Cloud Computing – The Magical New ICT-Paradigm for Academic xLearning[1]?

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***Abstract*— The current economic crisis is leading many industrial and commercial organizations as well as institutions of higher education to seek ways of lowering expenditures, including those derived from efficiently utilizing information and communication technologies (ICT). A major means of achieving this objective is through Cloud Computing, which is based on advanced technologies such as grid computing, virtualization capabilities, storage systems, and high bandwidth. The term Cloud Computing refers to computer services and resources obtained through the Internet rather than from local private platforms. Offering many technological and economic advantages, Cloud Computing is rapidly becoming the new computing paradigm for delivering ICT services. Cloud Computing consists of three layers: hardware-infrastructure, platform and applications. The hardware-infrastructure layer is associated with computing power, grid computing, virtualization and storage. The platform layer refers to the operating system, application-development environments and databases. The third layer consists of applications. Gmail and Facebook are probably the best-known Cloud Computing applications. Over the last years, the College of Management Academic Studies (COMAS), has implemented, as a first stage, six different Cloud Computing applications. Cloud Computing implementation was found to be fast, cost-effective, and efficient. Users report considerable satisfaction with the systems. Despite its many benefits, there are some barriers challenging the adoption of Cloud Computing, such as security risks and the integration of the organization's systems. In this paper we describe the basics of Cloud Computing and current trends. We then illustrate the different advantages and, disadvantages in implementing such core xLearning[1] systems as: LCMS (Learning Content Management System) and Virtual Classroom, Meeting and Conference System (VCMCS) for synchronous eLearning.**

***Keywords*— Cloud Computing, eLearning, Grid Computing, Virtualization**

I. CLOUD COMPUTING AT A GLANCE

The term Cloud Computing is relatively new but the concept behind the phrase has been around for some time [1]. Such cloud applications as software-as-a-service, for example, are not particularly new [2] and over-the-net applications have been available for many years. "Hotmail" or Web hosting sites are well-known Cloud Computing applications par excellence.

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[1] eLearning, mLearning, uLearning, etc.

While there are many definitions of Cloud Computing [3], the simplest one defines Cloud Computing as obtaining computer services/resources from the Internet rather than from local individual platforms. Cloud is a known metaphor for describing the Internet. Other terms related to Cloud Computing are [4]:

- Software-as-a-Service (SaaS) - software application services obtained from the Internet.
- Platform-as-a-Service (PaaS) - the user utilizes the Internet as a computing platform, rather than having his own individual, localized platform.
- Infrastructure-as-a-Service (IaaS) - a computing infrastructure based on the Internet rather than local servers.

According to Merrill Lynch, the annual global market for Cloud Computing in 2012 will surge to $95 billion and the main players will be: Microsoft, Google, Amazon, and Yahoo. CA Technologies Chairman and CEO William E. McCracken said in CA World, May 2010 – "In recent months, many ask me whether I think that Cloud Computing is the IT future. I always reply that I don't think. I'm sure"[2]. Marc Andreessen, founder of Mosaic and Netscape has noted that the "The cloud is a smart, complex, powerful computing system in the sky that people can just plug into“[3].

Cloud computing is based on three main layers. The first layer is the hardware infrastructure consisting of two pillars. The first pillar is the CPU which lies at the heart of grid computing and which is the combination of computer resources from multiple administrative domains to achieve a common goal. Grid computing, an essential element in Cloud Computing [5], is what makes it possible for Google and other search engines such as Yahoo, Bing and others to instantaneously access the world's knowledge. The other major element of CPU power is virtualization [6]. The ability to have multiple servers dynamically using the same CPU makes the cloud very affordable. With virtual servers there is no need to buy a dedicated server for every application. In order to configure a virtual server, all that is required is an allocation of memory and CPU power. The main advantage of virtualization is that it is dynamic. In a typical environment, every physical server serves 10 virtual servers. The second pillar of the hardware infrastructure is storage. One of the goals of using the cloud is access to a working storage system that is smart and reliable and offers high performance and advanced management tools [7]. Today's storage systems have these capabilities. Firms offering Cloud Computing services can easily manage to expand and provide smart backup capabilities, allocating it to different clients along with data protection and security. The demand for storage systems is growing every day. Since storage suppliers are in strong competition with each other, the storage price is dropping and becoming more reasonable for Cloud Computing suppliers.

The second layer, the platform, consists of three components: the operating system; the application development environment; and the database.

I. The operating system (OS). Today's technology makes it possible to use a computer that doesn't have an OS at all. The OS is obtainable from the cloud and can become a Cloud Computing service as well.

II. The application development environment such as .Net technology from Microsoft ("Azure" the new name for the Cloud Computing foundation by Microsoft) or Sandbox by Google.

III. The database may be an open source DBMS (data base management system) like MySQL or a proprietary database like Microsoft SQL Server or Oracle.

The third cloud layer is devoted to the applications themselves such as customer

[2] *http://investor.ca.com/releasedetail.cfm?ReleaseID=470122*

[3] *http://www.businessweek.com/magazine/content/08_18/b4082059989191.htm*

relationship management (CRM), like Sales*f*orce and project management software, like Clarizen. While these entail a payment, others such as Gmail, Google and Microsoft Live are free. The variety of applications obtained over the cloud is growing exponentially.

There are two main models for working with the cloud. The first is free of charge. This model usually has two implications: a. the user is exposed to commercials; b. there is no service agreement between the user and the supplier in terms of support, service, backup, data security etc. The most famous examples of this model are Gmail and Facebook. If one deletes some information by mistake there is no support by the provider and there is almost no way to recover the data. With the second model, the user has to pay for the service. When using the Sales*f*orce cloud application for instance, the user can choose between three different service level agreements (SLA), (1) basic support; (2) premier support; and (3) premier support with administration. Charges to the user are based on the level of service. The user feels much more secure knowing there is an SLA with the supplier.

II. TRENDS IN INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) THAT MAKE CLOUD COMPUTING POPULAR

The current economic crisis has lead many industrial and commercial organizations as well as institutions of higher education to seek ways of lowering expenditures, including those associated with information and communication technologies. A major means of achieving this objective is through Cloud Computing and the implementation of such advanced technologies as grid computing, virtualization capabilities, storage systems, and high bandwidth.

Some of the features that are driving the expansion of Cloud Computing are:

Bandwidth – Institutions of higher education use more bandwidth than many commercial organizations. Students and professors share advanced learning materials in video and audio formats that demand high bandwidth, both for downloading and uploading. High bandwidth technology is now available at a reasonable cost.

24/7 computer services - Faced with the necessity of providing services on a 24/7 basis, institutions of higher education require a means of maintaining this highly intense IT activity. IT professionals, however, are expensive and institutions of higher education can't usually pay what IT professionals can earn on the open market. Cloud Computing offers a way of significantly reducing IT maintenance costs.

Total Cost of Ownership (TCO) - In the face of the economic crisis which is plaguing most western economies, higher education has been hard hit and many institutions are discovering that Cloud Computing is a highly attractive alternative by lowering total cost of ownership. Devoting scarce resources to maintaining their own server is a luxury that companies are unwilling to pay for and many large companies have now moved their entire server room to the cloud. The result is that firms have more office space and no longer need to worry about the costs of electricity, UPS systems, air conditioning systems, restricting access etc.

Green IT has recently become a world issue. In keeping with its green goals, the College of Management Academic Studies (COMAS) received a "Green Campus" award from the Israel Ministry of Environmental Protection. The use of Cloud Computing strengthens the green IT trend by saving, for example, energy and space.

Pay-Per-Use [2] – When a computer service is installed on a dedicated server, the payment is for 100% of the server capacity, while the CPU is idle most of the time. In Cloud Computing, payment is only for the actual use and not for total available resources. This significantly reduces an organization's costs.

Scalability - The need for scalability is another major Cloud Computing benefit. Once a server has been installed, its full capacity is final and fixed. Using Cloud Computing eliminates this problem by enabling an organization to acquire software and services as it develops and grows without any capital investment.

Risks - According to the Standish Group less than 50% of the ICT projects are considered successful (meeting projected specifications, timetable and budget). The use of Cloud Computing can reduce the risks of IT projects.

Smartphones and mobile devices - The convergence between the laptop and the smartphone has changed the equation between the client and server [8]. The weight is moving towards the server. On the one hand, the smartphone client has less CPU power, memory, disk space and screen resolution than a desktop or a laptop. On the other hand, the need for computing services 24 hours a day 7 days a week, for any client, anywhere in the world, is pushing IT departments to exploit the cloud.

Economies of scale - Cloud vendors (like EC2 by Amazon) obtain the advantage of economies of scale by purchasing and maintaining the bulk of their hardware at much lower prices than other organizations.

The phobia among CIOs of using applications based on open source code, when there is almost no external support responsibility for the code, has almost vanished. In the past, CIOs avoided using open source applications. Today, Linux or MySQL are common among most organizations. The mix of using open source applications side-by-side with everything as a service (X-A-A-S) is an important factor in driving Cloud Computing rapid growth.

Implementation and assimilation – Using Cloud Computing shortens and reduces the timetable and costs of implementing and assimilating new information systems.

TCP/IP communication protocols have become the standard for all major applications and devices, from smartphones up to mainframes and super computers. The Internet and Cloud Computing are based on TCP/IP.

Who can benefit from Cloud Computing?

In general, everybody needs Cloud Computing, from the individual to large organizations. The number of users signed up with Facebook (more than 500,000,000), Gmail (more than 150,000,000) or Hotmail (more than 250,000,000), demonstrates the popularity of Cloud Computing services.

However, Cloud Computing is not necessarily right for all applications. The question as to what specific kind of application is best served still has to be researched. For small organizations, without any need for unique applications and who probably don't have an IT department, Cloud Computing is the right choice. The cloud offers a variety of applications and services such as: email, hosting of the organization's websites, open office collaboration with others, calendar collaboration, data protection, firewall, backup, maintenance, and various management and sales tools. All of these applications and services are available on a 24/7 basis and can be accessed from any place around the world. However, large organizations should consider carefully the use of Cloud Computing for their core business systems because of the potential risks (see Section IV below). General applications like project management and office systems, including document management, email, calendar, contacts, social networks and more, can be easily replaced by cloud applications and services.

III. RISKS AND DISADVANTAGES

There are major potential risks and disadvantages in using Cloud Computing:

Losing management control [9] of applications or infrastructure

Loss of control on the backup and maintenance activities time slot for core business activities. Choosing the right time slot minimizes interfering with daily business processes.

Losing data protection management (security and reliability – Google Buzz4, Facebook5) and the loss of privacy [9].

Dependence upon outer services.

Integration between local and Cloud Computing systems.

Implementing Identity Management (IDM) using one main WEB Portal entrance for the users - Single Sign On (SSO) is complicated. Operations like synchronizing usernames, passwords, new users, disabling / delete old users become much more complicated,

Data interchange between applications – Service Oriented Architecture (SOA) -- is much more difficult with the cloud. Users and management are expecting a smooth interface between all applications. This task is also more difficult to implement in a cloud environment.

Risk management using Cloud Computing is much more complicated.

Taking into consideration all the above risks and difficulties indicates that Cloud Computing needs further analysis and examination.

4Google Buzz Has A Huge Privacy Flaw
http://www.businessinsider.com/warning-google-buzz-has-a-huge-privacy-flaw-2010-2#ixzz0oaWG7fEt
5Facebook Hit by Five Security Problems in One Week
http://www.pcworld.com/article/160545/facebook_hit_by_five_security_problems_in_one_week.html

IV. OUR EXPERIENCE

The College of Management Academic Studies (COMAS) founded in 1978, is the first non-subsidized, not-for-profit academic institution in Israel. COMAS is the largest college in Israel, with over 12,000 students, over 31,000 alumni, more than 1000 academic staff and over 300 administrative staff. In national examinations, COMAS students rank in the top percentiles in their scores and professional success. The College's seven schools and departments offers 12 degrees in Business Administration; Law; Media Studies; Economics; Computer Science; Behavioral Sciences and Interior Design. The COMAS campus is located in Rishon Lezion, the fourth largest city in Israel, just south of Tel-Aviv. Built on 40 acres, long range plans call for eleven buildings including dormitories, a faculty club and a sports center. The ICT infrastructure is based on more than 1300 workstations (PCs) and 150 servers, 80 of them virtual.

About ten years ago we had to decide upon two main eLearning systems. The first was a simulation business game for the “Business Game” course; the second was a platform for delivering synchronous eLearning courses.

“Business Game” is an interdisciplinary course that is obligatory for all undergraduate students during their last year of studies [10] at the School of Business Administration

The integrative approached used in this course enables students to gain managerial skills and practice and to develop a broad-minded approach to diverse commercial and financial operations such as accounting, marketing, finance, HRM, manufacturing, resource planning, international activity and more. Decision-making processes and team work are gained through the activities of a simulated management board of a commercial firm.

Simulation software constitutes the technical core of the course. This software integrates student decisions and outputs detailed reports and performance indicators. Students use various analytical and deduction tools (some computerized) in order to make their decisions.

The original system that we used was on FORTRAN language and was unstable and difficult to maintain. We began looking for a new system that would fit our needs. After reviewing different alternatives, we were faced with deciding on one of two systems. The first we could purchase and run on our own servers. The second was available only over the Internet (Cloud) on American servers. At that time the Internet connection at COMAS was slow and unreliable, so the computer steering committee decided to purchase the first system and allocate the proper resources and professionals to run it. We are still using this system.

The second system that we had to choose was a platform for delivering synchronous eLearning courses following an academic decision to start delivering such courses [11]. We evaluated some platforms. Some could be run internally on our servers, and others were available only as a service on external servers (SaaS). The preferred alternative was Interwise ECP - Enterprise Communications Platform. It was originally developed and produced by an Israeli firm – Interwise. The firm was later bought by AT&T and the original software is now marketed under the name of AT&T Connect6. AT&T Connect combines voice conferencing, Web meetings, eLearning, Web seminars / broadcasts, and recordings in a single, integrated, IP-based solution that delivers enterprise-class security, reliability and scalability. AT&T Connect is a combined Web, video and voice conferencing system that is mainly used by companies to conduct meetings online. It is used by more than 1 million users in approximately 20 countries around the world. Our decision to use this system was based also on the large technical infrastructure (IaaS) that is needed to deliver synchronous courses. We signed an SLA with Interwise that included 24 hour technical support for both students and professors. The main reason for choosing a “cloud” solution at that time was the vast technical infrastructure and the technical support needed.

Cloud computing is becoming more and more popular among institutions of higher education [2], [4] and like other institutions of higher education COMAS is attempting to more efficiently exploit its resources. Among the major steps it has taken in recent years to lower ICT costs is to utilize the Cloud Computing concept. Presently six out of 29 central applications at COMAS are based on Cloud Computing: conference registration; decision follow-up; project portfolio management; customer relation management (CRM) for community relations; CRM for donor relations; and the AT&T Connect for synchronous eLearning.

Excluding AT&T Connect, these applications were chosen for five reasons: 1. They are not core applications. 2. There was no advantage in installing these applications on local servers. 3. It was much cheaper to get these applications over the cloud. 4. Shorter implementation timetable. 5. The risk to data security was low.

The Cloud Computing projects were successful. The implementation and assimilation were fast (ranging from a few days to several few weeks), cheap [3], efficient, and effective. Satisfaction was high among COMAS users. Following the remarkable success of the Cloud Computing projects, the COMAS ICT steering committee decided to give priority to implementing new systems using Cloud Computing, and to examine, at the same time, the migration of current systems to Cloud Computing.

6 http://uc.att.com/ ; http://en.wikipedia.org/wiki/AT%26T_Connect

V. CONCLUSION AND IMPLICATIONS

Cloud computing is here to stay. The global economic crisis and the pressure to lower costs are causing the ICT market to move to Cloud Computing. Although Cloud Computing is not a new concept, it is rapidly gaining popularity. The advanced technologies of grid computing, virtualization technology, storage systems, Cloud Computing platforms and bandwidth are accelerating the phenomenon. Cloud computing fits everyone needs: organizations of various size as well as individuals. Institutions of higher education as well as other organizations are increasing their use of Cloud Computing. However the risks involved in Cloud Computing, primarily related to data protection and security, are very important issues that must be addressed.

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Further information about Cloud Computing services:

- Microsoft Cloud services - http://www.microsoft.com/cloud/
- Google Cloud services - http://www.google.com/apps/intl/en/business/index.html
- Amazon (EC2) Cloud services - http://aws.amazon.com/ec2/
- CA Cloud services - http://www.ca.com/us/cloud-solutions.aspx
- IBM Cloud Services - http://www.ibm.com/ibm/cloud