Review Article

A Comprehensive Survey for Hadoop Distributed File System

ABSTRACT

The Hadoop Distributed File System (HDFS) is designed to effectively store and transmit huge data sets to high-bandwidth user applications. The differences between this and other file systems provided are relevant. HDFS is intended for low-cost hardware and is extremely tolerant to defects. Thousands of computers in a huge cluster both have directly associated storage functions and user programmer. The resource scales with demand while being cost-effective in all sizes by distributing storage and calculation through numerous servers. Depending on the above characteristics about the HDFS, many researchers worked in this field trying to enhance the performance and efficiency of the addressed file system to be one of the most active cloud systems. This report offers an adequate study to review the essential investigations in this direction as a trend to be beneficial for researchers wish to operate in such system. The essential ideas and features of the investigated investigations were taken in account to have a powerful comparison which in turn simplify the selection for the future researchers in this subject.

Keywords: Hadoop, HDFS, Distributed File System.

1. INTRODUCTION

One of the latest jobs in software technology trends, developed methods to store, manipulate and retrieve data from enormous data volumes. Hadoop [1] is a distributed filesystem and a multi-data processing and analysis platform based on the MapReduce methodology [2]. In the 10 years after it started out as an open-source project Hadoop has become the most frequently used computer platform for distributed data-storage and processing [3]. A key characteristic of Hadoop is the separation of data and processing over multiple (thousands) hosts and, in parallel with their data, the execution of application calculations [4]. By adding extra commodity servers, a Hadoop cluster will improve computer power, storage capacity and bandwidth. Hadoop is an Apache project. The Apache open-source license allows all its modules to be distributed freely. Yahoo! established Hadoop's Centre, and donated 80% of it (HDFS and MapReduce). HBase is currently a Microsoft division, developed at Powerset. Facebook has developed and generated Hive [5]. Pig [6], ZooKeeper [7], and Chukwa conceived and developed Yahoo!. In cooperation with Cloudera, Avro was created at Yahoo!. Hadoop was created, an effective open-source application, due to the necessity of MapReduce. Hadoop is currently utilized for backend data analysis by many business and academic users, which was developed in Java for cross-platform portability. The distributed Hadoop file system (HDFS) is a crucial component of Hadoop and is utilized for the storage of both input and output data for applications [8]. HDFS separates metadata and files of the device from metadata. HDFS maintains metadata on a dedicated server known as the Name Node same like other distributed file systems such as PVFS [9] and GFS [10]. Application data is saved on extra Data Nodes servers.

Both servers are fully connected with each other and interact with each other using TCP protocols.

2. BACKGROUND THEORY

2.1 Hadoop

A free open-source Apache Foundation project, Hadoop, is a Java framework. It enables enormous volumes of data to be processed in a cluster of one or more hundred machines. This is the first technology that enables you to digitally store, manage and analyse an endless amount of data in order to allocate suitable work to the system concerned. TECHNOX [11] includes Hadoop's two core services: Hadoop Distributed File System (HDFS) data storage and MapReduce technique, large-scale parallel data processing [12].

2.2 Fiber Optic Communication principles

Every Hadoop distribution has a Big Data system notion. A number of studies to define and describe big data as a huge data volume have been undertaken. In addition, big-data features are speed, variety and increasing data volume [13]. Big data are divided into three different types: structured, unstructured and half-structured data Additional big data categories include pictures, video, audio and natural language [14]. Highly organized structured data is, however unstructured data is not maintained systematically and clearly. For example, Wikipedia, Google, Facebook and Amazon utilize unstructured data formats whereas e-commerce businesses use structured data formats [11]. NoSQL is a new database technology class designed to handle big data problems that is "Not only SQL." Unstructured and semi-structured data eventually generates a variable number of data fields and diverse content, providing a challenge for the database model. Current systems of NoSQL might be categorized into four large groups. Key/Value: This idea is like a distributed hash map. It maintains information as a key/value pair, where the value may be an integer or serialized object string [15].

Column-oriented: Because the data is kept in a row with columns, it simulates relational database [16].

Document-oriented: The document-oriented model's ability to retrieve a hierarchically structured set of information using a single key distinguishes it [17].

Graph-oriented: on the basis of graph theory It is primarily based on the concept of nodes, connections, and attributes associated to the nodes [18].

2.3 HDFS

Hadoop distributed file system need security solutions in order to safeguard their data while retaining high performance. In order to be secure, several researches assume that HDFS is encrypted [12]. In this situation, big data is divided into 64MB or 128MB. Three duplicates are made of each block and these copies are stored on three different computers [14]. When the system has a large amount of data and a simultaneous job, accessing the HDFS files may need multiple interacting Name Node and Data Nodes connection, which lowers the speed of access considerably [19].

Name Node maintains the hierarchical file tree structure in the filesystem. The files are stored as blocks on behalf of the customer by the Data Nodes [20]. Each block is stored to the local node filesystem as a separate file. Data nodes do not need to be equal in their features since Data Nodes abstract the underlying filesystem details [21].

2.4 HDFS Architecture

The name node and data node are software components that may be executed on commodities machines. HDFS is created in Java language and can run the Nama node or Data node software on any Java-supporting devices. The use of Java language is extremely portable and allows for HDFS on multiple computers [22].

The Hadoop user can process the dataset on the local system on a single node, by using local mode or stand-alone mode. Known as the Hadoop Distributed File System (HDFS) and MapReduce are Hadoop's key components [23]. The HDFS is developed in Java and splits the dataset file into blocks according to data size. In the processing of the data set the HDFS employs the Name and Data Node systems [24].

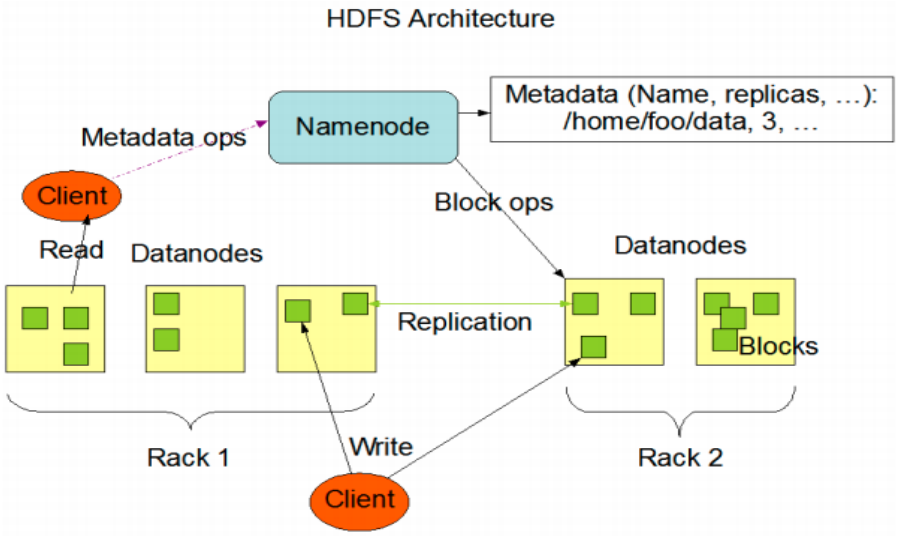

Fig. 1. HDFS Architecture

2.4.1 Name Node:

The name space for HDFS is a hierarchical file and directory. Files and folders on the Name Node are specified using inodes which hold attributes like rights, changes and access times, namespace and disk space quotas [25].

The Name Node keeps the namespace tree and routes file blocks in Data Nodes 2 (the physical location of file data) [26]. When an HDFS customer wishes to read a file, they first contact the Name Node in order to identify the data blocks in the file and then receive the information on the block from the Data Node closest to the customer [27]. The client asks the client to pick a group of three data nodes to host replicas of the block while typing data. The customer then transfers data in a pipeline format to the Data Nodes. Every cluster has its Name Node in the current arrangement [28].

HDFS holds all namespace in the RAM. Indole data and the list of blocks belonging to every file is the image metadata of the naming system. A control point is a persistent picture archive saved on the default localhost filesystem [29]. The Name Node also keeps the record of changes to the picture, called the document, on the original file system of the localhost. Redundant checkpoint and diary copies can be generated to improve durability on different servers [30]. The Node name reads the namespace and replays the log to reset the namespace upon restarting. Block copies that vary over time and do not form part of the permanent checkpoint.

2.4.2 Data Nodes

In the native file system of localhost, three files support each Block Replication on the Data Node [31]. The first file contains the information and the second file contains the metadata of the block and gives the block data and the stamp creation [32]. The size of the data file equals the whole block length and does not need considerable space, as in traditional file systems, to round it to its nominal block size. Therefore, if a block is half filled, then the local drive requires just half the size of a complete block [33].

Each Data Node block reproduction is defined by two files in the default filesystem of the local host. The Name Node does not contact Data Nodes directly [34].
It delivers commands in response to heartbeats to the data knots. The following guidelines include:

- Distribute blocks to other nodes.
- Get rid of local block replicas;
- Re-register the node or shut it down;
- Submit a block report right away.

As these instructions are necessary to preserve the overall integrity of the device, it is crucial to maintain heartbeats even in big clusters. Despite interfering with other Name Node activities, the Name Node can handle miles of heartbeats every second [34].
Data Node without namespace ID was born in an era and the cluster's namespace ID is permitted to enter and gather [33].

2.4.3 HDFS Client

HDFS organizes a group to read, edit, and delete files and transactions for creating and deleting folders, like most classic file systems [35]. The administrator uses namespace paths to connect to files and folders. The user application must not be aware that the metadata and persistence of the file system are hosted in various repositories or blocks have several replicas [33].

2.4.4 Image and journal

The name space image is the metadata system file defining how to organize data in folders and files. The image archive written to disk is a continuous checkpoint [34].

2.4.5 Checkpoint Node

The Node includes the current control point and diary for the regular construction of a new control point and a blank diary. Since the Checkpoint Node has the same RAM as the Name Node, it is generally run on a different host [36].

2.4.6 Backup Node

The Backup Node allows you to construct intermittent control points but also maintains a current image in the memory of the name of the file system that is always manfully aligned with the Name Node [34].

2.4.7 Upgrade, file system snapshot

Snapshots in HDFS are designed by device updates to decrease the chance of data loss. The snapshot feature allows admins to record frequently the current status of the file system, meaning that the upgrade may be rolled back and HDFS restored in the name and storage state of the file at the time of the shoot if an upgrade leads to data failure or abuse [24].

HDFS was meant to store large files with data access streaming patterns. As said before [37]. In other words, as seen below, there are problems with minimum data:

- **High Name Node’s memory consumption**

Node Name eats a lot of memory. Name Node stores metadata in the main memory. A total of around 250 bytes of main memory are used in a document's metadata. Metadata will absorb roughly 368 bytes of every block with the usual three copies [38].

- **Unacceptable storing time**

For example, 550,000 tiny files of between 1KB and 10KB in size are saved in HDFS in around 7.7 hours. On the other hand, it takes around 660 seconds to save such data in a local file system, such as ext3 [39].

- **Name Node becomes bottleneck**

Metadata maintenance in HdFS is a time-consuming operation, as it requires node coordination [28]. The HDFS client must first obtain the metadata of the file from the Name Node to access a file. For tiny files the transfer of data needs very little time, but disk search and metadata management constitute considerable overhead [29]. The HDFS client must call Name Node often with a high number of tiny files, which can substantially influence the performance of Name Node [40].

For the management of a large number of tiny files, Hadoop Archive (HAR) gives Hadoop. The user groupes and saves all the tiny files in a certain archive format (.her) [41]. The Hadaop archive command uses the HAR command to construct a task for MapReduce to compress a set of local files onto large files to enable the parallel (file extension free) and efficient retrieval of the original files [42].

2.5 MapReduce

MapReduce is a software framework that belongs to the Hadoop context. It can manage large quantities of data that may be used in thousands of nodes in the terabyte range [43]. The MapReduce approach splits maps into maps and reduces the functionality [44]. Users supply a map function which processes a key/value pair to produce a collection of mid-key/value pairs and decreases a function that merge all the mid-term values with the same key [45]. MapReduce and HDFS are the fundamental components of Hadoop. In essence, HDFS employs a writing and reading process mechanism to disseminate data inside a local node (Single Node model) or via many nodes (Multiple Nodes Model) [13]. HDFS offers the MapReduce replication feature to enhance performance. MapReduce is a master node (Job Tracker) and multiple slave nodes (Task Trackers). A JobTracker is responsible for the task trackers group of slave nodes [14].

MapReduce operates on the acceptable items by running the map function first and subsequently the reduction function on the unwanted things [46]. The implementation of MapReduce is based upon programs in many languages such Java, C, or Python [45]. MapReduce is a Hadoop function which reorganizes a dataset content [47]. A program code comprises largely of the Mapping funktion and subsequently the Reducer function for the rearrangement of items in a dataset. During the MapReduce process, the main and value rule are applied on target objects to use Map and Reduce processes [43].

3. LITERATURE REVIEW

The distributed file system has always been necessary for continued progress and expansion since the 1990s. Chandrasekhar and others [21]. Proposed Extended Hadoop Distributed File System (EHDFS) to enable the combination of a vaster number of small files, increase access to small files efficiently and improve EHDFS metadata management for smaller files to improve memory usage of HDFS resources.

The techniques of simulation and modeling relied on Mendoza and Lorene [48], In order to examine the system's behavior inside a cluster of workstations many simulations have been done. (HDFS) Model of colored Petri Networks (CPN) to study and evaluate the accessibility of workstations to a model by exploring different configurations and alternative approaches. The simulation findings show that acceptance or rejection of the Name Node pipeline is a key constraint.

The automatic benchmarking system introduced by Kim et all [49] (ABCM), This work developed the identification process for the set of settings parameters, reducing the benchmark runtime. Especially TestDFSIO write and read, the major setup generated by ABCM to change the Benchmark Time. Optimal parameters have been determined, lowering by 32 percent the average execution time compared to the default set of Hadoop setup options. The four kinds of NoSQL database are included by Erraissi and Belangour [11] as

proposed For big data efforts, several companies use this software platform and its various components. Ethiopia and others [14] The complexity of the time of an algorithm indicates how long an algorithm takes to finish. O (long) time complexity is fair scheduling. Masmoudi and Almansouri [13]. Hadoop proposed on one node architecture allows the cost-effective analysis on a local workstation and automatic HDFS backup. The proposed encryption of Mahmoud et al. [49] HDFS files were encrypted with AES and OTP methods. Enhance the Encryption/Decryption file performance of this technique. Liao and al ., [50] Presented a hierarchical approach to structural structure, which may be utilized to facilitate the processing of HDFS data, as well as B-tree and R-tree variants. The distributed caching system built on top of the HDFS dubbed HDCache was described by Zhang et al. [19]. Use common memory to compensate for the shortcomings in performance (HDFS). Vijayakumari and others[51]. Apache-owned components of the Hadop Project include Hadoop Distributed File System and MapReduce. Comparisons are made between these two file systems with certain parameters (Security, File serving ... etc.).
Wang et al. [52] proposed Zput's Remote Block Placement support and design. Zput's major benefit over HDFS-put is an improved upload efficiency while avoiding negative effects. They provided Hua et al. [53] with rigorous interaction tasks The HDFS modifications are: (2) the caching on each rack to increase I/O functionality in accessing interaction-intensive files; (3) the use of PSO-based methods, in order to establish a near optimum storage allocation plan for incoming documents. Shahabinejad et al, respectively [54]. They have suggested a locally repairable binary code (BLRC) since our binary code does not include finite set multiplication, encoding, decoding and repair which saves considerable time. Krishna and others [55]. They realized that HDFS works well for files bigger than the default size of blocks, and poorly for files smaller than the normal size of blocks. Clubric et al. [56] The security of essential data, not accomplished by Kerberos, at an HDFS storage level. Day and al .[57] Suggest a novel replica placement method for HDFS that addresses the problem of load balancing through the consistent distribution of replicas onto cluster nodes and hence eliminates the need to provide any load balancing utility. Qu et al. Qu et al. [58] The DRS approach based on an improved Markov model of the chain is proposed. The Markov model distinguishes between various data kinds and changes the copies dynamically, which will then be spread equitably throughout the rack, depending on the connection between the files. Zebedie and al. [27] In distributed systems, Hadoop's performance is clearly higher than other technologies used for the same purpose. A number of important companies, like Facebook, have implemented Hadoop.

4. DISCUSSION AND COMPARISON

In this article, it is crucial to emphasize that every author has distinct perspective, but identical aims, while analysing HDFS performance. The purpose of Hadoop adaptation to distributor systems is to speed up storage, processing, analysis and management of huge data. The Hadoop in an original manner, including Twenty researchers covered in the literature review part (architecture and operation) were detailed. An overview of the comparison of twenty prior publications is provided in Table 1. Comparing the performance of Hadoop in the distributed system area with previously dependent approaches. The comparison focuses on the dependent instruments, the aims attained and the important results for each study.Hadoop's architecture and operation, is described by each writer. Comparing Hadoop's performance with other previous techniques in the distributed system

Table 1. Comparisons of related works

Ref. no.	Tools	Achieved Objectives	Significant Results
Mendoza	CPN the Colored Petri Nets combined	The feasibility of exploiting the idle computational	in order to achieve a reliable service for Writing and reading files despite the

and Quesada **[48]**	with the CPN ML programming language	storage in a large Cluster of Workstations (COW).	random failures due to the turning on and off of the computers in a COW with hundreds of machines.
Aswan et al. [59]	small single rack implementation and multi rack implementation of the HDFS	the high overview of Hadoop Distributed File System architecture and different server roles	MapReduce is used for implementation, and HDFS is in charge of storing huge datasets.
Chandra sekhar et al. **[21]**	Extended Hadoop Distributed File System (EHDFS).	To minimize the file count, a collection of associated files discovered by the client is merged into a single huge file.	EHDFS can minimize metadata while increasing the efficiency of storing and accessing a large number of tiny files.
Kim et al. **[49]**	small single rack implementation and multi rack implementation of the HDFS	the high overview of HDFS architecture and different server roles	MapReduce is used for implementation, although suitable dataset management and storage, HDFS assumes the job of storing huge datasets.
Manias and Schroeder [3]	(HDFS)'s code evolution. based on the reports and patch files (patches)	classify the root causes of issues at a finer granularity than prior work	having an ever-increasing pace through time Furthermore, the total breadth and complexity of reports and patch files stay fairly consistent through the lifespan of HDFS.
Erase and Selangor **[11]**	Model Driven Engineering (MDE)	the storage layer is very useful and is essential	Model Driven Engineering (MDE) is used to offer universal Metamodeling for the storage layer of a Big Data system.
Hussain et al. **[14]**	introduce a job scheduling algorithm	Scheduling is more complicated since it is Required in large data time optimization.	The approach has lowered the number of iterations while increasing time efficiency
Almansouri and Masmoudi **[13]**	Illustrated the main steps to setup Hadoop and MapReduce	Hadoop for big data analysis has provided critical information that may be used for analysis.	Hadoop employs MapReduce, in which the dataset is processed in the Mapping phase before being reduced in the Reducing phase.
Mahmoud et al. **[12]**	encryption /Decryption file by using AES and OTP algorithms	Because of huge data Cloud computing provide users with on-demand, reliable, flexible, and low-cost services	As the size of the encrypted file expanded by 20% from the initial file size, This ratio improved.
Liao et al. **[50]**	built-in block-based hierarchical index structures, like R-tree	to arrange data sets in one, two, or more dimensions	increase query performance for commonly used query types (e.g., point Query, range query) on (HDFS).
Zhang et al. **[19]**	HDFS-based Distributed Cache System (HDCache).	Files loaded from HDFS are cached in shared memory and may be accessed immediately By a client library.	cache system can store files with a wide range in their sizes
Vijayakumari et al. **[51]**	Cloud computing, Google File System (GFS) and (HDFS)	Hadoop MapReduce is based on the Google MapReduce concept.	GFS is built to function in data centers to provide exceptionally high data throughputs, minimal latency, and the ability to withstand individual Server outages.
Wang et al. **[52]**	Zput.	which can substantially speed up uploading by employing a metadata mapping strategy	the remote block placement can boost the course of block
Hua et al. **[53]**	interaction-intensive files	The paper addresses the throughput degradation problem while reading interaction-intensive files and proposes an improved HDFS design,	HDFS throughput for interaction-intensive files rises by 300 %, with just a little performance hit for big data set workloads.
Shahabin	locally repairable	(LRCs) computational	code has lower complexity than most

ejad et al. **[54]**	codes (LRCs) ,binary locally repairable codes (BLRC)	complexity reduction can be attractive.With regard to the immense size of modern energy-hungry HDFS	recent non-binary LRC desirable requirements in HDFS such as storage overhead and reliability.
Krishna et al. **[55]**	Apache Hadoop project	The computation in HDFS is Done at the nodes where the necessary data is stored.	For files larger than the default block size, HDFS operates admirably.
Shetty and Manjaiah , **[56]**	data security is to encrypt the data that is stored in Hadoop,	Data security will be a crucial consideration when storing sensitive data on Hadoop.	Hadoop security features include Kerberos And Transparent Data Encryption (TDE) for Hadoop as well as security in the Hadoop Distributed File System.
Dai et al. **[57]**	placement of data replicas	Another placement policy that approaches the sender of information from an entirely different angle	HDFS replica placement policy, capable of generating replica distributions that fulfill all HDFS replica placement standards
Qu et al. **[58]**	DRS, a dynamic replica strategy based on improved Markov model	DRS may dynamically increase or decrease the number of replicas when the Data becomes hot or cold.	DRS is effective, and it clearly outperforms HDFS's static replica Method.
Zeebare e et al. **[27]**	Hadoop Distributed File System (HDFS) and Map Reduce (MR).	HDFS, analyze, process and manage large data and very easy and fast to access data on different servers in the clustered system	HDFS is used to process and compute The number of words in a large database. Hadoop obviously out-performs alternative software used for The same goal.

5. CONCLUSION

From the previous works addressed in this paper, and depending on the summarized comparison in section 4, it can be concluded that the previous researchers focused on: the unstructured data sets are processed quickly using the programming paradigm and HDFS of Hadoop MapReduce. Also, the Hadoop enables you to work with the MapReduce framework while masking the complexity in public or private cloud to install, configure and operate computer modules, the users can build a cluster of commodity servers using Hadoop. MapReduce has been developed by some researchers as a stand-alone, service-like platform, which can be adapted to fit the demands of cloud providers. It also enables consumers to gather and analyze data. Adding to that, the HDFS is a fast-changing technology for storing and managing large data. Finally, HDFS is master/slave design-based and more powerful for read-intensive business intelligence systems databases.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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