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Integration of E-learning and Cloud Computing – A Review

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Abstract: Computer networks have brought opportunities for educational development and social progress. Cloud computing introduces efficient scale mechanism, lets the construction of e-learning system to the suppliers and provide a new mode for e-learning. An enhanced integration between cloud environment and e-learning is the need of hour for upcoming e-learning tools that are considered as Software as a Service (SaaS). The aim of this paper is to give an overview of the current state of the Cloud Computing and its impact on e-learning and to compare the various cloud based e-learning architectures. At first the paper introduces concepts of e-learning and cloud computing infrastructure. The paper then describes the cloud services and deployment models. Finally, the paper presents an in-depth comparison of cloud based e-learning architecture.

Keywords: *(ABS) Cloud computing, e-learning, distributed system, SaaS, Paas, IaaS, Cloud Models, e-learning architecture*

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I. Introduction

Education is indispensable to development of any nation. Presently there are lots of patterns to acquire knowledge. One of the most promising paradigms for education is e-learning. E-learning is commonly referred to use of computer networks for learning process. Some other terms are also used to describe this mode of teaching and learning including online learning, virtual learning, distributed learning, network and web-based learning. The growth of e-learning is directly related to the increasing access to ICT, as well as its decreasing cost[1]. The capacity of ICT to support multimedia based learning is also relevant to the growing interest in e-learning.

Cloud Computing is a new paradigm that provides an appropriate pool of computing resources with its dynamic scalability and usage of virtualized resources as a service through the Internet. The resources can be network servers, applications, platforms, infrastructure segments and services. Cloud computing deliver services autonomously based on demand and provides sufficient network access, data resource environment and effectual flexibility[2]. This technology is used for more efficient and cost effective computing by centralizing storage, memory and computing capacity of servers. With the tremendous advantages of cloud computing, we expect this technology to revolutionize the field of e-learning. The benefits of cloud computing can support education institutions to resolve some of the common challenges such as cost reduction, quick and effective communication, security, privacy, flexibility and accessibility.

Cloud computing allows to move the processing effort from the local devices to the data centre facilities. The software is seen as a service and the applications and data are stored on multiple servers that can be accessed from the Internet. Cloud computing has many advantages such as expected performance, reduced upfront investment (i.e. software, hardware, and professional staff to maintain servers and upgrade software), high availability, reduced launching time, infinite scalability, tremendous fault tolerance capability, accessibility, enhanced collaboration and mobility, allows users to use any device such as a mobile phone, personal computer (PC) etc. [3]

II. Basic Concept and Architecture of Cloud Computing

Cloud Computing is a technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing data storage, processing and bandwidth[4]. Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet).

According to the official NIST (National Institute of Standards and Technology) definition, "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." The NIST definition lists five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services. The definition is intended to serve as a means for broad comparisons of cloud services and deployment strategies, and to provide a baseline for discussion from what is cloud computing to how to best use cloud computing. Cloud offers services that can be grouped into the following categories:

A. 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. As examples in this category, Amazon1 offers S3 for storage, EC2 for computing power, and SQS for network communication for small businesses and individual consumers[5][6].

B. 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[7][8]. Most often Internet browsers are used as the development environment. Examples of platforms in this category are Microsoft Azure Services platform6, Google App Engine7, Salesforce.com Internet Application Development platform8 and Bungee Connect platform9. PaaS enables SaaS users to develop add-ons, and also develop standalone Web based applications, reuse other services and develop collaboratively in a team.

C. Software as a service (SaaS): In this model, software applications are offered as services on the Internet rather than as software packages to be purchased by individual customers[9]. One of the pioneering providers in this category is Salesforce.com offering its CRM application as a service. Other examples include Google web-based office applications (word processors, spread sheets, etc.)

III. Cloud Computing Deployment Model

A. Public Cloud: Public cloud applications, storage, and other resources are made available to the general public by a service provider. These services are free or offered on a "pay-per-use" model. Generally public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure and offer access only via Internet (direct connectivity is not offered).

B. Private Cloud: The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises[10].

C. Community Cloud: Community cloud shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud), so only some of the cost savings potential of cloud computing are realized[11].

D. Hybrid cloud: Hybrid cloud is a composition of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models[12].

IV. E-learning in the Cloud

One of the most interesting applications of cloud computing is educational cloud. The educational cloud computing can focus the power of thousands of computers on one problem, allowing researchers search and find models and make discoveries faster than ever. The universities can also open their technology infrastructures to private, public sectors for research advancements. The role of cloud computing at university education should not be underestimated as it can provide important gains in offering direct access to a wide range of different academic resources, research applications and educational tools. Usually, e-learning systems are developed as distributed applications, but not limited to[13]. The architecture of an e-learning system, developed as a distributed application, includes a client application, an application server and a database server beside the hardware to support it (client computer, communication infrastructure and servers).

There are numerous advantages when the e-learning is implemented with the cloud computing technology, they are:

Cost effectiveness – Cloud computing is very cost effective as compared to initial investment of traditional e-learning systems.
Reliability – The technology is scalable and stable with the ability to handle periods of heavy traffic.
Adapting to the lifestyle of people – The technology is very flexible and all the electronic gadgets can be used to access the e-learning contents on go. [Mobile platforms and devices].
Dynamic, relevant and timely curricula – The time sensitive content can be updated dynamically in a timely manner to keep the relevance of the information up-to-date.
Bridging space and time between individuals – Not only should the technology adapt to the ways people view information but also the time and places. Content should be designed in such a way that can be accessed on slower connections also as broadband availability becomes a barrier in rural areas.
Multiple teaching styles – Any new technologies implemented should be able to provide multiple ways to deliver information. They should have the ability to render content in various styles and languages to reach all in the community who may have different learning styles[14].
Powerful mobile platform – Mobile learning (m-learning) is referred as the next step in e-learning. Content can be displayed on mobile devices and shared over fast wireless networks. Access with mobile devices will be much easier than with a traditional PC or laptop and just as user friendly. Also mobile users surpass the number of users PC/Laptop users and these devices will provide the next big platform for learning[15].

V. Comparison of Proposed Cloud Architectures

1. An e-learning ecosystem based on cloud computing infrastructure by Bo Dong, Qinghua Zheng, Jie Yang, Haifei Li and Mu Qiao at Ninth IEEE International Conference on Advanced Learning Technologies is composed of three layers: Infrastructure layer, Content layer, and Application layer. It is also with four ad *hoc* modules: monitoring module, policy module, arbitration module, and provision module.

In the above proposed model, the Infrastructure layer is the resource pool of an e-learning system. Hardware and software virtualization technologies are used to ensure the stability and reliability of the infrastructure. The infrastructure layer provided the computation and storage capacities to higher layers.

The Content layer consists of e-learning contents, such as Web file systems, database systems, Web Services, and so on. This layer exposes the standard interfaces and APIs of contents for higher layers.

The Application layer consists of e-learning services, systems, tools, and so on. It also provides functions and interaction interfaces for users or other programs.

The Monitoring module keeps track of the executions of requests and resource utilization levels of species, including the health of CPU, memory, I/O, and so on. The data of monitoring module is the source to adjust the balance of an e-learning system.

The Policy module establishes and maintains the teaching and learning strategies, the run-time and resource scheduling strategies. It also decides the resource scheduling to safeguard the running applications.

The arbitration module completes the requests made by users and solves the disputes among species within the e-learning system. Arbitration module amends, adjusts, and improves the resource allocation and management. It is an efficient complement to the policy module, while the privilege of its policy is higher than the one in the policy module.

The Provision module starts the execution of resource allocation solutions set by the policy module and arbitration module, and deploys resources referred to users or species automatically in a short time.

2. Another cloud based e-learning architecture was proposed by Md. Anwar Hossain Masud, Xiaodi Huang, World Academy of Science, Engineering and Technology 2012. This architecture has infrastructure layer as a dynamic and scalable physical host pool. The software resource layer offers a unified interface for e-learning developers, resource management layer that achieves loose coupling of software and hardware resources. The service layer containing three levels of service (software as a service, platform as a service and infrastructure as a service) and the application layer provides with content production, content delivery, virtual laboratory, collaborative learning, assessment and management features.

3. Xiao Laisheng, Wang Zhengxia at Third International Conference on Measuring Technology and Mechatronics Automation proposed E-learning proposed cloud architecture which is logically divided into four layers, namely, hardware resource layer, software resource layer, resource management layer, server layer and business application layer.

The hardware resource layeris located in the lowest level of cloud service and provides the basic computing power like CPU and memory. This layer provides the facility of virtualization technology, physical server, storage and network form virtualization group for being called by upper software platform. The physical host pool is dynamic and scalable, new physical host can be added in order to enhance physical computing power for cloud middleware services.

The Software resource layer mainly is composed by operating system and middleware which provides a unified interface for software developers, so they can easily develop a lot of applications based on software resources.

Resource management layer is essential to achieve loose coupling of software and hardware resources. Through integration of virtualization and cloud computing scheduling strategy, on-demand free flow and distribution of software over various hardware resources can be achieved.

Business application layer: This layer represents the major e-learning business logic, composed of expanded upon a group of e-learning components. E-learning application layer mainly consists of content production, educational objectives, content delivery technology, assessment and management component[16].

4. The architecture of cloud computing platform proposed by Zhang Guoli and Liu Wanjun[17] can be divided into three layers, from the bottom to top it is followed by Based management system layer, Shared Service Interface Layer and Access Layer[18]. The architecture model is shown in the following figure a[19].

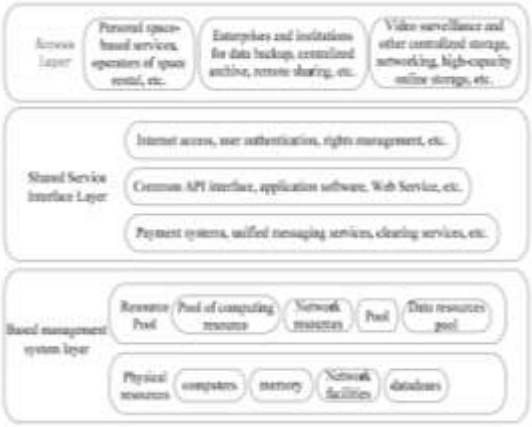

Fig. (a) System Architecture Model of Cloud Computing Platform

Here, the Based management system layer is mainly to solve the sharing of computing resource. This includes hardware, storage, operating system and some other IT infrastructure and resource pool. It uses the hardware and software virtualization technology, coordinating action between the multi-level frameworks, to ensure stability and reliability of infrastructure. At the same time it provides the basic network supported environment and provides the basic realization environment of service-oriented architecture, but also supplies the computing and storage capacity for the higher level. This layer ensures scalability and efficient use of resources for the cloud computing platform, provides

computing resource, memory resource and data storage resource for the cloud computing application.

The Shared service interface layer is mainly the manner in which the external provision of services, presents a powerful, high scalability, high availability of distributed to solve applications for the users. And it is the Based management system layer's network expansion, involving unified management, distributed scheduling and security controls for large amounts of data or computing resources. This layer is a software system of an actual run of storage, maintenance and provision of data, it is a collection of objects of storage medium, processing and management system, and it is the e-learning web development/resource integration platform. In addition to the content network storage and maintenance, this layer also provides standard interfaces and content of the API for the higher layer. When resources in the library have a rich accumulation and a certain amount of knowledge systems, there is a need for resources package to form an independent resource platform to the upper access.

Access layer is the use of cloud computing means to achieve some specific applications; it is the last application platform to supply service for customer. It can divide into different application areas according to the specific needs of customers, such as office software service, personal space-based service, and e-commerce and so on. At this level, cloud computing provides more convenient access to the e-learning resources.

5. Abderrahim El Mhouti Azeddine Nasseh & Mohamed Erradi[20] proposed the architecture of e-learning systems based on the cloud is divided into three main layers.

The first layer is the Cloud Management System Layer. It represents the interface of e-learning system with the cloud environment. This layer consists in several management subsystems which allow the integration of e-learning practices in the cloud computing model. Rather than having to install course design and management software, actors involved can simply use their Internet browsers to upload content, create new courses and collaborate between them.

The second layer represents the virtual machines implemented within the system and which deliver cloud services. It delivers three types of cloud services: SaaS, Paas and IaaS. Users use software via the Internet. They do not need to purchase software and hardware nor to maintain or upgrade them.

Finally, the third layer is the Physical Hardware Layer, which includes all the physical architecture of the system. This layer represents the information infrastructure and all resources used. It represents also for learners the basic computing power like physical memory, CPU ... The physical host pool is dynamic and scalable. This means that new physical host can be added in order to enhance physical computing power for cloud middleware services.

Table [1] Comparison of proposed cloud architecture

uthor(s)	**o. of Layers**	**ayers**	**escription of Layers**
o Dong, Qinghua Zheng, Jie ang, Haifei Li and Mu Qiao	hree	frastructure layer, ontent layer and pplication layer	**frastructure Layer** esource pool of an e-learning system. ovides the computation and storage capacities to higher yers. **ontent Layer** ontent layer consists of e-learning contents xposes the standard interfaces and APIs of contents for gher layers **pplication Layer** onsists of e-learning services, systems and tools ovides functions and interaction interfaces for users or her programs
d. Anwar Hossain Masud, iaodi Huang	ve	frastructure layer, oftware resource layer, esource management yer, service layer and pplication layer	**frastructure Layer** ynamic and scalable physical host pool **oftware Resource Layer** ffers a unified interface for e-learning developers **esource management layer** chieves loose coupling of software and hardware sources **ervice Layer**

			ontaining three levels of service (software as a service, atform as a service and infrastructure as a service) **pplication Layer** ovides with content production, content delivery, virtual boratory, collaborative learning, assessment and anagement features
iao Laisheng, Wang Zhengxia	hree	ardware resource layer, ftware resource layer, source management yer and business plication layer	**ardware Resource Layer** located in the lowest level of cloud service and provides e basic computing power like CPU and memory ovides the facility of virtualization technology, physical rver, storage and network dynamic and scalable **ftware Resource Layer** composed by operating system and middleware which ovides a unified interface for software developers **esource Management Layer** essential to achieve loose coupling of software and rdware resources n-demand free flow and distribution of software over rious hardware resources can be achieved **usiness Application Layer** epresents the major e-learning business logic, composed expanded upon a group of e-learning components
hang Guoli and Liu Wanjun	hree	ased management system yer, Shared Service terface Layer and ccess Layer	**ased Management Layer** o solve the sharing of computing resource. This includes rdware, storage, operating system and some other IT frastructure and resource pool **hared Service Interface Layer** owerful, high scalability, high availability of distributed solve applications for the users **ccess Layer** the use of cloud computing means to achieve some ecific applications
oderrahim El Mhouti zeddine Nasseh & Mohamed radi	hree	oud Management ystem Layer, Service ayer and Physical ardware Layer	**loud Management System Layer** onsists in several management subsystems which allow e integration of e-learning practices in the cloud mputing model **rvice Layer** he virtual machines implemented within the system and hich deliver cloud services. It delivers three types of oud services: SaaS, Paas and IaaS **hysical Hardware Layer** cludes all the physical architecture of the system. This yer represents the information infrastructure and all sources used

VI. Challenges and Research Issues

The cloud based e-learning system deployment will receive various issues and challenges [20]. The challenges and issues would be bigger barrier to cloud computing adoption in e-learning. The few most challenging issues are discussed below:

- In cloud-based e-learning the high data rate for data communication is required. Due to old infrastructure of the internet the demand for high-speed communication sometime compromises.
- Most of the e-learning data require a high level of security. In the case of cloud based e-learning, data is at the mercy of cloud providers. The data leakage and malicious activities of data could be one of the challenges for this system.
- Privacy is one of the biggest challenges for all the cloud based applications. In cloud based e-learning system the data present in the system is at the mercy of cloud providers. The cloud provider can easily see any part of data and even the most private data and can get all possible benefits[21]
- To achieve high performance in cloud based applications is still a challenge. The more complex situation could occur we try to implement high security schemes and full privacy may affect the performance.
- Mostly for the management of e-learning system, we practice any suitable Learning Management System (LMS), but according to [22] in cloud based e-learning, the management could be one of the complex and challenging tasks. To handle learning materials, fee charging, exam conduct, result display and certificate generation etc. demand extensive management.
- The cloud based e-learning system may observe some legal issues. Since the country where cloud data are hosted, their laws may possibly govern cloud data [23].

VII. Conclusion

Cloud computing as an exciting development is a significant alternative today's educational perspective. Students and administrative personnel have the opportunity to quickly and economically access various application platforms and resources through the web pages on-demand. This automatically reduces the cost of organizational expenses and offers more powerful functional capabilities. There will be an online survey to collect the required data for the use of cloud computing in the universities and other governmental or private institutions in the region. This will help us review the current status and probable considerations to adopt the cloud technology. Beginning with the outsourcing of email service seems attractive. The gradually removal of software license costs, hardware costs and maintenance costs respectively provides great flexibility to the university/corporate management. In this paper we discuss a cloud computing based e-learning. Describe its definition and some benefits. Cloud based education will help the students, staff, Trainers, Institutions and also the learners to a very high extent and mainly students from rural parts of the world will get an opportunity to get the knowledge shared by the professor on other part of the world. Even governments can take initiatives to implement this system in schools and colleges in future and we believe that this will happen soon.

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