

## Cloud Computing: A Key to It Development in West African Sub Region

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**Abstract:** *There is no gainsaying the fact that information technology (IT) development in West Africa has met a lot of challenges ranging from cyber threat to inadequate IT infrastructure. Cloud computing is a revolution. It is creating a fundamental change in computer architecture, software and tools development and of course, in the way we store, process, distribute and consume information. This paper, therefore explores the basic concepts of cloud computing and how cloud computing could be harnessed to improve IT and economic development in West African sub-region.*

**Keywords:** *cloud, cloud computing, cyber threat, infrastructure and revolution.*

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### I. Introduction

Cloud computing is the use of computing resources (hardware and software) that are delivered as a services over a network, typically the internet (Wikipedia 2013).

According to [1], cloud computing is a comprehensive solution that delivers IT as a service. It is an internet-based computing solution where resources are shared.

It is a new computing technology that delivers it resources to the door step of the users at a reduced and affordable cost. It would be recalled that research shows that IT utilization, especially internet penetration in West Africa is improving but it is still low when compared with IT in advanced countries.

According to survey conducted by a Canadian-based International Institute for Sustainable Development (IISD), only Nigeria, Senegal, Ghana and Togo have improved/better internet penetration. Other countries in the West Africa have low internet penetration [2]. The survey shows that though internet penetration has been on the rise in the above mentioned countries, but the growth rate varies across these countries. Thus, there are still the challenges of internet access in other countries like Liberia, Sierra Leone, Gambia etc.

According to [3], a study commissioned by mobile advertising network, Twin pine, has confirmed that internet adopted in Nigeria, Ghana and Ivory Coast remains very low in spite of the growth of mobile internet in the countries. The study however blamed lack of fixed line infrastructure in the countries for low penetration.

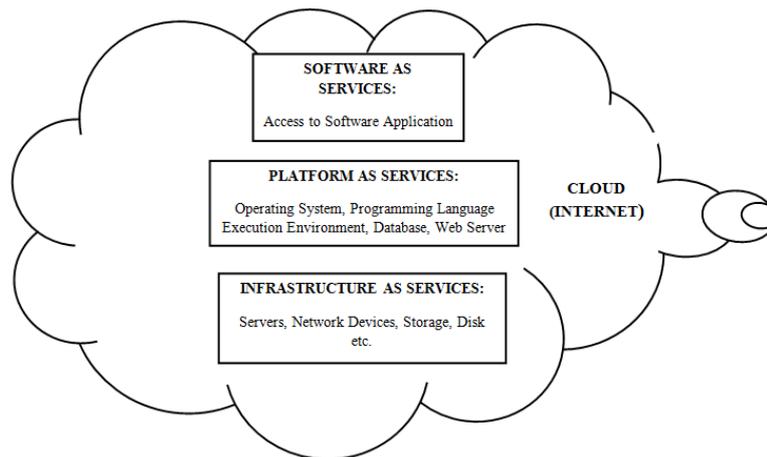
Even in Africa as a whole, internet is limited by lower penetration rate. Measureable parameters such as the number of ISP subscription, overall number of hosts, IXP-traffic and overall available bandwidth all indicate that Africa is way behind the digital divide [3].

We can cite a host of research papers which shows that all is not well with information technology utilization in West Africa/Africa. IT usage in West Africa is faced with a lot of challenges such as lack of basic IT infrastructure cost, slow network services etc.

In view of the above, this paper borders on how to harness cloud computing to overcome the above mentioned challenges and enhance IT usage in West Africa sub region.

### II. Cloud Computing Concepts/ Methodology

Cloud computing has been defined earlier as a comprehensive solution that delivers IT as a service. That is to say that all IT resources and services could be obtained on demand, from the cloud. Computers in the cloud are configured to work together and various applications/users use the collective computing power as if they are running on a single system. See the diagram below (fig 1)

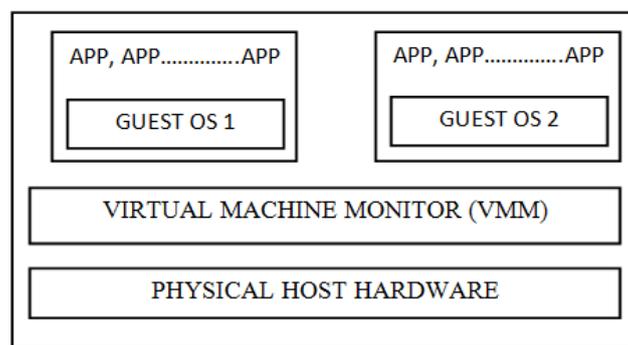


**FIG 1: CLOUD AND ITS RESOURCES**

A simple example of cloud computing is provided by yahoo email or hot mail. Here all you need is just internet connection and you can start sending emails. The server and email management software are all on the cloud (internet) and are totally managed by the cloud service provider-yahoo, Google etc [3 and 4]. The flexibility of cloud computing is a function of the allocation of resources on demand. This facilitates the use of systems cumulative resources, negating the need to align specific hardware to a task. Before cloud computing, websites and server-based applications were executed on a specific system. With the coming of cloud computing, resources are used as an aggregated virtual computer. This provides an environment where applications execute independently without regard for any particular configuration.

**VIRTUAL MACHINE MONITORS (VMM)**

Virtual machine monitor provides the means for simultaneous utilization of cloud facilities. Virtual Machine Monitor is a program on a host system that lets one computer support multiple, identical execution environments. In reality, every user is being served by the same machine. A virtual machine is one operating system (OS) that is being managed by underlying controls program allowing it to appear to be multiple operating systems. In cloud computing, VMM allows users to monitor and thus manage aspects of the process such as data access, data storage, encryption, addressing, topology and work load environment.



**FIG 2 VIRTUAL MACHINE MONITOR**

**CLOUD COMPUTING LAYERS OR SERVICES MODELS**

Cloud computing has 3 main services model or classification namely; Infrastructure as a services (IaaS), Platform as a services (PaaS) and Software as a services (SaaS).

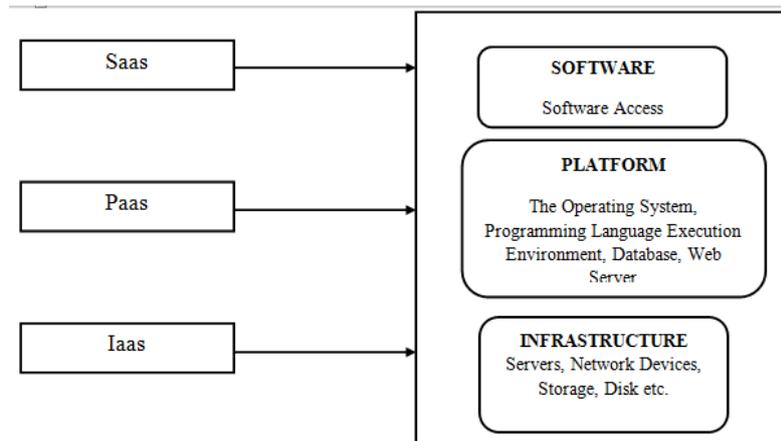


FIG 3: CLOUD COMPUTING SERVICE MODEL (LAYERS)

### INFRASTRUCTURE AS A SERVICE (IAAS)

The infrastructure layer is a foundation of the cloud. It consist of servers, network devices, storage disk etc. without cloud computing, the infrastructure mentioned above are to be provided by the companies or any group of people that need them as assets. But with cloud computing, infrastructure as service marks the shift from the paradigm of infrastructure as an asset to infrastructure as a service. Therefore, with cloud computing, organizations have access to computing infrastructure without owning any of them. They just pay for the services rendered by the cloud IaaS providers such as IBM cloud, Amazon cloud formation, Google compute engine, windows Azure virtual machine etc.

### PLATFORM AS A SERVICE (PAAS)

In the PaaS service model, cloud providers deliver a computing platform, typically including operating system, programming language execution environment, database and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and the complexity of buying and managing the underlying hardware and software layers.

One important thing to remember is that when we talk about platform, we are not talking about the software itself but rather the platform on which it is built to run. Common examples of platforms include Windows™, Apple Mac OSX, Linus for operating system etc.

### SOFTWARE AS A SERVICE (SAAS)

Software as a service provides network-based access to commercially available software. When cloud providers install and operate application software in the cloud and cloud users access the software from the cloud, this eliminate the need to install and run application on the cloud user's own computer, thus simplifying maintenance and support.

In this service model (SaaS), there is paradigm shift from software being assets of the organization (in form of license) to software being provided as a service. Examples of SaaS include Google app, and Trade card. A good provider of SaaS is Google pack, which includes internet access applications tools such as Calendar, Gmail, Google talk, doc etc.

### CLOUD FORMATIONS

There are 3 types of cloud formations; Public cloud, Private cloud and Hybrid cloud.

1. **Public Cloud** – It is a cloud computing model where services providers make their computing resources available online for the public. Here, users are emancipated from performing certain important task on their computing machine such as installation of resources, their configuration and storage [5].
2. **Private Cloud** – Private clouds exist within a company and are managed by the company or organization. Private cloud installations are in parts motivated by user's desire to retain control over the infrastructure and avoid control of information security. Private cloud has attracted criticisms because users still have to buy, build and manage it and thus, do not benefit from fewer hands on management [6].
3. **Hybrid Clouds** – Hybrid clouds are a combination of the public and private cloud using services that are in both the public and private space. Using a hybrid cloud, organizations can determine the objectives and requirements of the services to be created and obtain them based on the most suitable alternative. It provides access to extra resources when the private cloud hits maximum utilization [7].

## **CLOUD COMPUTING AND IT/ECONOMIC DEVELOPMENT IN WEST AFRICA SUB-REGION**

The bane of IT in West African sub-region arises from cost of IT infrastructure, such as computer, software installation and maintenance; low internet penetration, cyber threat and a host of other challenges. It is the belief of the researchers that if cloud computing is adopted, that some of the challenges mentioned above will be eliminated or minimized.

West African sub region can benefit from cloud computing in the following ways:

**Cost Reduction** - Cloud computing can reduce both capital and operating expenses costs because resources are only acquired when needed and are only paid for when used. This will eliminate the need to spend money on hardware and software or licensing fees.

**Improve Accessibility** – With cloud computing, one can have access to computing resources anywhere, anytime, thus making your life easier. With cloud computing, access to computing resources is no longer restricted to fixed locations. This is bound to be a big relief to the people of West Africa, especially those living in rural areas where IT facilities are lacking.

**Back up Benefit** – One of the setbacks of IT development in West Africa sub region is the fear of host of shared data. This fear has been eliminated by cloud computing.

Since all your data are stored in the cloud, backing it up and restoring the same is relatively cheaper and much easier than storing the same on a physical device. Furthermore, most cloud service providers are usually more competent to handle recovery of information than traditional system.

**Storage Capability** – Storing information in the cloud gives almost unlimited storage capability. Hence, people in West Africa sub region will no longer need to worry about running out of storage space, when cloud computing is adopted.

**Data Security** – When data are stored in the cloud, they can still be accessed, no matter what happens to a machine. This has reduced the fear of lost of data by IT users.

**Increased Collaboration** – Cloud computing increases collaboration. It allows employees, students, researchers, etc. wherever they are, to work on shared documents and applications simultaneously with colleagues and also obtain critical updates in real-time. This is bound to improve the education of our children and increase return on investment by various companies in West Africa sub region and other developing countries.

A survey by Frost and Sullivan found out that companies which invested in collaboration technology had a 400% return on investment.

**Disaster Recovery** – Cloud computing providers take care of most issues that border on disaster recovery. When companies use cloud computing services, they no longer need complex disaster recovery plans since provider do that better and faster.

**Flexibility** – Cloud computing gives real time services. If a company needs more bandwidth, cloud-based services can instantly meet the demand because of the vast capacity of the services of remote servers. A survey carried out on cloud computing concluded that “the ability to quickly meet business demand was an important reason to move to cloud computing”. This will improve IT delivery, usage and economic development in West Africa.

The above benefit of cloud computing does not exhaust all that one stands to benefit if cloud computing is adopted and applied.

**Rationale usage of Personnel:** Using cloud computing frees value personnel, allowing them to focus on delivering values rather than engaging in hardware and software maintenance.

## **THE CHALLENGES OF CLOUD COMPUTING**

Cloud computing is not a “bread and butter story”. It has a wide range of challenges; depending on the region in advanced countries will definitely not be the same with that of developing countries.

Cloud computing challenges in West Africa includes

1. **Internet Access:** One of the greatest challenges of cloud computing is access to the internet. Internet is the basic requirement for application of cloud computing. Although internet penetration in West Africa is growing, but it is still low.

2. **Inadequate Power Supply** – As IT equipment is powered by electricity, power supply in West African region is supposed to be adequate. However, the issue of inadequate power supply is not a problem in some West African countries such as Ghana, Togo, Benin republic etc. but unfortunately some countries in West Africa has serious problem of power supply, Nigeria has a serious power supply problem.
3. **Security:** Security threat is a serious problem facing cloud computing. Some people are afraid and are not willing to move their sensitive data into the cloud. As the uses of cloud computing increase, it is like that more criminals will try to find new ways to exploit it.
4. **Illiteracy** – a good number of West Africans people cannot read and write. This group of people may not be comfortable with IT education. Some of them who can read and write need mass literacy program on IT.

Cloud computing is not implemented wholly within African/ West African region. Cloud computing is deployed outside West African sub region, just like the internet which will continue to be money making venture for advance countries benefit most from the internet.

We, in West African sub region pay some money directly or indirectly for every second we spend on the internet through our phone and computers. The implication is that, though we may derive benefits from cloud computing, but we keep on spending without much return to us as a region.

### **III. Conclusion**

The fact that West African sub region stands to gain a lot from cloud computing is not in doubt, but it is also vulnerable to threats. There are many underlying challenges and risks in cloud computing that increase the threat of data being compromised. As the uses of cloud computing increase, it is highly likely that more criminals will try to find new ways to exploit it.

It is our opinion that we should not succumb to the above mentioned threats. When ATM card came on board, it was highly threatened by cyber criminals. Today these threats have been overcome by the ATM providers. It is our belief that cloud computing providers should move ahead of IT criminals in order to ward them off as is done in ATM issue. This is to enable cloud computing users enjoy the maximum benefits of the new computing technology which is overwhelming.

Nothing good comes easy. No system is free from bad influence of bad people who derive pleasure in making their fellow human beings miserable [3]. We should expedite efforts to provide cloud facilities within West African sub region so as to derive the expected maximum benefit arising from it.

### **Recommendation**

In view of the potential benefits of cloud computing and the expected challenges, the researchers recommend as follows:

- i. Cloud computing technology is recommended for use in West African sub region and beyond. This is because adopting it will improve IT development in the sub region. Those who have adopted cloud computing have started counting their blessings.
- ii. There should be strong federal and state laws to safeguard data and information in the cloud.
- iii. Before adopting cloud computing technology, the users need to make absolutely sure that they choose the most reliable service provider, who will keep their information totally secure.
- iv. Serious efforts should be made to develop cloud that is indigenous to West African sub region, so as to strengthen our economies. It can be wholly sourced from our region as it is mainly software that drives it. Hardware can be sourced from anywhere.
- v. Cloud providers should as a matter of urgency work as a team to protect the resources provided in the cloud. This is because cyber terrorism has no boundary. It cuts across every part of the world.

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