E-LEARNING IN THE CLOUD

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Abstract — While learning has always expanded beyond the walls of the classroom, the proliferation of affordable devices and internet connectivity has led to the phenomenon in which information technology is being used to transform education. Due to this, most of the educational institutes are adopting the concept of e-learning as an integral part of their education system. However, many hardware and software resources are required for designing e-learning systems. Cloud computing technology has managed to gain attraction due to the effective usage of resources, scalability and on-demand service. If cloud computing technology is used for designing e-learning systems, it can provide a low cost solution to the educational institutes. The objective of this paper is fourfold. It gives an overview of the cloud computing concepts, its benefits and then discusses cloud computing as an e-learning solution by building an e-learning cloud and then analyzes the benefits of using this approach.

Keywords — E-learning, Cloud Computing, Deployment Models, Service Models, Cloud Computing based E-Learning, Architecture

I. INTRODUCTION
Education is acknowledged as one of the pillars of social development. In the modern era, the global economy has been shifting towards “Knowledge Based Economy” where knowledge is created, acquired, disseminated and utilized more efficiently and effectively by educational institutes, enterprises, individuals and communities for greater socioeconomic development and global competitiveness. But today, most of the conventional education methods are not suitable for social progress and are not being able to cater to the changing needs of the learner. The conventional education methods have some important phases: content delivery, assessment of student achievement and feedback on the assessment [1]. The e-learning system tries to use the same phases as well as it adjusts the learning process according to the learner so that the learner is able to learn anytime and anywhere at his/her own pace.

E-learning is an Internet based learning process, using Internet technology to design, implement, select, manage, support and extend learning, which will not replace traditional educational methods, but will greatly improve the efficiency of education [2]. E-learning systems usually require many hardware and software resources and system construction and maintenance lies in the interior of the educational institutes which require lot of investment. Another issue is the requirement of a variety of experts, not only in education but also in digital media development. Thus, the most worrying prospect is the number of paying end users to justify the cost. The need for education is increasing and the improvement of e-learning systems is necessary. The new direction is to use cloud computing with e-learning.

Cloud computing is a computing model based on networks, especially the Internet, whose task is to ensure that the users can simply use the computing resources on demand and pay money according to the usage [3]. The two distinctive features of cloud computing are, on the one hand, the use of resources under demand and on the other hand, the transparent scalability [4]. When combined with the traditional e-learning systems, cloud computing platforms arise as a cost effective and efficient e-learning solution. There are several cloud computing service providers like Amazon, Google, Yahoo, Microsoft etc. that offer support for educational systems. Integration of e-learning with cloud computing, not only helps distributing information and aids learning and teaching registry, but can also resolve the high cost of development, increase performance of management and monitor security [5].

In order to integrate cloud computing and e-learning, in this paper, section II focuses on the cloud computing concepts, its benefits and related issues. Cloud computing based e-learning is elaborated in section III and architecture of such a system is provided. The advantage of such type of integration is stressed in section IV. Finally, the concluding remarks are given in section V.

II. CLOUD COMPUTING
A. Definition
Cloud computing refers to the applications and services that run on a distributed network using virtualized resources and accessed by common Internet protocols and networking standards. It is distinguished by the notion that resources are virtual and limitless and that details of the physical systems on which software runs are abstracted from the user [6]. The use of the word “cloud” essentially means two things-
Abstraction. The detail of system implementation is hidden from the end user, data is stored in locations that are unknown to the users and system construction and maintenance is outsourced to the third party.

Virtualization. IT resources from server to storage, network and applications are virtualized to provide implementation independent infrastructure and with elastic scaling. Costs are assessed using pay by consumption with metering.

In short, in cloud environment, it is not necessary to buy any hardware or software to run the applications. Thus, it helps to reduce the investment on hardware resources and IT maintenance team [2].

Cloud computing is based on an architecture that combines service management, asset management, virtualization and consolidation, information infrastructure, energy efficiency, security and resilience [7]. Cloud computing attributes can be realized from its comparison with the traditional computing as follows-

<table>
<thead>
<tr>
<th>Area of Difference</th>
<th>Traditional Computing</th>
<th>Cloud Computing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acquisition</strong></td>
<td>Buy asset</td>
<td>Buy service</td>
</tr>
<tr>
<td><strong>Capital Expenditure</strong></td>
<td>Fixed upfront cost, pay for assets</td>
<td>Variable cost, pay for use</td>
</tr>
<tr>
<td><strong>Virtualization</strong></td>
<td>Sometimes</td>
<td>Usually</td>
</tr>
<tr>
<td><strong>Technical Model</strong></td>
<td>Single tenant and non shared</td>
<td>Multi tenant and shared</td>
</tr>
<tr>
<td><strong>Scalability</strong></td>
<td>Static and manual</td>
<td>Dynamic, elastic and automatic</td>
</tr>
<tr>
<td><strong>Access</strong></td>
<td>Internal usually by desktops</td>
<td>Over the Internet by any device</td>
</tr>
<tr>
<td><strong>Deployment</strong></td>
<td>Costly and lengthy</td>
<td>Less deployment time</td>
</tr>
<tr>
<td><strong>Remote Access</strong></td>
<td>Not easy</td>
<td>Easy to access data anywhere and at anytime</td>
</tr>
<tr>
<td><strong>Cost of Enhancement</strong></td>
<td>An additional fee is incurred</td>
<td>Included in the pay per use fee</td>
</tr>
<tr>
<td><strong>Energy Efficiency</strong></td>
<td>Less efficient as the same energy and bandwidth is required due to pre configuration</td>
<td>More efficient as this type of service has as much space and bandwidth as necessary at every single moment</td>
</tr>
</tbody>
</table>

B. **Cloud Types**

The U.S. National Institute of Standards and Technology (NIST) has a set of working definitions that separate cloud computing into two distinct set of models [8]:

- **Deployment Models** that refer to the location and management of cloud’s infrastructure.
- **Service Models** that refer to the particular services that can be accessed via cloud computing platforms.

The NIST definition for the four deployment models is as follows [6]-

- **Public Cloud.** The public cloud infrastructure is available for public use alternatively for a large industry group and is owned by an organization selling cloud services.
- **Private Cloud.** The private cloud infrastructure is operated for the exclusive use of an organization. It may be either on or off premises.
- **Hybrid Cloud.** A hybrid cloud combines multiple clouds where those clouds retain their unique identities but are bound together as a unit.
- **Community Cloud.** A community cloud is the one where the cloud has been organized to serve a common function or purpose.

Three service types have been accepted:

- **Infrastructure as a Service.** It is the delivery of the hardware resources such as servers, storage, data center space, networking as a service with the help of virtualization.
- **Platform as a Service.** At this level, the provider delivers more than just the infrastructure i.e. it delivers whatever is required for both software development and runtime environment [9].
- **Software as a Service.** It is a complete operating environment with applications, management and the user interface [6].

C. **Advantages and Challenges**

Cloud computing is widely accepted today due to its key advantages:
- **On demand self service.** A client can use resources without any interaction with the cloud service provider.
- **Scaling.** Resources can be either scaled up or scaled out automatically and rapidly.
- **Resource pooling.** Cloud computing supports multi-tenant usage where cloud service provider creates resources that are pooled together but the location is hidden from the end user.
- **Pay per use model.** The client is charged based on the amount of storage used, number of transactions, amount of bandwidth and processing power used etc.
- **Anywhere, anytime access.** Access to the resources is provided over the network via devices like laptops, PDA and mobile phones.
- **Outsourced IT management.** The infrastructure is managed by the cloud service provider and thereby reduces the IT staffing cost and overheads.
- **Access to latest technology.** Due to centralization, the upgrades can be applied easily.
- **Low upfront capital investment.** Initial setup cost is dramatically reduced with the use of cloud computing, thus making it applicable to any type of organization. Apart from the advantages, there are some technological issues that may be taken into account:
  - **Security and privacy.** Since the storage of the data is no longer in the hands of the customer, there is an increased risk on the security of the data. The companies that want to use cloud services must have the assurance that there are well-defined security measures taken.
  - **Latency due to network connectivity.** All cloud computing applications suffer from inherent latency due to network connectivity, thus making it least suitable for applications that need huge amounts of data transfer.
  - **Lack of state.** Cloud computing systems are stateless. Lack of state information may lead to out-of-order arrival of data. To overcome this problem, additional overheads in the form of middleware have to be added to the system.

### III. CLOUD COMPUTING BASED E-LEARNING

With the increase in number of students, rapid growth of education content and changing IT infrastructure, the educational institutes are confronted with a dramatic increase in costs and a decrease in budgets which leads to the need of finding some alternative for their e-learning solutions. Also, the current e-learning systems are not scalable and do not lead to the efficient utilization of the resources. As a response to this increase in pressure and to increase the efficiency and availability of their current e-learning system, the educational institutes may adopt a service-oriented approach. The potential efficiency of using cloud computing in higher education has been recognized by many universities such as University of California, Washington State University’s School of Electrical Engineering and Computer Science, higher education institutes from UK, Africa, US and others [10].

In cloud based e-learning systems, the institutions are responsible for content creation, management and delivery while the cloud service provider is responsible for system construction, development, management and maintenance. The institutes are charged according to the usage that directly depends on the number of students.

![Fig. 3 Separation of roles in Cloud based E-learning](image)

In [5], Kaewkiriya and Utakrit have proposed a model for e-learning using cloud computing which is shown in fig.4.

![Fig. 4 Abstract model of Cloud Computing based E-learning](image)

In this model, the request from the user is sent to the cloud service provider which in turn connects to the e-learning cloud in order to give response to the user’s query.

The architecture of a system that uses cloud computing as an e-learning solution is shown in Fig. 5.

![Fig. 5 Cloud Computing Architecture](image)

This architecture has five layers:
Infrastructure Layer is composed of dynamic and scalable resources such as physical memory, CPU and memory etc.

Software Resource Layer mainly consists of operating system and middleware to provide interface to the software developers for easy development of applications that will be made available to the end users.

Resource Management layer is used to achieve loose coupling of hardware and software resources so as to provide on demand service.

Service Layer has three levels namely IaaS, PaaS and SaaS that help the cloud users to use various cloud services.

Application Layer includes specific applications to integrate teaching resources with cloud computing model.

IV. BENEFITS OF CLOUD BASED E-LEARNING

The potential benefits of cloud based e-learning include:

- **Mobile, decentralized and just in time learning.** A more flexible learning mechanism is provided that aligns itself more closely to the learner’s day to day activities. In taking content outside the learning structures, cloud computing allows for the delivery of learning anytime and anywhere.

- **Cost effective.** According to Marc Benioff, CEO of Salesforce.com, “the cloud services companies of all sizes... The cloud is for everyone. The cloud is a democracy.” If used properly, it is highly cost effective as institutes have to pay only for the server space they use and costs of maintenance and updates.

- **Speed of implementation and updating.** Implementation can be done in a short span of time. Due to this, the needs of the learner can be given more attention as compared to IT implementation and maintenance of infrastructure.

- **Virtualization.** Replacement of a server can be done very easily and rapidly as a clone can be created due to virtualization, thereby reducing the cloud downtime.

- **Easy to monitor data access.** Monitoring is an easy task as only one place has to be supervised, not thousand systems belonging to an institution.

- **More personalized learning experience.** The open and collaborative nature of the cloud opens up opportunity for more contributions from other people within the learning environment.

- **Least dependency on IT department.** Traditionally, IT worked hand in hand with the learning organization. Due to this, priority was given to the creation of platforms and their maintenance. The cloud has a potential to change this scenario. The priority will be given to the learning content which is more beneficial for the learner.

V. CONCLUSION

In taking content outside traditional learning structure, cloud computing will essentially allow for the delivery of learning anywhere and at anytime. No longer requiring memory intensive laptops, the cloud will enable learners to access the content from any device like desktop, laptop, PDA, mobile phone etc. as long as they are connected to the network.

Cloud based e-learning will enable people to build their learning around their specific needs with the cloud allowing relevant, tailored content to be created for the users without any dependence on IT to update delivery platforms accordingly.

REFERENCES


