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Research paper

Next generation of e-learning through the effective usage of cloud computing services

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Abstract

Cloud Computing is an essential technology intruded in almost all areas where information technology is used. One of the major areas which require Cloud Computing is the Higher Education System where broad and in-depth knowledge and right guidance are highly demanded. Providing such teaching services has also impediments in the traditional education system where cloud computing plays a vital role in a new technology-based educational ecosystem. In this paper, we bring out the advantages of cloud computing to overcome the barriers by providing a new framework of cloud-based e-learning for higher education. Meanwhile, we keep in mind that the use of the system is very much needed for developing countries like India. Using cloud computing in educational institutions can create a common virtual classroom thereby reducing the expenses and the manpower required to install a well-equipped platform. The proposed model facilitates the students and the faculty can access the content 24/7 and also improve the educational performance. This model comes up with cloud system features and with specified cloud services for each purpose. It facilitates the cloud system to perform the services such as PaaS, DBaaS, SaaS, CaaS, and RDaaS for some service components in API. Each of this service has its own functions through the Hypervisor.

Keywords: *Cloud System; Cloud-Based E-learning; CaaS; DBaaS; SaaS; PaaS; RDaaS.*

1. Introduction

Technology is very dynamic and it changes day by day through invention and innovation. Technology has evolved in various sectors and in addition, it is an activity that creates a new culture and reduces the efforts. In the past, we used to learn by direct interaction between a teacher and a student. But today technology has brought some imminent changes in the learning style. We use virtual classrooms instead of going to classes every day which reduces the time and the cost of learning. E-learning is meant to provide economical as well as widespread online education to the populace. Using electronic technologies helps to access the education curriculum on the outer side of the traditional system of learning. By using the internet and its features we are delivering learning online. Despite being in different places a virtual interaction can access the class through electronically developed resources. It needs a storage device to keep information that one can retrieve and access as per need. Keeping large data not only reduces the storage space but also it is a burden to preserve and keep data. There is, however, the danger that if the storage system is jeopardized due to some errors, all those information will be lost. So technology has come up with a new solution for storage and a platform for the online environment, called cloud system [1]. The cloud system helps to access and back up or store our data on the internet. Furthermore, it provides a platform for building and maintaining the data through the internet. Amazon cloud service and Google cloud systems are the pioneers in the IT industry for providing cloud services [2]. They give their service based on customer demand and need.

E-Learning through the cloud system is a new concept. It delineates the combination of e-learning and cloud service that makes an impact on e-learning concept. Through these cloud services, virtual classrooms are available 24/7 and we can access them from anywhere and at any time. By the invention of cloud in the e-learning environment, we can enlarge the number of learners and achieve an educated society [3]. The user will get the opportunity to enroll themselves in another online course that they find useful [4]. We need training and development for employees to face the fast-paced business environment. To accommodate the entire employees in one room is quite intricate for the company. So they choose to learn through cloud computing and it provides the possibility of corporate learning and the collective method of instructions for their stakeholders. E-learning is different from the traditional way of education like seminars and class, which is one of its major advantages [5]. E-learning administrations make use of vast computing scenarios like data analysis, virtual works, video streaming virtual word and large-scale collaboration for content creation such as Massive Open Online Courses (MOOC) [7]. The cloud computing can be connected with both platform and application type whereby it can act both as a platform to do the work and carry the physical and virtual machine in the cloud. The cloud help to share the resources with the public and private and it can even customize its accessibility. The cloud is basically a distributed data center which provides infrastructure as a service to its users [6]. The main attractive attribute of the cloud is its scalability [2], [6] and virtualization [2], [6] which means that it can accommodate large data, data servers. It can be accessed on a mobile device or computer with internet facility. It can't run without internet; it helps to bring the external services with the help of internet features.

Cloud computing should exhibit five fundamental characteristics : (1) On-demand services, which allows consumers to deal with their own virtual resources without interacting with the supplier,

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with high network access. (2) Resource pooling, this makes the resources available to the authorized consumer and to any multiple producers. (3) Rapid allocation, which gives resources rapidly and releases them instantly after use. (4) Measured services, which automatically controls the provision of service. (5) Metric template, which improves measured service provision for both the provider and the client. These five features provide many opportunities for educational development [7].

The cloud system consists mainly of three categories:

1) Infrastructure-as-a-service (IaaS).The basic level of cloud architecture is IaaS. Amazon web services (AWS) and Google cloud platform (GCP) are some of the best IaaS providers [4]. The business and educational organizations will choose the IaaS because it is faster, easier and economic for the organization and it can handle the workload without purchasing, operating and support from the underlying infrastructure. The online services with a great extent of an application programming interface with the help of Hypervisor function. It means Hypervisor function has the features that abstract and isolate the operating system and application [8]. The features of abstraction help two or more virtual machines to run independently with the support of host machine hardware so that the cloud can accommodate large virtual machines and the ability of its scalability brings utility to the user [8]. IaaS helps online educational platforms to run cost-effectively [9].
2) Platform-as-a-service (PaaS). We experience this in Microsoft Office365 which can work online without software infrastructure in the computer. It is possible because Microsoft Office 365 acts as IaaS and PaaS [10]. The PaaS provides a platform for the user to maintain, develop and run the applications without the complication of creating typically associated infrastructure for running that application [11]. The main attraction of PaaS is that it is user-friendly with convenience and simple by its performance. It provides application hosting to the user and it acts as the middleman for database and another runtime into a cloud environment. The third party provider delivers the hardware and software tools through the internet for the application development which helps to collaborate the work together. The PaaS provides the features of computing, storage, testing, compiling, and editing that enable the user to create the software in a convenient manner. This works under the principle of pay as you go method.
3) Software-as-a-service (SaaS). All Google applications are SaaS model because the third party vendors who actually deliver the application and its interface are accessed by the client. The SaaS is possible as it works in a web browser without downloading or installing some required platform [12]. This SaaS is known as web delivery model. It provides online streamline to the user instead of installing and running the application on the computer [11]. The best example is email services provided by Google. The main purpose of this paper is to explore the contribution of studies on the impact of cloud computing on e-learning and to analyze the new way of teaching and learning and thereby to develop a more secure e-learning system.

2. Literature review

Pocatilu P, Alecu F and Vetrici M (2010) [13] tell about the positive impact of using e-learning in cloud computing. This paper explains how software projects can be managed using e-learning in cloud computing. The management projects are influenced by using cloud computing in e-learning. This paper presents the risk management and the cost which influences the cloud-based e-learning system. A matrics system was developed to measure the cloud-based e-learning system.

Gunjita Shrivastava, Sandeep Sahu (2013) [14] developed a new proposed framework which provides a chance to students across the universe to use the learning content shared by the faculty. This proposed model provides the chance of online communication between the faculty and the student. In this research, the main thrust is on SaaS advancement to propose a cloud answer or solution for e-Learning. The two main services provided by the system are whiteboard and online examination. The whiteboard services are used by the faculty mainly to teach the students using images, text and different types of multimedia services. Online examination system is utilized basically to evaluate the dexterity of the students who are attending the course.

Mingwei Wang, Jingtao Zhoul, Shikai Jing et. al. (2012) [15] indicate in their work that the suggested frameworks must be self-adaptive and adaptable to the customers according to their needs. They introduced a new model called cloud manufacturing vision (GetCM) which provides flexibility and reliability. The paper examines the economic and functional aspects to find evidence of the benefits of GetCM.

Yangpeng Zhu, Jing Zhang, (2012) [16] focus on their research over the SaaS layer. They give strong evidence to support the SaaS is turning into a popular research field in the development of the software with its specifications such as low cost, simple implementation, and zero frameworks.

Thaiposri P, Wannapiroon P, (2015) [17] tell about the purpose of this paper. In this paper, the research methodology has two steps: designing the learning activities and evaluation. This paper deals with the learning activities and determines their appropriateness using an evaluation form and the resulting data is analyzed using statistical measures such as mean and standard deviation. Finally, this paper shows research findings in three steps, namely, preparation for learning and pre-teaching, enhancing students' critical thinking skills through teaching and learning by inquiry-based learning activities using the cloud computing and social networks and finally, evaluation and measurement. These findings in the research shows that information technologies are the main sources of student development in this century.

Verma, K, Rizvi, M. A. (2013) [18] study the current e-learning framework, introduce its characteristics and finally analyze concepts of cloud computing and develop an architecture for cloud-based e-learning. It focuses on the limitation of cloud computing in the present scenario and presents the way to overcome its limitation by shifting the paradigm in Internet-based learning to the cloud environment. One of the main benefits of shifting the e-learning paradigm in web-based learning to the cloud environment is content transparency.

Thyagharajan, K., Nayak, R. (2007) [19] present the problems of automatically integrating and selecting the proper learning outcomes for the students using web services. They describe a system which gives the learning content to institution and multimedia industries who are working in Adobe Flash. This approach basically fulfills the e-learning objective based on the dynamic supply of service and it is based on the reusable studying objects which describe the process of composition of learning objectives. This new approach is proposed to produce extensible e-learning resources by runtime reconciliation of elements which are discrete.

Mehta, H. K., Chandwani, M., Kanungo, P. (2010) [20] explore the applications such as cloud, grid and cluster computing to develop a new e-learning concept. This paper basically implements the distributed e-learning system in order to evaluate three main problems: the selection of appropriate distributed computing platform to implement e-learning framework, finding the appropriate resource management policies, and proposing an architecture for e-learning system. In order to get a suitable distributed e-learning cloud system, they proposed a parameter based approach. They implement the new e-learning framework to the cluster, grid and cloud computing. They find that grid and cloud computing contains a large number of resources and they can propose an efficient framework on decentralized resource management.

Wang, C.-C., Pai,W.-C., Yen, N. Y. (2011) [21] introduce, in order to enhance the interoperability of learning objectives, cloud computing into an e-learning platform to allow the integration of different e-learning standards in order to get an appropriate e-

learning platform for the learners, they proposed a sharable e-Learning platform. They built three-layer architecture to facilitate concurrence of various learning contents and sharing of the learning objects.

Conghuan, Y., Xiaowen, C. (2011) [22] propose a framework of e-learning for campus cloud in order to maintain the quality of the distance education. Based on the interaction among the local campus cloud this paper provides a new e-learning framework. The quality of distance education is ensured by this approach.

Lohmosavi, V., Nejad, A. F., Hosseini, E. M. (2013) [23] present the idea about service-oriented cloud computing architecture. The proposed model in this paper is a market-based architecture named Mandiis used to design the e-learning ecosystem. Mandi architecture gives the users more flexibility for negotiating protocols and cause scalability for the request. This paper also introduces the method named Aneka which is the most efficient and earliest method for companies. In order to provide quality service, Aneka platform provides the resource for public cloud providers.

Ketel, M. (2014) [24] mainly focused on the limitations and benefits of the clouds based e-learning framework. Cloud computing paved the way for the future of the e-learning across the world. By the introduction of cloud in the e-learning ecosystem, the institution can reduce their budgets. This helps the students, faculty, and administrators to adopt the modern mobile world.

Masud, A. H., Huang, X. (2012) [25] focus on the current e-learning architecture and analyze the cloud system and thereby describe the architecture of cloud computing in the e-learning system. The paper introduces the cloud in the e-learning environment and thereby build an e-learning cloud. Using cloud-based teaching in the educational institution the students and teachers can access the e-learning materials anywhere and anytime with the help of internet.

Encalada, W. L., Sequera, J. L. C. (2017) [26] propose a framework of e-learning for hands-on information technology. In order to access the e-learning content, the virtual technology is used. With the help of technologies which exist like virtual desktop service MOOCs, and cloud computing a new e-learning framework is developed.

Bora, U. J., Ahmed, M. (2013) [27] present the benefits of cloud computing. In our country, many of the educational institutions cannot afford huge expenses for educational purpose. This paper suggests that learning through cloud computing is the cost-effective as well as the best solution for an educational institution because the students can access the e-learning content with the help of the internet. Cloud-based education pattern helps the students especially those from the rural part of the world.

3. Proposed framework

In this section, we propose a framework which can be implemented and used for higher education. The framework evolves from the problem statement described here. The framework architecture is designed with the help of the problem statement. A brief definition of the problem statement, the theoretical framework, the crucial technologies in cloud computing are also described. The proposed e-learning environment as depicted in Figure 1.

3.1. Problem statement on which framework is built

From the literature review, we could find the gaps in the usage of cloud services in different areas of higher education. E-learning has taken vast space in higher education these days in many educational institutions and it is the need of the hour also. There are several e-learning solutions in both open sources and commercial. The server operating system used in these applications has the limitations of dependencies to the programming languages in which the applications are developed. Meanwhile, the data for the learning resources placed in the database are stored on different servers and because of this reason the numerous resources for learning can't be shared by another system. Usually, E-learning framework transfers the repositories of learning to the web application, but the different platforms cause incompatibility. The drawback of the current e-learning systems is the migration of the e-learning data among the various systems. Elimination of these interoperability problems will make the e-learning in higher education more effective.

To address this problem statement, we are adding cloud services to the current e-learning system, thereby developing an efficient model to promote the e-learning courses in the dynamically changing education environment with the economic storage and 24/7 availability for the students and facilitators in university with the help of Relational Database as a Service.

3.2. Architecture

In this proposed model we use some additional cloud categories and an educational cloud framework for efficient E-learning as presented in figure 1 which helps the technological enhancement of the University education system. In this framework, the services offered by the cloud are incorporated into several typical Universities' clouds. Services like Database as a Service, Content as a Service, Software as a Service, Platform as a Service, and Relational Database as a Service are located in the cloud. Varied users like the students, the faculty, and the University administration make use of the Education cloud. All its services including E-learning contents are made available by the University to the learners through the cloud. The faculties can access and make changes to the existing e-learning content or upload new e-learning content into university cloud, and share the information. Since the students can freely access the E-learning contents supplied through the university cloud the primary goal of providing effective E-Learning services to the students is easily obtained.

The application layer, a platform layer, an infrastructure layer are basics to cloud services and they constitute the architecture of the E-Learning system in a cloud platform. Out of these the Infrastructure layer is a hardware layer and implemented by the e-Learning and virtualization software technologies. Service layer provides the reliability and stability of the infrastructure. It also supplies storage capacity and the computing power for the next level. The application layer provides an interface for the students just like an application platform. Cloud computing offers suitable access to the e-Learning contents at this layer.

The middle layer is the platform layer which contains middleware. This middleware is basically a Web service which provides E-Learning resources as a service. This layer also develops a service called Content as a Service [3]. In Content as a Service, the teachers use their live educational report, information, and some contents to go live for the benefit of the students in their educational curriculum. The main advantage of the Content as a Service which is easy to manage helps in maintaining the content activities and keeps the curriculum updated [28]. The parents also can know the assignments of each student as well as their activities. Content as a service helps to rid the content management (CMS) system and other traditional methods like WordPress and Drupal for the content creation and making websites. Karen McGran's contribution WYSIWTF and visual editor are playing important roles in editing in CMS [3]. The SDK and its library, and third-party integration help to develop a cloud-based CMS service. The main advantage is the decoupled approach towards CMS architecture. It separates the backend and frontend i.e. from presentation to storage and delivery, the infrastructure of the content is stored within the API via two-way street.

The live practical environment can be created by using PaaS and SaaS. The student might not have the particular software requirement for doing the practical problem, so these cloud categories deliver the practical environment for doing it. In this proposed model the researcher gives an idea that programs which are needed for a student can be installed in the cloud. Their own software should be compactable to run online. It facilitates the function of accessibility with the hypervisor.

Database as a service is a cloud model that comes up with the features of a database without a physical hardware requirement. So the University or any other Educational Institution can set up database services in the cloud to avoid the huge cost of establishing physical storage space and its maintenance [29]. The security of the data stored in the cloud, scalability, and elasticity will be the main features. In Database as a Service the University owns its own database in the cloud; it is a private cloud and all the educational management information, learning and teaching methods are stored in this database. The study materials and practical solutions are saved to the students' personal files with recovery options. The University can share it with the public. For example, the theses of Ph.D. students are stored in DaaS and the public has access to it anytime. It is also accessible at the common university portal. The highly confidential matters relating to the student and the University will be stored in the relational database as a service and its outcome should be numerical. Data in this database are stored in the model of relations as it contains the grades of the students, financial statistics, and other important matters.

RDaaS offers to transfer from the database users to the service operator much of the operational load of provisioning, configuration, scaling, performance tuning, backup, privacy, and access control and to reduce the overall expense to the users. The relational database as a service provides efficient multi-tenancy and minimizes the workload. It can easily encrypt and decrypt data to provide high security. The different constituent elements of Relational Cloud have been developed here and before presenting it as a service on the public cloud we have to integrate them into a single coherent system. Along with the routing, partitioning, replication, and CryptDBelements, we have implemented the distributed transaction coordinator. Our transaction coordinator supports both MySQL and Postgres back-ends and implements a JDBC public interface.

All these cloud services are taken by different service providers that increase the efficiency of each function like DaaS for storing the data. We use oracle enterprise manager 12c that enhance the snap clone for a point in time viewing data. And the use of NoSQL cloud database facilitates Store and Sync rather than relational storage. For a relational database as a service using Amazon Relational Database as a Service that is easier to set up a relational database, by dealing with different service providers to enhancing the safety and security of the services by following inter cloud specification[30]. We can go through the Cisco inter cloud Fabric Director (ICFD)[31] that facilitates the seamless experience for the user and administrators by controlling and managing multiple cloud networks.

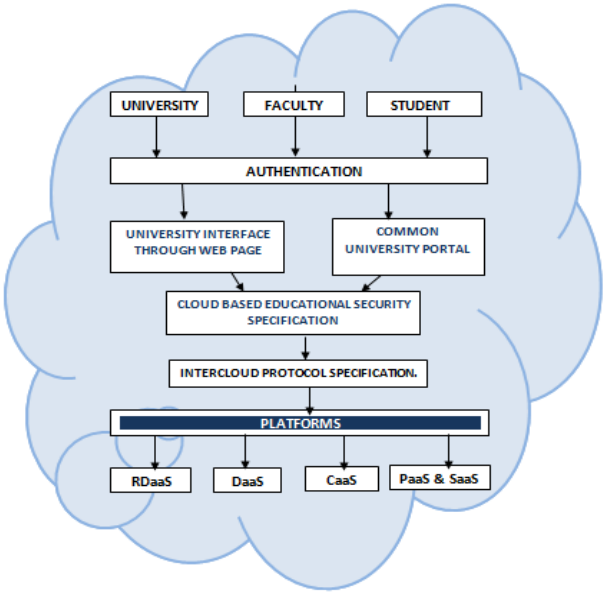

Fig. 1: The Proposed Model of the Next Generation of E-Learning through the Effective Use of Cloud Computing Services.

3.3. Advantages of the proposed framework

1) Using different independent cloud platforms brings scalability and allocation of specified services effectively.
2) It helps to integrate the universities and to establish a common educational curriculum.
3) The combination of internal and external user accessibility helps authorized persons to access it from anywhere in the world.
4) It is the combination of all cloud services integrating into a simple specified purpose.
5) Its database services increase the scalability of storage, safety, and security.
6) Content services help to put updates live by the faculty through a stable content delivery network (CDN).
7) Using inter cloud protocol specifications helps to run multiple clouds and control them.
8) The real-time platform helps to run different kinds of software without host machine hardware. It helps students to do computer lab experiments through cloud services. It also provides help to install cloud compactable software
9) The relational database helps to arrange and store the student and institutional data in a more secure form (encrypt and decrypt).

4. Conclusion

With the use of efficient cloud platforms, manual works are rid by allocating the functions in specified clouds. It helps to overcome the problems of the traditional and existing cloud-based-learning system. In this paper, the proposed framework for the efficient use of cloud service facilitates each functionality in different specified clouds rather than pointing to the particular cloud since the framework uses inter cloud protocol specifications that control and maintain the multiple cloud platform. Since the education is one of the most important pillars of any country, cloud computing in higher education will surely cross the barriers and take knowledge to a person in any corner of the world. Since it is cost effective and scalability to each utility, the adoption of the proposed framework will support millions, especially people in developing countries like India to get access to higher education.

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