ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 1, Issue 8, October 2012

A Study of Green ICT and Cloud Computing Implementation at Higher Technical Education Institution

Kavita Suryawanshi[1], Sameer Narkehde[2]

***Abstract*:Recently biggest challenge facing the environment is global warming caused by carbon emission. This paper provides a role of Green ICT and Cloud Computing at higher technical education, focusing on the implementation need and benefits.In this paper we have proposed cloud computing strategy and architecture of cloud computing implementation at higher technical education institutions based on the latest technologies. The study identified Green strategies and also identifies the benefits of Green ICT and cloud computing implementation at higher educational institutions.**

Keywords: **CloudComputing,Cloud Strategy, Higher Technical Education (HTE),*Green ICT (GICT).***

I. INTRODUCTION

In the current scenario every enterprise wants to implement Green ICT and cloud computing to fulfill their computing needs and social responsibilityInnovative use of ICT in teaching and learning stimulated dynamic learning environment. ICT have improved the quality of teaching and learning by providing access to a great variety of educational resources. Higher education has acknowledged in time as one of the pillars of society development. [6].Cloud computing is a new method to add capabilities to a computer without licensing new software, investing in new hardware or infrastructure or training new personnel. Applications are purchased, licensed and run over the network instead of users' desktop [1].Globalization, requirements of the students from the twenty first century and other factors are leading to pressure on universities in terms of ensuring appropriate Information Technology supports necessary for educational and research/development activities [2].The Cloud Computing implementation at higher technical education may be a solution to improve the agility and quick access to technology, with the achievement of savings at institution level [3]. Cloud has many benefits for educational institutions. Here are four to consider with cloud computing higher technical education can open their technology infrastructures to students and academicians for research advancement [3].

Generally, cloud computing could be roughly defined as provision of a new computing infrastructure or a scale out computing paradigm shifting the location of the traditional infrastructure to the Internet in order to cut costs for managing resources of hardware and software [4].As part of the evolution of cloud computing in the last two years, many renowned companies have begun to engage in the provision of cloud computing infrastructures and services. Amazon, Microsoft, Google, IBM, Sun, Dell are examples of Service Providers and Infrastructure Providers [7].Here we have defined educational cloud as the software ,infrastructure and platform data of higher technical educational institutions hosted centrally over Internet Green Information and Communication Technology is broadly understood as an initiative to encourage individuals, groups, and organization engaged in the use of ICT to consider environmental problems and find solutions to them [17]. Use of ICT in education is a cause of carbon dioxide emission, high energy consumption and hazardous waste production. These pressure led education institutions to adopt Green ICT so as to minimize energy consumption, carbon footprint, ICT waste and to reduce energy cost.

II. LITERATUREREVIEW

Supaporn Chai-Arayalert, Keiichi Nakata have reviewed the concept of Green ICT and presented a framework to analyze Green ICT strategy, practice and measurement in UK Higher Education Institutions. The study analyzed the evolution of Green ICT practices in UK HEIs based on web based data collection in 2009 and 2011 [17].

Robert C. Meuranthave conducted a study on ICT uses to go Green in institutional education at Korea. The studies have found that educational institutions seek to adopt responsible environmental practices. The study has evaluated blended learning system [16].

MarinelaMircea ,AncaIoanaAndreescuhave found out alternatives to use information technologies. The paper also provided strategies for the use of cloud solutions in universities by improving knowledge in this field and providing a practical guide adaptable to the university structures[1].

Liladhar R. RewatkarUjwal A. Lanjewar has analysed the implementation of cloud computing on web application. He also discussed the advantages of cloud

computing and issues related to cloud computing on web application [3].

Dr AshishRastogihas proposed a model based framework to implement cloud computing in E-governance. He has also discussed the various problems that have been identified in implementing the various phases of the E-governance in developing countries[6].
Amrit Shankar Dutta has provided educational cloud architecture and use of cloud computing in education. He has also suggested the benefits of cloud implementation in education[13].

MarinelaMircea has provided an approach to use the mix of SOA, BPM and cloud computing in higher education. He has presented the current state of Romanian universities regarding the implementation of integrated solutions based on the latest technologies[2].

Matthew James, Karen Card (2012) was used case study methodology to determine factors contributed to three USA universities institution's achieving environmental sustainability. The study identified six factors that were present at all three institutions [10].

Nan –Chou Chen has studied the feasibility of the adoption of cloud computing in the development of Information Systems in IT Firms in Taiwan[14].

Shahid Al Noor,F.T. Jaigirdarhas proposed architecture of cloud computing for education system in Bangladesh and discussed the impact of his proposed architecture on current education system of Bangladesh[8].

ZuqiangWu have presented constraints that hampered the development of green schools in china including outmoded conventions of educators,finance and trained teachers, inadequate environmental teaching methods and the limitations of Green school criteria. The paper also suggested strategies to foster Green schools in China [15].

III. RESEARCHDESIGN

A. Objective of Research :

1. To study the feasibility of cloud computing and Green ICT implementation at higher education.
2. To proposed cloud strategy for higher education.
3. To study cloud computing architecture with reference to higher education institutions.
4. To identify the benefits of cloud computing and Green ICT implementation at higher educational institutions.

B. Research Questions:

The research aims to answer the following research questions:

1. What is implementations status of Green ICT and cloud computing in Educational Institutes?
2. What are phases in implementation of cloud computing services at higher technical education?
3. What are benefits attained through cloud computing and Green ICT implementations?

C. Research Methodology :

The research methodology comprises a rigorous analysis of the latest research on Cloud Computing and Green ICT.

D. *Type of Data:*

Only secondary data is used. The various statistics, facts, and figures on cloud computing Articles published in national and international journal, E-journal, internet, books, newspaper etc.

E. Scope of Research:

The scope of research is limited to higher technical education institutions8.The population of study consists of faculty, student, researcher, and administrative staff of any higher technical education.

IV. CLOUD IMPLEMENTATION STRATEGIES FOR HIGHER TECHNICAL EDUCATION

In this section we discuss the cloud strategies to migrate from traditional computing structure to Cloud computing as shown in figure 1. These strategies are based on prototyping model of software engineering and includes eight phase. This is continuous improvement process till higher technical Education attained their goal [19]. Following are the phases for cloud computing implementation at higher technical education:

A. Phase 1: Form Cloud Computing Steering Committee.

This committee is formed to supervise all the activities regarding implementation of cloud computing at higher technical education. This committee is mainly consisting of the stakeholders of educational institutionslike faculties, students, researchers, administrative staff, and parents.

B. Phase 2: Develop the knowledge base about cloud computing.

Cloud computing steering committee develops knowledge base by attending seminars, conferences on cloud computing solution. The committee has a discussion with cloud computing service providers like Amazon, Microsoft, etc.

C. *Phase3: Feasibility Study*

After forming the knowledge base, there is need to do feasibility study for implementing cloud computing solutions with respect to economic concern, technical concern and reliability concern. In economicconcern, higher technical education need to consider the preliminary capital investment and ongoing cost involved in the adoption of cloud services. In technical concern, the speed of broadband and performance ofwebbased application should be improved. In reliability concern, the capability of cloud services must be audited by third parties. Service vendor must provide reliable system.

D. Phase 4: Identify Service Provider Agency

Higher technical education has to study and analyse different service provider's policies and strategies. The institution need to approach various service providers and compare their policies to match their requirements as well as analyse the

bestand optimal cloud computing solutions with minimum cost and efforts.

E. Phase 5: Develop architecture

After deciding the service provider the cloud computing architecture is formed according to the needs of higher technical education institutes for implementing cloud services for their users. The detailed architecture is explained in the next section.

F. Phase 6: Pilot Deployment

The deployment is done in iterative phase, through the continuous transition of data, services and processes towards cloud. While deploying the data, services and processes, the continuous evaluation of the cloud technology is done to benefit the higher technical education with the cloud services.

G. Phase 7: Training

After implementation it is essential to give proper training to all the service users like faculties, researchers, admin staff, and parents to get maximum advantage of using cloud services in higher technical education.

H. Phase 8: Continuous improvements.

There should be continuous improvement till educational institute get the functional cloud computing base system using live data.

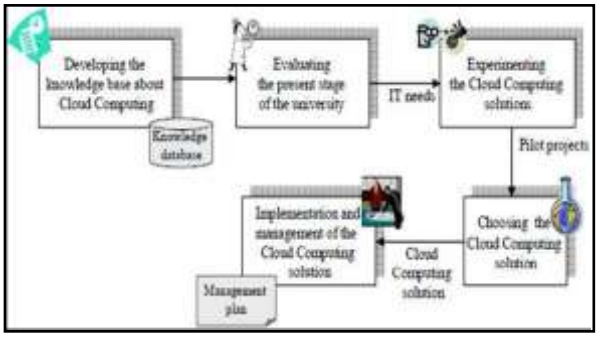

Fig 1: Cloud Strategy in higher education (Source:ICEMT 2010)

V. CLOUD COMPUTING ARCHITECTURE FOR HIGHER TECHNICAL EDUCATION

The higher technical education can use cloud computing services such as Saas, Paas and Iaas which allow users to use computer applications without having to purchase, install and run software's on their local computers or servers. The proposed architecture should be able to implement these services for the users of Higher Technical Education for carrying out their activities [19].For e.g. the administrative staff handling student related work, finance and accounting, purchasing and procurement etc. Also education, training and research related needs of students and academic staff who work especially in higher technical education. The service providers for cloud computing like Amazon, Google Microsoft, Sun, etc can provide these services in real time by managing the entire infrastructure at some remote location [14]. There are basically three types of cloud services offered in the proposed architecture of cloud computing as shown in figure 2.

A. Software AsService (SaaS)

Through Software as a service (SaaS), the software support can be provided to Higher Technical Education to meet for their users like faculties, student, administrative staff, researchers and other personals. The software provided is either very expensive or rarely found.Here we are trying to list out the various softwareservices, web portals and collaboration tools required in highertechnical education for their Faculties, Students,Researchers, Parents, Administrative staff and non-teachingstaff.

1. Software services for students

Students needs software for having student corner student information management,e-learning, live courses, online exam, software projects, placement support, training to students, computer lab etc[12]. Student Corner is provided to register them and also to utilize the services from education clouds. Educational clouds can built a virtual computing lab equipped with original licensed softwares which can be accessed by students and faculties for developing various computer applications and projects. E-learning applications and processes provide virtual education opportunities and digitalcollaboration. Educational Content is delivered via the Internet, intranet, audio or video tape, Satellite TV, and CD-ROM etc.

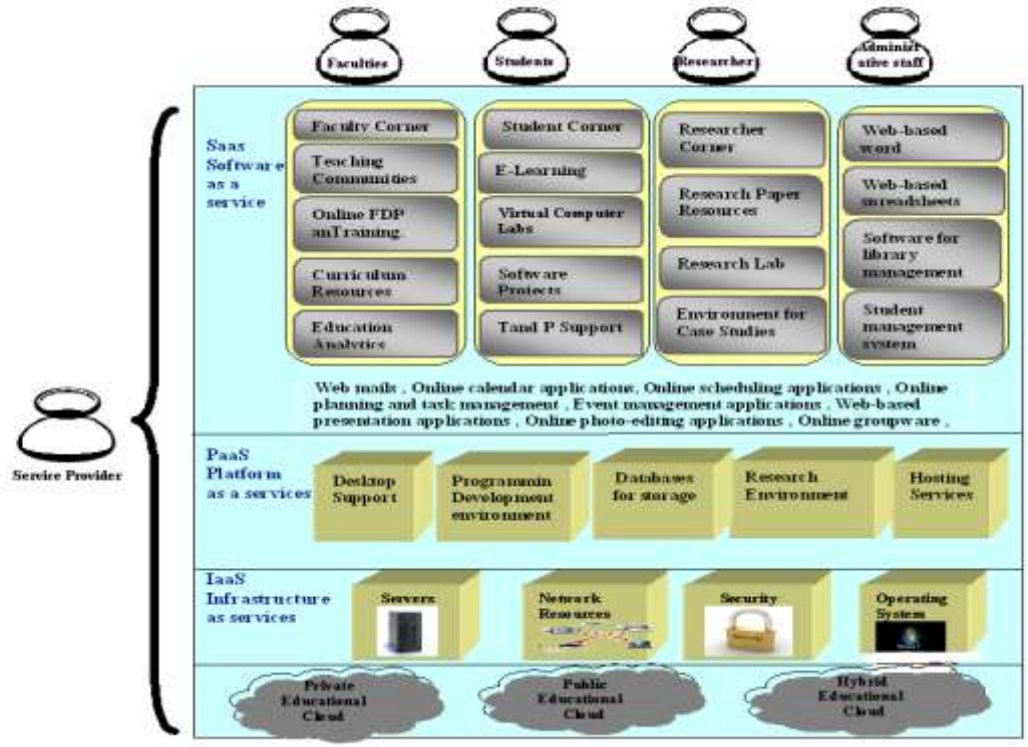

Fig. 2 The ProposedCloud computing Architecture for HTE

2. Software services for researchers and faculties

Researchers needs research paper resources, presentations, virtual research lab like Meta lab etc.The various software services can be provided to faculties for having faculty corner, curriculum resources, education analytics, online faculty development program and training.

3. General softwares services

Cooperative library collection will provide the live tutoring help on demand. It also provides Writing Lab for students to submit their articles and other forms of writing for constructive feedback .Cloud service provider can offer web portals for live webinars and web mails. The students, faculties, researchers and non teaching staff can access emails using a webmail client i.e. the Higher Technical Education itself. Computer as their webinar instructor can describe about the new technology, trading and the market around the world.Other Collaboration Tools like document management system (DMS) is very useful in academics to store electronic documents and images of paper documents like question papers, Exam Schedule, paper solutions, assignment question etc. It is usually also capable of keeping track of the different versions created by different users. It is related to digital asset management, documentimaging, workflow systems and records management systems to help and manage the documents for higher technical education institutes.

B. Platform as a service (PaaS)

The scalable architecture of the cloud can provide the platform for Higher Technical Education to serve the softwares and applications that we have described in section V (A) for their users**.** The platform requires the programming and development environment for developing various computer applications and projects in various programming languages using the different development toolkits like JDK, .net IDE etc. Desktop support is provided to secure, update, monitor, configure and troubleshoot computers from a single, web-based console without the overhead associated with installing and maintaining an on-premise management infrastructure. Separate Database storage will be required for storing the various applications, documents created and developed by the students, faculties and non-teaching staff of the higher technical education.

C. Infrastructure as service (Iaas)

The infrastructure for hardware and software configurations can be demanded from the cloud services in order to meet the requirement for running the various softwares and platforms specified above sectionV (A and B) .The servers like file server, application server for running database applications as well as the different servers like windows, Unix, Linux can be provided for hosting other services. Different operating systems can be provided to satisfy the infrastructure need of the higher technical education.

Any educational Institute can build their private institute's educational cloud over their existing computation resources [13]. Any university level hybrid educational cloud can be implemented by collaborating various institutes and colleges under that university. For e.g. University of Pune, ShriSantGadge BabaAmravati University, Nagpur University etc. can have the hybrid cloud for their colleges and institutes by combiningthe resources. Similarly the above implementation can be extended to any state level educational cloud for all the universities running under that state government policies like Maharashtra State's educational cloud, Punjab state' s educational cloud etc.In this way, the basic requirement for setting up cloud environment can be fulfil by the implementation of above specified cloud architecture.

VI. GREEN ICT INITIATIVES

Withthe increasingawarenessofenvironmentalissuesaroundtheworld, higher education organizationsareturningtogreen ICT initiativesmoreandmore. Green ICT is attracting a lot of attention in academic circles.It is also necessary to change the mindset of academic professionals and forced them to adopt GICT in their day-to-day life through emphasizing on GICT implementation benefits.SeeTable1foralistofthe initiatives obtained through secondary data.

TABLE I
FIVEGREENICTINITIATIVES

Green ICT Initiative	Green Strategies
IT Equipment Recycling	Reduces carbon footprint through proper disposal of hardware and its hazardous components.
Printer Consolidation & Reduction	Reduces the consumption of paper, ink, toner, energy, and hazardous material from printer devices and cartridges.
End-User Device Power Management (PCs, monitors)	Reduces the consumption of energy during extended idle times, overnights, etc.
Telecommuting Capabilities & Strategies	Reduces carbon emissions from employee commuting activities (cars, trains, etc.).
Remote Conferencing & Collaboration	Reduces carbon emissions from business travel (flights, car rentals, etc.)

VII. BENEFITS OF GREEN ICT AND CLOUD COMPUTING IMPLEMENTATION AT HIGHER TECHNICAL EDUCATION INSTITUTE.

A. Reduce cost

By implementing the cloud services in higher technical education, the cost of hardware configurations and software purchasing is reduced, as the whole responsibility of providing hardware and software services is of the cloud service provider. Higher technical education institute don't need to purchase the licensed softwares for a fixed period of time, instead for these services they have to pay as per theusage and they only require having the low configuration computers in their campus. GICT study is beneficial for reduction in environmental impact and power bill which is very essential for future sustainability

B. Simplicity

It is simple to use and set up all the services.So higher technical education institute don't have to worry about resource management and other hassles that come with infrastructure set up and management.

C. Reliability &Security

Network and data access are guaranteed to be reliable as they are maintained by the experts from the cloud service provider. Standard encryption and decryption has been used and there is no need to worry about the security of the applications in educational clouds.

D. Minimise hazardous ICT waste

The ICT generates large amount of hazardous waste. Hazardous ICT waste not only has impacts on people's health but also consumes space in a landfill [18].Examples of reducing ICT wastes are recyclable or reusableequipment which can extend the ICT lifecycle equipment. Therefore, HTE Institutions need to minimize hazardous ICTwaste, which is one of the objectivesof Green ICT.

E.Manpower

Green ICT sets nontoxic material in the equipment's make the worker safe from health problem and occupational hazardsBy providing the training to the users of higher technical education organization, it becomes easy for them to utilized the cloud services.

F. Collaboration and Flexibility

User of higher technical education has the universal access to projects, applications; documents so they can work collaborate through Saas.Also the cloud services are flexible to use anywhere and can be transferred to any location in case of failure or system crash.

G. Sustenance of ICT

The Government sets targets for carbon emissionsand other environmental impacts which require strictregulations. HTE Institutions should comply with the regulatorystandards for ICT procurement procedures,ICT waste, ICT-related aspects of buildings, etc. The institute cancomply with environmental laws, protocols for sustainability by way of reducing e-waste, providing healthy environment.

VIII. CONCLUSION AND FUTURE WORK

The cloud computing is gaining popularity as an inexpensive way of providing storage and software.This paper discussed the reasons why higher education institutions need to pay attention to Green ICT. In this paper we have given an analysis of cloud computing solutions and discussed the

benefits of cloud computing and Green ICT implementation at higher technical education institute. This is very cost effective and efficient as compare to traditional computing structure. Also the paper proposed cloud computing architecture for higher technical education as well as suggested cloud strategy which includes eight stage but research shows that it is continuous process till institutes attaining their goals. In future we would introduce challenges or barriers that may be encountered during practical implementation of our proposed architecture of cloud computing and green ICT practices. With the increase in the number of institutions offering higher education, green ICT and cloud computing implementation at higher technical education has become key ingredient to achieve cost effective solutions, to rent computational infrastructure, to meet occasional uses for personal, educational, research works etc.It is very much necessary to save the environment and ultimately the earth

REFERENCES

[1] MarinelaMircea and AncaIoanaAndreescu,"Using Cloud Computing in Higher Education : A Strategy to Improve Agility",IBIMA Publishing, Communications of the IBIMA, Vol.2011,[online,http://www.ibimapublishing.com/journals/CIBIMA/cibima.html]

[2] MarinelaMircea , " SOA,BPM and Cloud Computing : Connected for Innovation in Higher Education",In Proc of IEEE International conference on Education and Management Technology ICEMT 2010,ISBN 978-1-4244-8618 ,pp 456-460.

[3] LiladharRewatkar,UjwalLanjewar," Implementation of Cloud Computing on web Application",International Journal of Computer Applications ,Volume 2,No.8 June 2010,pp28-32.

[4] Lazowska, E., Lee, P., Elliott, C. &Smarr, L. (2008). "Infrastructure for Escience and Elearning in Higher Education," Computing Community Consortium. [Online], [Retrieved October 5, 2010], http://www.cra.org/ccc/docs/init/Infrastru cture.pdf

[5] Ms.ShivaniGoel, Dr Ravi Kiran , Dr Deepak Garg , " Impact of Cloud Computing on ERP implementations in Higher Education", (IJACSA) International .

[6] Dr AshishRastogi Department of Computer Science, GGU, "A Model based Approach to Implement Cloud Computing in E-Governance", International Journal of Computer Applications (0975 – 8887) Volume 9– No.7, November 2010.

[7] Gartner, Inc., Cloud Computing: Defining and Describing an Emerging Phenomenon, June 17, 2008, p. 3.

[8] Shahid Al Noor, Golam Mustafa, ShaifulAlamChowdhury, Md. ZakirHossain, FarihaTasminJaigirdar, "Proposed Architecture of Cloud Computing for Education System in Bangladesh and the Impact on Current Education System" ,IJCSNS International Journal of Computer Science and Network Security, Vol.10 No.10, October 2010.

[9] XIAO-YONGL,LI-TAO ZHOU,YONG SHI1, YU GU China," A trusted computing environment model in cloud Architecture"Proceedings of the Ninth International Conference on Machine Learning and Cybernetics, Qingdao, 11-14 July 2010.

[10] Matthew James, Karen Card, "Factors contributing to institutions achieving environmental sustainability ", International Journal of Sustainability in Higher Education, Vol.13 Issue 2, 2012, pp. 166-176.

[11] Richard N. Katz, Philip J. Goldstein,RonaldYanosky, ECAR ,Center for Applied Research,"Demystifying Cloud Computing for Higher Education"Research Bulletin Volume 2009, Issue 19, September22,2009.

[12] A Microsoft U.S. Education white paper April 2010, "Cloud computing in education Savings, flexibility, and choice for IT",[online] www.microsoft.com.

[13] Amrit Shankar data, "Use of cloud computing in education"[online available at http: //fosetonline.org/Academicmeet/CS&IT /Use%20of%20Cloud%20Computing%20in%20Education.pdf, accessed Nov. 2011]

[14] Nan- Chou Chen"A feasibility study of the adoption of cloud computing in the development of information system" [on line available at http://dagda.shef.ac.uk/dissertations/2008-09/External/Chen_Nan_Chou_MscIM.pdf, accessed Dec. 2011]

[15] Zuqiang Wu, "Green schools in China", The Journal of Environmental Education, volume 34, Issue 1, 2002, pages 21-25.

[16] Robert C. Meurant, "Facing reality: Using ICT to go green in education" communications in computer and information science, 1, volume 150, Ubiquitous computing and multimedia applications, 2011, pages 211-222.

[17] Supaporn Chai-Arayalert, KeiichtNakata,"The Evolution of Green ICT Practice: UK Higher Education Institutions Case Study", IEEE International Conference on Green Computing and Communications, 2011, United Kingdom, pp 220-225.

[18] P. James and L. Hopkinson, "Sustainable ICT in Further and Higher Education-A Report for the Joint Information Services Committee (JISC)", SusteIT, London UK, 2009.

[19] KavitaSuryawanshi,R. Choudhary,P.Naidu"An Analysis and Implementation of Cloud Computing at Higher Technical Education", International Journal of Computer Applications and Business Intelligence (IJCABI), Jan 2012, Volume 02, Issue 04, pp. 13-19.

[20] Green ICT: managing sustainable ICT in education and research, JISC Group, London, U.K., January 2009.

[21] C. R. Kothari, "Research Methodology", New Age Publication, Second Edition

Kavita Suryawanshipassed herMaster of Computer ApplicationExaminationand now pursing PhD from North Maharashtra University, Jalgaon.. She has contributed papers in reputed national and international journals and also presented papers at various conferences. She has awarded with Best Paper Award at National Conference ETIT 2010. Her research area is Green ICT and cloud computing.

Dr. Sameer Narkhedereceived his Ph.D. in MIS andMBA, MSc. (Applied Electronics). He has contributed number of papers in reputed national and international journals. He has published one book on "Challenges of Higher Education in India". He is Life member of IETE, ISTE. Presently working as a Assistant Professor, School of Management Studies, North Maharashtra University, Jalgaon (M.S.) INDIA.