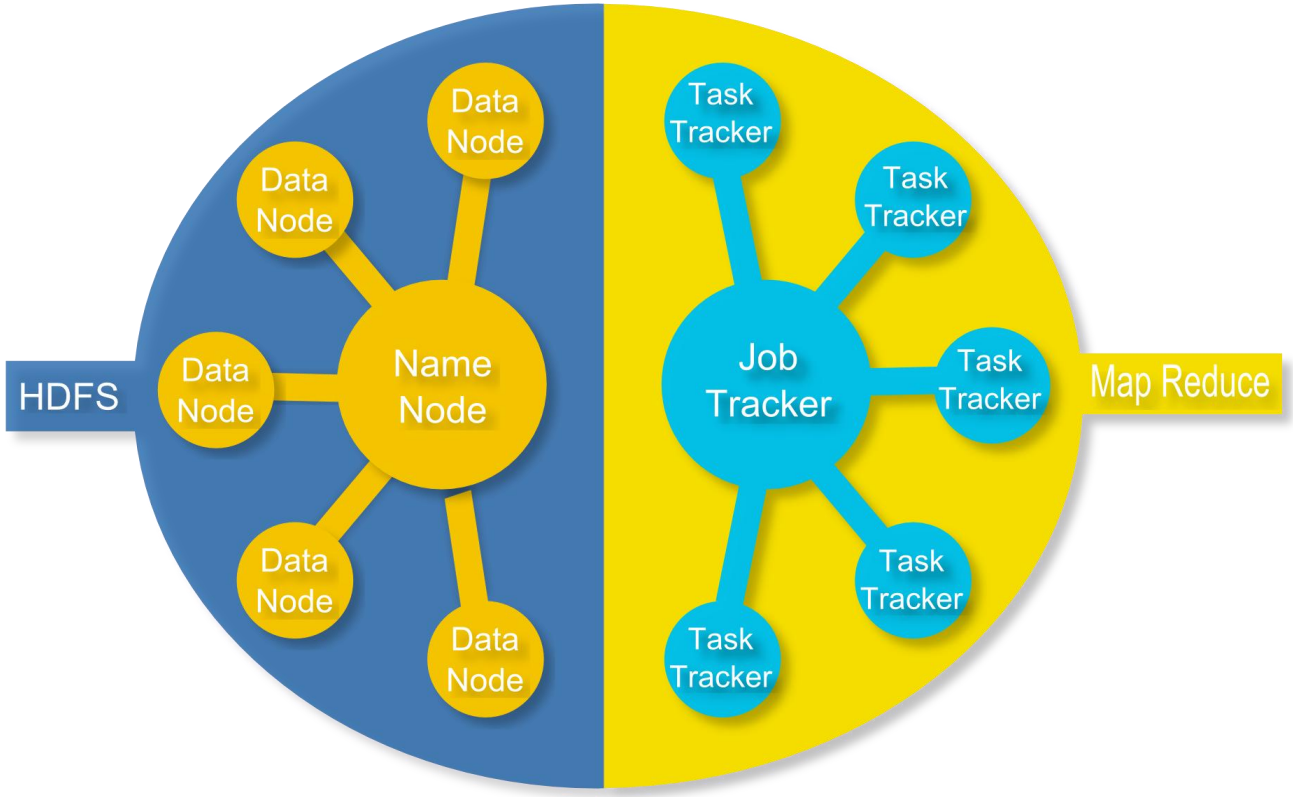
Hadoop Core Components



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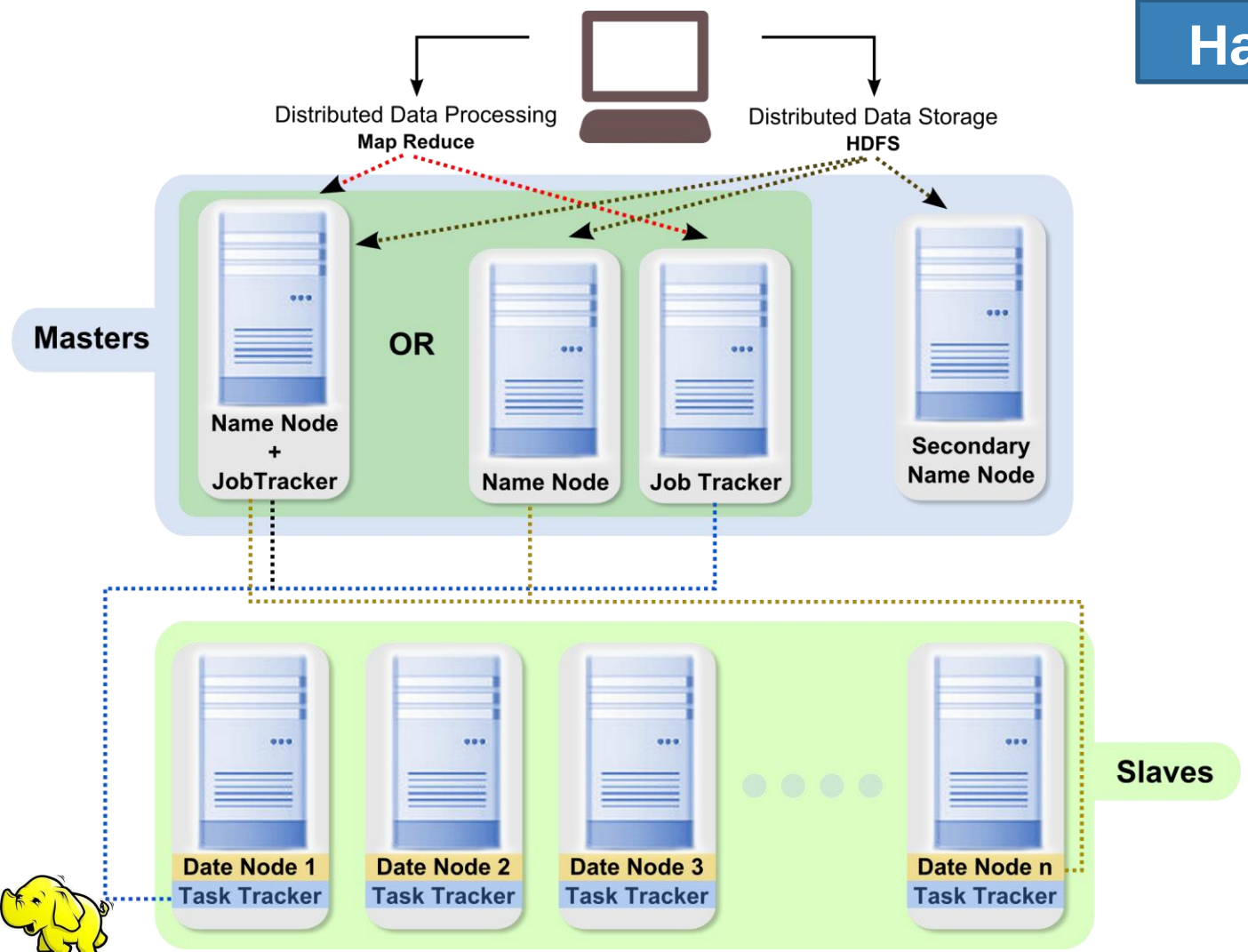
Hadoop Daemons



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HDFS Overview

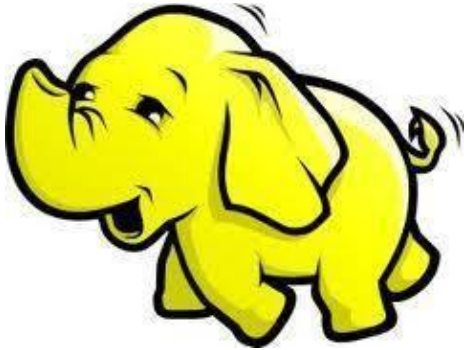
HDFS Design

- What is Hadoop designed for
  - Storing very large files MB,GB and TB range files each
  - Write once - Read many times
  - Works of commodity hardware

- What is Hadoop not designed for
  - Low latency data Access
  - Lots of small Files
  - Multiple writes and Arbitrary file modifications

The HDFS Concepts

- Data will continue to grow indefinitely, so need hardware that grows with data
- Cannot keep buying Bigger machines because after a while they become cost prohibitive
- Hardware should 'grow' as data grows and scale Horizontally
- Additional hardware should result in a proportional increase in performance



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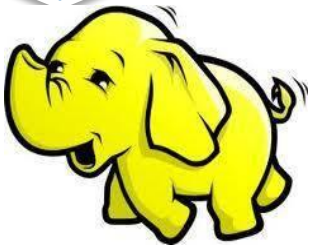
Hadoop Wants to Know?

Does HDFS have a single point of failure?



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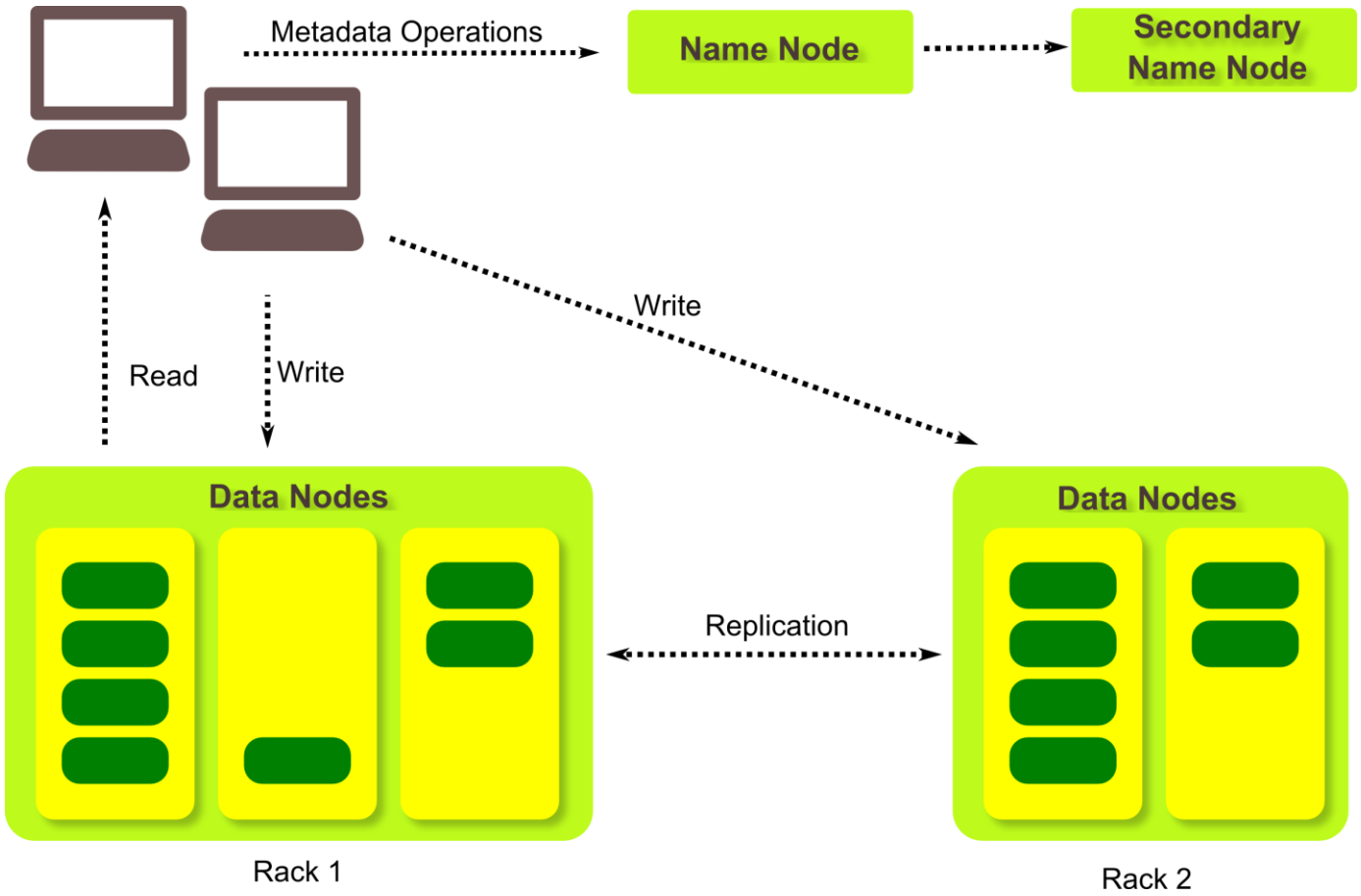
HDFS Architecture



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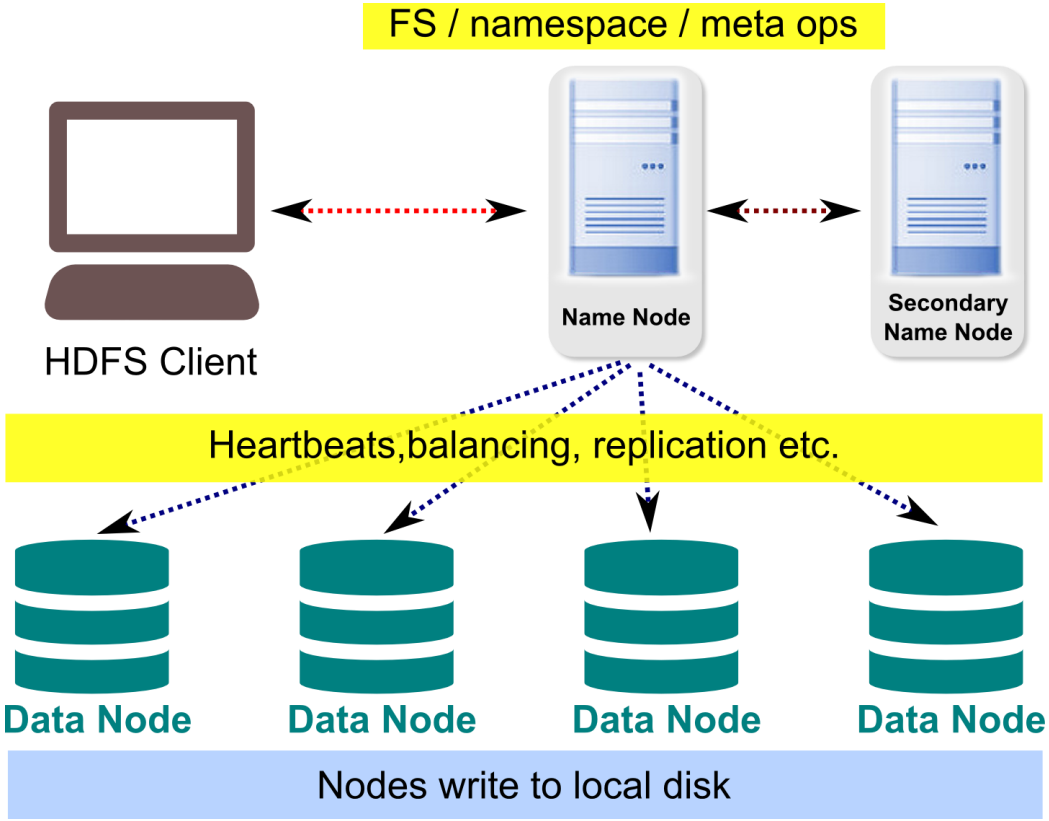
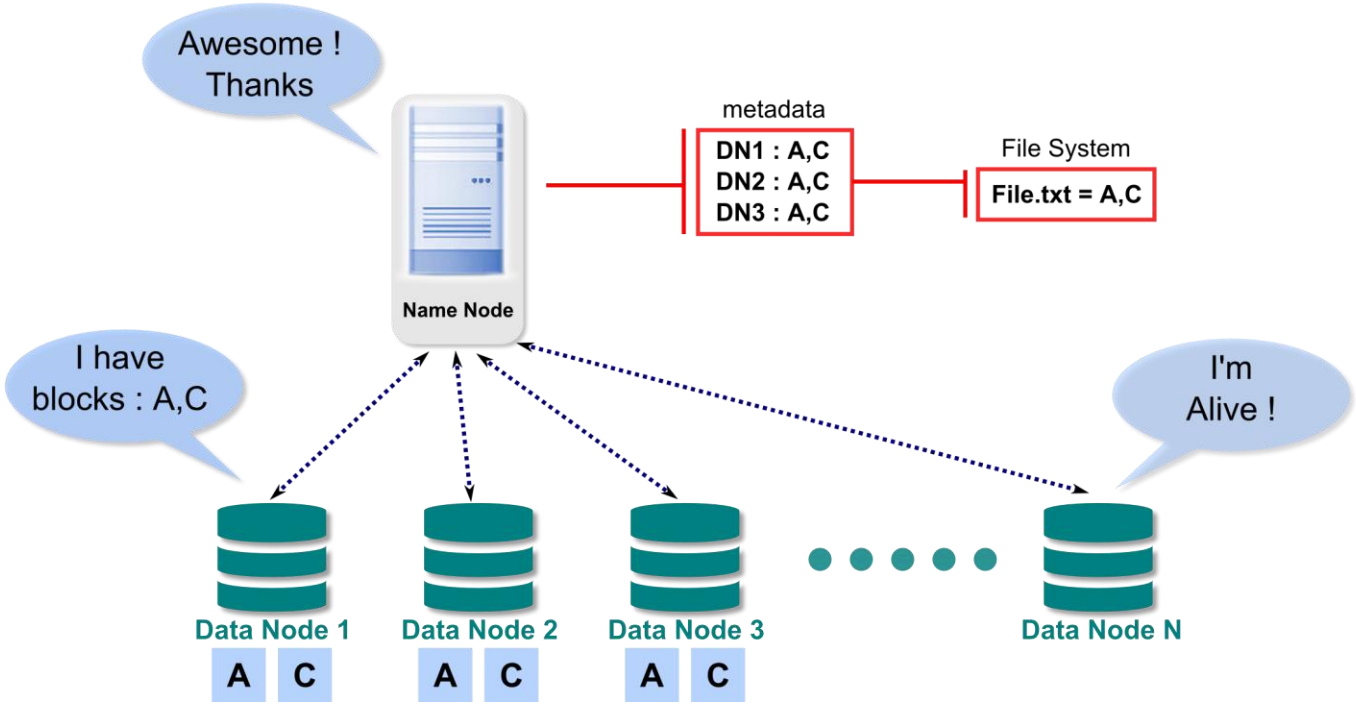
HDFS Architecture

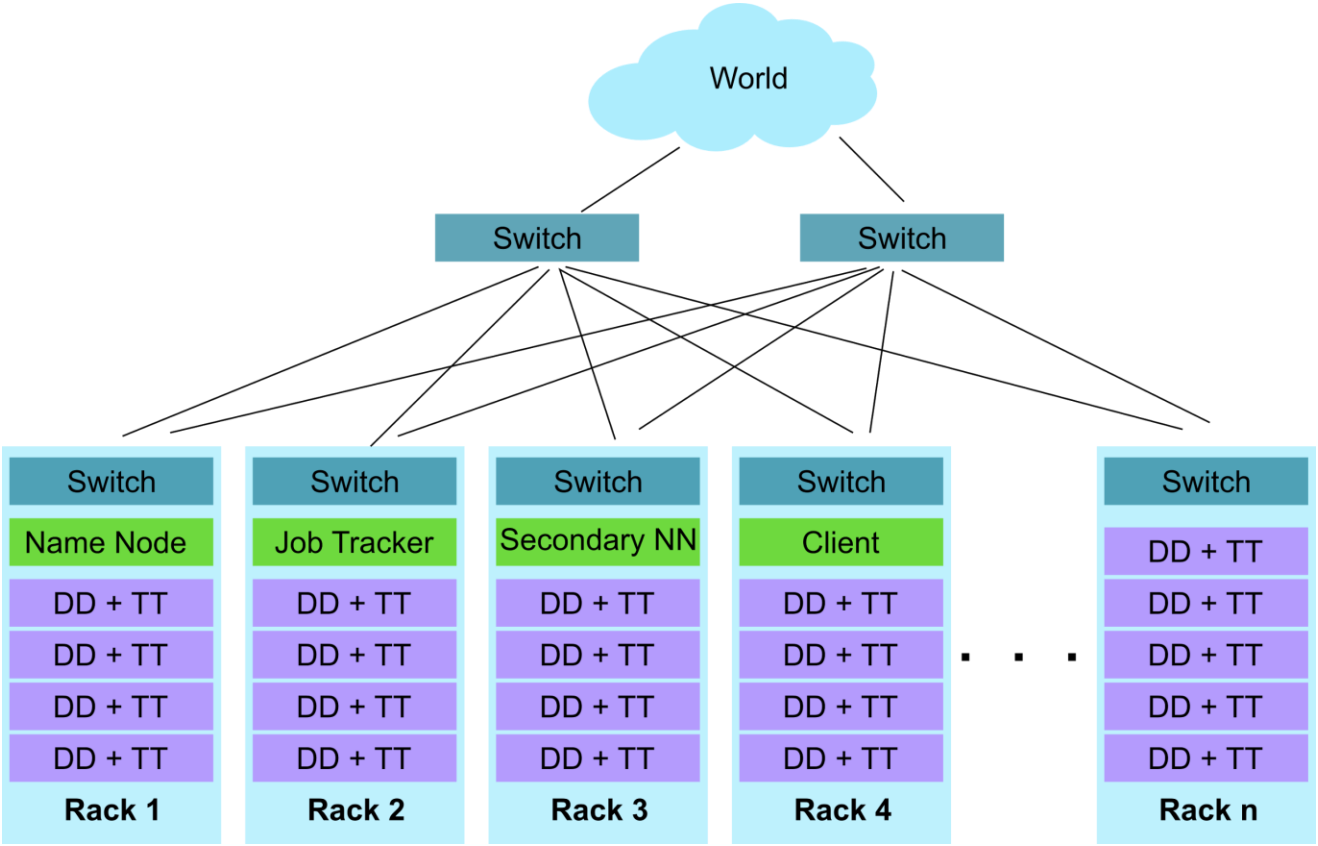


HDFS Architecture



- Data Node sends heartbeats
- Every 10th heartbeat is a Block report
- Name node builds metadata from block reports
- TCP every 3 seconds
- If name node is down, HDFS is down.

Hadoop Cluster in Production



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HDFS Main Components

- **Name Node (Master Node)**
  - Maintains and manages the blocks which are present on the Data Nodes
  - Manages the file system tree and Other meta information
  - It is responsible for maintaining namespace image and edit log files
  - Any Changes to the file System namespace or its properties is recorded by Name Node
  - Mapping of file blocks to Data Node(Physical location of Data)
  - Aware of the data nodes for a particular file
  - Important files for Name Node
    - Image: File Consist of Meta data information
    - Check Point: Persistent record of image stored in the native file system
    - Journal: Modification log of image stored in local file system

- **Data Node (Slave Node)**
  - Slaves which are deployed on each machine and provide the actual storage
  - Responsible for serving read and write requests for the clients
  - Store and retrieve blocks when they are told to
  - Report back to Name Node periodically with the list of blocks they have
  - Data Nodes are the work horses of the Hadoop file system
  - Block replica is represented by two files
    - File that stores the data itself
    - File that stores the block meta data which includes checksum for the block and block's generation time stamp

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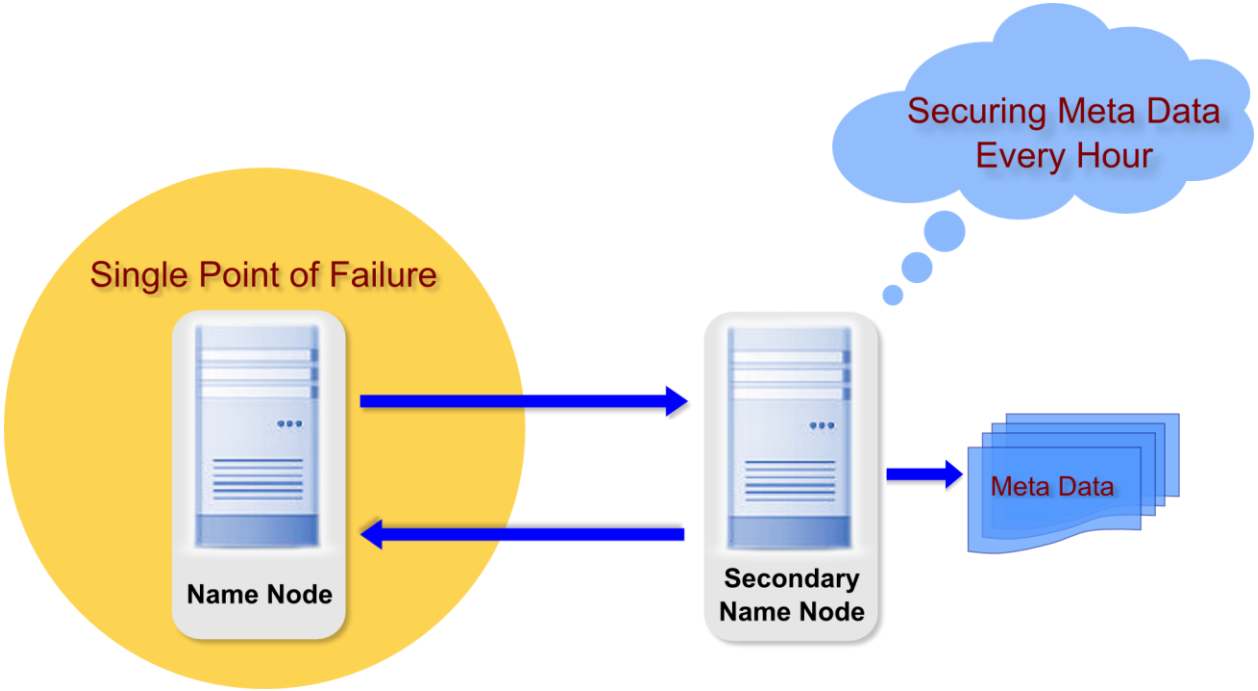
Secondary Name Node



- Not a hot standby for the Name Node
- Connects to Name Node every hour
- Housekeeping, backup of Name Node metadata
- Saved metadata can build a failed Name Node
- Its primary role is to periodically merge the namespace image and edit log size within a limit
- Secondary Name Node usually runs on separate physical machine because it requires as much memory as Name Node to perform the merge

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Name Node Meta Data

- Meta-data in Memory
  - The entire metadata is in main memory
  - No demand paging of FS meta-data
- Types of Metadata
  - List of files
  - List of Blocks for each file
  - List of Data Node for each block
  - File attributes, e.g. access time, replication factor
- A Transaction Log
  - Records file creations, file deletions, etc.

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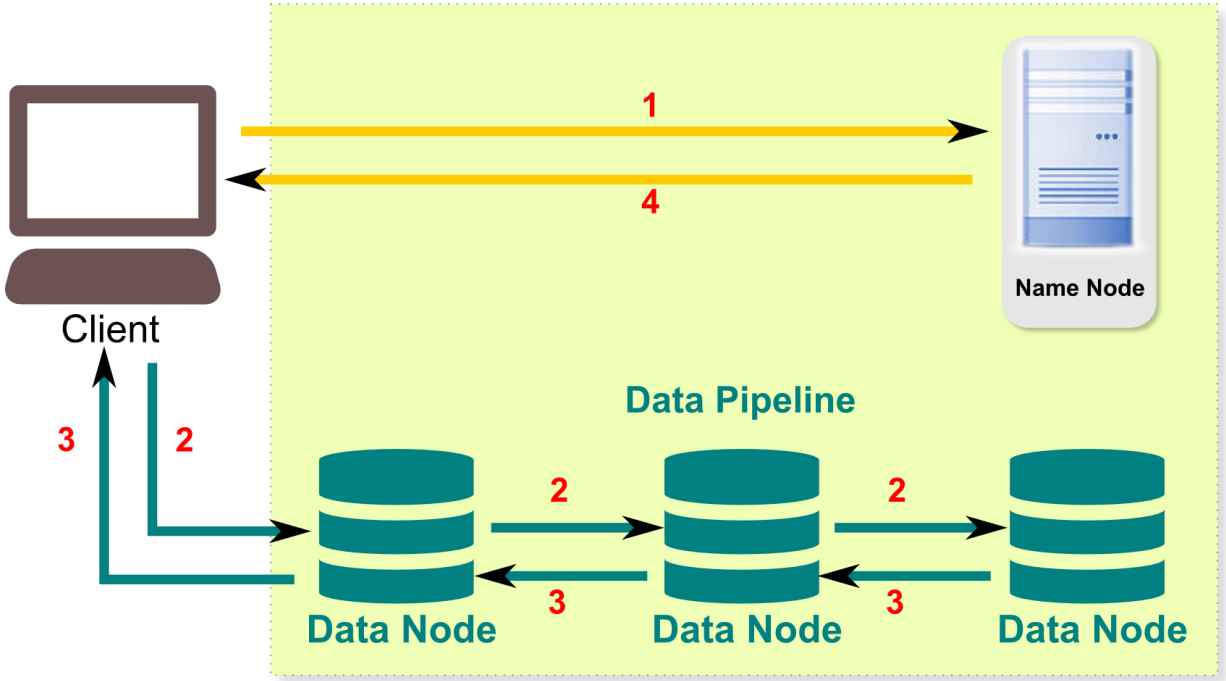
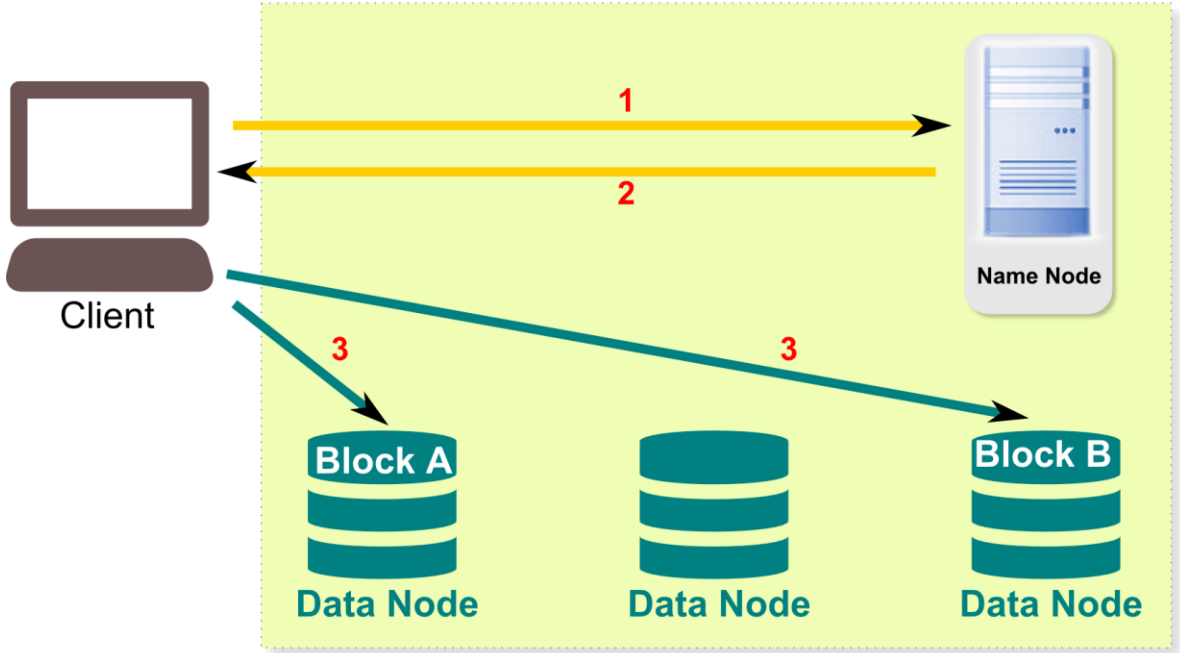
Anatomy of File Write



- Client creates a new file by giving path to Name Node
- For Each Block Name Node returns the list of data nodes to host its replicas
- Client Pipelines the data to the chosen data nodes
- Data node confirms the creation of block replica to name node

Anatomy of File Read



- Connects to Name node
- Asks name node to give the list of data nodes that is hosting the replica's of the block of file
- Client then directly reads from data node without contacting again to name node
- Along with the data, checksum is also shipped for verifying the data integrity. Why??
  - If the replica is corrupt client intimates name node, and try to get the data from other data node
- Client ask name node to fetch
  - List of blocks
  - Location of each block from name node
  - Location is ordered by the distance from the reader

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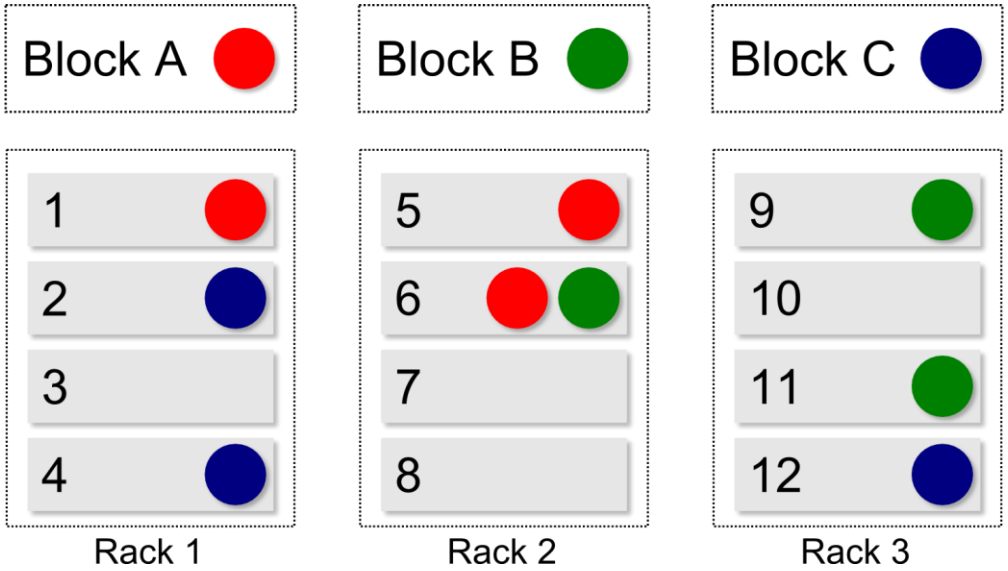
Replication and Rack Awareness



- **Replica placement policy**
  - 1st replica on one node in the local rack
  - 2nd replica on different node in different rack
  - 3rd replica on different node but same rack as 2nd replica
- **Improves read latency**
  - Block size and replication can be configured per file
  - Application can specify the replication of file

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RDBMS vs Big Data

RDBMS		Big Data
Structured	Data Types	Multi and Unstructured
Limited, No Data Processing	Processing	Processing coupled with Data
Standards & Structured	Governance	Loosely Structured
Required on write	Schema	Required on Read
Reads are Fast	Speed	Writes are Fast
Software License	Cost	Support only
Known Entity	Resources	Growing, complexities, wide
Interactive OLAP Analytics Complex ACID Transactions Operational Data Store	Best Fit Use	Data discovery Processing unstructed data Massive storage/processing

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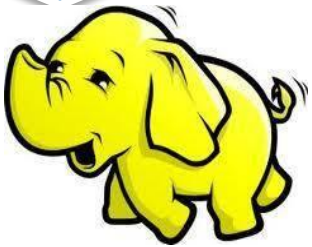
Hadoop Wants to Know?

What are the different components of the Hadoop ecosystem?



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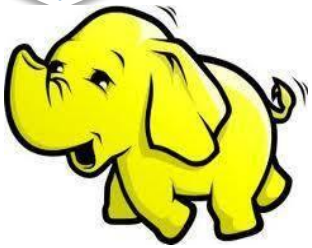
Hadoop Wants to Know?

Which type of nodes store the data in HDFS?

a) Job Tracker
b) Data Node
c) Name Node
d) Task Tracker



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Appendix

Links

- http://bigdataanalyticsnews.com/hadoop-interview-questions-hdfs/
- http://hadoop.apache.org/docs/r1.2.1/hdfs_design.html
- https://hadoop.apache.org/docs/r1.2.1/hdfs_user_guide.html
- https://hadoop.apache.org/docs/r1.2.1/commands_manual.html

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