The International Journal of Soft Computing and Software Engineering [JSCSE], Vol. 3, No. 3, Special Issue:
The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE'13],
San Francisco, CA, U.S.A., March 1-2, 2013
Doi: 10.7321/jscse.v3.n3.123 e-ISSN: 2251-7545

A Quality Model for E-Learning as a Service in Cloud Computing Framework

Dr Rajni Jindal
Professor, Department of IT
Indira Gandhi Institute of Technology,
New Delhi, INDIA
rajnijindal@dce.ac.in

Alka Singhal
Research Scholar, CSE Dept
Delhi Technological University
New Delhi, INDIA
alkasinghal83@gmail.com

***Abstract* — Absence of proper metrics to evaluate cloud services holds back the customers to decide whether to shift their E-learning services on clouds or not. Therefore there is a requirement for a reliable Quality of Service Model which will act as a base to a well defined Service Level Agreement between Cloud providers and consumers. The Quality of Service model will be based on various functional and non functional requirements. This paper will provide a set of Cloud metrics like Availability, Elasticity etc which will help the cloud provider to create Cloud computing a mature and stable framework for E-learning system which will be adopted by the consumers at any level with reliability. The paper proposes a Quality of Service model for Cloud computing based E-learning system where construction and maintenance of the e-learning system is done by the cloud service providers and further these services are used by the E-learning provider by paying in cost per unit.**

Keywords— Framework, Quality of Service, Cloud Computing, Service layers, E-learning system

I. INTRODUCTION

A. Traditional E-learning Model

E-learning has emerged as a new paradigm of learning in the modern world. It economizes the cost of infrastructure and facilitates online learning. It also provides reusability of learning material and facilitates time and space independence. There can be lots of ways to use E-learning in education, example: continuous education, company training or community colleges etc but the underlying architecture is common. Traditional E-learning system is composed of following elements as shown in Fig1:

Content experts are responsible for the production of authorized learning material. Material can be lecture notes, video courses etc.

Learning Content Manager is responsible for management of the system. He is responsible for the management of the repository, registration of students, allocation of courses, conducting exams etc.

Repository consists of the content management. It is the metadata about the content. It involves proper indexing of the data. It involves authorization and authentication at the time of access etc.

Distribution Environment is the environment used for delivery of content. It includes high speed networks and setup for networking (switches, routers etc).

Finally, **Learner** is the one using the system to gain knowledge. He registers in the course and pay for the usage and content [1].

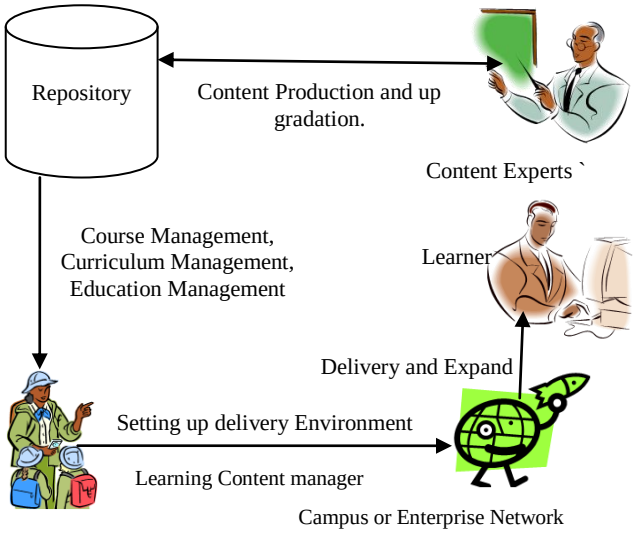

FIG1. TRADITIONAL E-LEARNING MODEL [2]

There were many challenges in front of traditional E-learning system which hampers its development and universal acceptance. The major challenge was the requirement of proper infrastructure and change management. Generally E-contents are videos, seminars which are bulky and require high speed networks for delivery. E-learning can be only successful if there is a proper infrastructure used for it. As infrastructural investment is more than the capital gained through the system, providers avoid switching their system to an online one. Other challenge is change management which depicts the required enhancement, up-gradation of content, updating all elements of E learning system like students, examinations etc. In E-learning system, there is a

The International Journal of Soft Computing and Software Engineering [JSCSE], Vol. 3, No. 3, Special Issue:
The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE'13],
San Francisco, CA, U.S.A., March 1-2, 2013
Doi: 10.7321/jscse.v3.n3.123 e-ISSN: 2251-7545

requirement of an efficient application which enable regular change management.

Both of these problems can be solved by cloud computing. Cloud computing offers a dynamic provision of virtualized resources and payment on basis of the use of the resources. Cloud computing prevents the E-learning service provider to invest in initial hardware like servers, virtualization etc. In e-learning cloud computing business model, cloud provider is responsible for building and maintaining e-learning cloud, providing technical support to it. Cloud users pay to cloud provider for services from e-learning cloud and services accessed on- demand [2].

II. EVOLUTION OF CLOUD COMPUTING

Cloud computing is considered to be the fifth era of computing paradigms. Although there are many upcoming computing technologies which are still in development phase like HPC (High Performance Computing), Pervasive Computing, Service Oriented Computing etc but still cloud computing is considered as fifth era of Computing [3]. The reason is versatility of services which targets a broad area of users of various fields. It can be a scientist to a business man doing his deals. All the former computing paradigms target only specific users like HPC was made for the scientists or the people who require high computational powers [4][5].Pervasive Computing was for the people who require adaptability of their application. As their environment regularly changes due to their mobility, they require intelligent software which can provide a flexible mode of computation. And similarly, Service oriented computing targets the web service providers and consumers and doesn't care about computational power and flexibility. Cloud computing not only helps to increase the computational power by providing them infrastructural support but also provide flexible computing with on demand self service.

Cloud computing has many advantages as [5]:

(1) demand Self service

(2) Flexibility

(3) Availability

(4) Robustness

(5) Scalability

(6) Resource Sharing

Cloud computing provides 24X7 service to the customers. Whenever there is a need for the customer of any service (such as Software, Platform, Hardware etc), all what he needs is an internet connection and subscription to the provider. He can access the service without any manual intervention of the provider. Cloud computing services are flexible and they are not location dependent.

A. Cloud Computing Service Layer Model

The Cloud computing provides services at various levels and it can be viewed as layered structure as shown in Fig2. Various layers in Cloud computing service layer architecture are [6]:

Hardware Layer: It is the layer which provides actual hardware resources to the cloud infrastructure. As it is composed of different types of servers like rack servers, blade servers, it is also called server layer. It is basically the heart of the cloud and composed of data centre. It helps virtualization layer to implement redundancy and fault tolerance.

Virtualization Layer: This layer is basically a separator between request of service and actual underlying hardware. It helps in attaining hardware independence and also helps in managing multiple OS to provide efficient and reliable performance. It provides dynamic mapping of resources and service. It can be further viewed in three small layers Core Layer, Aggregation Layer and Access layer. Core Layer helps in traffic management, Aggregation helps in load balancing and Access layer manages multiple servers and interconnect them using switches.

Infrastructure as Service Layer: Infrastructure is to connect resources to business. It offers users to build their Virtual machines as service. They can create machine, configure them according to their requirement. They are billed according to their consumption of VM. This prevents them for spending in setting up data centers including physical server, networking devices.

Platform as Service Layer: It is not VM sufficient to build and run an application. One requires suitable operating system, programming languages. This layer provides user a complete setup to create and run programs. There is no need to manage operating system, but one just has to create programs in a given customized environment.

Software as Service Layer: This layer eliminates the requirement of developing of application. It provides complete application to work on. User uses these application and pay according to the usage of the software.

Client layer: It is User Interface on the client/user machine, which helps him to use the underlying services.

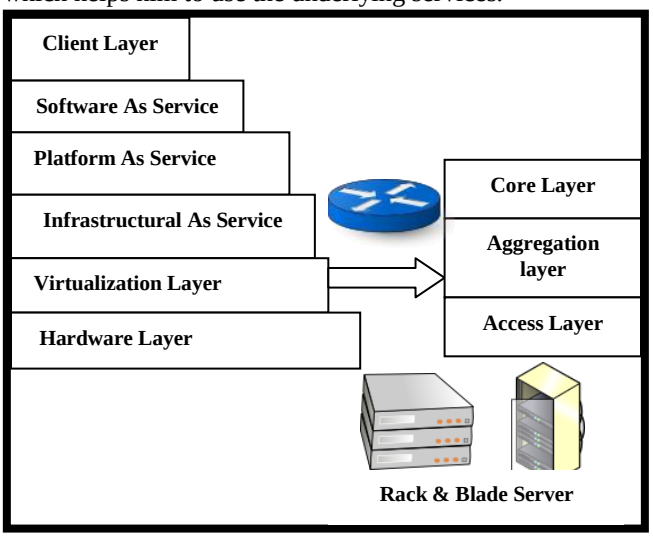

FIG2. CLOUD COMPUTING SERVICE MODEL

The International Journal of Soft Computing and Software Engineering [JSCSE], Vol. 3, No. 3, Special Issue:
The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE'13],
San Francisco, CA, U.S.A., March 1-2, 2013
Doi: 10.7321/jscse.v3.n3.123 e-ISSN: 2251-7545

B. Cloud Computing Deployment

There are following cloud computing deployment model [7]:

Private cloud: It is a proprietary architecture subscribed by an organization, which provides hosted services to the users within the organization. This is protected by the firewall to form a barrier against outside the world to access hosted services from the private cloud. A private cloud infrastructure is operated solely within a single organization, and managed by the organization or a third party regardless whether it is located premise or off premise.

Public cloud: It is not proprietary of any organization; the services provided in these clouds can be accessed by any organization. The public cloud is used by the general public cloud consumers and the cloud service provider has the full ownership of the public cloud with its own policy, value, profit, costing, and charging model.

Hybrid cloud: In Hybrid cloud, the services are offered to the limited and well defined number of parties. The cloud infrastructure is a combination of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

Community cloud: Several organizations jointly construct and share the same cloud infrastructure as well as policies, requirements, values, and concerns. The cloud community forms into a degree of economic scalability and democratic equilibrium. The cloud infrastructure could be hosted by a third-party vendor or within one of the organizations in the community.

III. E-LEARNING ON CLOUDS

As earlier explained the major challenges to adopt E-learning as a business model are infrastructure and change management.

Both of these problems can be solved by cloud computing as it offers a dynamic provision of virtualized resources and payment on the basis of the use of the resources. Cloud computing prevents the E-learning service provider to invest in initial hardware like servers, virtualization etc. In e-learning cloud computing business model, cloud provider is responsible for building and maintaining e-learning cloud, providing technical support to it. Cloud users pay to cloud provider for services from e-learning cloud and services accessed on- demand [9].

Cloud computing provides various layers of services which can be utilized by the E-learning providers. Therefore there can be various architectures for E-learning on clouds as shown in Fig4. It can be Infrastructural as Service (IaaS) and Platform as Service (PaaS), where one will utilize just the basic infrastructure or platform provided by the cloud. Rest the software, application setup is consumer's overhead. In this case the second challenge of change management is still in the part of consumer. Here consumer has to develop the software for the whole system.

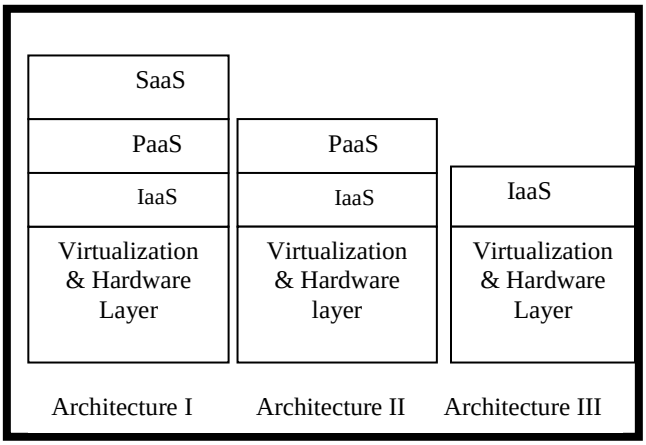

FIG3.VARIOUS CLOUD SERVICE ARCHITECTURE OF e-LEARNING

Second option is to utilize Software as Service (SaaS) where cloud provider will provide the whole application to maintain E learning system as shown in Fig 4. At the lowest level, the institutions which will provide the e-learning service produce courses, content management and its up-gradation and maintenance. E-learning Cloud provides suitable resources for storage and computation. Then the service layers in cloud computing, namely, SaaS (Software as a Service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service) provides services to cloud users (Institutions) for Education management, Course management etc. On the other hand it provides environment for delivery to the learner. Learner can be at any remote place. Cloud services help in efficient delivery. Learner pays to the Institution for courses undertaken and in response cloud users (Institutions) pay Cloud providers for their services. Such services are provided by SCORM cloud.

SCORM (Sharable content object reference Model) provides set of technical standards for E-learning software and SCORM cloud provides an API to develop ones E-learning system in a standardized form with full maintenance provided by them [11].

IV. QUALITY OF SERVICE IN E-LEARNING BASED ON CLOUDS

Though there are lots of advantages of adopting cloud services for E-learning, absence of proper metrics to evaluate cloud services holds back the customers to decide whether to shift their E-learning services on clouds or not. Therefore there is a requirement for a reliable Quality of Service Model which will act as a base to a well defined Service Level Agreement between Cloud providers and consumers. The Quality of Service model will be based on various functional and non functional requirements. It will make Cloud computing a mature, stable and computable framework for E-learning system which will be adopted by the consumers at

The International Journal of Soft Computing and Software Engineering [JSCSE], Vol. 3, No. 3, Special Issue:
The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE'13],
San Francisco, CA, U.S.A., March 1-2, 2013
Doi: 10.7321/jscse.v3.n3.123 e-ISSN: 2251-7545

any level with reliability. Key process areas responsible to make a quality cloud suitable for E-learning system are:

A) Availability

B) Response Time

of first response of service. Response time reflects the fastness of the service. Less is the time, better is the service. Average Response time can also be calculated by

Response Time (RT) =Time taken by the service to give first response on the request of service

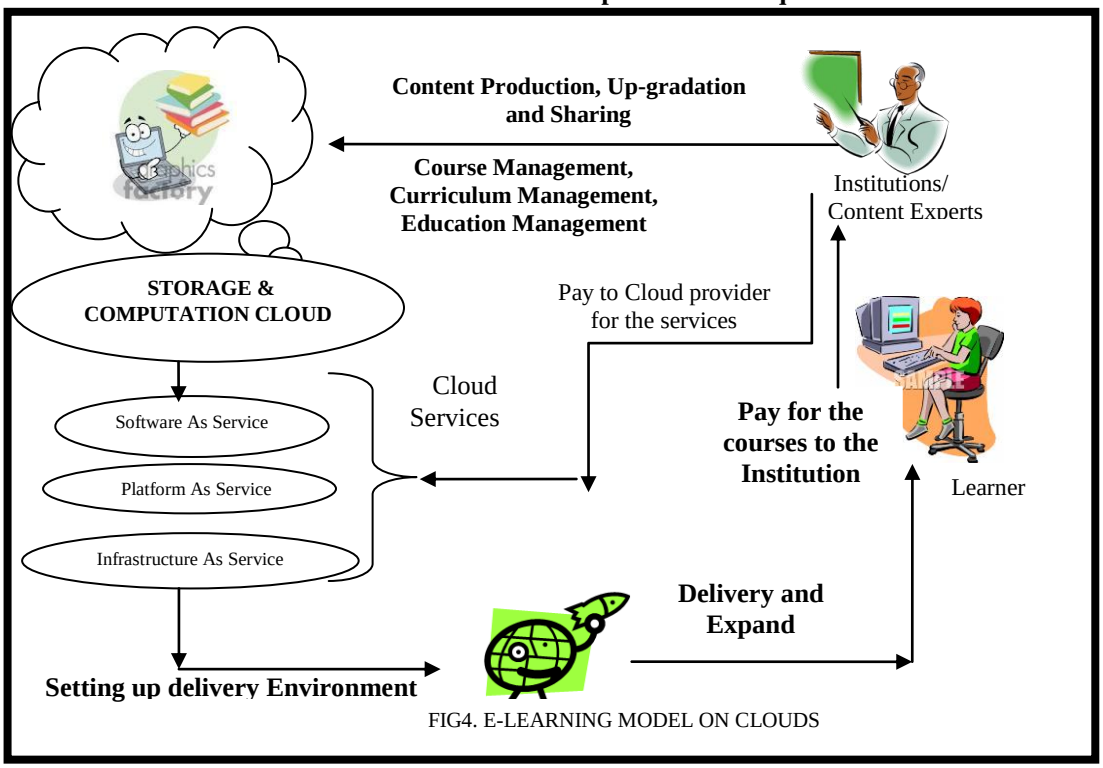

FIG4. E-LEARNING MODEL ON CLOUDS

C) Change management

D) Elasticity

E) Reliability

Availability: Availability is expressed as the percentage of time the application can be accessed by the user. If cloud technology is used for E-learning systems, it should provide 24x7 (100%) availability to the customers (students). Availability lacks when service cannot be invoked due to some service failure at the provider side. Availability is an important quality metric as it is the most important factor which motivated the switching from traditional learning to E-learning.

Availability can be calculated by

$$\mathbf{Av = \frac{\text{Number of times service was able to invoke}}{\text{Number of times service was called}}}$$

Value ranges from 0…1

Average Response time: Response Time can be expressed as time elapsed between time of requesting service and time

Average response time = RT_n/n

Change management (Agility): Change management can be viewed as the efforts required for changing the software with respect to customers requirement. E-learning system is a system which requires regular updation with time.

It requires regular amendment in curriculum; syllabus, policies etc and all these are reflected in the software. The Cloud SaaS used for E-Learning should be easily modifiable according to time.

Modifiability of the application can be measured by cohesiveness and degree of coupling between different modules of the code. More is the cohesiveness; difficult is to modify the code.

Elasticity: Elasticity is the criterion which depicts the capability of software to keep its performance consistent with increase or decrease in demand. In case of E-learning system it is basically the number of users which can increase as well as decrease with time. Software should be adaptable to scale its resources according to the requirement.

$$\mathbf{Elasticity} = \frac{\text{Number of resources getting utilized for ith of n service}}{\text{Number of resources available for ith of n service}}$$

The International Journal of Soft Computing and Software Engineering [JSCSE], Vol. 3, No. 3, Special Issue:
The Proceeding of International Conference on Soft Computing and Software Engineering 2013 [SCSE'13],
San Francisco, CA, U.S.A., March 1-2, 2013
Doi: 10.7321/jscse.v3.n3.123 e-ISSN: 2251-7545

Elasticity also depends on number of services (n) running at a given point of time. If users of one service reduce in number then its allocated resources can be given to other service whose users are greater than expected.

Reliability: Reliability can be expressed as the chances of failure free operation of the application for a specified time in a given environment. It depends on occurrence of failures and fault recovery. It is measured in terms of
Number of failures (n) per execution time and

$$\textbf{Fault tolerance} = \frac{\textbf{Number of failures recovered}}{\textbf{Number of failures occurs}}$$

V.FUTURE WORK AND CONCLUSION

With above mentioned Quality criteria, there are some more criteria which should also be addressed like Accountability, Cost model. Accountability is responsible for creating trust between provider and user. It plays vital role in Security issues and data ownership. It ensures user that his data will not be shared with any unauthorized user. Costing Model is also required for a proper E-learning system. There can be two ways of costing (CAPEX and OPEX). Cloud based application generally follows OPEX model. But then also a proper costing model is yet to be made for an E-learning system cloud based on usage of infrastructure and services.

This paper proposes a quality of service model of Cloud Computing based E-learning. It comprise of a framework where construction and maintenance of e-learning system is done by the cloud services providers and further these services are used by the e-learning provider by paying in cost per unit. Here E-learning provider is not concerned about the infrastructural and maintenance expenses but focuses on the content quality and management .Whereas, the Cloud providers have already established infrastructure, so they can utilize it for providing E-learning services without any additional investment in compare if it is done by Institution itself. This paper provides a basic Quality model for E-learning Cloud to measure basic quality metrics for an E-learning Cloud. It extracts five basic quality attributes which will help cloud provider to create efficient, flexible cloud for E-learning system.

REFERENCES

[1] Xiaofei Liu, Abdulmotaleb El Saddik, Nicolas D. Georganas, "An implementable architecture of an E-learning system", presented at CCECE 2003, Montreal, May 2003

[2] Rajni Jindal, Alka Singhal "Social Networking based E-Learning System on Clouds" International Journal of Computer Applications, March 2012, pp.45-48

[3] Laisheng,Wang Zhengxia, "Cloud Computing: a New Business Paradigm for E-learning", presented at Third International Conference on Measuring Technology and Mechatronics Automation 2010

[3] Sameer Rajan, Apurva Jairath, "Cloud Computing: The Fifth generation of Computing", presented at International Conference on Communication Systems and Network Technologies, 2010

[4] Shuai Zhang, Shufen Zhang, Xuebin Chen, Xiuzhen Huo, "The Comparison Between Cloud Computing and Grid Computing", presented at International Conference on Computer Application and System Modeling (ICCASM 2010)

[5] Naidila Sadashiv,S. M Dilip Kumar, "Cluster, Grid and Cloud Computing: A Detailed Comparison", presented at the sixth International Conference on Computer Science & Education (ICCSE 2011) August 3-5, 2011

[6] Tharam Dillon, Chen Wu and Elizabeth Chang," Cloud Computing: Issues and Challenges" presented at 24th IEEE International Conference on Advanced Information Networking and Applications, 2010

[7] Junjie Peng, Xuejun Zhang, Zhou Lei, Bofeng Zhang, Wu Zhang, Qing Li, "Comparison of Several Cloud Computing Platforms",2009 IEEE.

[8] Lijun Mei,W.K. Chan†,T.H. Tse, "A Tale of Clouds: Paradigm Comparisons and Some Thoughts on Research Issues", presented at IEEE Asia-Pacific Services Computing Conference 2008

[9] Laisheng,Wang Zhengxia, "Cloud Computing: a New Business Paradigm for E-learning", Third International Conference on Measuring Technology and Mechatronics Automation 2011

[10] Mohssen M. Alabbadi, "Cloud Computing for Education and Learning: Education and Learning as a Service (ELaaS)", presented at 14th International Conference on Interactive Collaborative Learning (ICL2011)

[11] Shared Content Object Reference Model (SCORM), http://scorm.com/scorm-explained