

Prospectives of Cloud Computing Applications in Professional Education

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Abstract: Among the many computing methods, the emergence of “Cloud Computing” attained prominence in its evolution and applications in various domains viz., IT industry, institutions, universities and organizations. Cloud computing application in education is vital as it offer many advantages in terms of its affordability, accessibility by the users or clients. Many educational institutions are constrained in facilitating the required computer hardware and software infrastructure facilities in view of high costs, need of specialists, space, maintenance, operation, investment, etc. Moreover, the time to time up-gradation of hardware and software also pose severe limitations in possession, operation, up-keeping and maintenance. Adapting cloud computing envisage cost effectiveness, optimization of resources like space, power, services, investment costs, etc., by the users or clients. As a novel concept, cloud services are offered by cloud service providers to the clients as per the needs and requirements, which facilitate the end users expectations. The clients in utilizing the cloud services may be educational institutions, universities, R&D organizations, industries and others. The paper brings out cloud computing applications in professional education, which will be viable, flexible, user conducive in fulfilling the organizational needs and requirements for its functioning and operation. Cloud services have accessibility by the users using gadgets like notebooks, PDAs, ipads, mobile phones, etc., that makes it flexible, convenient and user friendly as it can be utilized anytime and anywhere. Cloud services in the domain of education are helpful in teaching and learning process like e-learning, web-based learning, etc. Cloud services can bring more awareness among the academia, R&D organizations, industries, institutions and universities to facilitate dynamism in information processing, data base management, knowledge acquisition and its management. Discussion and conclusions are drawn in emphasizing the effective adaption of cloud services for the benefits of all users.

Key words: software as a service; elastic cloud computing; processing clouds; storage clouds; application clouds

1. Introduction

Cloud Computing (CC) refers to the delivery of scalable IT (Information Technology) resources over the Internet, as against to hosting and operation of these resources locally, such as on a network of any company, firm, organization, institution, university, college, etc. (www.educause.edu, 2009). The resources inclusive of applications and services as well as infrastructure on which it operate. By developing IT infrastructure and services over the network, an organization can purchase resources on need basis and capital costs on software and

hardware can be avoided, which result in savings on these aspects. With cloud computing, IT capacity can be adjusted quickly to accommodate the changes in demand towards infrastructure requirements from time to time.

Cloud computing solutions appear to be widespread and growing in higher education in focused areas such as student e-mail, enhanced reliability of IT services and access to IT functionality (www.educause.edu, 2009). The cloud computing is becoming an adaptable technology for many organizations with its dynamic scalability and usage of virtualized resources as a service through the Internet (Tuncay Ercan, 2010). The cloud computing is an excellent option for educational institutions which have financial constraints in operating their information systems effectively without incurring costs towards possession of computers and network devices. Universities and established educational institutions can avail cloud computing applications rendered by the service providers, which enable their own users/students to perform activities related to academic and in general (Tuncay Ercan, 2010).

2. Emergence of Cloud Computing

In conventional or traditional enterprise the IT departments fore-cast the demand for IT applications, capacity and invests time and money to develop the required resources as in-house or purchase them from the manufacturers and operate them as in-house augmentation. In case of cloud computing, institution or organizations procure IT services from external providers and the various internal users and departments access these resources over the Internet. For instance, e-mail is a vital IT operations of an institution can be obtained from different sources of service providers. Cloud services in case of huge e-mail services of an organization/institution can be provided by a large university or consortium including storage and processing requirements.

Cloud computing facilitate IT organizations with basically different model of operation that takes the benefits of web applications and networks and the increasing interoperability of computing systems to provide IT services. The cloud computing providers specialize in particular applications and services and this expertise makes them to efficiently manage upgrades and maintenance, backups, disaster recovery and fail over functions. As a result, users of cloud services may find increased reliability and reduction in costs of operation, maintenance and services. Cloud computing accommodates the fluctuations in quantum of work such that cost is incurred based on the utility and use during the peak and off-peak times. The cloud computing induce IT organizations and service providers to enhance standardization protocols and processes which makes cloud computing model to interoperate properly and efficiently. Cloud computing's scalability is the vital benefit to higher education viz., research projects that needs vast storage or processing capacity for a limited time (Tuncay Ercan, 2010). Some firms have built data centers near the sources of renewable energy such as wind farms and hydroelectric facilities in promoting the 'Green IT' concepts.

The cloud computing generate certain concerns regarding privacy, security, data integrity, intellectual property management, adult traits and other issues. For any institution or organization these issues are very sensitive, complex and complicated in the context of inter-institutional cloud initiatives and provide integrity and confidentiality makes cloud computing as long-term viability in terms of its usage and applications.

The emergence of cloud computing as viable choice for a number of IT services emphasizes the penetration level of the Internet and infrastructure maturity which was not there a few years ago. The cloud computing application and its adaption will emerge in the near future in all the domains of IT services unless no breach of confidentiality is maintained by the cloud providers. The benefits of cloud computing is becoming more tangible, vital policy and technology issues must be ironed out to reach its optimum level in its usage. The cloud computing

offers for educational institutions to increase its operational efficiency and prevents the delays due to lack of facilities in any functional operation in its requirements and necessities. The operation of a cloud environment requires IT leaders and staff to develop integration between in house and outsourced services and mastering a different model of IT budgets. The cloud computing services facilitate inter-institutional collaboration as they can be easily accessed by students and faculty at disparate institutions. Despite the potential security risks posed by cloud services, it is perceived that cloud services offer more security compared to on-campus solutions in case of complexity involved for an effective IT security effort at the institutional level (www.educause.edu, 2009).

3. Developments in Cloud Computing

Cloud computing is of recent concept in computing techniques and it is defined by the 'National Institute of Standards and Technology' (NIST) as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Sclater N., 2009). Multiple research for various application by different agencies are in progress to assess the benefits on implementation of cloud computing. Higher education institutions like universities, research organizations, professional education institutions etc., have to invest huge sum to possess server, software and other hardware to keep pace with the developments as well as in case of voluminous database management. Adopting of a cloud environment lessen the burden of investment required on these infrastructure apart from maintenance, establishment and service cost. Cloud users are envisaged to a flexible type of utility based on the needs and necessities like "rent-by-the-hour" or "pay-as-you-go" concept to hire computing and storage horse-power such as "Amazon Elastic Cloud Computing" (EC2), which provides realizable computing capacity in the cloud (Sclater N., 2009). In a cloud service, the elasticity like EC2 provides a researcher with the advantage to rent exactly the needed capacity with the ability to adjust it on need basis that becomes economical and viable compared to in-house servers (Sclater N., 2009). Moreover, cloud computing offers significant savings against the establishment costs like air-conditioning, electricity, manpower, space maintenance and other over-heads, etc., which are required for in-house computing facility. In addition, complexity can be reduced in the network and software management if cloud is adapted. The three types of cloud services viz., "process clouds", "storage clouds" and "application clouds" offer benefits to institutions of professional and higher education (Sclater N., 2009). The cloud computing has the potential to play a significant role in education transformation. In the context of education, cloud computing function as "service" that is described as a type of software function or capability, which is accessible anytime and anywhere via a compute device such as laptop, desktop, handheld PDA or cellphone (Banerjee P., 2009). Some of the common examples of cloud services are Google Apps, Amazon EC2, Salesforce.Com, Wikis, blogs and e-mail.

The e-Portfolio service is an example of a cloud service that can be delivered to the members of an education community. A student portfolio is a valuable record of a student's academic life, which includes items such as assessments, evaluations, assignments, homework, classroom projects, performance, attendance, etc. Students' e-portfolios or digital portfolios provides more advantage compared to paper based records in terms of accessibility by the concerned viz., students, teachers, parents, administrators and the government departments. The academic head can use e-portfolio to monitor the performance of the students in order to initiate necessary measures for the academic progress. Using cloud computing, the e-portfolio service can be designed as a

standalone service on a laptop without connectivity or can run from local institution servers or from service providers via Internet.

4. Significance of Cloud Computing Services

The inclusive definitions of cloud computing includes tools like basic web services, service-oriented business applications, SaaS (Software as a Service), virtualization, managed hosting-technologies, etc. (Samir Tout, William Sverdlik and Gerald Lawyer, 2009). Information technology in higher education is skeptical about cloud services and it has earmarked its difference compared to service bureau application hosts, grids and sourcing techniques. The first prime difference is technical that are the maturing of standards, the widespread availability of high-performance network capacity and emergence and diffusion of virtualization technologies, which are combining to enrich the sourcing options available. The IT trends in every sphere is broadband connections, Google search, Facebook community, Wiki, etc., likely to follow the idea of cloud-based services in their enterprise roles. The consumerization of IT along with the emergence of SaaS and other web-based services options will derive the movement of enterprise services both external that is in the form of high-end resources able to replace conventional in-campus based services and internal services in a multitude of commodity tools and environments, directly available to the users. Options for cloud services are based on the users, enterprise economic trends, developer communities and system integrators who are all drifting away from the traditional software services and the vendors are working towards cloud enabled services and products.

Use of clouds for computing tasks envisages a revolution in IT similar to the evolution of web and e-commerce. The prospective and effective cloud services on-demand infrastructure, application and support services is important as a possible means based on the following factors (Samir Tout, William Sverdlik and Gerald Lawyer, 2009):

- Minimizing the capital and total cost of IT in higher education
- Enabling the transparent matching of IT demand costs and funding
- Scaling IT
- Promoting further IT standardization
- Accelerating time for marketing by reducing IT supply bottlenecks
- Countering or channelizing the adhoc consumerization of enterprise IT services
- Increasing access to deficit or limited IT talent
- Generating a pathway to a five 9s (99.999 % availability of services) and 24×7×365 environment
- Enabling the sourcing of cycles and storage powered by renewable energy
- Enhancing interoperability between distinguished technologies and within institutions

The commercial scope for cloud services tends to cluster around agility, economics and the size of the in-house IT organization. The use of cloud services solves the real business problem in a very cost effective way.

5. Cloud Computing Applications in Education

Currently cloud computing is one of the new technology trends with broadband Internet, fast connection and virtualization will have a significant impact on teaching and learning environment. In the present days, cloud platforms such as “Microsoft” and “Google” are facilitating free services to students and staff at educational institutions which include e-mail, contact lists, calendars, document storage, creation and sharing of documents

and the possibility to create websites (Amazon, 2009). Many of the applications of cloud computing being in the areas of new technologies like intelligent structure, smart environments viz., utility computing, smart data centers, pervasive computing, automation, virtualization and intelligent networks, etc. (Robert Fogel, 2010).

The cloud computing works as a service on demand criteria and it is a new business model based on new technologies like virtualization–SaaS and broadband Internet. The recent new applications and elastic scalability with higher computing parameters lead to outsourcing of hardware setup, IT administration of the resources related to IT. A survey on cloud computing applications that has been carried out by Gartner is shown in Table 1, which indicates that cloud computing being predominantly used in the domains of financial services and business among the number of applications (Tuncay Ercan, 2010).

Table 1 Cloud Computing Applications in Different Domains (Tuncay Ercan, 2010)

Sl. No	Name of the Domain	Cloud Computing Usage in %
1	Financial Services	12
2	Business & Management Services	10
3	Manufacturing	10
4	Telecommunications & Equipements	9
5	Government	7
6	Insurance	6
7	Professional Services	5
8	Specialized Services	5
9	Oil, Gas and Electric	5
10	Schools and Educational Services	4
11	Food /Retail/HealthCare	4,4,4
12	Media/Military and National Security	3,3
13	Chemical and pharmaceutical	3
14	Freight Services/Energy Management/Membership Organization	2,2,2
15	Commercial ,Physical Research	1
16	Others	4

Many technologies that were previously expensive or not available are now freely available with a web browser. This is the fact for all web sites, blogs, video sharing, music sharing, social sharing, collaboration software, editing/presentation and publishing and computing platforms in the “cloud” (Tuncay Ercan, 2010). In the professional world, the trend of discovering and using technologies in our personal life is known as “consumerization”, which implies that the required services should be demanded and consumed. The education system should pave way for this kind of trend that would enrich the student’s/user’s technology enabled education and minimizing the capital investment by academic institution in providing the facilities and provisions. Educational curriculum management should identify and leverage emerging technologies that are to be the cost-effective and feasible, accessible by all the users who are students, academic and professionals. The required software and hardware are being facilitated by cloud rather being provided in the institutions or organizations. The needed facilities are cheap access devices, web browser, broadband connectivity and wireless hotspots (Tuncay Ercan, 2010).

Adaption of cloud computing in education otherwise in general requires a combination of consistent performance, versatile results, service guarantees, transparency and plans for contingencies (Samir Tout, William

Sverdlik and Gerald Lawyer, 2009).

- Cloud computing applications in higher education imply the following significant inferences (Samir Tout, William Sverdlik and Gerald Lawyer, 2009):

- Cloud computing exhibit great viability, which is conceived with great build-up.
- Policy and control issues would slow cloud adaption in higher education
- Out sourcing services of cloud computing requires proper account keeping of its usage
- Different types of computing activity of cloud services will operate different rates of speed (campus or company services, policy process and control and R&D activities)
- Certain services are preferably outsourced using cloud computing viz., business availability computer labs for students, computing cycles, cooperative collection development, desktop support, data storage, e-mail, ERP, identity services, IT help desk and telephony.
- IT services firms are venturing as the cloud services providers.
- Any new services will be outsourced in comparison to prevailing in-house services
- Adopting cloud services will pave way for falling in line with the developments and advancements of IT enterprise.

6. Cloud Computing Applications in E-Learning

The e-learning systems require many hardware and software resources. The nature of Internet is constantly changing depending on its applications and use such as to read webpages to an environment that allows end users to run software applications. Interactivity and collaboration have become the keywords of the new web content. There are several cloud computing services providers that support educational systems viz., Amazon, Google, Yahoo, Microsoft, etc. (Paul Pocatilu, Felician alecu and Marius Vettrici, 2009). The cloud computing consists of three layers as indicated (Paul Pocatilu, Felician alecu and Marius Vettrici, 2009):

- (1) Infrastructure as a service (IaaS)
- (2) Platform as a service (PaaS)
- (3) Software as a service (SaaS)

Based on the requirements the clients may select one or more services as listed above. Hardware devices viz., PCs, notebooks, mobile phones, PDAs or any other similar equipment or software applications viz., web-browsers (Google, Chrome) can be used as a cloud client. The clients are accessing the required processing capacity from the data center using the client's applications. The quality of the service becomes a vital factor for the success of cloud computing. Cloud computing is no way different from grid computing as it create a virtual processor by joining together a cluster of computers. The objective of a grid computing architecture is to solve large tasks by using the advantage of concurrency and parallelism, while the cloud is focused on collaboration (Paul Pocatilu, Felician alecu and Marius Vettrici, 2009).

Cloud computing become popular as it moves the processing efforts from the local devices to the data center facilities. Hence, any device like an Internet connected by phone could able to solve complex equations by simply passing the specific arguments to a service running at the data center, which delivers the results in a very short time. In these conditions, the security of data and applications becomes a prominent issue. Cloud computing is broadly accepted due to its significant advantages or benefits as listed below (Paul Pocatilu, Felician alecu and Marius Vettrici, 2009):

- The cost is low or even free in some cases and very little costs for hardware up gradation.
- For some applications (spreadsheets) it can be used in the off-line mode and when the client goes back to online a synchronization process is refreshing the data.
- Facilitate the required results or output using Internet with minimum software requirements.
- Minimum software and hardware requirements (mobile phones) can be used as cloud clients.
- Absolutely no maintenance and up gradation costs are to be met by clients.
- It helps companies and individuals to avail resources from the cloud and to work smartly.

The major players in the domains of cloud computing are Google, Microsoft, Amazon, Yahoo and hardware vendors like IBM and Intel. The Google cloud is as major service provider in cloud computing and it can be accessed by “Google Apps” intended to be software as a service suite dedicated to information sharing and security. “Google Apps” covers messaging (Gmail, Calendar and Google Talk), collaboration (Google Docs, video and Sites) and security (e-mail security, encryption and archiving) (Paul Pocatilu, Felician alecu and Marius Vetrici, 2009). Microsoft is developing a new Windows platform known as “Windows Azure” that can run cloud applications. In 2006, Amazon extended its Amazon Web Services (AWS) suite with a new component known as ‘Amazon Elastic Compute Cloud (EC2), which permits the users to rent from Amazon processing power to be used to run their own applications (Richard Katz, Philip Goldstein and Ronald Yanoskyv, 2009). The cloud is elastic as the user can start, stop and create the virtual machines through the web service.

7. Pros and Cons of Cloud Computing

Cloud computing is visualized as the next wave of IT for individuals, institutions, companies, organizations and governments. The vast provision of IT capabilities at a low cost offer many attractive opportunities apart from reduction in operational costs. Cloud computing becomes the base for drastic business innovation and new business models in effective utilization of IT as a tool (www.weforum.org, 2010). It is expected that the cloud computing will provide enormous potentials in terms of job opportunities, higher productivity, accelerated innovation, growth and development of emerging economies of the world. Great gains of cloud services can be achieved in health care, education and other societal issues (www.weforum.org, 2010). The issues concerned with cloud computing services are data security, maintaining privacy of people and organizations. Many service providers aim for provision of proper regulatory balance between customer protection and business efficiency.

Potentials of cloud computing in offering benefits to organizations, industries and institutions are as listed (www.weforum.org, 2010):

- Accelerate dramatically in the development of new products and services, which enable the professionals around the world to collaborate more effectively in using powerful and economical computer resources.
- Enhancing the ability of organizations to mine the data related to customers’ changing needs and competitors moves in the business arena.
- Facilitate emerging economies to attain higher level of technological development by providing more immediate and affordable access to next generation applications, tools and infrastructure.

The concept of cloud computing has been adapted rapidly and widely by the IT industry and the studies indicate that the potential benefits derived by the organizations, industries, institutions and firms are (www.weforum.org, 2010):

- Dramatically accelerating the creation of new products and services by the companies and also to collaborate

more effectively and access more powerful and economical computer resources.

- Enhancing the ability of organizations to mine the data for vital information such as customers' trend, needs and competitors moves in the market.
- Access to IT for any size and quantum of information or data by the organizations.
- Envisage to higher level of technological development by providing more immediate and affordable access to next generation applications, tools and infrastructure.

Some of the immediate and long term benefits offered by cloud services are listed as shown in Table 2 (www.weforum.org, 2010).

The disadvantages associated with cloud computing are:

- The Internet connection speed may affect the overall performance.
- In the long run the data center service fee may be more expensive.
- The service quality is crucial and the need of the back-ups is critical about data security.

Table 2 Immediate and Long-term Benefits Offered by Cloud Computing

Sl. No	Immediate Benefits	Long-term Benefits
1	Increases IT flexibility	Accelerate innovation
2	Improve IT/Business process efficiency	Transform R&D in Science and Technology
3	Reduced IT costs	Contribute to GDP growth
4	Better services for clients	Generate new jobs /business
5	Lower cost of failure	Empower individuals
6	Improves Government's effectiveness	Improve competitiveness
7	Productivity improves	Transform education
8	Enhance collaboration	Promote sustainability
9	Facilitate business agility	Even out the fluctuations
10	Increases user experience	Provide advanced opportunities

Several hurdles are prevailing in adaption of cloud computing that is security, performance and availability, integration with in-house IT and customizability and cost factor (Sclater N., 2009). These factors are briefed as given.

(1) Security: There are several concerns related to security in the implementation of cloud computing. The primary concern of cloud adaptors being the security of enterprise information. Data placed in storage clouds can be sent to different countries which all have different data privacy laws and hence the sensitive and confidential data may be exposed to unauthorized and unconcerned individuals. These concerned risks put the cloud adapter in back-foot in its usage. This aspect warrants enough trust from the vendors along with strict "Service Level Agreements" (SLAs) in order to safeguard information and prevention of pilferage or intrusion of data apart from theft of data.

(2) Integration: Integration of cloud security controls with university-wide departments and their various applications is a challenging task in the adaption of cloud. The integration of cloud computing should ensure in maintaining the required level of information assurance for various applications including their confidentiality and availability.

(3) Performance and Availability: For research and development tasks require extensive computing power and such performance is to be ensured by the cloud service providers. Also the availability of the required level of services shall be guaranteed for timely delivery of research results is a concern for the firms and organizations.

(4) Cost: It is a significant factor that has to be solved by the service providers and the users.

(5) Safeguards against Disaster: Cloud service providers have to assure the provision for data safeguards against disasters and calamities due to any force majeure in ensuring customers' trust and confidence.

8. Discussion

Scientific and technological innovations and advancements have been progressed stupendously with the use of computers in almost in every domain, which helped to make rapid strides in their respective areas. With the advent of computers, numerous computing techniques have been evolved from time to time that all brought developments in various fields of technology and its applications helped in many ways to achieve modernization. Among many computing techniques that are in use, the recently developed 'cloud computing' has become popular as client's friendly in terms of availing the needed service, up gradation of infrastructure, maintenance, etc., and constraints regarding operation, maintenance are taken care by the service providers. Cloud services are catching up in many areas including in the field of education. The paper highlights the significant applications of cloud services in professional education that brings lot of advantages in information processing and data base management, e-learning, etc. Cloud services in education will make the education as affordable, cost effective, resourceful, dynamic and conducive for self-learning. Cloud computing service is provided by service providers like "Google Apps", "Amazon", "Yahoo", "Wiki", etc., are accessible by the users, institutions, organizations and universities. Cloud services can be effectively used for students' data base management, academic activities, R&D, information processing, etc. Cloud services concept eliminate the constraints from the users side as the required up gradation of infrastructure is taken care by the service providers and economize the operation and maintenance costs of systems. Cloud services will help the developing countries in the field of education in terms of cost, accessibility to information, etc. Knowledge dissemination by cloud services will reduce competitiveness among learners enable the required knowledge exploration, propagation of education and virtual learning techniques and methodologies.

9. Conclusions

(1) Cloud computing is a viable option for bringing the transformation in education of communities and the nations where cost of education is climbing. The entire spectrum of knowledge can be made available to the teachers, students and to educators that can be accessed anytime, anywhere from any device like laptop, PDA, ipad, mobile, etc.

(2) Cloud based education, which can be accessed world-wide, would lower cost and simplify the delivery of educational services.

(3) Cloud computing enables the learners worldwide to acquire the skills and training required in any domain for successful performance and achievement in terms of career development and professional knowledge acquisition.

(4) Cloud computing envisage to access the various application platforms and resources through the web pages on demand quickly and economically.

(5) Outsourcing of e-mail service and eliminates of software license costs, hardware costs and maintenance costs, etc., provide greater flexibility and affordability in terms of cost to the university, institutions, organizations and firms.

(6) Security issues with cloud computing is still a prominent concern when information or data is of highly confidential apart from problems and constraints with its applications and service level agreements.

(7) Cloud computing offers considerable benefits in improving the IT applications and infrastructure at higher education institutions in terms of R&D and consultancy, etc.

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