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DESIGN OF CLOUD-BASED E-LEARNING SYSTEM FOR VIRTUAL CLASSROOM

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Abstract

Cloud computing provides a great collection of computing resources that can be rapidly and elastically provisioned and released based on users' demand to serve a wide and regularly expanding variety of information processing requirements. Due to its tremendous advantages this technology is maturing quickly and is being adopted in many applications including government, business, and education. This research employs the Cloud as a learning environment for teaching Computer Science and related courses by removing the locality constraints, while simultaneously improving students' understanding of the material provided through practical experience with the finer details and subjects' complexities.

Most of the universities infrastructures are underutilized and in some cases over utilization of resources occurs, in order to balance the usage of the resources there is need for an elastic technology. In order to develop an e-Learning platform for virtual or open distance learning (ODL) undergraduate students

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e-Learning,
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of computer science new methodologies (like cloud based e-Learning) should be taken into consideration for project, problem based learning and virtual computorium. The research identified several potential Computer Science courses which could be launched and taught through Clouds. This framework addresses the services of cloud computing in a new dimension and each layer (in virtual classroom cloud-based system) specifies the essential components (that is matching of computer science courses with cloud layers) needed to construct an academic cloud in an open distance learning environment. And finally, a way of implementing the framework is proposed.

1. Introduction

In modern time, web based technologies have an enormous contribution in reducing routine work. Many institutions and universities are introducing some new courses to give knowledge about these technologies. But institutions are facing many problems like lack of experienced teachers to teach technical courses to their students. So to overcome this problem, many institutions introduce online education service for those courses. Virtual or E-learning is a term used to describe any form of electronically-based learning and teaching, including computer-based teaching both in and outside of the classroom, such as the streaming of university lectures on an institution's website. So it becomes necessity for many countries especially developing nations such as Nigeria to implement the e-Learning software solutions to improve their educational standard. But there are many problems to implement these solutions like lack of infrastructure and proper facilities in educational institutes throughout the country. Thus, the cloud computing technology in e- Learning is the best solution to overcome this problem. [1].

University has various departments where many students need to access the computing and resources such as highly available software and hardware. Cloud computing has the capacity of

scaling and elasticity which is perfect for such an environment. A cloud computing service has ubiquitous access through a Web browser or mobile device with application programming interface (APIs) or special desktop applications. Use of Cloud Computing on universities has many benefits such as accessing the file storages, databases, educational resources, research applications and tools anywhere, anytime on demand. Furthermore, cloud computing reduces universities' information technology (IT) complexity and cost. The main goal of an academic cloud is to manage effectively the technological needs of universities such as delivery of software, providing of development platform, storage of data, and computing. The implementation of cloud services at universities provides various opportunities and benefits for the users of the university. For example, in a typical university scenario, personal computer laboratories and servers are under-utilized during the night and semester breaks. In addition, these resources are on high demands mainly towards the end of a semester, following a dynamic rule of use. The Physical machines are old even when they are idle, wasting its full potential. Every day that goes by, research and educational needs of universities' change with developing technology. All the software and hardware of universities' must be renewed in accordance with the changes. For example, there are office applications, programming language, and multimedia developing courses in computer education. Also every year, the new versions of applications were used for courses with respect to the needs of industry. [2]

Thus, the aim of this work is design an cloud based e-learning framework for Ladoke Akintola University of Technology Open Distance Learning (LAUTECH ODL) using Computer Science education as a case study. This research is intended to create a framework for Computer Science education to remove some of the above limitations and challenges by harnessing the power of Cloud Computing. The framework removes the locality constraints, allowing students and faculty to collaborate in a distributed and interactive surrounding. In addition, Cloud Computing provides a set of tools to help educators explore subject complexities in a manageable manner without the risk of harming the system because of the virtualization technology within the Cloud Computing preventing the damage. The new Cloud-based E-learning environment can be solid, hold more sophisticated packages, and support synchronized contents without much concern about the infrastructure limitations. The resources, when they are needed, can be rented from the Cloud. [3]

2.0 LAUTECH E-LEARNING MODEL

An e-Learning system is a popular technology for distance education. The e-Learning education system based on the web models conventional in-person education by providing equivalent virtual access to classes, contents, and other resources. It is also a social space where students and teacher can interact through threaded discussions or chat. E-learning systems are usually developed as distributed applications. The architecture of distributed E-learning systems includes software components, like the client applications, an application server and a database server and the necessary hardware components like client computer, communication infrastructure and servers. Overall, this design is called a three-tiered architecture. The architecture for E-learning system is shown in Figure 1.

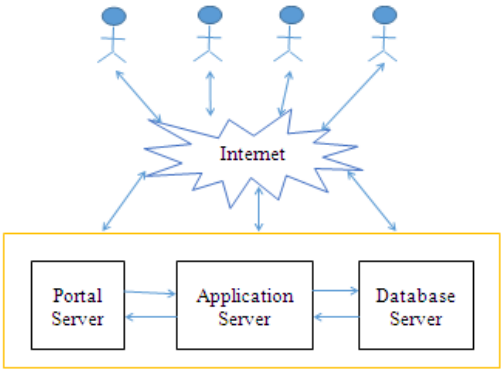

Figure 1: LAUTECH E-learning Architecture

In a LAUTECH E-learning system, all three tiers are maintained at a central location by the content provider and this design implementation is called E-Learning Server. The problem with the existing technologies is that they are platform specific and are not interoperable. They do not allow the learners to avail the e-learning resources from different places. They are not flexible and dynamically scalable infrastructure. Also, they decrease the performance and increases the overall cost.

3.0 BASICS OF CLOUD COMPUTING

Cloud computing is 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. Cloud Computing is a technology that uses the internet and central remote servers to maintain data and applications. There are five essential characteristics of cloud

computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service.

3.1 Cloud Services: Cloud offers services that can be grouped into the following categories as shown in figure 2:

***(i) Infrastructure as a service (IaaS)*:** Hardware resources (such as storage) and computing power (CPU and memory) are offered as services to customers. This enables businesses to rent these resources rather than spending money to buy dedicated servers and networking equipment. Here, Amazon1 offers simple storage services (S3) for storage, elastic compute cloud (EC20 for computing power, and single queue server (SQS) for network communication for small businesses and individual consumers.

***(ii) Software as a service (SaaS)*:** In this service, software applications are offered as services on the Internet rather than as software packages to be purchased by individual customers. Examples include Salesforce.com , Google web-based office applications (word processors, spreadsheets, etc.),

***(iii) Platform as a service (PaaS)*:** This refers to providing facilities to support the entire application development lifecycle including design, implementation, debugging, testing, deployment, operation and support of rich Web applications and services on the Internet. Most often Internet browsers are used as the development environment. Examples of platforms in this category are Microsoft Azure Services platform6, Google App Engine7, etc.

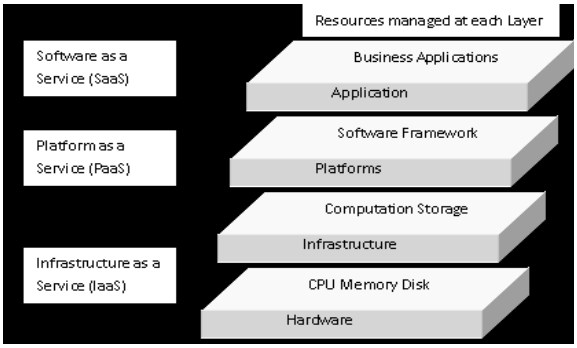

Figure 2: Cloud Computing Architecture.

3.2 Cloud Models: There are four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services. A ***private*** cloud exists for the use

of one consumer (business) exclusively. The cloud may be used by many business units within the same enterprise but the service provision may, in fact, be outsourced to a third party. A ***community*** cloud is similar except that the consumer in this case is a group of interested parties that are not from the same enterprise. The service may be managed by one of the parties in the community or by a third party. A ***public*** cloud provides applications, storage and other resources to the general public. These services are free or offered on pay per use model. An ***hybrid*** cloud, is the use a combination of any of the three aforementioned deployment models. The models remain distinctive but are linked by standards or proprietary systems that permit data and/or application portability. [4]

4.0 RELATED WORK

Over the years of inception of e-learning, various researchers have came up with different e-learning architectures. Ivica et al. [5] developed a system called StartHPC to teach parallel programming at MIT. This system is based on a virtual image of Amazon EC2 machine which is used to build the class cluster. By using Cloud Computing, both the faculty and the students were allowed to focus on the concepts of parallel programming in OpenMPI and OpenMP without being distracted by non-related details such as networking and installation problems. Tian et al., [6] in 2010 developed a high serving education fields and research institutes to manage a virtual Cloud lab's resources allocation, users, and access with the ability to deploy it on a public or private Cloud. They implemented the framework using the VMware workstation 5.5 which creates virtual platforms; Apache web server, MySQL database server, and security remote access tools. Their framework enhances resource utilization and sharing. The researchers design and implement the framework to manage PaaS in virtual Computing labs (VCL). Yang and Zhu [7] built Open-source software (OSS) for e-learning based on Cloud Computing in China. They proposed the EduCloud platform to launch their e-learning environment on a public Cloud, using IaaS and SaaS to overcome resource limitation and lack of e-learning scalability.

Virtual Computing Laboratory (VCL), developed by Vouk et al [8] in North Carolina State University (USA), enables students to reserve and access virtual machines (VMs) with a basic image or specific applications environments, such as Matlab and Autodesk. VCL does not offer collaboration features, but offers (IaaS and PaaS) platforms which could be used to host

collaboration systems (SaaS) on top of it. Bo Dong et al [9] presented an e-Learning framework called Blue-sky cloud framework in which physical machines have been virtualized and allocated on demand for e-Learning systems. It also solves the challenges faced by e-Learning systems. It also consists of three layers such as the virtual infrastructure, capability and data caching layer. It improves the availability, performance and scalability of e-Learning systems. Other works can be found in Al-Zoube [10]; Xu et al. [11]

5.0 METHODOLOGY

5.1 Identifying the Computer Science and related Courses

To determine the potential Computer Science and related courses, it is pertinent to analyzing computer science related courses. The analyzing process was based on the assignment types, components of the syllabus, and the course with respect to the basic Cloud Computing service layers, as shown in Figure 3 adopted from [3]. In teaching the concepts of computer science courses in a much more interactive platform, comparing to simulation scenarios with a local cluster, it is better to spotlight the non-theory courses since most of the Cloud's PaaS services depend on a programming model. All courses can benefit from SaaS and IaaS layers, such as Cloud based virtual classroom applications and tools. In addition, multi levels of difficulty to the courses which can fit in more than one layer of Cloud basic layers of services are identified. Moving from the SaaS layer to the PaaS means the course depth and difficulty increases, and students have to understand course concepts more deeply. In the same way, moving from the PaaS layer to the IaaS, more sophisticated courses with higher levels of difficulty which reached the details of VMs configuration and details of networking and operating systems are added.

5.2 *Building the Framework*

Distance learning (DL) in its current shape is very primitive and harnessing the cloud into the e-learning environment gives more flexibilities and dynamic resource allocation which solves the scalability issue. Then the virtual classroom on the top of Cloud Computing layer helps to conquer some DL limitations. Applying the Cloud based architecture to Computer Science courses will result in adding the course content in the appropriate layer through the interface by adding the content. Using this architecture will enhance the quality of service for adding more students and more multimedia content. In addition, the live video streaming is a problematic in the previous systems, but when utilizing the Cloud infrastructure, this problem will be eliminated

when we have a good bandwidth for the private networking.

Based on the identified courses, a Virtual Classroom for Computer Sciences based on Cloud Computing (VC-CS) framework is built based on [3]. Now, to integrate the course to use the Cloud in its teaching process is focused. By highlighting the how part, we can proceed to the details of the framework layers and architecture. The following figure 3 shows the VC-CS framework. The presented frame work namely VC-CS contains four layers (User Interface, SaaS, PaaS and IaaS) and three modules (User log database, system security, and service management).

User Interface Layer: A user Interface represents LMS since it acts as an interface between the user and the e-learning content. The User Interface layer contains three important components: *User Portals*: provide an access path to specific web applications or services since everything is located on the web and can be accessed using an Internet connection. *Service Catalog*: contains different types of services with detailed information about the additional access information, such as what layer the service is located and who can access this specific service. *Courses Repository*: composed of the courses content categorized and arranged depend on the course name and access level which may be in one of the three other layers (SaaS, PaaS, or IaaS).

SaaS Layer: This layer provides access to hosted programs–applications or tools on the Cloud—used most of the time by beginner levels, such as Intro to Computer Science, Fundamentals of Data Structures, Foundations of Sequential Program, Information Technology Law, Data Management I, Algorithms and Complexity Analysis and Discrete Structure. Using Microsoft Word, Microsoft Access or Microsoft Excel, for example, as a hosted application on the Cloud by Google Apps [12] is considered as a component for this layer.

PaaS Layer: In the PaaS level courses, they need more than just an existing application to reach their goal. Building a distributed system or simulation needs control of the number and the IPs for the virtual machines (VMs) with a platform to host the developed application. For For Human-Computer interaction course, there is need for a platform to host and deploy the developed application or system to measure and test the usability of the deployed system. For the Information Management and DB courses, they are able to build more sophisticated systems and

distributed DBs using different tools to manage these systems and DBs. They can use different programming languages to build an application or system on the provided platform for the PaaS level. In the PaaS level, the user can access the VM level with some limitations, and with this access, they are able to control part of the networking issues, such as IPs and routing mechanism which help in teaching Computer Networks and Communication, Net-Centric Computing courses for the beginner. For the Computational Sciences course, they can build a temporary multiprocessing system using multiple VMs to solve an existing problem quickly and efficiently. The Software Engineering courses need a platform to develop the software which can be found on the PaaS level. Also, we can choose multiple Operating Systems (OS), build specific scheduling algorithm, and compare the Central Processing Unit (CPU) utilization and speed when using different OS. Lastly in the Computer Security course, in the PaaS level the user is enabled to build inception keys and data encoding mechanisms.

IaaS Layer: Infrastructure-as-a-Service (IaaS) is a computational service model widely applied in the cloud computing paradigm. In this model, virtualization technologies can be used to provide resources to cloud consumers**.** The IaaS level gives more flexibility to Computer Hardware course when dealing with the Hardware layer but through the virtualization. Now, the point where there is need to build the servers and set up their configurations is reached as represented in the Database management II course. For the Distributed Computing course, the user can personalize their firewalls, ports, and IPs access. In this level, the OS and the network can be manipulated more deeply above the virtualization layer. Meanwhile with Artificial Intelligence, combining the complexity of machine learning with the scalability of cloud computing resources makes for a powerful match. By offering machine learning tools through the cloud, the idea is to democratise access - both in terms of hardware costs for compute and storage, and also access to data science skills needed to benefit from the technology. [3].

6.0 SELECTING APPROPRIATE CLOUDS

Cloud candidates considered for this work are Amazon, IBM Clouds, and Windows Azure based on the following criteria:

- Identification of Clouds that provide a platform as a service since it is the most appropriate layer to deploy the framework on;

- Since the courses would utilize the PaaS to develop and deploy their application besides the course interface which would be built using IaaS and PaaS, especially for virtual classroom tools that can be found in the PaaS layer;
- To include the Clouds that affords a great amount of services to apply more courses.
- Also to depend on ease of the use and the existence of ongoing technical support services.

7.0 CONCLUSION

Cloud computing is a new emerging technology that is expected to significantly change the field of IT in the next few years and lead it for the coming decades. Numerous services and applications can be provided in the Cloud due to its many interesting and promising characteristics. Cloud services and applications are expected to attract many individuals and organizations from different disciplines and our project helps them understand the impact of these services on their e-learning, however, cloud computing technology is not free of risks and concerns. Examples of Six pilot Computer Science courses have been given. The selected courses are Database Management, Human-Computer interaction, Operating System, Parallel Programming, Artificial Intelligence and Data Communication and Network. Because CloudSim is the only existing open source simulation toolkit that

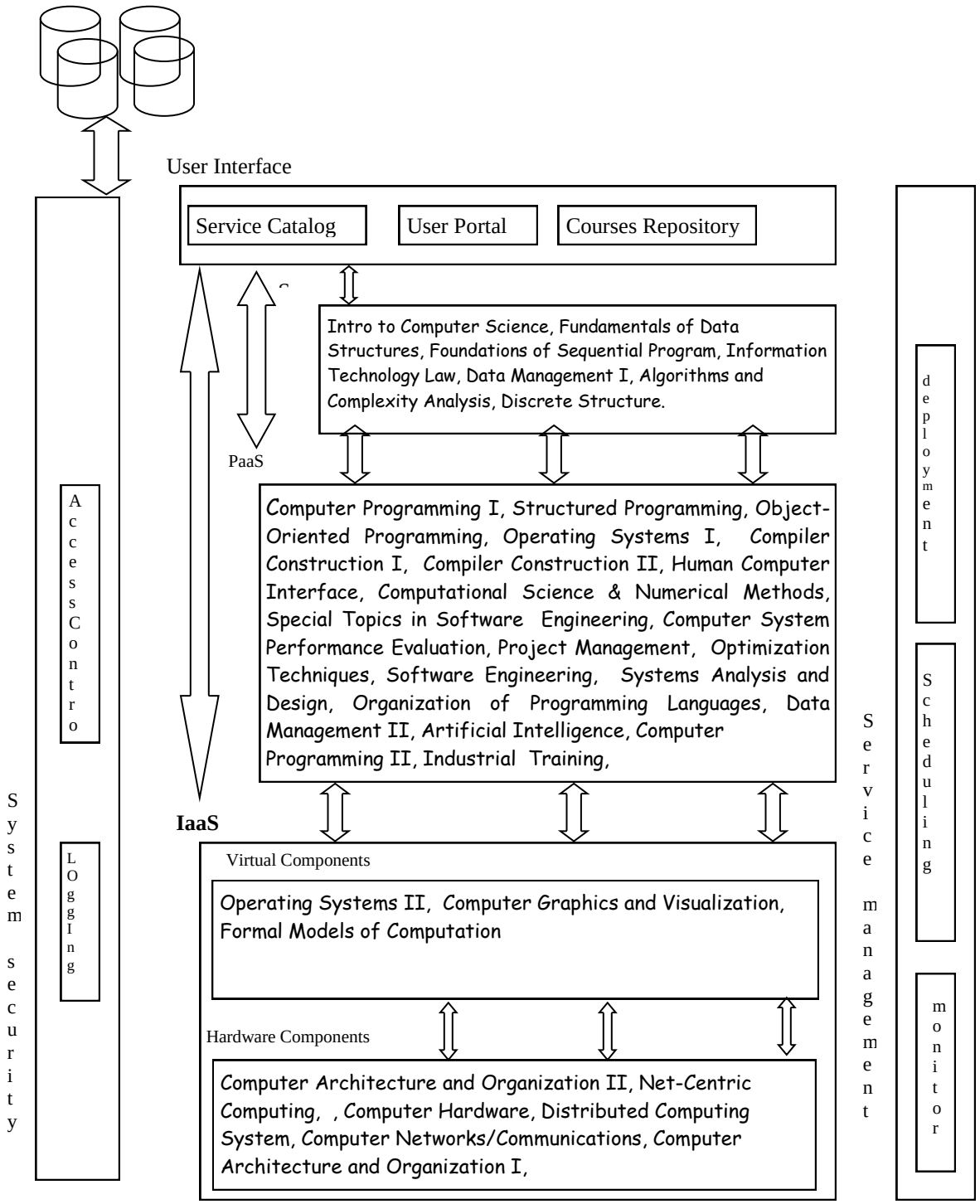

Figure 3: Virtual Classroom for Computer Science based on Cloud Computing. (Adapted from [3]).

simulates the IaaS, we could not use it to simulate PaaS, the main layer in our framework. This framework helps and satisfies organizations, institutions, learners and instructors to provide an efficient e-Learning mechanism using cloud computing. By means of the cloud based e-Learning, students will attain the 21st century skills

within them and also increases the university-industry collaboration.

This research identified the potential advantages of using Cloud Computing in educational settings as well as limitations that should be considered. In short, without any doubt, Cloud Computing offers a plethora of tools and choices, which should be carefully evaluated to ensure that all the educational stake-holders gain the maximum benefits from such technology.

Security and privacy issues continue to be the biggest concern on cloud computing that limits its adoption in practice. The multi tenancy nature and resource and data outsourcing are the main reasons for the security issue in cloud computing. Organizations and individuals are still concerned about storing and processing their sensitive data and critical applications on the cloud. They continue to raise many questions for their CSPs such as where is their data located and who manages and accesses it, why is their personal information requested and who uses it and what is the fate of their data in case of disasters or when the CSP went out of business. It is not surprising that much of the future work in cloud computing will focus on developing approach that are able to address its security issues.

The research possibilities regarding Cloud Computing for educational purposes are immense since the technology is relatively new. Research in the education fields has much to be examined, but there is not yet a clear definition and standard for such technology. The movement will be rapid after the standardization. The future works on educational cloud computing include but not limited to:

- Investigate the effectiveness of the course content and placement in the framework as well as the ability to move and add courses. In other words, refine the framework after examining actual scenarios.
- Compare the implementation of the framework on the public Cloud, private Cloud, and hybrid Cloud by highlighting the strengths and weaknesses of each Cloud architecture while considering the performance and security issues.

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