

CeMSE: A Cloud enabled Model for Smart Education

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ABSTRACT

Education and research per se have been the major contributing factors in the development process of many countries. In the present context, the role of education in building a smart society cannot be overlooked. There is growing demand for quality education across all sections of society, irrespective of economic, ethnic, and geographical diversities. In order to cope up with the demand it is envisaged that the cloud computing paradigm can provide a technological solution in terms of resource utilization and scalability. In this paper, we have explicated the evolution of Indian education system and the ever growing challenge to foster “quality education for all”. We elucidate how cloud enabled education can redefine the education landscape in India. We have presented a cloud enabled model for maintaining and disseminating academic contents, and a variety of student related services. We believe that the National Knowledge Network (NKN), which is a Government of India initiative to seamlessly interconnect leading scientific and technological institutions across the country, can provide the required backbone infrastructure to implement the proposed cloud enabled education model (CeMSE). This will be a value addition to the huge network infrastructure which can go a long way to facilitate distance learning, access to quality study material, academic guidance by subject experts and even pave the way for collaborative research in emerging areas.

Categories and Subject Descriptors

H.3.5 [Information Systems]: Information Storage and Retrieval - *Online Information Services, web-based services.*

General Terms

Design, Human Factors, Management

Keywords

Smart education; Cloud enabled services; Knowledge network

1. INTRODUCTION

India has one of the oldest education systems in the world. It has evolved from the ancient “Gurukul” system (when students had to stay in the ashrams for days together with the teacher for learning) to today’s e-learning system (when students need not even physically meet the teacher). Over the years the education system in India has undergone several changes and is continuously

working towards the holistic development of individuals through access to quality education. In 2009, the country has passed the “Right to Education Act” declaring that school education is compulsory for all children between the age group of 6-14 years. Though the mission is quite successful in cities and urban areas but there are many impediments in the implementation of the policy so far as the remote areas are concerned. Availability of qualified teachers who would be interested to work in remote locations and monitoring the progress of academic activities in such areas has been the major concern. Moreover, dissemination of quality reading and training materials in such areas is a real challenge.

Likewise, higher education both at the undergraduate as well as post graduate level has almost grown unevenly across the country. There are universities and institutions which enjoy internationally acclaimed reputation and have no dearth of resources both in terms teachers and infrastructure. But, at the same time there are a huge number of institutions which are deprived of good teachers, proper infrastructure and access to quality education. The irony is that in many cases the resources of those few top level institutions are underutilized while a majority of institutions starve for resources. We believe that the cloud computing paradigm [1] and the related technologies can bridge this gap between the “haves” and the “have-nots” by facilitating effective resource utilization and sharing of infrastructure [2]. Cloud enabled systems are being increasingly deployed in many organizations for several applications due to its dynamic scalability and usage of virtualized resources. It is envisioned that, in the near future, cloud computing will have a significant impact on the educational and learning environment, enabling teachers, learners, and administrators to perform their tasks effectively within budgetary constraints by utilizing the educational services offered by cloud service providers [3]. Some initiatives have already been taken by the developed countries in this direction but very little progress has been made by the developing countries to leverage the education domain with cloud technology. A model to aggregate the computational potentialities of many small, low power, heterogeneous systems of rich education resources to build educational clouds has been proposed in [4]. Application of cloud computing as a platform for e-learning in contemporary school education has been explored in [5]. It is envisioned that cloud computing has a significant place in the higher education landscape both as a ubiquitous computing tool and a powerful platform [6]. While such technological innovations are considered to be means for improving the life style of people there has also been studies to argue that technological interventions may not result in the expected socioeconomic development, especially in developing countries [7]. The question of sustainability has been raised in [8][9] when technological solutions designed in developed countries are imported to developing countries, the later find it difficult to catch up in their context. Nevertheless, we believe that technological interventions can still contribute in the

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development process of countries that are rich in technical manpower and are determined to use technology as a vehicle for realizing a better tomorrow. Towards this end in the following sections we explicate the education scenario in India and highlight the major challenges which stand as impediments for imparting quality education across the length and breadth of the country. We propose a cloud enabled model to facilitate teaching, learning and access to quality academic contents in order to realize the dream of “smart education” in a huge country like India. It is envisioned that the cloud enabled education model can be built on top of the existing national knowledge network which is being extended to the nook and corner of the country, thus making the best use of the infrastructure without any additional cost.

2. INDIAN EDUCATION SYSTEM

In this section, we present the Indian education system as a background to understand the need for quality education at different levels of education.

2.1 School Education

This is the first level of formal education. Normally children in the age group of 6-16 come under this category. It has three components, namely, primary school (5 years), middle English school (2 years), and secondary school (3 years). Students have the option of pursuing their studies in public schools run by the government, private schools, and international schools. There is also provision for national open schools which enable students to complete their formal education in case of any discontinuity.

2.2 Higher Secondary Education

After 10 years of schooling students enter into this level and have to decide on an academic stream that is commensurate with their future plan of studies, i.e., engineering, medicine, law, science, commerce or humanities etc. Higher secondary education is imparted by junior colleges managed either by the government or private bodies.

2.3 Under Graduate Education

Undergraduate courses, in general, are of three years duration leading to Bachelor degree in Humanities, Science, or Commerce. However, for professional subjects like Engineering, Medicine, Pharmacy, etc. the duration is relatively longer which ranges from 4 to 5 ½ years.

2.4 Post Graduate Education

Postgraduate Courses in Humanities, Science, Engineering and Medicine are usually for two years leading to a Master degree. Such courses are normally offered at the University level. Universities also offer Doctoral courses like M. Phil and Ph. D. which involve research work.

3. RESOURCE CONSTRAINTS

In the past most of the educational institutions were run by the government. But, with the passage of time private enterprises have entered into the education sector right from school education to Universities. There are central universities which are directly funded by the central government and state universities which are funded by the provincial government. There is a third category of university termed as private /deemed universities which are owned by private bodies, sometimes sponsored by industries. In some cases the privately run institutions are doing better than public institutions in terms of infrastructure and adoption of

modern technologies in education. Today many of the government institutions are facing serious problems due to insufficient funding, shortage of manpower, and inadequate facilities. Therefore, it has become a real challenge to maintain quality in education across the vast country with an overwhelming young population. There are several impediments to quality education:

- *Affordability*: All cannot afford to go for private institutions due to poor economic background.
- *Accessibility*: Difficulty in having access to quality academic contents because of infrastructural limitations.
- *Locational disadvantage*: Though there has been tremendous progress in the communication technology but majority of institutions in rural areas are yet to enjoy the boon of technology.

4. INFRASTRUCTURAL READINESS

In order to provide a technological solution to the resource constraint issues we explored the possibility of utilizing available infrastructural resources. The idea is to effectively harness the infrastructure with the proposed cloud enabled education model without additional cost. In this section we provide a brief description of the infrastructure that is being expanded in India to connect leading educational institutions across the country. We envision that the proposed model can be implemented on top of the network infrastructure being developed as a value addition.

4.1 Cloud Infrastructure

Government of India has prepared a roadmap for developing cloud services both at the national as well as at the provincial level. The typical cloud services include compute, storage, network infrastructure, backup, and application development. To a large extent, this infrastructure can be effectively used for the education domain in order to mitigate the problem of quality education.

4.2 National Knowledge Network

The idea of a National Knowledge Network (NKN) was envisaged to optimally utilize the potential of institutions engaged in generation and dissemination of knowledge by connecting them through a high speed broadband network [10]. The purpose of such a knowledge network is to foster quality institutions across the country with requisite research facilities and to create a pool of highly trained professionals whose expertise can be utilized over a large cross-section of students.

The NKN is built on an ultra-high speed CORE (multiples of 10 Gbps), complimented with a distribution layer at appropriate speeds. The network is designed to support Overlay Networks, Dedicated Networks, and Virtual Networks. The participating institutions can connect to the NKN seamlessly at speeds of one Gbps or more. Institutions are encouraged to develop advanced applications in the areas of Science & Technology, Health, Education, Agriculture, and Governance and integrate with the NKN. Further, it is proposed to seamlessly integrate the entire network with the global scientific community for exchange of knowledge.

The typical services which are envisioned can be broadly categorized into three major service groups, namely, (i) Generic

Services that include Internet, Intranet, Network Management Views, e-Mail, Messaging Gateways, Caching Gateways, Domain Name System, Web Hosting, Voice over IP, Multipoint Control Unit (MCU) Services, Video Portals, SMS Gateway, Co-Location Services, Video Streaming etc., (ii) Community Services that include Shared Storage, Authentication Service, EVO, Collaboration Service, Content Delivery Service, International Collaborations with EU-India Grid, Global Ring Network for Advanced Applications Development (GLORIAD) etc., and (iii) Special Services that include Virtual Private Network Switching Services.

5. CLOUD ENABLED MODEL

In this section, we present our proposed cloud enabled education model, CeMSE along with the services envisaged to address various requirements of a growing student population.

5.1 The Proposed Cloud Model: CeMSE

Figure 1 depicts the overall model of CeMSE which is essentially a hierarchical organization of data centres at different levels of administrative regions. The capacity of the data centres is determined by the services they are designed to offer, normally in the decreasing order as one moves from the higher level to the lower level in the hierarchy. The topmost level is occupied by the national level data centre. The entire geographical area of the country is divided into several regions each of which has a regional data centre. For reasons of convenience, the regional data centres are located at major cities. Under a region there can be several provinces depending on the geographical coverage. Each province has a provincial level data centre which caters to the requirements of a specific province. Finally, a province can have a number of universities and other academic institutions including schools and colleges which can access the resources of the provincial data centre. At the moment data centres are already maintained at the national and provincial levels by the government. Private players have also shown interest to invest on regional as well as university level data centres in a private-public-partnership mode. The data centres at different levels cater to the requirements of a specified geographical/administrative area in terms of various educational services. The hierarchical arrangement of data centres is meant to address the issue of load sharing, data communication overheads and future expansions. Further, because of the regional diversities the nature of educational services can differ from province to province and region to region. For instance, uniform cloud courseware can be designed for a particular province/region depending on the needs of the students in that area which may be quite different from another province/region. Similarly, cloud classrooms and cloud labs can be implemented at the provincial level whereas student assignments and evaluation can be monitored at the university level. With the success of some of the initial services more and more services can be suitably rendered using the facilities available at a particular data centre.

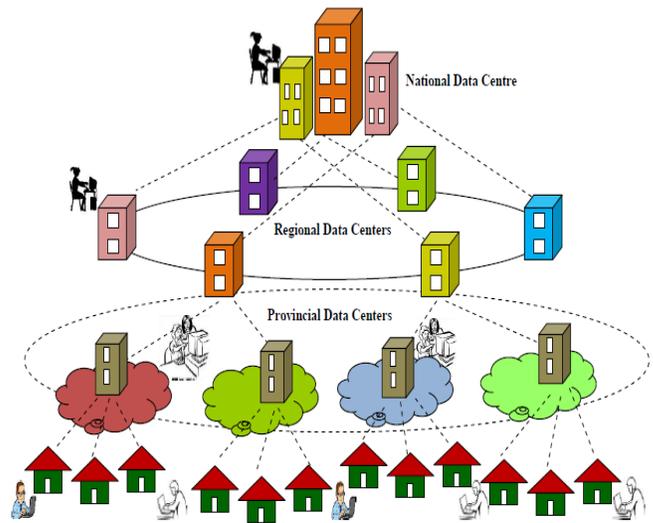


Figure 1. CeMSE Model

5.2 Cloud Enabled Educational Services

Here, we envision a list of services (Table 1) to be provided by CeMSE which ranges from access to various educational material to a whole range of classroom activities.

Table. 1 Cloud Enabled Educational Services

Service Name	Service Description
Cloud Courseware	This can provide access to a whole range of digital contents by the students at their convenience.
Cloud Classroom	This can enable students to interact with expert teachers irrespective of their location.
Cloud Lab	This is a facility which can be of great use to engineering students. A student can have remote access to modern equipment and software products which might be expensive for an institution to own.
Student assignments	Students can download assignments and submit solutions
On Demand lessons	Students can request for lessons on topics of their interest.
Online evaluation & feedback	Students can take examinations online for certification and get feedback from teachers on their performance.
E-Publications	Researchers from different institutions can access varieties of e-journals which can reduce the burden of individual institutions to procure their own copies.
Data sharing	Researchers can share data for conducting experiments
Remedial Classes	Special attention can be provided to weak students/slow learners to cope up

The following diagram depicts the mapping of various cloud enabled educational services to different service models, namely, Software-as-a-service (SaaS), Platform-as-a-service (PaaS), and Infrastructure-as-a-service (IaaS). Further, at present only three

deployment models, viz., public, private and community models have been envisaged as indicated in figure 2. Depending on the organizational policies and the target group of service consumers a suitable deployment model needs to be adopted.

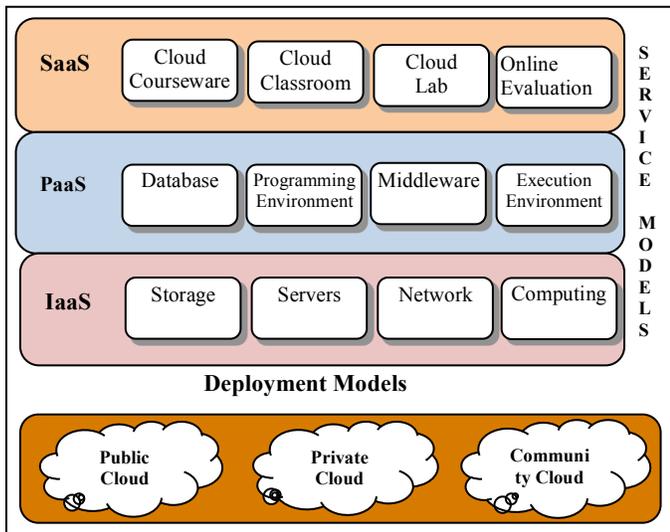


Figure 2. Service Mappings

5.3 Benefits

There are several benefits in having a cloud enabled educational model which can be summarized as follows.

- The model provides 24 x 7 x 365 environment to access infrastructure and learning resources.
- It is possible to drive down the capital investment on deploying IT infrastructure for supporting a large number of educational institutions.
- Standard curriculum contents can be uploaded for wider access.
- Access to quality study materials and lessons taught by experts can be made available to a wide range of student community at a lower cost.
- Live interaction with subject experts can be facilitated.
- Student evaluation and performance monitoring can be made possible by experts located at different places.
- Software licensing issues can be centrally handled.
- Software/ Hardware maintenance hassles can be easily dealt.

5.4 Challenges and Issues

Though the benefits of a cloud based educational model are quite impressive but there are several implementation issues relating to security and sustainability. At the moment there is no successfully implemented global cloud model by any public sector in India. Therefore one has to learn from the experience of other countries. We continue to work in this direction in order to propose a roadmap for successful implementation of CeMSE.

6. CONCLUSIONS

Globally, education has occupied the front seat of the development process. The mode of imparting education and the learning behavior of students have undergone a sea-change. The key to successful education today demands live consultations, data sharing and resource sharing. Research and innovations are increasingly getting multidisciplinary, collaborative, and require substantial computational power. With significant budget cuts in higher education coupled with growing demand for IT enabled services, institutions are considering alternatives to meet their needs. In order to cope with the ever changing demands of the present student community cloud enabled systems hold the promise of addressing most of the requirements. Although there are challenges with the implementation of cloud computing models, the potential benefits appear to outweigh the risks. As this model matures and the risks are mitigated, it is expected that more and more institutions will embrace cloud enabled educational services as an alternative to current practices. We continue to work in identifying other aspects of the education system that can benefit from the cloud paradigm, so that those can be incrementally incorporated to the proposed model.

7. REFERENCES

- [1] Zhang, Q., Raouf Boutaba, L.C. *Cloud computing: state-of-the-art and research challenges*, Journal of Internet Service Applications, 2010, vol. 1, pp. 7-18.
- [2] Marston, S., Li, Z., et al. *Cloud computing-The business perspective*, Decision Support Systems, vol. 51, 2011, 176-189.
- [3] Mohssen M., Alabbadi *Cloud Computing for Education and Learning: Education and Learning as a Service (ELaaS)*, 14th International Conf. on Interactive Collaborative Learning (ICL2011), Slovakia, 2011, 589-594.
- [4] Li, G., Chen, G. *A Novel Enhanced Education Application of Cloud Computing*, Proc. IEEE CCIS2011, 526-529.
- [5] Mariya, S. *Cloud computing – an advanced e-learning platform of school education*, 14th International Conf. on Interactive Collaborative Learning (ICL2011), Slovakia, 2011, 569-570.
- [6] Anwar Hossain Masud, MD, Huang, X., et al. *Cloud Computing for Higher Education: A Roadmap*, Proc. 2012 IEEE 16th International Conf. on Computer Supported Cooperative Work in Design, 552-557.
- [7] Avgerou, C. *Discourses on ICT and development*, Information Technologies and International Development, vol.6, no. 3, Fall 2010, 1-18.
- [8] Braa, J., Monteiro, E. and Sahay, S. *Networks of Action Sustainable Health Information Systems Across Developing Countries*, MIS Quarterly, vol. 28, no. 3, 2004, 337-362.
- [9] Sheikh, Y. H. and Braa, K. *Mobilising Local Networks of Implementers to Address Health Information Systems Sustainability*, Electronic Journal on Information Systems in Developing Countries, vol. 48, no. 6, 2011, 1-21.
- [10] www.nkn.in/download.php?file=NKN_Brochure.pdf