Mapping of e-learning Components to Cloud Computing

Maria Dominic[1], Dr. Sagayaraj Francis [2]
1 Dept of Computer Applications, Sacred Heart College, India
2 Dept of Computer Science and Engineering, Pondicherry Engineering College, India

Abstract

With the development of new frontiers in computational technologies we are provided with ways to improve the process of teaching –learning process to new scales. Therefore this paper firstly introduces the uniqueness of e-learning by providing e-learning components and the resourcefulness of cloud computing and provides an architecture which integrates both e-learning and cloud and identifies the services provided by each layer of the cloud towards e-learning. This platform will meet the demand of learning community such as quality, form and availability.

Keywords: *e-Learning, e-learning Components , Cloud Computing*

Introduction

e-Learning
Education is defined as the conscious attempt to promote learning in others to acquire knowledge, skills and character [3]. To achieve this mission different pedagogies were used and later on with the advent of new information communication technology tools and popularity gained by internet were used to enhance the teaching learning process and gave way to the birth of e-learning [1]. This enabled the learner to learn by breaking the time, geographical barriers and it allowed them to have individualized learning paths [5]. The perception on e-Learning or electronic learning is that it is a combination of internet, electronic form and network to disseminate knowledge. The key factors of e-learning are reusing, sharing resources and interoperability [4]. At present there are various organizations providing e-learning tools of multiple functionalities [5] and one such is MOODLE (Modular Object Oriented Dynamic Learning Environment) [9] which is used in our campus. This in turn created difficulty in sharing the learning objects between heterogeneous sites and standards such as SCORM & SCORM LOM [6], IMS & IMS DRI [7], AICC [8] and likewise were proposed by different organizations.

Cloud Computing

The National Institute of Standards and Technology (NIST) defines cloud computing as follows: Cloud computing is a model for enabling 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 [10].

The cloud architecture can be viewed from the following Table 1.

Table 1: Cloud Architecture

Clients	Ubiquitous Devices	Computers		
Services	**SaaS**	Applications, Business Process, Collaboration		
	PaaS	Middle Ware and Development Environment, Databases		
	IaaS	Computing, Operating Systems, Servers		
	DaaS	Storage		
	CaaS	Networks		
	Software Kernel			
	HaaS	Hard ware		
Cloud Types	Public	Private	Hybrid	Community

SaaS – Software as Services: This provides the application services which enable the users to export the computational works to the data center.
PaaS – Platform as Services: This service provides programming environment and predefined API's. This is mainly useful for the development community.
IaaS – Infrastructure as Services: This layer handles the computation resources. It provides configuration for setting and protecting infrastructure of the data center. Scaling and load balancing are the main attributes related with this layer. This layer is useful for the customer community.
DaaS – Data as Services: This layer handles the data part. It provides storage of data at different and disjoint disks and provides accessibility to it any where and any time. Usually the providers provide either availability, scalability, consistency.

CaaS – Communication as Services: This layer provides configurable, schedulable, predictable, secure communication services.
Software Kernel - This layer handles software management for physical server.
HaaS – Hardware/Firmware as Services: This layer handles upgrades as per required for and by the user.

The benefits of cloud weigh higher than the risks involved if the service level agreement is properly configured. Some of the key advantages of it are: Cost - Choosing the best configuration for the organization will result in low cost or even free in some instances, Flexibility- Scaling up and down of the services as per required, Accessibility- Access to data online and also offline, available over internet, crash recovery.

The Risks Involved in Cloud [11] are as follows,
Abuse of Cloud Computing - Since the cloud registration is less stringent any person unlawful can register into cloud and conduct their activities without resistance. Insecure Interfaces - weak Interfaces exposes confidentiality, integrity, availability and accountability issues. Malicious Insider - An insider can infiltrate can organizations and assets and can cause damage to it. Shared Technology inadequacies - Due to the scalability of the infrastructure the underlying CPU caches and GPU were not compartmentalized and hence the attackers focused on gaining unauthorized access. Data Loss/ Leakage - Due to insufficient security like authorization, authentication, Strong Keys, Strong API data loss (deletion, modification, unlinking from a cluster, etc…) can happen to data which will render it unreliable. Account/Service/Traffic hijacking - Attackers use Phishing and use other software loop holes to obtain user credentials and other information to launch such kind of attacks which will compromise the integrity of the cloud. Unknown Risk Profile - The information about data, related logs and access rights to them are not disclosed to the customer and hence security by obscurity can result in unknown exposure that may include serious threats.

Existing e-Learning Tools in Web 2.0

Web 2.0 is a collection of inter operable web applications that facilitate user interaction and collaboration with each other as creators of content rather passive viewers as in web 1.0. Examples of Web 2.0 are social networking sites, blog, wikis, mashups etc. [18]. Many of these tools can be used by learner community to interact, share knowledge and augment problem based learning. It has ignited the culture of not only connection but also contribution. Some of the popular sites which will be useful and augment e-learning 2.0 are as follows in Table 2,

Table 2: Sites useful for e-Learning

Website	Description
https://voicethread.com/	It is an Interactive, collaborative and sharing tool.
www.facebook.com www.myspace.com www.twitter.com	These are Social networking sites.Theses are used to create community and share information
http://www.wepapers.com/	Document sharing website mainly for college and universities fully accessible by anyone
http://www.wordpress.com/	Create free blogs with 3 giga bytes of free storage
http://www.stumbleupon.com/	Is a discovery engine. Finds and recommends web content to its users.
www.wikiversity.org	Open educational resources Wikipedia – Free content encyclopedia Wikinews - Free content news WikiSource - Free content library Wiktionary – Dictionary and thesaurus Wikispecies – Directory of species commons – Shared media repository Wikiquote – Collection of quotes Wikibooks – Free textbooks and manuals Meta-Wiki – Wikimedia project coordination
www.visualthesaurus.com	Is an online thesaurus and dictionary of over 145,000 words that you explore and visualize using an interactive map
www.classmarker.com	Customizable online test maker for business, training & educational assessment with tests and quizzes graded instantly
http://www.smg2000.org/	It offers a vast library of learning materials and standards in Math, Business Education, Economics, English/Language Arts, Technology, Social Studies and Family and Consumer Sciences

www.cut-the-knot.org/	Arithmetic articles, problems, puzzles simulated using java
http://lstat.kuleuven.be/java/	Java Applets for visualization of statistical concepts
http://en.wikipedia.org/wiki/Webcast	It is a media presentation distributed on Internet
http://www.librivox.org/	It provides free audio books for listening
www.docs.google.com	It is a free web based office suite and data storage service
www.youtube.com	Watching and sharing videos
http://www.google.com/talk/ https://www.google.com/calendar/ http://translate.google.com/ https://sites.google.com/ http://www.google.co.in/ig	Google talk is downloadable chat application Google Calendar is a free calendar Google Translator is a free translator for 65 languages Google sites allow free rich webpage creation and sharing Igoogle creates a personalized home page
www.mediafire.com	Free cloud storage for computers and mobile devices
http://www.csse.monash.edu.au/~dwa/Animations/index.html http://www.edsim51.com/ http://www.ontko.com/moss/ http://www.modelsphere.org/open_modelsphere.html http://www.isi.edu/nsnam/ns/	Animations and Simulation tools on Data Structures Microprocessor Operating System Database Networks
www.durpal.com	Official homepage of the open source content management system. Offers documentation and the source for download and hosts a developers and community.

e-Learning Components and Cloud Computing

In Berner-Lee's famous architecture for Semantic Web ontologies are used for sharing and interoperability which can be used to build better e-learning systems [16]. In order to define components for e-learning systems the methodology we used is the principle of composibility in Service Oriented Architecture [17] since it enables us to define the inter-relations between the different e-learning components.The most popular model used nowadays in teaching learning process is Felder-Silverman learning style model [12]. This models learning style description is tabulated in Table 3.

Table 3 : Felder-Silverman Learning Style Models [13]

Learning Styles	Description
Sensory	Concrete, Pragmatic
Intuitive	Conceptual, Innovative
Visual	Preferences to Pictures
Verbal	Preferences to text/audio
Inductive	Prefer explanation from concrete to general
Deductive	Prefer explanation from general to concrete
Active	Learn by experimentation and collaboration
Reflective	Learn by thinking
Sequential	Learn by small steps
Global	Learn by jumping from one topic to another in a non linear manner

This is the base upon which an e-learning model is to be modeled which satisfy all the learning styles mention in [12]. In spite of all the progress the current state of e-learning not full fledged [14]. So the authors have tried to give components for e-learning which will satisfy the learning styles in Table 2. The e-learning components are depicted in Figure 1.

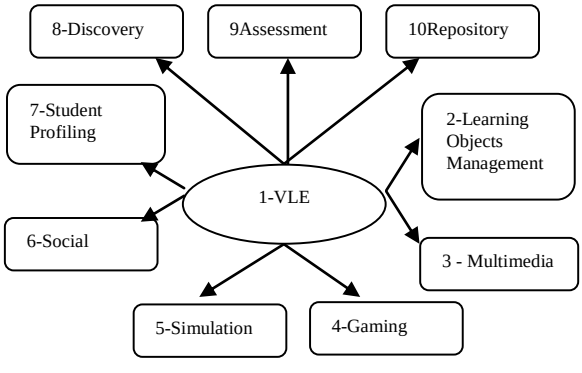

Figure1. E-learning Components

The e-Learning components is based on key topics, topic types and associations and occurrences. VLE – Virtual Learning Environment is the software which handles all the activities of learning. Learning Objects are the learning materials which promotes a conscious attempt to promote visual, verbal, logical and musical intelligence [13] through presentations, tutorials, problem solving and projects. By the multimedia, gaming and simulation kin aesthetic intelligence is promoted. By means of social and discovery, interpersonal, intrapersonal and naturalistic intelligence are promoted by means chat, SMS, e-mail, forum, video, audio conference, survey, voting and search. Finally assessment is used to test the knowledge acquired by the learner and the repository is the place which will hold all the learning materials. From the e-

learning components given in Figure 1 the following cloud architecture as in Figure 2 is drawn. The architecture gives the different layer of the cloud and its respective e-learning services. The Saas and Paas also includes smart agents which keeps track of the learner's behavior which will be useful to the faculty to monitor every student individually and agents also guides the learner's through the course according to his level difficulty. Agents are autonomous system which dwells in a system to meet its design objectives [15]. The cloud is connected to the university by means of a web server which is turn is connected to ubiquitous devices such as lap tops, mobile phones, ipad, tablet etc… by which the human stake holders get involved in the teaching-learning process. The same architecture can also be used for a cluster of universities which would like to share there resources with each other for the enrichment of the human resources. In this case each university will be connected by a web server to the same cloud but they need to use the standards for interoperability mentioned in [6, 7 and 8].

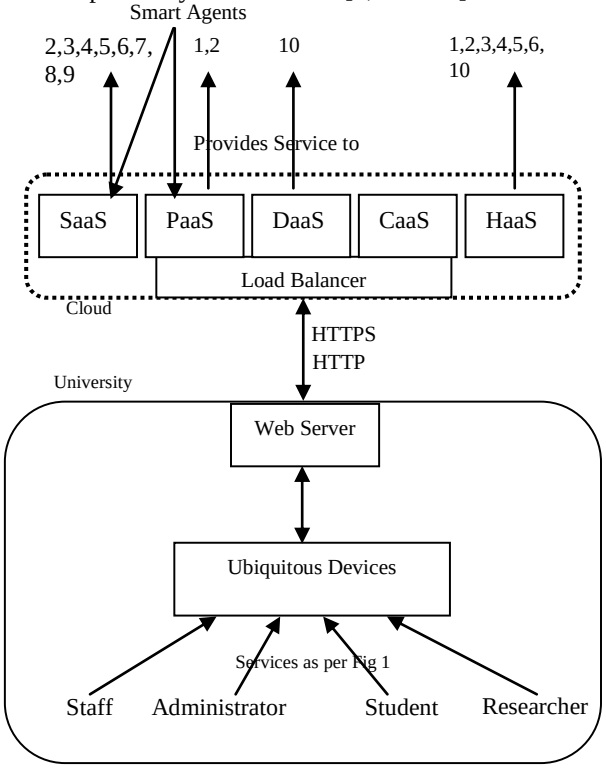

Figure 2. Sharable e-Learning Architecture in Cloud for Cluster Universities, Numbering represent the components in Figure 1

Retrieval model for e-Learning resources in Cloud

The cloud provides us with many services using different layers as seen from Table 1. In the e-learning model in the figure 1 there are 10 components mentioned and it can vary according to different models by different authors. So in order to minimize the cost incurred by the client of a cloud service for the proposed e-learning model we have mapped this problem to a simplex method problem definition. All the components of the e-learning mentioned in figure 1 will become variables x_i and the cost incurred by each variable for the services from the cloud are denoted as C_i. Cost incurred for SaaS, PaaS, Daas, Caas and Haas *is* C_s,C_p,C_d,C_c and C_h respectively . So the Simplex form for the proposed model is as follows,

Minimize Z =
$(C_p+C_h)\ X_1+ (C_s+ C_p+C_h)\ X_2+ (C_s+ C_h)\ X_3+ (C_s+ C_h)\ X_4+ (C_s+ C_h)\ X_5+ (C_s+ C_h)\ X_6+ (C_s)\ X_7+ (C_s)\ X_8 + (C_s)\ X_9+ (C_d+ C_h)\ X_{10}$ (1)

Subject to
$X_2+ X_3+ X_4+ X_5+ X_6+ X_7+X_8+X_9 <= C_s$
$X_1+ X_2 <= C_p$
$X_{10} <= C_d$
$X_1+X_2+ X_3+X_4+X_5+X_6+X_{10} <= C_h$

$X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9,X_{10} >= 0$

Generalizing this
Minimize Z =
$(C_{p1}+C_{p2+Cpk}+C_{h1}+_{Ch2}+_{Chk})\ X_1+$
$(C_{s1}+C_{s2}+C_{sk}+ C_{p1}+ C_{p2}+C_{pk}+C_{h1}+C_{h2}+C_{hk})$
$X_2+(C_{s1}+C_{s2}+C_{sk}+C_{h1}+C_{h2}+C_{hk})\ X_3+$
$(C_{s1}+C_{s2}+C_{sk}+ C_{h1}+C_{h2}+C_{hk})\ X_4+$
$(C_{s1}+C_{s2}+C_{sk}+C_{h1}+C_{h2}+C_{hk})\ X_5+$
$(C_{s1}+C_{s2}+C_{sk}+ C_{h1}+C_{h2}+C_{hk})\ X_6+(C_{s1}+C_{s2}+C_{sk})X_7+$
$(C_{s1}+C_{s2}+C_{sk})\ X_8 +$
$(C_{s1}+C_{s2}+C_{sk})\ X_9+$
$(C_{d1}+ C_{d2} + C_{dk} +C_{h1}+C_{h2}+C_{hk})\ X_{10}$ (2)

Subject to
$X_2+ X_3+ X_4+ X_5+ X_6+ X_7+X_8+X_9 <= C_{s1}$
$X_2+ X_3+ X_4+ X_5+ X_6+ X_7+X_8+X_9 <= C_{s2}$
$X_2+ X_3+ X_4+ X_5+ X_6+ X_7+X_8+X_9 <= C_{sk}$
$X_1+ X_2 <= C_{p1}$
$X_1+ X_2 <= C_{p2}$
$X_1+ X_2 <= C_{pk}$
$X_{10} <= C_{d1}$
$X_{10} <= C_{d2}$
$X_{10} <= C_{dk}$
$X_1+X_2+ X_3+X_4+X_5+X_6+X_{10} <= C_{h1}$
$X_1+X_2+ X_3+X_4+X_5+X_6+X_{10} <= C_{h2}$
$X_1+X_2+ X_3+X_4+X_5+X_6+X_{10} <= C_{hk}$

$X_1+X_2+X_3+X_4+X_5+X_6+X_7+X_8+X_9+X_{10}>=0$

In brief

Minimize Z =

$$\sum_{i=1}^{k} (C_{pi}+C_{hi})\, X_1+(C_{si}+ C_{pi}+C_{hi})\, X_2+ (C_{si}+ C_{hi})\, X_3+$$

$$(C_{si}+ C_{hi})\, X_4+(C_{si}+ C_{hi})X_5+(C_{si}+ C_{hi})X_6+(C_{si})\, X_7+ (C_{si})\, X_8 + (C_{si})\, X_9+ (C_{di}+ C_{hi})\, X_{10} \quad (3)$$

Subject to

$$X_2+ X_3+ X_4+ X_5+ X_6+ X_7+X_8+X_9 <= C_{si}$$
$$X_1+ X_2 <= C_{pi}$$
$$X_{10} <= C_{di}$$
$$X_1+X_2+ X_3+X_4+X_5+X_6+X_{10} <= C_{hi}$$

$$X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9,X_{10} >= 0$$

For the n dimensional model with *n* variables (e-learning components) and *m* cost(Services provided by different clouds) is as follows,

$$\text{Min } Z = \sum_{j=1}^{n} C_{jp1p2...pk}\ X_{jq1q2...qk} \quad (4)$$

Subject to

$$\sum_{j=1}^{n} X_{jq1q2...qk} <= b_{ip1p2...pk},\ i = 1,2,...m$$

$$X_{jq1q2...qk} >= 0, \qquad j = 1,2,...n$$

Where, p's and q's are the parameter fixed by the model developers and b_i are the restrictions.

Conclusion

Most of the e-learning system focuses on visual, verbal and logical intelligence forgetting about the other kinds of intelligence a learner has to acquire to have a complete learning experience. The e-learning components given in Figure 1 would help the learning community to understand in a better way and get a holistic view of the e-learning activities which need to be looked upon. Since the next generation is cloud which drastically benefit the education institution to reduce the cost of investment into the infrastructure, the e-learning architecture in merged into the cloud architecture and the services provided by each layer is given in Figure 2 will surely enhance the knowledge of the knowledge provider and the receiver to make use of the latest computing technology for his objective.

References

[1]Anita Finke, Janis Bicans, *E-Learning System Content and Architecture Evolution*,
[2]Stash, Cristea, De Bra, *Adaptation to Learning Styles in E-Learning:* Approach Evaluation, Proceedings of E-Learn 2006 Conference, 2006
[3]Lavanya Rajendran, Ramachandran Veilumuthu, *A Cost Effective Cloud Service for E-Learning* Video on Demand, European Journal of Scientific Research, 2011, pp.569-579
[4]Zhang Guoli, Liu Wanjun, *The Applied Research of Cloud Computing* Platform Architecture in the E-Learning Area,IEEE, 2010
[5]Thaddeus, Maria Dominic, *Multi-Agent e-Learning System for Programming Languages*, Amazing Elearning 2008
[6]SCORM(Sharable Courseware Object ReferenceModel), http://www.adlnet.org
[7]IMS IMS Global Learning Consortium, Inc., "Instructional Management System (IMS)", http://www.imsglobal.org.
[8]AviationIndustry CBT Committee(AICC), Computer Managed Instruction(CMI), http://www.aicc.org
[9]Chris Riedel, Infinity Learning Uses Amazon Web Services, Takes MOODLE to the Cloud, 2008
[10]www.intel.com/Assets/PDF/whitepaper/IN_Ed_Cloud_Computing.pdf
[11]*Top Threats to Cloud Computing V1.0*, Prepared by the Cloud Security Alliance, March 2010
[12]Graf, Viola, Kinshuk, Representative *Characterestics of Felder-Silverman Learning Styles:* an Empirical Model, IADIS, 2006, pp. 235-242
[13]Sleigh, Learning Styles – from Theory to Practice. Training and Development in Australia, Australian Institute of Training and Development, 2002,29(2),p.44
[14]Lorna Uden, Ernesto Damiani, The Future of E-Learning: E-Learning EcoSystem, Proceeding of IEEE Conference on Digital EcoSystems and Techniques, Australia, 2007,113-117
[15]Aleksandras Targamadze, Ruta Petrauskiene, Classification of Distance Learning Agents,
[16]Uschold, Gruninger, Ontologies, *Principles , Methods and Applications*, Knowledge Engineering Review, 1996, 11(2)
[17]Papazoglou, Heuvel, *Service Oriented Architectures: Approaches, Technologies, and research issues"*, The VLDB Journal, vol 16, no. 3, pp. 389-415, 2007
[18]http://en.wikipedia.org/wiki/Web_2.0#cite_note-0