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Educational Clouds – The Future Computing Model for Indian Higher Educational Institutions

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ABSTRACT
Cloud Computing has emerged as the most disruptive technology in the last decade. It has impacted every domain. Indian Higher Education is no exception. Higher Educational Institutions in India have shown the desire to embrace this new paradigm of computing so as to support, interactive teaching and learning, personalized content delivery, digital materials and so on. In order to fully achieve the cost benefits, the process of resource provisioning needs to be carefully fine-tuned. This paper analyses the compelling reasons for the higher educational institutions to move towards cloud based teaching and learning and compares the different resource provisioning mechanisms and suggests the best methods to achieve cost effectiveness.
***Keywords* :-** Cloud Computing, Higher Education, Resource Provisioning

I. INTRODUCTION

"The destiny of a nation is determined in its class rooms", said Pandit Jawaharlal Nehru. The traditional methods of teaching and learning have moved on from being conventional chalk and talk to digital class rooms. But, ironically, even after 60 years of independence, access to education and basic amenities is still a dream for rural students. Cloud Computing is promising to break this deadlock. NGO's have started to use Cloud computing based healthcare solutions to nook and corner of the country. Complete Cloud based teaching and learning may be a reality in the very near future.

A. CLOUD COMPUTING BASICS

Internet has grown manifold and the emergence of mobile technology has made internet access available to 80% of human population. Today, Internet has evolved into Cloud Computing, offering computing capabilities on the go. Cloud computing has revolutionized every domain in the business. The National Institute of Standards and Technology(NIST) of the U.S government defines Cloud Computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable resources(eg., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. NIST's cloud model consists of five essential characteristics, three service models and four deployment models. The five characteristics are on-demand self- service, broad network access, resource pooling, rapid elasticity, and measured service. The three service models are Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), and Cloud Infrastructure as a Service (IaaS). The four deployment models are Private Cloud, Public Cloud, Community Cloud and Hybrid Cloud. . In order to provide highly reliable and secure services, automated and intelligent mechanisms are needed for managing the resources in cloud.

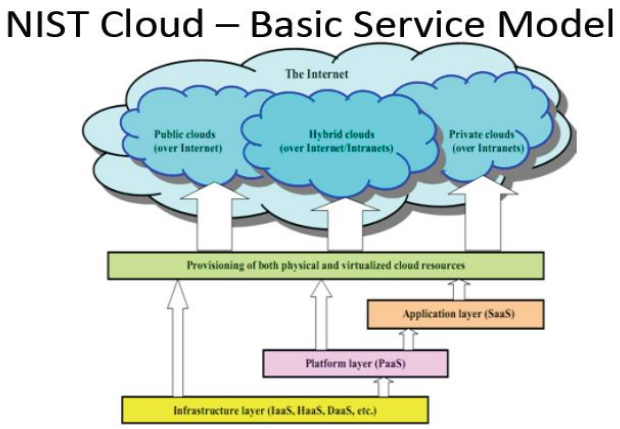

Fig 1.NIST Cloud-Basic Service Model

Cloud Computing is presumed to offer computing as an utility [4] in the next generation of IT platforms. Apart from IaaS, PaaS, and SaaS it also provides XaaS. XaaS is anything as a service. This includes AaaS (Architecture as a Service), DaaS (Data as a Service), NaaS (Network as a Service), HaaS (Hardware as a Service), RaaS (Recovery as a Service), Vaas (Voice as a Service), FaaS (Framework as a Service), and the list is endless [5]. Thus, Cloud is a combination of the above business developments and technologies such as Virtualization, Grid Computing, Web Services and utility computing. Cloud Services could be outsourced to Cloud Service Providers deployment and maintenance of specialized cloud products and services. The main advantage would be to pay only for the services that the user has availed. Cloud Computing has revolutionized the way data is stored and accessed. It also promises the capability to offer quality computing services which could be subscribed. As the number of users is increasing exponentially, Resource Management Systems (RMS) play a vital role in ensuring that the Service Level Agreements with clear QoS (Quality of Service)

parameters are enforced. The RMS balances the service requests from the users and the expected service performance from the provider. System oriented approaches in resource allocation maximize system usage and job performance but fail to deliver on-demand-service computing.

II. CLOUD COMPUTING AND HIGHER EDUCATION

Adopting Cloud computing for teaching and learning provides immense efficiency and potential. With more and more, higher educational institution getting upgraded as research institutes, the need for up gradation of educational infrastructure for teaching, learning, evaluation and scientific research has become inevitable [5]. Higher Educational Institutions are involved in re-designing the learning space for students by incorporating new pedagogies and interactive learning models.

A. WHAT CLOUD COMPUTING BRINGS TO A HIGHER EDUCATIONAL INSTITUTION

- A completely transformed learning experience.
- Learning virtually from anywhere
- Catering to the differing requirement of students through Tailored Learning.
- Richer link with International Industry
- Globally connected Learning ecosystem
- Synergized on and off campus experience through Digital campus.
- A cloud class room provides shared learning, High engagement, immersive space, and global collaboration.
- Rich learning environment
- On demand mobile access.
- Smarter workforce.

Thus cloud adoption by an educational institution completely reinvents the process of teaching and learning. But there are challenges too. To work in a cloud environment Higher Educational institutions must be able to cope up with the challenges such as

- Uncertain definitions
- Privacy
- Contractual issues
- Jurisdictional issues
- Risk
- Non performance
- Interoperability
- Network capacity
- Re-architecting
- Staff
- Perceptions

B. TECHNOLOGY ADOPTION IN INDIAN HIGHER EDUCATIONAL INSTITUTIONS

Computers have revolutionized the medium of work. Although, the western universities are ahead in the digitization of campus, Indian universities are catching up slowly and steadily. The budgetary constraints are a huge bottleneck for Indian universities, which has affected the research scenario. When it comes to technology adoption, Indian universities are lagging behind. Higher educational institutions are looking at new avenues and technology to withstand global competition. Cloud computing with its huge computational power and virtual computing environment is the right choice for universities to foster growth and sustain momentum. Globally, education sector is one of topmost sectors and is no different in India. Currently, there are about 722 universities in India, which includes public as well as private ones. With the ever growing population in India likely to reach the number 1 spot in the world by 2050, there is an urgent need for a standard cloud computing architecture customized for Indian universities that could offer cost effective yet powerful solutions. Initially higher educational institutions opted for commercial cloud service providers who made a lot of economies of scale. As the urge to move to the cloud was greater, the higher cost involved was not considered by the higher educational institutions. But, the commercial cloud service providers actually have not met the teaching, learning and business requirements of higher educational institutions [6].

University of California, Washington state University's School of Electrical Engineering and Computer Science, North Carolina State University and Higher Educational institutions from U.K. adopted cloud computing in the early 21st century and are reaping the benefits. Cloud has enabled these institutions to concentrate on teaching, learning, evaluation and research activities rather than software and I.T configuration [7]. One of the compelling reasons for higher educational institutions to move towards Cloud computing is the enormous amount of storage capacity and massive computing capacity. Cloud Computing enables higher educational institutions to cut down on cost and make a giant leap in terms of processing speed. Add to these, cloud offers unique services such as self-service, PAYGO (Pay As You GO), and metered billing.

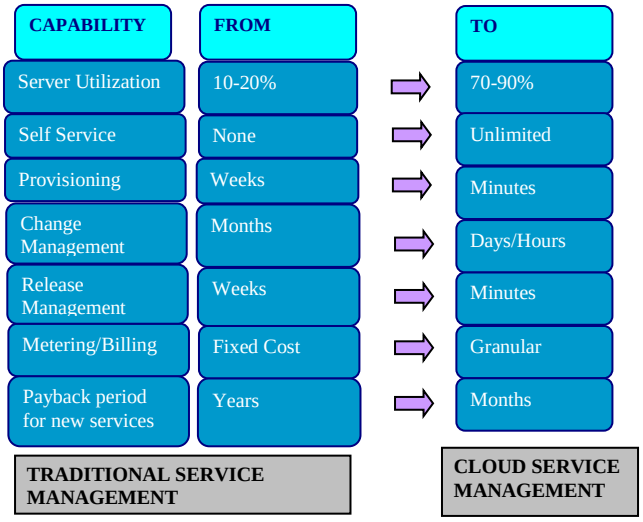

Fig.2 Benefits of Cloud Service Management over Traditional Service Management

III. CLOUD BASED TEACHING AND LEARNING IN HIGHER EDUCATION

The trend of transformation in higher educational institution is technology adoption for enhanced teaching and learning environments. This is fueled by the compelling demand of the 21st century's market based economy. This is also made necessary by the growing disconnect between what a graduate level student learns and what skills he is to deliver as an employee. In a country like India, the population is increasing at an exponential rate. The higher educational institutions are struggling with huge intakes. In order to deliver quality content to all the students the age old traditional learning methods are inadequate.

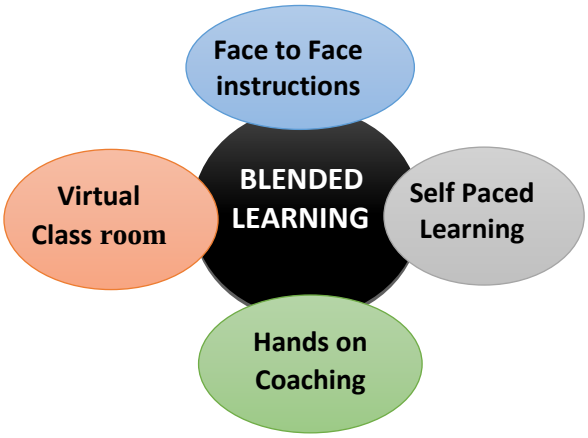

Fig.3 Blended Learning Scenario

In such a scenario, hybrid learning / blended learning will be more effective. Hybrid learning combines traditional chalk and talk lectures with out-of-class and online course work. This is also called as blended learning as the student learns through conventional methods supplemented by digital content which the student can control over place, time, pace and path. This is shown in fig.3

A. ADVANTAGES OF BLENDED LEARNING

- ♣ A continuous process
- ♣ Combination of physical and virtual environments
- ♣ Variety of learner grouping
- ♣ Emphasis on needs of the learner
- ♣ Rebuilding of a lesson or course
- ♣ Recognize the affordances of the media
- ♣ Role shifts

So, Blended learning could be described as a mode of teaching that eliminates situational barriers like time, place, and, enables interactions of the highest quality between the teachers and students. The conventional lectures, video tutorials, and online environments serve different purposes and do different functions. Video Tutorials provide the right platform and opportunity for students to apply their knowledge and interact with theory at the applied level. The most important function of the online environment is a central repository for resources. Online content could be core content, course book publisher's resources such as slides, PowerPoint notes, administration information, and other resources such as YouTube videos.

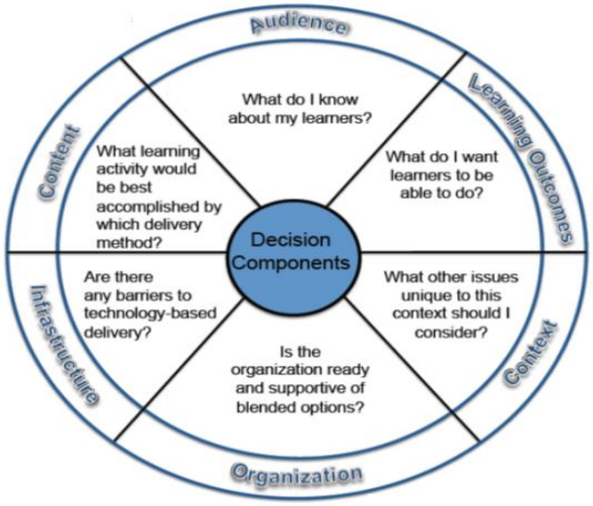

Fig.4 Design Components for Blended Learning Scenario

Higher Educational Institutions have to move towards providing Adaptive Learning that supplements blended learning. In Adaptive learning environment, instructional content is delivered based on the preferences and responses of the students. This should ease the emergence of Collaborative learning where the scale and magnitude of teaching and learning reaches the global stage. Collaborative Learning technology facilitates online educational content delivery on a global scale, where graduates belonging to higher educational institutions scattered all over the globe can interact, share their ideas, discuss and collaborate on a project.

Fig.5 Collaborative Learning Scenario

Collaborative Learning will be a boon for Research as knowledge dissemination across the globe is converged in a team and the effectiveness of the findings will be truly beneficial to humankind.

Goal	Strategies, Tools and Resources	
	Classroom Learning	**Blended Learning**
Communication between teacher and students	• Full group lessons • Small group lessons or tutorials • Individual conferences • Marked assignments and rubrics	• Full group lessons • Small group lessons or tutorials • Individual conferences • Marked assignments and rubrics • Digital course materials • Online discussions • E-mail • Instant messages • News announcements • Online calendar • Dropboxes • Online grade tool
Demonstration of learning	• Paper-and-pencil tests and assignments submitted in person • Live presentations, labs, performances, or exhibits of skill • Models, works of art, posters, and other physical artifacts submitted in person	• Paper-and-pencil tests and assignments submitted in person • Live presentations, labs, performances, or exhibits of skill • Models, works of art, posters, and other physical artifacts submitted in person • Blogs • Electronic portfolios • Online discussions • Online surveys and quizzes • Assignments, such as essays, worksheets, slide shows, photographs, and videos submitted to electronic dropboxes

The Comparison between Conventional classroom learning and Blended Learning is shown in Table 1. The Blended learning augmented by Cloud Computing has more offerings than the conventional learning method.

IV. THE ROLE OF RESOURCE PROVISIONING TECHNIQUES IN ENHANCING CLOUD BASED TEACHING AND LEARNING IN HIGHER EDUCATION

In Cloud Computing, Resource management involves Resource Provisioning, Resource Allocation and Resource Monitoring. Cloud resources include the web servers, memory, storage, network, CPU, application servers, and virtual machines. Virtual Machines are the processing units in Cloud. Virtualization offers scope for solutions to manage resources but increases complexity [8]. . The complexity involved in resource provisioning has grown exponentially manifold due to increased complexity [6]. The Complexity mainly arises from the heterogeneity of the users and their requests. The traditional resource management model is not capable of processing the task of resource assignment and allocating resources dynamically [7]. As Cloud offers the capability to access information anytime, anywhere and anyhow, it is difficult for a cloud service provider to dynamically allocate resources efficiently. In order to provide highly reliable and secure services, automated and intelligent mechanisms are needed for managing the resources in the cloud.

As the number of users is increasing exponentially, Resource Management Systems (RMS) play a vital role in ensuring that the Service Level Agreements with clear QoS (Quality of Service) parameters are enforced. The RMS balances the service requests from the users and the expected service performance from the provider. System oriented approaches in resource allocation maximize system usage and job performance but fail to deliver on-demand-service computing. The scale and magnitude of cloud computing is vast, and the process of managing the Cloud, be it resource utilization or system management is too complex. In order to provide highly reliable and secure services, automated and intelligent mechanisms are needed for managing the resources in the cloud. The growing trend of cloud adoption in higher educational institutions warrants new management models for this highly challenging computing environment. As the need for cloud computing solutions continue to grow exponentially, so too the threats.

The performance of any system depends on the effective management of resources. This is particularly significant in cloud computing systems which involves management of large number of Virtual machines and Physical machines. In particular, the performance is inherently dependant on effective provisioning of resources [9]. Significant performance degradation is caused by resource contention by

multiple applications. The heterogeneous nature of hardware resource in the cloud make it even more challenging.

So as to exploit optimally, the cost effectiveness of cloud resources, higher educational institutions are required to have methods to assess and estimate the educational cloud user request demand and promptly make adjustments in resource allocation. The educational cloud user request and resource allocation can be done in two ways, 1) Dynamically allocating resources as and when the need arises 2) Resource allocation using Pre-determined load balancing mechanisms. The Dynamic allocation of resources can be done in two ways. 1) Pro-active Resource Allocation, where the demand is analysed in particular the education domain, and predicting the expected load. 2) Reactively allocating resources based on the current demand only. Autonomic Cloud Computing offers ability to dynamically allocate resources in an automatic manner. Significant optimal cost in incurred, when resources are allocated dynamically based on the application knowledge, without compromising on Quality of Service (QoS).

A. REACTIVE RESOUCE ALLOCATION MECHANISM

The Reactive resource allocation mechanism takes into consideration the educational domain specific information such as 1) When and how the students access the cloud 2) The nature of the content the students access 3) Student's work schedule and Time table. This allows this method to dynamically allocate resources efficiently with the prior knowledge of the demand pattern. The Figure 6. Presents the proposed architecture for dynamically allocate resources.

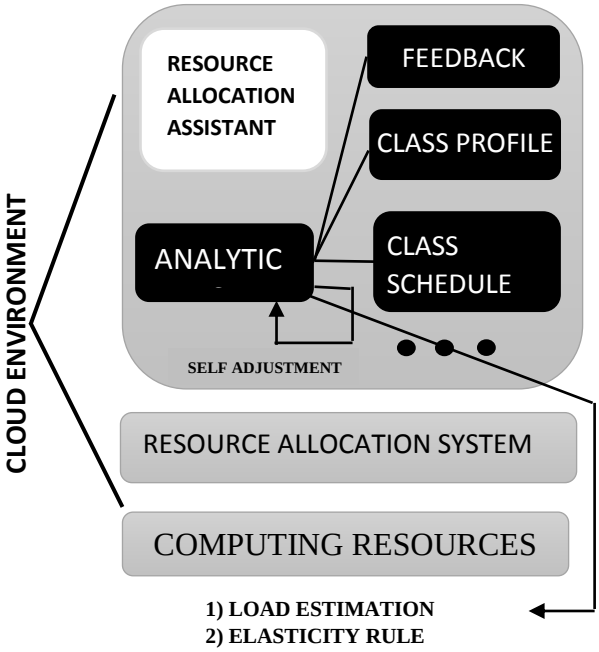

Fig.6.Dynamic Resource Allocation Architecture

The main component of this architecture is Resource Allocation Assistant exclusively for educational domain. This component gets the demand information from the analytics module which has the following information. 1) Class Schedule gives information on classes timings. 2) Class Profile gives the information on the expected no. of users in the class, their profile, expected applications request, and the expected workload. 3) Interaction Details gives information on the pattern of device usage by the students.

B. ALGORITHM FOR DYNAMIC RESOURCE ALLOCATION MECHANISM

The algorithm for dynamic resource allocation is designed to be run by the analytics module. The pseudo code for the algorithm is given.

Input: Class Profile, Class Schedule, Device Interaction
Output: Class Profile(Updated)
1 class ←selectClass(classSchedule)
2 load ←getExpectedLoad(classProfile)
3 provisionDelay←getExpectedProvisionDelay(classProfile)
4provisionResources(class.startTime,provisionDelay,classProfile)
5 **while** *demand for resources* **do**
6 monitor user interaction and resource consumption
7 **if** *demand changed* **then**
8 adjust resources
9 update (classProfile)
10 release resources
11**return** classProfile

C. RESULTS

The cost incurred by the way of resource utilization and the quality of service rendered for the three methods of Resource Allocation are analysed. A safety margin" of 30% was setup in this experiment.

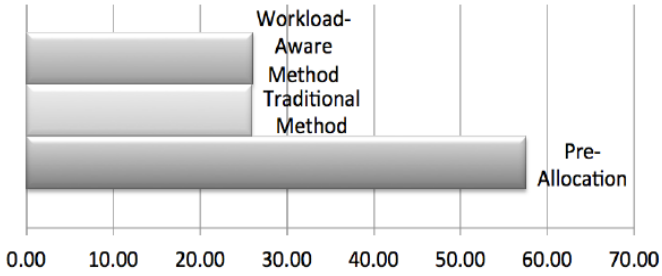

Fig. 7 Cost per Week Method

It is clear that the cost incurred in the Pre-Allocation method is very high. The cost incurred in the Reactive and Proactive methods are found to be optimal.

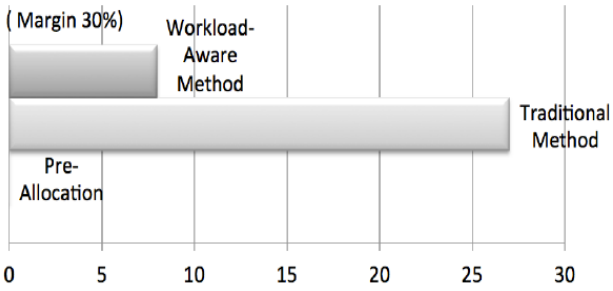

Fig.8 QoS Violations Summary

It is clear that the QoS violations in the Reactive allocation method is high for 30% safety margin. The Pre allocation mechanism provides the best QoS value. But, the Reactive allcoation methods strikes a good balance between cost and QoS. The Dynamic Resource Allocation(Reactive) provides the balanced solution with lower cost and moderate QoS violations.

V. CONCLUSION AND FUTURE DIRECTIONS

The growing trend of cloud adoption in higher educational institutions warrants new management models for this highly challenging computing environment. As the need for cloud computing solutions continue to grow exponentially, so too the threats. The proposed autonomic computing model is a humble first step in addressing the above problems. The dynamic nature of autonomic provisioning is found to be able to satisfy the QoS (Quality of Service) requirements of the consumer, resulting in improved efficiency in managing resource provisioning and optimized consumption of energy. Also, the proposed algorithm employs a two pronged approach to include pre-allocation as well as dynamic allocation. This helps the model to provide a economically cost effective and a QoS aware solution to the problem of resource provisioning. The SLA obligations are thoroughly met, thereby resulting in increased customer satisfaction. In future more QoS aware algorithms could be employed resulting in more energy consumption and security aware architecture could be realized.

REFERENCES

[1] Cloud computing for education: A new dawn?, Nabil Sultan, Faculty of Business and Computer Science, Liverpool Hope University, Hope Park, Liverpool, L16 9JD, UK International Journal of Information Management 30 (2010) 109–116

[2] Rajkumar Buyya, Rodrigo N. Calheiros, and Xiaorong Li, ―Autonomic Cloud Computing: Open Challenges and Architectural Elements‖, *IEEE Digital Library*, EAIT, 2012.

[3] R. Buyya, C. S. Yeo, and S. Venugopal,‖.Market oriented Cloud Computing: Vision, Hype and Reality for delivering IT services as computing utilities‖, *Proceedings of 10th International Conference on High Performance Computing*, 2008.

[4] Classroom in the Cloud', Jamie Smith, Birmingham Metropolitan College, UK, ICA CON, Nov 2014.

[5] Cloud Computing for Higher Education: A Roadmap, MD. Anwar Hossain Masud , Xiaodi Huang, Proceedings of the 2012 IEEE 16th International Conference on Computer Supported Cooperative Work in Design

[6] Cloud Computing in Higher Education: A Guide to Evaluation and Adoption, White paper, Cisco Press.

[7] Cloud Computing for Education and Learning: Education and Learning as a Service (ELaaS), Mohssen M. Alabbadi, 14th International Conference on Interactive Collaborative Learning (ICL2011) 11th International Conference Virtual University (vu'11), Slovakia, September 2011.

[8] Ali-Eldin, A., Tordsson, J., Elmroth, E.: An adaptive hybrid elasticity controller for cloud infrastructures. In: Proceedings of the IEEE Network Operations and Management Symposium (NOMS'12) (2012).

[9] Bobby Hobgood, Ed.D., Reaching every student with blended learning, Research and Development in Online Curriculum and Instruction, The University of North Carolina.

[10] Lynn M. Jeffrey, John Milne and Gordon Suddaby Massey University, New Zealand Blended Learning: How Teachers Balance the Blend of Online and Classroom Components, Journal of Information Technology Education: Research, 2014

[11] Del Siegle, Ph.D., *Cloud Computing: A Free Technology option to Promote Collaborative learning,, ijct,2013*.

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