

# Big-Data Problem solution using Hadoop and MapReduce

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**Abstract** -The size of the databases used in today's enterprises has been growing at exponential rates day by day. Simultaneously, the need to process and analyze the large volumes of data for business decision making has also increased. In several business and scientific applications, there is a need to process terabytes of data in efficient manner on daily bases. This has contributed to the big data problem faced by the industry due to the inability of conventional database systems and software tools to manage or process the big data sets within tolerable time limits. Processing of data can include various operations depending on usage like culling, tagging, highlighting, indexing, searching, faceting, etc operations. It is not possible for single or few machines to store or process this huge amount of data in a finite time period. The big data problem and its optimal solution using Hadoop cluster, Hadoop Distributed File System (HDFS) for storage and using parallel processing to process large data sets using Map Reduce programming framework is used.

**Index Terms**-- Big Data Problem, Hadoop cluster, Hadoop Distributed File System, Parallel Processing, Map Reduce

## I. INTRODUCTION

In this electronic age, increasing number of organizations are facing the problem of explosion of data and the size of the databases used in today's enterprises has been growing at exponential rates. Data is generated through many sources like business processes, transactions, social networking sites, web servers, etc. and remains in structured as well as unstructured form [1]. Today's business applications are having enterprise features like large scale, data-intensive, web-oriented and accessed from diverse devices including mobile devices. Processing

or analyzing the huge amount of data or extracting meaningful information is a challenging task.

## II. BIG DATA

The term "Big data" is used for large data sets whose size is beyond the ability of commonly used software tools to capture, manage, and process the data within a tolerable elapsed time. Big data sizes are a constantly moving target currently ranging from a few dozen terabytes to many petabytes of data in a single data set [2]. Difficulties include capture, storage, search, sharing, analytics and visualizing. Typical examples of big data found in current scenario include web logs, RFID generated data, sensor networks, satellite and geo-spatial data, social data from social networks, Internet text and documents, Internet search indexing, call detail records, astronomy, atmospheric science, genomics, biogeochemical, biological, and other complex and/or interdisciplinary scientific research, military surveillance, medical records, photography archives, video archives, and large-scale eCommerce. Big Data impacts include Walmart handles more than 1 million customer transactions every hour, which is imported into databases estimated to contain more than 2.5 petabytes of data – the equivalent of 167 times the information contained in all the books in the US Library of Congress, Facebook handles 40 billion photos from its user base and so on.

### A. What is Big Data Problem?

Big Data has emerged because we are living in a society which makes increasing use of data intensive technologies. One feature of big data is the difficulty working with it using relational databases and desktop statistics/visualization packages, requiring instead "massively parallel software running on tens, hundreds, or even thousands of servers" [3]. The various challenges faced in large data

management include – scalability, unstructured data, accessibility, real time analytics, fault tolerance and many more. In addition to variations in the amount of data stored in different sectors, the types of data generated and stored—i.e., whether the data encodes video, images, audio, or text/numeric information—also differ markedly from industry to industry [3].

### B. Big data techniques and technologies

Big data requires exceptional technologies to efficiently process large quantities of data within tolerable elapsed times. Technologies being applied to big data include massively parallel processing (MPP) databases, data mining grids, distributed file systems, distributed databases, cloud computing platforms, the Internet, and scalable storage systems. Real or near-real time information delivery is one of the defining characteristics of Big Data Analytics. Latency is therefore avoided whenever and wherever possible. A wide variety of techniques and technologies has been developed and adapted to aggregate, manipulate, analyze, and visualize big data [2]. These techniques and technologies draw from several fields including statistics, computer science, applied mathematics, and economics. This means that an organization that intends to derive value from big data has to adopt a flexible, multidisciplinary approach.

### C. Hadoop [5]

The Apache Hadoop project develops open-source software for reliable, scalable, distributed computing. The Apache Hadoop software library is a framework that allows for the distributed processing of large data sets across clusters of computers using a simple programming model. It enables applications to work with thousands of computational independent computers and petabytes of data. Hadoop was derived from Google's MapReduce and Google File System (GFS).

### D. HDFS (Hadoop Distributed File System)

The Hadoop Distributed File System (HDFS) is a distributed file system providing fault tolerance and designed to run on commodity hardware. HDFS provides high throughput access to application data and is suitable for applications that

have large data sets. Hadoop provides a distributed file system (HDFS) that can store data across thousands of servers, and a means of running work (Map/Reduce jobs) across those machines, running the work near the data. HDFS has a master/slave architecture. Large data is automatically split into chunks which are managed by different nodes in the Hadoop cluster.

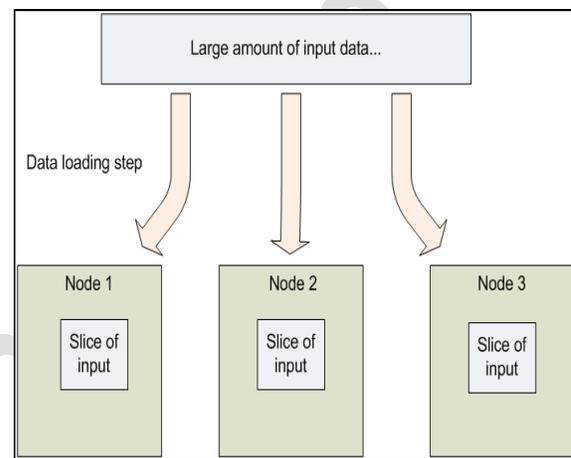


Figure 1: Data is distributed across nodes at load time

### E. MapReduce Programming Framework [6]

MapReduce is a software framework introduced by Google in 2004 to support distributed computing on large data sets on clusters of computers. MapReduce is a programming model for processing and generating large data sets. Users specify a map function that processes a key/value pair to generate a set of intermediate key/value pairs and a reduce function that merges all intermediate values associated with the same intermediate key [7]. "Map" step: The master node takes the input, partitions it up into smaller sub-problems, and distributes them to worker nodes. A worker node may do this again in turn, leading to a multi-level tree structure. The worker node processes the smaller problem, and passes the answer back to its master node. Map takes one pair of data with a type in one data domain, and returns a list of pairs in a different domain:  $\text{Map}(k1, v1) \rightarrow \text{list}(K2, v2)$  "Reduce" step: The master node then collects the answers to all the sub-problems and

combines them in some way to form the output – the answer to the problem it was originally trying to solve. The Reduce function is then applied in parallel to each group, which in turn produces a collection of values in the same domain:

Reduce (K2, list (v2)) → list (v3)

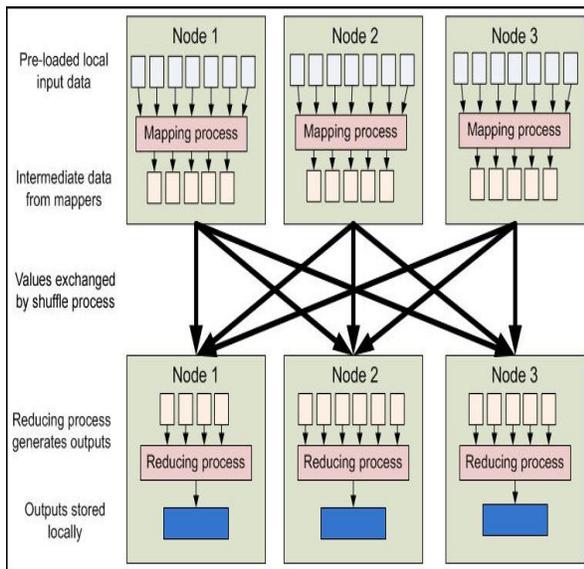


Figure 2: Distributed Map and Reduce processes

### III. SYSTEM ARCHITECTURE

The system architecture comprises of hadoop architecture, hadoop multi-node cluster setup, setup of HDFS and implementation of Map Reduce programming work to solve the data intensive problem.

#### A. HDFS Architecture [6]

As shown in Figure 3, an HDFS cluster consists of a single NameNode, a master server that manages the file system namespace and regulates access to files by clients. In addition, there are a number of DataNodes, usually one per node in the cluster, which manages storage attached to the nodes that they run on. HDFS exposes a file system namespace and allows user data to be stored in files. Internally, a file is split into one or more blocks

and these blocks are stored in a set of DataNodes. NameNode determines the mapping of blocks to DataNodes. HDFS is designed to reliably store very large files across machines in a large cluster. It stores each file as a sequence of blocks.

#### B. Hadoop Cluster High Level Architecture

Hadoop cluster comprises of a single master and multiple slaves or "worker nodes". The JobTracker is the service within Hadoop that farms out MapReduce tasks to specific nodes in the cluster, ideally the nodes that have the data, or at least are in the same rack. A TaskTracker is a node in the cluster that accepts tasks - Map, Reduce and Shuffle operations - from a JobTracker. The master node consists of a JobTracker, TaskTracker, NameNode, and DataNode. A slave or worker node acts as both a DataNode and TaskTracker.

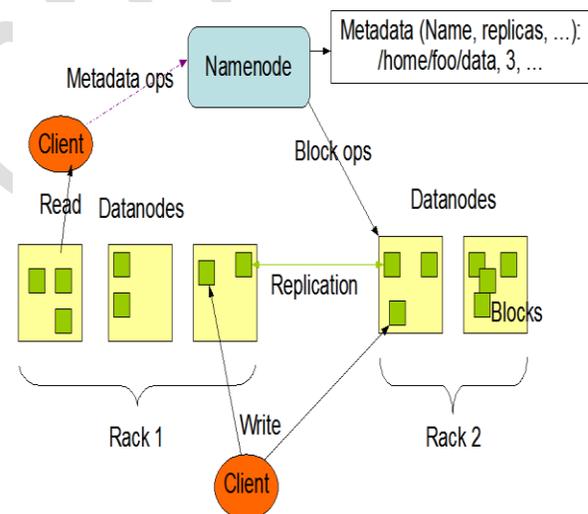


Figure 3: HDFS Architecture

In a larger cluster, the HDFS is managed through a dedicated NameNode server to host the file system index, and a secondary NameNode that can generate snapshots of the name node's memory structures, thus preventing file system corruption and reducing loss of data.

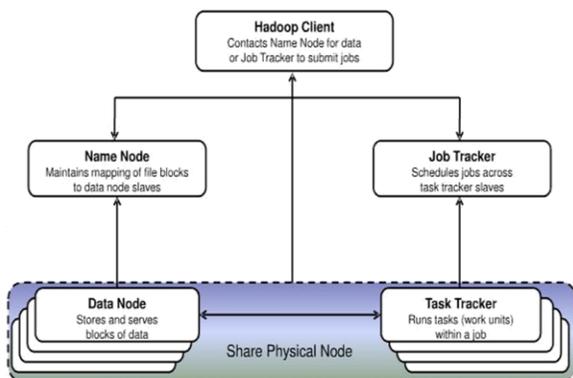


Figure 4: Hadoop high-level architecture

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## IV. CONCLUSION AND FUTURE WORK

In this work, we have explored the solution to big data problem using Hadoop datacluster, HDFS and Map Reduce programming framework using big data prototype application scenarios. The results obtained from various experiments indicate favorable results of above approach to address bigdata problem. Future work will focus on performance evaluation and modeling of hadoop data-intensive applications on cloud platforms like Amazon Elastic Compute Cloud (EC2).

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