A COMPARATIVE ANALYSIS OF VARIOUS CLOUD BASED E-LEARNING PLATFORMS: EVOLUTIONARY ANALYSIS

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Abstract

e-Learning is comprehended as a proficient way of learning. These days, educational institutes hugely make use of e-Learning to support their learning process. But, due to increasing demands, the educational institutes have been facing the issues to provide essential IT support to the educational research and activities development. With the expansion of technologies, cloud computing has come into existence that provides a good opportunity for developing e-Learning, by which various occurred issues can be resolved. CC technologies make educational institutes enabled for supporting their infrastructure for getting access to CC on demand. For various institutes, utilization of CC became a necessity because of several factors like cost raise, the pressure of income enhancement, the success of students, academic performance, and competition. In educational institutes, CC's payment per utilize model, management policies of security, and risk presented to be advantageous in utilizing CC. Thus, various platforms, tools, and architectures of CC for e-Learning have been proposed that are contending for user attention. Some of the efficient works presented in this field are explored based on their performance matrices in this paper.

Keywords: CeMSE, Cloud based e-Learning Model, e-Learning, e-Learning Improved Architecture for Clouds, NIGEDU Cloud, Seattle.

1. Introduction

e-Learning is the learning process based on the internet that makes use of internet technology for designing, implementing, choosing, managing, supporting, or extending the learning that will not take place of conventional education techniques, however, can hugely enhance educational efficiency. Due to numerous advantages of e-Learning such as measurement, diversity, flexibility, opening, etc., it will turn out to be a prime approach to learning in the modern era. Figure 1 represented below illustrates the e-Learning system [1].

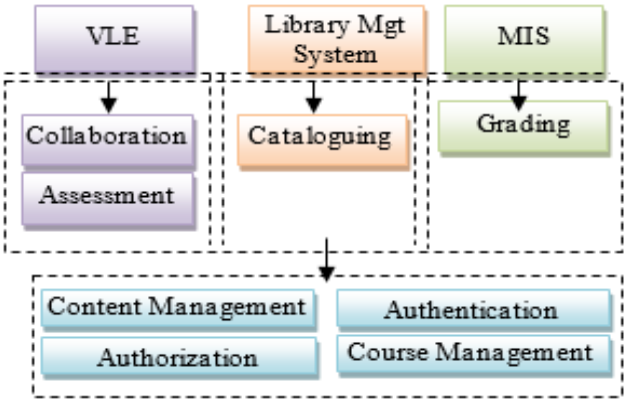

Figure 1: Traditional E-Learning system [Source: 1]

These days, educational institutes hugely make use of e-Learning to support their learning process and give their learners the service such that they can access the learning material anytime. A number of educational institutes have implemented the e-Learning system. As mentioned earlier that e-Learning offers numerous advantages, however, the implementation of it also consists of various difficulties [2]. The major difficulty faced while its implementation is the great initial cost or one can say its fiscal factor [3]. It has been regarded as the main concern for institutes that implement e-Learning. The low-budget institutes will find it difficult for implementing e-Learning, and also, the

institutes having a sufficient budget anticipates a minimum budget that can be invested for e-Learning implementation. For implementing e-Learning, insufficient infrastructure is also regarded as the main issue. Institutions coveting for e-Learning implementation, find the problem in acquisition of server, network, and storage, [4]. The other problem is human resources. Not every institute comprise professional staff to design, develop systems for e-Learning management, also, the increasing implementation of e-Learning needs expert to design the teaching materials usually referred to as the instructional designer. Thus, every institute while implementing e-Learning, must consider this aspect as institutes will also evaluate their employment cost for providing particularly for an e-Learning system.

With the growth of ICT technologies, cloud computing (CC) progressively became a novel exemplar of modernism in the IT world. CC is the computing services that can be utilized via the Internet as per users' needs with small interaction among the users and service providers. CC technology can be also delineated as a computing resource that offers extremely scalable external services via the Internet. Thus, CC can be regarded as a substitute for decreasing the infrastructure and human resources cost to develop and maintain the e-Learning process [5].

Due to vast expansion in the number of registrations of students, the content of learning, services which are provided, and available resources, the extent of the e-Learning system rose at a great rate. The difficulties on the subject of this topic concern optimization of resource calculation, storage and communication needs, and handling requests of dynamic concurrency emphasized the requirement of utilizing a platform that fulfills scalable needs as well as controls the cost. This milieu is referred to as CC (Cloud Computing) [6].

The CC platform architecture exemplified in Figure 1 is generally common to the majority of e-Learning systems on Cloud [7]. In this, the 1st layer represents the interface with Cloud setting, that comprise of various management subsystems to understand the present requirements of user with respect to resources for computation, considering it as conniver for services of storage, managing load distribution among virtual machines (VMs), system administrator for monitoring and initializing the actions of every layer, and security module for assuring privacy, security, integrity, and recovery of users' information and their transactions with other users. The 2nd layer delineates VMs applied in the system. At last, the 3rd layer consists of the entire system's physical architecture.

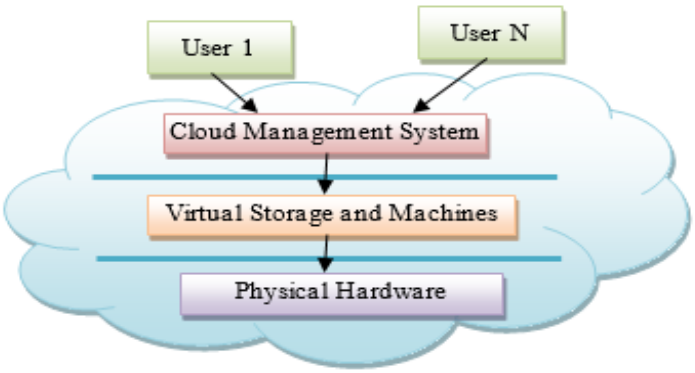

Figure 2: Architecture of cloud for e-Learning [Source 7]

Aptness of CC for e-Learning

In the cloud environment, e-Learning is sighted as Education Learning Software-as-a-Service (ELSaaS). It can be deployed extremely fast as the users' requirements are very less. Also, it reduces the maintenance load and the institutes can focus on their main business as vendors provide support to them and can attain the system's most recent updates without any charges and sharing the primary resources. To this end, the corollaries and insinuations about e-Learning services development in the CC setting, as represented by [8] are:

- **Accessed through Web:** Anyone can access the application from anywhere and at any time.
- **Does not require client-side software:** Thus, it minimized the subscriber prices, because it does not require installation and software maintenance, and less IT workforce is needed by institutes.
- **"Pay per use" subscription:** It is appropriate for Software Model Learning and felicitates to use the expensive and complicated applications.

- **SaaS server can be shared by different educational institutions:** As the application runs on the server-side, scalability is innate to the system. The performance of the software does not get degrade with the rise in usage of a student.
- **Complete subscriber data apprehended on SaaS server:** SaaS provider needs great security for gaining the subscribers' trust and complicated multitenant software design. The distribution of the data of subscribers is done among various providers and its integration should be done for gaining the outline of the business, great system demand, and data integrators.

Lastly, various impending values of CC for education have been illustrated in [9] as below:

- Does not require backup of the whole information to internal drive or direct it from one to other devices. It implies that learners can create the information repository which remains with them and keep extending till they want.
- It almost does not require crash recovery. If the user's computer gets crashed, then no data get lost as everything has been stored in the cloud.
- Students can work from numerous places (home, library, work, etc), identify their files, and can do editing in them via the cloud. And the applications based on the browser can be also accessed via different devices (PC, mobile, laptop, provided internet must be available).
- It is flexible as CC permits its users to scale dynamically with fluctuation of demand.
- It has enhanced improbability as the thief cannot get the physical device which stores wanted data to steal for getting digital asset.
- Its virtualization makes the quick replacement of compromise cloud situated server with no high costs or damages.
- It has centralized data storage thus the important part of data and applications is stored in the cloud so that new users can be connected rapidly.
- The data access can be monitored easily as only one place has to be analyzed and not numbers of computers distributed over the wide geological area.

Thus, all these points demonstrate the suitability of CC fore-Learning. Further, this suitability is verified by performing the comparative analysis among e-Learning systems in terms of earlier than and later than moving on to Cloud as represented in table 1 [10].

Table 1: Comparative analysis of e-Learning system before and after shifting to cloud **[Source: 10]**

e-Learning Attributes	Before shifting to cloud	After shifting to cloud
Requirement for In-House Deployement	√	×
Less control on the resources	×	√
Conflicts among contrasting goals of various users	×	√
Great risk of resource obtainability and failure	×	√
Not have trust in data amendment before storing	×	√
DoS attack in serious server health	×	√
Great risk of data load, hassle, and congestion	×	√
Hard to audit	×	√
User logs and information monitoring by 3rd party	×	√
Require support of technical IT in case of any hardware failure	√	×
Require team for developing Learning System	√	×
Require additional hardware and software resources	√	×
Require configuration of recent software/technological updates	√	×
Require internal arrangement of additional power and cooling system	√	×
Not have accuracy and computation trust	×	√
Be deficient in confidentiality	×	√
Not have trust on security and access control policies	×	√

Load of daily storage and backup	√	×
High investment cost	√	×
Require high-speed internet connectivity	×	√
Registration and AMC charges	×	√
Requirement collection and induction	√	×
Require project administration	√	×
Require coding	√	×
Require testing	√	×

2. Comparing Cloud Based Platforms and Architectures for e-Learning

Numerous tools and platforms of e-Learning are present that are contending for attention. The arrival of the cloud-based platforms and architectures are reasonably efficient and rising inclination in thee-Learning. Some of the most effective present CC models are discussed below:

3.1 Seattle

The CC is rapidly becoming very popular. Companies like Microsoft, IBM, Amazon, RedHat, and Google are more and more doing bursary to CC infrastructure and research, making it significant for students for gaining the essential skills for working with cloud-based resources.

The Author [11] provides the educational platform i.e. Seattle which is a community-driven endeavor that relies upon resources provided by software users. It delivers the students with an extremely diverse set of resources.

Stimulus:

Various platforms of cloud computing are present which are used today. Amazon runs the RedHat servers cloud for providing computing resources [12], which provide VM. It results in enhanced performance; however, it is not flexible for supporting the provided resources and also is not free. Microsoft [13] released the developer toolkit to provide the user with "software +service". However, as far we know, it is unavailable presently. Also, Google presented the CC-like architecture with AppEngine [14] that supports high abstractions. However, due to its way of handling scalability and vicinity apparently, it became inappropriate to teach such primary topics of distributed systems (DS).

Seattle has been designed to perform this in a safe and efficient way. The author [11] tried to make easy deployment of Seattle by aiming the education of DS complications. The architecture of Seattle is thus presented to overcome the shortcomings of other models.

Architecture of Seattle: Seattle architecture comprises of different layers. The lowermost layer is the "sandbox module" that comforts the control of resources and security for each unit. The "node manager" was existing at the upper layer which decides the sandboxed programs be run on the local computer. At last, an "experiment manager" was existing that permit the learners to govern their program cases over computers.

3.2 Cloud based e-Learning Architecture (5-Layers):

The author in [2] emphasized the novel paradigm in the field of education by presenting the CC for increasing flexibility, scalability, and availability of the e-Learning systems. In this article, the authors assessed the conventional model of e-Learning, with its progress and issues, and leeway of the moving system of e-Learning out of institutes or schools, inside CC arrangement, and proposed e-learning cloud architecture.

Stimulus: The author [15] presented that conventional web-based learning leads to various problems, like considerable investment required but exclusive of capital gains that result in inadequate development potential. On the contrary, the e-Learning model based on the cloud presents a scale efficiency mechanism and it is capable of running on a great variety of hardware components, by keeping information on the cloud. The authors in [16] examined the benefits of "cloud-based e-Learning 2.0 applications i.e. viability, scalability, or obtainability" and emphasized on the enhancements in threat management and price. Chandran [17] highlighted the problems of e-

Learning, particularly the scalability, openness, and development costs, and introduced an amalgam cloud delivery approach that can overcome these issues.

Thus, motivated by these, the author in [2] introduced CC architecture for increasing scalability, elasticity, and accessibility of e-Learning systems.

Architecture (5-Layers): The architecture presented in [2] was classified into 5 layers: "Infrastructure layer which is the scalable and dynamic physical host pool, software layer which provides an integrated interface for developers of e-Learning, resource management layer which attains software and hardware resources' loose coupling, service layer which contains three services level (SaaS, PaaS, IaaS), and application layer which gives the creation of content, delivery of content, virtual laboratory, mutual learning, evaluation and management characteristics".

3.3 E-Learning Improved Architecture for Clouds:

Author [18] had proposed a novel distributed architecture for providing the opportunity to learners all over the world to utilize resources that are being shared by staff and to do online communication among students and teachers. In this paper, the author mainly emphasized SaaS development to provide cloud solutions to e-Learning, which is a research field in which no other researchers were presented previously.

Stimulus: The author [19] had addressed the CC issue as, conventional e-Learning system relies upon client/server architecture which was not scalable, flexible, and interoperable. Authors in [20] delineated that the system should be self-adaptive and must offer flexibility to users based on their requirements. In research work [21], authors concentrated on the SaaS layer. The amalgamation of SaaS and CC platforms can reduce operating costs, propose better elasticity, etc.

Improved cloud architecture: The architecture of CC includes "front end and back end" which are connected with the use of the internet. To explain the proposed algorithm's working, "examination system and online text whiteboard were utilized". Both the educators and learners are allowed to access and use the documents. In this architecture, "DBaaS (Database as a Service) was also used" to perform record keeping. The design of architecture was modest and provides easy access for cloud users.

3.4 CeMSE:

Author [22] proposed the cloud-enabled model to preserve and distribute learning resources and services required by the students. The author understood that the "National Knowledge Network (NKN)", can aid as a vital mainstay for employing projected model. The model can facilitate "distance learning, academic guidance by experts of the subject, access to excellence study material, and also lead to collaborative research in the promising fields".

Stimulus: At present, various government institutions are going through critical difficulties because of insufficient finance, deficiency of manpower, and other facilities. Thus, it is an actual challenge to maintain quality education all over the country. For offering the scientific answer to such restrictions, author [22] targeted to competently associate the infrastructure with an anticipated model.

Cloud-Enabled Model: The proposed CeMSE model is fundamentally a hierarchical model in which the data centers' are organized at regional levels. "National level data centre" is kept at the top-most level. On the basis of geographical exposure, regions are further divided into different zones. Every zone consists of "zonal level data". At last, many HEIs and Schools can access "provincial data centers' resources".

3.5 NIGEDU Cloud:

Author [23] proposed the model which was envisioned for achieving the goals related to "education of national IT policy of Nigeria". With the aid of this archetypal, the government can give ICT resources and services to academic institutions in the country.

Stimulus: The IT (Information Technology) policies are evolved and implemented by the government of developing countries to make their nations participate in the contemporary ICT revolution. One such national IT policy has been created by the Nigerian government to make their

country IT capable country in Africa [24]. In this policy, IT will be utilized for education, wealth creation, and worldwide competitiveness [24]. However, there is an obstacle to obtain education objectives of policy which is, insufficient national ICT service and infrastructure [25]. This fissure can be minimized if the educational organizations of developing countries can access the same ICT services and infrastructures which are present in developed countries [26]. The CC platform makes it possible for the country to utilize the resources for providing e-Education with improved standards and accessibility. The prime element of the cloud model is the obtainability of the internet [27], thus the CC model was proposed for education in Nigeria [28].

Architecture: The Nigedu cloud defines 3 roles viz. "Cloud Service Provider, Cloud Service Consumer, and Cloud Service Creator". In this, the CSP is the government. Educational institutions are cloud consumers. The customers of cloud "requests, utilizes and manages the cloud services" that include "enrollment management systems, course management systems, e-examination systems, etc". The autonomous 3rd party government is the cloud service creators.

3. Research Outcomes

The effectual works in the field of CC based e-learning system are discovered in this research paper from which the following findings are determined:

- In the Seattle model, the tremendous variety of set of resources was delivered to scholars,
- The improved CC model was presented in which the emphasis is on SaaS expansion and improvement to offer more functionalities,
- In the CeMSE model, the learning material and education-related services required by students were upheld and circulated,
- In the NIGEDU cloud model, the aims of the NIGERIA IT Policy were achieved with the help of which the government can offer improved infrastructural and e-Education service to schools and colleges of the country.

However, all these works do not provide performance matrices-oriented analysis for determining the effectiveness of techniques. Thus, by considering the benefits and limitations of the existing models, the new efficient model can be designed further and hence gave an efficient cloud-based e-Learning system.

4. Conclusion

In this paper, various platforms and architectures of cloud-based e-Learning systems have been explored such as Seattle, Could-based e-Learning Architecture (5-layer), e-Learning Improved Architecture for Clouds (SaaS), CeMSE, and Nigedu Cloud. However, on considering these schemes, it has been realized that these schemes lack performance analysis to check their usefulness.

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