



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 9, Issue 9, September 2020

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

A Secured Cloud-Based Computing Framework

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ABSTRACT:The advents of Information Technology have led to the evolutions of big data and have gained much impetus in enhancing knowledge management. However, the availability of these big data can no longer be effectively stored and analyzed with traditional data management techniques to provide insights for Knowledge development. This brought about the emergence of new technologies and architectures that are required to store and analyze this big data through advanced data analytics and in turn generate vital real-time knowledge for effective decision making, innovation, efficiency and productivity for National Data Management. Hence, a unified, flexible, and scalable Cloud Based technology is used to collect, host and analytically process large-scale computing tasks efficiently and manage knowledge with minimum cost. Despite these benefits Cloud Data Management and Traffic management are issues of concern. This Study explores an intelligent cloud based computing framework that effectively analyze big data captured from different enterprise data sources and share the data to facilitate knowledge management and enhanced decision making intended for National data Management. The study adopts a Model Design and Simulation-based approach using Java API 8.2 and CloudSim 3.0 respectively. This paper contributes to both the theoretical and practice domains of Cloud Computing, Big Data Analytics and Knowledge Management that will aid in the management of National Data. Testing the performance of the framework with more complicated data and bandwidth/memory were recommended for further studies.

KEYWORDS:Cloud Computing, Big Data, Big Data Analytics, Knowledge Management

I. INTRODUCTION

The advent of Information Technology, have increase the amount of Data/Information being generated, stored and shared at an unprecedented pace [1]. The availability of this data brought about the emergence of new waves as the next frontier of innovation, competition and productivity in all facet of live. This requires a new, innovative and scalable technology to collect, host and analytically process the vast amount of data gathered in order to derive real-time insights that relate to consumers, risk, profit, performance, productivity management and enhanced shareholder value [2]. These leverage the concept of Big Data that emerges as the latest stage of the evolution that combines three trends in technology, which [3] described as the three perfect storms: computing, data and convergence. The computing storm results from the exponential growth of processing power, mobile computing, social network, and cloud computing, The data storm results from the accessibility of data with high volume, velocity and variety. The convergence storm results from the availability of open-source technology and commodity hardware [4].

II. LITERATURE SURVEY

A. Data, Big Data and Big Data Analytics

Data as the basic block for building information comes from various sources, organized or unorganized and will continue to increase at a faster rate [5]. Such massive amount of data that is being produced continuously is what can be termed as “Big Data”. However, as the amounts of data increases exponentially, the current techniques are becoming obsolete while it requires comprehensive coding skills, domain knowledge and statistics [6]. The volume of data has reached to the point where the management of the data asset by traditional means is no longer possible [1].

Big data refers to the high volume, velocity, and variety of information assets that demand new, innovative forms of processing for enhanced decision making, business insights, and process optimization [7]. The basic idea of big data includes the techniques, technologies, and skilled professionals needed to manage [8].The concept of big data with the capability to store data quickly isn't new. What's new is the capability to do something meaningful with that data, quickly and cost effectively [9]. Therefore it is concluded that there is a competitive advantage for institutions and corporations that can afford the computing infrastructure necessary to analyze Big Data with certain ethical concerns about accessibility that people can be analyze without knowing it [10].

Big data is originally characterized by the “3Vs” of volume, variety, and velocity, and has begun from the developments in sensing, measuring, and social computing technologies [7]. [11] In contrast to the above, further identify the Vs as; visualization, variability, vulnerability, visibility, vagueness and, no doubt others all of which must be managed. [12] extend the original V’s to incorporate; validity and volatility. In another view, [13] identify new attributes, transforming the 3Vmodel into the multi-V model. Additional characteristics include; veracity, value, variability, validity, visibility and verdict where the 3Vs; value, visibility and verdict – constitute the business intelligence (BI) aspects of the data concerned while veracity, validity and variability constitutes the statistical perspective of the data. However, veracity (accuracy) and value are the most important, and the value is the most time-consuming to extract, and difficult to determine [1].

Big data analytics (BDA) is emerging as an interesting area among scholars and practitioners, it is defined as a holistic approach to managing, processing and analyzing the V’s data-related dimensions (i.e., volume, variety, velocity, veracity and value etc.) to create actionable ideas for delivering sustained value, measuring performance and establishing competitive advantages [14]. Certain practitioners and scholars have gone so far as to advocate that there is no need to distinguish BDA from Data analytics, as data will continue to grow and will never be small again [10]. [15][16] and [17] refers to BDA as “the next frontier for innovation, competition, and productivity”, the “fourth paradigm of science”, and a “new paradigm of knowledge assets” respectively. It is argued that Big Data concept may be just a hype to sell Hadoop based computing Systems and may not always be the better data [10]. Big data analytics includes all the qualitative and quantitative techniques and processes used in enhancing data productivity. However, the data is extracted and classified in order to identify, and analyze its behavior and patterns related to the techniques in accordance with organizational requirement [1]. Currently, research and application of Big Data are being extensively explored by governments, academics and companies [18]. Limited access to Big Data creates new digital divides that emanates between organizations being able to analyze Big Data or not. Also organizations with access to Big Data will be able to extract knowledge in the best possible way, which may create a division between Big Data rich and poor organizations [10].

B. Knowledge and Knowledge Management (KM)

Managing and utilizing knowledge effectively is vital for organizations in order to take full advantage of its value, and therefore must depend on its key elements: employees, processes and content in order to acquire an applicable technological solution. Knowledge as the final step in the data-information-knowledge signal development could be referred to as the understanding of someone or something, such as facts, information, descriptions, or skills, which is acquired through experience or education by perceiving, discovering, or learning [19].

Knowledge Management (KM) is recognized as a framework for designing an organization’s strategy, structures, and processes so that it can use what it knows to learn and to create economic and social value for its customers and community [20]. Knowledge management, be it explicit or tacit has increasingly become a key component of improving organizational effectiveness and considered important, and necessary for managers and executives to consider as a prerequisite for higher productivity and flexibility in both the private and the public sectors [21]. Thus, effective knowledge management plays an important role in decision making, and disparately guiding the strategic plan for knowledge-based organizations in the context of sustainable development [2]. The knowledge Management functions includes finding, mapping, gathering, filtering information, developing new knowledge, converting personal knowledge into shared knowledge resources, understanding and learning, adding value to information to create knowledge, enabling action through knowledge, processing shared knowledge resources, delivering explicit knowledge, and building adequate technical infrastructures [19].

C. Cloud Computing

The concept of cloud computing emerged around 2006, and has been embraced by businesses and governments as a new way to deliver IT services over the Internet [22]. A number of computing experts, researchers and practitioners have attempted to define Clouds in different perspectives. [23] Have argued that despite the numerous Cloud Computing definitions some writers have criticized the whole idea as just the rebranding of same old IT packaged in a new bottle and doubt if it is really new concept. The variability of technologies and these hypes around Cloud Computing further confused the concept [23][24]. However the most accepted definition of cloud computing was according to the U.S National Institute of Standards and Technology (NIST); Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or cloud provider interaction [25].

Cloud Computing evolved from other technologies like distributed computing, grid computing, virtualization, etc., and supports the theme of one application and many users. This was brought about due to rapid development of processing and storage intensive technologies. And with the success of the Internet, computing resources have become

cheaper, more powerful and more ubiquitously available than ever [26]. These resources; CPU and storage are provided as general utilities that can be leased and released by users through the Internet in an on-demand fashion. The emergence of cloud computing has made a tremendous impact on the Information Technology (IT) industry over the past few years, where large companies such as Google, Amazon and Microsoft strive to provide more powerful, reliable and cost-efficient cloud platforms, such that sectors and industries seek to reshape their business models to gain benefit from this new paradigm. Indeed, cloud computing provides several compelling features that make it attractive to sectors, industries and Governments. Despite the benefits of using cloud for data analytics, there exist some challenges which includes; Service Level Agreements (SLA's) Management [27], Cloud Data Management & Security [28][29]. Access Controls issues [30], Common Cloud Standards [31] and Platform Management [32].

It is in light of these challenges that this paper proposes an architectural framework, which envisaged a well-Managed and secured cloud based data computing and knowledge management with the capability to prevent some critical issues such as abuse of permissions, unauthorized access, loss of data and data modification in motion for national data management.

III. EXPERIMENTAL METHODOLOGY

A. Design and Setup

The study proposed a designed National data management flow model using UML techniques in Microsoft Visio, and also embarked on a real experiment using CloudSim tool to model the cloud environment and conduct the necessary experimentation. The CloudSim tool was used to run different operations with different workload of composition, configuration, and deployment requirements. The simulation is aimed to determine the latency in sending the encrypted files by varying the file sizes with overall execution time of successful cloudlets using TimeSharedVmScheduler. Therefore number of data centers has been fixed to 2, the number of host to 1, 2 processors of 1000mips with 2048MB of RAM each, 10000 bandwidth, 1,000,000GB of storage capacity, the number of users is 1000 and finally the number of Cloudlets have been fixed to 20, with the length of 1000, file input size of 300, file output size of 300 and 1Pes.

B. Performance Matrices

The characteristics of the parameter are known to *belatency* and *execution time*. The administrator of a large data processing center may be interested in increasing the *execution time* i.e. the total amount of work done in a given time. And the end users is interested in *low latency*-the time between sending the encrypted file and receiving the file between authorized users, and interested in reducing *response time*-the time between the start and the completion of an event-also referred to as *execution time*.

C. Delimitation of the Study

Delimitations do exist from the machine and environment used, the study employs the use of a machine with specific characteristics (Intel(R) Core TM i3-2310M [CPU 2.10GHZ](#) processor, 64bit operating system and 2GB of RAM), virtual machines and CloudSim environment which may affect:

- (i) The time at which the runtime environment (Netbeans java virtual machine) is directed to load the java program and CloudSim program.
- (ii) The instance at which CloudSim's entities and components are fully initialized and are ready to process events.

IV. PROPOSED FRAMEWORK

This is a cloud-based computing framework which integrates big data analytics, cloud computing, and knowledge management. It contains an overview of the system architecture from a technological and management perspective, with a suitable architectural pattern for exploiting the data analytics and knowledge management techniques that are the root of management system, enhanced Role based security Access control with a data encryption/decryption to and from the cloud. The proposed framework is separated into three layers namely: Infrastructural, Platform and Knowledge management Layers as illustrated in Figure 1.

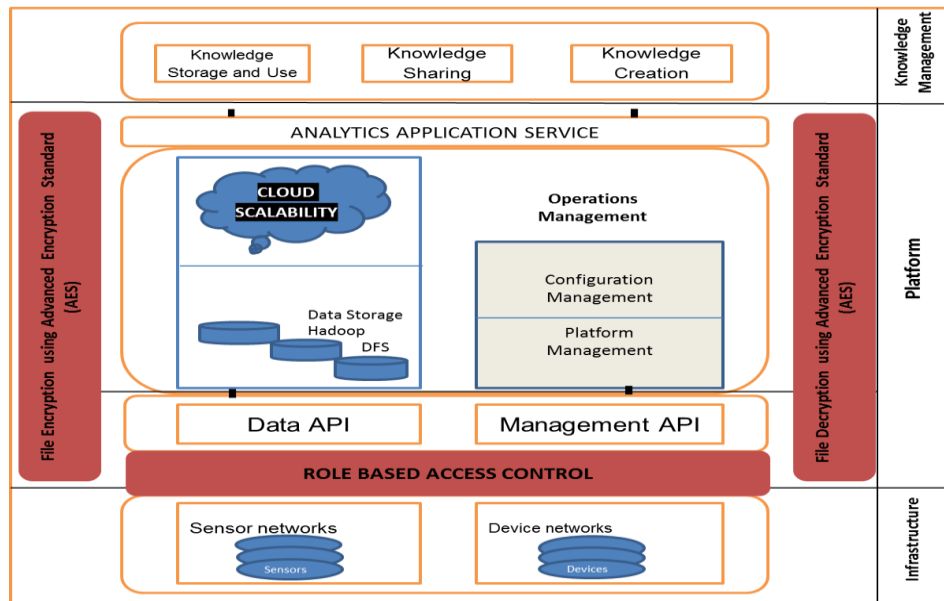


Figure 1: A Secured Cloud-based Computing Framework for National Data Management

A. Description of the Proposed Framework

Infrastructure Layer: The infrastructure layer consists of sensor networks, device networks, and data management interface. The network components consist of several types of sensors, software and other devices that collect data from different sources. To manage the essential network infrastructure and to arrange the data generated, a generic control plane (interface) consisting of well-defined data and management APIs (Application Programming Interface) are added with the aim of capturing and processing data quickly (as in the case of real time monitoring).

Platform Layer: This Layer serves as the second and heart of the architecture; it includes all the basic building blocks of the framework, namely; Role based access control, big data analytics in the cloud with scalable storage and computing resources, analytics application service, operations management and Advanced Encryption Standard scheme.

- i. **Role based access control (RBAC):** The proposed framework includes a main entry control using roles control within the Platform Layer: In role based access control, users are classified according to their role. The Data can be access from the cloud if they have valid role. Users with appropriate role can only access the part of data from the cloud based on position of a user within the organization. In general, the role is described as a semantic construct, which includes a set of tasks, authority and responsibility related to a specific working activity making access authorizations on resources assigned to the roles instead of each individual user.
- ii. **Cloud Computing Infrastructure:** the proposed framework includes scalable storage and computation resources to store and analyze the data that are collected from the bottom layer. The big data analytics will be provided as a service by integrating it with cloud computing, not as a separate entity. Instead of deploying self-developed servers, cloud-based big data services to store and analyze the data are to be used. The framework will make use of Hadoop Distributed File System (HDFS) and/or key-value stores (NoSQL database) to acquire and store big data that are enhanced for exceedingly fast data collection and simple query patterns. In addition, further processing of data will be performed by implementing analytics algorithm using MapReduce framework.
- iii. **Analytics Application Service:** this section utilizes the results from the big data analytics for developing domain specific components and services. Hence, users will be able to interact with web-based analytics services easily without being disturbed about the fundamental data storage, management, and analyzing procedures.
- iv. **Operations Management:** This section has two subs; the configuration management and platform management. The configuration management section performs configuration of system components and manages network resources while the platform management section provides administrative support for the proposed framework.
- v. **Advance Encryption Standard Algorithm (AES):** The entire data in motion of the framework is control with an end to end encryption technique using Advance Encryption Standard Algorithm (AES). The Advanced Encryption Standard (AES) is a new specification for the encryption of electronic data established by the U.S. National Institute of Standards and Technology (NIST) in 2001 to replace DES.

AES is a block cipher with key length of 128, 192, or 256 bits; default 256. It encrypts data blocks of fixed 128 bits in 10, 12 and 14 rounds depending on the key size. AES Encryption is fast, flexible and can be implemented on various platforms. Also, AES has been carefully tested for many security applications [33], and is suitable for cloud data [34]. The algorithm described by AES is a symmetric-key algorithm, meaning the same key is used for both encrypting and decrypting data based on a design principle known as a substitution-permutation network, combination of both substitution and permutation, and is fast in both software and hardware. [35] Opine that AES involves replacing of inputs by specific outputs or shuffling of bits around and is designed to perform all its operations on bytes rather than bits. Due to this plaintext block of 128 bits is treated as 16 bytes by AES. The 16 bytes are arranged in a matrix of 4*4 (four rows and four columns) known as the state, with flexible number of rounds [33]. They depend on the length of the key, where 128-bit keys require 10 rounds, 192-bit keys require 12 rounds and 256-bit keys require 14 rounds. Each round makes use of different 128-bit round key which is calculated from original AES key [34].

Knowledge Management Layer: The knowledge management layer is the top layer which provides the sequence for knowledge acquisition, creation, distribution and sharing, storage, and utilization. Actionable insights are created in real-time to be used in supporting on demand decision making. Precisely the, real-time analytic results are forwarded into the knowledge management layer as input to complete the knowledge management.

B. Process Model Design

This model is aimed to describe the logic which will drive the data flow between the integrated stakeholders that makes up the whole framework. The model shows how the entities in the National data management framework interact with one another, and has given step by step explanation on activities in National data Management process. National Data flow requires high storage capability with intensive processing computation.

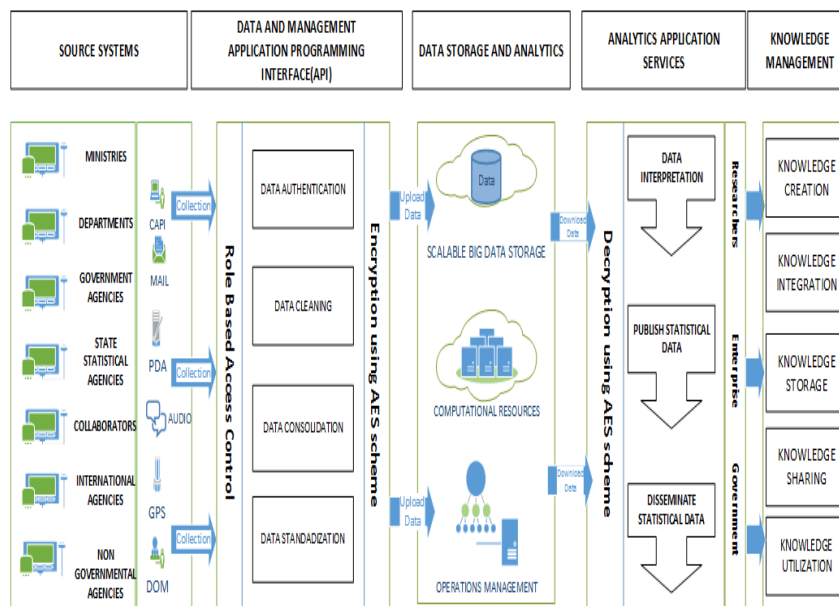


Figure 2: Process Model Showing National Data Management flow.

As shown in figure 2, The whole flow of big data processing includes the extraction and collection of widely used data from various sources using source systems, Source authorization and data refinement, data transfer, storage and analyses of stored data using proper data analytics technologies, in order to present the result to end users in a proper way and finally extract and manage useful knowledge. This is achieved in stages as follows:

Stage 1: Data Extraction Phase is where the system administrators initialize the system, assign and authorize functions/roles to designated stakeholders. The source system authenticate users via Application programming interface (API) based on assigned role, gather and collect extracted data from various source systems and forwarded to the Authorized users.

Stage 2: The variety of data collected need source authentication, then clean, consolidate and standardize by data professionals based on organizational policy for archival. As each function is assign to an authorize user in the



enterprise equal to the task. Due to the vulnerability of threats to the standardized data, it is essential to be encrypted using an API generated token-key in the primary storage location to maintain large throughput, the encrypted data is sent to the cloud storage.

Stage 3: The Cloud owner receives an encrypted data files, were it is sum up to be larger (Big data) with more intense for analytics and performs all cloud operations management.

Stage 4: At this stage since big data analytics alone is of limited value if users cannot understand the results the organizational administrator assigned download and decrypt the analyzed and standardized data, interpret, publicize and disseminate the output result to end users based on domain specific in a proper way.

Stage 5: This stage involves all knowledge management functions, where knowledge is created, integrated, stored, utilized and shared to every stakeholders involved. Thus the required infrastructure will be able to automate decisions based on the analytical model and manage knowledge accordingly.

V. RESULTS AND DISCUSSION

A. Simulation Result

The results in Table 1 were obtained from running the Cloudsim simulation program and observing the average execution time in seconds. Multiple numbers of virtual machines have been used to determine the average execution time of successful cloudlets. The cloud performance is measured by the speed of execution time of computation.

SIMULATION OUTPUT						
Cloudlet ID	STATUS	Data center ID	VM ID	Time	Start Time	Finish Time
2	SUCCESS	2	2	6	0.1	6.1
5	SUCCESS	2	2	6	0.1	6.1
8	SUCCESS	2	2	6	0.1	6.1
11	SUCCESS	2	2	6	0.1	6.1
14	SUCCESS	2	2	6	0.1	6.1
17	SUCCESS	2	2	6	0.1	6.1
0	SUCCESS	2	0	7	0.1	7.1
3	SUCCESS	2	0	7	0.1	7.1
6	SUCCESS	2	0	7	0.1	7.1
9	SUCCESS	2	0	7	0.1	7.1
12	SUCCESS	2	0	7	0.1	7.1
15	SUCCESS	2	0	7	0.1	7.1
18	SUCCESS	2	0	7	0.1	7.1
1	SUCCESS	2	1	7	0.1	7.1
4	SUCCESS	2	1	7	0.1	7.1
7	SUCCESS	2	1	7	0.1	7.1
10	SUCCESS	2	1	7	0.1	7.1
13	SUCCESS	2	1	7	0.1	7.1
16	SUCCESS	2	1	7	0.1	7.1
19	SUCCESS	2	1	7	0.1	7.1

Table 1: Simulation Results

B. Results Discussion

The table above shows the execution time of specified cloudlets in order to determine the efficiency of the proposed framework. Sticking to the specified parameters in the model as mentioned earlier, it signifies that there is an inverse proportion relation between the number of virtual machines time and execution time. Such that, the increase in the number of virtual machines led to the decrease in the execution time, hence as the number of virtual machines increase there is a significant decrease in the execution time to a certain level, but as the number of virtual machines exceed five(5) the average execution time remains constant. Thus, the average execution time of successful cloudlets is used to determine the speed and performance of cloud service respectively. The Performance parameters values conveyed the performance of the simulation, hence; have resulted to an efficient performance in its execution for National data in the cloud.

VI. CONCLUSION AND RECOMMENDATIONS

A. Conclusion

Cloud computing is emerging as a new phenomenon where many enterprises and governments are moving toward building dependable, available, scalable data management systems capable of serving a large volume of data to a

considerable number of users efficiently. The key consideration dealt in this study is the provision of dataflow, user control and encryption schema to secure national data privacy with the aim of making it unintelligible for all except the authorized users. The presented simulation results of low latency and high throughput showed that the secured cloud Framework can be implemented for national data management because it is relatively fast, reliable, scalable, secured and coupled with good performance.

The main feature in this solution is that the security operations are performed at the client side, and therefore there is no need to render all trust to cloud servers. The only elements that make it possible to access the stored data are based on roles and corresponding keys, and thus file sharing between users can only happen by exchanging keys managed by the users. If an intruder (unauthorized user) tries to get the access data directly from the cloud, he must have to decrypt the data at each level which is a very difficult task. It may be expected that this will provide more security for Cloud Storage and computation than with no/single level encryption.

B. Recommendations

- i. There is need for Governments, Executives, Managers, Data Scientists and IT specialists to work together in order to actualize the Secured Cloud-based Computing framework for National Data Management.
- ii. Cloud computing is still at a developing stage and continuously changing and may need to be enhanced in the future.
- iii. Thus there are still several issues regarding data management in cloud computing environment that warrant further research in the future and integrated in the above framework for a better output. The following are the recommended future works:
 - i. Implementation of the framework using a real cloud platform/mathematical modeling rather than simulation to test for practical performance and reliability.
 - ii. Testing the Framework using other simulation tools apart from Cloudsim to see if there is any variability between them.

C. Implications of the Study

The framework if implemented will enhance User Control, Data availability, Integrity and confidentiality in accordance with National data Management policy (optimized data quality and security), and will accommodate big data with fast and efficient analytic process, hence will enhance reliability and collaboration among various stakeholders of data flow within any sector. The Study have contributed to the body of existing knowledge in the fields of Big data, Data Analytics, Knowledge Management and Cloud Computing,

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