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Use of cloud-based services for higher education in developing countries

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Abstract

With frequent power outages and labor issues, maintaining a server room to provide information technology (IT) related services to students and staff without any interruptions remains a challenging task in all higher educational institutes in developing countries. Although technical personnel involved in maintaining such a system know very well how difficult it is to keep the system running without hampering academic activities, often, the faculty and students are unaware of technical issues pertaining to providing such important services to the community. Prolonged power failures and red tape involved in procurement of urgent equipment have further aggravated this situation especially in state owned higher educational institutes. As a solution to overcome the above issue, we propose a cloud-based system that not only provides uninterrupted e-learning facilities to students but also hosts all IT related services such as library management, collaboration platform, human resource management, student management, etc. at an extremely low cost. Hosting all IT services in the cloud relieves the educational institute from maintaining backup generators and power supplies, air conditioners, hiring electricians on roster basis for full time monitoring of devices, cost of high-end servers to host the services and also reduceshigh energy consumption costs. Such a cloud based implementation, installed and configured with an open source operating system and application software, proves that for approximately US $170.00, we can provide all IT related services required for a higher educational institute in a developing country without any interruptions at all.

Keywords**:** *cloud services, higher education, IT services, e-learning*

Introduction

With increased opportunities in higher education in developing countries, authorities are finding it ever difficult to fund anticipated expansion in infrastructure and services. Together with a huge demand for student centered learning, a majority of higher educational institutes in these countries are opting to implement information technology (IT) based services for education such as e-learning and collaboration platforms.

The use of IT in higher education is mainly based on four rationales as given below (Tondeur et. al., 2007):

i. Social: All the students should be conversant in IT to become valuable citizens
ii. Educational: IT is considered as a supporting tool for classroom-based education
iii. Catalytic: IT is used to improve performance and efficiency of teaching
iv. Economical: Use of IT is essential for creating a skilled workforce

As such, it is evident that higher educational institutes cannot escape from implementing ICT-based learning practices and methods into the existing curricular in order to produce quality graduates who should be molded to become good citizens having relevant technical skills (Sife et al., 2007). A university planning to setup IT services to support education must take into account the three models of learning (Park 2009) as described below:

i. E-Learning: This technology is concerned with the use of electronic educational technologies for teaching and learning which reduce the geographical barriers in education between teachers and students. As all communication happens through an electronic portal, students will gain access to lecture materials from anywhere in the world at any time. Moreover, the use of a widely accepted tool such as Moodle will further enhance group participation among the students. While new educational approaches can be practiced, e-learning allow us to reach targeted individuals who are poor in grasping content from a class room-based session (Alonso 2005).

ii. Blended Learning: A blended learning environment may constitute face-to-face meetings augmented by digital tools, students undertaking independent learning activities and face-to-face interactions with teachers based on a pre-arranged schedule, delivering of curriculum using a digital platform while making face-to-face contacts, delivery of lessons using digital tools in a specific location, augmenting traditional learning with digital tools and delivery of all lesson material online together with face-to-face interactions (Osguthorpe et. al., 2003).

iii. Distance Learning: A distance learning scheme can be setup when the teacher and the learner are separated by time and distance. Such a scheme can be implemented using a central system delivering lesson material to several geographical locations using tools such as the Internet, television, radio or printed material (Chute et. al., 1998).

Providing an efficient and reliable learning atmosphere to support the above three learning models requires a comprehensive infrastructure platform of IT equipment consisting of the following:

- Servers: Often, high end servers with substantial speed, memory capacity and storage are required to serve and store online material hosted in a centralized environment.

- Backup system: Failure of a hard disk or other electronic device must not hamper services provided to the community. As such, an online backup system must be enforced not only for saved data but also for the entire system.

- High speed Internet connectivity: All online material stored in servers must be accessible to the learners and teachers via the Internet. The speed and the reliability of the Internet connection are very important at this to provide an efficient learning platform to the students. The speed of the link is dependent on the number of users accessing the system simultaneously and the size of material to be downloaded or uploaded to the servers.

- Uninterrupted power supply (UPS): When the supply of electricity is not reliable, a UPS is essential to provide a smooth and uninterrupted learning platform to the students. Often, in places where the reliability of the supply of electricity is not up to standards, students are unable to submit assignments online or access lecture material on time. Although, there is a

possible risk of the file systems, especially in Linux based system, getting damaged due to sudden interruption power together with the absence of a UPS.

- Technical personnel: Other than the required hardware, qualified support staff, including computer systems, electrical, security, must be available 24 hours a day.

As such, it is evident from the above facts that hardware devices, connectivity and man power are the key factors that decide whether the service provided by a digital platform is reliable or not.

Cloud Computing

Cloud computing refers to a large group of servers connected together and located remotely providing a centralized facility to store and access data. As seen in Fig. 1, cloud based computing facilities has grown tremendously over the past few years.

Figure 1.*Annual growth rate of public cloud services* (Anderson et. al., 2013).

The main reason for this growth can be mainly attributed to the benefits offered by cloud computing services. The major benefits offered by such a service are (Catteddu, 2010):

- Reduced costs: No capitalcosts are involved in purchasing hardware and also do not require staff to manage and maintain the systems. Energy consumption is minimized as no hardware is maintained in the premises.

- Scalability: Whenever an upgrade is required, the cloud service provider shall replace the hardware without any additional costs.

- Continuity: The service provider will take all necessary backups and ensure protection of data throughout the contract period.

- Compact learning curve: As major installation and setting up procedures are avoided, users find it convenient to adapt to the new system

Public vs Private Clouds

A public cloud is provided by a third party service provider where the general public can have access. There is no requirement to use hardware as this is provided via internet connection for pay-per-usage fee. (eg. Google Apps, Amazon AWS and Microsoft Office 365). Organizations prefer to have public clouds for its data availability and continuous uptime, on-demand capacity and inexpensive setup.

A private cloud, on the other hand, is used within an organization, often behind a firewall, where only the organizational members can have the access. For private cloud service, the particular client or the organization has to use their own hardware and software (eg. Windows Server 2008 R2 Hyper-v, System Center). The biggest advantage of a private cloud is its security and privacy than public clouds. Also, as resources and assets are controlled by the organization, the performance can be customized according to user needs. However, the major drawback of a private cloud is its high cost involving equipment, software and staff (Sumit, 2014).

Clouds in Higher Education

As far as developing countries are concerned, the main uses of cloud-based services in higher educational institutes are in the areas of:

- Collaboration: A platform to be used by students and staff to communicate, share documents and store files (eg. Google Apps and Microsoft Office 365 both offered free for educational institutes).

- Development: A facility to develop official websites of the institutes (eg. Wordpress andJoomla, open source web site development tools).

- Library management: Hosts all library functions including digital content (eg. Koha which is an open source software).

- Virtual learning environment: A learning environment where delivery of lecture notes and lesson material are carried out online. Also, this environment supports conducting online assessments as well as submission of assignments through a web portal (eg. Moodle, a widely used e-learning platform).

- Web conferencing: Universities in developing countries often encounter lack of qualified academics to deliver specific lessons to the students. In such cases, it is required to obtain the services of an academic from another institute located far away through a web conferencing platform (eg. Big Blue Button, an open source web conferencing system).

- Student information service: A service to store and retrieve all students' information such as personal data, examination results, time tables, courses, etc. (eg. Fedena, an open source university management software). This service must be available to administrators, faculty and students accessible from both within and outside the institute.

- Quality information portal: Quality plays a vital role in higher education in developing nations. Among the membership of the Asia Pacific Quality Network (APQN) (150 members from 55 countries), many quality assurance good practices are being practiced but stakeholders/users in APQN are in different geographical location. Therefore, it is difficult to access quality information physically that are on paper. Thus, a quality informational portal can be established in the cloud for the benefit of members as well as to improve the

information accessible to various society groups, including students and employers of a higher education institute.

The cloud-based approach to host a quality information portal will benefit all higher educational institutes located in the Asia Pacific region in promoting good practices and peer-to-peer learning across the region, improving links between APQN and its member agencies and increasing trust in education systems across the region by providing reliable information about quality assurance processes and standards

Risks of in-house computing in developing nations

In addition to the costs associated with maintain a server room within a higher educational institute in a developing nation, there are certain operations risks, as given below, to be looked into:

- Labor issues: there is a risk of the system going down and even a total disaster during labor unrests (eg. trade union actions, etc.). Moreover, technical personnel involved in maintaining the servers, over a period of time, start demanding better wages and facilities. At this stage, the institute may have to concentrate on solving the dispute rather than actually spending time developing required IT services. This scenario is further aggravated if the system is hosted in a Linux environment in which specialized expertise to maintain the servers is required and often difficult to hire for a nominal monthly wage.

- Electricity supply: Electricity is unpredictable in developing nations (Kshetri, 2010, Greengard, 2010) and dependability on standby generators cannot be guaranteed as tedious procedures are involved in the purchase of fuel, especially in state owned educational institutes. Once common issue faced by students and staff is during a sudden power failure at night, eg. lightening, all the systems may go down and as a result, students are unable to submit an online assignment scheduled for that day.

- Cost of Internet bandwidth: Hosting IT services required for a higher educational institutes needs high Internet bandwidth because thousands of students may access these services from outside the institute. As serving content to the outside requires high bandwidth, a leased circuit is the most suitable technique to connect the services to the outside. Leased line tariffs in developing nations are costly compared to those of developed countries such as US, Japan, etc. (Goswami, 2005).

- Security: The location housing the system must ensure both physical and network security of the equipment and data. For this purpose, the location must be secured not only from theft but also from natural as well as man-made disaster such as fire. Security guards must be hire to protect the physical properties while additional costs are involved to install security cameras.

- If the institute belongs to government, tedious procurement procedures will delay certain urgent repairs to the system. Often, there is no fast-track method to procure items required urgently in such events.

As seen from the above facts, maintaining a system inside the premises creates huge financial as well as service issues to a higher educational institute where the major activity is delivery of lesson material over digital media. The factors that must be considered to serve a community of thousands of users without any glitches, as such, outruns the actual expected service form the resources available. Hence, providing IT services using equipment located

in-house is an arduous task in terms of both technical and financial aspects to any higher educational institute located in a developing nation.

Table 1 gives the minimal hardware resources required with approximate costs in order to setup and install the above services in-house in a typical higher educational institute in a developing country having approximately 10,000 students. This table compares the costs involved between single installations (container-based) and virtualization, i.e. when the services are installed in separate machines and virtual machines are used to run the services. As seen, virtualization may offer a considerable cost saving compared to container-based hosting of IT services. In addition to the costs given in Table 1, we must take into consideration running costs of maintaining a server room to host these services. Salaries for staff, electricity and routine maintenance may incur a monthly cost of approximately US $ 3,000.00.

As such, it is evident that, irrespective of the hosting environment (i.e. whether container-based or virtualization), the cost of having computing facility in-house is extremely high in terms of affordability in a higher education setup of a developing country.

Table 2 shows a cloud-based dedicated server with an approximate cost of US $ 130 per month that can be used to provide the required IT services to the above university community. The only commitment the institute needs to make is the monthly payment which can be done by credit card. All the hassles encountered, as mentioned before, to maintain a server room in the premises can be thus avoided by utilizing such a cloud-based service with a dedicated server that gives all the freedom to the institute to concentrate more on development activities rather than the above issues. It is worth noting the high-end configuration of the dedicated server with substantial amount of memory, hard disk capacity and processing speed offered to the customer in the cloud is promising compared to what is being offered in the open market. Hence, moving to the cloud instead of container-based in-premises implementation is definitely cost effective, reliable and efficient.

Table 1. *Equipment required to host services in a higher educational institute.*

Servers	**Approximate cost (US $)**	
	Container based hosting	**Virtual hosting**
Web site hosting	4,000.00	20,000.00
Email service	8,000.00	
E-Learning system	7,000.00	
Library management	5,000.00	
Student information	8,000.00	
Network equipment and racks	4,000.00	2,000.00
Uninterrupted power supply units	1,000.00	500.00
Backup genarator	8,000.00	6,000.00
Total	**45,000.00**	**28,500.00**

Table 2.*Specifications for a cloud-based dedicated server.*

Description	**Specifications**
Processor speed	Intel Xeon E52620
Memory capacity	32 GB
Hard disk capcity	1TB with RAID 1
Speed of Internet link	100 Mbps
Monthly data transfer	Unlimited
Number of IP addressees	5
Support	24/7/365
Monthly cost	**US $ 130.00 per month**

Figure 1 shows the topology of a cloud-based implementation of IT services within a higher educational institute. A CentOS based Linux environment is used as a dedicated server. The learning management system, web site, library management, student information service and a quality information portal are all hosted in the dedicated server. A collaboration platform (this can be either Google Apps or Microsoft Office 365) is provided to the students and staff to interact through electronic media. According to this setup, the institute has to maintain only the Internet link connecting the collaboration platform and the cloud.

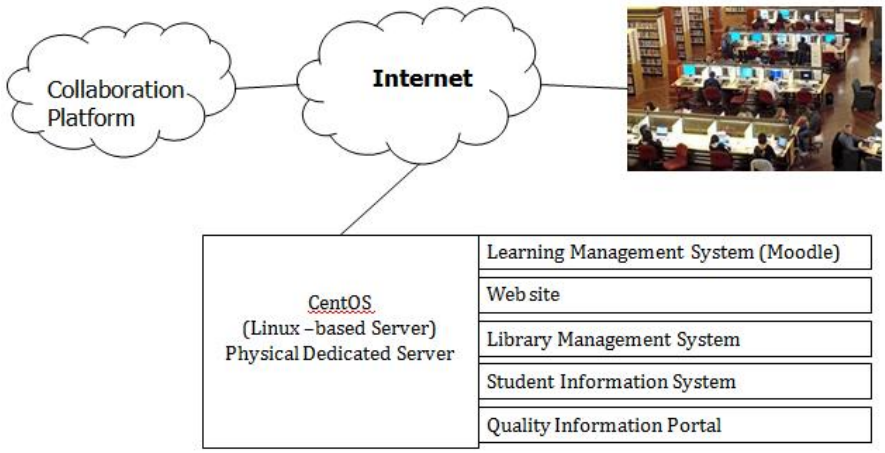

Figure 2.*Linux based dedicated server is used as a cloud hosting solution.*

Conclusion

There is a great demand for higher educational opportunities in developing nations and providing efficient and reliable IT services to an ever increasing student and staff is a primary responsibility of any university. As any IT service depends on external factors such as reliable supply of electricity, technical personnel, Internet bandwidth, etc, providing an uninterrupted service to the community becomes a major task for decision makers in the institute. A cloud-based approach is the ideal solution to provide uninterrupted IT services to

thousands of users in a higher educational institute at a very low cost because it does not involve huge capitol or running costs.

As the data is located outside the institute, it is up to the managemet to decide what is most important, i.e., whether the physical location of data or providing uninterrupted IT services to the community.

References

Tondeur, Jo, Johan Van Braak, and Martin Valcke. "Curricula and the use of ICT in education: Two worlds apart?." *British Journal of Educational Technology* 38, no. 6 (2007): 962-976.

Sife, Alfred, Edda Lwoga, and Camilius Sanga. "New technologies for teaching and learning: Challenges for higher learning institutions in developing countries." *International Journal of Education and Development using ICT* 3, no. 2 (2007).

Park, Sung Youl. "An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning." *Educational technology & society* 12.3 (2009): 150-162.

Alonso, Fernando, Genoveva López, Daniel Manrique, and José M. Viñes. "An instructional model for web-based e-learning education with a blended learning process approach." *British Journal of educational technology* 36, no. 2 (2005): 217-235.

Osguthorpe, Russell T., and Charles R. Graham. "Blended Learning Environments: Definitions and Directions." *Quarterly Review of Distance Education* 4, no. 3 (2003): 227-33.

Chute, Alan G., Burton Hancock, and Melody Thompson. The McGraw-Hill Handbook of Distance Learning: A``how to Get Started Guide"for Trainers and Human Resources Professionals. McGraw-Hill, Inc., 1998.

Anderson, E., L-L. Lam, C. Eschinger, S. Cournoyer, J. M. Correia, L. F. Wurster, R. Contu et al. "Forecast overview: Public cloud services, worldwide, 2011-2016, 4Q12 Update." Gartner Inc., February (2013).

Catteddu, Daniele. "Cloud Computing: benefits, risks and recommendations for information security." In Web Application Security, pp. 17-17. Springer Berlin Heidelberg, 2010.

Kshetri, Nir. "Cloud computing in developing economies." ieee Computer 43, no. 10 (2010): 47-55.

Greengard, Samuel. "Cloud computing and developing nations." Communications of the ACM 53, no. 5 (2010): 18-20.

Goswami, D, “Comparative Analysis of Leased Line Tariffs”, LirnEAsia, (2005).

Sumit Goyal, “Public vs Private vs Hybrid vs Community- Cloud Computing: A Critical Review”, International Journal of Computer Network and Information Security, no. 3 (2014): 20-29.