Overview of Cloud Computing and Recent Addendum

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***Abstract*— Cloud computing is an emerging technology paradigm, which enable and facilitate the dynamic and versatile provision of computational solutions and helps. Despite the fact that the advantages provided by cloud computing are several, security and secrecy concern of the cloud services still race question from users. Security stance of organizations and vital infrastructures is being affected with the Use of cloud services, thus it is necessary that new threats and risks introduced by this new paradigm are clearly understood and mitigated. This paper focus on the ethical constraints in cloud computing, placing emphasis on issues that deal with cloud adoption, recent additions to the cloud, ethical issues like The shifting of control, from technology users to the third parties servicing the cloud due to outsourcing and offshoring of ICT functionality to the cloud and as well as many other issues regarding cloud computing.**

To this end, this paper intimate us with some new ways cloud service providers has been improving this field of study so as to improve its adoption in the world. It was discovered that cloud computing is becoming the world 5th most demanded service after crude oil, water, electricity and Telephony as stipulated by many other researcher's in this field.

Keywords—Cloud Computing; Resource allocation; Virtualization; Big Data; Cloud; Containerization.

I. INTRODUCTION

Cloud computing is one phenomenon that has been defined by many scholars, but the one that captures many researchers' attention is the one defined by [1] which defines Cloud Computing as "a theoretical account for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, computer memory, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Likewise, the term cloud can be regarded as "the internet" as its services is run and hosted via the net, thus cloud computing is a facet of computing that deals with the storing of big data in the internet for future usage. Cloud-based computing has come to stay and its services are increasing at a geometric rate. It has disrupted every facet of the economic system. Research and recent trends shows a continuous drift towards the cloud. There is no uncertainty that the cloud adoption is a convincing over for businesses and public organizations with like interest, offering flexible access to shared, and simplify allocation of computing resources [2]. Proper implementation of the cloud model greatly reduces maintenance and operations cost of IT infrastructures paving way for enterprise to concentrate more on daily transaction instead of the IT provided by the cloud model. Conversely, the intent of cloud computing is to draw in businesses in the face of resource sharing, which provides an achieved economy of scale that can fix the cloud model vulnerability to threats and attacks by adversary's [2,3]. Cloud computing allows users to exploit its vast technological gains without requiring a deep understanding of the technology involved. Diverse Organization's offering cloud computing products and services understands the implications of actually processing, storing and retrieving information in a common virtualized format. In reality, most designers of cloud-based applications manage to add protection, nevertheless as an addendum. In other instances, developers just cannot provide tangible protection with recent reasonable technical strength [2].

Cloud computing has changed the way we handle data, it has drawn attention away from constant and endless hardware upgrades and purchases to limitless access to high-end computing without actual purchase of hardware. One no longer needs to concern his or herself with hardware limitations such as memory capacity, processor speed, disk space, etc. Thanks to virtual storage and computing over remote servers, all end user applications run directly from remote servers and not from the user's desktop computer; this gives the same experience as actually competing with high end computer systems without demanding additional hardware resources typically required by traditional software. Since cloud computing is web based, it gives the user automatic access to the latest edition of the software being used regardless of location and users are not wedded to specific devices or network interfaces in order to use an application. This eliminates compatibility issues and the need for software developers to create specific versions of the application for each device [4].

The immense benefits offered by cloud computing has drawn the interest of so many, this includes: Hardware makers, software giants and service providers such as: Amazon's Elastic Computer Cloud, Microsoft's Cloud Services and Windows Azure, AT&T's Cloud Services, Hewlett-Packard's Cloud Assure and Cloud Consulting Services, IBM's Smart Business Storage Cloud and Smart Analytics Cloud, VMware's vCloud, Logica's Cloud Services [4]. The current waves of cloud computing are such that it is believed that a wide-scale adoption of cloud computing is expected in the near future. Information technology (IT) research and Advisory Company: Gartner Inc. already forecasts the market for cloud services to

significantly expand in the coming years, from $58.6 billion in revenues in 2009 to an estimated $68.3 billion in 2010 and $148.8 billion in 2014. Likewise, another IT research and analysis firm, International Data Corporation (IDC), already forecasts that the spending by IT organizations on cloud servers will grow by over 20% by 2014, from $582 million in 2009 to $718 million in 2014. [4].

II. Characteristics of Cloud Computing.

There are outstanding characteristics of Cloud Computing that distinguishes it from other Computing paradigms; here are five characteristics as stated by National Institute of Standards and Terminology (NIST):

A. Resource Pooling

The cloud model has a multitenancy model which allows for simultaneous servicing of customer's request while enabling the usage of combined computing resources in order to service clients' requests. Examples of such resources are virtual machines, containers, storage and memory.

B. On-Demand Self-Service

The Cloud allow for services such as consumer and business products, services and solutions that are delivered and consumed in real-time over the Internet to be requested for as at when needed [5]. Also, setting up such services are usually automated and easy to call upon by the cloud customers.

C. Measured Service

Based on the utility computing model, cloud service has metering capability at different level of abstraction according to the type of service, e.g., storage, number of machines, processing, and bandwidth [6]. The supervision, control and proper report of resources promotes accountability for both the provider and consumer of the service. This means that just like air time, electricity, etc., IT services are charged based on per usage metrics, hence the concept: pay per use.

D. A Broad Network Access

Cloud Computing fits into the vision of global computing as capabilities are transmitted over the internet and can be accessed from different platforms such as laptops, tablets, mobile phones, etc.

E. Rapid Elasticity

The Cloud enjoys elasticity which implies that allocation of resource is very flexible, it can get bigger or smaller depending on demand. The Elasticity of the cloud's resources is rapid as it is built on the utility model whereby consumers are charged per resources used, and resources appear to be unlimited as the consumers can easily scale up or down as their computing need differs.

III. Benefit of Using Cloud

Cloud computing prides itself with enormous benefits for use in rendering or accessing computing resources. It is common to find people who are currently enjoying the benefits of cloud computing while being ignorant of what it means. It is interesting to know that users of Google mail, YouTube, Yahoo mail, and Skype are all in the Cloud. Progressively, more businesses and organizations are beginning to realize benefits provided by Cloud computing. Among these benefits are:

A. Reduced Cost

Cloud computing is cheaper and less labor intensive for users when compared to traditional hardware usage. Cloud computing provides a pay-as-you-go pricing model instead of a large up-front investment. This pricing model allows end users to pay only for what they use and thus frees up resources such as money and time for other important business activities. With cloud computing, there is no need to buy and install expensive software and this puts a stop to the illegal reproduction and distribution of software [7]. It also eliminates the need to acquire, track and manage software licenses. The cloud also offers some free software.

B. Flexibility and Storage

Cloud storage is the crux of cloud computing. This paves way for expansion of the organization since workers no longer concern themselves with file storage. Files can be accessed anywhere independent of time and location. This makes for virtual presence, allowing workers to work together virtually even when they are not at the same place at the same time. Different documents can be viewed simultaneously provided there is an Internet connection.

C. Time Saving

Cloud computing also aids easier access to information. The Ease is in relation to how fast it is to access information other than downloading and installing software.

IV. TYPES OF CLOUD

Cloud computing is classified based on two models namely: Cloud computing deployment models and Cloud computing service models.

A. Cloud computing deployment models

This represents the different kinds of cloud environment and are primarily differentiated by their size, ownership and access. There are four types of Cloud Computing deployment model and they include: the public cloud, the private cloud, the hybrid cloud and community cloud.

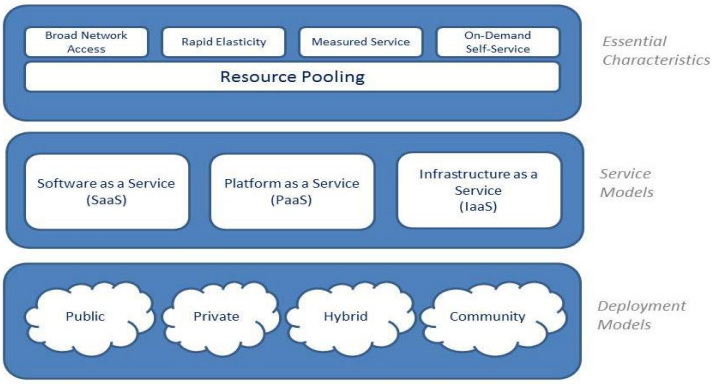

Fig. 1. Image Showing the cloud models, service models and essential characteristics.

- *Public Cloud*

  This deployment model is most often thought of as the cloud, this is because of its multitenant capability as it is shared by the general public. It provides a pay-as-you-go service to the general public. In this configuration, technological resources and services are outsourced to service providers, it is suitable for handling applications that many users consume. For this model, the customers does not have any distinguishability and control over the location of the infrastructure and it is economical for organizations servicing a large number of clients. Compared to other models, public clouds are less secure because it places an additional burden of ensuring all applications and data accessed on the public cloud are not subjected to malicious attacks [7]. A good example of a public cloud is Google.

- *Private Cloud*

  This is also known as an internal data center, and it's usually employed by businesses that are not available to the general public but uses cloud structure. It is implemented on a cloud-based secured environment which is safeguarded by a firewall which is under the surveillance of the IT department belonging to the particular company that works with the cloud space. In this configuration, resources and services are owned by the business, with the services accessible within the business through the intranet and since the technology is owned and operated by the business, this type of cloud is more expensive than a public cloud [7]. Private cloud provides a great deal of security since it is managed only by authorized users.

- *Hybrid Cloud*

  Hybrid cloud is an integrated form of cloud computing. It is a combination of two or more forms of the deployment model with some form of management structure in place so that the environment appears as a single cloud. This integrates security and regulatory compliance alongside pricing and performance. When a company uses a hybrid cloud; it uses a public cloud for some tasks and a private cloud for other tasks. For instance, if a company combines both public and private cloud then in this model, then the public cloud is used to expedite extra tasks that cannot be easily run in the company's data center or on its private cloud while the private cloud is used to maintain critical, confidential data and information within it firewall while leveraging the public cloud for non-confidential data. The private cloud portion of the hybrid cloud is accessed by company employees, both in the company and on the go, and is maintained by the internal technology group [7]. Also note that each portion of the hybrid cloud can connect to each other.

- *Community Cloud*

  This is a type of private cloud in which different users with the same security concern shares the cloud infrastructure. The cloud infrastructure can be on-site or off-site, it doesn't matter.

B. Cloud Services Delivery Models

Cloud computing providers offer their services through three standardized service models namely:

i. Platform as a Service (PaaS)

ii. The Infrastructure as a Service (IaaS)

iii. Software as a Service (SaaS) Models.

The service models specified above directly define the three layers comprised in the core of most modern Cloud Computing Infrastructure. Each of these layers offer the specified types of services to a particular segment of the consumer market while at the same time paying for the services provided by the preceding layer (except the IaaS layer) [7].

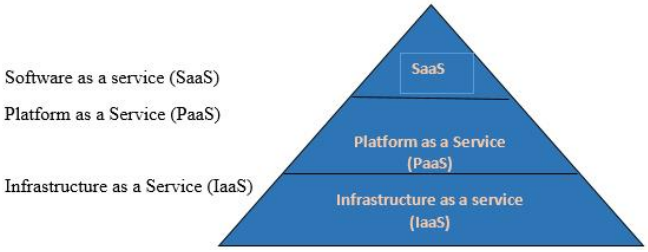

Fig. 2. Cloud Services Delivery Models.

- *Infrastructure As A Service (IAAS)*

  The infrastructure as a Service (IaaS) model gives the users full access to manage their data on the server, they need not concern themselves with details such as physical computing resources, networks, firewalls, data partitioning, backup, etc. as these are provided by

the service provider. To use their applications, cloud users install the operating system's image and their software's on the cloud infrastructure and are run via virtual machines. Clients are billed on a per-use basis as cost is a reflection of the amount of resources consumed. The advantages offered by this model include: increased security, increased financial flexibility, choice of services, business agility and cost-effective scalability.

IaaS also has two subdivisions namely: Hardware as a service (HaaS) and Software as a Service (SaaS).

i. Hardware As A Service (HaaS)

This is a pay as you go model for accessing a provider's infrastructure and CPU power. In this package the computing power of several computer's are combined to act as a single and more powerful computer. Data sent by the user is processed by the vendor's hardware after which the result is sent back to the user.

ii. Software As A Service (SaaS)

This is a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted [18,19] It is sometimes referred to as "on-demand software" [20]. SaaS is usually accessed by users using a thin client via a web browser. This model is now becoming a common delivery model for many business applications, including office and messaging software, payroll processing software, DBMS software, management software, CAD software, development software, gamification, virtualization , accounting, collaboration, customer relationship management (CRM), management information systems (MIS), enterprise resource planning (ERP), invoicing, human resource management (HRM), talent acquisition, content management (CM), antivirus software, and service desk management [7, 21].

- *Platform As A Service (PAAS)*

Platform as a Service is a level above Infrastructure as a service (IaaS). This model offers a development environment for consumers such as an operating system, programming language execution environment, database, and web server. In this model, cloud providers delivers a computing platform and are not concerned with the cost and management in the hardware and software layers. Some benefits of using PaaS includes: Risk reduction by the use of pretested technologies, promotion of shared services, improved software security, and lowering skill requirements needed for new systems development [7].

There is also a new service delivery model propended by some other researchers and its known as: ***Everything as a Service***. Everything as a service is a way whereby the fine-grained software components or re-usable across a network can be called up. It is a subset of cloud computing. The common example is software as a service (SaaS), but the term 'as a service' has been associated and used with many core components of cloud computing including infrastructure, data, communication and platforms. A number of vendors, including Google, Microsoft, Hewlett Packard and Amido have been associated with the "everything as a service" trend.

Fig. 3. Everything as a Servic.

- *Software as a Service (SAAS)*

Software as a service (SaaS) is the level above Platform as a service (PaaS). In this model, consumers are given access only to the application software, which can be run remotely from the data centers of the cloud service provider. The provider is responsible for the maintenance and support of the infrastructure and operating platforms, i.e. it provides businesses with applications that are stored and run on virtual servers in the cloud [8], SaaS benefits includes: easier software administration, automatic updates and patch management, software compatibility across the business, easier collaboration, and global accessibility [10].

V. Recent Addendums in Cloud Computing

The cloud computing paradigm has continued to gain ground in the IT world, especially now that many people in the world keep coming online on a daily basis and many business owners want to have their key resources hosted in the cloud for easy accessibility to them, it is therefore important for us to explore some of the recent happenings in this field. Some of which have been cited below.

A. Green IT and Cloud Computing Revolution

One of the greatest issues in the field of Green IT is finding ways whereby the carbon dioxide emission can be reduced to the barest minimal level, however, recent research conducted shows that Results from this case indicate that both costs and carbon dioxide emissions can be reduced by more than a half by using an integrated cloud computing solution with still

potential remaining when integrating business processes and services on the cross-organizational level.

B. Cloud Computing in Low Enforcement and Cyber Forensics

Cloud computing technologies offer substantial potential benefits to law enforcement and government agencies. Cost savings, rapid deployment of critical resources, off-site storage and disaster recovery, and dynamic provisioning of new and additional resources when needed are among the tangible benefits that cloud computing potentially offers to law enforcement agencies of all sizes. Recognizing the sensitivity of law enforcement information, and the special responsibilities that law enforcement has to ensure the accuracy, reliability, security, and availability of data within their control, however, demonstrates some of the challenges that agencies face in evaluating the potential use of this new computing paradigm. Recent calls for the expansion of data collection by law enforcement officers through, for example, the use of body-worn cameras and other sensor devices, only serve to reemphasize the need for clearly articulated policies regarding cloud-based data storage. Given the volume of locally-generated data, it is inevitable that some of that information will be stored and processed using cloud services. To meet the dynamic operational needs, while maintaining the security of systems and data, law enforcement agencies using or contemplating the use of cloud computing services should ensure that their planning and implementation of cloud solutions satisfactorily address the following key principles. The cloud service providers should maintain the security and privacy of the data collected by them in helping to pursue criminal investigations, ownership right of the data generated by the CSP must remain with the Law enforcement agencies, Mining of data generated by the CSP should be discouraged, etc. RTD in software tools for use in forensic investigations in today's ICT environments (cloud computing, mobile etc.) is necessary. The flow of data and information across the geopolitical borders in the cloud paradigm will require some sort of global data and information flow agreement to facilitate not only the export control but also help in identifying, apprehending and punishing the digital culprits. There will be obstacles to agreeing universal definitions; however, like global navigation treaties, it can be achieved by taking all the stakeholders on board..

C. Development of international trust models international cultural based trust models for cloud computing that can be measured

This requires client authenticated policy enforcement mechanisms for the cloud to attain a trusted platform with privacy-preserving processing in the cloud. With regard to trust measurement, outsourcing leads irreversibly to a yielding of one's digital heritage to others. Such third parties are mostly located abroad. Trust towards these third parties is generally not measured. The evolution of this trust over time is often unknown. Therefore, RTD on cloud spaces with the measurement of trust must occur. Trust models implemented in currently available technology are based on the principles of trust as a social phenomenon within the context of the western world. Indeed, the majority of the research on these topics has come from westernized or individualistic cultures, where consumer trust is facilitated through trust mechanisms such as institutional guarantees, laws and policies, information security mechanisms, and social controls. Examples of this approach to trust formation are evident in the number of positive experiences and recommendations between entities in a trust community. This is in contrast with trust formation in other cultures, e.g. Africa, Asia, India and South America, where structures embedded in the society are much more relevant.

D. IoT And Cloud Revolution

As things continually gets connected to the internet, which happens to be a new paradigm in the field of IT, the Internet of Things also relates to the cloud model, the nature of legally and globally consistent identifiers of both people and "things" required international harmonization.

E. Big Data And Cloud Revolution

Big data cannot exist on its own without the existence of cloud computing, which is its backbone, hence to this end, data created by users of the internet on a daily basis has been usefully hosted and keep by cloud computing services providers. To this end, big data and cloud computing are interwoven as they depend on each other to run successfully.

VI. Issues and Challenges Associated with Could Computing

Cloud computing challenges have always been there. Companies are increasingly aware of the business value that cloud computing brings and are taking steps towards transition to the cloud. A smooth transition entails a thorough understanding of the benefits as well as the challenges involved. Like any new technology, the adoption of cloud computing is not free from issues. Some of the most important challenges as highlighted by Jack Rosenblum (2015) are as follows.

A. Security and Privacy

The main challenge to cloud computing is how it addresses the security and privacy concerns of businesses thinking of adopting it. The fact that the valuable enterprise data will reside outside the corporate firewall raises serious concerns. Hacking and various attacks to cloud infrastructure would affect multiple clients even if only one site is attacked. These risks can be mitigated by using security applications, encrypted file systems, data loss software, and buying security hardware to track unusual behavior across servers.

B. Service Quality

The quality of service rendered is often one of the most significant factors that has often prevented businesses from moving their business applications to the cloud. The Service-Level Agreements (SLAs) provided by the service provider are

usually deemed inadequate to guarantee the smooth running of a production application on the cloud, especially those related to availability, performance and scalability. Business owners need assurance that their data will always be available, secured and reliable at all time. Businesses will be reluctant to host their critical infrastructure within the cloud if these conditions are not met.

C. Interoperability and Portability

It is necessary for businesses to have the ability to switch between providers whenever they want rather than being locked-in to a particular provider or product. Cloud computing services should have the capability to integrate smoothly with the on-premise IT.

D. Reliability and Availability

Another challenge cloud computing faces is its dependence on internet connection rather than on local connection, this means that businesses would shut down once the network is down as data cannot be accessed. Cloud infrastructure performance can also be affected by user's activities, number of users, etc. and this might result to frequent outages. It is important to monitor service's provided using internal or third-party tools and also to have plans to supervise usage, SLAs, performance, robustness, and business dependency of these services..

E. Performance and Bandwidth Cost

Cloud computing eases the burden with cost of hardware, but the downside to this is with the cost of bandwidth. Smaller applications may not consume much data and thus the cost of operation will not be much, but the cost is significantly higher for data-intensive applications. Delivering intensive and complex data over the network requires sufficient bandwidth. This challenge has really stopped a lot of businesses from adopting the cloud.

F. Real Benefits / Business Outcome

Even though studies have showcased benefits accruable to implementing cloud technologies yet prospective users and customers are still not convinced of the possible benefits. Customers are mainly concerned with return on investment and having a good view into the real benefits of cloud computing beyond just seeing the potential cloud computing might seem to offer. The return on investment (ROI) with cloud based services needs to be properly demonstrated by clearly drawing a parallel with specific metrics between Cloud based solutions and that of traditional IT which should demonstrate savings on the basis of quality, cost, compliance, time, revenue and profitability improvement. The cloud Return on Investment (ROI) model should also include indicators for comparing the availability, performance versus recovery Service-Level Agreements (SLAs), Workload-wise assessments, etc.

G. Integration

Integration of most user applications with cloud applications is also a big challenge faced by cloud computing. Most of this enterprise applications have complex integration needs which involve integrating existing cloud applications with existing enterprise applications and data structures, thus there is a need for a simple, quick and cost effective way of connecting cloud applications with the rest of the enterprise.

H. Ethical Issues Associated with Cloud Computing

The essential ethical principles of IT remain unchanged with the advent of cloud computing. And even though the governing ethics remain unchanged.

There are three relevant ethical Issues in Cloud Computing:

a) The shifting of control, from technology users to the third parties servicing the cloud due to outsourcing and offshoring of ICT functionality to the cloud.

b) The storage of data in multiple physical locations across many servers around the world possibly owned and administrated by many different organizations

c) The interconnection of multiple services across the cloud. At the different levels functionality of different providers is connected to provide a specific service their customers.

Service providers must understand the operational risk they are assuming for their customers. Providers become stewards of customer data, functional operation, and risk mitigation. Consumers of cloud services must have a deep understanding of the technology being utilized and its accompanying risks. The only way to meet this responsibility is to perform due diligence when considering a third party cloud service provider and maintain consistent communication with their chosen provider is to be honest, responsible, respectful of privacy, and treat both customers and vendors as we would like to be treated. Cloud computing can only reach its full potential, if a lasting trust is established between providers and customers through a well-defined system of ethics.

All these challenges should not be considered as roadblocks in the pursuit of cloud computing. It is rather important to give serious consideration to these issues and the possible ways out before adopting the technology.

CONCLUSION

Cloud computing is not a revolution. It is an evolution that has been ongoing for well over a decade, if not since the very beginning of electronic computing. The cloud is simply an architectural model that employs many of the same components used in data centers around the world today in a more flexible, responsive, and efficient way. The primary difference is in how these components are tied together with a dynamic control plane, which helps enlighten and inform the architecture about the rapidly changing requirements of today's applications, data and clients.

Cloud computing has brought about a paradigm shift in the world of IT and computing because of its adoption on a daily basis by business organizations hence this pros a lot of issues

and challenges. This study takes a global overview of what cloud computing is, its components, benefit, types and characteristics also in the research recent addition in this area were also considered.

More so emphasis was laid on the ethical issues in cloud computing that may hinder business owners from adopting this technology so also a way out was suggested to help solve the ethical issues.

To this end it was discovered from several studies conducted that cloud computing will eventually become the 5th (after crude oil, electricity, telephony and water) world's utility due to its increasing demands.

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