Cloud Computing and Its Applications in e-Library Services: Nigeria in Focus

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Abstract—**Cloud computing is an evolving technological paradigm that facilitates conveniently, on-demand network access to a shared pool of configurable computing resources like network, servers, storage, applications and services etc that can be presented as a service and released with minimal management effort. The model promotes availability of resources and creates powerful distributed computing system with global reach and super computing capabilities. Cloud computing is enriching and will widen the horizon of human knowledge, empower human capital for sustainable scientific development as well as educational development of nations. This paper tries to explore the vast and immense benefits of cloud computing and its applications in e-library services in Nigeria today.**

Index Terms—**Cloud computing, e-library services, internet computing.**

I. INTRODUCTION

Cloud computing can transform the way systems are built and services delivered, providing libraries with an opportunity to extend their impacts [1]. Cloud computing offers a new dimension in computing, it changes how we invent, develop, scale, update, maintain and pay for applications and the infrastructure on which they are run. In cloud computing data and services reside in massively scalable data centers in the cloud and can be accessed from a web browser. Cloud computing is away of providing various services on virtual machines allocated on top of a large physical pool which reside in the cloud, in other words cloud computers is capable of collecting large quantity of information and resources stored in personal computers, mobile phones and other equipment and integrate them and put them on the cloud for serving users.

E-library allows users an improved access to library services at the comfort of their homes and offices. That is, users of library can read library books, conduct research at home and offices. E-library is therefore an integrated platform of hardware and software with developmental orientation. The popularization of E-library in Nigeria has grown very rapidly in recent years, but its growth and usage has been stifled by poor infrastructure, high cost of running e-library and software development. Cloud computing offers a solution to the above problems, it provide a cost effective way of running and managing E-library. It equally offers a better and much more efficient ways of collaborating between users of E-library within and outside

Nigeria.

This paper addresses the various aspects of cloud computing, internet computing and E-library, it also attempts to show how cloud computing can be applied in E-library to cut cost and improve services and increase the growth of E-library in Nigeria which may lead to development.

II. CLOUD COMPUTING

Cloud computing is a style of computing in which massively scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies [1]. Cloud Computing is the improvement of Distributed Computing, Parallel Computing, Grid Computing and Distributed Databases. And the basic principle of Cloud Computing is making tasks distributed in large numbers of distributed computers but not in local computers or remote servers [2]. Cloud computing can be defined as an emerging computer paradigm where data and services reside in massively scalable data centers in the cloud and can be accessed from any connected devices over the internet. Cloud computing is a way of providing various services on virtual machines allocated on top of a large physical machine pool which resides in the cloud [3].Cloud computing provides a way for businesses to increase capacity and quality without investing in new infrastructure, licensing new software or training personnel [4].

On-demand self-services: to enable consumers to use Cloud provisions as and when required by business demands.

Resource pooling: to allow dynamically assigned computing resources to serve multiple consumers through the use of virtualization technologies.

Rapid elasticity and scaling: to allow Cloud services, resources and infrastructures to be automatically provisioned as business requirements change.

Measured provision: to provide a metering capability to determine the on-demand usage for billing purposes.

Effective management: to provide and facilitate easy monitoring, controlling and reporting

Cloud computing offers information retrieval systems, particularly in digital libraries and search engines, a wide variety of options for growth and reduction of maintenance needs and encourages efficient resource use. These features are particularly attractive for digital libraries, repositories, and search engines [5].

III. TYPES AND CHARACTERISTICS CLOUD COMPUTING

The following are types of cloud computing [3]:

A. *Software as a Service (SaaS)*

Software package such as CRM or CAD/CAM can be accessed under cloud computing scheme. Here a customer upon registration is allowed to use software accessible through net and use it for his or her business process. The related data and work may be stored on local machines or with the service providers. SaaS services may be available on rental basis or on per use basis.

B. *Platform as a Service (PaaS)*

Cloud vendors are companies that offer cloud computing services and products. One of the services that they provide is called PaaS. Under this a computing platform such as operating system is provided to a customer or end user on a monthly rental basis. Some of the major cloud computing vendor is Amazon, Microsoft, and Google etc.

C. *Infrastructure as a Service (IaaS)*

The cloud computing vendors offer infrastructure as a service. One may avail hardware services such as processors, memory, networks etc. on agreed basis for specific duration and price

IV. CHARACTERISTICS OF CLOUD COMPUTING

The following are characteristics of cloud computing [3]:
- Self-Healing
- Multi-tenancy
- Linearly Scalable
- Service-oriented
- SLA Driven
- Virtualized
- Flexible

V. CLOUD COMPUTING DEPLOYMENT MODELS

Deploying cloud computing can differ depending on requirements, and the following four deployment models that have been identified [6], each with specific characteristics that support the needs of the services and users of the clouds in particular ways.

Private Cloud: The cloud infrastructure has been deployed, and is maintained and operated for a specific organization. The Operation may be in-house or with a third party on the premises.

Community Cloud: The cloud infrastructure is shared among a number of organizations with similar interests and requirements.

This may help limit the capital expenditure costs for its establishment as the costs are shared among the organizations. The operation may be in-house or with a third party on the premises.

Public Cloud: The cloud infrastructure is available to the public on a commercial basis by a cloud service provider. This enables a consumer to develop and deploy a service in the cloud with very little financial outlay compared to the capital expenditure requirements normally associated with other deployment options.

Hybrid Cloud: The cloud infrastructure consists of a number of clouds of any type, but the clouds have the ability through their interfaces to allow data and/or applications to be moved from one cloud to another. This can be a combination of private and public clouds that support the requirement to retain some data in an organization, and also the need to offer services in the cloud

VI. INTERNET COMPUTING

Internet Computing includes all forms of computation, and the hardware and software needed to perform it, with a significant use of the Internet. Internet 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 service provider interaction.

VII. CHARACTERISTICS OF INTERNET COMPUTING

On-demand self-service: customers can adjust their services without needing anyone's help. Best of breed self-service provides users the ability to upload, build, deploy, schedule, manage, and report on their business on demand.

Ubiquitous network access: available through standard Internet enabled devices.

Location independent resource pooling: processing and storage demands are balanced across a common infrastructure with no particular resource assigned to any individual user.

Rapid elasticity consumers can increase or decrease capacity.

Pay per use: Consumers pay for only what resources they use and therefore are charged or billed [7].

VIII. E-LIBRARY SERVICES

E- Library refers to all the library resources that are available online through computers and databases. This is different from the open internets because E- Libraries have restricted access. E-library system facilitates library operations by offering:
- Systematic records of the library collection
- Reliable records of library patrons
- Seamless check out and check in of library materials
- Ease of accessing statistical results
- Generate real time report for management decision
- Outstanding/Overdue loan
- Periodic loan transactions
- Hassle free stock taking of library materials
- Personalized service to each patron

Specific access account to library patrons to search or make reservation of library materials anywhere and anytime at their conveniences.

IX. ADVANTAGES OF E-LIBRARY

- Innovative and productive library operations
- Experience the efficiency and convenience of library management with the help of proven technology
- Flexibility in choice of auto identification technology, and seamless transition from barcode to

Radio-Frequency Identification (RFID) technologies
- Modular yet scalable deployment at preferred pace and schedule.
- Improved customer service provided to library patrons as a result of reducing time to borrow
- Library materials, cutting down queue and queuing time, and ease of identifying the library materials required from the library.
- Provide quality service to library patrons by raising the librarian service standard to higher value added and professional service provider in information and resource.
- Cuts down laborious tasks
- Smoothens business workflow and upgrades the library image to its library patrons [8].

X. PROBLEMS OF E-LIBRARY IN NIGERIA

Despite the advantages of E-library and the Federal government effort to encourage the growth of E-library, it has been stifled by the following problems:
- Lack of technical knowledge and support
- Cost of managing E-library
- Poor infrastructure
- Inherent problem of E-library in collaboration

A. Lack of Technical Knowledge and Support

The technology required to provide e-library services continue to change rapidly as researchers and commercial vendors expand the kinds of content and access services that might be included. As the technology changes and improves, the country users of e-library like the universities, vision and requirement for e-library evolve accordingly. The software to support these services is complex and dynamic. It is difficult for an average user; say a university with limited technical resources to manage the development and growth of a practical, real world e-library [9].

B. Cost of Managing e-Library

The cost of installing and managing e-library is high in Nigeria. This is because, network cost in Nigeria consist of not only capital cost but also high operating cost. Example, the varieties of discipline that is inherent within a university learning environment impose the need for a variety of hardware and software platform to be install for the running of e-library, with other supportive technologies such a massive air condition etc.

C. Inherent Problem of e-Library in Collaboration

The present method offered by e-library in collaboration to research and development among user is a little bit clumsy. Assuming university B is carrying out a research and needed a contribution from other sister universities, and sends a copy of the research work to all the universities in the network if each university make changes and send it back to university B then the number of copies university B will receive may be equal to the number of copy send out. This method of collaboration is a little bit clumsy. Cloud computing offer a more efficient and consistent way of collaboration between sister universities.

XI. ROLE OF CLOUD COMPUTING IN E-LIBRARIES

Cloud computing is completely a new technology and it is known as 3rd revolution after PC and Internet. Cloud computing is an enhancement of distributed computing, parallel computing, grid computing and distributed databases. Among these, grid and utility computing are known as predecessors of cloud computing. Cloud computing has large potential for libraries. Libraries may put more and more content into the cloud. Using cloud computing user would be able to browse a physical shelf of books, CDs or DVDs or choose to take out an item or scan a bar code into his mobile device. All historical and rare documents would be scanned into a comprehensive, easily searchable database and would be accessible to any researcher. Many libraries already have online catalogues and share bibliographic data. More frequent online catalogues are linked to consortium that share resources [3]. Data storage could be a main function of e-libraries, particularly those with digital collections storing large digital files can stress local server infrastructures. The files need to be backed up, maintained, and reproduced for patrons. This can strain the data integrity as well as hog bandwidth. Moving data to the cloud may be a leap of faith for some library professionals. A new technology and on the surface it is believed that library would have some control over this data or collections. However, with faster retrieval times for requests and local server space it could improve storage solutions for libraries. Cloud computing or IT infrastructure that exists remotely, often gives users increased capacity and less need for updates and maintenance , and has gained wider acceptance among librarians

XII. ADVANTAGES OF CLOUD COMPUTING IN E-LIBRARIES

The advantages of cloud computing in e-libraries include the following:
- Cost saving
- Flexibility and innovation
- User centric
- Openness
- Transparency
- Interoperability
- Representation
- Availability anytime anywhere
- Connect and Converse
- Create and collaborate [3]

XIII. CLOUD COMPUTING IN E-LIBRARY IN NIGERIA

Cloud computing offers many possibilities that will help to reduce technology cost of installing and maintaining e-library and improve collaboration among users a good example is the universities in the country. Fig. 1 shows universities in the country running e-library with huge servers, and licensed software packages which is actually very costly.
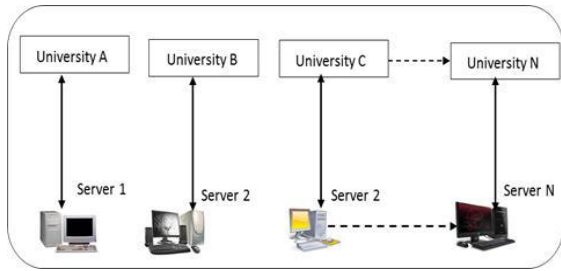
Fig. 1. Schematic diagram of Nigerian universities running e-library services with huge servers, and licensed software packages.

Fig. 2 shows when the universities adopted cloud computing. The adoption of cloud environment relieves the institutions of the need to acquire an actual costly server in order to install an e-library, one costly software applications needed for individual universities to run e-library can be placed in the cloud and all the universities in the country will have access to it as shown in the diagram. Every change in technology can be accommodated and updated in the cloud which all the universities would have access to.

Fig. 2. Schematic diagram of Nigerian universities adopting cloud computing.

XIV. CONCLUSION

There is an overpowering agreement between IT professionals that cloud computing offers a new approach to produce solutions for old problems. These new technology hold the concept of cutting cost and adopting better IT capabilities in enterprise, industries, universities as well as other tertiary institutions in the country.

Researchers, IT professionals are provided with the ability to leverage "rent- by- the hour" or pay-as you go concept to rent computing CPU, and storage power horse. This will lead to reduction of in-house data center and delegation of a portion or all of the information technology infrastructure capability to a third party. These ideas hold the promise of driving down cost while fastens innovation and promoting agility. Most of the research focused on the benefits of cloud computing, internet computing and e-library. We have tried to show how cloud computing can be applied in e-library in Nigeria with an example of the universities in Nigeria.

From the financial perspective, cloud computing holds the promise of cutting down cost of installation and maintenance of e-libraries, since it will do away with purchasing and maintaining of extensive hardware and software for high power servers which would no longer be in existence as shown in Fig. 2.

REFERENCES

[1] G. Matt. (2010). Winds of change: Libraries and cloud computing. OCLC Online Computer Library Center. [Online]. pp. 5. Available: http://www.oclc.org/content/dam/oclc/events/2011/files/IFLA-winds-of-change-paper.pdf

[2] S. Rupesh and K. Gaurav. (July 2011). Cloud computing in digital and university libraries. Global Journal of Computer Science and Technology. [Online]. *11*(*12*). pp. 37. Available: https://globaljournals.org/GJCST_Volume11/e-Journal%20_GJCST_Vol_11_Issue_12_July.pdf

[3] G. Nandkishor, S. S. Seetal, and D. Bhagyashree. (July-September, 2012). Use of cloud computing in library and information science field. International Journal of Digital Library Services. [Online]. *2*(*3*). pp. 52-57. Available: Http://Www.Ijodls.In/Uploads/3/6/0/3/3603729/Vol._2_July_-_Sept._2012_Part-2.Pdf

[4] E. Craig, M. Diana, and T. Florence, "Cloud computing an overview," *MIS 641*, pp. 6, 2009.

[5] M. Gopalaswamy and S. N. Kumar. Cloud computing technology: A boon for library and information services. *Indian Journal of Library and Information Science*. [Online]. Available: http://www.rfppl.com/subscription/upload_pdf/Art.1_844.pdf

[6] Dialogic Making Innovation Thrives. *A White Paper on Introduction to Cloud Computing.* [Online]. Available: https://www.dialogic.com/~/media/products/docs/whitepapers/12023-cloud-computing-wp.pdf

[7] F. E. Mehmet and B. K .Serhat, "Cloud Computing For Distributed University Campus: A prototype suggestion," presented at The International Conference on The Future of Education Yildiz Technical University, Turkey.

[8] Tunity Technologies Pte Ltd. (May 5, 2013). E-Library Management System. [Online]. Available: http://www.tunitytech.com/TunityLibraryManagementSystem/ext/e-Library%20Management%20System.pdf

[9] S. M. Reza. (November 2006). Problem and Prospects of Digital Library Digitization in Bangladesh Institutes of Higher Education. Inflibnet's Publications. [Online]. pp. 106. Available: http://hdl.handle.net/1944/1197

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