Understanding Cloud Computing, It's Services, Benefits, And Challenges

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---**ABSTRACT**--

All over the world, it is increasingly and strongly becoming more and more popular to deploy computer resources, both hardware and software as services via the Internet on the basis of pay-as-you-go. This is termed Cloud Computing. It is widely considered the 21st century technology for the efficient and effective use of information and communication technologies. This paper exposes the composition and architecture of Cloud computing and unravels its potentials benefits and challenges. It also explores ways through which the challenges could be effectively and efficiently handled to encourage more and more IT users to leverage on the services and potentials afforded by the Cloud. As more and more IT users deploy the Cloud, the digital divide among nations of the world will be drastically reduced and the world will truly become a global village.

I.   INTRODUCTION

Cloud computing is a cutting edge technology that enables one to leverage computer resources and services over the Internet. Thus rather than spend huge sums of money to procure computer equipment, resources or services, you access them over the Internet for a small amount of money in a service-on-demand and pay-as-you-go basis. The European Network and Information Security Agency, ENISA, (2009) defines cloud computing as an on-demand service model for IT provision, often based on virtualization and distributed computing technologies. Also the US National Institute of Standards and Technology, NIST (2011) defines Cloud computing as a model for enabling ubiquitous, 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 service provider interaction. According to a report by the International Telecommunication Union, ITU (2012), Cloud computing offers a new economic model for ICTs – a model which heralds new modes of investment in, and operation of, IT resources. With Cloud computing, the report goes on to say that organizations, institutions and companies no longer need to invest heavily in such resources, which are of necessity limited and require burdensome and costly internal management, having instead the option to migrate to a Cloud model enabling them to purchase or lease resources on line. This model thus frees organizations, institutions and companies from internal management costs, the IT resources being administered by the Cloud computing provider. In a nutshell, Cloud computing provides tremendous opportunities to streamline the use of IT, reducing costs and driving up efficiency.

II.   CHARACTERISTICS, SERVICES AND MODELS OF CLOUD COMPUTING

The NIST (2011) definition lists five essential characteristics of cloud computing, three service models and four deployment models. These together categorize ways to deliver cloud services. ITU (2012) reports that the characteristics of Cloud computing distinguish it from other computing technologies.

The characteristics, of Cloud computing, are given by NIST (2012) as follows:
[1]   On-demand self-service: As a rule, Cloud computing users do not own the IT resources they use, the servers they exploit being hosted in external data centers;
[2]   Measured service: Services are provided via the pay-per-use model or subscription model;
[3]   Resource pooling: The resources and services provided to the client are often virtual and shared among several users;
[4]   Broad network access: The services are provided via the Internet;
[5]   Rapid elasticity or expansion: Services can be scaled larger or smaller.

With regard to services, Cloud presents:

[1]   **Software as a Service (SaaS):** This is a software delivery service that provides access to different computing software on the web. Eric (2008) explains that SaaS delivers a single application through the browser to thousands of customers using a multitenant (multiple customers using the same public Cloud) architecture. A popular example of this service is the Google or Gmail which provides access to word processing and email services in the Cloud. No document or email is stored locally and these documents can be accessed from anywhere (Miller, 2011). In this platform companies can share and access all the software delivery models remotely via web based Internet. This implies that such applications are run virtually through virtual servers and paid for as per their use. The service is usually provided through some type of front end or web portal. While the end user is free to use the service from anywhere, the company pays a per use fee.

[2]   **Platform as a service (PaaS):** PaaS is another popular service which is offered by Cloud computing. It is often seen as a variation of SaaS. As the name conveys, Platform-as-a-Service area of Cloud computing offers developers a medium through which they can create and develop software applications virtually. All the content management systems like Joomla and WordPress are platforms that are usually pre-configured open content management (CM) systems, which allow IT professionals to develop software applications remotely. An example of PaaS is GoogleApps. With PaaS, software development environments can be made available on the Cloud for use. PaaS providers use APIs, websites portals or gateway software installed on the customer's computer (IBM, 2007). An example of PaaS Clouds is "Force.com." Force.com is a Cloud computing system provided by Salesforce. It is used by developers to build and deliver applications, it is a platform where multiple customers can use an application offered on the server (Cloud) for service (Miller, 2011). Other providers of PaaS include Microsoft's Azure, Google Maps, ADP Payroll processing, and US Postal Service offerings.

[3]   **Infrastructure as a service (IaaS):** The infrastructure of any company comprises of hardware, software, networking components, servers, and storage space (NIST, 2011). With the IaaS of Cloud computing, a company does only get the devices independently but can also enjoy working in the virtual world. This model is similar to a utility company model, and as such, IaaS allows a company to pay for only as much capacity of data as needed. It provides more space when necessary. An example would be when a shop is on sales and the managers wish to expand their capacity to avoid crash from overload. The company can expand the size and then undo the size change after the sales peak period is over. An example of a site that uses IaaS Cloud is Amazon (Michael et al, 2010).

In terms of deployment models, the ITU (2012) opines that Cloud services are typically made available via a private Cloud, community Cloud, public Cloud or hybrid Cloud. These are explained further by ITU (2012) as follows:

[1]   Public Cloud: Generally speaking, services provided by a public Cloud are offered over the Internet and are owned and operated by a Cloud provider. Some examples include services aimed at the general public, such as online photo storage services, e-mail services, or social networking sites. However, services for enterprises can also be offered in a public Cloud.

[2]   Private Cloud: In a private Cloud, the Cloud infrastructure is operated solely for a specific organization, and is managed by the organization or a third party.

[3]   Community Cloud: In a community Cloud, however, the service is shared by several organizations and made available only to those groups. The infrastructure may be owned and operated by the organizations or by a Cloud service provider.

[4]   Hybrid Cloud: This refers to the deployment of a combination of two or more of the other deployment models given above.

III.   THE BENEFITS OF CLOUD COMPUTING

Cloud computing provides tremendous opportunities to streamline the use of IT, reducing costs and driving up efficiency (Arno, 2011). These benefits are given by Arno (2011) as follows:

- **Flexibility and storage:** With Cloud computing Files are stored in the "Cloud". This allows for development in the organization because workers no longer have to worry about the storage of documents. Also, workers can access office files from wherever and whenever. Workers can also work together virtually even when they are not at the same place at the same time. Various documents can be viewed simultaneously provided Internet connection is available.

- **Time saving:** Alongside easy collaboration, Cloud computing also aids the easy access to information. Easy access in this context could be seen in how fast it is to access Gmail, Yahoo mail, mailboxes in general. It is fast and easy in contrast to the time it would take to download and install software.

- **Reduced Illegal Use of Software:** Cloud computing puts a stop to the illegal reproduction and distribution of software.
- **Reduced Cost:** Hinchcliffe (2009) states that, Cloud computing is a pay-as-you-go pricing model instead of a large up-front investment. Such pricing models, he says, allow end users to pay only for what they use thus freeing up resources such as time and money for other more important (core) business activities. Implementation of Cloud computing, thus, will reduce the investment cost in server hardware and software licensing. Cloud computing is therefore cheaper and less labor intensive for companies. There is no need to buy and install expensive software. There is no need to acquire, track and manage software license

IV. THE CHALLENGES FACING CLOUD COMPUTING
Cloud computing solves many conventional computing problems, including handling peak loads, installing software updates, and utilizing excess computing cycle new technology has also created new challenges in data security, data ownership, trans-border data storage, and the training of highly skilled cloud computing professionals. Some of the challenges posed by Cloud computing are discussed as follows.

Privacy : Privacy is a vital concept in the world of Information and Communications Technology. Cloud computing basically refers to entrusting a company's data to systems managed by companies on remote servers. As Miller (2011) rightly pointed out, there are serious privacy and confidential issues involved when talking about Cloud computing. The companies entrusted with customer information and data have constant access to them and can accidentally or intentionally reveal it or utilize it for unauthorized purposes. This is why most users have a second thought when considering Cloud computing. Pardeep (2011) also points out that the Privacy statements written by Cloud providers are written in very complicated ways and are not understood by their customers. Customers, bored away by the complex terms, agree to the terms of service and hand over their personal information and data to these Cloud providers. He further predicted that Cloud computing will be the wave of the future but the massive availability of data and resources within a Cloud will be a very attractive target for hackers. This he said would continue to serve as a main drawback of Cloud computing.

Data Availability : Data availability is one of the key requirements users expect from any software or computing technology. According to WHSR (2012), as much as Cloud computing serves as a good storage device, it is not readily available, especially in the case where network service is not assured. A country like Nigeria without constant Internet connectivity will be at a disadvantage as long as this status quo prevails.
Most times, customers want to move around with their data. For example, most people would store their personal data such as pictures in an eight gigabytes or sixteen gigabyte memory chip and carry it around. Whenever the need to view pictures arises, they can plug in the memory chip into a camera and view/use the pictures or images.

Security : According to IEEE magazine (2013), one of the largest problems to be addressed in Cloud computing is that of security—identifying threats, understanding responses, and evaluating the trade-offs involved in making this emerging technology secure for common use. In the same vein Pardeep et al (2011) explains that the security issues of Cloud computing stems from the fact that the platforms used in integrating Cloud applications are not securely created. Even the infrastructures used to connect and interact with the Cloud (servers) are not fully secured. He opines that this is because, the knowledge of authentication and authorization of Cloud programs have not been fully explored. Anna (2011) also points out to another security issue which arise from the fact that in order to effectively search through the data in the Cloud it requires un-encrypting it – which gives the Cloud provider and possible hackers an access to the data.

V. PROFFERED SOLUTIONS TO THE CHALLENGES
The following solutions are proffered by experts to stem the challenges that mar the development and use of the services and potentials offered by the Cloud computing technology. It is hoped that with these solutions the inertia and fear in people would be dealt with, and they will be more at home to harness and enjoy the ever increasing great potentials and opportunities of the Cloud.

Web Application Solutions : The best security solution presently researched for web applications is the possibility to create a development framework that shows and teaches a respect for security (WHSR, 2012). Talks of putting forth a four-tier framework for web-based development are ongoing; this implies a security facet in the process. Also the X10 language is looked at as one way to achieve better use of the Cloud capabilities of massive parallel processing and concurrency.

Accessibility Solutions : According to WHSR (2012), researchers are pointing out the value of filtering a packet-sniffer output to specific services as an effective way to address security issues shown by anomalous packets directed to specific ports or services. An often-ignored solution to accessibility vulnerabilities is to shut down unused services, keep patches updated, and reduce permissions and access rights of applications and users.

Authentication Solutions : Basta (2007), a researcher, suggested one way to avoid IP spoofing by using encrypted protocols wherever possible. He also suggests avoiding ARP poisoning by requiring root access to change ARP tables; using static, rather than dynamic ARP tables; or at least to make sure changes to the ARP tables are logged.

Data Verification, Tampering, Loss and Theft Solutions : In this regard, Basta (2007) points out that there is no way to know if the Cloud providers properly deleted a client's purged data, or whether they saved it for some unknown reason. Talks are around the possibility of employing resource isolation to ensure security of data during processing, by isolating the processor caches in virtual machines, and isolating those virtual caches from the Hypervisor.

Privacy and Control Solutions : According to Basta (2007), a feeling of absolute security or control is relative. The issues of privacy and control cannot be completely solved in absolute terms, but can be assured with tight service-level agreements (SLAs) or by trying to keep the Cloud itself private. According to him, this will always point out a persisting wrinkle, because allowing a third-party service to take custody of personal/company documents raises awkward questions about control and ownership.

VI. CONCLUSION

Cloud computing holds a lot of hopes and potentials for all kinds of users of IT, despite their age, culture or race. In fact, the Cloud is a panacea for the digital divide between the rich and the poor, the developed and the underdeveloped. This is because, as has been pointed out before, rather than spend huge sums of money to procure computer equipment, resources or services, you access them over the Internet for a small amount of money in a service-on-demand and pay-as-you-go basis. Cloud, therefore, offers nations especially developing nations such as Nigeria, the ability to have immediate access to the latest innovations without paying heavily for it. For developing nations to take advantage of the Cloud, however, their government should increase effort in the of provision of basic infrastructures that favour the adoption of Cloud computing, such as broadband access to the Internet, local data centers, consistent electricity power supply, reduction of cyber attacks, and establishment of legislation for data protection in line with international standards.

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